Federal Court Cour fédérale

Date: 20240607

Docket: T-126-19

Citation: 2024 FC 871

Ottawa, Ontario, June 7, 2024

PRESENT: Mr. Justice McHaffie

BETWEEN:

TEKNA PLASMA SYSTEMS INC.

Plaintiff / Defendant by Counterclaim

and

AP&C ADVANCED POWDERS & COATINGS INC.

Defendant / Plaintiff by Counterclaim

JUDGMENT AND REASONS

Federal Court Cour fédérale

TABLE OF CONTENTS

Para.

II. Introduction

III. Issues Common to the ’502 and ’236 Patents

IV. Canadian Patent 3,003,502

V. Canadian Patent 3,051,236

> The scope of patent protection must not only be fair, it must be reasonably predictable. A patent is, after all, a public instrument issued under statutory authority which may result in severe financial consequences for its infringement. The scope of its prohibition should be made clear so that members of the public may know where they can go with impunity.
>
> *Free World Trust v Électro Santé Inc*, 2000 SCC 66 at para 41.

I. Overview

[1] The *Patent Act*, RSC 1985, c P-4, requires the claims of a patent to define "distinctly and in explicit terms" the subject-matter of the invention for which an exclusive privilege or property is claimed. Patent claims perform a vital public notice function. Since the monopoly granted by the claims is enforceable through various monetary and other remedies, it is important the public know what is prohibited, so it knows what it can and cannot do without infringing the patent.

[2] Although the claims must define the subject-matter distinctly and in explicit terms, they need not be perfect or a model of lucidity. They are addressed to a reader versed in the art who wants and tries to understand them in a purposive way and to give them a meaning that is fair to the inventor and the public. A lack of clarity or potential competing constructions is not alone fatal. It is therefore a rare case where the Court will conclude that the claims of a patent cannot be meaningfully understood.

[3] This case raises these important principles in the context of two patents relating to the production of reactive metal powders. These powders, made up of tiny particles of reactive metals such as titanium or titanium alloys, are particularly useful in additive manufacturing,

sometimes termed “3D printing,” in which three-dimensional objects are made by depositing, joining, or solidifying a material layer by layer.

[4] AP&C Advanced Powders & Coating Inc and Tekna Plasma Systems Inc are both manufacturers of metal powders that are used in, among other things, additive manufacturing. AP&C owns the patents in question, Canadian Patent 3,003,502 [the ’502 Patent] and Canadian Patent 3,051,236 [the ’236 Patent]. AP&C alleges that Tekna’s production of titanium alloy powders infringes the patents; Tekna alleges that the patents are invalid and that, in any case, it does not infringe them.

[5] The ’502 Patent and the ’236 Patent are closely related. They share common inventors and an identical disclosure, but have different claims. Central to the claims in each patent is the concept of a *depletion layer* at the surface of particles of reactive metal powder. Each of the claims of the two patents includes, as an essential element, the formation of a *depletion layer* or a system configured to control the formation of a *depletion layer*. The meaning of the term *depletion layer*, and the ability to determine whether a powder particle has a *depletion layer*, is therefore central to the patents and to the disputes in this action.

[6] The term *depletion layer* is not one that is generally used in the field of powder manufacturing. As AP&C’s counsel aptly put it, it is not a term of art but a “term of patent,” coined by the inventors. What it means must therefore be gleaned from the patents themselves, read and construed by the skilled reader in light of their common general knowledge and in accordance with the various principles governing patent construction.

[7] Based on my review of each patent as a whole, the evidence filed, including the reports and testimony of each party's experts, and the parties' arguments, I conclude that with the exception of a few claims in the '236 Patent, it is impossible for the skilled reader to know or determine whether or not a powder particle has a *depletion layer* within the meaning of the patents' claims. Neither the claims nor the disclosure of the patents provide the reader with the ability to understand and assess whether a particle has a *depletion layer*, and thus whether a given process or system reads on the claims or not. In the words of Justice Binnie cited above, the public reading the patents simply cannot know "where they can go with impunity."

[8] I therefore find that despite the Court's general disinclination to find a patent claim ambiguous, all of the claims of the '502 Patent and most of the claims of the '236 Patent are invalid for ambiguity.

[9] In doing so, I reject AP&C's proposed construction, in which the existence of a *depletion layer* in a subject particle is determined by conducting a comparison of the oxygen concentration profile of the subject particle to that of a particle made without *additive gas*, another element of the claims of the '502 Patent and most claims of the '236 Patent. AP&C argues this approach is set out by the inventors in the disclosure of the patents and provides an objective method to assess whether a particle has a *depletion layer*.

[10] I disagree. The disclosure of the patents does not instruct the reader to undertake the comparison AP&C proposes. Nor do the claims, which require a different comparison in the case of the '502 Patent, and either no assessment method at all or a completely different method in the case of the '236 Patent. AP&C effectively seeks to read its comparative method into the

disclosure before then reading it into the claims. This is not a sound or justifiable approach to patent construction. Notably, the approach that AP&C proposes is not one that its own expert suggested would be understood from the claims of either patent when he first construed them.

[11] A few of the claims of the ’236 Patent set out explicitly what a *depletion layer* is and when a powder particle does and does not have one. These claims are not ambiguous and I reject Tekna’s utility and overbreadth arguments with respect to them. These claims are valid.

[12] AP&C does not assert that Tekna infringes any of the valid claims of the ’236 Patent. The issue of validity is therefore effectively determinative of this matter. The ambiguity of the claims also makes it difficult to assess the question of infringement in the alternative, since the very problem is that it is impossible to tell whether a process or system falls within the scope of the claims. Nonetheless, AP&C’s evidence relating to infringement is flawed. AP&C does not show that Tekna’s powders have a *depletion layer* by comparing them to the patents. Nor does it compare them to the AP&C powder samples that were tested in the patents, or even to samples of other Tekna powders. Rather, AP&C seeks to prove that certain of Tekna’s powders have a *depletion layer* by comparing them to other samples of AP&C’s products, which it purports to use as positive and negative controls.

[13] This approach is inconsistent with the principle that infringement is assessed by evaluating the impugned product, method, process, or system against the claims of the patent, and not against the patent owner’s product. Indeed, AP&C’s apparent inability to demonstrate infringement by reference to the patents and their claims without conducting a separate comparison to its own product simply highlights the ambiguity in the claims. I am also not

satisfied that the fundamental assumption underlying AP&C’s infringement evidence—that the samples it used as positive controls have a *depletion layer* while the negative controls do not—is justified or supported on the evidence or with reference to the patents.

[14] For these and the more detailed reasons set out below, I conclude the ’502 Patent is invalid and is not infringed by Tekna. Most of the claims of the ’236 Patent are similarly invalid and none of its claims are infringed.

[15] Tekna’s action seeking declarations of invalidity and non-infringement in respect of the ’502 Patent is therefore granted. AP&C’s counterclaim seeking declarations that Tekna has infringed the ’502 Patent and the ’236 Patent is dismissed. Tekna’s “counterclaim to counterclaim” seeking declarations of invalidity in respect of the ’236 Patent is granted in part. If the parties are unable to agree on costs, they may make submissions in accordance with the schedule set out at the end of these reasons.

[16] I conclude this overview by commending counsel both for the manner in which this case proceeded to trial and for the manner in which the trial was conducted. Counsel co-operated admirably with respect to logistical and scheduling matters, including when unexpected difficulties arose in pre-trial scientific testing, requiring an adjournment of the trial. Both sides worked to ensure the matter was put before the Court on a reasonably streamlined basis, focused on the merits, although a substantial number of issues remained in dispute. The Court expresses its thanks to both teams of advocates, each of whom were excellent. I also express my regret and apologies to the parties for the length of time between the completion of trial and the issuance of this judgment.

II. Introduction

A. *The Patents at Issue*

[17] The ’502 and ’236 Patents are members of a patent family: the ’236 Patent issued from a divisional application based on another application that was in turn a divisional from the ’502 Patent. The two patents therefore share a filing date (October 27, 2016); a publication date (May 4, 2017); and a priority date based on a United States patent application (October 29, 2015). They also share identical disclosures, except for their paragraph numbering: owing to an unexplained empty paragraph at the beginning of the ’502 Patent, the paragraph numbers in the disclosure of the ’502 Patent are one higher than those of the equivalent paragraph in the ’236 Patent.

[18] The difference between the two patents lies in the particular processes and systems claimed in their respective claims. The two patents were also issued on different dates: the ’502 Patent issued on January 8, 2019; the ’236 Patent on September 22, 2020.

[19] As discussed in considerably more detail below, most of the ’502 and ’236 Patents relate to processes for manufacturing metal powders through gas atomization. In gas atomization, a metal source such as a wire is melted and subjected to a high velocity flow of gas that breaks the melted metal into liquid droplets, which then cool and solidify as solid powder particles. Some claims of the ’502 Patent relate to a spheroidization manufacturing process. In spheroidization, a similar process of heating, melting, and cooling is used to improve the sphericity of powders created by other methods, such as milling. These spheroidization claims are not asserted as

infringed by AP&C, although they are covered by Tekna’s invalidity arguments. Some claims of the ’236 Patent relate to atomization systems rather than processes.

[20] When metal powders are produced through gas atomization or spheroidization, the resulting powder particles vary in size, and might range from less than 1 μm to over 100 μm. The particles of various sizes are typically separated, by sieving or other methods, into subsets with different particle size distributions, a process known as classification. Powders with different particle size distributions are beneficial for different industrial applications. Specific particle size distributions can depend on desired applications, but the parties generally referred to “fine” powders as having a particle size distribution of approximately 5 μm to 25 μm; and “medium” powders having a particle size distribution of approximately 20 μm to 53 μm.

[21] The processes and systems claimed in the two patents are said to improve the “flowability” of the resulting powders. As the word suggests, the flowability of a powder is a measure of its ability to flow, that is, to behave like a fluid. Flowability is an important attribute of metal powders used in industrial applications, including additive manufacturing.

[22] At a high level, the atomization or spheroidization processes claimed in the ’502 Patent involve using a mixture of gases in which an *additive gas* is present, which forms a *surface layer* on the metal powder comprising two layers: a *first layer* or *depletion layer*, with atoms of the metal and atoms or molecules of the *additive gas*, and a *second layer*, which is a *native oxide layer*. The *first layer*/*depletion layer* is claimed to be *deeper and thicker* than the *native oxide layer*, and a given particle size distribution of the resulting powder has a given flowability.

[23] The claims of the ’236 Patent similarly involve atomization processes or systems involving the formation of a *depletion layer*, although the claims vary as to whether they include reference to an *additive gas*, defined flowability parameters, and/or a *native oxide layer*.

B. *The Parties and the Action*

[24] Tekna is based in Sherbrooke, Quebec. It was created in 1990 to commercialize plasma torch technology developed by professors at the University of Sherbrooke. A plasma torch is a device that uses energy to heat gases to a very high temperature at which most of the atoms in the gas become ionized, with the electrons separated from the nuclei. This ionized gas is referred to as plasma. Plasma has different properties than matter in the solid, liquid, and gaseous states. It is therefore sometimes termed the “fourth state of matter.”

[25] Tekna originally focused on the development and manufacture of plasma systems and components, including plasma torches. These systems were built for use in a variety of applications, including the synthesis of nanopowders (with particles in the range of 50–100 nm) and spheroidization. In 2009, Tekna increased its focus on the production and commercialization of metal powders, establishing production facilities in Sherbrooke and in France. Tekna was acquired by a Norwegian investment firm, Arendals Fossekompani, in 2013. After this acquisition, Tekna sought to expand its presence in the market for titanium alloy powders for use in the growing additive manufacturing industry. It began a research and development project known as the Tekna Atomization Process [TAP] project in late 2013 and began atomizing titanium alloy wire in 2014. Tekna currently has five plasma torch atomization reactors in Canada producing metal powders.

[26] AP&C and its affiliates have been manufacturing and selling plasma atomized metal powders since 2005, with a focus on titanium and titanium alloy powders. Its production facility in Boisbriand, Quebec, has been in operation since then, and it opened a second in St-Eustache in 2017. Between the two facilities, AP&C operates 15 reactors for powder production, as well as a research and development reactor. In 2014, AP&C was acquired by Arcam AB, a Swedish public company, which was in turn acquired by a division of General Electric.

[27] Tekna and AP&C are competitors in the market for metal powders produced by plasma atomization. Shortly after the ’502 Patent issued in early 2019, Tekna brought this proceeding as an impeachment and non-infringement action pursuant to section 60 of the *Patent Act*. AP&C counterclaimed alleging infringement of the ’502 Patent. When the ’236 Patent later issued, pleadings were amended to add allegations of infringement and invalidity of that patent. Two other patents owned by AP&C were also previously at issue in this action, but the parties resolved their disputes with respect to those patents. The parties also resolved their disputes regarding three patents owned by Tekna, which were the subject of another proceeding (Court File No T-1769-19) that was to be heard concurrently with the trial of this matter but was discontinued. As a result, only the ’502 and ’236 Patents are now at issue.

[28] This action was bifurcated on the consent of the parties. This first liability phase of the proceedings addressed issues of construction, infringement, and validity of the ’502 and ’236 Patents, as well as the availability of the prior use exemption under section 56 of the *Patent Act* and AP&C’s entitlement to certain remedies, if any.

C. *The Lay Witnesses*

[29] At trial, the Court heard evidence from four witnesses from Tekna: **Dr. Richard Dolbec**, Director of Emerging Technologies and IP Management; **Éric Bouchard**, Director of Plasma Systems Products and Senior Advisor; **Jean-François Carrier**, Product Line Manager for Tekna's powder products; and **Patrick Lemay**, former Vice President of Human Capital and Organizational Transformation. They described Tekna's history, business, the TAP project, and Tekna's atomization manufacturing systems and processes, including the changes made over time to improve those processes. These included efforts to meet clients' oxygen content specifications and flowability requirements and to address technical issues arising as changes were made to its systems.

[30] The Court also heard evidence from **Dr. Frédéric Larouche**, Chief Technology Officer of AP&C and one of the inventors of the '502 and '236 Patents. Dr. Larouche described AP&C's business and its atomization manufacturing processes, changes made to improve those processes, and in particular the various steps and developments at AP&C that resulted in applying for and obtaining the patents.

[31] There were few significant or material controversies regarding the factual aspects of the evidence from the lay witnesses. For the most part, the evidence of these witnesses was not central to the issues that are determinative of this case, namely the construction, validity, and infringement of the '502 and '236 Patents. In particular, Tekna formally admitted that in at least some cases, its processes met all of the elements of the claims asserted by AP&C other than those related to the *depletion layer*. As a result, the evidence from Tekna's lay witnesses was not

necessary to establish those elements of the claims, although they did provide context for Tekna's processes and their development. The evidence from Tekna's witnesses was relevant to its argument that it did not infringe AP&C's patents by virtue of subsection 56(1) of the *Patent Act*, because its processes after the claim date of the patents were the same as they were before. However, my conclusions on other issues render it unnecessary to address Tekna's subsection 56(1) argument.

[32] Dr. Larouche's evidence provided general context regarding the industry and the background to the claimed invention, as well as some aspects of AP&C's infringement analysis, as discussed below. It may also have been relevant to certain validity issues; however, these were either not pursued by Tekna or not determinative given my conclusions on other issues. As an inventor, Dr. Larouche's evidence regarding the invention or his intentions is not relevant to the construction of the patents: *Free World Trust* at paras 61–66; *Bombardier Recreational Products Inc v Arctic Cat, Inc*, 2018 FCA 172 [*Bombardier (FCA)*] at paras 22–23, 51.

D. *The Expert Witnesses*

[33] Patents are addressed to a person skilled in the art or science to which they pertain, so the Court must read, understand, and assess a patent from the perspective of that person: *Patent Act*, ss 27(3), 28.3; *Whirlpool Corp v Camco Inc*, 2000 SCC 67 at paras 53–54; *Free World Trust* at paras 31(e), 44. This notional addressee is an individual or team who has the ordinary amount of knowledge incidental to a particular trade and is thus often termed the person of ordinary skill in the art [POSITA] or the skilled reader: *Whirlpool* at paras 70–71, citing *Consolboard Inc v MacMillan Bloedel (Sask) Ltd*, 1981 CanLII 15 (SCC), [1981] 1 SCR 504 at p 523.

[34] Prior to trial, the Court was profoundly unlearned in the art of manufacturing metal powders. The parties called five experts to assist the Court by providing their expertise in the relevant fields of endeavour. Collectively, they helped put the Court in the position of being able to perform in a knowledgeable way its task of identifying the POSITA and assessing how they would read and understand the patents: *Whirlpool* at para 57.

[35] Tekna called two expert witnesses. **John Barnes** was Tekna’s primary expert with respect to the construction, validity, and infringement of the ’502 and ’236 Patents. Mr. Barnes holds a Master of Science in Metallurgical Engineering from Purdue University and has worked in additive manufacturing and metal powder production for over 25 years. This work has included working for manufacturers and government agencies in the areas of metals technology, metal powder production, and additive manufacturing; contributions to international standards organizations on additive manufacturing technology standards; and consulting and training in these areas. He is a named inventor on a number of patents in the field of metals technology, and speaks and writes frequently in the area, including on the subject of titanium alloys and metal powders. Mr. Barnes is currently an Adjunct Professor of Materials Engineering at both Carnegie Mellon University and the Royal Melbourne Institute of Technology University.

[36] Mr. Barnes was qualified, without objection from AP&C, to give expert evidence as a materials and process engineer with an expertise in metal powder production, processing, and characterization, and additive manufacturing. Mr. Barnes authored an initial report on construction, validity and infringement, dated October 15, 2021 [Barnes First Report]; a responding report on construction issues dated February 12, 2022 [Barnes Second Report]; and a

reply report, dated September 8, 2022, addressing AP&C’s expert reports on non-infringement [Barnes Third Report].

[37] **Jeffrey Shallenberger** gave evidence with respect to a particular analytical technique referred to in the ’502 and ’236 Patents, namely a type of Secondary Ion Mass Spectrometry [SIMS] known as Time-of-Flight Secondary Ion Mass Spectrometry [ToF-SIMS or TOF-SIMS]. Mr. Shallenberger holds a Master of Science in Materials Science & Engineering from Pennsylvania State University, and has over 30 years’ experience in materials characterization, particularly surface and interface analysis. In various roles with private and academic institutions, Mr. Shallenberger has been involved in materials testing and surface analysis, using a wide variety of analytical techniques, and has published frequently in these areas. He is currently Associate Director of the Materials Characterization Laboratory at the Millennium Science Complex at Penn State.

[38] Mr. Shallenberger was qualified, without objection from AP&C, to give expert evidence as a materials scientist with an expertise in materials characterization, including surface and interface analysis and analytical techniques, for example, SIMS, X-ray Photoelectron spectroscopy [XPS], and Auger Electron Spectroscopy. Mr. Shallenberger prepared two reports: a first report addressing the scientific principles and shortcomings of ToF-SIMS, dated October 15, 2021 [Shallenberger First Report]; and a reply report responding to AP&C’s experts on these issues and on the ToF-SIMS testing of metal powder samples, dated September 12, 2022 [Shallenberger Second Report].

[39] AP&C called three experts. **Dr. Javad Mostaghimi** addressed the construction, validity, and infringement of the ’502 and ’236 Patents. Dr. Mostaghimi obtained a Ph.D. in Mechanical Engineering from the University of Minnesota in 1982. After a post-doctoral fellowship and a brief position in industry, Dr. Mostaghimi has held various academic positions of increasing seniority, including the title of Distinguished Professor in Plasma Engineering at the University of Toronto. He is currently a Professor in the Department of Mechanical & Industrial Engineering at UofT, where he is also the director of the Centre for Advanced Coating Technologies. Dr. Mostaghimi’s primary research areas relate to thermal plasma, including thermal spray coatings, plasma torches, and heat transfer. He has published numerous academic and conference papers and authored or co-authored texts in the area, as well as being the named inventor on a number of patent applications.

[40] Dr. Mostaghimi was qualified, without objection from Tekna, to give expert evidence on thermal plasmas, including plasma torch design, mathematical modelling of plasmas, and heat transfers and plasma gas flows generated by such torches; and on the preparation of advanced materials, including metal powders, including the physics and chemistry of metals and gases used as part of such processes, the formation and solidification of molten droplets, and the physical and chemical characterization of metal powders. Dr. Mostaghimi authored an initial report on the construction of the ’502 and ’236 Patents, dated October 18, 2021 [Mostaghimi First Report]; and a second report, dated June 10, 2022, responding to Mr. Barnes’ First Report on construction, validity, and infringement [Mostaghimi Second Report].

[41] **Dr. Joseph A. Gardella** gave evidence in response to Mr. Shallenberger's evidence regarding ToF-SIMS, and on certain validity and infringement issues. Dr. Gardella is a Distinguished Professor of Chemistry at the University of Buffalo at the State University of New York, where he has been on the faculty since shortly after earning his Ph.D. in Analytical Chemistry from the University of Pittsburgh in 1981. Dr. Gardella's research relates generally to surface and analytical chemistry, including the molecular and macromolecular structure at surfaces and interfaces, particularly biological surfaces. His research involves a variety of surface characteristic testing methods, including SIMS and ToF-SIMS. He has published numerous academic and conference papers, including in the area of ToF-SIMS, and has authored or co-authored book chapters relating to surface analysis.

[42] Dr. Gardella was qualified, without objection from Tekna, to give expert evidence on materials science, methods for the characterization of materials and surface analysis, including analytical methods such as transmission electron microscopy, electron diffraction, energy dispersive analysis, and SIMS. Dr. Gardella prepared two reports, dated June 10, 2022, and October 3, 2022, responding to the reports of Mr. Shallenberger and Mr. Barnes as they related to ToF-SIMS and the results obtained by this testing method [Gardella First Report and Gardella Second Report].

[43] **Dr. Michael J. Cima** gave evidence on issues of thermochemistry and on the results of testing of samples of the parties' metal powders. Dr. Cima is the David H. Koch Professor of Engineering and a Professor of Materials Science and Engineering at the Massachusetts Institute of Technology. Dr. Cima joined the faculty at MIT after earning his Ph.D. in chemical

engineering from the University of California at Berkley in 1986. His current research involves advanced forming technologies for complex macro and micro devices, including medical devices used for drug delivery and diagnostics. He has authored or co-authored numerous scientific papers, and lectures frequently on materials science, including powder-forming technologies such as 3D printing. Dr. Cima is a co-inventor on over 90 patents, including on a patent covering MIT’s 3D printing process, which was among the first solid free-form fabrication technologies to see widespread use.

[44] Dr. Cima was qualified, without objection from Tekna, to give expert evidence on materials science, including the physics and chemistry of metals and gases, methods for the characterization of materials and surface analysis, including analytical methods such as transmission electron microscopy, electron diffraction, energy dispersive analysis, SIMS, and processes for the manufacture of materials, including metal powders. Dr. Cima’s first report, dated June 9, 2022, responded to Mr. Barnes on the issue of thermochemistry and addressed the testing of samples of Tekna and AP&C’s metal powders [Cima First Report]. He also prepared a reply report, dated October 3, 2022, responding to the Barnes Third Report and the Shallenberger Second Report [Cima Second Report].

[45] These expert reports were filed on consent and taken as read. As indicated, no objections were made to the witnesses’ qualifications as experts, although argument was directed to their relative qualifications and the weight the Court should place on their opinions.

[46] I address the substance of the experts' evidence on the relevant issues in more detail below. However, I make a few initial observations on the experts and the evidence they presented.

[47] AP&C contends there is a "very significant chasm" between the level of expertise of its experts and those put forward by Tekna. There is no doubt that Drs. Mostaghimi, Gardella, and Cima are distinguished academics with impressive credentials who are experts in their fields. Mr. Barnes and Mr. Shallenberger, who have Masters degrees and extensive industry experience in their respective fields, also have impressive backgrounds, but do not have—and do not purport to have—the academic expertise of AP&C's experts.

[48] Academic credentials may be relevant, and even important, in assessing the competing evidence of experts in certain cases. In other cases, practical knowledge and experience will be particularly important. Either way, as AP&C recognizes, assessing expert evidence is not simply a battle of qualifications. The Court must assess the particular evidence given by the expert, its internal consistency, its consistency with the other evidence and the patent at issue, and the extent to which the evidence draws on the expert's qualifications and expertise. This can often put experts in a difficult position, as distinguished scientists are called to opine on matters that lie at the intersection between scientific knowledge, the legal document that is a patent, and the legal principles relevant to patent law, each of which can have their complexities.

[49] In the present case, the two primary scientific areas on which the experts' views diverged related to (a) the extent to which the ToF-SIMS testing technique can yield "distortions" in a

depth profile, the extent to which those distortions can be minimized, and thus its suitability for analyzing the chemical profile of the surface of metal powders; and (b) the application of certain principles of thermochemistry as they relate to the manufacturing conditions of metal powders by plasma atomization, including rates of cooling, crystalline formation, and diffusion. Differences of opinion on the former were expressed by Mr. Shallenberger and Dr. Gardella, while differences of opinion on the latter were expressed primarily by Mr. Barnes and Dr. Cima, and to a lesser extent Dr. Mostaghimi. Ultimately, I conclude that I need not resolve the evidence on these questions, given my conclusions on other issues. The aspects of the science relating to ToF-SIMS testing and the thermochemistry in powder production that are relevant to the construction, validity, and infringement issues I address below were largely uncontroversial.

[50] In the present case, each of the experts was helpful and seemed desirous of assisting the Court by sharing their knowledge and opinions as impartially as possible on matters relevant to their expertise. I do consider it worth highlighting at the outset that I found that in some areas, Dr. Mostaghimi strayed beyond his areas of expertise, notably in the analysis of ToF-SIMS oxygen profiles, and that his evidence was at times inconsistent or presented explanations that were difficult to understand. I have referred to these concerns in greater detail below as they relate to the issues raised. Similarly, Mr. Barnes had extensive experience and expertise in additive manufacturing, but occasionally strayed into areas where he had less expertise, including the limitations of ToF-SIMS as an analytical technique. Mr. Barnes’ evidence was nonetheless generally consistent and straightforward.

[51] The foregoing having been said, there were no flaws in the evidence of any of the experts that justified an overall rejection of their evidence. Each of the experts had greater knowledge and expertise than the Court on the relevant scientific and industrial issues, and assisted the Court in its task of considering how the POSITA would read and understand the patents. I have adopted certain of the opinions of each expert, particularly on issues of construction, while rejecting others, and have accepted their evidence on the scientific and interpretative issues where helpful, and discounted or rejected it where it seemed less helpful, inconsistent, or strained. The experts' assistance has allowed me to reach my own conclusions on the relevant legal issues of construction, validity, and infringement.

III. Issues Common to the '502 and '236 Patents

A. *Principles of Patent Construction*

[52] A patent includes a disclosure that describes the invention and its operation, and one or more claims that set out the exclusive right claimed by the inventor: *Patent Act*, s 27(3)–(4). Patent protection rests on the concept of a "bargain" between the inventor and the public, the inventor agreeing to disclose their invention to the public in exchange for the exclusive right to exploit the invention for a limited time: *Free World Trust* at para 13.

[53] Since the claims define the monopoly protected by the patent, how they are interpreted or construed will determine the scope of the monopoly. As the Federal Court of Appeal recently reiterated, interpreting a patent is like interpreting a regulation: *Biogen Canada Inc v Pharmascience Inc*, 2022 FCA 143 at para 72, citing *Whirlpool* at para 49(e); *Interpretation Act*,

RSC 1985, c I-21, s 2(1) (“enactment”; “regulation”). As with regulatory interpretation, claims construction is conducted in accordance with a series of principles and rules, designed to bring rigour, predictability, and fairness to the process: *Free World Trust* at para 31.

[54] The jurisprudence with respect to these principles establishes that the claims of a patent are to be construed:

a) through the eyes of a POSITA, in light of their common general knowledge [CGK], at the date of publication: *Tearlab Corporation v I-Med Pharma Inc*, 2019 FCA 179 at para 32; *Free World Trust* at paras 31(e), 51, 53;

b) adhering to the language of the claims, read and understood in the context of the patent as a whole including its disclosure and other claims, but without using the disclosure to enlarge or contract the monopoly as expressed in the claims: *Biogen* at paras 71–73; *Tetra Tech EBA Inc v Georgetown Rail Equipment Company*, 2019 FCA 203 at para 86; *Tearlab* at paras 31, 33; *Whirlpool* at paras 49(e)–(f), 52, 54; *Free World Trust* at paras 31(a)–(b); *Viiv Healthcare Company v Gilead Sciences Canada, Inc*, 2021 FCA 122 at paras 57–60;

c) in an informed and purposive way, in the sense the inventor is presumed to have intended and sympathetic to accomplishing the inventor’s purpose, with a mind willing to understand and not one desirous of misunderstanding: *Tearlab* at para 31; *Free World Trust* at paras 31(c), 44, 51; *Whirlpool* at para 49(c);

d) in a neutral manner, neither benevolent nor harsh, that achieves a result reasonable and fair to both patentee and public, and endeavouring to give effect to a construction that affords the inventor protection for that which they have actually in good faith invented, if the language of the claims can reasonably bear it: *Whirlpool* at para 49(g), citing *Consolboard* at pp 520–521; *ABB Technology AG v Hyundai Heavy Industries Co, Ltd*, 2015 FCA 181 at paras 37, 42–45;

e) with the goal of identifying the essential elements of the subject-matter as claimed, derived from an informed interpretation of the claims: *Biogen* at para 74; *Free World Trust* at paras 31(e), 51–60;

f) before considering infringement or validity, and adopting a single construction for all purposes without regard to whether the construction will affect those issues, although the Court may properly focus on determinative areas of disagreement, and need not construe elements over which there is no dispute, particularly in dependent claims: *Whirlpool* at paras 43, 49(a)–(b); *Tearlab* at para 34; *Seedlings Life Science Ventures, LLC v Pfizer Canada ULC*, 2021 FCA 154 [*Seedlings (FCA)*] at para 22; *Cobalt Pharmaceuticals Company v Bayer Inc*, 2015 FCA 116 at para 83; *Swist v MEG Energy Corp*, 2022 FCA 118 at paras 21–23, 30–31;

g) recognizing the inventor’s ability to define words used in the claims: *Biogen* at para 73; *Whirlpool* at paras 52, 54; *Kramer v Lawn Furniture Inc*, [1974] FCJ No 100 (FCTD) at para 16; and

h) with rebuttable presumptions that (i) different claims and/or claim elements are not redundant but have distinct and useful meanings (the presumption of claim differentiation); (ii) the same words have the same meaning within a claim and throughout the claims of a patent (the presumption of claim consistency); and

(iii) conversely, different words have different meanings: *Whirlpool* at para 79; *Ratiopharm v Canada (Health)*, 2007 FCA 83 at para 33; *Seedlings (FCA)* at paras 20–21, 32; *Tetra Tech* at paras 113–115; *Nova Chemicals Corp v Dow Chemical Co*, 2016 FCA 216 at para 82; *Seedlings Life Science Ventures, LLC v Pfizer Canada ULC*, 2020 FC 1 [*Seedlings (FC)*] at para 75, aff'd *Seedlings (FCA)*; *Wenzel Downhole Tools Ltd v National-Oilwell Canada Ltd*, 2012 FCA 333 at paras 16–17, 52–54; Donald H MacOdrum, *Fox on the Canadian Law of Patents*, 5th ed (Toronto: Thomson Reuters Canada Limited, 2017) at §8:30.

[55] In the present case, there was no dispute regarding the essentiality of the elements of the claims, the experts and parties effectively agreeing that they are all essential: *Corlac Inc v Weatherford Canada Inc*, 2011 FCA 228 at para 26; Barnes First Report, para 23(g)(iii) (fn 2); Mostaghimi First Report, paras 64, 113; Barnes Second Report, paras 20, 34. Rather, the construction issues related to the interpretation of terms in the claims that are recognized to be essential.

[56] For reasons that will be clear below, in reviewing these terms, the experts and parties made frequent reference to the disclosure of the '502 and '236 Patents. As noted above, the Supreme Court in *Whirlpool* confirmed that the words of a claim are to be read and understood in the context of the specification as a whole: *Whirlpool* at para 49(f). An understanding of the claims therefore comes from "a reading of the claims, together with any definitional assistance from the rest of the specification": *Whirlpool* at para 54.

[57] The Federal Court of Appeal recently cited this aspect of *Whirlpool*, reiterating that “a patent’s description (also referred to as the disclosure) must be considered when construing claims,” and that “the whole disclosure must be reviewed, even for words that would appear at first glance to be simple and unambiguous when reading only the claims”: *Biogen* at paras 71–73.

[58] Nonetheless, the jurisprudence is clear that reading the words of a claim in the context of a patent as a whole does not mean that limitations of the disclosure can be read into (or out of) a claim to enlarge or contract the scope of the claim as written and understood in context: *Whirlpool* at para 52. A line must therefore be drawn between construing the claims as written in light of the patent as a whole, which is appropriate and necessary, and importing into the claims elements of the disclosure that are not found in the claim, which is not.

[59] Finally, I note that patent construction is undertaken on the basis of the patent itself and not on the basis of extrinsic evidence of the inventor’s intent: *Free World Trust* at paras 61–67; *Whirlpool* at para 49(f). While section 53.1 of the *Patent Act* now permits reference to the patent prosecution history for certain purposes, neither party relied on this section, and the section does not permit consideration of other evidence of the inventor’s intent: *Bauer Hockey Ltd v Sport Maska Inc (CCM Hockey)*, 2021 FCA 166 at paras 33–39. Thus, as noted above, Dr. Larouche’s evidence regarding the invention story and the problems the inventors were seeking to solve may be relevant to certain issues of validity, but it is irrelevant to the exercise of claims construction.

B. *The Person of Ordinary Skill in the Art*

[60] There were no meaningful differences in the parties’ and experts’ respective descriptions of the POSITA, who they agreed would be the same for the two patents. The parties agree the patents are directed to a materials scientist or engineer experienced in the field of metal powder production, the equipment used in such production, and the analysis and use of such powders. Such a person would have an advanced degree, together with at least a few years of work experience in the area, depending on the level of their education: Barnes First Report, paras 47, 49–50, 52–56; Mostaghimi First Report, paras 25–26, 105–106; Gardella First Report, para 148.

[61] Dr. Cima suggested that the POSITA would be a group of persons that included someone skilled in the manufacture of metal powders and someone skilled in the analysis of metal powders: Cima First Report, para 78 (fn 36). Whether defined as one person or a group, the parties and experts agree the POSITA of the ’502 and ’236 Patents is skilled both in the production of metal powders and in the analysis of such powders. While Mr. Barnes considered the POSITA would not themselves perform the analysis of powders, he recognized they would have an understanding of the analytical techniques available for the surface characterization of metal powders: Barnes First Report, paras 56, 650.

C. *The Common General Knowledge of the Person of Ordinary Skill in the Art*

(1) Principles

[62] The POSITA approaches the patent with an appreciation of the common general knowledge in the art to which the patent relates: *Free World Trust* at paras 31(e)(i), 44, 51; *Whirlpool* at paras 53, 74; *Cobalt* at para 14. The content of the CGK is therefore relevant to the purposive construction of the claims, as well as to aspects of the analysis of anticipation and obviousness: *Biogen* at para 61; *Apotex Inc v Sanofi-Synthelabo Canada Inc*, 2008 SCC 61 at paras 37(2), 67(1)(b); *Mylan Pharmaceuticals ULC v Eli Lilly Canada Inc*, 2016 FCA 119 [*Mylan Tadalafil*] at para 25.

[63] The jurisprudence establishes a number of principles regarding what constitutes the CGK, which may be summarized as follows:

a) The CGK is the knowledge generally known by persons skilled in the relevant art at the relevant date, namely the date of publication for purposes of construction, or the claim date (*i.e.*, the priority date if there is one, or the filing date if not) for purposes of invalidity: *Whirlpool* at para 55; *Mylan Tadalafil* at para 31; *Patent Act*, ss 28.1, 28.2, 28.3.

b) The POSITA is "reasonably diligent in keeping up with advances in the field to which the patent relates," such that the CGK undergoes continuous evolution and growth: *Whirlpool* at para 74. The CGK thus includes what the POSITA "may reasonably be expected to know and be able to find out": *Gemak Trust v Jempak Corporation*, 2022 FCA 141 at para 93, aff'g 2020 FC 644 at para 97; *Tetra Tech* at para 28.

c) However, what the skilled person may "be able to find out" does not cover all prior art or everything the person might obtain through a reasonably diligent search: *Gemak* at paras 94–100. Rather, knowledge only becomes part of the CGK where it is "generally known and accepted without question by the bulk of those who are engaged in the particular art; in other words, when it becomes part of their common stock of knowledge relating to the art": *Gemak* at para 96, citing, among others, *British Acoustic Films LD v Nettelfold Productions* (1936), 53 RPC 221 at p 250; *Mylan Tadalafil* at para 24.

d) The CGK is thus a "subset" of the state of the art: *Hospira Healthcare Corporation v Kennedy Trust for Rheumatology Research*, 2020 FCA 30 at para 84.

e) The CGK may include the information presented as background knowledge in the patent itself: *Valeant Canada LP/Valeant Canada SEC v Generic Partners Canada Inc*, 2019 FC 253 at para 47. However, it is not limited to this information.

[64] While the CGK may in some cases be different as of the relevant dates, in this case there is no dispute that the CGK of the skilled reader would be the same as of the priority date of the '502 and '236 Patents (October 29, 2015) and their publication date (May 4, 2017): Barnes First Report, para 59.

(2) Evidence regarding the common general knowledge

[65] Mr. Barnes' mandate included defining the CGK of the POSITA: Barnes First Report, para 20(a)(ii). In his First Report, he set out in some detail information that in his view would have been generally known to the POSITA at those dates. This knowledge covered (i) the fundamentals of thermodynamics and heat transfer; (ii) metals and metal powders; (iii) uses of metal powders; and (iv) production of metal powders: Barnes First Report, paras 58–279.

[66] Dr. Mostaghimi, on the other hand, was not initially given the mandate of setting out the CGK of the POSITA: Mostaghimi First Report, paras 18–19. Although he was instructed that the POSITA is familiar with the CGK and reasonably diligent in keeping up with advances, he was not asked to describe or define the CGK before construing the patents: Mostaghimi First Report, paras 18 (fn 1), 27; Transcript, Day 11, p 92. In his Second Report, Dr. Mostaghimi stated that, with minor clarifications, he materially agreed with Mr. Barnes' discussion of the CGK: Mostaghimi Second Report, paras 135–136; Transcript, Day 11, pp 93–96. He also made some additional observations about what would be within the CGK: Mostaghimi Second Report, paras 55, 77.

[67] AP&C nonetheless criticizes Mr. Barnes' discussion of the CGK based on his legally incorrect belief, revealed in cross-examination, that all findable documents are within the CGK: Transcript, Day 5, pp 72–74; Barnes First Report, paras 23(f), 30(b), (d). AP&C suggests that Mr. Barnes' misunderstanding of the legal scope of the CGK "calls into question all aspects of his opinion which depend on an appreciation of this legal concept": AP&C Closing Argument,

para 142. AP&C also criticizes the fact that the first approximately 80 paragraphs of Mr. Barnes' 220-paragraph description of the CGK do not include any citations to literature: AP&C Closing Argument, paras 135–138; Transcript, Day 5, pp 79–81.

[68] These arguments are unpersuasive, given Dr. Mostaghimi's agreement with Mr. Barnes' description of the CGK, and the lack of any expert evidence contradicting that description. Other than its generalized attempt to undermine Mr. Barnes' opinions, AP&C has not identified any particular piece of knowledge described by Mr. Barnes that it asserts would not be within the CGK. Nor has it shown how Mr. Barnes' reference to documents illustrative of the CGK, which documents themselves might not have been part of the CGK, affected his opinions in a way that they ought to be given lesser weight. Indeed, AP&C's criticism of Mr. Barnes' lack of citations to literature in his CGK discussion is rather hypocritical, given that Dr. Mostaghimi did not address the CGK at all before undertaking his claims construction. Having failed to present any substantial evidence of the CGK, and having indeed presented expert evidence agreeing with Mr. Barnes' description of the CGK, AP&C's attempts to undermine Mr. Barnes' evidence based on the way in which his discussion of the CGK was presented are misplaced.

[69] Based on Mr. Barnes' evidence, and in the absence of conflicting evidence, I conclude that the matters set out in paragraphs [73] to [102] below were part of the common knowledge of the skilled reader of each of the '502 and '236 Patents at each of the relevant dates. In setting out this summary, I have not attempted to include all of the information described in Mr. Barnes' discussion of the CGK.

[70] Neither Mr. Shallenberger nor Dr. Gardella was specifically mandated to describe the CGK of the POSITA. Mr. Shallenberger was asked to address what was "generally known in the field" with respect to the ToF-SIMS analytical technique as of October 29, 2015, while Dr. Gardella was asked to respond to Mr. Shallenberger, and gave his views on the "state of the art" of ToF-SIMS as of the same date: Shallenberger First Report, paras 17, 86; Gardella First Report, paras 27–34, 47, 138.

[71] Although Mr. Shallenberger and Dr. Gardella's opinions were not specifically presented as describing the CGK of the POSITA, I conclude that the POSITA to whom the '502 and '236 Patents are addressed would have had some general knowledge with respect to, at least, the ToF-SIMS analytical technique. I reach this conclusion because (i) the disclosure of the '502 and '236 Patents refers to ToF-SIMS testing and appears to assume some knowledge regarding the technique on the part of the reader; (ii) SIMS has been widely used since at least the 1970s, and ToF-SIMS instruments were introduced in the late 1980s: Shallenberger First Report, para 20; Gardella First Report, paras 53, 60; (iii) Dr. Mostaghimi and Mr. Barnes agreed the POSITA would have a general understanding of the techniques available for the analysis of metal powders: Barnes First Report, para 56; Mostaghimi First Report, para 26; (iv) Dr. Gardella asserted that the POSITA would be able to operate a ToF-SIMS instrument and conduct a depth profile by ToF-SIMS: Gardella First Report, para 155; and (v) although there was disagreement about whether it was a suitable and reliable technique for the purpose, Mr. Barnes agreed that by 2015, ToF-SIMS was an analytical technique available for the surface characterization of metal powders: Transcript, Day 5, pp 93–94.

[72] Mr. Shallenberger described the basic science behind ToF-SIMS and the data produced: Shallenberger First Report, paras 19–61. Dr. Gardella generally agreed with Mr. Shallenberger's discussion of the basic science and data produced by ToF-SIMS, subject to certain qualifications, additions, and clarifications: Gardella First Report, paras 55–109. In paragraphs [103] to [107] below, I set out information regarding the ToF-SIMS testing technique drawn from the evidence of Mr. Shallenberger and Dr. Gardella that I conclude would have been within the common knowledge of the POSITA at the relevant dates.

(3) The common general knowledge

(a) *Metal powders and their industrial applications*

[73] Powders made of small particles of metal have a number of known industrial applications, including injection molding, isostatic pressing, and thermal spray coatings. One of these industrial applications is additive manufacturing. Although the '502 and '236 Patents do not single out additive manufacturing in particular over other applications, the parties focused on this application since it is the primary market for their metal powders.

[74] As alluded to above, additive manufacturing involves making three-dimensional objects by depositing or solidifying a material in multiple layers. Additive manufacturing can use a number of different techniques and a number of different input materials, including polymers and metals in both wire and powder form. Given the subject-matter of the '502 and '236 Patents, the following discussion focuses on additive manufacturing using metal, particularly metal powders.

Techniques for using metal in additive manufacturing include Directed Energy Deposition (DED) and Powder Bed Fusion (PBF).

[75] DED techniques use metal wire fed through a feeder or powder directed through nozzles to deposit the material in the right place according to the computational model of the object. As it is deposited, the material is melted by a heat source, such as a laser or an electron beam. In PBF techniques, a thin, continuous layer of powder is spread in a chamber known as the powder bed. A heat source such as a laser or an electron beam is then used to fuse the powder as needed for the layer. The powder bed indexes down as each layer is completed, with new powder spread in the bed for the next layer.

[76] Metal additive manufacturing technologies are used both to make prototypes (“rapid prototyping”) and to manufacture parts, components, or tools for production (“direct digital manufacturing”). These technologies are used in a variety of industries including the aerospace, automotive, medical, and industrial manufacturing fields. The creation of 3D objects can involve many thousands of layers, with a defect in one layer potentially causing a failure of the object being manufactured. The manufacturing process is therefore sensitive to the quality and attributes of the metal powder being used.

[77] As a side note, the term “3D printing” is often used as synonymous with additive manufacturing, although it is technically a form of additive manufacturing. The ’502 and ’236 Patents refer to fine metal powders as being useful in 3D printing. The distinction between the terms “additive manufacturing” and “3D printing” is inconsequential for present purposes.

(b) *Properties of metal powders*

[78] Metal powders will have different properties depending on parameters such as the shape and size of the particles, and their composition (the metal or metal alloy they are made from). Although powders are solid, the fact that they are made up of small particles means that they typically flow like a liquid when shaken or tilted. As the ’502 and ’236 Patents note, the flowability of a powder was known to depend on various factors, including particle shape, particle size distribution, surface smoothness, moisture level, the presence of satellites [very small (1-10 μm) particles on the surface of a particle], and the presence of static electricity.

[79] With respect to particle shape, an important element is the sphericity of the particles, that is, how close they are to spherical. The more spherical particles in a powder are, the better the powder will flow. Powders with larger particles will also generally flow better than finer powders, while higher humidity and the presence of satellites will each tend to inhibit powder flow. It was generally known to the skilled person that powder properties and environmental conditions could be controlled to control the flowability of a powder.

[80] The flowability of a powder can be measured in a flowmeter. Flowability is typically expressed in the number of seconds that a standard weight of powder takes to flow through a standardized funnel: the faster the powder flows through the funnel, the lower the flowability in seconds. Two standard measurements of flowability are based on the “Hall” flowmeter and the “Carney” flowmeter. Hall flowability, defined in an international standard known as ASTM B213, typically measures the amount of time it takes 50g of powder to flow through a

Hall flowmeter. Carney flowability is defined in a different standard, ASTM B964, and is generally used when the ASTM B213 does not give a meaningful flowability value, such as when the powder does not readily flow through the 2.5mm diameter aperture of the Hall flowmeter.

[81] Factors such as humidity and temperature may affect the flowability of a powder, but the standards do not specify the environmental conditions in which the flowability measurement procedure is conducted. Flowability measurements were therefore known to be highly variable, as identical powder samples could exhibit different flowability based on environmental factors, and prior manipulation or handling of the powder. Since flowability is also correlated to particle size distribution, flowability measurements are expressed for a specific particle size distribution.

[82] While powders may flow differently in different contexts, Hall and Carney flowability measurements were generally considered as proxies for the suitability of a metal powder in additive manufacturing processes. Flowability was therefore an important metric for powder production processes and was relied on to assess the suitability of a powder in a given manufacturing process.

[83] Different additive manufacturing techniques call for metal powders with different compositions, particle size distributions, and flowabilities. DED generally uses powders with a particle size distribution between 50 µm and 150 µm, while PBF generally uses finer powders with a particle size distribution between 20 µm and 100 µm. Since laser PBF is a larger market

and uses finer powders than electron beam PBF, metal powders for use in PBF techniques usually range between 15 µm and 60 µm.

[84] The properties of a metal powder also depend on the metal or metal alloy they contain, which can affect chemical changes in the particles and inter-particular interactions, as well as the uses to which they can be put. Again, given the focus of the parties' respective businesses and the demand in the market for metal powders for additive manufacturing, much of the evidence focused on powders made from titanium alloys. In particular, at the relevant dates, the most common alloy used for the production of metal powders contained 90 percent by weight [wt%] of titanium, 6 wt% of aluminum, and 4 wt% of vanadium. This alloy is generally known as Ti-6Al-4V, or simply as "Ti 6-4."

[85] Various titanium alloys are assigned different grades, depending on their chemical composition, and limits on the quantity of trace elements such as oxygen and iron in the alloy. Ti-6Al-4V alloy with a maximum oxygen concentration of 0.20 wt% is known as titanium grade 5. Titanium grade 23 has the same percentages of aluminum and vanadium but a more restrictive limit on the amount of oxygen of 0.13 wt%.

[86] Specifications for metal powders are established in published standards, such as the AMS 4998 standard for Ti-6Al-4V titanium alloy powder. These standards set out the chemical composition requirements for the powder, including minimum and maximum concentrations of chemical elements, and powder properties such as particle size distribution and powder density.

[87] Oxygen can be present in a metal alloy either in the form of an interstitial element (O_2 molecules present within the lattice structure of the metal), or in the form of oxides. Most metals can form metal oxides when exposed to oxygen. The extent to which metals undergo oxidation is governed in part by the reactivity of the metal, as well as environmental conditions. Titanium reacts with oxygen to form titanium dioxide TiO_2, while aluminum forms aluminum oxide Al_2O_3. This oxidation takes place at the surface of a piece of metal, forming an oxide layer that then restricts the further oxidation of metal below the surface. Since the metal then becomes "passive" and less prone to further oxidation, the surface oxide layer is also known as a passivation layer.

[88] The oxidation reaction is exothermic, that is, it gives off heat. Since particles of reactive metal powders have a relatively large surface area where oxidation can occur, an uncontrolled oxidation reaction can make reactive metal powders flammable or even, if the powder is fine enough and dispersed in air, explosive. As a result, titanium and aluminum powders are typically passivated through a controlled oxidation reaction by exposing the powder to oxygen or air, to ensure the safe handling of the powder. This passivation step results in the formation of a "native oxide layer" on the surface of the particles.

[89] The thickness of this oxide layer is a function of parameters such as the size and temperature of the particle, the type and reactivity of the metal, and the concentration of oxygen around the particle. Titanium powders typically have a native oxide layer of up to 10 nm. This is a fairly thin layer on a particle the size of those used in metal powders for additive manufacturing: on a 50 μm particle, a 10 nm native oxide layer would take up about 0.02% of

the diameter of the particle on each side. As discussed further below, the value ascribed to the thickness of the native oxide layer depends in part on how the thickness is measured.

(c) *Production of metal powders*

[90] Metal powders can be produced by a number of methods, including mechanical production and atomization. Mechanical milling of powders involves physically breaking metals into smaller particles, with different mills being suitable for different particle sizes. The particles in such powders typically have low sphericity and they may therefore be subsequently subjected to a process of spheroidization, in which a source metal powder is rapidly heated and melted, typically by being passed through a high-energy plasma gas, and then cooled.

[91] Atomization methods of producing powders include spray drying, in which a liquid feed such as a slurry is sprayed into a drying chamber where a hot gas, such as air, dries the material into solid particles. They also include water, gas, and plasma atomization. In water atomization, molten metal held in a container called a tundish is released through a nozzle and then contacted with several high-pressure water jets, breaking the stream of metal into liquid droplets, which then cool into solid particles. Since certain metals can react with water, water atomization is typically used to produce powders from non-reactive metals such as steel or copper. As water atomization results in powders with irregular, non-spherical shapes, it is not generally used to produce powders for additive manufacturing.

[92] In gas atomization, which has been used since the 1920s, high-velocity gas is used as the atomizing fluid to break down molten metal into particles. Various gases and concentrations of

gases, both inert and non-inert, are used in gas atomization, depending on the result desired. The particles cool within a chamber containing gas or air known as the reactor, and fall to be collected in a collection chamber. Since the particles cool and solidify more slowly than in water atomization, the particles can become more spherical before solidification, yielding powders with good sphericity. While gas atomization produces powders with a wide particle size distribution, the yield of particles below 150 µm was typically low.

[93] To avoid the potential contamination associated with keeping a molten metal source in a tundish, a metal bar can be used as a feedstock, with the bar being heated by an induction coil before being contacted with the atomizing gas. The bar is rotated and fed through the induction coil, melting a thin film of metal that then flows toward the atomization nozzle. This process, known as Electrode Induction-melting Gas Atomization, was developed for the production of reactive metal powders like titanium.

[94] In plasma atomization, very high temperature plasma gas is directed by plasma torches at high velocity toward the metal source. The plasma therefore both melts the metal and disperses the resulting liquid into droplets. Again, the droplets cool in a reactor before falling to be collected in a collection chamber. Since the plasma itself melts the metal, metal wire or rod can be used as the feedstock, although energy can be saved by pre-heating the metal source before the atomization. Plasma atomization produces powders with highly spherical particles, with particle sizes of up to 200 µm, but with higher yields of particles below 150 µm than water or gas atomization processes. Plasma atomization also requires less gas than gas atomization.

[95] At the relevant dates, plasma atomization was widely accepted as a method to produce metal powders, including reactive metal powders such as those made of titanium alloys. Gas atomization was still the most common method, however, as it could produce higher quantities of metal powder.

[96] In both gas and plasma atomization, non-reactive (inert) gases such as argon or helium, were typically used, although reactive gases were also used for particular purposes, such as to passivate reactive metal powders, achieve certain surface reactions, and produce powders with particles or surface layers of oxides, nitrides, carbides, or other metal-gas reaction products. I note that in this context, the term “inert” refers to gases that do not react with reactive metals at the temperatures involved in atomization, *i.e.*, the noble gases. Gases such as nitrogen may be considered “inert” in some contexts because of their low reactivity, but they can react with reactive metals such as aluminum and titanium, particularly at higher temperatures.

(d) *Chemistry, thermochemistry, and thermodynamics*

[97] Much of the information presented by the experts with respect to the principles of thermodynamics and thermochemistry is not relevant to the determinative issues. I therefore do not propose to present a complete summary of that evidence. However, some basic principles of chemistry are helpful in understanding the patents and the parties’ disputes about the construction, validity, and infringement issues. Some of these principles are introduced above in discussing the properties and production of metal powders.

[98] Chemical elements vary in their degree of electronegativity, that is, their ability to attract electrons. With the exception of the noble gases, elements found on the right side and at the top of the periodic table are generally more electronegative than those further left and down on the table. Fluorine, oxygen, nitrogen, and chlorine are the most electronegative elements.

[99] Electronegativity has an impact on an element's reactivity, which is a measure of how easily it will combine with other elements to form molecules. Reactivity is not solely determined by electronegativity, as more electronegative non-metals, such as halogens, are generally more reactive owing to their tendency to gain electrons, while less electronegative metals are generally more reactive owing to their tendency to lose electrons. The relative stability of chemical reactants and the product of the reaction will also affect reactivity. Reactivity between metals and non-metals to form compounds such as metal oxides or metal nitrides also tends to increase with an increase in temperature.

[100] When solid, metals form a crystal lattice structure in which the atoms appear in various geometric configurations. Some metals, including titanium, can form different types of crystalline structures, depending on temperature, rate of cooling, and the presence of impurities.

[101] Diffusion is the passive movement of atoms or molecules from a region of higher concentration toward a region of lower concentration. Rates of diffusion will depend on various factors, including the size of the molecules, the temperature and, importantly, the state of matter. Diffusion will occur more rapidly in a gas than in a liquid, and more rapidly in a liquid than in a solid. Thus, for example, oxygen will diffuse significantly more rapidly in liquid (molten)

titanium than in solid titanium. However, diffusion does nonetheless occur within the lattice structure of solid metals, with diffusion happening at a higher rate at higher temperatures, even below the melting point.

[102] Stoichiometry is a measure of the quantity or ratio of reactants and products in a chemical reaction. A “stoichiometric” compound has atoms combined in exact, whole number ratios, such as titanium dioxide TiO_2 or water H_2O. A “non-stoichiometric” compound does not have exact whole number ratios, such as non-stoichiometric iron oxide $Fe_{0.95}O$. Metal oxides, including titanium dioxide, are often non-stoichiometric, with the ratio between the number of metal and oxygen atoms present being different than the ideal stoichiometric ratio.

(e) *Time-of-Flight Secondary Ion Mass Spectrometry*

[103] Secondary Ion Mass Spectrometry, or SIMS, is a technique that can detect chemical elements at the surface or subsurface of a solid. It involves bombarding an area on the surface of the solid with an energetic beam of “primary ions,” which act as projectiles hitting the surface of the solid. A number of different primary ions can be used, with different properties and different effects on the testing. The collision of the primary ions with the atoms in the material causes a cascade of atomic collisions, ultimately causing atoms from the solid to be ejected, a process known as “sputtering.” Some of the ejected atoms become ionized. These “secondary ions” are identified in a mass spectrometer, giving information about the composition of the solid.

[104] ToF-SIMS is a type of SIMS analysis performed in an instrument that uses a Time-of-Flight mass spectrometer. In a ToF mass spectrometer, the secondary ions from the solid being

tested are accelerated to the same kinetic energy in an electric field. Lighter ions will fly faster than heavier ions, so will take less time to arrive at a detector. The secondary ions are then identified by their mass.

[105] The rate at which material is removed from the surface of the solid by the bombardment of primary ions is known as the “sputtering rate,” usually measured in nanometres per second or nanometres per minute. The sputtering rate will depend on the nature, energy, and angle of incidence of the beam of primary ions, and the properties of the solid being analyzed. These factors can also affect the yield of secondary ions from the solid, *i.e.*, how many secondary ions (positive or negative) are produced per primary ion.

[106] The primary information provided by ToF-SIMS is the total count of secondary ions sputtered from the material, known as the “secondary ion intensity.” This raw data does not give a direct measurement of the amount or concentration of an element in the material, since the secondary ion yield can depend on various factors, including the composition and properties of the solid being tested. However, the raw data can be converted to quantitative data where standards are available, allowing a correlation between the raw data and the actual amount or concentration of the element in the material being analyzed.

[107] Continuing to sputter the material of a sample with the primary ion beam will expose deeper atomic layers. Analyzing the secondary ions sputtered from these deepening layers can yield a depth profile for the material. This is generally presented as a plot of the total count of secondary ion intensity (on the y-axis) vs the sputtering time (on the x-axis). If suitable standards

are available to permit correlation, the secondary ion data can be quantified and the depth profile can be presented as a plot of total count of secondary ions. The sputtering time can also be converted to a measured depth by using calibrated standards or with an instrument called a profilometer.

[108] If sputtering parameters are the same across analyzed samples, some comparison can be made between the ion intensity curves in the different samples. As Mr. Shallenberger described it: "[f]or example, assuming the sputtering parameters are identical, if the curve for oxygen in a sample A exhibits a secondary ion intensity that is greater than that of the curve of oxygen in a sample B, this means that there is more oxygen in sample A than in sample B (but it is not possible to tell how much more)" [footnotes omitted]: Shallenberger First Report, para 58. Dr. Gardella agreed: Gardella First Report, para 106.

D. *The Disclosure of the '502 and '236 Patents*

[109] While the claims of a patent define the monopoly granted to the patentee, a patent's disclosure must be considered when construing the claims: *Biogen* at para 71. As discussed above, there are limits on the use of the disclosure in claims construction, but the claims must at least be read in the context of the specification as a whole: *Whirlpool* at para 49(f).

[110] As the disclosure of the '502 and '236 Patents is effectively identical, I will provide a review of the disclosure here before turning to the claims of each of the patents. The particular aspects of the disclosure that the parties argue are relevant to claims construction will be discussed in further detail below.

(1) Structure of the disclosure

[111] The disclosure of each of the ’502 and ’236 Patents covers 35 pages and 193 paragraphs. These are numbered from 1 to 193 in the ’236 Patent, and from 2 to 194 in the ’502 Patent, since the ’502 Patent begins with an empty first paragraph. I will adopt the parties’ convention of referring to the paragraph numbers in the ’502 Patent when referring to paragraphs in the disclosure.

[112] The patent begins by describing the “Field of the Disclosure,” stated to be the production of spheroidal powders such as reactive metal powders, and in particular reactive metal powders having improved flowability: ’502 Patent, para 2. A three-paragraph “Background of the Disclosure” follows. It describes the desired features of high quality reactive metal powders and their known use in various industrial applications (para 3); identifies the problem that powder with poor flowability may form agglomerates, which are undesirable for a number of reasons (para 4); and states that metal powders having improved flowability are therefore desirable (para 5).

[113] The next section of the disclosure is entitled “Summary.” It begins with the statement that a “device, system or method that would at least partially address the poor flowability of reactive metal powder related to static electricity sensitivity” would be highly desirable: ’502 Patent, para 6. The following 18 paragraphs then provide aspects of the invention, in the form of what appear to be patent claims introduced by the words “[a]ccording to one aspect,” “[a]ccording to another aspect,” or “[a]ccording to another example,” although none of them mirror the claims of

either the ’502 Patent or the ’236 Patent. Beyond AP&C’s passing mention of paragraph 8, no party or expert asserted that anything of significance could be drawn from these paragraphs.

[114] The final two paragraphs of the Summary restate that the disclosed processes enable production of reactive metal powder that exhibits high flowability; note that the process does not add foreign particles to the powder since it is only a “surface treatment”; and state that the described technologies help reduce static electricity sensitivity of the powder, resulting in improved flowability: ’502 Patent, paras 25–26.

[115] After a brief introduction of the drawings, the remainder of the disclosure is presented under the general heading “Description of Various Embodiments.”

(2) Description of the various embodiments

[116] This section of the disclosure includes some express definitions of terms found in the claims, as well as definitions of some terms not found in the claims: ’502 Patent, paras 36–44, 133. It also includes a large number of paragraphs that do no more than recite claim limitations with the words “for example”: ’502 Patent, paras 46–124. Again, no party or expert suggested that the POSITA or the Court could draw anything particularly valuable or instructive from these paragraphs.

[117] More importantly, this section includes the disclosure’s substantive discussion of the invention, which covers a detailed discussion of the drawings, a non-binding discussion of scientific theories underlying the invention; and a discussion of the results of two experiments, named Experiment 1 and Experiment 2.

[118] The inventors describe a process to produce spheroidal powders through atomization, in which the heated metal source is contacted by an additive gas as well as the atomizing fluid: ’502 Patent, paras 125–149. The inventors note that powders formed with the addition of an additive gas exhibited substantially higher flowability than those formed without the additive gas, including after sieving, stirring the powders in water, and drying them: ’502 Patent, paras 150–154.

[119] The inventors refer to the knowledge in the art that titanium forms a native surface oxide layer when exposed to air, which acts as a passivation layer and reduces reactivity: ’502 Patent, para 155. They cite a scientific paper for the statement that this layer is typically about 3–5 nm and is composed essentially of titanium oxides: ’502 Patent, para 155, citing S. Axelsson, “Surface Characterization of Titanium Powders with X-ray Photoelectron Spectroscopy”, Diploma work No. 103/2012 at Department of Material and Manufacturing Technology Chalmers University of Technology (2012) [Axelsson 2012]; Barnes First Report, Exhibit JB-8.

[120] Without wishing to be bound by the theory, the inventors go on to state that the additive gas reacts with the particles of the metal powder as they are being formed, such that:

> … a first layer formed of a compound of the heated metal with the additive gas and that is depleting through the thickness is formed on the outer surface of the particles of the reactive metal particle. This layer is thicker and deeper in the surface and is located below the native oxide layer. For example, the compound of the heated metal with the additive gas in the depleted layer is metal oxide, nitride, carbide or halide. Since the atoms of the additive gas are depleting through the thickness of the surface layer, it forms a non stoichiometric compound with the metal. Such compound causes this first layer to have a substantially positive charge.
>
> [Emphasis added; ’502 Patent, para 156.]

[121] The inventors note that this “first layer” can only be formed at high temperature since the electronegative atoms and/or molecules need to have enough energy to diffuse much more into the surface layer than in a native oxide layer: ’502 Patent, para 157. The native oxide layer is formed on the surface of the particles and has a substantially negative charge due to a hydroxyl group formed at the surface: ’502 Patent, paras 155, 158. The inventors refer to Figures 2 and 3 to illustrate this and compare a particle produced without additive gas to one produced with additive gas:

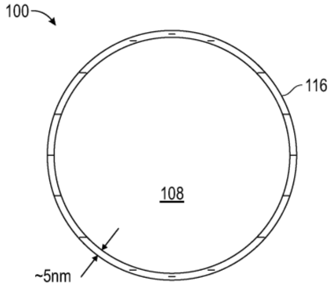


FIG. 2

[Description: A figure labeled 100 shows two concentric circles with a narrow gap between them. The space between the circles is filled with a series of small minus signs. The outer circle is labeled 116. Two arrows showing the measurement of the space between the circles is labeled ~5nm. The number 108 appears in the centre of the circle.]

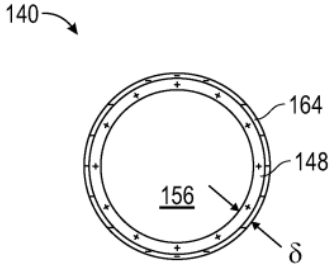


FIG. 3 (Excerpt)

[Description: A figure labeled 140 shows three concentric circles. A narrow gap between the outer and middle circles is labeled 164 and is filled with a series of small minus signs. The slightly larger gap between the middle and inner circles is labeled 148 and is filled with a series of small plus signs. Two arrows showing the measurement of the space between the inner and outer circles is labeled with a lower case delta. The number 156 appears in the centre of the circle.]

[122] The disclosure states that Figure 2 shows a particle that has not been heated with the additive gas, and shows a surface native oxide layer with a generally negative charge, giving the particle a net non-zero charge: ’502 Patent, para 160. Figure 3 shows a particle formed using the atomization methods disclosed using an additive gas. A first layer (the inner layer labeled 148) is formed on the outer surface resulting from compounding the heated metal with electronegative atoms or molecules that are depleting through the thickness. A second layer (the outer layer

labeled 164) is a native oxide layer. The two layers have a combined charge that is substantially neutral, causing the overall particle to have a substantially net zero charge: ’502 Patent, para 161.

[123] Figure 3 also contains the following graphs showing oxygen concentration profiles, which appear below the schematic diagram of the particle:

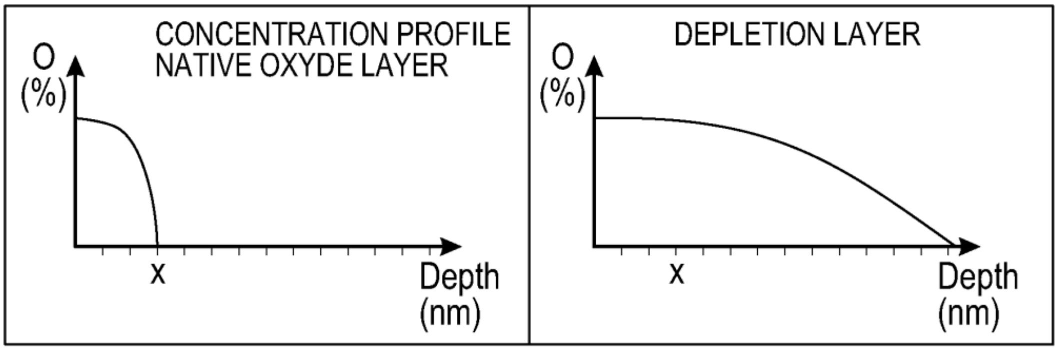


FIG. 3 (Excerpt)

[Description: Two line graphs with x- and y-axes appear side by side in a table. The x-axis of each graph is labeled Depth (nm) and has 13 axis ticks along its length that are unlabeled except for an X below the third tick. The y-axis of each graph is labeled O(%) and is not subdivided. The left graph is titled Concentration Profile Native Oxyde Layer and shows a curve commencing near the top of the y-axis and descending to meet the x-axis at the third tick marked X. The right graph is titled Depletion Layer and shows a curve starting at the same place on the y-axis as the curve in the left graph, but descending more slowly and extending further to the right, meeting the x-axis at the far right end, near the 13th tick.]

(3) The experiments

[124] The disclosure discusses two experiments. In Experiment 1, four lots of powder were produced by plasma atomization, changing the composition of the gas mixture used for the atomization. In Tests 1 and 2, only high purity argon atomizing gas was used; in Test 3, 80 ppm of air was added to the argon; in Test 4, 50 ppm of oxygen was added to the argon. The powders were then sieved, mixed, stirred in water, and dried: ’502 Patent, paras 169–177.

[125] The inventors present and discuss the results of ToF-SIMS analysis of samples from Tests 1 to 4. Given their importance to the parties’ arguments, I reproduce below Figure 5 from

the ’502 and ’236 Patents, together with the two paragraphs from the disclosure discussing the figure:

> [00178] Fig. 5 is a graph illustrating the oxygen profile comparison between different samples by TOF-SIMS. The TOF-SIMS signature of powder is obtained for Test 1 to 4. The presence of a depletion layer can be associated with the high flowability powders as can be seen in Table 1.
>
> [00179] The TOF-SIMS signature of a fine powder that has been treated can be clearly seen from the Fig. 5. A tail in the oxygen content enters deeper in the surface layer. It is critical to obtain this depletion layer with a certain critical depth in order to get the improved flowability behavior. The TOF-SIMS results suggest that the depletion layer has a depth of the order of 100 nm. The depth can be estimated by calibrating the sputtering rate of the ion beam obtained on a Ti-6A1-4V bulk part with a profilometer. The sputtering rate depends of the ion beam intensity and of the type of material. The calibration is done prior to measurements and the ion beam energy is very stable.

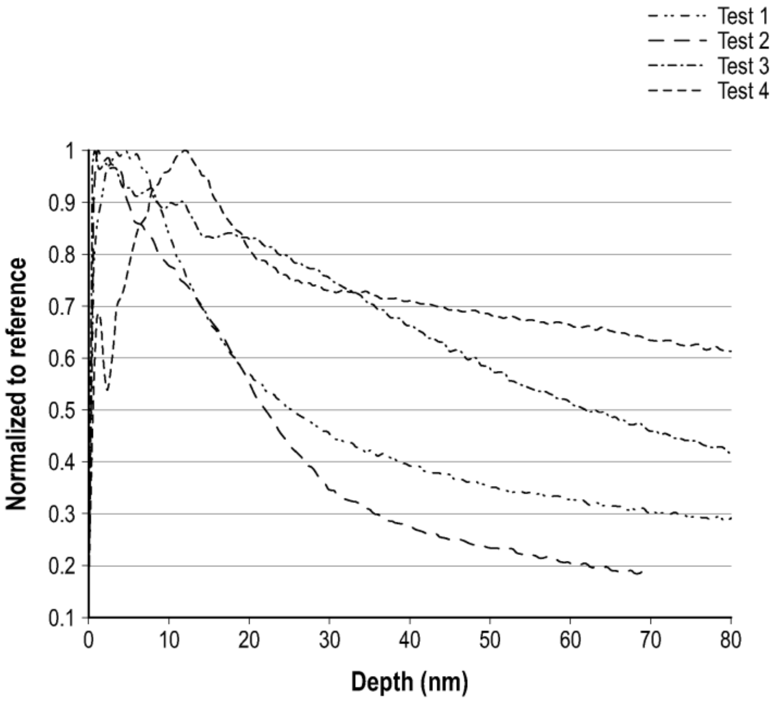


FIG. 5

[Description: A line graph is shown with x- and y-axes. The x-axis is labeled Depth (nm) and has axis ticks labeled in increments of 10 from 0 to 80. The y-axis is labeled Normalized to reference and has axis ticks and gridlines numbered in increments of 0.1 from 0.1 to 1. Four dotted lines are plotted on the graph with different sorts of dots. A legend identifies them as being, from top to bottom, Test 4, Test 3, Test 1, and Test 2.]

[126] As explained in paragraph 178, Figure 5 shows a comparison of the oxygen profile of different samples, obtained by ToF-SIMS testing, with a normalized oxygen concentration appearing on the y-axis and the depth into the surface of the particle on the x-axis.

[127] The “Normalized to reference” label on the y-axis means that the concentration measurements have been normalized or scaled against the largest observed measurement for each test, which is given the value of 1 or 100%. This explains why each curve peaks at the value of 1. Each curve thus represents the oxygen concentration as a percentage or fraction of the highest measured concentration of oxygen: Mostaghimi First Report, para 43; Transcript, Day 12, pp 3–4; Day 15, pp 155–156.

[128] I note that Dr. Mostaghimi’s First Report refers to the measurements being normalized against the largest observed measurement “amongst the four Tests”: Mostaghimi First Report, para 43 (fn 9). I do not understand this to mean that the single highest concentration measurement among the four tests was used as a single value for normalization of all four lines. In addition to being contrary to all of the other ToF-SIMS profiles presented in this trial, this would mean that all four particles had exactly the same maximum measured concentration, since all four lines peak at the same value of 1. No expert or party suggested this was or was likely to be the case. The underlying data also shows that this was not the approach taken: Exhibit 128.

[129] With respect to the x-axis, Figure 5 presents the depth from the surface of the particle measured in nanometres. As explained above at paragraph [107], data generated from a ToF-SIMS analysis can be correlated to specific depths of a surface, rather than simply sputtering

time, using a calibrated standard or a profilometer. Consistent with this, paragraph 179 states that the depth can be estimated by calibrating the sputtering rate of the ion beam obtained on a Ti-6A1-4V bulk part with a profilometer.

[130] Paragraph 178 states that the presence of a depletion layer can be associated with the high flowability powders “as can be seen in Table 1.” That table provides, for each of the four test lots, the additive gas concentration; the flowability of the sample measured in a Hall flowmeter; the apparent density; and a visual assessment in the collection bucket after atomization. Additional data is provided in Tables 2 and 3. In particular, Table 2 sets out the chemical composition of the powders from the four test lots, including the oxygen, nitrogen, aluminum, vanadium, and titanium content.

[131] Still discussing Experiment 1, the inventors provide information based on statistical data analysis regarding the amount of nitrogen and oxygen added to the powders through the injection of air (Test 3) and oxygen (Test 4): ’502 Patent, paras 180–181. They also refer to photographs (Figures 6 and 7) showing batches of powder formed with and without additive gas: ’502 Patent, paras 184–185. The batch without additive gas (Figure 6) has bad visual compaction due to agglomeration. The parties used terms such as “fluffy” and “foam-like” to describe the powder in the photograph. The batch with additive gas (Figure 7) has good visual compaction.

[132] Experiment 2 involved a subsequent heat treatment of metal powders that were produced without additive gas. It was expected that this would thicken the native oxide layer, but it was observed that it did not produce a similar result in terms of improved flowability to that of having the additive gas in the atomization process. The inventors posit that the subsequent

heating only thickens the native oxide layer and does not provide “a sufficient deep and depletion oxide/nitride layer on the particle”: ’502 Patent, paras 188–192.

[133] Having reviewed the disclosure common to the patents, I turn to each patent individually, including the construction, validity, and infringement of their claims.

IV. Canadian Patent 3,003,502

A. *Claims Construction*

(1) Introduction and Claim 1

[134] The ’502 Patent has 87 claims, including two independent claims: Claim 1, which claims a “reactive metal powder atomization manufacturing process,” and Claim 60, which claims a “reactive metal powder spheroidization manufacturing process.” Claims 2 to 59 depend directly or indirectly from independent Claim 1. Claims 61 to 67 depend directly or indirectly from independent Claim 60. Claims 68 to 87 depend directly or indirectly from either independent Claim 1 or independent Claim 60.

[135] Most of the parties’ arguments focused on Claim 1, which reads as follows, with subparagraphs lettered for ease of reference, and the terms discussed below underlined:

> 1. A reactive metal powder atomization manufacturing process comprising:
>
> (a) atomizing a heated reactive metal source to produce a raw reactive metal powder;
>
> (b) contacting said heated reactive metal source with an atomization mixture comprising at least one atomizing gas and

> at least one additive gas that is present at a concentration of less than 1000 ppm in said atomization mixture while atomizing said heated reactive metal source; and
>
> (c) forming, with said at least one additive gas, a surface layer on said raw reactive metal powder, said raw reactive metal powder with said surface layer thereon, comprises less than 1000 ppm of at least one element from said at least one additive gas,
>
> (d) wherein said surface layer comprises a first layer and a second layer, said first layer comprising atoms of said heated reactive metal source with atoms and/or molecules of said at least one additive gas, said first layer being a depletion layer deeper and thicker than said second layer, said second layer being a native oxide layer,
>
> (e) and wherein a particle size distribution of about 10 to about 53 µm of said raw reactive metal powder with said surface layer thereon, has a flowability less than 40 s, measured according to ASTM B213.

[136] At a high level, Claim 1 claims a process for manufacturing *reactive metal powders* through *atomization* of a heated *reactive metal source* using an *atomizing mixture* that includes an *atomizing gas* and a small amount of an *additive gas*. The *additive gas* forms a *surface layer* that has a number of characteristics, including that it comprises two layers, namely a *first layer* termed a *depletion layer,* and *second layer* that is a *native oxide layer*. A fraction of the resulting powder with particular particle size distribution has identified flowability characteristics.

[137] As stated above, the parties agree that each element identified in Claim 1 is essential. Thus, the *atomization manufacturing process* must, in particular, (1) involve an *additive gas*; (2) form, with the *additive gas,* a powder that has a *surface layer* that includes a *depletion layer* and a *native oxide layer*; and (3) form a powder with the defined flowability. It is important to note at the outset that these elements must each exist and that they are, though related,

independent requirements. That is to say, the presence or use of *additive gas* does not automatically mean that the resulting powder has a *surface layer* with a *depletion layer* and a *native oxide layer*, nor that it has the defined flowability. Nor does the use of *additive gas* and a resulting powder with the defined flowability mean that a powder necessarily has a *surface layer* with a *depletion layer* and a *native oxide layer*. Were it otherwise, then one or more of the central elements would be entirely redundant and could have been left out of the claim. No party contended that this was the case: Transcript, Day 15, pp 77–82.

[138] The primary construction issue between the parties—and the one determinative of the issues of infringement and validity—relates to the element I have labeled 1(d), pertaining to the *surface layer,* and in particular, the *first layer*, which is said to be a *depletion layer*. This element also appears in identical language in the other independent claim, Claim 60. It is thus an essential element of every claim of the ’502 Patent.

[139] While the *first layer*/*depletion layer* is the primary area of dispute, there is also disagreement regarding some additional terms in Claim 1, which the parties highlight largely to undermine the evidence of the other side’s experts. To provide context to the disputed *first layer*/*depletion layer* term, I will first discuss the other terms of the claim that are either undisputed or subject to less dispute.

(2) Defined terms

[140] The parties and experts agree the POSITA would understand the terms in the claim in accordance with the definitions given by the inventors, in keeping with their ability to act as their

own lexicographer: *Biogen* at para 73; *Kramer* at para 16. Two of the terms used in Claim 1 (*reactive metal powder* and *raw reactive metal powder*) are expressly defined in the disclosure of the ’502 Patent, while a third (*particle size distribution of about 10 to about 53 μm*) is similar to a defined term.

(a) *reactive metal powder*

[141] The inventors of the ’502 Patent define the term *reactive metal powder* as “a metal powder that cannot be efficiently prepared via the classical gas atomization process in which [a] close-coupled nozzle is used. For example, such a reactive metal powder can be a powder comprising at least one member chosen from titanium, titanium alloys, zirconium, zirconium alloys, magnesium, magnesium alloys, aluminum and aluminum alloys”: ’502 Patent, para 43.

[142] From this definition and the use of the term “reactive,” the process of Claim 1 is clearly to produce a powder made of reactive metals, such as titanium or its alloys, rather than non-reactive metals: Barnes First Report, paras 285–291; Mostaghimi First Report, paras 34 (fn 8), 68–69; Transcript, Day 11, pp 62–65. The powder is made of such a reactive metal (the *reactive metal powder*), and is made from a source of such a reactive metal (the *reactive metal source*).

[143] Dr. Mostaghimi stated that the POSITA would understand that the metal powder is “reactive” because atoms or molecules from the *additive gas* become “incorporated” into a surface layer of a metal powder particle: Mostaghimi First Report, para 69. I agree with Mr. Barnes that this description is an unusual one, particularly since Dr. Mostaghimi appears to use the word “incorporate” to refer to the introduction of the atoms or molecules either by way of

chemical reaction or by other methods such as diffusion: Mostaghimi First Report, paras 54 (fns 10, 11), 74, 77, 82; Mostaghimi Second Report, paras 76–78, 82–83; Transcript, Day 11, pp 13–15; Barnes Second Report, paras 23–26.

[144] Ultimately, it appears Dr. Mostaghimi agrees that a *reactive metal powder* is a powder made from a chemically reactive metal: Transcript, Day 11, pp 63–65. However, to the extent Dr. Mostaghimi is suggesting the *reactive metal powder* could include a metal that is not chemically reactive, I disagree. The term *reactive metal* would be well understood by the POSITA to refer to chemically reactive metals, used to distinguish them from those that have low reactivity. Indeed, the parties agreed that reactivity is a measure of how easily an element will combine with other elements to form compounds (*i.e.*, chemically react) and that metals such as titanium and aluminum that exhibit such reactivity are referred to as “reactive metals”: Agreed Statement of Facts, Exhibit 35, paras 3–4. A construction of *reactive metal powder* that does not incorporate the notion of chemical reactivity would also be internally inconsistent with the fact that Claim 1 requires the creation of a *native oxide layer*, discussed further below.

[145] Mr. Barnes also noted that it was unclear what the inventors meant by referring to *reactive metal powders* as metal powders that “cannot be efficiently prepared via the classical gas atomization process,” since most reactive metal powders were and continue to be produced by gas atomization, and in particular Electrode Induction-Melting Gas Atomization: Barnes First Report, para 290; Transcript, Day 10, pp 61–62; see also Transcript, Day 11, pp 61–62. Dr. Mostaghimi attempted to explain this by putting emphasis on the word “efficiently,” which he understood to relate to variations in particle size distribution and the resulting waste:

Transcript, Day 11, p 62. Given that the ’502 Patent does not purport to address the reduction of waste due to particle size distribution, Dr. Mostaghimi’s explanation provides little illumination. However, any such lack of clarity in this aspect of the inventors’ definition does not affect any contested issues in this proceeding.

(b) *raw reactive metal powder*

[146] The disclosure defines the term *raw reactive metal powder* as referring to “a reactive metal powder obtained directly from an atomization process without any post processing steps such as sieving or classification techniques”: ’502 Patent, para 44; Mostaghimi First Report, para 72.

[147] Mr. Barnes opined that a POSITA would understand *raw reactive metal powder* to mean a *reactive metal powder* that has not yet been passivated through contact with air or another reactive gas: Barnes First Report, para 303. Dr. Mostaghimi disagreed, asserting that this construction is inconsistent with the balance of the claim, which indicates that the *raw reactive metal powder* is the product of the claimed process and includes a *native oxide layer* that is the result of passivation: Mostaghimi Second Report, paras 69–73.

[148] In my view, Mr. Barnes’ construction is consistent with the definition provided by the inventors and the POSITA’s understanding of the term as used in Claim 1. Importantly, while element 1(a) refers to the *raw reactive metal powder*, element 1(c) refers to forming a *surface layer* on the *raw reactive metal powder*, and elements 1(c) and (d) then use the term *raw reactive metal powder with said surface layer thereon*. As Mr. Barnes notes, the POSITA would

understand the *raw reactive metal powder with said surface layer thereon* to mean the *raw reactive metal powder* that has then undergone passivation: Barnes First Report, paras 323–327; Barnes Second Report, para 22; see also ’502 Patent, para 126. It is this *raw reactive metal powder with said surface layer thereon* that is the product of the claimed process, rather than simply the *raw reactive metal powder*.

[149] The experts ultimately agree that the process results in a *reactive metal powder* with a *surface layer* that includes a passivation layer (the *native oxide layer*), and that the relevant parameters in elements 1(c), (d), and (e) relate to the powder with the *surface layer*.

[150] Mr. Barnes also contended that there was some inconsistency between the language of the claim and the inventor’s definition of the *raw reactive metal powder* being powder “without any post processing steps such as sieving or classification techniques.” Element 1(e) specifies a flowability for a particular particle size distribution of the produced powder. Since gas or plasma atomization does not produce metal powders with a precise particle size distribution, measuring the flowability for the 10 µm to 53 µm fraction necessarily requires the powder to have been sieved or otherwise classified, contrary to the definition of *raw reactive metal powder* in the disclosure: Barnes First Report, paras 305–306, 364. Again, however, the flowability measurement is in respect of not simply the *raw reactive metal powder*, but the *raw reactive metal powder with said surface layer thereon*. This may explain the apparent anomaly, although the presence of a *surface layer* does not alone mean that there has been sieving or classification. In any event, nothing turns on this anomaly, if it is one, as the experts agree the flowability

measurement of element 1(e) would be undertaken on the indicated fraction of the powder produced by the atomization process, *i.e.*, after classification, as discussed below.

(c) *particle size distribution of about 10 to 53 µm*

[151] The inventors state that the expression “metal powder has a X-Y µm particle size distribution” means it has less than 5 wt% of particles above Y µm in size, measured according to the ASTM B214 standard, and less than 6 wt% of particles below X µm in size, measured according to the ASTM B822 standard: ’502 Patent, para 40. Consistent with this definition, the disclosure further states that “metal powder having a 15-45 µm particle size” means it has less than 5 wt% of particles above 45 µm, measured according to the ASTM B214 standard, and less than 6 wt% of particles below 15 µm, measured according to the ASTM B822 standard: ’502 Patent, para 41.

[152] The language of Claim 1 is slightly different, referring to *particle size distribution of about 10 to 53 µm*. Mr. Barnes, referring to the definitions above, considered that the POSITA would consider the expression *particle size distribution of about* to incorporate the statistical variations referred to in the above definitions, and not to attribute any specific meaning to the term *about*, since the definition already accounts for statistical uncertainties: Barnes First Report, paras 360–363.

[153] Dr. Mostaghimi, whose initial construction simply repeated the language of the claim, took issue with the suggestion that the POSITA would ignore the term *about*, and contended it would be given its regular meaning of “approximately or around”: Mostaghimi First Report,

para 83; Mostaghimi Second Report, paras 101–104. However, he provided no greater precision than this, and did not explain why the POSITA, reading the inventors’ specific definition regarding particle size distributions, would not incorporate that understanding into the term of Claim 1 referring to particle size distributions.

[154] While again this disagreement is not determinative, I agree with Mr. Barnes’ reading, despite the slight variation in the language of the claim compared to the defined terms. The inventors have set out in a definition a particular degree of statistical variation when discussing particle size distribution. In my view, the POSITA viewing the words *particle size distribution of about 10 to 53 μm* would understand the *about* to refer to and incorporate the degree of statistical variation defined by the inventors. The POSITA would understand that classification of powder particles to obtain a desired particle size distribution would yield some particles smaller than the minimum and some larger than the maximum, but that the large majority of particles would be desired to be in the given distribution range. This is consistent with adopting the definition given, albeit in slightly different language, by the inventors.

[155] As discussed above, and as Mr. Barnes notes without disagreement from Dr. Mostaghimi, since it was not possible at the relevant dates to limit particle sizes in the atomization process, the POSITA would understand the reference to particle size distribution to refer to a subset or fraction of the powder produced that has been sieved or classified: Barnes First Report, para 364; Mostaghimi Second Report, paras 101–104.

(3) Other terms

(a) *atomization manufacturing process/atomizing*

[156] There is no dispute that the POSITA would understand these terms as referring to a process of manufacturing *reactive metal powders* through the atomization of a heated source of reactive metal, such as wire, rod, or molten metal, as described above: Barnes First Report, para 297; Mostaghimi First Report, para 71. However, Mr. Barnes and Dr. Mostaghimi disagreed on whether the POSITA would understand these terms as including water atomization. Mr. Barnes opined that the POSITA would understand them to be limited to gas or plasma atomization, since water atomization cannot be used with reactive metals: Barnes First Report, paras 292–294. Dr. Mostaghimi disagreed, because the claim does not expressly limit the atomization to gas or plasma atomization: Mostaghimi Second Report, paras 66–67.

[157] I agree with Tekna that Dr. Mostaghimi's reading is overly literal, rather than a contextual and purposive one. Importantly, while element 1(a) only refers to *atomizing*, element 1(b) refers specifically to the use of an *atomizing gas*. This would indicate to the POSITA that the fluid used for the atomization process is a gas rather than a liquid such as water: Barnes First Report, para 311. This would also accord with the POSITA's knowledge of the risk of reaction between water and a reactive metal, and their knowledge that water atomization does not produce spherical particles, contrary to the patent's stated goal: Transcript, Day 11, pp 67–70; '502 Patent, paras 2, 3, 131, 138. A POSITA reading Claim 1 contextually and purposively would therefore understand the *atomization manufacturing process* of Claim 1 to be a gas or plasma atomization process, and the step of *atomizing* in element 1(a) to similarly refer to gas or plasma atomization.

> (b) *contacting said heated reactive metal source with an atomization mixture comprising at least one atomizing gas and at least one additive gas*

[158] As set out in element 1(b), the claimed atomization process involves *contacting* the *heated reactive metal source* with an *atomization mixture* comprising at least one *atomizing gas* and at least one *additive gas*. I agree with Mr. Barnes that the POSITA would understand the *atomization mixture* to be a combination of gases used to atomize the metal source to form the metal powder: Barnes First Report, paras 308–310.

[159] Dr. Mostaghimi did not expressly disagree, although his construction was that the *atomizing gas* would be understood as the gas or plasma that heats and contacts the metal source, causing it to melt and/or to form droplets, while the *additive gas* would be understood as the source for the added component that forms part of an outer layer on the powder (*i.e.*, the *surface layer*, discussed further below): Mostaghimi First Report, para 74. Two aspects of this description require clarification. First, the statement that the *atomizing gas* would both heat and contact the metal source would be true for plasma atomization, but Mr. Barnes' evidence regarding the POSITA's common knowledge makes clear that gas atomization can involve a pre-melted metal source, and that the *atomizing gas* in such a process may or may not be heated: Barnes First Report, paras 238, 312; Barnes Second Report, para 28. Dr. Mostaghimi's report acknowledges that the *heated reactive metal source* may include molten metal: Mostaghimi First Report, paras 71, 74.

[160] Second, I cannot take Dr. Mostaghimi's description to suggest that only the *atomizing gas* and not the *additive gas* is involved in the atomization. Although it is not a point of

controversy between the parties, the process of Claim 1 involves contacting the *reactive metal source* with the *atomization mixture*—and not with the *atomizing gas* alone or the *atomizing gas* and the *additive gas* separately—and doing so *while atomizing* the metal source. The gases of the *atomization mixture* must therefore be mixed either at or before the time that they are contacted with the metal source in the atomization process. The disclosure of the ’502 Patent discusses each of these two possibilities, referring to the example of mixing the *atomizing gas* and the *additive gas* prior to contact with the metal source (also claimed in Claim 44), and to injecting the *additive gas* “with” the *atomizing gas* to form the *atomization mixture*: ’502 Patent, paras 140, 162–164. Similarly, in discussing the experiments, the inventors note that in Tests 3 and 4, the metal was contacted with the *atomization mixture* “during the atomization process”: ’502 Patent, paras 172, 173. As a result, both the *atomizing gas* and the *additive gas* are involved in the atomization.

[161] That said, the at least one *atomizing gas* contained within the *atomization mixture* is the predominant gas in the mixture, since the at least one *additive gas* is present at a concentration of less than 1,000 parts per million [ppm], or less than 0.1% of the *atomization mixture*. The *atomizing gas* is thus primarily responsible for the atomization of the metal source, but ultimately all gases in the *atomization mixture* are involved in the atomization: Barnes First Report, paras 308, 310–311, 319.

[162] The experts had a more substantive disagreement over the nature of the *additive gas*, and in particular whether it must be a reactive gas or whether it can be an inert gas.

[163] Mr. Barnes notes that the term *additive gas* itself had no specific meaning to the POSITA at the relevant dates: Barnes First Report, para 313; Transcript, Day 5, p 133. Dr. Mostaghimi did not disagree, and AP&C does not contend otherwise. Mr. Barnes then turned to the disclosure of the ’502 Patent, which contains the following language, which Mr. Barnes described as a definition of *additive gas*:

> [00132] <u>The additive gas can be any gas comprising [an] electronegative atom or molecule</u>. The additive gas may include fluorine, chlorine, iodine, bromide, hydrogen-based, nitrogen-based and carbon-based compounds.
>
> [00133] The additive gas may be an oxygen-containing gas. The expression “oxygen-containing gas” as used herein refers to a gas that contains at least one atom of oxygen. For example, such gas may be O_2, CO_2, CO, NO_2, air, water vapor, ozone, etc.
>
> [Emphasis added.]

[164] From this passage, Mr. Barnes concluded the term *additive gas* would be understood to refer to a non-inert gas capable of undergoing a chemical reaction with the *raw reactive metal powder*: Barnes First Report, para 315. This would be consistent, in Mr. Barnes’ view, with the POSITA’s knowledge that non-inert gases such as oxygen and nitrogen could be used in atomization processes to produce metal oxides or metal nitrides: Barnes First Report, para 316.

[165] Dr. Mostaghimi, on the other hand, contends that the *additive gas* is not limited to a gas that reacts with the reactive metal powder: Mostaghimi Second Report, paras 18(c), 74–79; Transcript, Day 11, pp 13–14, 72–75. Dr. Mostaghimi did not specifically address the inert or reactive nature of the *additive gas* in his First Report, stating simply that the term would be understood to refer to a gas that is the source for the “added component […] that becomes <u>incorporated</u> with the metal source to form part of an outer layer on the produced particles”

[emphasis added]: Mostaghimi First Report, para 74. However, he disagreed with Mr. Barnes' reading in his Second Report, opining that neither the claim nor the passage in the disclosure cited above excludes inert gases: Mostaghimi Second Report, para 75.

[166] In my view, the answer to this question comes from a purposive reading of Claim 1. The POSITA would recognize that the *additive gas* is set out as a different component in the *atomization mixture* from the *atomizing gas*, with a different purpose. The claim itself makes clear that the *atomizing gas* is primarily responsible for atomization, while the *additive gas* forms the *surface layer*. The POSITA would understand that the inventors intended these two different purposes to be performed by two different gases, with different properties. If there were no restriction on the nature of the *additive gas*, it could simply be another *atomizing gas* and the inventors could simply have referred to having two *atomizing gases*, since there would be no functional or purposive difference between them.

[167] This is particularly so since Claim 1 provides that there can be "at least one" *atomizing gas*. For example, a POSITA would know that the inert gases argon and helium could each be used as an *atomizing gas*. The POSITA would recognize that the inventors could not have intended that a mixture of, for example, mostly argon with a small amount of helium could be described in Claim 1 as either "at least one" *atomizing gas* or as the *atomizing gas* plus an *additive gas*. Further, the POSITA would have no idea, either from their CGK or from the '502 Patent, why or how the small amount of helium in the *atomizing mixture* could affect the properties of the *reactive metal powder*.

[168] The POSITA reviewing Claim 1 in the context of the disclosure as a whole would find their expectation that the *atomizing gas* and the *additive gas* had different purposes and properties confirmed. The *atomizing gas* is not discussed at length, but it is described as being a type of atomizing fluid and can be, for example, an inert gas: ’502 Patent, paras 126–127, 140, 170–171. The POSITA would recognize this as consistent with their general understanding of gas atomization processes, as discussed above. The *additive gas* is frequently referred to in the patent, as a material difference between particles manufactured in accordance with the process of the patent and those that are not: ’502 Patent, paras 29–30, 33–34, 131–150, 154–156, 160–164, 184–186.

[169] It is in this context that the POSITA would read paragraph 132, reproduced above. In context, the POSITA would understand the inventors’ statement that “[t]he additive gas <u>can be</u> any gas comprising [an] electronegative atom or molecule” [emphasis added] as being a limiting description of the *additive gas*, and not simply as providing an example. This is particularly so when the “can be” language is contrasted with the “may” language used in the second sentence of paragraph 132 and in the two sentences of paragraph 133, which set out gases with electronegative atoms or molecules that may possibly be used as the *additive gas*.

[170] The POSITA would observe that every example provided in the disclosure in respect of the *additive gas* is of a gas with an electronegative ion. The inventors never suggest an inert gas as an *additive gas*, and indeed such a suggestion would run contrary to the inventors’ general discussion and theories about the process. Patent claims are, of course, not limited to the preferred embodiments or examples set out in the disclosure: *Bombardier (FCA)* at para 54;

Seedlings (FC) at para 58. Nonetheless, the language and examples used by the inventors in the disclosure are relevant, particularly where the inventors use a functional term in the claim that has no meaning in the art (*i.e.*, *additive gas*, rather than simply *gas*). An inventor's choice to set out particular examples to the exclusion of others may give the POSITA an understanding of the meaning of a term used in the claim: see *Schering-Plough Canada Inc v Pharmascience Inc*, 2009 FC 1128 at paras 161–168.

[171] The POSITA would also note that while the inventors included a series of dependent claims that limit the identity of the *additive gas*, there is no dependent claim that limits the *additive gas* to a gas containing an electronegative ion or molecule. Rather, the dependent claims limit the *additive gas* to <u>particular</u> gases containing electronegative ions or molecules: '502 Patent, Claims 68–75; see also paras 105–112. This is in contrast to the *atomizing gas*, for which there is a dependent claim that limits the *atomizing gas* to an inert gas: '502 Patent, Claim 43; see also paras 126–127.

[172] I conclude that the POSITA would understand the *additive gas* to be a gas with an electronegative atom or molecule. I view this not as reading a limitation from the disclosure into the claims but as the POSITA construing the term in the claims—*additive gas*—purposively in light of the patent as a whole.

[173] In any event, and regardless of the foregoing, Claim 1 is even more specific than the language of paragraph 132 with respect to the identity of the *additive gas*. Claim 1 states that the process comprises "<u>forming, with</u> said at least one *additive gas*, <u>a *surface layer*</u> on said *raw*

reactive metal powder" [emphasis added]. As discussed further below and agreed by the parties, the *surface layer* comprises both a *first layer*/*depletion layer* and a *second layer*/*native oxide layer*. Claim 1 therefore states expressly that the *native oxide layer* is formed with the at least one *additive gas*, since it is part of the *surface layer*.

[174] Evidently, to form an oxide layer, oxygen must be present: Transcript, Day 11, pp 11, 80; Barnes First Report, paras 355–356; Mostaghimi Second Report, para 90. Therefore, in order for the *native oxide layer* to be formed with the *additive gas*, at least one *additive gas* must contain oxygen: Barnes First Report, paras 326, 356–357. Put another way, the POSITA would know that if the *additive gas* were only an inert gas like helium or argon, as Dr. Mostaghimi contended, or even limited to a non-oxygen reactive gas like nitrogen, it would not be chemically possible to form, with such *additive gas*, a *surface layer* that comprised a *native oxide layer*.
Dr. Mostaghimi's construction, in which the *additive gas* could be an inert gas, is thus not only a non-purposive reading, but also in direct conflict with the remainder of Claim 1.

[175] I note that paragraph 132 of the disclosure states that the *additive gas* may include halogens such as fluorine or chlorine, or nitrogen-based compounds, while dependent Claims 70 to 75 include limitations on the at least one *additive gas* that include gases that do not contain oxygen. However, I do not view the construction above as inconsistent with either paragraph 132 or these dependent claims. Notably, Claim 1 is clear that more than one *additive gas* can be present, so other gases may be present provided that oxygen is also present to form the *native oxide layer*: Barnes First Report, para 357. In any event, even if there were an inconsistency, the

language of Claim 1 is clear that the *native oxide layer* must be formed with the at least one *additive gas*, so at least one *additive gas* must necessarily contain oxygen.

[176] I recognize that this construction renders largely redundant Claim 68, which specifies that the “at least one *additive gas* is an oxygen-containing gas.” As a general rule, such claim redundancy should be avoided: *Whirlpool* at para 79; *Halford v Seed Hawk Inc*, 2004 FC 88 [*Halford (FC)*] at paras 91–94, rev’d in part on other grounds, 2006 FCA 275; *Eli Lilly Canada Inc v Apotex Inc*, 2020 FC 814 at paras 111–113; *Apotex Inc v Lundbeck Canada Inc*, 2010 FCA 320 [*Apotex Escitalopram*] at paras 109–110; *Ratiopharm* at para 33.

[177] However, the principle of claim differentiation is a rebuttable presumption that must yield to the clear language of the claim: *Halford (FC)* at para 94; *Apotex Escitalopram* at para 110. In the present case, if the at least one *additive gas* could contain no oxygen, it would be incapable of forming a *surface layer* that comprises a *native oxide layer*, resulting in an internal inconsistency within Claim 1. In my view, this internal inconsistency is sufficient to rebut the presumption of claim differentiation with respect to this term. I note as an aside that the ’502 Patent clearly has other redundant claims, such as Claims 40 and 42, discussed below at paragraphs [308] and [311].

[178] An additional issue regarding the term *additive gas* in the context of Claim 1 relates to the question of intention, *i.e.*, whether the *additive gas* must be deliberately or intentionally added in order to meet the process of Claim 1. In the disclosure, the inventors recognized that in existing atomization processes, some *additive gas* such as air or oxygen may be inherently

introduced into the atomization through contamination, impurities, or leaks: ’502 Patent, para 137. The inventors state that in the embodiments described, the *additive gas* for *contacting* the *metal source* is “deliberately provided in addition to any additive gas that could be inherently introduced during the atomization process”: ’502 Patent, para 138. AP&C contends that Claim 1, either through the term *additive gas* or the use of the word *contacting*, refers to the intentional (deliberate) controlled addition of gas: Transcript, Day 15, pp 45–46, 91–92, 97–98; AP&C Closing Argument, paras 91–92, 361, 368–378.

[179] I need not resolve these questions, as they are not relevant to the issues I have concluded are determinative. In particular, they are relevant primarily to the question of Tekna’s subsection 56(1) argument, which I have concluded I do not need to address.

> (c) *said raw reactive metal powder with said surface layer thereon, comprises less than 1000 ppm of at least one element from said at least one additive gas*

[180] The experts agreed that a POSITA would understand that this term in element 1(c) puts a maximum limit on the concentration of an element from the *additive gas* in the resulting powder: Barnes First Report, para 328; Mostaghimi First Report, para 78. However, there were differing opinions on two aspects of this expression, each relating to the calculation of the 1,000 ppm limit.

[181] The first aspect relates to the portion of the particle that is subject to the limit. Dr. Mostaghimi initially opined that the 1,000 ppm concentration limit was a specified requirement for the *surface layer*, not the entire particle: Mostaghimi First Report, para 78. In

reaching this conclusion, Dr. Mostaghimi reproduced only the language “said surface layer thereon, comprises less than 1000 ppm…” in element 1(c), omitting the initial “said raw reactive metal powder with….” In his oral testimony, Dr. Mostaghimi readily agreed that Mr. Barnes was correct in interpreting the claim to mean that the metal powder as a whole, *i.e.*, the metal powder *with* the surface layer, must together contain less than the 1,000 ppm limit: Transcript, Day 11, pp 11–12; Barnes First Report, para 330; Barnes Second Report, para 29. Indeed, Dr. Mostaghimi appears to have taken this approach in his infringement analysis: Mostaghimi Second Report, paras 498–500. AP&C ultimately did not dispute this construction in closing submissions.

[182] I agree that Mr. Barnes’ reading is the only one that accords with the language of Claim 1. The Claim puts a limitation on the composition of the “said *raw reactive metal powder* <u>with</u> said *surface layer* thereon” [emphasis added]. This language clearly refers to the entirety of the powder and not the *surface layer* alone. Further, where the inventors wanted to specify limits on the composition of the *surface layer* itself, they do so in different language. In Claims 50 to 54 of the ’502 Patent, the inventors claim processes of the prior claims “wherein <u>said *surface layer* thereon comprises</u> less than about [X] ppm of said at least one element from said at least one *additive gas*” [emphasis added].

[183] The second, and more disputed, aspect relates to whether the 1,000 ppm limit includes atoms or molecules that were present in the original metal source, or only those contributed to the powder by the *atomizing gas*. As discussed above at paragraph [85], reactive metal sources typically contain other trace elements such as oxygen, with amounts dictated by the grade of the

metal. Tekna argues the 1,000 ppm limit in claim element 1(c) relates to the entire amount of the element in the particle, including that which was present in the original metal source. AP&C argues it is only a limit on the amount of the element that is "picked up" from the *atomizing gas* in the atomization process.

[184] Tekna's submission accords with Mr. Barnes' opinion of how the POSITA would understand the phrase: Barnes First Report, paras 331–334. Dr. Mostaghimi's reports did not clearly address this construction issue. In his First Report, he stated that the claim element means that the *surface layer* "must incorporate less than 1000 [ppm] of at least one component from an additive gas" [emphasis added]: Mostaghimi First Report, para 78. It is unclear that Dr. Mostaghimi's substitution of the word "incorporate" for "comprise" is intended to give a construction that limits the calculation to the incremental amount of the element contributed by the *additive gas*. If so, no explanation is given for the conclusion. At the same time, Dr. Mostaghimi's Second Report does not disagree with Mr. Barnes' opinion that the measurement includes the entire amount of the element in the particle: Mostaghimi First Report, para 78; Mostaghimi Second Report, paras 80–81.

[185] In cross-examination of Mr. Barnes, however, AP&C suggested that the 1,000 ppm was a measurement of only the pick-up of the element from the *atomizing gas*, calculated by deducting from the total amount in the particle the amount that was in the original metal source: Transcript, Day 5, pp 133–137. Mr. Barnes did not accept this proposed construction.

[186] During his testimony in chief, Dr. Mostaghimi addressed the 1,000 ppm limit, but only as it related to the first aspect, namely whether it covers the entire particle or just the surface layer: Transcript, Day 11, pp 11–12. In cross-examination, though, Dr. Mostaghimi asserted the 1,000 ppm limit pertained to the amount the powder picked up from the *atomizing gas*, excluding that which was in the metal source: Transcript, Day 11, pp 80–82.

[187] Focusing on the language of the claim, the question engaged by these competing constructions is essentially whether the word "from" in the phrase "less than 1,000 ppm of at least one element from said at least one *additive gas*" means that one measures the <u>amount</u> of the element that specifically comes from the *additive gas*, or whether it simply identifies the <u>element</u> to be measured as being one that comes from the *additive gas*, which is then measured in its entirety. For the following reasons, I conclude the POSITA would understand the phrase in the manner proposed by Mr. Barnes and Tekna.

[188] First, AP&C's proposed construction is inconsistent with the fact that the measurement is of the "*raw reactive metal powder* <u>with</u> said *surface layer* thereon" [emphasis added], *i.e.*, the whole particle, as discussed above. Claim 1 refers to forming the *surface layer* on the metal powder with the *additive gas*. It does not refer to the *additive gas* contributing elements deeper into the particle than the *surface layer*. Dr. Mostaghimi himself asserted that the pick-up is limited to the *surface layer*: Transcript, Day 11, pp 81–82. This being so, measuring the concentration of the element in the whole particle would have no purpose if the goal were only to measure the amount of the element contributed by the *additive gas*.

[189] Second, when the inventors meant to refer only to the amount of an element contributed by the *additive gas*, they did so in clear language, as seen in Claims 55 to 59. Each of these claims adds a limitation in which the "*surface layer* […] has an added content of an electronegative element from said at least one *additive gas* of less than about [X] ppm" [emphasis added] (see also paragraphs 98–103 of the disclosure). The concentration limit in these claims is clearly restricted to (a) the *surface layer* only; and (b) the added content or pick-up only: Barnes First Report, paras 404–408; Mostaghimi First Report, para 98. The fact that the inventors use this language in Claims 55 to 59 but chose not to use it in Claim 1 suggests they did not intend to limit the measurement in Claim 1 to the "added content" contributed by the *additive gas*: *Seedlings (FCA)* at paras 20–21.

[190] The claims thus present three types of measurement of the concentration in the powder of the "at least one element from said at least one *additive gas*." Claim 1 requires that the "*raw reactive metal powder* with said *surface layer* thereon, comprises less than 1000 ppm." Claims 50 to 54 require that the "*surface layer* thereon comprises less than about [X] ppm." Claims 55 to 59 require that the "*surface layer* thereon has an added content of an electronegative element from said at least one *additive gas* of less than about [X] ppm." The different language used by the inventors indicates that different measurements were intended: Claim 1 refers to the total amount in the whole particle; Claims 50 to 54 add a limitation regarding the measurement of the total concentration in the *surface layer*; and Claims 55 to 59 add a limitation regarding the measurement of the added content or pick-up in the *surface layer*, while also requiring that the content be an electronegative element.

[191] Third, Dr. Mostaghimi's evidence on this construction issue is considerably weakened by the fact that it was put forward for the first time in cross-examination. Even when mandated to respond to Mr. Barnes' opinions on claim construction, which clearly stated that the POSITA would understand the measurement to refer to the total amount in the particle, Dr. Mostaghimi did not respond by saying the POSITA would consider the measurement limited to the pick-up of the element from the *additive gas* alone. Indeed, in addressing infringement in his First Report, Dr. Mostaghimi appears to have assessed this claim element based on measurements of the total amount of the element in Tekna's powders: Mostaghimi Second Report, paras 498–500. As he conceded in cross-examination, he conducted no calculation of the pick-up of gas before concluding that the 1,000 ppm limit was met: Transcript, Day 11, pp 88–90. The construction is further undermined by the fact that AP&C appears to advance it at trial to address an oxygen concentration issue in respect of one of Tekna's samples: AP&C Closing Argument, para 345; Transcript, Day 11, pp 81, 87–90.

[192] Further, Dr. Mostaghimi did not explain why he concluded a POSITA would understand the term to cover only the amount of the element picked up from the *additive gas*, beyond the general statement that the pick-up is the "whole idea" of the two patents: Transcript, Day 11, p 81. In particular, he provided no scientific explanation why it would matter to the properties or behaviour of a powder whether the atoms or molecules of an element, or the resulting concentration of that element, came from the original metal source or from the *additive gas*. While the location of the element within the powder particle may matter, there was no evidence to suggest that the source of the element could possibly matter when measuring the content of the entire particle. Conversely, Mr. Barnes' uncontested evidence was that the POSITA would know

that an element present in the *additive gas* might already be present in the source metal and would have to be taken into consideration: Barnes First Report, paras 329–331.

[193] The POSITA would be well aware of the importance of limitations on the total amount of trace elements in metal and metal alloy powders, and their impact on the properties and specifications of such powders. As set out above at paragraph [86], the POSITA would know that international standards define limits on chemical elements in metal powders, including oxygen. The POSITA would therefore recognize the purpose and value of measuring the total concentration of an element in a manufactured metal powder.

[194] This is consistent with paragraphs 141 to 148 of the ’502 Patent. There, the inventors discuss controlling the amount of *additive gas* based on desired end properties: ’502 Patent, para 141. They note as an example that the amount of *additive gas* can be controlled so the amount of the gas “<u>contained within the reactive metal powder</u> is maintained within certain limits” [emphasis added]: ’502 Patent, para 142. They further note that the chemical composition limits within the powder may be prescribed by various international standards, such as AMS 4998 (the standard for Ti-6Al-4V titanium alloy powder), so the amount of *additive gas* is controlled based on its composition “and the limit or limits prescribed by standard for the one or more atoms and/or molecules composing the additive gas”: ’502 Patent, para 143. The inventors then provide a series of examples of limits on the amount of gas “within the formed reactive metal powder,” ranging from 120 to 1,800 ppm: ’502 Patent, paras 144 to 149. The POSITA would know that these standards set out specifications for the chemical compositions of metal powders as a whole, such that what is discussed in these paragraphs is the total amount of the

element within the powder, including both that contributed by the *additive gas* and that originally within the metal.

[195] AP&C contends that the language in these paragraphs can be contrasted with that in Claim 1, since paragraphs 144 to 147 speak to the amount of elements “within” the powder, and have different ppm limitations than the 1,000 ppm limit of Claim 1. I cannot agree. I note that some of the examples given in these paragraphs have the same 1,000 ppm limitation seen in Claim 1: ’502 Patent, paras 145, 148. More to the point, the paragraphs as a whole show the inventors’ concern with the final concentration of the elements from the additive gas in the final powder. Although the claim does not use “within,” it uses the word “comprises,” in contrast to the clear “added content” language of Claims 55 to 59. Read in the context of the disclosure and the claims as a whole, I conclude that paragraphs 144 to 148, if anything, support Mr. Barnes’ construction.

[196] AP&C also cites the discussion of the experimental results set out in Table 2 and paragraphs 180 and 181 of the disclosure. As discussed above, Experiment 1 involved the production of metal powders in four different tests, numbered 1 to 4. Mr. Barnes agreed that the POSITA would understand Test 4 to have been produced with the intentional addition of an *additive gas*, such that it was intended to be illustrative of the invention: Barnes First Report, paras 800–801; Transcript, Day 6, pp 136–137. Table 2 shows that the total chemical composition of oxygen in the powder of Test 4 is 0.112 wt%, or 1,120 ppm, greater than the 1,000 ppm limit of Claim 1. AP&C argues that construing the claims of the patent so as to exclude an illustrative example does not show a “mind willing to understand.”

[197] I agree that examples provided in a patent's disclosure, which are designed to help explain and illustrate the inventor's invention, are relevant to claims construction as part of what a POSITA would read and understand in construing the claims. Indeed, Justice Grammond in *Seedlings (FC)* held that a construction that excludes a preferred embodiment is "suspect": *Seedlings (FC)* at para 58, citing *Bristol-Myers Squibb Canada Co v Teva Canada Limited*, 2016 FC 580 [*BMS Atazanavir (FC)*] at para 335, aff'd on other grounds, 2017 FCA 76. Nonetheless, the Court of Appeal upheld Justice Grammond's construction of the term "rearwardly" despite arguments that it was inconsistent with a drawing of the preferred embodiment: *Seedlings (FCA)* at paras 18–23, aff'g *Seedlings (FC)* at paras 80–83.

[198] It is also worth highlighting that in *BMS Atazanavir (FC)*, cited by Justice Grammond, the Court ultimately rejected Teva's argument that the claim should be construed to include one of the examples described in the patent as an embodiment of the invention: *BMS Atazanavir (FC)* at paras 308, 335, 372. Justice Mactavish noted that Teva had not cited any Canadian authority to support its contention that a claim construction that excludes a preferred embodiment is unlikely to be correct, and found that the example cited in that case was not enough to override the express text of the claim: *BMS Atazanavir (FC)* at para 372.

[199] While I agree that the argument based on Table 2 provides some support for AP&C's construction, I conclude that Table 2 would not lead the POSITA reviewing the entirety of the '502 Patent to understand the 1,000 ppm restriction in Claim 1 to refer to only the "pick-up" of *additive gas*, as opposed to the total amount in the powder. Notably, Table 2 does not present or even permit the calculation AP&C proposes would be implicitly conducted by the POSITA. The

disclosure does not give the amount of oxygen or nitrogen present in the original metal source used in Experiment 1, nor does it deduct that amount from the given 0.112 wt% for the sample of Test 4 to give the pick-up with respect to that test batch: Transcript, Day 15, p 89.

[200] As AP&C points out, the inventors do refer to statistical data analyses, based on many batches, that show the amount of oxygen and nitrogen that injection of *additive gas* in Test 3 and 4 adds to the powders: ’502 Patent, paras 180–181. However, the inventors do not relate this result to the particular information in Table 2. They also present it in language that is more consistent with the “added content” language of Claims 55 to 59 than the “comprising” language of Claim 1, and they provide values of added gas between 50 and 200 ppm that do not readily correlate to the 1,000 ppm limit in Claim 1. Finally, it is worth mentioning that none of the experts, including Dr. Mostaghimi, stated their opinion that the POSITA would understand from Table 2 and/or paragraphs 180 and 181 of the ’502 Patent that this element of Claim 1 would be limited to the pick-up of *additive gas*: Mostaghimi First Report, para 47; Transcript, Day 5, pp 133–137.

[201] Ultimately, the focus must be on the language of the claims, read in light of the knowledge of the POSITA: *Free World Trust* at para 31. While the disclosure, including examples, are relevant to the understanding of the patent as a whole and the claims in particular, care must be taken to ensure that the disclosure is only used to understand and interpret the claims, and not to change the words of the claim as drafted or impose limitations not found in them. To the extent the inventor has misspoken, with the result that the words, fairly construed, create an “unnecessary or troublesome limitation”—such as excluding from the claims an

example given in the disclosure—this is what Justice Binnie memorably called a "self-inflicted wound": *Free World Trust* at para 51.

[202] I therefore conclude that the POSITA would construe the limitation that the *raw reactive metal powder with said surface layer thereon, comprises less than 1000 ppm of at least one element from said at least one additive gas* to mean that the powder as a whole contains less than 1,000 ppm of the element from the *additive gas*, rather than being limited to that portion of the element that was contributed by the *additive gas*.

> (d) *particle size distribution of about 10 to about 53 μm of said raw reactive metal powder with said surface layer thereon, has a flowability less than 40 s, measured according to ASTM B213*

[203] The experts agreed the POSITA would understand claim element 1(e) to mean that a subset of the manufactured particles of powder meeting the given particle size distribution would have a flowability of less than 40 seconds, as measured in a Hall flowmeter in accordance with the ASTM B213 standard: Barnes First Report, paras 364–365; Mostaghimi First Report, para 83.

(4) Surface layer

[204] As set out above, the construction of the claim element 1(d), pertaining to the *surface layer*, was the primary interpretive dispute between the parties. Within this claim element, the meaning of the term *depletion layer* is the main controversy, although there was also some

disagreement over the terms *first layer* and *second layer* and, as will be seen, over the term *layer* itself.

(a) *first layer* and *second layer*

[205] It is an essential element of Claim 1 that the *surface layer* formed with the *additive gas* have at least two layers, namely a *first layer* and a *second layer*: Barnes First Report, paras 324, 336–337; Mostaghimi First Report, para 79. As Dr. Mostaghimi stated, “the surface layer is defined as the two layers”: Transcript, Day 11, pp 79, 86, 102, 105.

[206] Mr. Barnes thought the POSITA would understand the use of the terms *first* and *second* to mean the *first layer* is formed before the *second layer*: Barnes First Report, para 350. He noted that the disclosure describes the formation of the *first layer* and then speaks of the *second layer* as being “further formed”: ’502 Patent, paras 158, 161. Dr. Mostaghimi disagreed, concluding the terms *first* and *second* did not impose a requirement in respect of the timing of the formation of the two layers, while the word “further” would be understood as synonymous with “additionally” or “also”: Mostaghimi Second Report, paras 98–100. Still, Dr. Mostaghimi was of the view that as a matter of thermochemistry, the *first layer* would in fact be formed first: Transcript, Day 11, p 119; see also Cima First Report, para 78 and Transcript, Day 13, p 29.

[207] I agree with AP&C that the POSITA would understand the use of *first* and *second* in Claim 1 as terms used merely to distinguish the two layers, rather than imposing a limitation on the order in which they are formed.

[208] Depending on the context, the words “first” and “second” in a patent claim may signify a temporal or sequential element, or they may simply be used to distinguish between claim elements in accordance with patent drafting conventions: *Guest Tek Interactive Entertainment Ltd v Nomadix, Inc*, 2021 FC 276 at paras 95–101 and the cases cited therein. The POSITA, familiar with such conventions, would review the terms in the context of the claim and the patent as a whole to determine their significance.

[209] Neither the claims of the ’502 Patent nor the discussion in the disclosure give any indication that the timing of formation of the layers is relevant. To the contrary, the inventors also use the alternative terms “layer 1” and “layer 2” to refer to the layers: ’502 Patent, paras 161–162, 164, 191. While Mr. Barnes fairly considered the disclosure in assessing the meaning of the terms *first* and *second*, the mere use of the words “further formed” without any substantive discussion of the timing of formation of the layers says little about the meaning of the terms.

[210] In this context, the POSITA familiar with patent drafting conventions would understand the terms *first* and *second* as terms used in Claim 1 to distinguish between the two layers rather than introducing a requirement regarding the order in which they are formed. In cross-examination, Mr. Barnes conceded this was a plausible reading, and Tekna did not press Mr. Barnes’ construction in closing submissions: Transcript, Day 5, pp 128–131.

(b) *second layer/native oxide layer*

[211] Turning to the nature of the two layers, and beginning with the less controversial one, element 1(d) states that the *second layer* is a *native oxide layer*. A POSITA would understand a *native oxide layer* to be a layer comprised of oxygen and metal atoms in the form of a metal oxide, such as titanium dioxide TiO_2 or aluminum oxide Al_2O_3: Barnes First Report, paras 355–359; Mostaghimi First Report, para 82. Mr. Barnes suggested the term *native* would be understood to refer to an oxide formed from the metal in the powder rather than being applied separately, while Dr. Mostaghimi understood it to mean a layer that is similar to oxide layers that normally or naturally occur on metal powder particles: Barnes First Report, para 355; Mostaghimi First Report, para 82. The difference between these two understandings, if there is one, is immaterial.

[212] The terms *oxide layer* and *native oxide layer* are not new or exclusive to the ’502 Patent: Transcript, Day 11, p 121. The evidence shows use of these terms in scientific papers and patents to describe a layer of metal oxide formed on the surface of reactive metal powders: Barnes First Report, Exhibits JB-8 (pp iii, 1, 8–10); JB-17 (p 64), JB-19 (pp 5–7, 45–48, 54, 77), JB-20 (paras 8–9), JB-24 (col 3), JB-27 (cols 5, 9–10), JB-29 (pp 14, 30), JB-36 (pp 5, 58–59, 64–65). As noted, the inventors state that “[i]t is well known that titanium forms a native surface oxide layer” made essentially of titanium oxides and typically 3–5 nm in thickness, citing the Axelsson 2012 paper: ’502 Patent, para 155; Axelsson 2012, Barnes First Report, Exhibit JB-8.

[213] I pause to note that Axelsson 2012 uses two methods of calculation to determine the thickness of the oxide layer on a titanium powder particle. The first is calculated as the depth where the oxygen content decreases to half its maximum value. The second is calculated using a complex equation (drawn from a 1989 paper), based on the area ratio between the titanium metal and the oxide peaks from XPS data: Axelsson 2012, Barnes First Report, Exhibit JB-8, pp 27, 36, 53; see also Barnes First Report, para 879. The 3–5 nm thickness cited by the inventors appears to come from the second method, since that method shows a range of 34.6 to 45.9 Å, or 3.46 to 4.59 nm, while the first method shows almost doubled thickness measurements, between 61.2 and 117.3 Å, or 6.12 to 11.73 nm: Barnes First Report, Exhibit JB-8, p 37.

[214] As discussed at paragraph [87] above, the POSITA would know that such surface metal oxides are non-reactive, creating a protective shell around a particle. Mr. Barnes opined that the POSITA would therefore understand the *native oxide layer* of Claim 1 to be a “passivation layer”: Barnes First Report, para 359; Transcript, Day 5, p 23. Dr. Mostaghimi agreed: Mostaghimi Second Report, paras 71–73. Mr. Barnes’ reference to the *native oxide layer* as a “passivation layer” is also consistent with the inventors’ observation that “[t]he native oxide acts as a passivation layer and reduces the reactivity”: ’502 Patent, para 155.

[215] While the experts who directly addressed construction agreed the POSITA would understand the *native oxide layer* to be a passivation layer, there was competing evidence about the thermochemistry of this layer, including the speed and manner in which it would be formed and the extent to which it might interfere with the penetration of atoms or molecules into the

particle: Barnes First Report, paras 773–790; Cima First Report, paras 39–89. I need not reach a conclusion on this scientific dispute given my conclusions on other issues.

(c) *first layer/depletion layer*

[216] Element 1(d) states that the *first layer* comprises atoms of the heated *reactive metal source* with atoms and/or molecules of the at least one *additive gas*, and that the *first layer* is a *depletion layer* that is *deeper and thicker* than the *second layer*.

[217] Unlike the term *native oxide layer,* the term *depletion layer* would not have a known meaning to the POSITA from their knowledge of the art: Barnes First Report, para 341; Barnes Second Report, para 31; Mostaghimi First Report, para 81; Transcript, Day 11, p 118. The POSITA would therefore recognize it as a term coined by the inventors for use in the patent. As noted at the outset, it is not a term of art, but a "term of patent": Transcript, Day 15, p 3.

[218] In their arguments and evidence regarding the construction of this claim element, the parties and experts on both sides referred to aspects of the disclosure, recognizing that the POSITA would not fully understand the term *depletion layer* and the limitations regarding the *first layer* from the language of the claim alone. The parties' arguments and the experts' construction of this term bring into focus the importance of considering and construing the language of a claim in light of the disclosure, while not "borrowing this or that gloss from other parts of the specification" to expand or contract the claim under the guise of interpreting its terms: *Whirlpool* at para 52, quoting *Metalliflex Ltd v Rodi & Wienenberger Aktiengesellschaft*, 1960 CanLII 83 (SCC), [1961] SCR 117 at p 122. It also brings into focus the importance of an

inventor doing what the *Patent Act* requires them to do: correctly and fully describe their invention and its operation or use; set out clearly the various steps in a process in such full, clear, concise and exact terms as to enable a POSITA to use it; and provide claims that define distinctly and in explicit terms the subject-matter of the invention for which an exclusive privilege or property is claimed: *Patent Act*, ss 27(3)–(4).

[219] The language of the claim, the patent disclosure, the experts' evidence, and the parties' submissions raise the following related questions with respect to the meaning of the *first layer*/*depletion layer*:

(i) What does *depletion* signify, if anything?

(ii) Do the atoms of the *additive gas* have to be present in the *first layer* in the form of a reaction product such as a metal oxide and/or do they have to be present as a result of diffusion?

(iii) What does the limitation that the *first layer* be a *depletion layer* that is *deeper and thicker* than the *second layer/native oxide layer* require, particularly in terms of the location, size, measurability, and nature of the *depletion layer*?

[220] I will address these three questions in sequence.

(i) *depletion*

[221] In his First Report, Dr. Mostaghimi concluded, without reference to the disclosure of the patent or the common knowledge, that the POSITA would understand the term *depletion layer* to

merely be a name the inventors ascribed to the *first layer*, without introducing any further requirements: Mostaghimi First Report, para 81; Transcript, Day 11, pp 10–11. He reaffirmed this view in cross-examination, suggesting the inventors could have as easily called it a “Rembrandt layer” since it is just a name: Transcript, Day 11, pp 12, 119–120, 122, 126–127.

[222] Mr. Barnes, in an approach more in keeping with the principles of patent construction, concluded the POSITA seeing the term *depletion layer* would have consulted the disclosure of the ’502 Patent to try to better understand it: Barnes First Report, paras 338–350, citing ’502 Patent, paras 135, 156–158, 161. Mr. Barnes concluded the term *depletion* would be understood to mean that the quantity or concentration of the element from the *additive gas* decreases within the *first layer* as one moves toward the centre of the particle: Barnes First Report, paras 344–345.

[223] In my view, Mr. Barnes’ construction is consistent with how the POSITA would understand the inventors’ use of the word *depletion* in the term *depletion layer*. As Tekna argues, Dr. Mostaghimi’s approach would render the word *depletion* meaningless, effectively ignoring the inventors’ choice to use the additional term *depletion layer* to describe the *first layer*. While the word *depletion* on its own might signify a number of things to the POSITA, the POSITA reviewing the claims in light of the patent as a whole would see that the inventors refer on several occasions to atoms and/or molecules that are “depleting through the thickness” of the layer and would understand the inventors’ use of *depletion layer* in Claim 1 as reflecting this meaning: ’502 Patent, paras 156, 161. Indeed, Dr. Mostaghimi’s assertion that *depletion layer* is “just a name” seems inconsistent with his own recognition that the POSITA would understand

that the atoms of *additive gas* would “deplete” through the thickness of the *surface layer* and his connection of this to the term *depletion layer*: Mostaghimi Second Report, paras 349, 356.

[224] I conclude the POSITA would understand that the inventors chose the term *depletion layer* to signify a depletion/reduction in concentration of the atoms from the *additive gas* through the thickness of the layer. As the parties recognize, however, this depletion is not the only characteristic of the *first layer*.

(ii) *comprising atoms of said heated reactive metal source with atoms and/or molecules of said at least one additive gas*

[225] The parties agree the *first layer* must contain atoms of the *reactive metal source* and atoms and/or molecules of the *additive gas*. However, they disagree as to whether the POSITA would understand that the atoms of the *additive gas* must be present in the *first layer* (a) in the form of a reaction product, such as a metal oxide, rather than in their original form, such as elemental oxygen (O_2); and (b) as a result of diffusion from the surface of the particle.

[226] Mr. Barnes concluded the POSITA would interpret the phrase *comprising atoms of said heated reactive metal source with atoms and/or molecules of said at least one additive gas* to mean the *first layer* is the result of a chemical reaction between the *reactive metal source* and the *additive gas*: Barnes First Report, paras 338–340. In other words, the atoms of the *reactive metal source* are “with” the atoms and/or molecules of the *additive gas* in the sense of them being in a compound that is the reaction product, such as a metal oxide. He also concluded that the formation of the *depletion layer* would involve the diffusion of this reaction product/oxide

compound into the powder particle: Barnes First Report, paras 341–343. Mr. Barnes reached these conclusions based on the language of the claim, the discussion in paragraphs 135, 156, and 157 of the disclosure, and the POSITA's knowledge of factors affecting diffusion.

[227] Dr. Mostaghimi's initial construction—again given briefly without explanation or consideration of the disclosure or the CGK—was simply that the *first layer* must include atoms from the *reactive metal source* "and" a component from the *additive gas*: Mostaghimi First Report, para 80. In his Second Report, Dr. Mostaghimi disagreed with Mr. Barnes' construction, opining that the POSITA would understand that Claim 1 only requires atoms or molecules of the *additive gas* in the *first layer* to be "added to or combined with" atoms of the *reactive metal source*, without restriction on how they were added or combined, and in particular without requiring a chemical reaction: Mostaghimi Second Report, paras 76–79.

[228] Dr. Mostaghimi also disagreed the POSITA would understand Claim 1 to require diffusion of the element into the *depletion layer*. While he agreed it could involve diffusion, he considered that since Claim 1 does not refer to diffusion and does not specify the mechanism of formation of the *depletion layer*, the claim would encompass processes that have a *depletion layer* formed by any mechanism, such as oscillation and convective currents in the atomization process: Mostaghimi Second Report, paras 82–84, 241–244; Transcript, Day 11, pp 15, 23–26. Dr. Cima, responding to an invalidity issue, referred to the diffusion of oxygen into the particles to create the *depletion layer*, without discussion of oscillation or convective currents: Cima First Report, paras 27–28, 53–56; 81–88.

[229] In closing submissions, Tekna endorsed Mr. Barnes' construction: Tekna Closing Argument, paras 64–65; Transcript, Day 14, pp 59–63.

[230] AP&C submitted in its closing that the *depletion layer* would be understood as "an oxygen diffusion zone beneath a native oxide layer": AP&C Closing Argument, paras 6, 386; Transcript, Day 15, pp 57–58, 70. This definition—raised for the first time in closing argument—suggests that the oxygen enters the *depletion layer* by way of diffusion, contrary to Dr. Mostaghimi's opinion. At the same time, AP&C also referred to his oscillation and convection theories, and ultimately submitted that the principles of claim construction did not permit the Court to read Claim 1 as restricted to diffusion: Transcript, Day 15, pp 55–56; 63–64; 66–67; Mostaghimi Second Report, paras 82–84. Since AP&C argues that the mechanism is not limited to diffusion, its proposed definition of the *depletion layer* essentially amounts to simply "an oxygen zone beneath a native oxide layer."

[231] AP&C similarly argued that to interpret Claim 1 as requiring the *depletion layer* to be formed from the reaction product of the *additive gas*, such as an oxide, would inappropriately read a limitation from the disclosure into the claim: Transcript, Day 15, p 67. The "oxygen" in AP&C's "oxygen [diffusion] zone beneath a native oxide layer" definition is thus not limited to that present in the form of a reaction product with the metal: AP&C Closing Argument, paras 105–107.

[232] I agree with Mr. Barnes that review of the disclosure would give the POSITA a number of indications that the inventors understood that (a) the atoms or molecules of the *additive gas*

were present in the *depletion layer* in the form of a chemical reaction product, and (b) diffusion was the mechanism by which those atoms or molecules enter the *depletion layer*.

[233] Paragraph 135 of the ’502 Patent states that the “reaction” between the metal particles and the additive gas can take place “as long as the metal particles are sufficiently hot to allow the electronegative atoms and/or molecules to diffuse several tens of nanometers into the surface layer.” The POSITA would understand the relationship between temperature and both reactivity and diffusion: Barnes First Report, paras 107–110, 153–161.

[234] Paragraph 156 similarly describes the *first layer* as containing the reaction product, referring to a “first layer formed of a compound of the heated metal with the additive gas,” and giving specific examples of metal oxide, nitride, carbide, and halide. The same paragraph refers to the depletion of the atoms through the thickness of the *surface layer* as forming a “non stoichiometric compound”—which the POSITA would recognize as often being found in compositions of metal oxides such as titanium oxide—causing the *first layer* to have a substantially positive charge: Barnes First Report, paras 97–95; Cima First Report, para 72, Exhibit P, p 3688; Cima Second Report, para 31; Transcript, Day 13, p 20. Paragraph 157 then reiterates that the *first layer* is only formed at high temperature because the electronegative atoms or molecules “need to have enough energy to diffuse much more into the surface layer than in a native oxide layer.” No other mechanism than diffusion is suggested by the inventors as to how the atoms of the *additive gas* end up in the *depletion layer*.

[235] To the same effect, the inventors’ discussion of the schematic diagram in Figure 3, which shows the electronegative *native oxide layer* outside the electropositive *depletion layer*, states that the *first layer* is formed on the outer surface of the particle and “results from the compounding of the heated metal with the electronegative atoms and/or molecules that are depleting through the thickness”: ’502 Patent, para 161.

[236] The inventors also define the *heat zone of an atomizer* as a zone “where the powder is sufficiently hot to react with the electronegative atoms of the additive gas in order to generate a depletion layer,” and refer to the need for a “a sufficient deep and depletion oxide/nitride layer on the particle”: ’502 Patent, paras 38–39, 134, 191–192.

[237] At the same time, the POSITA would also recognize the inventors’ insistence that they were not “bound by the theory” regarding electronegative atoms from the *additive gas* or the substantially positive charge created in the *depletion layer* by the presence of a non-stoichiometric compound: ’502 Patent, paras 156, 192. Most of the foregoing references to the creation of compounds takes place in the context of the inventors’ discussion of that theory. The POSITA would also note the inventors’ discussion of standards regarding the chemical composition of alloys, and the need to control the total amount of *additive gas* to keep within the limits of such standards: ’502 Patent, paras 142–148, 183; see paragraphs [86] and [193] to [194] above. The evidence indicates that the limits in such standards relate to the total amount of an element without specifying its form (*e.g.*, oxide or elemental oxygen): Barnes First Report, paras 189–190, 477–479, Exhibit JB-8, p 21; Shallenberger Second Report, Exhibit JS-7. The inventors also tested the powders produced in a manner showing (i) the chemical composition of

the particles, and (ii) the oxygen profile of the surface through techniques showing the total amount of oxygen, rather than the amount of oxide in particular: ’502 Patent, paras 178–179, Table 2, Figure 5.

[238] Ultimately, the focus must remain on adhering to the language of the claims, read and understood in the context of the patent as a whole. In Claim 1, the inventors elected to put a number of specific limitations on the *first layer*: it is part of the *surface layer* formed with the *additive gas*; it comprises *atoms of said heated reactive metal source with atoms and/or molecules of said at least one additive gas*; and it is a *depletion layer* that is *deeper and thicker* than the *second layer*/*native oxide layer*. However, they did not include other aspects of the *depletion layer* discussed in the disclosure, including its formation through the diffusion of a reaction product into the layer.

[239] In Claim 1 itself, the inventors do not refer to a reaction between the *reactive metal source* and the *additive gas* to form the *first layer*, they do not refer to a “compound” of the heated metal with the *additive gas*, and they do not use the term “depletion oxide/nitride layer” used in the disclosure. Reading the claim in context, I conclude the POSITA would not understand the reference to the *first layer* as *comprising atoms of said heated reactive metal source with atoms and/or molecules of said at least one additive gas* as requiring that the atoms from the *additive gas* be present in the *first layer* in the form of the reaction product.

[240] Similarly, the language of Claim 1 does not refer to the mechanism by which the atoms and/or molecules of the *additive gas* reach the *first layer*. It simply states that the *first layer*, as

part of the *surface layer*, is formed with the *additive gas*. Interpreting this language, or the term *depletion layer*, to include as an essential element that the atoms of the *additive gas* enter the *depletion layer* through the mechanism of diffusion would go beyond a reasonable interpretation of these terms and enter into the realm of reading limitations into the claim based on the discussion in the disclosure. In other words, the claim language requires the *depletion layer* to comprise atoms of the *reactive metal source* with atoms of the *additive gas*, but does not place limitations on how the atoms got there.

[241] Given the primacy of the claim language in construction, I conclude that a POSITA construing Claim 1 purposively and in light of the entirety of the patent and the CGK would conclude that it does not include a limitation or requirement either that the atoms of the *additive gas* are present in the *depletion layer* in the form of a reaction product or—despite AP&C's own submission that the *depletion layer* is a "diffusion zone"—that diffusion is the operative mechanism: *Free World Trust* at para 40. In other words, while the inventors may have understood or theorized that the *additive gas* is present in the *depletion layer* (a) in the form of a reaction compound; and (b) as the result of diffusion, they did not require this to be so or restrict their claims to that understanding.

[242] Conversely, however, Claim 1 does not limit the *atoms and/or molecules of said at least one additive gas* in the *depletion layer* to those in their unreacted state (*e.g.*, elemental oxygen rather than in the form of a metal oxide). Thus, to the extent that AP&C's definition of an "oxygen [diffusion] zone beneath a native oxide layer" suggests that the POSITA would understand the oxygen in the *depletion layer* to necessarily be in its elemental form, I disagree.

(iii) *deeper and thicker*

[243] The final requirement of the *depletion layer* set out in Claim 1 is that it be *deeper and thicker* than the *native oxide layer*. The evidence and the parties' submissions on this, which overlapped with their submissions on the *depletion layer* generally, raise several interrelated construction issues.

deeper and thicker: one requirement or two?

[244] The first question is whether the terms *deeper* and *thicker* impose separate requirements or whether they are essentially synonymous. While the parties ultimately agreed that the two terms impose two separate requirements, it is worth reviewing the evidence and different positions taken by the experts on the issue, as they raise important questions about the explanations in the patent.

[245] Mr. Barnes concluded the POSITA would understand the terms *deeper* and *thicker* to impose separate requirements with respect to the *depletion layer*, with *deeper* meaning closer to the centre of the particle and *thicker* meaning have a greater thickness when considered along the radius of a generally spherical particle: Barnes First Report, paras 351–352.

[246] Dr. Mostaghimi, however, construed the term as meaning that the *first layer* "must have a depth (or thickness) greater than that of the second layer" [emphasis added]: Mostaghimi First Report, para 81. He contended, with reference to the graphs in Figure 3 reproduced at paragraph [123] above, that both the *first layer* and the *second layer* started at the surface of the

particle: Transcript, Day 11, pp 5–6, 16; Exhibit M (for identification), p 17, citing Mostaghimi First Report, para 37. On this approach, *deeper* and *thicker* have essentially the same meaning, since a *depletion layer* that starts at the outer surface of the particle (where the *native oxide layer* also starts) and goes *deeper* into the particle than the *native oxide layer* is necessarily also *thicker* than the *native oxide layer*.

[247] AP&C put this suggestion to Mr. Barnes, presenting a diagram in which the two graphs in Figure 3 were overlaid, and suggesting that there may be an overlap of the two layers, each having a depth that begins at the y-axis: Transcript, Day 5, pp 142–145; Exhibit B (for identification). The "Depletion Layer" graph in Figure 3 can certainly be read as showing a *depletion layer* that starts at the outer surface of the particle, since it shows the oxygen concentration of the *depletion layer* starting at the y-axis, which presumably represents a depth of 0 nm. This would be consistent with the measurement δ shown in the schematic diagrams in Figure 3 and Figure 4, defined in the disclosure as the "depletion depth," which is indicated as starting at the outer surface of the particle: '502 Patent, para 165, Figures 3, 4.

[248] However, the POSITA would recognize that the two graphs in Figure 3 cannot simply be overlaid or coexist within the same particle, as this would mean that the same particle had two very different average oxygen concentrations at the same depth (*e.g.*, the depth of X nm), which is plainly impossible. Dr. Mostaghimi's explanation that the "Concentration Profile Native Oxyde Layer" graph shows oxide concentration only while the "Depletion Layer" graph shows total oxygen concentration is unconvincing for a number of reasons: Transcript, Day 11, pp 18–22. First, the graphs are labeled in the same way, each y-axis simply representing "O(%)," rather

than oxygen in a particular form. Second, Figure 3 cannot be read independently of the inventors' own discussion of the figure. That discussion specifically states that Figure 3 shows a *first layer* that results from the "compounding of the heated metal with the electronegative atoms" [emphasis added] and the reaction rate of the chemical reaction, indicating that the *depletion layer* as shown in Figure 3 is comprised of the reaction product (*e.g.*, metal oxide) that also makes up the *native oxide layer*: '502 Patent, paras 161–164. The inventors' discussion of Figure 3 also follows the theory that the *first layer* has a substantially positive charge, as depicted in the schematic of Figure 3, and refers back to the inventors' discussion that this is caused by the non stoichiometric presence of metal oxide: '502 Patent, paras 156, 161, 163–164.

[249] Further, while the graphs in Figure 3 can be read as showing a *depletion layer* that starts at the outer surface, the schematic in Figure 3 shows the *native oxide layer* (labeled 164) as being distinct from the *depletion layer* (labeled 148)—to the extent of having a different net charge—and starting inside the *native oxide layer*: '502 Patent, paras 159, 161; Mostaghimi First Report, para 37. This inconsistency, even within Figure 3 itself, would leave the POSITA uncertain as to the inventors' intention. It is not surprising that Mr. Barnes' impression upon reading Figure 3 as a whole was that "it was not obvious and super clear": Transcript, Day 5, pp 143–144. Even after expert evidence and argument from the parties, it remains far from clear to the Court how the schematic in Figure 3 is intended to relate to the graphs in Figure 3.

[250] This said, the schematic in Figure 3, showing the *depletion layer* beneath the *native oxide layer* (*i.e.*, starting where the *native oxide layer* ends) is consistent with the discussion in paragraph 156 of the disclosure, where the inventors state that the *first layer* is "thicker and

deeper in the surface <u>and is located below the native oxide layer</u>" [emphasis added]. As noted, the inventors then refer back to that discussion when describing Figure 3: '502 Patent, para 161.

[251] I note that Dr. Mostaghimi's evidence on this point has some internal inconsistency. In his oral testimony, Dr. Mostaghimi clearly stated his view that the *depletion layer* and the *native oxide layer* both began at the outer surface of the particle: Transcript, Day 11, pp 5–6, 16. This means that the *native oxide layer* necessarily and entirely overlaps with the *depletion layer*, as it would occupy the same physical region of the particle as the outer portion of the *depletion layer*. However, in responding to Mr. Barnes' evidence on construction, which included Mr. Barnes' view that the *depletion layer* began where the *native oxide layer* ended, Dr. Mostaghimi did not assert that they both started at the outer surface. Rather he said the POSITA would understand that the "two layers that comprise the surface layer <u>may overlap</u> each other" [emphasis added]: Mostaghimi Second Report, paras 85–90.

[252] In closing submissions, AP&C itself rejected Dr. Mostaghimi's contention that both the *depletion layer* and the *native oxide layer* start at the outer surface of the particle, acknowledging that the POSITA would understand each word in Claim 1 to have a meaning, and that the *depletion layer* starts below or beneath the *native oxide layer*: Transcript, Day 15, pp 58–60, 73–74. As a result, the parties are effectively aligned, both agreeing that the *depletion layer* is distinct from and inside the *native oxide layer,* rather than starting at the outer surface, and that it is *thicker* than the *native oxide layer*: Transcript, Day 15, pp 60, 69.

[253] I agree. The claim includes *deeper* and *thicker* as separate criteria, which must be presumed to each have meaning. The POSITA would recognize that the inventors generally refer to depth and thickness as different parameters in the disclosure, and that the preponderance of the disclosure indicates that the *depletion layer* is a separate layer that begins inside the *native oxide layer,* despite the lack of clarity described above: ’502 Patent, paras 156, 161–162, 164–165, 179, 189, 191. This construction is also consistent with dependent Claim 45, which requires the *first layer* to have a substantially positive charge, the *second layer* to have a substantially negative charge, and the two layers to have a combined charge that is substantially neutral. This dependent claim would make no sense at all if the *first layer* and the *second layer* both started at the outer surface of the particle.

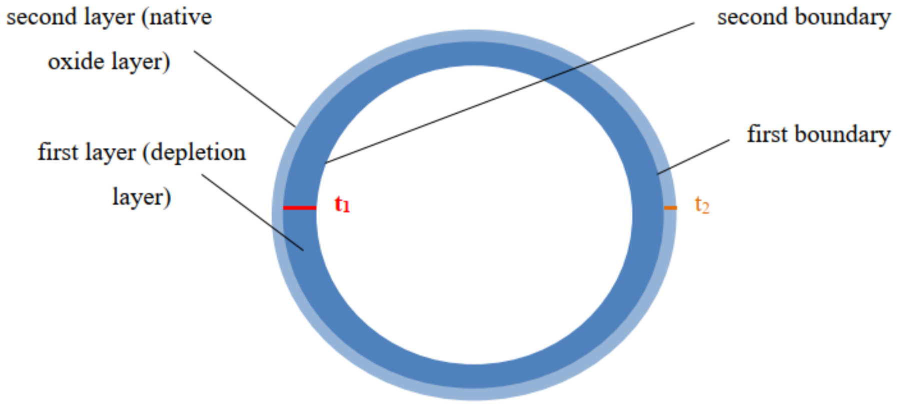
deeper and thicker: making the comparisons

[254] The next—and most significant—construction issue arising from the requirement that the *depletion layer* be *deeper and thicker* than the *native oxide layer* pertains to how the comparisons invoked by the comparative terms *deeper* and *thicker* are to be made.

[255] As the parties agree, the *depletion layer* must be beneath the *native oxide layer*, and thus *deeper* than it. The requirement that it also be *thicker* inherently means that the *depletion layer* has a greater thickness than the *native oxide layer*: Barnes First Report, para 352; Mostaghimi Second Report, para 97; Transcript, Day 15, pp 69–70. But how is the depth and/or thickness of the one layer to be compared to that of the second to make the determination? This question raises the issue of whether the two layers would be understood to have boundaries that serve as

limits to allow for measurement and, if so, where those boundaries are or, if not, how the depth and/or thickness comparison is to be undertaken.

[256] Mr. Barnes opined that the POSITA would understand the term *layer* to refer to a region with definable boundaries, allowing the *depletion layer* to be differentiated from the *native oxide layer* and from the remainder of the particle: Barnes First Report, paras 346–347. He illustrated this with the following diagram, showing the layers, boundaries, and the thicknesses of each layer (t_1 for the thickness of the *first layer*, t_2 for the thickness of the *second layer*):



[Description: Two concentric circular layers are presented, with a large white space inside them. A thinner outside circular layer is presented in light blue, labeled "second layer (native oxide layer)," with a thicker dark blue circular layer immediately inside it, labeled "first layer (depletion layer)". The border between the outer light blue layer and the inner dark blue layer is labeled "first boundary." The border between the inner dark blue layer and the central white space is labeled "second boundary." A red line runs across the width of the dark blue layer, labeled t_1. An orange line runs across the width of the light blue layer, labeled t_2.]

[257] Despite Dr. Mostaghimi's contrary suggestion, I do not take Mr. Barnes' presentation of this schematic diagram—which has clear similarities to the schematic in Figure 3 of the '502 Patent—to suggest that the POSITA would understand the two layers to be "perfectly circular and uniform in shape, without any overlap and abutting": Mostaghimi Second Report, paras 85–90; Transcript, Day 11, pp 15–16, 128. As Mr. Barnes' discussion of the CGK shows, the POSITA would know that while sphericity is a desirable attribute and plasma atomization

may produce highly spherical particles, “spherical” powders are not perfectly spherical: Barnes First Report, paras 162, 182(c), 224, 243, 251, 253. Similarly, the *surface layer* of a particle would not be expected to be perfectly spherical. Like Figure 3, I take Mr. Barnes’ diagram to be an explanatory schematic to illustrate the POSITA’s understanding, rather than an attempt to accurately depict exactly what is happening in a real-world powder particle.

[258] The more important question, however, is whether the *layers* described and claimed in Claim 1 have some form of definable boundary allowing for measurement of depth and/or thickness. AP&C contests Mr. Barnes’ assertion that the POSITA would understand that the *layers* have definable boundaries. It points to Dr. Mostaghimi’s evidence that scientists know that “layers” can have unclear boundaries, giving as examples the atmospheric layer, or boundary layer theory in fluid mechanics: Transcript, Day 11, pp 15–17, 127–128:

> I mean, these layers, you know approximately where they start and where they end. And it’s true throughout, I mean, science and engineering. I mean, we call atmospheric layer 300 kilometres, but you could say it’s 320 and 280 kilometres and not -- because there is not a clear 0 and 1 in these particular cases. You asymptote to a level, and depending on what you agree, you can say this is the cut-off for my layer, basically, and it will not change much if you change your cut-off by a per cent or two per cent or more.
>
> […]
>
> You see, when you go to science and theory, basically, layers are not zeros and one[s], okay. I can give you a very famous -- in fluid mechanics, we have boundary layer theory. Suppose a flow is moving over surface. What will happen when it touches the surface, the viscosity causes it to stop. And then it goes to this velocity which is here. So, this goes through a layer.
>
> Now, theoretically, this in infinite, but practically, what we say, we say okay if the velocity is at 99 per cent of the free stream velocity, that is the thickness of my boundary layer. And that’s where all the activities in terms of transfer of energy momentum happens.

> [Emphasis added; see also Mostaghimi Second Report, paras 87–90.]

[259] I note that in the examples given by Dr. Mostaghimi—the atmospheric layer and boundary layer theory—the layers do have a boundary (*i.e.*, they are not boundless), even if that boundary is not defined by a clear line or a precise point. Further, Dr. Mostaghimi's examples each describe some form of consensus on how to determine the boundary, with that consensus depending on the nature of the layer. In reference to the atmospheric layer, he states that "[y]ou asymptote to a level, and depending on what you agree, you can say this is the cut-off for my layer." In reference to boundary layer theory, he states that "what we say, we say […] if the velocity is at 99 per cent of the free stream velocity, that is the thickness of my boundary layer." Thus, the scientific recognition that the boundaries of a layer may be imprecise is coupled with an effort to nonetheless define or approximate the boundary through identifiable means.

[260] Another example of this appears to be measurement of the *native oxide layer*. As noted above at paragraph [213], the Axelsson 2012 paper cited in the patent uses two identified calculation methods to measure the depth of the native surface oxide layer and explains those methods to the reader. The inventors refer to one of these measurements in describing the typical thickness of a native surface oxide layer, and no party or expert took issue with this estimate: '502 Patent, para 155.

[261] I accept that a *layer* as a POSITA would understand it can describe a region whose boundaries have some degree of imprecision. A powder particle is not a Nanaimo bar, with clear and visible boundaries between the chocolate layer, the custard layer, and the coconut/crumb

base. I also agree with AP&C that the comparison in Claim 1 only requires that the layers be measurable to the extent of being able to determine whether the *depletion layer* is distinct from, and *deeper and thicker* than, the *native oxide layer*, rather than necessarily having a specific thickness measured with accuracy: Transcript, Day 15, pp 69–70, 73–74.

[262] However, the POSITA reviewing Claim 1 and considering a powder particle with a *surface layer* comprising a *first layer*/*depletion layer* and a *second layer*/*native oxide layer* would recognize that they would necessarily have to have some way of (a) distinguishing between the two layers, given the importance to the claim of having not one but two layers; and (b) comparing their depth and thickness in order to determine whether the *first layer* is *deeper and thicker* than the *second layer*. AP&C conceded this was the case: Transcript, Day 15, pp 69–70, 73–74. In this regard, AP&C's definition of a *depletion layer* as an "oxygen [diffusion] zone beneath a native oxide layer" addresses its depth to some degree (it is "beneath" the *native oxide layer*) but does not address its thickness.

[263] As noted at the outset, the parties agree the term *depletion layer* is not a known term in the art but one that was created by the inventors. There is therefore no acknowledged standard in the art or scientific consensus for how the thickness of a *depletion layer* is to be determined, how to distinguish between a *native oxide layer* and a *depletion layer*, or how to compare the depth and thickness of such layers. Nor did any of the experts assert that the CGK of the POSITA included knowledge of a standard method for determining thickness of layers in a powder particle. The question thus returns to how the POSITA reading the '502 Patent would understand the two layers to be distinguished, and how to compare their depth and thickness.

[264] In the passage of his evidence reproduced above, Dr. Mostaghimi suggests that a POSITA would "know approximately where [the layers] start and where they end," a statement that AP&C relied on in closing arguments: AP&C Closing Argument, para 109. However, Dr. Mostaghimi made clear immediately after this statement that in his view the *depletion layer* started at the outer surface of the particle, an interpretation which AP&C itself rejected: Transcript, Day 11, pp 15–16. He did not elaborate in his oral testimony on where he thought the approximate end of the *depletion layer* (what Mr. Barnes calls the "second boundary") would be.

[265] In his Second Report, Dr. Mostaghimi did discuss where the POSITA would understand the second boundary to be. He considered three scenarios: (i) a particle in which the concentration of *additive gas* reaches zero; (ii) a particle in which the concentration of *additive gas* does not reach zero, and the added element is also present in the particle from the original metal source (*i.e.*, the element may have come from the *additive gas* or from the *reactive metal source*); and (iii) a particle in which the concentration of *additive gas* does not reach zero, and the added element is not otherwise present in the particle from the original metal source (*i.e.*, the element can only have come from the *additive gas*): Mostaghimi Second Report, paras 91–97. He suggests the POSITA would understand different ways for determining the end of the *depletion layer* in each of these three scenarios.

[266] In the first, he agrees with Mr. Barnes that the *depletion layer* would end at the point of zero concentration: Mostaghimi Second Report, para 93; Barnes First Report, para 349. In the second, he contends the POSITA would understand the boundary to be the point at which the rate of decline of the added element is effectively zero (*i.e.*, the first derivative of the concentration vs depth curve is effectively zero): Mostaghimi Second Report, paras 94–95. In the

third, he contends the POSITA would conclude that the second boundary continues to the centre of the particle, but that such a particle would not be within the scope of the claims because the *depletion layer* would cease to be a *surface layer* since it would extend through the entire particle: Mostaghimi Second Report, para 96.

[267] Dr. Mostaghimi provided no explanation why the POSITA reading the patent would understand the inner boundary of the *depletion layer* to be defined in this way, particularly with respect to the second and third scenarios. He did not refer to or identify any aspect of the CGK or the patent that would lead the POSITA to this conclusion.

[268] Curiously, and significantly, he also did not apply this construction in assessing whether powder particles manufactured by AP&C and Tekna had a *depletion layer* that is *deeper and thicker* than the *native oxide layer*: Mostaghimi Second Report, paras 465–489, 497. Those particles would fall into Dr. Mostaghimi’s second category, since the *additive gas* being measured (oxygen) was already present in the source titanium alloy. On Dr. Mostaghimi’s evidence, the POSITA would know that the *depletion layer* of such particles ended when the rate of decline of oxygen is “effectively zero.” However, Dr. Mostaghimi did not assess where that point was on any of the particles, or whether any or all of the particles had a *depletion layer* measured by this standard that was *deeper and thicker* than the *native oxide layer*. Rather, he conducted a comparative analysis of ToF-SIMS profiles, an approach discussed further below. I also note that Dr. Mostaghimi’s evidence with the respect to the third scenario confirms his recognition that the *depletion layer* must have <u>some</u> inner boundary, or else it ceases to be part of a surface layer.

[269] Notably, Dr. Mostaghimi's opinion on this subject directly conflicts with that of Dr. Cima, on which AP&C also purports to rely. AP&C asserts in closing submissions that "Dr. Cima similarly did not appear to have any difficulty in understanding the confines of the depletion layer when asked by the Court": AP&C Closing Argument, para 111. The reference AP&C is making is to Dr. Cima's answers to questions from the Court seeking clarification of his statement that the *depletion layer* observed in experiments on AP&C and Tekna powder particles was "tens of nanometers thick": Cima First Report, para 135; Confidential Transcript, Day 13, pp 15–16, 33–35. Dr. Cima stated that this estimate started from "the interface below the oxide, which is roughly six nanometres thick," an estimate he based on a change in the slope of the oxygen signal in the ToF-SIMS profile, and that it ended at a point at approximately 23% of the maximum (a value he apparently derived from e^{-1}), which he described as being a convention for determining the "diffusion distance": Confidential Transcript, Day 13, p 34.

[270] Dr. Cima's evidence in this regard was surprising. At no point in either of his reports or in his oral testimony in chief or cross-examination did Dr. Cima suggest that the end of the *native oxide layer* and the start of the *depletion layer* could be determined on the basis of an observable change in slope in the ToF-SIMS profiles, either in the '502 Patent or in the parties' experimental results, or that the end of the *depletion layer* was at 23% of maximum concentration. The Court, without Dr. Cima's expertise, does not see the change in slope at around 6 nm Dr. Cima is referring to, either in the ToF-SIMS profiles of the '502 Patent or in those presented in the parties' experimental results. Dr. Cima's evidence did not identify either of these two points in the four ToF-SIMS profiles in Figure 5 of the '502 Patent, or in *any* of the various profiles presented in evidence, to permit the Court to understand his evidence. Nor did he compare the resulting *depletion layer* with the *native oxide layer*. As with Dr. Mostaghimi,

Dr. Cima's analysis of whether the parties' powder particles had a *depletion layer* did not use this assessment: Cima First Report, paras 115–131. AP&C, not surprisingly, placed little reliance on either suggestion in closing argument. Yet it still asserted that Dr. Cima did not appear to have any difficulty in understanding the confines of the *depletion layer*: Transcript, Day 15, pp 160–162.

[271] Thus, while AP&C asserts that both Dr. Mostaghimi and Dr. Cima stated that the POSITA would know the confines of the *depletion layer*, the two proposed completely different opinions on both the starting point and the end point of the layer. Dr. Mostaghimi opined that the POSITA would understand it started at the outer surface of the particle and ended at one of several points depending on the nature of the *additive gas* and the particle, including where the rate of decline is effectively zero. Dr. Cima opined that it started under the *native oxide layer* at a point determined by a change in slope he saw in the ToF-SIMS profiles, and ended at a point at 23% of the maximum concentration.

[272] I reject the contention that the POSITA would understand the *thickness* of the *depletion layer* in accordance with either the evidence of Dr. Mostaghimi or that of Dr. Cima described above. I have rejected above Dr. Mostaghimi's opinion that the *depletion layer* would be understood to begin at the outer surface of the particle, as did AP&C. I also reject his assertion that the POSITA would understand that it ends approximately at one of three places depending on the nature of the *additive gas* and the *reactive metal source* and, in particular, that for the second of the scenarios, it would end where the rate of decline of oxygen is effectively zero. There is no teaching or other indication in the '502 Patent that the inventors meant to apply multiple approaches to assess the *depletion layer*, and no discussion of rates of decline as a

means to assess whether the *depletion layer* is *deeper and thicker* than the *native oxide layer*. Dr. Mostaghimi did not explain why a POSITA would adopt this approach based on their CGK. He also did not explain how a POSITA would understand or use this approach to distinguish between the particles that the inventors state have a *depletion layer* (Tests 1 and 2) from those that do not (Tests 2 and 3). Nor did he himself apply the approach.

[273] Dr. Cima's evidence was not directed to how the POSITA would understand the '502 Patent, but how *he* estimated the thickness of the *depletion layer*. Dr. Cima did not state that the POSITA would understand the *depletion layer* to start at an identifiable change in slope in the ToF-SIMS profile and end at a point at which the oxygen concentration would be at 23% of the maximum concentration, or explain why they would understand that based on reading the '502 Patent in light of their CGK. In any event, his assertions, raised for the first time in answers to clarification questions, are unsupported by anything in either the remainder of the evidence or the '502 Patent. They certainly do not appear to be based on the ToF-SIMS profiles presented in the '502 Patent, where only one of the four curves ever gets as low as 23% of maximum concentration (*i.e.,* 0.23 on the y-axis). His reports do not show where either of these points are on any given curve, and he did not explain how the POSITA would understand or use this approach to distinguish between the particles that the inventors state have a *depletion layer* from those that do not.

[274] Ultimately, while AP&C referred to Dr. Mostaghimi and Dr. Cima's evidence on these points, its primary submission is that the '502 Patent itself provides a way to determine that the *depletion layer* is *deeper and thicker* than the *native oxide layer,* namely by comparing the oxygen concentration profiles or ToF-SIMS signatures of particles that have been treated with

additive gas and those that have not been treated: AP&C Closing Argument, paras 7, 112; Transcript, Day 15, pp 3, 38, 57–59, 70–76, 79, 83–85, 181. In particular, it contends that a powder particle has a *depletion layer* if it has a normalized ToF-SIMS signature with a “tail”—to use the language of paragraph 179—that lies above that of a particle prepared without *additive gas*: Transcript, Day 15, pp 58, 74–75, 83–85. AP&C’s definition of the *depletion layer* as an “oxygen [diffusion] zone beneath a native oxide layer” has to be read in conjunction with this aspect of the *depletion layer*: Transcript, Day 15, p 58.

[275] A number of AP&C’s arguments elevate the ToF-SIMS testing profile to a definitional level. For example, it submits the ’502 Patent (and the ’236 Patent) “describe the ‘depletion layer’ by reference to a ToF-SIMS signature […]” and that the inventors exercised their ability to act as lexicographer by providing “specific guidance as to the meaning of a depletion layer”: AP&C Closing Argument, paras 7, 112; AP&C Closing Slides, pp 4, 83–84. Similarly, AP&C argued that the purpose of Figure 5 “is to tell you <u>what is the patent</u> […] which is a signature that <u>defines itself</u> by the disparity between a treated and non-treated powder” [emphasis added]: Transcript, Day 15, p 76, see also p 74.

[276] At the same time, AP&C in closing submissions took the position that the existence of a *depletion layer* is a “state of matter,” rather than being defined by its ToF-SIMS profile, *i.e.*, that a *depletion layer* exists or it does not, and that ToF-SIMS is simply one among many potential ways of testing whether or not that state of matter is present: Transcript, Day 15, pp 135–137.

[277] I repeat paragraphs 178 and 179 and Figure 5 here for ease of reference, with underlining for emphasis and with the clarifying annotations of Dr. Mostaghimi on Figure 5:

> [00178] Fig. 5 is a graph illustrating the oxygen profile comparison between different samples by TOF-SIMS. The TOF-SIMS signature of powder is obtained for Test 1 to 4. <u>The presence of a depletion layer can be associated with the high flowability powders as can be seen in Table 1</u>.
>
> [00179] The TOF-SIMS signature of a fine powder that has been treated can be clearly seen from the Fig. 5. A tail in the oxygen content enters deeper in the surface layer. It is critical to obtain this depletion layer with a certain critical depth in order to get the improved flowability behavior. The TOF-SIMS results suggest that the depletion layer has a depth of the order of 100 nm. The depth can be estimated by calibrating the sputtering rate of the ion beam obtained on a Ti-6A1-4V bulk part with a profilometer. The sputtering rate depends of the ion beam intensity and of the type of material. The calibration is done prior to measurements and the ion beam energy is very stable.
>
> [Emphasis added.]

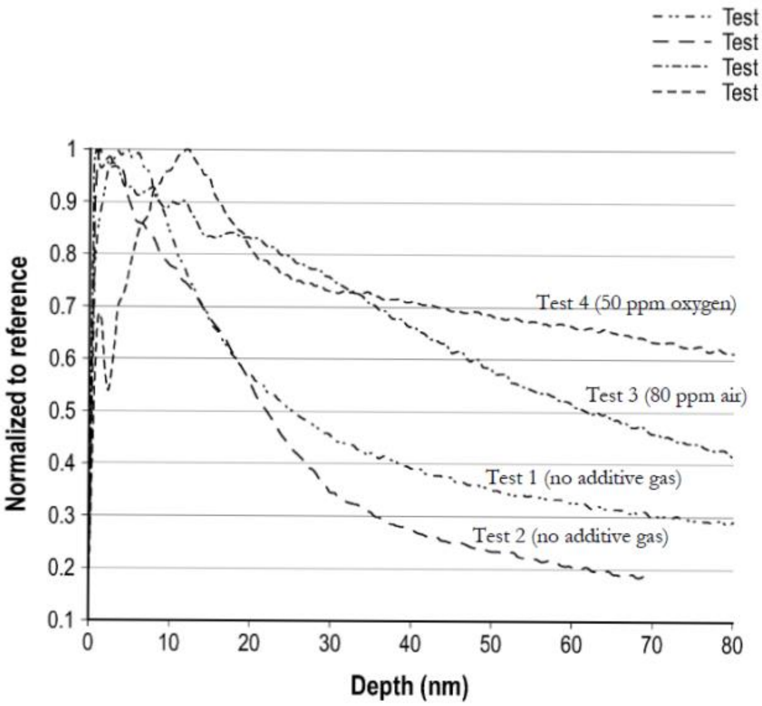


FIG. 5

[Description: A line graph is shown with x- and y-axes. The x-axis is labeled Depth (nm) and has axis ticks labeled in increments of 10 from 0 to 80. The y-axis is labeled Normalized to reference and has axis ticks and gridlines numbered in increments of 0.1 from 0.1 to 1. Four dotted lines are plotted on the graph with different sorts of dots, labeled, from top to bottom, Test 4 (50 ppm oxygen); Test 3 (80 ppm air); Test 1 (no additive gas); and Test 2 (no additive gas). A legend also identifies the lines by the dots used.]

[278] As can be seen from Figure 5, the two normalized oxygen concentration profiles of powder particles produced with *additive gas* (Tests 3 and 4) cross over those of the powder particles produced without *additive gas* (Tests 1 and 2) at around 5 to 10 nm, and remain above them to the end of the lines at around 70 or 80 nm. As the POSITA would recognize, what Figure 5 shows is thus an oxygen concentration (relative to the maximum in the particle) beyond around 10 nm that is highest in Test 4 (treated); generally lower in Test 3 (treated), although the lines cross twice at 20 nm and 30 nm; lower again in Test 1 (untreated); and lower again in Test 2 (untreated).

[279] I note parenthetically that the ToF-SIMS profile of Test 4 has a different general shape from that of the other tests. It shows an initial peak near the surface, followed by a dip in oxygen concentration, and then a peak oxygen concentration at around 13 nm. This peak oxygen concentration is considerably deeper than the peaks of the other curves and deeper than the described depth of the *native oxide layer,* where the highest oxygen concentration would be expected. None of the experts commented on this in their reports. The Court asked Dr. Mostaghimi if he could explain the difference in the curve, but he was unable to, stating that his “expertise is not in ToF-SIMS, basically”: Transcript, Day 12, pp 1–3. This was a rather surprising statement, as he was qualified as an expert in the “physical and chemical characterization of metal powders” and gave material evidence reviewing and interpreting ToF-SIMS profiles: Transcript, Day 10, p 99; Mostaghimi Second Report, paras 460–489. In closing submissions, counsel for Tekna submitted that, although there was no expert evidence on the

subject, their best explanation or hypothesis was that there was some sort of carbon-based surface anomaly on the particle that pushed the peak oxygen concentration value later into the measurement: Transcript, Day 15, pp 165–166.

[280] In paragraph 178, the inventors state that the presence of a depletion layer can be associated with high flowability powders, with reference to Table 1. Table 1 shows the powders of Tests 1 and 2 do not have good flowability, while those of Tests 3 and 4 have good flowability. It is therefore clear that the inventors are intending to convey that the powders of Tests 3 and 4 have a *depletion layer*, while those of Tests 1 and 2 do not. However, neither paragraph 178 nor paragraph 179 refer to a comparison between the depth and thickness of the *depletion layer* and that of the *native oxide layer*, nor explain how to make that comparison.

[281] Based on these passages, AP&C argues the POSITA would understand that a powder particle has a *depletion layer* that is *deeper and thicker* than the *native oxide layer* in accordance with Claim 1 if its ToF-SIMS oxygen concentration profile, and in particular the “tail” of the profile, is above that of a powder particle prepared without *additive gas*.

[282] I cannot accept AP&C’s submission and proposed construction, for the reasons that follow.

[283] I begin by noting some inconsistency in AP&C’s position on the importance of not reading elements of the disclosure into the claim. As discussed above, AP&C insists it would be inappropriate to read into Claim 1 the statements in the disclosure that the *depletion layer* is

made of the reaction product between the *reactive metal source* and the *additive gas*, and that it reaches the *depletion layer* through a diffusion mechanism: AP&C Closing Argument, paras 105–107; Transcript, Day 15, pp 64, 66–67. Yet it asserts that the statements in paragraphs 178 and 179 and Figure 5—which are expressly described by the inventors as simply an "illustration"—should be read as not only providing an effective definition of *depletion layer* but setting out how the existence of a *depletion layer* would be ascertained.

[284] Further, it appears that AP&C's submission is that not all of the statements in paragraphs 178 and 179 should be read into the term *depletion layer*. Notably, the inventors state in paragraph 179 that "[t]he TOF-SIMS results suggest that the depletion layer has a depth of the order of 100 nm," and go on to explain how the depth can be estimated through calibration of the sputtering rate of the ion beam. AP&C does not argue that the POSITA would understand the *depletion layer* of Claim 1 to have a depth of "the order of 100 nm." To the contrary, it removes this part of paragraph 179 from its assertion that the inventors provided "specific guidance as to the meaning of a depletion layer": AP&C Closing Argument, paras 112, 434. AP&C provides no explanation as to why some statements in paragraph 179 are so central to the patent as to be definitional of the term *depletion layer*, while other statements in the same paragraph are to be ignored and not considered as relevant to the *depletion layer*. This approach underscores the difficulty with "borrowing this or that gloss" from the disclosure.

[285] I add that while paragraphs 178 and 179 state that Figure 5 shows a comparison between the ToF-SIMS profiles of different samples, they do not state that the way to ascertain whether or not a particle has a *depletion layer* is by conducting a comparison between the ToF-SIMS profile

of a subject powder and a powder made without *additive gas*. Thus, AP&C's arguments seek not to simply read the claims in light of statements from the disclosure. They seek to read or imply statements into the disclosure before then reading them into claim.

[286] More significantly, though, I view AP&C's reliance on paragraphs 178 and 179 and Figure 5 of the disclosure to be inconsistent with the language of Claim 1. The comparison AP&C argues is mandated by these parts of the disclosure is a comparison between a sample powder made with *additive gas* and a powder made without *additive gas*: AP&C Closing Argument, paras 7, 386; Transcript, Day 15, pp 37–38, 50, 72–73, 75–76, 79, 83–86, 179–180, 182. However, Claim 1 makes no such comparison. To the contrary, Claim 1 expressly defines the *depletion layer* based on a comparison not to a powder made without *additive gas*, but to the *native oxide layer* within the same particle of powder, *i.e.*, one made with *additive gas*. Claim 1 requires the *depletion layer* of the powder particle to be *deeper and thicker* than the *native oxide layer* of the particle.

[287] Further, the comparison AP&C suggests is required is between the oxygen <u>concentration</u> profiles of those powders, as seen in a ToF-SIMS signature. In other words, AP&C argues that what defines the existence of a *depletion layer* is having <u>more</u> oxygen deeper into the particle than in a powder made without *additive gas*: see Transcript, Day 1, p 96; Day 15, pp 76, 84–85; Mostaghimi Second Report, paras 471, 477; Gardella First Report, paras 152, 178–198.

[288] Again, Claim 1 makes no such comparison. Claim 1 refers to the depth and thickness of the *depletion layer*. It also refers, through use of the word *depletion*, to the concentration

decreasing over the depth of the layer. But it does not refer to the amount of oxygen in the depletion layer, either as an absolute amount, or relative to the maximum measured concentration in the particle, or relative to other particles. Even in paragraphs 178 and 179, the inventors' focus is on the depth of the *depletion layer* (and even the existence of a "critical depth") and not the relative level of oxygen in the *depletion layer*.

[289] Thus, AP&C's construction seeks to import into Claim 1 a requirement to conduct an entirely different comparison than the one set out in the claim, based on an inference it draws from a passage from the disclosure. Put simply, Claim 1 says "the *first layer* [is] a *depletion layer deeper and thicker* than the *native oxide layer*." AP&C asks the Court to read it as saying "the *first layer* is a *depletion layer* with more oxygen in the region below the *native oxide layer* than a particle that has been produced without *additive gas*." Adopting such a construction would go well beyond interpreting the terms *depletion layer* and/or *deeper and thicker* in the context of the patent as a whole to inappropriately rewrite the claim based on aspects of the disclosure that are not claimed.

[290] Significantly, even AP&C's expert, when first called upon to construe the claims of the '502 Patent, did not state that a POSITA would understand Claim 1 to mean that a comparison should be made between the ToF-SIMS curves or oxygen concentration profiles of a particle of interest and one made without *additive gas* to determine if it has a *depletion layer*: Mostaghimi First Report, para 125. Dr. Mostaghimi discussed Figure 5 in his review of the disclosure, noting that it showed that the untreated powders have lower levels of oxygen beyond a depth of approximately 10 nm. However, he did not return to Figure 5 at all in discussing the construction

of Claim 1 or any other claim: Mostaghimi First Report, paras 43–44. Rather, he simply stated that the *depletion layer* “must have a depth (or thickness) greater than that of the second layer”: Mostaghimi First Report, para 81.

[291] It was not until responding to Mr. Barnes’ opinion on invalidity and infringement that Dr. Mostaghimi suggested that the POSITA would use the guidance of Figure 5 to understand how ToF-SIMS can be used to determine whether a sample has a *depletion layer*: Mostaghimi Second Report, paras 57, 265–271, 356, 465–491, 497. Claims construction is to be antecedent to consideration of infringement or validity: *Whirlpool* at para 43; *Seedlings (FCA)* at para 22. Adopting a different construction or approach to a claim when assessing infringement than that adopted when first construing the claim materially undermines the later construction.

[292] AP&C argues that Dr. Cima and Dr. Gardella reached the same conclusion in their reports, and similarly used a comparison of the ToF-SIMS profiles to assess infringement: Transcript, Day 15, pp 115–116, 121. Dr. Cima and Dr. Gardella each briefly address, in part, the term *depletion layer* in their reports: Cima First Report, paras 109, 115–116; Gardella First Report, paras 141–145, 150–158. However, neither was mandated to construe the claims of the patents, nor did they set out in their reports how they would construe or define the term *depletion layer* or any other term in the claims: Cima First Report, paras 17–24; Gardella First Report, paras 27–30.

[293] Dr. Cima does not give any indication as to why or how he concludes a skilled person would understand the term *depletion layer* as used in Claim 1 to invoke a comparative oxygen

profile analysis with a different particle, based on either a ToF-SIMS profile or any other testing method. He does not refer to Figure 5 of the ’502 Patent or to paragraphs 178 and 179. He simply states that “based on the teachings of the 502 and 236 Patents,” he expected ToF-SIMS profiling should show that certain AP&C oxygen-treated samples should have a *depletion layer* and other AP&C samples should not: Cima First Report, para 115. I cannot conclude that this statement shows a considered assessment of how the POSITA would construe the term *depletion layer* within the meaning of Claim 1, or why they would reach that construction. In other words, to the extent Dr. Cima reached an independent construction of the term *depletion layer* based on his reading of Claim 1 in light of the ’502 Patent as a whole and the CGK of the POSITA, he gave neither a comprehensible description of that construction nor an explanation of why or how he reached that construction.

[294] Dr. Gardella presents somewhat more discussion on the POSITA and their understanding of the use of ToF-SIMS to determine the presence of a *depletion layer*: Gardella First Report, paras 141–145, 150–158, 175, 178–196. However, this discussion is expressly presented as a response to Mr. Barnes’ views on the invalidity of the patents based on insufficiency, and in the context of assessing infringement. Dr. Gardella’s report does not set out any effort to construe the patent independently of these invalidity and infringement issues. As with Dr. Cima’s report, Dr. Gardella does not refer to the requirement of Claim 1 of the ’502 Patent that the *depletion layer* be *deeper and thicker* than the *native oxide layer*, which indicates that his review was not directed to construing the language of the claim. Dr. Gardella states generally that his understanding “from reading the claims” of both the ’502 and ’236 Patents is that the presence of “<u>more</u> oxygen […] at deeper subsurface depths” [emphasis added] is indicative of a *surface layer*

comprising a *native oxide layer* and a *depletion layer*: Gardella First Report, paras 169, 175, 178–196. This statement provides little assistance in explaining why the POSITA reviewing the language of Claim 1 of the ’502 Patent in the context of the patent as a whole would reach this conclusion. In any event, as set out above, this construction relies on a comparison that is not found in Claim 1.

[295] As the POSITA would note, the inventors were clearly aware of the possibility of defining their invention with reference to a particular test or standard. Element 1(e) requires a particle size distribution of about 10 to about 53 μm of the powder to have a flowability less than 40 seconds, measured according to the ASTM B213 standard. If the inventors had intended to define the *depletion layer* with reference to comparisons between ToF-SIMS profiles in particular, or by conducting an “oxygen profile comparison” to a particle produced without *additive gas* regardless of the method used to assess it, they no doubt would have done so. They certainly could have done so, and it does not lie with AP&C to now introduce such a testing methodology or comparison into the claim when the inventors did not.

[296] I add that AP&C’s proposed construction of the *depletion layer,* involving a comparison to another powder particle, conflicts with its recognition that the existence of a *depletion layer* in a particle is a “state of matter” in the sense that a powder particle will either have a *depletion layer* falling within Claim 1 or not, as a physical matter. If the construction of a *depletion layer* depends on a comparison to another powder particle, the existence of a *depletion layer* is not dependent simply on the physical properties of a powder particle being examined, but on the physical properties of another powder particle. Dr. Mostaghimi was explicit in this regard,

agreeing that with just one powder, there was no way of knowing if there was a depletion layer, since "you always must have a reference": Transcript, Day 11, pp 141–142.

[297] Consider two manufacturers that produce powder particles using *additive gas* that have essentially identical oxygen concentration profiles. If one manufacturer has atomization equipment that has more air leaks, uses different temperature settings, or uses a metal source with a different amount of oxygen, the particles they produce without *additive gas* could have different oxygen profiles. The result could be, on AP&C's approach, that of the two identical powder particles made using *additive gas*, one could be found to have a *depletion layer* and one not to have a *depletion layer*, depending not on the properties of the particle, but on the differences in the comparison standard. If two particles with the same composition either have a *depletion layer* or not depending on the profile of a different particle entirely, this is not a construction that describes a "state of matter."

[298] I conclude the POSITA reviewing Claim 1 of the '502 Patent would not understand the term *depletion layer* as meaning or being defined by the existence of an oxygen concentration profile in which a particle shows a higher amount of oxygen (in either absolute terms or relative to a maximum measured concentration) than a particle that is not treated with *additive gas*, either based on Figure 5 or otherwise.

[299] The POSITA would understand that the *depletion layer* is *deeper* than the *native oxide layer* in the sense of being beneath it, that is, closer to the centre of the particle and starting where the *native oxide layer* ends, and *thicker* than the *native oxide layer* in the sense of having a

greater thickness when considered along the radius of the particle. The POSITA would understand that they would need to be able to distinguish between the two layers and to compare their depth and thickness in order to determine whether the *first layer* is *deeper and thicker* than the *second layer*.

[300] The question then returns: How would the POSITA construe the term *depletion layer* so as to know whether a particle has a *depletion layer* that is *deeper and thicker* than the *native oxide layer*? Put another way, how would a POSITA be able to distinguish between a particle that has a *depletion layer* of Claim 1 and one that does not?

[301] Having reviewed the disclosure and claims of the ’502 Patent and having heard and considered the expert evidence on the issue, I conclude that the POSITA applying a purposive approach to construction and with a mind willing to understand the patent would be simply unable to answer these questions. I will address these questions further below in assessing Tekna’s arguments regarding ambiguity.

[302] Before returning to these questions, I will briefly address the construction of the remaining claims in the ’502 Patent.

(5) Independent Claim 60

[303] Claim 60 is similar to Claim 1, but it claims a *spheroidization manufacturing process* rather than an *atomization manufacturing process*. As discussed above, spheroidization involves a process of heating, melting, and cooling to improve the sphericity of powders created by other

methods, such as milling: Barnes First Report, paras 222–223, 410–411; Mostaghimi First Report, para 85.

[304] The process of Claim 60 does not include the *atomizing* step found in element 1(a). It also refers to a *spheroidization process gas mixture* (rather than an *atomization mixture*), which mixture contains at least one *spheroidization process gas* (rather than at least one *atomizing gas*) in addition to the *additive gas*. The process involves contacting a *reactive metal powder source* (rather than a *heated reactive metal source*) with the *spheroidization process gas mixture* while *spheroidizing* (rather than *atomizing*) the source*, to produce a raw reactive metal powder*. The remainder of Claim 60 is identical to Claim 1, including in the description of the *surface layer* and the flowability.

[305] The parties raised no disputes over the terms in Claim 60 separate from those raised in respect of Claim 1, and did not contend that the terms would be understood differently in Claim 60 than their meaning in Claim 1. I agree that the same terms found in Claim 60 would be understood in the same way as in Claim 1: Barnes First Report, para 409; Mostaghimi First Report, para 84. This is also so in respect of terms that, while different, parallel those in Claim 1. Thus, a *spheroidization process gas mixture* would be understood in the same way as the *atomization mixture*, although the mixture is used in a different process. Similarly, the *spheroidization process gas* would be the gas used for spheroidization rather than atomization, but would otherwise be understood in the same way as the *atomization gas*.

(6) Dependent claims

[306] The parties also raised no disputes with respect to the construction of the dependent claims. A brief summary of the limitations imposed by the dependent claims will suffice, with some observations on the interaction between these limitations and the elements of the independent claims.

[307] Claims 2 to 39 each depend directly from Claim 1 and each add a different limitation with respect to the flowability of an identified particle size distribution: Barnes First Report, para 366; Mostaghimi First Report, para 86. For example, Claim 2 claims the process of Claim 1, wherein the *raw reactive metal powder* with the *surface layer* thereon has a particle size distribution of about 10 to about 45 µm having a flowability less than 40 seconds, while Claim 7 requires a particle size distribution of about 45 to about 75 µm to have a flowability less than 28 seconds, each measured according to ASTM B213. The limitations in these claims are in addition to those in Claim 1, such that a powder must have a flowability less than 40 seconds for both the particle size distribution of 10 to 53 µm and the particle size distribution of 10 to 45 µm to meet the requirements of Claim 2. Claims 9 to 12 add lower limitations with respect to the 10 to 53 µm particle size distribution that is referred to in Claim 1 (flowability less than 36, 32, 30, or 28 seconds, respectively).

[308] Claim 40 claims the process of any of Claims 1 to 39, wherein the *heated reactive metal source* is contacted with the *additive gas* in an *atomizing zone of an atomizer*. The inventors define the term *atomization zone* (presumably synonymous with *atomizing zone*) as referring to a zone in which the material is atomized into droplets of the material: ’502 Patent, para 38; Barnes

First Report, paras 368–370; Mostaghimi First Report, paras 87–88. However, the process of Claim 1 already comprises *atomizing* a *heated reactive metal source*. While Claim 1 does not refer to an *atomizing zone*, it is clear from both the patent and the expert evidence that the process of Claim 1—gas atomization—cannot possibly occur without the apparatus having a zone in which the material is atomized into droplets, *i.e.*, an *atomization zone*: Barnes First Report, para 368; Mostaghimi First Report, para 88. Further, Claim 1 requires the *additive gas* to be part of the *atomization mixture* together with the *atomizing gas*, and for the mixture to contact the *heated reactive metal source* while atomizing it. The *additive gas* therefore necessarily contacts the *reactive metal source* in the *atomizing zone of an atomizer* in Claim 1. I therefore read Claim 40 as redundant over Claim 1, despite the presumption against such redundancy.

[309] Claim 41 claims the process of any of Claims 1 to 39, wherein the *heated reactive metal source* is contacted with the *additive gas* within the *heat zone of an atomizer*. As discussed above, the inventors define the *heat zone of an atomizer* as a zone "where the powder is sufficiently hot to react with the electronegative atoms of the additive gas in order to generate a depletion layer": '502 Patent, para 39; Barnes First Report, paras 373–374. Claim 41 therefore requires the process to include a *heat zone of an atomizer* meeting this definition, and the *additive gas* (as part of the *atomization mixture*) to contact the *reactive metal source* within that zone.

[310] Notably, the existence of a *heat zone of an atomizer* appears to require (a) the *additive gas* to have electronegative atoms; (b) the zone to be sufficiently hot to cause a reaction between the *additive gas* and the metal of the powder; and (c) that this reaction product generate the *depletion layer*. Thus, although the limitations of Claim 41 appear to relate to the timing of

contact, the inclusion of a *heat zone of an atomizer* adds a number of further limitations to those in Claim 1, including that the *depletion layer* be formed not only from atoms or molecules of the *additive gas*, but from those atoms or molecules in a reaction product with the *reactive metal source*. The *heat zone of an atomizer* appears to be related to and/or overlap with the *atomization zone*, namely the zone in which the material is atomized into droplets, since the inventors describe the *atomization zone* as being a "high heat zone of the atomizer" suggesting at least some overlap between the zones: '502 Patent, paras 38, 134; Barnes First Report, paras 367–379.

[311] Claim 42 claims a process of any one of Claims 1 to 39 wherein the *reactive metal source* is contacted with the *additive gas* "at substantially the same time as" contact with the *atomizing gas*. However, Claim 1 already provides that the *atomization mixture* (which includes both the *atomizing gas* and the *additive gas*) is contacted with the *reactive metal source* "while atomizing" the *reactive metal source*. Again, since the *additive gas* and the *atomizing gas* are provided as an *atomization mixture* that is contacted with the *reactive metal source*, the two must necessarily contact the *reactive metal source* concurrently: Barnes First Report, paras 321–322, 380–382. Claim 42 must therefore again be read as redundant over Claim 1, despite the presumption against such redundancy.

[312] Claim 43 claims a process of any one of Claims 1 to 42, wherein the *atomizing gas* is an inert gas, *i.e.*, a gas that would not chemically react with the reactive metal.

[313] Claim 44 claims the process of Claim 43, in which the *atomizing gas* and the at least one *additive gas* are mixed together prior to contact with the *heated reactive metal source*. As discussed above at paragraph [160], this requires the *atomization mixture* made up of the

atomizing gas and the *additive gas* to be mixed together before the point of contact, rather than at the point of contact.

[314] Claim 45 specifies that the *first layer* has a substantially positive charge, the *second layer* has a substantially negative charge, and the *first layer* and *second layer* have a combined charge that is substantially neutral. This claim effectively requires the particle to have the charge characteristics discussed as a non-binding theory at paragraphs 156 to 164 of the disclosure of the ’502 Patent.

[315] Claims 46 to 49 add further steps involving sieving the powder after atomizing, to separate it by particle size distributions (Claim 46), stirring the powder in water (Claims 47, 48), and measuring the flowability of the powder after it has been sieved, stirred, and dried (Claim 49).

[316] Claims 50 to 54 add limitations to the process of any one of Claims 1 to 49 on the amount in the *surface layer* of the at least one element of the at least one *additive gas*. These limitations on the *additive gas* in the *surface layer* (ranging from 500 ppm in Claim 50 down to 100 ppm in Claim 54) are in addition to the limitation in Claim 1 of 1,000 ppm of *additive gas* in the particle as a whole.

[317] Claims 55 to 59 add limitations to the process of any one of Claims 1 to 49 on the amount in the *surface layer* of *added content of an electronegative element* from the at least one *additive gas*. In addition to specifying that the element from the *additive gas* is electronegative, these limitations (ranging from 500 ppm in Claim 55 down to 100 ppm in Claim 59) are specifically

directed to the *added content* of the element, rather than the total content, as discussed at paragraphs [189] to [190] above.

[318] Claims 61 to 67 add limitations to the spheroidization process of Claim 60 with respect to the flowability of the powder that are equivalent to dependent Claims 2 to 8.

[319] Claims 68 to 75 add limitations to the processes of any one of Claims 1 to 67, refining the identity of the at least one *additive gas*. For example, Claim 61 requires the at least one *additive gas* to be an oxygen-containing gas (see discussion at paragraph [176] above). Claims 70, 72, 73, and 74 require the at least one *additive gas* to be a halogen-containing gas, a hydrogen-containing gas, a sulfur-containing gas, and a nitrogen-containing gas respectively.

[320] Claims 76 to 82 add limitations to the processes of any one of Claims 1 to 75, refining the identity of the metal in the *raw reactive metal powder* to one comprising titanium, zirconium, magnesium, aluminum, and their alloys.

[321] Claims 83 to 86 add limitations to the processes of any one of Claims 1 to 82, specifying the use of a plasma torch generally (Claim 83), or a specific type of plasma torch (Claims 84 to 86).

[322] Finally, Claim 87 defines a process for preparing a *reactive metal powder mixture* comprising mixing together a *reactive metal powder* obtained by the process of any one of Claims 1 to 86 with that obtained by a process different than those recited in Claims 1 to 86.

B. *Validity*

[323] Subsection 43(2) of the *Patent Act* creates a presumption that an issued patent is valid. The burden is therefore on the party challenging a patent, in this case Tekna, to prove it is invalid on a balance of probabilities: *Whirlpool* at para 75.

[324] Although it initially raised a greater number of grounds of invalidity, Tekna focused its arguments on three primary grounds: inutility, overbreadth, and what it describes jointly as "insufficiency/ambiguity." For the reasons below, I conclude that Tekna's arguments regarding ambiguity are determinative of the validity of the '502 Patent. I will therefore limit the discussion below to this ground.

(1) Ambiguity

(a) *Principles*

[325] Subsection 27(4) of the *Patent Act* requires the claims of a patent to define "distinctly and in explicit terms the subject-matter of the invention for which an exclusive privilege or property is claimed." Failure to do so may render the patent invalid for ambiguity: *Pharmascience Inc v Bristol-Myers Squibb Canada Co*, 2022 FCA 142 [*Pharmascience Apixaban*] at paras 60–61.

[326] As the Federal Court of Appeal has recently reiterated, the basis for invalidity due to ambiguity is that the patent must give adequate notice to the public as to what is claimed to be exclusive to the patentee: *Pharmascience Apixaban* at para 61, citing *Western Oilfield*

Equipment Rentals Ltd v M-I LLC, 2021 FCA 24 at para 121. The Court of Appeal in *Pharmascience Apixaban* drew from the jurisprudence a number of principles governing the assessment of whether a claim is invalid for ambiguity:

a) a claim may be invalid for ambiguity if it uses language that is avoidably ambiguous or obscure;

b) a claim is likely not invalid if the phrase in issue can be interpreted using grammatical rules and common sense;

c) a claim that can be interpreted in more than one way, such that it would be impossible for the skilled person to know in advance whether or not something would be within the claims, is ambiguous;

d) a claim is not invalid simply because it is not a model of concision and lucidity.

[327] These principles are very much in keeping with the general approach to claims construction, which requires a reading that is sympathetic to accomplishing the inventor's purpose, with a mind willing to understand and not one desirous of misunderstanding: *Tearlab* at para 31; *Free World Trust* at paras 44, 51; *Whirlpool* at para 49(c). In other words, the Court will not readily find that a claim is ambiguous: *Pfizer Canada Inc v Canada (Minister of Health)*, 2005 FC 1725 at paras 52–53, citing *Letourneau v Clearbrook Iron Works Ltd*, 2005 FC 1229 at paras 37–38.

[328] That said, the Court of Appeal in *Pharmascience Apixaban* underscored the statutory source of ambiguity as a ground of invalidity, and the importance of the fundamental principle

that a patent must give the public notice as to what is claimed and what is not, *i.e.*, what activity falls within the claim and what does not: *Pharmascience Apixaban* at paras 60–61. In the words of Justice Binnie cited at the outset of these reasons, "the scope of [a patent's] prohibition should be made clear so that members of the public may know where they can go with impunity": *Free World Trust* at para 41. If the claims, when read purposively in the context of the patent as a whole, and with a mind willing to understand, do not permit the POSITA to understand what falls within the claim and what does not, the patent does not serve its notice function and becomes a "patent of uncertain scope" that is a "public nuisance": *Free World Trust* at para 42.

[329] Tekna referred to patent jurisprudence from the United States and the United Kingdom in support of these principles. On the basis of US case law regarding indefiniteness, they suggest a patent claim must have some "objective anchor" by which the POSITA can identify whether they are practicing the patented invention: *Halliburton Energy Services v M-I LLC*, 456 F.Supp.2d 811 at 820 (2006) (US Dist Ct, ED Texas), aff'd 514 F.3d 1244 (2008) (US Court of Appeals, Fed Cir). Although *Halliburton* was decided before the United States Supreme Court's leading decision on indefiniteness in *Nautilus, Inc v Biosig Instruments*, 572 US 898 (2014), AP&C accepts that the reference to the need for an "objective anchor" is applicable to the Canadian law of ambiguity: AP&C Closing Argument, paras 394, 399.

[330] To similar effect, Tekna cites UK jurisprudence underscoring the need to have certainty in the boundaries of a claim: *Sandvik Intellectual Property AB v Kennametal UK Ltd*, [2011] EWHC 331 (Pat) at para 164; *Generics (UK) Ltd v Yeda Research and Development Co Ltd*, [2013] EWCA Civ 925 at para 78.

[331] Foreign jurisprudence in the intellectual property area must be treated with some caution, given the central role of Canadian legislation in defining the scope of intellectual property protection: *Society of Composers, Authors and Music Publishers of Canada v Bell Canada*, 2012 SCC 36 at para 25; *Apotex Inc v Eli Lilly and Company*, 2018 FCA 217 at para 48. However, I accept that the foregoing statements are consistent with Canadian law on the question of ambiguity. Certainly the US Supreme Court's statement that "[a] patent holder should know what he owns, and the public should know what he does not" is entirely consistent with Justice Binnie's observation that "[t]he scope of [a patent's] prohibition should be made clear so that members of the public may know where they can go with impunity": *Festo Corp v Shoketsu Kinzoku Kogyo Kabushiki Co,* 535 US 722 (2002) at 731; *Free World Trust* at para 41.

[332] In any event, regardless of whether there is a requirement in Canadian law for an "objective anchor," the ultimate question is whether it is "impossible for the skilled person to know in advance whether or not something would be within the claims": *Pharmascience Apixaban* at para 61.

[333] For the following reasons, I conclude that despite the Court's disinclination to find a claim invalid for ambiguity, it is impossible for the POSITA to know whether or not a process for producing a metal powder would be within the claims of the '502 Patent. In particular, based on the information presented in the '502 Patent, the skilled person would be unable to determine when a particle of metal powder has a *depletion layer* that is *deeper and thicker* than the *native oxide layer*.

(b) *The claims of the ’502 Patent are ambiguous*

[334] As set out above, Claim 1 of the ’502 Patent claims a process that comprises forming a *surface layer* on the metal powder particle that comprises a *first layer* and a *second layer*, wherein the *first layer* is a *depletion layer* that is *deeper and thicker* than the *second layer*, which is a *native oxide layer*. Claim 60 includes the same requirement; but I will refer to Claim 1 below for ease of reference.

[335] I have concluded the POSITA would understand that the *depletion layer* is a *layer* at the surface of the particle that (a) contains atoms from the *reactive metal source* and atoms and/or molecules of the *additive gas*, not necessarily in the form of a reaction product; (b) must be distinguishable from the *native oxide layer* to allow comparison with that layer; (c) is *deeper* than the *native oxide layer* in the sense of being beneath it, that is, closer to the centre of the particle and starting where the *native oxide layer* ends; and (d) is *thicker* than the *native oxide layer* in the sense having a greater thickness when considered along the radius of the particle. However, simply being able to restate aspects of the claim in other language does not answer the question of ambiguity. The question is whether it defines distinctly the subject-matter of the invention so as to allow the POSITA to know what falls inside it and what does not.

[336] Tekna contends the POSITA would be unable to assess the meaning of the *depletion layer*, particularly in respect of its inner boundary, in such a manner as to distinguish between a powder particle that has a *depletion layer* that is *deeper and thicker* than the *native oxide layer* and one that does not: Tekna Closing Argument, paras 222–232; Barnes First Report, paras 346–

349, 876–881. Having reviewed the disclosure and claims of the ’502 Patent and having heard and considered the expert evidence on the issue, I agree.

[337] I begin by reiterating that AP&C and its experts put forward multiple different theories of how the POSITA would assess whether a *depletion layer* is *deeper and thicker* than the *native oxide layer* and, in particular, where the *depletion layer* would be understood to begin and end. As discussed at paragraphs [264] to [274] above, Dr. Mostaghimi stated that the POSITA would understand the *depletion layer* to begin at the outer surface of the particle and end at one of a number of points, including the point at which the rate of decline of the added element is effectively zero. Dr. Cima apparently undertook a measurement beginning at the end of the *native oxide layer*, based on a change in slope in the ToF-SIMS profile, and ending at a point where the oxygen concentration is at approximately 23% of its maximum.

[338] I have discussed above why I reject each of these suggestions as being unsupported by either the claims, the disclosure of the ’502 Patent, the CGK and, indeed, by the experts’ own evidence and approach to assessing infringement. While not alone determinative of ambiguity, the fact that AP&C and its experts were themselves unable to put forward a consistent and coherent explanation of how the comparison between the thickness of the *depletion layer* and that of the *native oxide layer* would be performed tends to show that the POSITA would be unable to understand the limits on the claim.

[339] AP&C’s primary submission is that the ’502 Patent provides the POSITA with the very “objective anchor” that Tekna says is missing, in the form of the ToF-SIMS profiles described at

paragraphs 178 and 179 and Figure 5 of the disclosure: AP&C Closing Argument, paras 386–401. It draws parallels to *Pharmascience Apixaban*, in which the Court of Appeal affirmed this Court's finding that a claim element referring to "measurement by laser light scattering" was not ambiguous because the skilled person would resolve any ambiguity by referring to the disclosure and seeing that it describes the use of wet dispersion laser light scattering: *Pharmascience Apixaban* at paras 62–67, aff'g 2021 FC 1 at paras 150–153; see also *Angelcare Canada v Munchkin, Inc*, 2022 FC 507 at paras 475–478. AP&C argues the POSITA reading the '502 Patent would similarly turn to paragraphs 178 and 179 and Figure 5 and "follow the clear directions of the patent to determine whether it possesses a depletion layer": AP&C Closing Argument, para 391.

[340] In particular, AP&C argues the POSITA, or any potential infringer, would understand from the '502 Patent that they could manufacture powders with and without an *additive gas*, subject those powders to ToF-SIMS testing, and then compare the profiles of the powders to determine if that treated with *additive gas* shows a *depletion layer*, "being an oxygen enriched diffusion zone running deeper and thicker into the powder than the typical 6 +/- 2 nanometer native oxide layer": AP&C Closing Argument, para 386. In particular, as noted above, AP&C argues that a particle would have a *depletion layer* if the "tail" in the ToF-SIMS signature lies above that of a particle prepared without *additive gas*: Transcript, Day 15, pp 58, 74, 83–85. They suggest that through these references to Figure 5, the public was made aware of the boundaries of AP&C's exclusive right: AP&C Closing Argument, para 7.

[341] I agree with AP&C that a claim cannot be ambiguous if the POSITA reading the claim in light of the disclosure would understand how to construe the terms in the claim and how to assess or test whether an impugned product or process falls within the claim.

[342] However, I have discussed above at paragraphs [283] to [298] why the POSITA reading the claims in light of the disclosure would not construe Claim 1 of the ’502 Patent, and thus all the other claims, in the manner suggested by AP&C. The comparison AP&C proposes is simply not the comparison set out in the claims, which compare the thickness of the *depletion layer* to that of the *native oxide layer* in the same particle, rather than comparing oxygen concentration profiles between different particles. Unlike the situation in *Pharmascience Apixaban* and *Angelcare*, what AP&C is proposing would not involve the POSITA turning to the text and/or drawings in the disclosure to resolve an uncertainty or ambiguity as to a testing method or claim element. It would involve the POSITA re-writing the claim entirely to undertake a different comparison that is inconsistent with that in the claim.

[343] The POSITA reviewing Figure 5 would be unable to understand how it assists in undertaking the comparison set out in Claim 1. In particular, they would be unable to understand how Figure 5 distinguishes particles that have a *depletion layer* that is *deeper and thicker* than the *native oxide layer* and those that do not.

[344] Figure 5 says nothing about where the *depletion layer* of any of the four samples begins or ends. Nor do paragraphs 178 and 179 attempt to define where the *depletion layer* ends, either qualitatively or quantitatively, to allow the POSITA to compare the respective depths of the

depletion layer in the four test samples. Paragraph 179 states that "[a] tail in the oxygen content enters deeper in the surface layer," and stresses the importance of obtaining this *depletion layer* with a "certain critical depth," suggesting that it has a "depth of the order of 100 nm." However, it says nothing about how to measure the "critical depth" of the tail or the *depletion layer*. Further, the reference to a "depth of the order of 100 nm"—which AP&C does not contend is a required aspect of the *depletion layer*—is itself hard to reconcile with the graph in Figure 5, which extends to only 80 nm for three of the curves and 70 nm for the fourth. Notably, none of these observations refers to the amount or concentration of oxygen in the "tail," *i.e.*, how high it is on a ToF-SIMS graph. They refer to its depth, *i.e.*, how far to the right it extends.

[345] Dr. Cima, who claimed that the end of the *native oxide layer* and the start of the *depletion layer* could be observed through changes in the slope of the ToF-SIMS profiles in the samples tested in the infringement analysis, did not identify a point or area of transition from the *native oxide layer* to the *depletion layer* in any of the curves in Figure 5. Nor did he identify where the *depletion layer* would be considered to end on any of the curves. I note that if applying Dr. Cima's approach of the *depletion layer* ending at 23% of the maximum concentration, only Test 2 ever reaches that level, and it appears to do so at around 50 nm. Assuming the *native oxide layer* to be in the range of 3–5 nm, or even up to 10 nm, all of the four tests, including those the inventors indicate do not have a *depletion layer*, would show a *depletion layer* that is *deeper and thicker* than the *native oxide layer* on Dr. Cima's approach. This conflicts with the clear implication that Tests 1 and 2 do not have a *depletion layer* within the meaning of Claim 1.

[346] Before concluding that the term *depletion layer* was ambiguous, Mr. Barnes considered whether Figure 5 would assist the POSITA in understanding the term: Barnes First Report, paras 877–881. This is consistent with *Pharmascience Apixaban* and *Angelcare*. Noting the absence of any definition in the ’502 Patent as to how to assess the depth of the *depletion layer*, he applied two possible approaches to determining the inner boundary of the *depletion layer*: the depth at which the oxygen concentration levels off, and the depth at which the oxygen concentration is 50% of the maximum concentration. He noted that using either of these approaches, Figure 5 shows that all four samples have a *depletion layer* that extends tens of nanometres into the particle and is thus *deeper and thicker* than the *native oxide layer*: Barnes First Report, paras 814–816, 880; Transcript, Day 5, pp 36–37.

[347] While Dr. Mostaghimi and Dr. Gardella each responded to Mr. Barnes’ evidence on this point, neither presented a clear basis on which the POSITA would be able to conduct a comparison between the *depletion layer* and the *native oxide layer* in order to determine that the former was *deeper and thicker* than the latter: Mostaghimi Second Report, paras 91–97, 427–432; Gardella First Report, paras 150–153, 168–170.

[348] Dr. Mostaghimi’s response to Mr. Barnes’ ambiguity opinion adopted the approach to the parameters of the *depletion layer* discussed above at paragraphs [265] to [266]. He contended that the POSITA could identify the inner boundary by measuring the depth at which the rate of change of the element reached zero (*i.e.*, Mr. Barnes’ “leveling off”) or at the 50% concentration: Mostaghimi Second Report, paras 60, 431. However, this contention seems to suggest that a POSITA could use one of two very different approaches to determine the inner boundary, which

reinforces concerns about ambiguity rather than assuaging them. It also does not refute Mr. Barnes' contention that on either of these two approaches, Figure 5 shows all four test samples to have a *depletion layer* that is *deeper and thicker* than the *native oxide layer*.

[349] To the contrary, Dr. Mostaghimi appeared to effectively concede that Mr. Barnes was correct, stating that the POSITA would not think that the plots in Figure 5 define the scope of the *depletion layer* "on their own": Mostaghimi Second Report, para 431.

[350] Dr. Gardella's response to Mr. Barnes' opinion similarly seems to underscore the *lack* of information contained in Figure 5. He notes that the POSITA "would realize that the patents include no details of how the depth profile was generated". Absent such detail, he concludes that the POSITA would understand the stated depth values to be an "approximation of depth" rather than having been precisely derived: Gardella First Report, para 170; Transcript, Day 10, pp 32–33. This may be so, but it does not address the concern that neither the claims nor the disclosure of the patent helps the POSITA understand the parameters of the *depletion layer* so as to compare its depth and thickness to that of the *native oxide layer*. Indeed, if Dr. Gardella is correct, then Figure 5 gives even less information about the thickness of the *depletion layer*, and whether it is thicker than the *native oxide layer*.

[351] Both Dr. Mostaghimi and Dr. Gardella also responded to Mr. Barnes' observations about the curves in Figure 5 by stating that the POSITA would understand there is no *depletion layer* in the powders of Tests 1 and 2 not because of their ToF-SIMS profile but because they were not treated with *additive gas*: Mostaghimi Second Report, paras 61, 431; Gardella First Report,

para 168; Transcript, Day 10, pp 31–32. This misapprehends the concern. The question is not the use of *additive gas*, as required by element 1(b). It is the formation of a *depletion layer* that is *deeper and thicker* than the *native oxide layer*, as required by element 1(d).

[352] As noted above, it is clear from the context of paragraph 178 and Table 1 of the disclosure that the inventors were trying to convey that the powders of Tests 3 and 4 have a *depletion layer*, while those of Tests 1 and 2 do not. The issue is how the POSITA would be able to objectively distinguish between the particles that have a *depletion layer* that is *deeper and thicker* than the *native oxide layer*—a condition that is not referred to in paragraphs 178 and 179 or Figure 5 but is essential to the claims—and those that do not, when any attempt to compare the thickness of the *depletion layer* to that of the *native oxide layer* would appear to encompass all four test samples.

[353] I return to AP&C's recognition that the existence of a *depletion layer* is a state of matter, in that a given particle will either have a *depletion layer* that is *deeper and thicker* than the *native oxide layer* or it will not. This being so, the determination of whether there is such a *depletion layer* cannot simply be determined with reference to other parts of the manufacturing process. Among other things, this would make the use of an *additive gas* redundant with the presence of a *depletion layer*, despite them being expressed as separate essential elements in Claim 1. Indeed, as a general statement, much of the evidence of Dr. Mostaghimi, Dr. Gardella, and Dr. Cima appears based on an assumption that if an atomization process includes the use of *additive gas* and/or includes the use of *additive gas* and results in a powder with good flowability, the resulting particle must have a *depletion layer* in accordance with Claim 1.

[354] Dr. Mostaghimi’s evidence was the most direct on this point, stating (with reference to the ’236 Patent, although he construed the term *depletion layer* in the same way for the two patents) that “if you have the additive gas, you know that you have the depletion layer”: Transcript, Day 11, pp 131–132; see also Confidential Transcript, Day 12, pp 18–19. This approach effectively reads essential element 1(d) out of the claims and is inconsistent with the language of the claims chosen by the inventors. It is also inconsistent with other aspects of Dr. Mostaghimi’s own evidence, as he also recognized that using *additive gas* during atomization does *not* necessarily result in a *depletion layer*, that good flowability similarly does not demonstrate the presence of a *depletion layer*, and even that a *depletion layer* does not necessarily result in good flowability (only that it “improves” flowability): Confidential Transcript, Day 12, pp 56–57, 60, 63–65, 68–71.

[355] Further, neither Dr. Mostaghimi nor Dr. Gardella explained how a POSITA would understand Figure 5 to illustrate or assist in determining whether the *depletion layer* is *deeper and thicker* than the *native oxide layer*. Rather, they skip the language of Claim 1 to posit that a POSITA would use Figure 5 to understand whether or not a powder particle has a *depletion layer*: see, *e.g.*, Mostaghimi Second Report, paras 57, 267, 270–271, 424, 431–432; Gardella First Report, paras 48, 170.

[356] Ultimately, both Dr. Mostaghimi and Dr. Gardella responded to Mr. Barnes’ statements about ambiguity with the same primary argument that AP&C puts forward, namely that the POSITA would understand the determination of whether there is a *depletion layer* is to be made by comparing the oxygen concentration profile of a particle made with *additive gas* to one made

without *additive gas*: Mostaghimi Second Report, para 431; Gardella First Report, paras 168–170; Transcript, Day 10, pp 26–27, 32–33. I have explained above why I reject this contention as inconsistent with the claims of the ’502 Patent, which provide for a different comparison.

[357] In any event, even if I were to accept AP&C’s submission that the POSITA would understand Claim 1 to involve a comparison between the oxygen concentration profile of a particle at issue and one made without *additive gas*, I would still conclude that the claims of the ’502 Patent are ambiguous as they do not define the scope of the claim in a manner that would allow the POSITA to know whether a process falls inside it or outside it.

[358] On AP&C’s theory, the POSITA would know from Figure 5 and paragraphs 178 and 179 of the disclosure that a particle has a *depletion layer* within the meaning of the claims if the “tail” in the ToF-SIMS signature lies above that of a particle prepared without *additive gas*. However, a review of Figure 5 and these paragraphs makes clear that the inventors provide no basis to distinguish between the curves of Tests 1 and 2 and those of Tests 3 and 4. In other words, they provide no criterion by which to divide the bottom two curves from the top two curves so as to set a border between particles with a *depletion layer* and those without, *i.e.*, those that have this essential element of the claims and those that do not. Indeed, on AP&C’s own approach, the POSITA who made a particle of Test 2 (prepared without *additive gas*), and then compared the particle of Test 1 to it would conclude that the particle of Test 1 had a *depletion layer* (regardless of the presence of any other essential elements), since the “tail” in its ToF-SIMS signature lies above that of Test 2. Yet the implication of the patent is clearly that Test 1 does not have a *depletion layer*.

[359] As I have concluded above at paragraphs [197] to [201], it is certainly possible that the POSITA would reach a construction of a patent claim that is inconsistent with examples or diagrams in the disclosure, if the language of the claim requires it. Thus, if the POSITA understood how to measure the thickness of the *depletion layer* based on the ’502 Patent and/or their CGK, they might conclude that the powders of all four tests in Experiment 1 and Figure 5 had a *depletion layer* that is *deeper and thicker* than the *native oxide layer*, despite the inventors’ contrary indication. In such a case, the claim might not be ambiguous. However, this cannot be so in the present case, since (a) AP&C contends that Experiment 1 and Figure 5 are the very aspects of the ’502 Patent that are said to teach the distinction between a powder particle with a *depletion layer* that is *deeper and thicker* than the *native oxide layer* and one without; and (b) the POSITA would not have an understanding of how to measure the thickness of the *depletion layer*, either from the claims or disclosure of the ’502 Patent or from their CGK.

[360] It is telling, in my view, that in purporting to demonstrate that Tekna’s powders have a *depletion layer*, AP&C and its experts made no effort to try to compare the ToF-SIMS profiles of Tekna’s powder particles to the profiles set out in Figure 5 of the ’502 Patent. Rather, as discussed further below, they conducted ToF-SIMS testing on powders prepared by AP&C, *i.e.*, powders not generally available to the public and prepared in AP&C’s particular manufacturing facilities, and then used those ToF-SIMS profiles as baselines for comparison with Tekna’s powders.

[361] An assessment of patent infringement is generally made by comparing the impugned process or product to the claims of the patent, and not by comparing the impugned process or

product to the patent owner's process or product: *Evolution Technologies Inc v Human Care Canada Inc*, 2019 FCA 209 at paras 21, 23, citing *Monsanto Canada Inc v Schmeiser*, 2004 SCC 43 at para 30; *Janssen-Ortho Inc v Apotex Inc*, 2010 FC 81 at para 28. This is consistent with the "public notice" function of the patent, which must tell members of the public where they can go with impunity: *Free World Trust* at para 41. AP&C's apparent inability to conduct such a comparison to demonstrate infringement without introducing data derived independently of the patent from its own products speaks volumes about whether the claims of the patent are clear enough to allow a POSITA to assess whether the powder prepared by a manufacturing process falls within the scope of the claims. Put another way, the very assessment that AP&C undertook to demonstrate that Tekna's powders fall within the claim was an assessment that no member of the public reviewing the '502 Patent without access to AP&C's powders could undertake.

[362] AP&C's infringement analysis also shows the same concern raised above about the difference between the profiles of Tests 1 and 2. According to AP&C, a particle has a *depletion layer* within the meaning of the claims if it has a ToF-SIMS curve "above" that of a particle made without *additive gas*. AP&C's testing on two different particles, each of which are said not to have a *depletion layer*, shows that the curve of one of them is "above" that of the other: Mostaghimi Second Report, para 467; Gardella First Report, para 178. Yet no explanation was given as to why the POSITA would understand the sample with the higher ToF-SIMS profile not to have a *depletion layer*, whereas another sample that is in turn slightly higher (and in some places overlapping) does. This is particularly so since a ToF-SIMS curve that shows a greater oxygen ion intensity than another (*i.e.*, that lies "above" it) means that it has more oxygen but it

is “not possible to tell how much more”: Shallenberger First Report, para 58; Gardella First Report, para 106.

[363] The difficulty with using AP&C’s approach to determine the presence of a *depletion layer* was made apparent in Tekna’s cross-examination of Dr. Mostaghimi. Presented with a graph that included the ToF-SIMS curve of a fifth test conducted at the same time as the four tests set out in the ’502 Patent, Dr. Mostaghimi was unable to clearly say whether it had a *depletion layer* or not, initially conceding it did not have one, but then suggesting it might have one if one looked at just the first 20 nm, and ultimately concluding that “the depth of depletion layer is something that we can debate on, basically”: Confidential Transcript, Day 12, pp 1–6.

[364] Similarly, when presented with a series of ToF-SIMS curves of various particles that had been produced by AP&C and tested on their behalf, Dr. Mostaghimi was unable to clearly say which particles had a *depletion layer*, and which did not, without knowing the experimental conditions under which they were made: Confidential Transcript, Day 12, pp 7–16, 20–23. Indeed, Dr. Mostaghimi’s efforts to analyze the various curves led him to propose, among other things, looking at different depth points in the curves to consider particular gaps, rather than conducting the same overall assessment he conducted in his infringement analysis: Confidential Transcript, Day 12, pp 4–5, 7–8, 22–23.

[365] I make one final observation on the issue of ambiguity. The ’502 Patent on its face requires the formation of a *surface layer* consisting of a *second layer*/*native oxide layer* and a *first layer*/*depletion layer*, with the *depletion layer* being *deeper and thicker* than the *native*

oxide layer. At least as early as amendments to the pleadings in 2021, Tekna has alleged that the ’502 Patent does not allow the POSITA to distinguish between the *depletion layer* and the *native oxide layer*: Further Amended Statement of Claim, para 20. AP&C responded to this allegation by denying that the claim language of the ’502 Patent does not allow the POSITA to distinguish between the layers: Fourth Amended Statement of Defence and Counterclaim, para 12. Yet despite the filing of numerous reports, none of the experts were able to clearly say how the POSITA would distinguish between the layers so as to confirm their existence and compare their depth and thickness. I agree with Tekna’s observation in closing submissions that it is noteworthy that:

> ...after more than 3 years of litigation, very complex testing in specialized labs and universities, five experts in total, hundreds of pages of expert reports, and three weeks of evidence at trial, no one has been able to tell the Court (despite the Court asking the question on a few occasions) where the oxide layer and the alleged depletion layer are on any of the test results, and how thick these two layers are.
>
> [Emphasis removed; Tekna Closing Argument, para 231.]

[366] I conclude that despite the POSITA’s willingness to understand the claims and disclosure of the ’502 Patent, they would be simply unable to assess whether a particular powder particle has a *depletion layer* that is *deeper and thicker* than the *native oxide layer*. The patent itself gives no indication of the parameters of such a layer, and the various proposals put forward by the experts and AP&C are either entirely inconsistent with the language of the claims or provide no predictable and meaningful manner of determining whether the essential element of the claim is met, or both. In other words, it is “impossible for the skilled person to know in advance whether or not something would be within the claims” and they do not “defin[e] distinctly and in explicit

terms the subject-matter of the invention for which an exclusive privilege or property is claimed”: *Pharmascience Apixaban* at para 61; *Patent Act*, s 27(4).

[367] The requirement for a *depletion layer* that is *deeper and thicker* than the *native oxide layer* is an essential element of independent Claims 1 and 60, and thus of every claim of the ’502 Patent. None of the dependent claims include any limitations relating to the *depletion layer* that might affect the conclusion of ambiguity flowing from independent Claims 1 and 60.

[368] I am therefore satisfied on the evidence and argument presented that Tekna has met its burden to demonstrate that all of the claims of the ’502 Patent are invalid for ambiguity.

(2) Insufficiency

[369] As noted above, Tekna described its ambiguity arguments jointly as arguments going to “insufficiency/ambiguity.” A patent claim will be invalid for insufficiency if the specification fails to teach the POSITA to put into practice all embodiments of the invention: *Teva Canada Ltd v Pfizer Canada Inc*, 2012 SCC 60 at paras 51–52, 70–71; *Seedlings (FCA)* at para 68; *Patent Act*, s 27(3). Tekna effectively argues that since the POSITA reviewing the ’502 Patent would be unable to tell whether a given powder had a *depletion layer* within the meaning of Claim 1, it would be unable to put the invention into practice, such that the claims are both ambiguous and insufficient. AP&C’s response to Tekna’s insufficiency arguments is similar to its response to Tekna’s ambiguity arguments, pointing to paragraphs 178 and 179 and Figure 5 of the disclosure as teaching how to determine whether there is a *depletion layer*.

[370] There is certainly a relationship between insufficiency and ambiguity, as each relate to whether the specification of a patent adequately defines the invention and describes how it is put into operation: *Pioneer Hi-Bred Ltd v Canada (Commissioner of Patents)*, 1989 CanLII 64 (SCC), [1989] SCR 1623 at pp 1637–1638. Indeed, in the UK, ambiguity is considered a form of patent insufficiency, as is overbreadth: see *Sandvik* at paras 106–124. Insufficiency may also overlap with other grounds of invalidity, such as overbreadth: *Western Oilfield* at para 130.

[371] As the parties' arguments on ambiguity and insufficiency largely overlap, there is little additional value to a supplementary finding that the claims of the '502 Patent are also invalid for insufficiency. However, I note my agreement that a POSITA would be unable to put the '502 Patent into practice, since they would be unable to tell whether they had produced a *depletion layer* that was *deeper and thicker* than the *native oxide layer*, and thus unable to tell how to produce (or avoid producing) such a layer.

(3) Other argued grounds of invalidity

[372] Tekna raised two other primary grounds of invalidity, namely inutility and overbreadth. In light of my conclusion that all of the claims of the '502 Patent are invalid for ambiguity, I need not address Tekna's other invalidity arguments with respect to the '502 Patent.

C. *Infringement*

(1) Principles

[373] An invalid patent claim cannot be infringed: *Seedlings (FCA)* at para 74. My finding that the ’502 Patent is invalid is therefore also determinative of the issue of infringement. Nonetheless, given Tekna’s request for a declaration of non-infringement pursuant to subsection 60(2) of the *Patent Act*, and AP&C’s counterclaim seeking a declaration of infringement, and given the nature of the parties’ evidence and arguments on the issue, I will address the parties’ positions on the issue of infringement to the extent possible given the ambiguity of the claims.

[374] A patent claim is infringed if the impugned process, method, or product comprises all of the essential elements of the claim, as purposively construed. Conversely, it is not infringed if an essential element is omitted: *Free World Trust* at paras 31(f), 68, 75; *Western Oilfield* at paras 48–49. The assessment of infringement involves the comparison of the thing made or sold by the defendant with the claims as construed: *Monsanto* at para 30.

[375] As a general rule, the onus lies on the patentee alleging infringement to show that a claim has been infringed: *Monsanto* at para 29; *Gold v Serratus Mountain Products Ltd*, 2006 FCA 98 at para 10. In the present case, Tekna commenced this action seeking a declaration of non-infringement of the ’502 Patent pursuant to subsection 60(2) of the *Patent Act*. The parties agreed that, at least as a technical matter, Tekna bore the burden of proving non-infringement for the purposes of that declaration. AP&C nonetheless bears the burden of proving infringement for

the purposes of its counterclaim requesting a declaration of infringement and other relief flowing from that declaration. Ultimately, the issue of infringement does not turn on the burden of proof in this matter.

(2) Asserted claims and areas of agreement

[376] The parties agree that none of the claims of the ’502 Patent are infringed by Tekna’s (a) atomization of aluminum alloy powders ($AlSi_7Mg$ and $AlSi_{10}Mg$ powders) on its plasma atomization system known as “TAP-S4”; (b) vaporization processes to manufacture nanopowders; and (c) spheroidization processes without the use of “additive” or “passivation” gas: Agreed Statement of Facts, paras 58, 147, 150–151.

[377] AP&C further agrees that Tekna’s atomization processes for the manufacture of Ti-6Al-4V metal powders do not infringe Claims 45, 47–67, 70–73, 81 and 85–86 of the ’502 Patent, again assuming the process has not changed since May 2017: Agreed Statement of Facts, para 148. AP&C’s admissions in this regard are premised on Tekna’s processes not having changed since November 2017 (for the atomization) or May 2017 (for the vaporization and spheroidization), about which the Court had no evidence. AP&C does not object to the issuance of a declaration of non-infringement in respect of these claims on this basis.

[378] AP&C asserts, as the narrowest two claims of the ’502 Patent infringed by Tekna: (a) Claim 83, as it depends from Claims 79, 68, 44, 43, 41, and 1; and (b) Claim 83, as it depends from Claims 79, 69, 44, 43, 41, and 1.

[379] The allegation is thus that Tekna's production of metal powders constitutes the *reactive metal powder atomization manufacturing process* of Claim 1, in which the *atomizing gas* is an inert gas (Claim 43); the *additive gas* is an oxygen-containing gas (Claim 68) or an oxygen-containing gas chosen from a list of gases that includes oxygen O_2 and air (Claim 69); the *atomizing gas* and the *additive gas* are mixed together prior to contacting the *reactive metal source* (Claim 44) and then contacted with *reactive metal source* within a *heat zone of an atomizer* (Claim 41); the *raw reactive metal powder* comprises a titanium alloy (Claim 79); and the process is carried out by means of at least one plasma torch (Claim 83).

[380] AP&C also notes that if these narrower claims are infringed, then any of the broader claims on which they are based will necessarily also be infringed. I take this to effectively be an assertion that the broader claims are also infringed, including ultimately Claim 1.

[381] Tekna agrees that its atomization process to produce Ti-6Al-4V powders includes all of the essential elements of the asserted claims except for the formation of a *surface layer* comprising a *depletion layer*, on some but not necessarily all occurrences when its process is carried out: Agreed Statement of Facts, paras 153–154.

(3) The asserted claims of the ’502 Patent are not infringed

(a) *Introduction*

[382] As noted, an invalid claim cannot be infringed. I therefore conclude as an initial matter that Tekna does not infringe any of the asserted claims of the’502 Patent since all of those claims are invalid.

[383] Where a patent is found invalid for anticipation or obviousness, the Court may be able to nonetheless address infringement as an independent matter by determining whether the impugned process, method, or product falls within the scope of the claims as construed. Where the claims of a patent are void for ambiguity, however, this is not possible since the very problem is that the scope of the claims, and whether an impugned process, method, or product falls within them, cannot be determined.

[384] Since I am unable to assess whether Tekna’s atomization process for manufacturing Ti-6Al-4V metal powders fall within the scope of the claims of the ’502 Patent, I will address the question of infringement by considering the evidence presented and discussing whether it might show infringement on the various theories presented regarding the meaning of the *depletion layer*.

(b) *AP&C's evidence going to infringement*

[385] AP&C's infringement case is derived from ToF-SIMS analysis conducted by a company called Tascon USA, Inc on particles of AP&C and Tekna powder samples. At AP&C's request, Tascon analyzed the oxygen depth distributions of four different AP&C powder lots and six Tekna powder lots and produced a report dated May 21, 2022 [Tascon Report]: see, *e.g.*, Mostaghimi Second Report, Exhibit D; Agreed Statement of Facts, paras 141, 143.

[386] With respect to each powder lot, Tascon conducted two ToF-SIMS measurements. Each measurement involved the selection of a number of "regions of interest" [ROIs] from the surface of multiple powder particles. The oxygen depth profile was generated from the average data from the ROIs for the measurement. The result was two ToF-SIMS depth profiles for each powder lot: Tascon Report, pp 2–6.

[387] As with the profiles in Figure 5, the Tascon profiles are presented on a graph with the y-axis showing oxygen concentration data normalized to maximum intensity, such that the peak of each profile is seen at the value of 1. The x-axis of the graph shows the depth of the particle, expressed in "arbitrary units." These arbitrary units are a function of sputtering time, and Tascon suggested they could be read as a depth scale in nanometres, "within an error margin of a factor of 2–5," *i.e.* that the conversion of one arbitrary unit could range between 0.2 nm and 5 nm: Tascon Report, p 5; Shallenberger Second Report, para 81; Gardella First Report, para 176. Dr. Cima calculated a different error margin, although he did not explain why he did not adopt

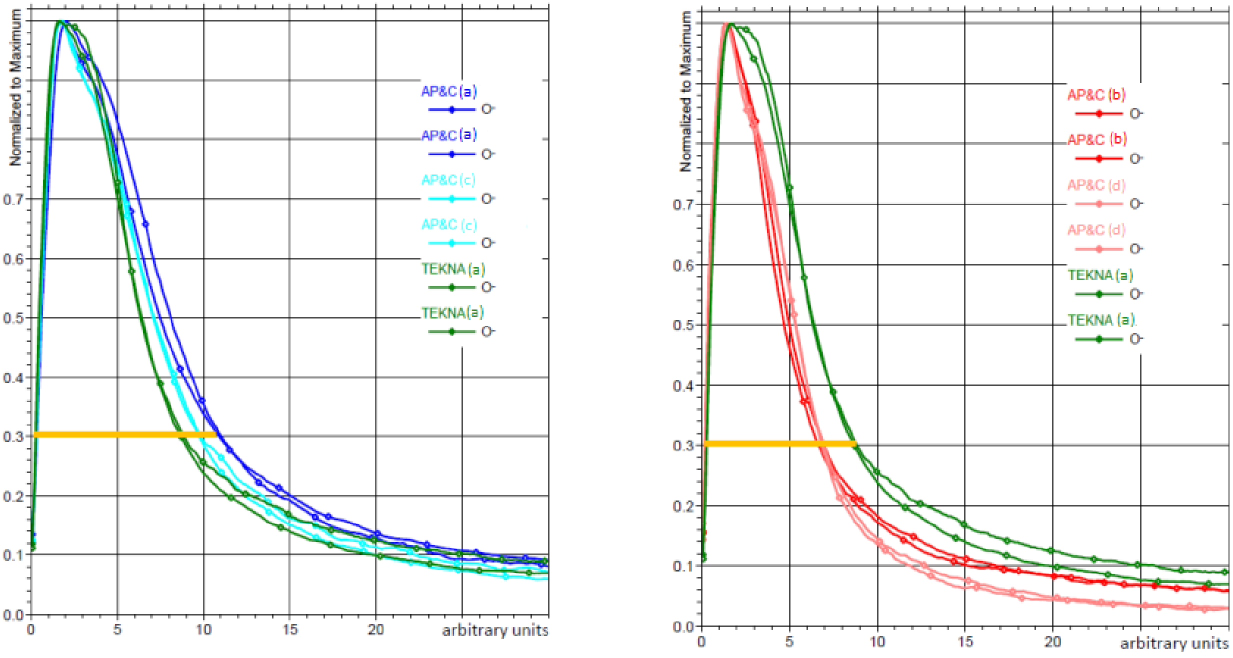
Tascon's error margin: Cima First Report, paras 134–135; Cima Second Report, paras 19–21; Confidential Transcript, Day 13, pp 21–22; Shallenberger Second Report, paras 82–84.

[388] The AP&C and Tekna powders each have lot numbers assigned by the companies. For ease of reference and to limit any confidentiality concerns, I will refer to the four AP&C samples as AP&C(a) through (d), adopting the lettering found in paragraph 461 of Dr. Mostaghimi's Second Report. I will similarly refer to the six Tekna samples as Tekna(a) through (f), adopting the lettering found in paragraph 460 of Dr. Mostaghimi's Second Report.

[389] In essence, AP&C's approach to demonstrating the presence or absence of a *depletion layer* in Tekna's powders was to (1) use the ToF-SIMS profiles of the two AP&C samples prepared with *additive gas* [AP&C(a) and (c)] and the two prepared without *additive gas* [AP&C(b) and (d)], as "controls," with the understanding that the former had a *depletion layer* (the "positive control") while the latter did not (the "negative control"); and (2) compare the ToF-SIMS profiles of the Tekna samples to those of the AP&C controls to assess whether the Tekna samples have a *depletion layer*: Mostaghimi Second Report, paras 465–491, 497; Gardella First Report, paras 172, 178–199; Cima First Report, paras 113–135.

[390] Adopting this approach, each of Drs. Mostaghimi, Gardella, and Cima concluded that two of the six Tekna samples had a *depletion layer* falling within the scope of the claims of the '502 Patent [Tekna(a) and (c)], while the remaining four did not [Tekna(b), (d), (e), and (f)]: Mostaghimi Second Report, paras 471–488, 497; Gardella First Report, paras 184–196; Cima First Report, paras 120–130, 135.

[391] For example, each of AP&C's experts reproduced the following ToF-SIMS results from the Tascon Report with respect to sample Tekna(a): Mostaghimi Second Report, para 487; Gardella First Report, para 184; Cima First Report, para 121. In the following figure, I have replaced the parties' lot numbers with the reference to the samples using the lettering above.



[Description: Two line graphs are shown with x- and y-axes. In each, the x-axis is labeled arbitrary units and has gridlines numbered in increments of 5 from 0 to 30, with axis ticks in increments of 1. The y-axis is labeled Normalized to Maximum and has gridlines numbered in increments of 0.1 from 0 to 1, with axis ticks in increments of 0.02. Each graph presents six coloured lines, with two lines in each of three colours. A legend identifies the lines by colour: on the left, dark blue for AP&C(a); light blue for AP&C(c); and green for Tekna (a); on the right, red for AP&C(b), pink for AP&C(d), and green for Tekna(a). Each graph also has a yellow line running horizontally at 0.3 units on the y-axis, from the y-axis to the location of the curves.]

[392] In the above graphs, the dark and light blue lines show samples AP&C(a) and (c), which were used as the "positive controls"; the red/pink lines show samples AP&C(b) and (d), which were used as the "negative controls"; and the green lines show sample Tekna(a), which was the subject of analysis in these graphs. Similar graphs were presented in respect of the other Tekna samples, overlaying each of them with, respectively, samples AP&C(a) and (c) and samples AP&C(b) and (d).

[393] Dr. Mostaghimi's analysis of the foregoing curves consisted of noting that the oxygen depth distribution curve for sample Tekna(a) (the green lines) was "noticeably higher" than the negative controls (the red and pink lines) and were "more consistent with" the positive controls (the dark and light blue lines), which he took to indicate that sample Tekna(a) has a *depletion layer*: Mostaghimi Second Report, para 488. The analysis of the other experts was to the same effect: Gardella First Report, paras 182–184; Cima First Report, paras 119–121. I note parenthetically that the yellow line appearing in the graphs at a value of 0.3 on the y-axis was placed on the graphs by Tascon and was not relied on by the experts.

(c) *AP&C's evidence does not demonstrate infringement*

[394] Tekna presents a number of criticisms of the Tascon Report and the analysis of it by AP&C's experts. These criticisms include concerns about the risk of distortions in ToF-SIMS analysis, including those arising from the oxide layer, and an asserted inability to distinguish between particles that have a thicker oxide layer and those that have a second layer beneath the oxide layer: Shallenberger Second Report, paras 8–16, 55–104.

[395] I need not address these criticisms, or AP&C's response to them, as I agree entirely with Mr. Barnes that AP&C's evidence rests entirely on an unestablished premise, namely that AP&C's "positive controls" have a *depletion layer*, particularly one that is *deeper and thicker* than the *native oxide layer*, while the "negative controls" do not: Barnes Third Report, paras 29–37; Transcript, Day 5, pp 6–9.

[396] Each of Drs. Mostaghimi, Gardella, and Cima assert or accept that samples AP&C(a) and (c) have a *depletion layer*, while AP&C(b) and (d) do not: Mostaghimi Second Report, paras 465–469; Gardella First Report, para 175; Cima First Report, para 115–117. However, none of the experts compares the oxygen concentration curves of either the positive controls or the negative controls to those contained in Figure 5 to determine whether all four AP&C samples, or some, or none, have a *depletion layer* as that term is used in the ’502 Patent.

[397] Rather, Dr. Mostaghimi appears to conclude that samples AP&C(a) and (c) have a *depletion layer* because they were atomized in the presence of an *additive gas* and showed good flowability: Mostaghimi Second Report, para 466. However, as discussed above, the existence of a *depletion layer* cannot be assumed simply from the presence of *additive gas* and a desired flowability: Transcript, Day 15, pp 80–81. If this were so, the requirement of a *depletion layer* would be redundant, as Claim 1 would simply claim any powder in which an *additive gas* was used that showed the desired flowability, with the *depletion layer* element implied from these other two parameters.

[398] As Dr. Mostaghimi’s own evidence states, various factors will affect whether a *depletion layer* will be formed, including temperature, concentration of *additive gas*, and wire feed rate: Mostaghimi Second Report, paras 31, 33, 52, 55, 308–309, 322; Confidential Transcript, Day 12, pp 56–57; Transcript, Day 15, p 180. Many factors can similarly affect flowability: ’502 Patent, para 45; Barnes First Report, paras 182–183; Confidential Transcript, Day 12, pp 68–70; Day 13, p 30. Simply assuming that a particle that has been treated with *additive gas* and has a desired

flowability therefore has a *depletion layer*, particularly one that is *deeper and thicker* than the *native oxide layer*, is inconsistent with Claim 1 and is effectively circular.

[399] Dr. Mostaghimi's assumptions regarding the negative controls AP&C(b) and (d) are equally circular. He concludes they do not have a *depletion layer* because they "would not be expected to possess" one: Mostaghimi Second Report, para 467. Rather than testing this expectation, he simply treats it as fact, and uses the samples as a negative control. This is so despite the fact that sample AP&C(b) was in fact treated with an *additive gas* (air, but not oxygen), while sample AP&C(d) showed good flowability and had a particle size distribution much higher than the other samples (and higher than the flowability parameters in Claim 1), which itself can affect oxygen absorption: Agreed Statement of Facts, paras 143–144; Tascon Report, p 2; Confidential Transcript, Day 12, pp 39–43.

[400] Dr. Gardella's acceptance of the existence or absence of a *depletion layer* in the control samples was similarly unsupported. He asserted baldly that the difference in the oxygen depth profiles between the oxygen-treated samples and the untreated samples "represent[s] the presence of a depletion layer as described in the patents": Gardella First Report, para 175. He conducted no verification and made no attempt to compare either the positive or the negative controls to the information in the patent to reach the conclusion that the positive controls had a *depletion layer* while the negative controls did not.

[401] Dr. Cima also reached his conclusions on existence or absence of a *depletion layer* based on the oxygen treatment and flowability of the AP&C samples. Again, he appears to have been

mistaken regarding the use of an additive gas in one of the negative controls and the flowability of the other: Cima First Report, para 113; Agreed Statement of Facts, paras 143–144. Nonetheless, he “expected” the positive controls to have a *depletion layer* and the negative controls not to have one, “based on the teachings” of the two patents: Cima First Report, paras 113–114. He concluded that his expectations were met because the ToF-SIMS oxygen profile of samples AP&C(a) and (c) showed “relatively larger amounts of oxygen at greater depths” than those of AP&C(b) and (d). As explained above, the ’502 Patent does not define a *depletion layer* in this way. As with Drs. Mostaghimi and Gardella, Dr. Cima only compared the ToF-SIMS profiles of the positive and negative controls to each other, and not to those shown in the patent.

[402] Notably, the ToF-SIMS oxygen profiles equally show that sample AP&C(a) had “relatively larger amounts of oxygen at greater depths” than sample AP&C(c) and that sample AP&C(b) has “relatively larger amounts of oxygen at greater depths” than sample AP&C(d). Dr. Cima provides no explanation as to why the “dividing line” between the presence and absence of a *depletion layer* should be located between sample AP&C(c) and AP&C(b), particularly since those curves become quite close together beyond 15 arbitrary units and even overlap at around 25 arbitrary units: Tascon Report, p 17; Cima First Report, paras 116–117.

[403] It is worth reiterating that Dr. Gardella and Dr. Cima each reached conclusions on the presence or absence of a *depletion layer* in the AP&C samples—and in Tekna’s samples—without undertaking the construction exercise of reading the term as a POSITA would understand it, in light of the patent as a whole and their CGK.

[404] Notably, although AP&C had access to the original ToF-SIMS analysis conducted on the samples disclosed in the ’502 Patent (Tests 1 to 4), no attempt was made to compare the ToF-SIMS profiles of AP&C(a) to (d) to the results of the earlier analysis. To the extent there was a concern about reproducing the parameters of the testing in the patent, this concern simply underscores the impossibility of assessing the existence of a *depletion layer* based on the disclosure of the patent: Mostaghimi Second Report, para 431; Gardella First Report, para 170; Transcript, Day 10, pp 32–33; see discussion at paras [349]–[350] above. Further, AP&C continued to have access to the original powder samples from Tests 1 to 4, yet did not use those samples as their control samples, nor analyze them to show the validity of their control samples: Barnes Third Report, para 44.

[405] We are therefore left with simply an assumption made by AP&C’s experts that the samples AP&C(a) and (c) have a *depletion layer* while AP&C(b) and (d) do not. In making this assumption, AP&C and its experts effectively purport to create or substitute boundaries and parameters on the term *depletion layer* that are not set out in the ’502 Patent. They then seek to compare Tekna’s powders not to the ’502 Patent, as an infringement analysis requires, but to these created or substituted parameters.

[406] In my view, nothing in paragraphs 178, 179, or Figure 5 of the ’502 Patent permits the patentee to use its own products as such a proxy for an assessment of infringement of the claims of the patent. As Tekna points out, the analysis AP&C conducted was one that relies on access to samples from AP&C, which the general public would not have. Indeed, much of the information about these samples remained confidential even in the context of this trial.

[407] Nor was there any principled explanation given by AP&C as to why these particular samples were adopted as positive and negative controls, particularly in place of those used in the ’502 Patent. Dr. Larouche testified that he was asked by counsel (not Dr. Mostaghimi) to provide two “normal, usual good flowability powder[s],” which became the positive controls, and “the two most untreated powders that we have,” which became the negative controls: Confidential Transcript, Day 9, p 15. As noted, despite Dr. Larouche’s reference to the “most untreated powders,” one of the negative controls was in fact treated with some *additive gas*: Agreed Statement of Facts, para 144. Neither of the positive controls were treated with the same parameters identified in Experiment 1 of the ’502 Patent, namely 80 ppm of air for Test 3 (although this itself appears to have been a mistake) and 50 ppm of oxygen for Test 4: Agreed Statement of Facts, para 143; Exhibits 144, 146; Confidential Transcript, Day 9, pp 15–18, 48–50.

[408] Dr. Mostaghimi’s evidence was that the same factors that will affect whether a *depletion layer* will be formed, such as temperature, concentration of *additive gas*, and wire feed rate, will also affect the extent of the *depletion layer*: Mostaghimi Second Report, paras 52, 55, 308–309, 404–406; Transcript, Day 10, p 40. On this theory, changing these process parameters will affect the oxygen concentration profile of the resulting particle, such that two different particles may each have a *depletion layer*, with one having a greater concentration of oxygen.

[409] The infringement comparison conducted by AP&C’s experts effectively involved an assessment of whether Tekna’s particles aligned more closely with the normalized profiles of the negative controls or the normalized profiles of the positive controls. The relative “height” of

these normalized profiles—which, again, is not an expression of the total amount of oxygen in the particle, but only the relative ion yield at different depths compared to the maximum ion yield—therefore matters to the analysis.

[410] By way of illustration, the ToF-SIMS curve of sample Tekna(a) (the green lines) could be described as lying between those of the AP&C negative controls and positive controls, while being closer to and at times overlapping the positive control, as seen above: Mostaghimi Second Report, para 487; Barnes Third Report, para 66. This led Dr. Mostaghimi to conclude that the sample was "more consistent with those of the positive control samples" and therefore had a *depletion layer*: Mostaghimi Second Report, para 488. Yet, if AP&C had used a positive control with a higher oxygen concentration profile—or indeed had only used samples AP&C(a) (dark blue) and (b) (red) as controls—the very same sample Tekna(a) could be viewed as "more consistent with" the negative control and thus as not having a *depletion layer*. In this light, AP&C's unexplained selection of two particular samples as positive controls and two as negative controls appears arbitrary, and its process of comparison, which Dr. Gardella recognized included "not enough data points for a proper statistical evaluation," entirely subjective and unpredictable: Gardella First Report, para 182. In this regard, I note again the concern that Dr. Mostaghimi provided extensive analysis of the ToF-SIMS profiles and what they show, before stating in testimony that he was "not a ToF-SIMS expert": Transcript, Day 11, pp 35, 139; Day 12, pp 1–3.

[411] The importance of different production parameters on the resulting oxygen profiles also means that the comparison that AP&C's experts undertook was not even the comparison that

AP&C says the POSITA would undertake to assess whether a powder particle had a *depletion layer*. AP&C says the POSITA would understand that the existence of a *depletion layer* could be determined through “a controlled experiment where you do your sample without the additive gas against your sample, with the additive gas”: Transcript, Day 15, pp 37–38, 76, 82–85, 179–181. However, the comparison AP&C’s experts undertook was not between Tekna powders made with and without *additive gas*, but between Tekna powders, manufactured in Tekna’s equipment in different conditions with different wire lots, and AP&C powders, manufactured in AP&C’s equipment in different conditions with different wire lots: Agreed Statement of Facts, paras 86, 88, 93, 98, 131, 142–144. AP&C’s experts did not compare samples of Tekna powders to other samples of Tekna powders to conduct the “apples to apples” comparison AP&C suggests ought to have occurred.

[412] A comparison conducted only between Tekna powders could yield significantly different results than a comparison between Tekna powders and AP&C powders. For example, sample Tekna(f) was produced with very little oxygen and had poor flowability. AP&C’s experts all concluded it did not have a *depletion layer*: Mostaghimi Second Report, paras 483–485; Gardella First Report, paras 193–194; Cima First Report, paras 130–131. If this sample had been used as a “negative” control against which to assess other powders, then each of samples Tekna(b), (d), and (e) would have been seen as having a ToF-SIMS oxygen profile with a higher “tail.” On AP&C’s theory, these samples would therefore have a *depletion layer*. Yet AP&C’s experts all concluded that Tekna(b), (d), and (e) did not have a *depletion layer* based on their comparison to AP&C samples rather than Tekna samples. Indeed, if sample Tekna(f) were used as the baseline, even the samples AP&C(b) and (d), which AP&C used as their “negative” controls, would show

a higher “tail” in the ToF-SIMS profile, and thus, on AP&C’s theory, would have a *depletion layer*.

[413] A final example serves to further illustrate the arbitrariness of AP&C’s infringement analysis through its selection of particular samples as positive and negative controls, namely the assessment of whether sample AP&C(b) has a *depletion layer*. Sample AP&C(b) was made with some *additive gas*, namely an injection of air: Agreed Statement of Facts, para 144. On AP&C’s approach, if a POSITA were asked whether sample AP&C(b) had a *depletion layer*, they would compare its ToF-SIMS oxygen profile to that of a sample made without *additive gas*, namely sample AP&C(d), to see if it has a higher “tail.” Sample AP&C(b) clearly does have a higher “tail” than sample AP&C(d), as the red lines in the right-hand graph reproduced at paragraph [391] are above the pink lines, particularly beyond the depth associated with the *native oxide layer*. This, on AP&C’s approach, would lead the POSITA to conclude that AP&C(b) has a *depletion layer*. However, all of AP&C’s experts assumed that AP&C(b) does <u>not</u> have a *depletion layer*, using it as one of the negative samples.

[414] The foregoing discussion underscores that AP&C’s approach of comparing ToF-SIMS profiles and concluding that a *depletion layer* is present if the “tail” in the profile is higher is entirely dependent on what ToF-SIMS profile is used as a baseline for comparison. Yet the ’502 Patent does not identify what ToF-SIMS profile should be used as a baseline for comparison. AP&C itself seemed unable to use the ToF-SIMS profiles of Tests 1 and 2 from Figure 5 of the patent as a baseline, since they used other AP&C powders instead, and did so

without testing them against any of the tests (or powders) from the ’502 Patent to confirm their assumption that two of the AP&C reference powders had a *depletion layer* while two did not.

[415] I conclude that the fundamental premise used by AP&C and its experts as the essential aspect of its infringement analysis, namely that samples AP&C(b) and (d) have no *depletion layer* but samples AP&C(a) and (c) do, has not been adequately established with reference to the ’502 Patent.

[416] Above and beyond this, it is important to note that none of AP&C’s experts demonstrated that any *depletion layer* that may exist in samples Tekna(a) and (c) is *deeper and thicker* than the *native oxide layer* in those samples. Dr. Mostaghimi’s analysis based on the Tascon Report was simply that samples Tekna(a) and (c) have a *depletion layer*: Mostaghimi Second Report, paras 477, 488. When he then conducted his infringement analysis, he simply reiterated this finding and the language of Claim 1, expressing his opinion that the test results for these two samples “is consistent” with the essential elements of Claim 1 of the ’502 Patent, including that the *first layer* is a *depletion layer deeper and thicker* than the *native oxide layer*: Mostaghimi Second Report, para 497. However, he provides no analysis as to how the existence of a *depletion layer* necessarily means that the *depletion layer* is *deeper and thicker* than the *native oxide layer*, particularly given his own evidence regarding the factors that can affect the depth of the *depletion layer*.

[417] Notably, Dr. Mostaghimi did not apply the very criteria that he said a POSITA would apply to determine the extent of the *depletion layer*—the point at which the first derivative of the

concentration vs depth curve is effectively zero—either to those powders he opined had a *depletion layer* or to those that did not: Mostaghimi Second Report, paras 60, 94–95, 430. For example, in reviewing the graphs from the Tascon Report relating to sample Tekna(a) reproduced above, he did not attempt to identify where the first derivative of any of the curves reached effectively zero. Nor did he apply the alternate criteria he felt a POSITA could apply, namely the point at which the oxygen concentration reached 50% of its maximum: Mostaghimi Second Report, paras 60, 430. Nor did he attempt to identify, either on the basis of the Tascon ToF-SIMS curves or otherwise, where the *native oxide layer* ended and the *depletion layer* began so as to be able to compare their depths.

[418] Similarly, Dr. Gardella and Dr. Cima concluded that samples Tekna(a) and (c) have a *depletion layer*, but neither of their reports give any opinion that the *depletion layer* in these samples is *deeper and thicker* than the *native oxide layer*. As discussed above at paragraphs [292] to [294], neither Dr. Gardella nor Dr. Cima attempts to construe the claims of the ’502 Patent. Each alludes generally to their understanding of the ’502 Patent, but neither discusses the *deeper and thicker* language of Claim 1, and neither states whether or why they conclude that samples meet this essential element: Gardella First Report, paras 195–196; Cima First Report, paras 109, 120, 124.

[419] Dr. Cima does assert that the *depletion layer* in these powders is “on the order of 25 AU [arbitrary units].” He converts this to between 15 and 25 nm, which he describes as being “tens of nanometers thick”: Cima First Report, para 135. However, his report does not explain why he considered that the *depletion layer* in the Tekna(a) and (c) samples were about 25 arbitrary units.

As discussed above at paragraphs [269] to [273], Dr. Cima stated for the first time in response to clarification questions from the Court that his “tens of nanometers” measurement was measuring the *depletion layer* as beginning at around 6 nm based on an asserted change in the slope in the oxygen signal, and ending at about 23% of the maximum concentration: Confidential Transcript, Day 13, pp 33–35. I have given my reasons above for rejecting this evidence.

[420] In any event, none of the curves that Dr. Cima was analyzing cross the 23% of maximum concentration threshold (*i.e.*, 0.23 on the “normalized to maximum” y-axis) at anywhere near 25 arbitrary units in depth, let alone 25 arbitrary units below an asserted 6 nm threshold between the layers. For example, in the curves reproduced above, it can be seen that the Tekna(a) sample (green) crosses the 23% of maximum concentration threshold at around 10 to 12 arbitrary units. Dr. Cima’s evidence is therefore difficult to comprehend and does not allow the Court to reach any conclusions on whether samples Tekna(a) and (c) have a *depletion layer* that is *deeper and thicker* than the *native oxide layer*. Notably, Dr. Cima also does not apply his purported parameters of the *depletion layer* to samples Tekna(b), (d), (e), or (f), simply concluding that they do not have a *depletion layer* because their oxygen profile curves lie closer to the AP&C negative control than the positive control.

[421] In addition to AP&C’s experts, it is worth noting that the section of AP&C’s written Closing Argument dedicated to infringement of the ’502 Patent (and, simultaneously, the ’236 Patent) does not even refer to Tekna’s powders having a *depletion layer* that is *deeper and thicker* than the *native oxide layer* or attempt to compare the thickness of the *depletion layer* to that of the *native oxide layer*: AP&C Closing Argument, paras 307–352. Despite the fact that the only essential element in dispute for purposes of infringement of the ’502 Patent was the

existence of a *depletion layer* that is *deeper and thicker* than the *native oxide layer*, AP&C studiously avoided any attempt to assess whether the testing of Tekna's powders showed the thickness of the *depletion layer* they claim to exist, or whether that thickness was greater than that of the *native oxide layer*.

[422] I therefore conclude that AP&C's evidence based on the Tascon Report, the ToF-SIMS profiles contained therein, and their experts' analysis of those profiles, do not demonstrate infringement, even on the various conflicting theories presented regarding the scope of Claim 1. To the contrary, the expert evidence and AP&C's attempts to demonstrate infringement by comparison to its own products rather than the parameters set out in the '502 Patent simply highlights the impossibility of assessing whether a powder particle has a *depletion layer* within the scope of Claim 1 based on the claims and disclosure of the patent.

[423] I conclude this section with two particular issues relating to AP&C's evidence and arguments related to infringement. The first relates to sample Tekna(a). The parties agree that the oxygen concentration in this powder sample is 1,400 ppm: Agreed Statement of Facts, para 142. This falls outside the requirement of element 1(c) that the *raw reactive metal powder* with said *surface layer thereon,* comprises less than 1000 ppm of at least one element from said at least one *additive gas*. While Dr. Mostaghimi contended that the "pickup" of oxygen in the particle was under 1,000 ppm, the limitation in element 1(c) refers to the total amount of the component of *additive gas* in the entire particle and not just the "pickup," as discussed above at paragraphs [180] to [202]: Transcript, Day 11, pp 88–90. Thus, this particle would not meet all of the essential elements of Claim 1, even if it had a *depletion layer* that is *deeper and thicker* than the *native oxide layer*.

[424] The second relates to Tekna’s argument that AP&C has not proved infringement of any claim since it has not shown that any oxygen present below the *native oxide layer* is in the form of a reaction compound, *i.e.*, an oxide. This argument is based on Mr. Barnes’ opinion that the POSITA would understand the *depletion layer* to consist of the reaction product of the *additive gas* with the *reactive metal source*. As noted above at paragraphs [232] to [242], I have concluded that the POSITA would not construe Claim 1 of the ’502 Patent as requiring the atoms or molecules of the *additive gas* to be present in the *depletion layer* in the form of a reaction product. Tekna’s argument on this ground is therefore unsuccessful for most claims of the ’502 Patent.

[425] However, dependent Claim 41 requires the *reactive metal source* to be contacted with the *additive gas* within a *heat zone of an atomizer*. As discussed at paragraphs [309] to [310] above, the inventors’ definition of the term *heat zone of an atomizer* incorporates the reaction of electronegative atoms of the *additive gas* in order to generate a *depletion layer*. I have concluded that the POSITA would therefore construe Claim 41, unlike Claim 1, as including the requirement that the *depletion layer* be formed from the reaction product of the *additive gas* with the *reactive metal source*. AP&C has not demonstrated, nor attempted to demonstrate, that any subsurface oxygen in Tekna’s powders is present in the form of a reaction product, *i.e.*, a metal oxide, and has therefore not demonstrated that Claim 41, and any claim dependent thereon, is infringed. At the same time, I note that while AP&C’s narrowest asserted claim includes dependency on Claim 41, it also asserts the broader claims, including claims that do not depend on Claim 41.

(d) *Extrapolation*

[426] AP&C argues the Court can extrapolate from the evidence regarding samples Tekna(a) and (c) that between about 40 and about 80 percent of Tekna's powder production in the relevant time frame infringes the '502 Patent: AP&C Closing Argument, paras 346–351; Transcript, Day 15, pp 185–186.

[427] There is no question that extrapolation from exemplary samples of an infringing product may be necessary and appropriate, permitting the Court to make broader conclusions regarding infringement based on an analysis of the samples: *Bombardier Recreational Products Inc v Arctic Cat Inc*, 2017 FC 207 [*Bombardier (FC)*] at paras 448–469, rev'd in part on other grounds, *Bombardier (FCA)*. However, as Justice Roy recognized in *Bombardier (FC)*, for the Court to extrapolate from exemplars, it must be satisfied on a balance of probabilities both that the exemplars are infringing, and that they are representative of the broader population of accused products: *Bombardier (FC)* at paras 448–451, 466–469.

[428] The exemplars examined in the present case are limited to samples Tekna(a) and (c). As set out above, I am not satisfied that AP&C has established that these samples infringe the asserted claims of the '502 Patent. However, even if AP&C had shown that samples Tekna(a) and (c) infringe the '502 Patent on its approach to the *depletion layer,* I am not satisfied it has shown these samples are sufficiently representative to demonstrate that the same conclusion could be made about other Tekna samples.

[429] In his infringement analysis, Dr. Mostaghimi concluded that the powders of samples Tekna(a) and (c) have a *depletion layer*, that they were treated with *additive gas*, and that they have improved flow characteristics. As noted above, he opines, without further analysis, that these powders meet the essential elements of Claim 1 relating to the *surface layer*, including that they have a *depletion layer* that is *deeper and thicker* than the *native oxide layer*: Mostaghimi Second Report, para 497. He goes on to state that he would "expect that other atomized powders produced by Tekna since May 2017 that are treated with additive gases and have good flow characteristics likewise possess these essential elements": Mostaghimi Second Report, para 497. Dr. Mostaghimi's extrapolation to other Tekna products is thus based on his "expectation" that powders that are treated with *additive gas* and meet the defined flow parameters must have a *depletion layer* within the meaning of the patent: Mostaghimi Second Report, paras 497–511, Exhibits M and N; Confidential Transcript, Day 11, pp 14–15.

[430] For the reasons set out above, this is circular, seeking to prove the existence of one of the essential elements of the claim on the basis of the presence of two other essential elements of the claim. The evidence does not support such an inference or correlation. To the contrary, as Dr. Mostaghimi recognized, the use of *additive gas* does not always result in the formation of a *depletion layer*, which depends on other parameters: Transcript, Day 11, pp 131–132; Confidential Transcript, Day 12, pp 56–57. He also recognized that having a defined flowability does not show that there is a *depletion layer*, and vice versa: Confidential Transcript, Day 12, pp 68–71; Mostaghimi Second Report, para 279. Yet he nonetheless concludes that the presence of an *additive gas* and good flowability means that there is necessarily a *depletion layer*.

[431] Thus, even on Dr. Mostaghimi's evidence, good flowability may be the result of factors other than a *depletion layer*. Yet Dr. Mostaghimi presents no analysis or explanation for his assertion that good flowability in powders made using an *additive gas* must be the result of, or indicative of, the existence of a *depletion layer*. Particularly given the subjectivity in the analysis on which he concludes that samples Tekna(a) and (c) have a *depletion layer*, while samples Tekna(b) and (d) do not, I am not satisfied that the evidence shows that Dr. Mostaghimi's "expectation" is sufficient to treat the samples as representative, or to conclude that any other Tekna powder that meets other essential elements also meets the *depletion layer* element: Barnes Third Report, paras 75–79; Exhibit 75.

[432] I also agree with Mr. Barnes that there is some irony, or at least inconsistency, in Dr. Mostaghimi's attempt to extrapolate from the two Tekna samples: Barnes Third Report, paras 80–81. When addressing Mr. Barnes' evidence about samples that were tested but not included in the '502 Patent, Dr. Mostaghimi noted that there was limited information about how the samples were manufactured, stored, and handled, such that drawing conclusions from them on the impact of the *depletion layer* on powder flowability was "difficult to impossible": Mostaghimi Second Report, paras 272–278. He further underscored that the presence of a *depletion layer* does not determine whether a powder will exhibit excellent flowability: Mostaghimi Second Report, para 279. Yet Dr. Mostaghimi was willing to conclude that any powder that was treated with *additive gas* (regardless of other manufacturing, storage, or handling conditions) and showed flowability had a *depletion layer* by definition. In my view, neither the evidence nor the patent supports such an extrapolation.

[433] Nor do I accept AP&C's contention that Mr. Barnes conceded in cross-examination that a certain percentage of Tekna's production would have a *depletion layer* if samples Tekna(a) and (c) did. While Mr. Barnes accepted counsel's tautological question that assumed the existence of a *depletion layer*, he did not agree that a certain amount of *additive gas* was necessarily sufficient to generate a *depletion layer*, or that any particular percentage of Tekna's production would result in a *depletion layer* as extrapolated from samples Tekna(a) and (c): Confidential Transcript, Day 6, pp 45–50.

[434] The foregoing being said, I agree with Tekna that the issue of extrapolation would be primarily relevant to damages as part of the liability phase of the trial in light of the bifurcation of this action. However, to the extent that the extrapolations presented may have been relevant to remedial issues at this stage of the trial, the evidence does not support the extrapolation of the existence of a *depletion layer* from samples Tekna(a) and (c) to other Tekna powders.

(e) *Tekna's evidence going to non-infringement*

[435] Mr. Barnes arranged for analysis of a series of powder samples from Tekna and AP&C using a Transmission Electron Microscope [TEM] combined with Energy-Dispersive X-Ray Spectroscopy [EDS]: Barnes First Report, paras 649–662. The TEM-EDS technique involves cutting out a very thin cross-section slice (a lamella) perpendicularly from the surface of the particle by milling, and measuring the concentration of elements at different depths of the lamella: Barnes First Report, paras 663–668, 711–719. The lamella is thin enough (less than 100 nm) to be electron transparent, allowing the TEM to visualize and measure the *native oxide*

layer, and take concentration measurements at various depths in and below the *native oxide layer* using EDS.

[436] The powder samples analyzed by TEM-EDS were the four AP&C powders produced and analyzed in Tests 1 to 4 in the ’502 Patent, plus eight Tekna powders, seven of which were titanium alloy (Ti-6Al-4V) powders [including samples Tekna(a), (d), (e), and (f)], while one was an aluminum alloy: Barnes First Report, para 674. After a false start at Purdue University, the testing was conducted at the CM^2 laboratory at Polytechnique Montréal: Barnes First Report, paras 697–698, 704–720. Lamellae were cut from the various samples, the oxide layer was observed and measured, and concentration measurements were taken from “spots” about 5 nm in diameter along a line at depths of 0 nm (in the oxide layer), 5 nm, 10 nm, 20 nm, 50 nm, 100 nm and 1,000 nm (1 µm): Barnes First Report, paras 715–719; Transcript, Day 6, p 48.

[437] Mr. Barnes presented the oxygen concentrations of the powders derived from the TEM-EDS approach on graphs showing the oxygen intensity ratio plotted against the depth in nanometres: Barnes First Report, paras 728, 802, 805. On Mr. Barnes’ interpretation of the data, the oxygen concentration of all of the samples peaks in the oxide layer at the surface (*i.e.*, at the y-axis of 0 nm), shows a “marked decline” within the first 5 to 10 nm, and then “essentially levels off” at around 10 nm: Barnes First Report, paras 725–730, 803, 806. Mr. Barnes concluded that these data did not correspond to a *depletion layer* of tens of nanometres for any of the samples, including any of the four samples from Tests 1 to 4 of the ’502 Patent (although Test 3 showed a thicker oxide layer): Barnes First Report, paras 729, 802–806. On this basis, Mr. Barnes concluded that none of the Tekna powders analyzed had a *depletion layer* and thus

none infringed any claim of the ’502 Patent: Barnes First Report, paras 884–885. Mr. Barnes also noted that the TEM-EDS oxygen profiles of the Tekna powders were similar to those of AP&C’s Tests 1 and 2, which were made without *additive gas*: Barnes First Report, para 886.

[438] AP&C’s experts criticized the use of TEM-EDS and Mr. Barnes’ analysis of the resulting data. While Dr. Mostaghimi and Dr. Gardella provided brief responses, the thrust of AP&C’s challenge to the TEM-EDS testing was in Dr. Cima’s evidence: Mostaghimi Second Report, paras 232–234; Gardella First Report, paras 162–164; Cima First Report, paras 29–32, 90–108.

[439] Dr. Cima presents three primary criticisms of Mr. Barnes’ analysis. The first is simply that Mr. Barnes used TEM-EDS testing instead of the ToF-SIMS analysis set out in the ’502 Patent: Cima First Report, para 93. I give this criticism little weight. There is nothing in the ’502 Patent that indicates that ToF-SIMS is the only testing method capable of detecting or identifying a *depletion layer*. Rather, the ’502 Patent indicates, as AP&C itself submits, that a *depletion layer* is something that exists in the chemical composition of the surface of the particle, *i.e.*, a “state of matter.” Any analytical method that can reasonably identify and characterize the surface composition of a powder particle may therefore be a useful method to detect and identify a *depletion layer* even if it is not mentioned in the ’502 Patent. AP&C itself recognized that the TEM-EDS results should not be ignored simply because the testing method is not referenced in the patent: Transcript, Day 165, pp 138–139.

[440] Indeed, a method that is able to distinguish between the *native oxide layer* and the *depletion layer* would be particularly beneficial in assessing whether a process falls within the

claims of the ’502 Patent. As set out above, the results of the ToF-SIMS analysis performed by AP&C and its experts suggest that ToF-SIMS is not particularly well-suited to this task, as no expert was able, or even attempted, to distinguish between the *native oxide layer* and the *depletion layer* using the ToF-SIMS analysis, leaving aside Dr. Cima’s brief reference to a change in slope: Confidential Transcript, Day 13, p 34; see also Day 9, p 61. The TEM-EDS technique, on the other hand, allows for both a visualization of the *native oxide layer*, which appears as a measurable darker layer at the surface of the particle, and an analysis of element concentrations in and below that layer.

[441] I note that Dr. Cima also contended that Mr. Barnes justified using TEM-EDS instead of ToF-SIMS because ToF-SIMS was difficult to perform: Cima First Report, paras 29, 93. I agree with Mr. Barnes that this criticism is difficult to understand, as Mr. Barnes’ explanation for choosing TEM-EDS was not based on it being easier than ToF-SIMS. Indeed, he expressly noted the practical difficulties associated with TEM-EDS, including the “tedious and challenging” preparation of lamellae: Barnes First Report, paras 655–667; Barnes Third Report, para 147.

[442] Dr. Cima’s second criticism is that TEM-EDS does not yield an average concentration of oxygen as a function of depth. Dr. Cima notes that oxygen will diffuse differently along grain boundaries within the crystals that form in a metal powder, such that the amount of oxygen may be different at different points at the same depth of the surface. Since TEM-EDS measures concentration at given points along a line from a very thin lamella, the data it generates represents a smaller section of the particle than ToF-SIMS, in which a much larger region of the

particle is bombarded to create the depth profile: Cima First Report, paras 30, 105–108; Confidential Transcript, Day 13, pp 1–2.

[443] I accept, as did Mr. Barnes, that oxygen can diffuse at different rates along crystal boundaries in a powder particle: Barnes Third Report, para 151. However, Dr. Cima did not comprehensibly explain why either the general concern about the size of the area measured by TEM-EDS or the more specific concern about differential oxygen diffusion rates would explain the oxygen depth profiles shown from the TEM-EDS testing. As Mr. Barnes points out, each of the samples shows fairly constant oxygen concentration measurements, rather than the outlier concentrations that might be expected if a specific measurement were not representative of the average: Barnes First Report, para 728; Barnes Third Report, para 155. Further, one of the concentration measurements was visibly at a crystal border, yet showed no material variation from other measurements from the particle: Barnes First Report, para 728; Barnes Third Report, para 156. Dr. Cima was not asked in his testimony to address Mr. Barnes' responses to his criticisms.

[444] Dr. Cima's third criticism was that Mr. Barnes "neglected to realize" that the lamellae of titanium alloy react with oxygen at room temperature to create an oxide layer and "took no precautions to prevent such reaction": Cima First Report, paras 32, 95–97. Again, the language of this criticism is difficult to reconcile with the express reference in Mr. Barnes' report to Ti-6Al-4V being prone to oxidation and specific steps taken in milling the lamellae to minimize any potential surface oxidation that could occur when creating a new surface during the thinning process: Barnes First Report, para 717; Barnes Third Report, paras 162–164.

[445] Further, as Mr. Barnes notes, Dr. Cima refers to literature that speaks of the reaction between oxygen and clean titanium surfaces at room temperature happening in the “initial 200 minutes” of exposure and describes experiments involving films being exposed to pure oxygen for 24 hours resulting in an oxide layer of about 2.6 nm: Cima First Report, paras 98–99. Dr. Cima appears to assume, without explanation, that an oxide layer of similar thickness would or could have appeared on the surface of the lamellae after exposure to room temperature air (not oxygen) for a matter of a few minutes: Cima First Report, paras 100–103; Confidential Transcript, Day 13, p 7; Barnes Third Report, paras 166–167.

[446] In any event, Dr. Cima’s opinion was that the resulting oxide layer would have the same thickness for all lamellae, so the oxide layer would contribute a higher relative amount of oxygen to a thinner lamella, and a lower relative amount of oxygen to a thicker lamella: Cima First Report, paras 100–101; Confidential Transcript, Day 13, pp 7–8. This may explain the fact that the oxygen concentration profiles of the samples showed varying total oxygen intensity ratios (*i.e.*, curves of varying heights on the oxygen intensity ratio scale): Barnes First Report, para 128; Cima First Report, paras 101–104; Confidential Transcript, Day 13. However, it does not explain the absence in those profiles of any variation of oxygen concentration that might be described as a *depletion layer*. If anything, the presence of an additional oxide layer would tend to increase the apparent level of oxygen in the layer: Barnes Third Report, para 168. Indeed, while Dr. Cima raised this concern to raise uncertainty about the oxygen concentration measurements, he presented no explanation as to how it might cause the observed levelling off in oxygen concentrations after 10 nm, or how it might mean that a *depletion layer* (even as he understood it) was present but not seen in the TEM-EDS results.

[447] In cross-examination of Mr. Barnes and in closing argument, AP&C raised two further attacks on the TEM-EDS testing not mentioned in their experts' reports. The first relates to the proprietary software used by Polytechnique Montréal to "deconvolute" EDS peaks created by oxygen, titanium, and vanadium in the testing, and the signature energies for these elements used in compiling the oxygen intensity profile: Confidential Transcript, Day 6, pp 4–15; Barnes Second Report, Exhibits JB-40, JB-41. AP&C contends that there are differences between reported signature energies for the elements and the figures that appear in the confidential spreadsheet provided by Polytechnique Montréal underlying their report: AP&C Closing Argument, paras 286–293. Having reviewed the examination and underlying report on these issues, I am not satisfied that AP&C's line of cross-examination materially undermines the TEM-EDS testing results or "calls into question the entirety of the TEM-EDS data", as AP&C argues, for the following reasons.

[448] First, while AP&C put to Mr. Barnes that the National Institute of Standards and Technology [NIST] website did not maintain theoretical energy values for oxygen, the information from Polytechnique Montréal was that the values used were from a database in the NISTA DTSA-II software, and not from the NIST's website: Barnes Second Report, Exhibit JB-41, p 1. I am therefore not satisfied that the evidence demonstrates that Polytechnique Montréal made any misstatement regarding the source of the theoretical energy of the oxygen Kα peak.

[449] Second, I am not satisfied based on the questions put to Mr. Barnes and the references made to the spreadsheet at Exhibit JB-40 to Mr. Barnes' second report that Polytechnique Montréal "used" an incorrect oxygen signature peak or that it "violated its own principle of using

the standards," as AP&C suggests. The spreadsheet cells to which AP&C points clearly have values that are different from each other and from the published oxygen Kα peak value of 0.5249 eV. However, there is no indication that these are input values as opposed to measured values, or whether the variation is due to expected or unexpected experimental variation: Confidential Transcript, Day 6, pp 12–13.

[450] Third, and as a related point, neither Dr. Cima nor any other expert raised this issue in a report that would allow for a more reasoned consideration of the issue than the one Mr. Barnes was able to present in cross-examination. Mr. Barnes' Second Report, which included the data in question, was produced in February 2022, some eight months before trial. Dr. Cima's First Report was produced in June 2022, while his Second Report was produced in October 2022. Neither report raised any concern with the data presented in Exhibit JB-40. At trial, Dr. Cima said he had "subsequently learned a bit more about the approach" (it is unclear from whom) and that he "now believe[d] that there may be some problems": Confidential Transcript, Day 13, p 32. Even at trial, however, when the issue had been canvassed with Mr. Barnes some ten days earlier, Dr. Cima said that he "[didn't] know what the implication of that is," just that it was something that "would certainly have to be investigated": Confidential Transcript, Day 13, p 33.

[451] This is far from sufficient for the Court to conclude that the testing and analysis conducted by Polytechnique Montréal and presented in Mr. Barnes' reports is unreliable. Among other reasons, had Dr. Cima expressed his concerns earlier—or attempted to reach a conclusion on what the implication of them was—Mr. Barnes may have been in a position to consider the issue further, assess the cells in question, and/or consult with Polytechnique Montréal. In the

absence of support in an expert report, the hypothetical questions put to Mr. Barnes (such as that "if the oxygen signature peak used in JB-41 was […] wrong, that would draw into question the conclusions that could be reached") do not establish an evidentiary basis to reject the TEM-EDS data.

[452] The second challenge to the TEM-EDS data put forward by AP&C in cross-examination and argument, but not by its experts, related to the selection of the various depths at which the oxygen concentrations were measured: Transcript, Day 6, pp 53–55; AP&C Closing Argument, paras 294–303. AP&C argues that the approach of doing the first analysis at 0 nm and the second at 5 nm resulted in a "gap" in the information about the first 2.5 nm interior to the oxide layer. AP&C contends that the TEM-EDS data does not show oxygen intensity in this gap, and that this is "troubling," since the '502 Patent (and the '236 Patent) show the greatest oxygen content immediately below the *native oxide layer*.

[453] It appears this argument is directed to Mr. Barnes' opinions regarding the possibility of oxygen diffusing into a particle through an oxide layer. I have not needed to address this issue, which relates principally to Tekna's utility arguments, given my other conclusions. Even on this issue, the relevance of the 2.5 nm region below the *native oxide layer* is far from clear. No expert suggested that the oxygen concentration at this location would be expected to be anything other than somewhere on the concentration gradient between the surrounding measurements.

[454] In any event, the Court is unable to understand why this "gap" region is in any way relevant to demonstrating the existence of a *depletion layer,* particularly one that is *deeper and*

thicker than the *native oxide layer*. The patent certainly does not suggest that the *depletion layer* would be seen in the space between 0 and 5 nm, or even between 5 and 10 nm. Nor have any of the experts, or even AP&C, suggested that this is where the *depletion layer* would be seen. I note again that neither Dr. Cima, who reviewed the TEM-EDS testing closely, or either of AP&C’s other experts appears to have been concerned about the lack of a spot measurement between the 0 nm and 5 nm points.

[455] Overall, I do not find either the criticisms of the TEM-EDS results raised by Dr. Cima or those raised by AP&C without expert evidence to be persuasive in undermining the reliability of the TEM-EDS testing. That testing appears to show that all of the particles tested have an oxide layer, but that the oxygen content in the particle drops quickly within the first 5 to 10 nm of the particle and then generally levels off.

[456] It is difficult to say that the TEM-EDS results clearly show that Tekna’s powders do *not* have a *depletion layer* within the meaning of the claims of the ’502 Patent for the simple reason that, as set out above, the POSITA would be unable to understand what the term *depletion layer* means. However, I am satisfied that the testing results provide a further basis to conclude that the evidence does not establish that Tekna has infringed the claims of the ’502 Patent.

D. *Conclusion*

[457] For the above reasons, I conclude that the ’502 Patent is invalid, and that AP&C has not demonstrated that Tekna has infringed the claims of the ’502 Patent.

V. Canadian Patent 3,051,236

A. *Claims Construction*

(1) Introduction

[458] The ’236 Patent has no fewer than 147 claims, including 11 independent claims, namely Claims 1, 9, 21, 39, 57, 64, 66, 73, 90, 98, and 104. The parties spent little time in argument addressing the construction of any of these claims beyond Claim 1, and largely addressed construction of that claim concurrently with their arguments in respect of Claim 1 of the ’502 Patent.

[459] While each patent must be construed independently, the parties each submitted that, in light of the identical disclosure, POSITA, and CGK for the two patents, the same construction should be placed on the same terms in each patent and, in particular, that their proposed construction of the terms should apply to the claims in both patents: Transcript, Day 14, pp 60–63; Day 15, p 41; see also Barnes First Report, paras 58–60, 421–422; Mostaghimi First Report, paras 105–107.

[460] As discussed below, I conclude that while most of the terms of Claim 1 of the ’236 Patent would be construed by the POSITA in the same way as in the ’502 Patent, the POSITA’s construction of the ’236 Patent would take into account the particular language of the claims, such that aspects of their claims construction of the ’236 Patent would differ from that of the ’502 Patent.

[461] As stated above, the disclosure of the ’236 Patent is identical to that of the ’502 Patent, save for paragraph numbering. To avoid confusion and inconsistency with the discussion above, I will refer below to the paragraph numbers in the disclosure of the ’236 Patent using the paragraph numbers of the ’502 Patent, but will mark those numbers with an asterisk to reflect that the paragraph numbers in the ’236 Patent are actually one lower. Thus, I will refer to the two paragraphs in the disclosure discussing Figure 5—which are paragraphs 178 and 179 of the ’502 Patent but paragraphs 177 and 178 of the ’236 Patent—as “ ’236 Patent, paras 178–179*.”

[462] As with the ’502 Patent, the experts agreed that each of the elements set out in the claims of the ’236 Patent would be considered by the POSITA to be essential: Barnes First Report, para 23(g)(iii); Mostaghimi First Report, para 113.

[463] As a final introductory note, a certified copy of the ’236 Patent was marked as Exhibit 2 in this proceeding. However, it appears that Exhibit 2 as marked does not include certain corrections that were made to the claims of the ’236 Patent in 2021. The version of the ’236 Patent found at Exhibit D to Dr. Mostaghimi’s First Report appears to be the corrected and correct version of the ’236 Patent and I have used that version for the purposes of this decision.

(2) Claims 1 to 4

[464] Claims 1 to 4 of the ’236 Patent read as follows, with elements lettered for ease of reference, and the terms discussed below underlined:

> 1. A reactive metal powder atomization manufacturing process comprising:
>
> > (a) atomizing a heated reactive metal source to produce a raw reactive metal powder, wherein (b) atomizing the heated reactive metal source comprises contacting said heated reactive metal source with an atomization mixture comprising an atomizing gas and an additive gas, wherein the atomizing gas is at a greater temperature than the heated reactive metal source, and
> >
> > (c) forming, with said additive gas, a depletion layer including a component from the additive gas on particles of the raw reactive metal powder, (d) the raw reactive metal powder having a particle size distribution of 10 to 53 micrometers with a flowability less than 40 s, measured according to ASTM B213.
>
> 2. The process of claim 1, wherein the depletion layer has a depth that is less than 100 nm.
>
> 3. The process of claim 1 or 2, further comprising:
>
> > forming a native oxide layer by exposing the raw reactive metal powder to a gas containing oxygen.
>
> 4. The process of claim 1 or 2, further comprising:
>
> > forming a native oxide layer by exposing the raw reactive metal powder to atmosphere containing oxygen.

[465] The attentive reader will note a number of similarities and differences between Claim 1 of the ’236 Patent and Claim 1 of the ’502 Patent. In particular, Claim 1 of the ’236 Patent, like Claim 1 of the ’502 Patent, claims a process for manufacturing *reactive metal powders* through *atomization* that comprises (a) *atomizing* a heated *reactive metal source* to produce a *raw reactive metal powder,* by (b) contacting the source with an *atomization mixture* comprising an *atomizing gas* and an *additive gas*, (c) forming a *depletion layer* on the *raw reactive metal powder*, and (d) the *raw reactive metal powder* having a given particle size distribution with a given flowability. Notably, however, Claim 1 of the ’236 Patent does not state that the process

includes forming a *native oxide layer*, a limitation that appears in Claims 3 and 4. These similarities and differences lead to similarities and differences in the construction the POSITA would put on these claims.

(a) *atomization manufacturing process; atomizing; reactive metal; raw reactive metal powder; atomization mixture; an atomizing gas; an additive gas; flowability*

[466] I see nothing in the claims or disclosure of the ’236 Patent that would lead the POSITA to construe the terms *atomization manufacturing process*, *atomizing*, *reactive metal source*, or *raw reactive metal powder* differently than as discussed above at paragraphs [141] to [150] and [156] to [157]: Barnes First Report, paras 422, 427–429; Mostaghimi Second Report, para 105.

[467] Similarly, I conclude the POSITA would construe the terms *atomization mixture*, *an atomizing gas* and *an additive gas* in the manner discussed at paragraphs [158] to [177] above in respect of the ’502 Patent, with two exceptions: one related to the temperature of the *atomizing gas* and one related to the makeup of the *additive gas*.

[468] With respect to the first exception, as discussed at paragraph [159] above, the POSITA would recognize that the *atomizing gas* of Claim 1 of the ’502 Patent may or may not be heated. Claim 1 of the ’236 Patent, however, specifies that the *atomizing gas* is at *greater temperature* than the *heated reactive metal source*, such that it would, by definition, be heated. It would therefore both heat and atomize the *reactive metal source*: Barnes First Report, paras 434–435.

[469] Mr. Barnes suggests that the POSITA would understand the heated *atomizing gas* to necessarily be in the form of plasma, thereby excluding gas atomization: Barnes First Report, para 435. However, the POSITA would recognize that where the inventors intended to limit their claim exclusively to plasma atomization, they explicitly refer to “a plasma source”: ’236 Patent, Claims 9, 73, 90–95, 98, 104, 109, 120–123, 144–147. Since there is no such reference in Claim 1, I conclude the POSITA would understand that the *atomizing gas* of Claim 1 of the ’236 Patent must have a higher temperature than the heated *reactive metal source*, but need not necessarily be in the form of plasma.

[470] With respect to the second exception, I have concluded at paragraphs [173] to [176] above that the *additive gas* of Claim 1 of the ’502 Patent must contain oxygen since the process of Claim 1 comprises forming, with the *additive gas*, a *surface layer* that includes a *native oxide layer*. Claim 1 of the ’236 Patent does not require the *additive gas* to form a *native oxide layer*. The language of the claim therefore does not include limitations that restrict the *additive gas* to oxygen or an oxygen-containing gas. Claims 7 and 8 of the ’236 Patent add limitations that the *additive gas* is oxygen or an oxygen-containing gas respectively. The presumption against claim redundancy, discussed at paragraph [176], operates to indicate that the *additive gas* of Claim 1 of the ’236 Patent is not limited to an oxygen-containing gas. Unlike Claim 1 of the ’502 Patent, there is no clear language in Claim 1 of the ’236 Patent to rebut this presumption.

[471] I nonetheless conclude that, as with the ’502 Patent, the *additive gas* is a gas that contains an electronegative ion or molecule (not an inert gas), as discussed at paragraphs [162] to [172] above. I note that, as with the ’502 Patent, the’236 Patent has numerous dependent claims that

limit the *additive gas* to particular electronegative gases, but none that simply limits the *additive gas* to a gas containing an electronegative ion or molecule:’236 Patent, Claims 6–8, 15–17, 27–38, 45–49, 51–53, 55, 59–60, 62–63, 68–69, 71–72, 76–82, 96–97, 107–108, 124–128, 134–140.

[472] I note that I agree with Mr. Barnes that despite the use of the term “<u>an</u> atomizing gas and <u>an</u> additive gas” [emphasis added], the POSITA reviewing Claim 1 of the ’236 Patent in light of dependent claims such as Claim 119 would understand that the *atomizing gas* and *additive gas* could include more than one gas: Barnes First Report, paras 431–432.

[473] The flowability parameters set out in Claim 1 of the ’236 Patent are the same as those set out in Claim 1 of the ’502 Patent, although Claim 1 of the ’236 Patent does not use the word “about” to describe the particle size distribution. For the reasons given at paragraphs [151] to [155] above, this element of Claim 1 of the ’236 Patent would be understood in the same way as the equivalent element in Claim 1, given the definition set out in the disclosure: ’236 Patent, paras 39–40*; Barnes First Report, paras 360–364, 441.

(b) *depletion layer*

[474] As with the ’502 Patent, the *depletion layer* is the primary term at issue between the parties in respect of the ’236 Patent. The parties generally did not distinguish between the two patents in their submissions on the construction of the term, adopting largely the same arguments in respect of both patents: Tekna Closing Argument, paras 58–71; AP&C Closing Argument, paras 108–112.

[475] A certain amount of the discussion above in relation to the ’502 Patent is directly applicable to the ’236 Patent as the disclosure of the patents is the same and there are no differences in the claims that would lead the POSITA to a different construction. In particular:

- as discussed at paragraph [217] above, the POSITA would have no prior understanding of the term *depletion layer* from their CGK and would recognize it as a coined term used by the inventors for purposes of the patent;

- for the reasons given at paragraphs [222] to [224] above, the POSITA reading Claim 1 of the ’236 Patent in light of the disclosure would understand the word *depletion* in the term *depletion layer* to mean that the quantity or concentration of the component from the *additive gas* decreases within the layer as one moves toward the centre of the particle: Barnes First Report, paras 344–345, 440; and

- for the reasons given at paragraphs [225] to [242] above, the POSITA would not understand the component of the *additive gas* to necessarily be present in the *depletion layer* in the form of a reaction product between the *additive gas* and the *reactive metal source*, or to be present as a result of diffusion.

[476] Notably, however, Claim 1 of the ’236 Patent does not require that the *depletion layer* be *deeper and thicker* than the *native oxide layer*. That language was material to the construction of the *depletion layer* element in the ’502 Patent, as discussed at paragraphs [243] to [299] above. The term *depletion layer* as used in Claim 1 of the ’236 Patent must be construed in the context of the claims and disclosure of that patent alone, without importing terms or limitations from the claims of the ’502 Patent.

[477] Claim 1 of the ’236 Patent states that the *depletion layer* is formed with the *additive gas*, contains a component from the *additive gas*, and is located “on” particles of the *raw reactive metal powder*. Other than this and the use of the word *depletion*, Claim 1 of the ’236 Patent contains no further limitation or guidance on what the *depletion layer* is or how to determine whether a *depletion layer* is present. As Dr. Mostaghimi recognized in cross-examination, Claim 1 of the ’236 Patent provides even less information on the *depletion layer* than Claim 1 of the ’502 Patent, and the POSITA reading Claim 1 of the ’236 Patent alone would not have enough information to understand the process: Transcript, Day 11, pp 123–126.

[478] The POSITA reading the term *depletion layer* in Claim 1 of the ’236 Patent would thus read it and look to understand it in light of the patent as a whole, including the other claims and the disclosure. The relevant references in the disclosure, identical to those in the ’502 Patent, include the schematic diagram and graphs in Figure 3 and the discussion of Figure 3 found at paragraph 161* of the disclosure (see paragraphs [121] to [124] and [247] to [250] above); the schematic of Figure 4 and the discussion of the figure and of the “depletion depth of δ” at paragraph 165* of the disclosure (see paragraph [247] above); and the discussion of Experiments 1 and 2, including the ToF-SIMS profiles of Experiment 1 shown in Figure 5 and discussed at paragraphs 178 and 179* of the disclosure (see paragraphs [124] to [132] and [275] to [280] above). I note that the disclosure makes clear that the terms “first layer” and “layer 1” are also used in the disclosure to refer to the *depletion layer*, such that the POSITA would understand references in the disclosure to the “first layer” to equally refer to the *depletion layer* of Claim 1 even though the claim does not use the term “first layer”: ’236 Patent, paras 156, 162, 191*.

[479] As discussed above, the POSITA would recognize from these references that the inventors sought to distinguish between particles that had a *depletion layer* and those that did not. They would also note the importance of the depth of the *depletion layer*, with the inventors referring to the *depletion layer* having “a certain critical depth”: ’236 Patent, para 179*; see also paras 135, 157*.

[480] How then would the POSITA construe the term *depletion layer* in Claim 1 of the ’236 Patent, and in particular how would they use the teachings of the ’236 Patent, in light of their CGK, to distinguish between powder particles with a *depletion layer* and those without? In AP&C’s submission they would turn to Figure 5 and paragraphs 178 and 179* of the disclosure and conclude that a particle has a *depletion layer* if its ToF-SIMS profile has a higher “tail” (*i.e.*, a greater relative concentration of the *additive gas* at a greater depth) than a particle made without an *additive gas*: AP&C Closing Argument, paras 108–112; Transcript, Day 15, pp 58, 74, 83–85.

[481] I again reject this submission, as I did with the same argument made in connection with the ’502 Patent. My reasons for doing so are similar to those expressed at paragraphs [283] to [299] above, but with some differences.

[482] I rejected AP&C’s position in respect of the ’502 Patent in part because AP&C’s proposed comparison is inconsistent with the language of Claim 1, since the claim does not make that comparison and, indeed, makes a different comparison between the depth and thickness of the *depletion layer* of the particle and the *native oxide layer* of the same particle. Claim 1 of the

’236 Patent does not set out a comparison to be made at all. It therefore cannot be said that the comparison AP&C proposes is a different comparison to a comparison set out in Claim 1 of the ’236 Patent.

[483] Nonetheless, it remains the case that the comparison AP&C proposes is not one found in Claim 1 of the ’236 Patent. Claim 1 of the ’236 Patent does not tell the POSITA that a powder particle has a *depletion layer* if it has a higher “tail” than a particle made without *additive gas*.

[484] Nor do paragraphs 178 and 179* and Figure 5 of the disclosure assist the POSITA by telling them to make the comparison, for the reasons given above. The inventors clearly highlight the differences in the oxygen profiles between the test samples of powders made without *additive gas* (Tests 1 and 2) and those made with *additive gas* (Tests 3 and 4). However, their focus remains on the depth of the *depletion layer* and not the relative oxygen concentration compared to a reference particle. While paragraphs 178 and 179* say that Figure 5 shows a comparison between the ToF-SIMS profiles of different samples, they do not say that the way to ascertain whether or not a particle has a *depletion layer* is by conducting a comparison between the ToF-SIMS profile of a subject powder and a powder made without *additive gas*. Thus, AP&C’s arguments again seek not to simply read the claims in light of statements from the disclosure. They seek to read or imply statements into the disclosure before then reading them into the claim.

[485] I also consider it worth repeating that even AP&C’s expert, Dr. Mostaghimi, did not refer to paragraphs 178 and 179* or Figure 5 when construing the term *depletion layer* in the

’236 Patent. In particular, he did not state that the POSITA would understand Claim 1 of the ’236 Patent to mean that a comparison should be made between the ToF-SIMS curves or oxygen concentration profiles of a particle of interest and one made without *additive gas* to determine if it has a *depletion layer*: Mostaghimi First Report, para 125. Rather, his recourse to the comparison arose for the first time in his infringement analysis, through incorporation by reference of his discussion of the testing in Tascon Report: Mostaghimi Second Report, paras 541–542.

[486] In addition to noting the importance of the depth of the *depletion layer* in the disclosure, the POSITA reviewing the ’236 Patent would see that many of the independent and dependent claims similarly focus on the depth of the *depletion layer*, providing either a functional definition of depth or defining a minimum and/or maximum depth: ’236 Patent, Claims 2, 10, 18–20, 57–61, 64, 66–69, 84–89, 99–103. None of these claims suggest that a comparison is to be made to an oxygen concentration profile of a reference particle. In other words, even when the inventors propose a specific method for determining the existence of a *depletion layer*, they do so in a completely different manner than that proposed by AP&C.

[487] The limitations of these other claims with respect to the particular depth of the *depletion layer*, or how to measure it, must not be read into Claim 1. However, Claim 1 should be construed in a manner consistent with the other claims. In my view, the POSITA reviewing the claims and the patent as a whole would recognize the importance of determining the depth of the *depletion layer* in a particle of powder, rather than conducting a comparison to another particle of powder made in a different way.

[488] Indeed, I consider that AP&C’s proposed construction of the *depletion layer* is directly inconsistent with other claims in the ’236 Patent. Take, for example, Claims 66 and 67 of the ’236 Patent. As discussed below, Claim 66 is an independent claim to a process that includes forming a *depletion layer* “persisting at a normalized concentration value of at least 50% additive gas atoms to a depth at which” the powder has a defined flowability. Dependent Claim 67 requires that the depth be at least 40 nm. As discussed further below, these claims set out a specific and objective basis for determining the depth of the *depletion layer*, namely the depth for which its normalized concentration is above 50% of the maximum: Barnes First Report, paras 503–505; Mostaghimi First Report at para 144.

[489] If, as AP&C argues, the comparison of oxygen profile concentration with a particle made without *additive gas* is inherent in the meaning of the term *depletion layer*, then to fall within Claim 67, a particle of powder would have to both (a) have a normalized concentration above 50% to a depth of at least 40 nm, to meet the express requirements of Claims 66 and 67; and (b) have a normalized concentration above that of another particle made without *additive gas*, to meet the requirement of having a *depletion layer*. This is incongruous. It would remove the value of the objective standard set out in these claims by reading in an additional unrelated comparative standard.

[490] The only other alternative, if AP&C’s construction is to be adopted, is that the construction of *depletion layer* used in Claim 1 and other claims of the ’236 Patent would then be abandoned in Claims 66 and 67 and other claims that have similar depth measurements. This would be inconsistent with the principle that the same terms used in a patent will generally be

given the same construction, *i.e.*, the presumption of claim consistency: *Nova Chemicals* at para 82. No expert suggested that the POSITA would adopt a different construction of the term *depletion layer* for the purposes of different claims of the '236 Patent.

[491] AP&C's proposed construction, in which the existence of a *depletion layer* depends on a comparison to a particle made without *additive gas,* is also inconsistent with the claims of the '236 Patent that do not require the use of *additive gas*. As discussed further below, independent Claims 9 and 64 involve the use of an *atomizing gas* but no *additive gas,* yet they each involve forming a *depletion layer* including an *additive component*. The POSITA would understand from these claims that the inventors appeared to consider that a *depletion layer* could be made without the use of an *additive gas*. In this context, it would make no sense to the POSITA that the existence of a *depletion layer* could be determined based on a comparison to a particle made without *additive gas,* as this would suggest that the *additive gas* is essential to creating a *depletion layer*, contrary to Claims 9 and 64.

[492] Thus, the other claims of the '236 Patent not only impose different methods for assessing the existence of a *depletion layer* that would strengthen the POSITA's understanding of the importance of its depth, as referred to in paragraph 179* of the disclosure, they also create an incongruity that would lead the POSITA away from the construction proposed by AP&C.

[493] I therefore conclude the POSITA reviewing Claim 1 of the '236 Patent would not understand the term *depletion layer* as meaning or being defined by the existence of an oxygen (or other *additive gas*) concentration profile in which a particle shows a higher amount of the gas

(in either absolute terms or relative to a maximum measured concentration) than a particle that is not treated with *additive gas*, either based on Figure 5 or otherwise. Rather, they would understand the *depletion layer* as meaning a layer on the powder particle that contains a component from the *additive gas* in addition to the metal of the *reactive metal source*, in a concentration that depletes over the course of the layer.

[494] The question then returns: How would the POSITA know whether a particle they had produced has a *depletion layer* in order to ascertain whether they fell within the scope of Claim 1 of the ’236 Patent or not? Put another way, how would a POSITA be able to distinguish between a particle that has a *depletion layer* of Claim 1 and one that does not? I will address these questions below in assessing Tekna’s arguments regarding ambiguity.

(c) *depth of the depletion layer*

[495] Claim 2 adds the limitation to the process of Claim 1 that the *depletion layer* has a depth of less than 100 nm. As noted above, other dependent claims also include limitations on the depth of the *depletion layer*. For these claims, the POSITA would seek to understand how the depth of the *depletion layer* is to be determined or measured. As discussed at some length above in addressing the requirement of Claim 1 of the ’502 Patent that the *depletion layer* be *deeper and thicker* than the *native oxide layer*, nothing in the CGK would assist the POSITA, and they would come away from their review of the disclosure of the ’236 Patent without any understanding how the inventors understood that depth would be measured.

[496] The POSITA would see claims in the ’236 Patent that set out a specific method of measuring the depth of the *depletion layer*. In particular, Claims 57 and 64 each describe the *depletion layer* as defining a *first depth* having a maximum concentration of the component and a *second depth* having a *depleted concentration* of the component equal to 50% of the maximum concentration. The experts agree this claim would be understood to effectively set the bounds of the *depletion layer* as being the point of maximum concentration of the *additive gas* (the *first depth*) and the point of 50% of maximum concentration of the *additive gas* (the *second depth*): Barnes First Report, paras 492–495, 500; Mostaghimi First Report, paras 139, 141.

[497] Similarly, Claim 66, referred to above, refers to the *depletion layer* “persisting at a normalized concentration value of at least 50% additive gas atoms” to a given depth. Mr. Barnes and Dr. Mostaghimi agreed that the POSITA would understand this as providing an inner boundary for the *depletion layer* at the point of 50% of the maximum concentration of atoms of the *additive gas*: Barnes First Report, paras 504–505; Mostaghimi First Report, para 144. As an aside, I note that Dr. Mostaghimi construed Claim 66 to also establish an outer boundary for the *depletion layer* at the point of maximum concentration, as seen in Claims 57 and 64. I do not read Claim 66 in this way since it does not refer to a *first depth* as Claims 57 and 64 do. However, nothing turns on this as the claims that depend on Claim 66 and define the depth (Claims 67 to 69) clearly refer to the depth set out in Claim 66, *i.e.*, the depth of 50% of maximum concentration.

[498] The POSITA seeing these claims, understanding the importance of depth to the *depletion layer*, and seeking to understand how to determine whether a particle falls within Claim 2 by

having a *depletion layer* with a depth that is less than 100 nm might be tempted to adopt the "50% of maximum concentration" approach of Claims 57, 64, and 66. However, I conclude that the POSITA would equally understand the importance of not reading into a claim limitations found in other claims and would recognize that the inventors chose to include the "50% of maximum concentration" measurement methodology in only certain claims and not in Claim 2. I note in this regard that AP&C did not argue that the POSITA would read the "50% of maximum concentration" approach of Claims 57, 64, and 66 into other claims of the '236 Patent. To the contrary, AP&C argued that limitations, including those in the disclosure and those in other claims, should not be read into claims that do not contain them: Transcript, Day 15, pp 56–57, 62–66, 70–73; AP&C Closing Argument, paras 105–106.

[499] The POSITA would therefore conclude that this measurement methodology was not intended to be used in Claim 2 and should not be imported from Claims 57, 64, or 66 into Claim 2 or other claims that specify a depth for the *depletion layer* without specifying how to calculate that depth. This conclusion would be strengthened by the POSITA's observation that the oxygen profiles of Tests 1 and 2 (which the inventors say do not have a *depletion layer*) also reach 50% of maximum concentration at a point less than 100 nm: Barnes First Report, paras 879–880. I note that the POSITA would be even less likely to import from Claims 57, 64, or 66 the methodology for determining the depth of the *depletion layer* into Claim 1 or other claims that do not specify a depth for the *depletion layer*.

[500] The POSITA would therefore be left with no information from the '236 Patent or their own CGK as to how to determine the depth of the *depletion layer* for purposes of Claim 2.

(d) *native oxide layer*

[501] Claims 3 and 4 depend from Claim 1 or 2, adding a limitation that the process includes forming a *native oxide layer* by exposing the *raw reactive metal powder* to either a gas (Claim 3) or atmosphere (Claim 4) containing oxygen.

[502] As noted above, the term *native oxide layer* would be familiar to the POSITA and would be understood in the same way as for the ’502 Patent. I agree with the experts that this limitation in Claims 3 and 4 of the ’236 Patent would underscore to the POSITA that the process of Claim 1 does not necessarily include the formation of a *native oxide layer* and could thus include both passivated and unpassivated powders: Barnes First Report, paras 437–438, 450; Mostaghimi First Report, paras 160–161; Mostaghimi Second Report, para 111. I also agree that Claims 3 and 4 do not require the *native oxide layer* to be formed with the *additive gas* as part of the *atomization mixture*, such that the passivation step could occur after the atomization has occurred: Barnes First Report, paras 449–451; Mostaghimi First Report, paras 160–161.

[503] The reference to a *native oxide layer* in Claims 3 and 4 would also reinforce the POSITA’s understanding that the *depletion layer* is a layer on the particle that is different in nature and distinct from the *native oxide layer*, as discussed in the context of the ’502 Patent. This would be clear to the POSITA, in any event, from the disclosure of the ’236 Patent, which underscores the difference between the *depletion layer* described in the patent and a *native oxide layer*.

[504] I note that there was a difference in the experts' interpretation of the word *atmosphere* in Claim 4. Mr. Barnes understood it to mean a combination of more than one gas (*e.g.*, air), while Dr. Mostaghimi understood it to mean "a surrounding environment": Barnes First Report, para 453; Mostaghimi Second Report, para 115. Nothing turns on this difference, although Dr. Mostaghimi's construction appears to fit more with the context of the claim.

(3) Other claims

[505] The parties spent little time in argument discussing the construction of the other independent claims of the '236 Patent, or their dependent claims. Not all of the claims require discussion, but I highlight the following aspects of the remaining claims.

(a) *Claim 9*

[506] Claim 9 is an independent claim to an atomization process in which the *atomizing gas* is provided from a *plasma source*. As noted above, the POSITA would recognize this as limiting the claim to plasma atomization processes, unlike the gas atomization of Claim 1: Barnes First Report, para 461; Mostaghimi First Report, para 129.

[507] Notably, Claim 9 does not refer to an *atomization mixture* or an *additive gas*. However, the process comprises forming a *depletion layer* including an *additive component* (not a "component from the *additive gas*"). Both experts noted the lack of reference to an *additive gas* and to any element specifying the source of the *additive component*: Barnes First Report, para 463; Mostaghimi First Report, para 128. Claim 14 depends from Claim 9 or 10, and adds

the limitation that the step of forming the *depletion layer* including the *additive component* comprises forming the *depletion layer* with an *additive gas*. This suggests that the *additive component* of Claim 9 may be added other than by using an *additive gas,* although neither the ’236 Patent nor the experts suggest another method.

[508] When first reviewing Claim 9, Dr. Mostaghimi asserted that there was “no requirement” in the claim that an *additive gas* contact the heated reactive metal source when it is being atomized: Mostaghimi First Report, para 128. However, in cross-examination, Dr. Mostaghimi stated that he assumed that there must be an *additive gas* “because if there is a depletion layer, it means there is an additive gas”: Transcript, Day 11, p 130. In addition to this being contrary to his own report, I disagree with Dr. Mostaghimi’s assertion. Unlike Claim 1, Claim 9 does not state that the *depletion layer* includes a component from the *additive gas*. Indeed, the only difference between Claim 1 and Claim 9 is that Claim 9 does not include an *atomization mixture* including an *atomizing gas* and an *additive gas*, and does not specify that the *depletion layer* is formed with, and contains a component from, the *additive gas*. Dr. Mostaghimi’s construction in cross-examination, reading the *additive component* of Claim 9 to imply there is an *additive gas* that is the source of the *additive component* in the *depletion layer,* Claim 9 would be entirely co-extensive with Claim 1. The presumption against claim redundancy, as well as the inventors’ apparently deliberate use of different language, suggests this is incorrect.

(b) *Claims 18 to 20*

[509] Claims 18, 19, 20 depend from either Claim 1 or 9 and add the limitation that the *depletion layer* has a depth of at least 20 nm, 30 nm, or 40 nm respectively. These claims raise

the same questions about the measurement of depth of the *depletion layer* discussed in respect of Claim 2 above.

(c) *Claim 21*

[510] Claim 21 is an independent claim to an atomization process similar to that of Claim 1, but (a) without specifying that the *atomizing gas* be at a greater temperature than the *heated reactive metal source*; (b) specifying that the *reactive metal source* is titanium or titanium alloy; (c) not specifying the particle size distribution of the particles with a flowability less than 40 s; and (d) specifying that the component of the *additive gas* in the *depletion layer* is at least one of oxygen, carbon, nitrogen, hydrogen, or chlorine, with a specified maximum concentration limit of the component in the powder (in parts per million) specified for each "according to AMS 4998."

[511] Mr. Barnes noted that since flowability is influenced by particle size, the POSITA would know that flowability is typically measured for a specific particle size distribution, which is not given in Claim 21: Barnes First Report, para 475. This issue also arises in several other independent claims that include flowability measurements without reference to a particle size: '236 Patent, Claims 39, 57, 64, 66; Barnes First Report, paras 483, 491, 498, 500, 503, 506. Dr. Mostaghimi did not comment on this aspect of the construction when first reviewing the claim, but responded to Mr. Barnes' observation by stating that the POSITA would understand that a specific particle size distribution is not an essential element of this claim and that the flowability measurement "could be conducted on any (reasonable) particle size distributions," excluding nano-powders: Mostaghimi Second Report, paras 50–51, 62, 396–401.

[512] The B213 standard sets out a testing methodology for testing the flow rate of metal powders using the Hall Flowmeter: Exhibit 67; Barnes First Report, paras 175–178. The standard does not specify a particular particle size distribution. Although the POSITA would know that flowability is typically tested on specific particle size distributions, they would also know that B213 testing methodology could be used on any powder lot. In my view, the POSITA reading Claim 21 would understand that the claimed “less than 40 s” flowability standard applies to the powder manufactured by the process as a whole, not to a particular cut of the powder, and not to “any reasonable particle size distribution” as suggested by Dr. Mostaghimi. Notably, the dependent claims specify flowability limitations on particular particle size distributions, such that a POSITA would understand that the flowability measurement within Claim 21 applied to the entirety of the powder and not a particular subset thereof.

[513] Mr. Barnes also noted that the reference in Claim 21 to the AMS 4998 standard, which is a standard for Ti-6Al-4V titanium alloy powders, is difficult to reconcile with the claim’s inclusion of titanium powders in addition to titanium alloys: Barnes First Report, paras 477–479. With respect to the latter point, Dr. Mostaghimi agreed that Claim 21 was “poorly worded” in this regard, but concluded that the POSITA would read the claim as referring to the AMS 4998 standard only for titanium alloy powders, and referring to no standard in respect of titanium powders: Mostaghimi Second Report, para 117.

[514] The evidence indicates that the AMS 4998 standard provides limits on the amount of various elements that may appear in different grades of Ti-6Al-4V powders: Barnes First Report, paras 143–146, 189–190. The evidence does not indicate whether the standard provides for

particular testing methodologies for determining the level of different elements in the powder, or whether those methodologies are different from those in the standard applicable to titanium metal powders, assuming there is one. In my view, the POSITA would understand the important aspect of the requirement to be the parts per million limit on the different elements, with the reference to the AMS 4998 standard simply indicating where the limits are drawn from. Thus the POSITA would understand that a titanium powder with less than, for example, 1,800 ppm of oxygen would fall within that element of the claim, despite the anomaly of the reference to the level being "according to the AMS 4998 standard."

(d) *Claim 39*

[515] Claim 39 is an independent claim to an atomization process that is identical to Claim 21, except that in place of the phrase "forming, with said *additive gas*, a *depletion layer* including a component from the *additive gas*" (the language in both Claims 1 and 21, as well as independent Claims 57 and 66), Claim 39 has the phrase "forming a *depletion layer* on the *raw reactive metal powder* comprising an *additive element*." Claim 39 includes limitations on the identity of the *additive element* that parallel the limitations in Claim 21 on the "component of the *additive gas*."

[516] Claim 39 does not specify that the *additive element* necessarily comes from the *additive gas*: Barnes First Report, para 484; Mostaghimi First Report, para 135. Although Dr. Mostaghimi indicated that the POSITA would not draw a distinction between the word *element* and the word *component*, I agree with Mr. Barnes that in context, the POSITA would understand the word *element* as meaning a chemical element: Mostaghimi First Report, para 135; Barnes First Report, paras 485–486.

[517] The only difference between Claims 21 and 39 is the absence in Claim 39 of the "forming, with said *additive gas*" language of Claim 21, and the reference in Claim 39 to an *additive element* instead of the "component from the *additive gas*" found in Claim 21. The principle of claims differentiation suggests that the *additive element* need not necessarily come from the *additive gas*. This reading is supported by comparison between dependent Claims 47 and 48; Claims 49 and 50; Claims 51 and 52; and Claims 53 and 54, each of which entail limitations on, respectively, the *additive gas* and the *additive element*. However, as with Claim 9, neither the '236 Patent nor the experts suggest another method by which the *additive element* could be introduced into to the *depletion layer*.

(e) *Claims 57 to 60*

[518] As alluded to above, Claim 57 is an independent claim claiming an atomization process using an *atomization mixture* comprising an *atomizing gas* and an *additive gas,* in which a *depletion layer* is formed with the *additive gas*. Claim 57 includes the following language in respect of the *depletion layer*, which I reproduce with terms discussed below underlined:

> forming, with said additive gas, a depletion layer including a component from the additive gas, the depletion layer defining a <u>first depth</u> having a <u>maximum concentration of the component</u> and a <u>second depth</u> having a <u>depleted concentration of the component equal to 50 percent of the maximum concentration</u>, wherein <u>the second depth is such that said raw reactive metal powder has a flowability less than 40 s</u>, measured according to ASTM B213.

[519] As the experts agree, this claim would be understood to set the bounds of the *depletion layer*. The outer boundary, termed the *first depth*, is the point of *maximum concentration of the component* from the *additive gas*. The inner boundary, termed the *second depth* is the point at

which the *depleted concentration* of the *additive gas* is at 50% of the maximum concentration: Barnes First Report, paras 492–495, 500; Mostaghimi First Report, paras 139, 141. Thus, on a ToF-SIMS profile, the *first depth* would be at the peak concentration, typically normalized to 1, while the *second depth* would be the x-axis value at which the profile crosses 0.5 on the y-axis, as demonstrated in the following annotated copy of Figure 5 of the ’236 Patent found at paragraph 814 of Mr. Barnes’ First Report:

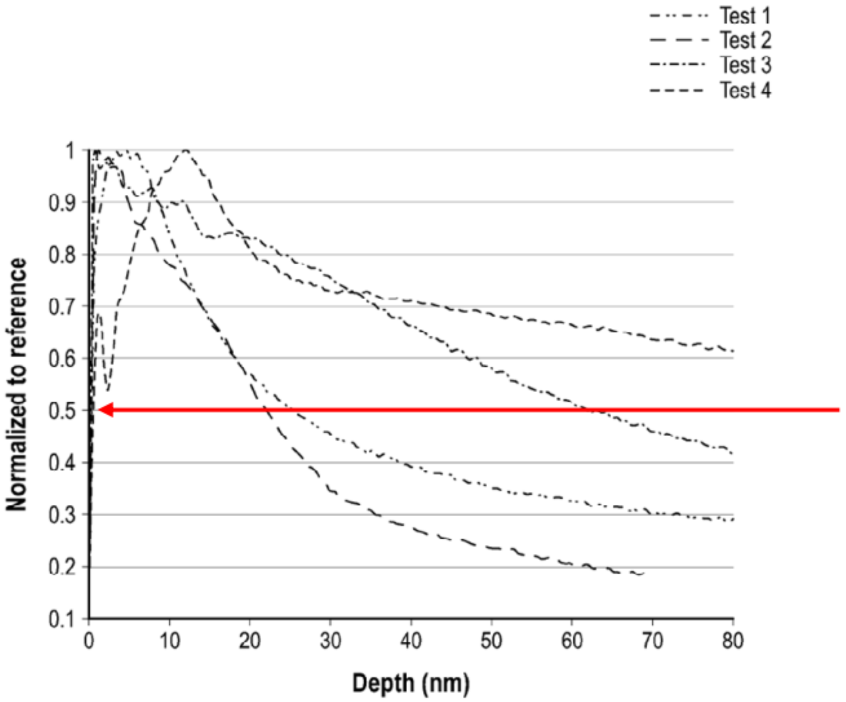


FIG. 5

[Description: A line graph is shown with x- and y-axes. The x-axis is labeled Depth (nm) and has axis ticks labeled in increments of 10 from 0 to 80. The y-axis is labeled Normalized to reference and has axis ticks and gridlines numbered in increments of 0.1 from 0.1 to 1. Four dotted lines are plotted on the graph with different sorts of dots. A legend identifies them as being, from top to bottom, Test 4, Test 3, Test 1, and Test 2. A horizontal red arrow is drawn across the graph at the height of 0.5 on the y-axis, with the arrowhead at and pointing to the y-axis.]

[520] The POSITA would recognize that based on the definitions in Claim 57, Figure 5 shows that, for example, the powder of Test 1 has a *first depth* of about 5 nm and a *second depth* of about 26 nm, while the powder of Test 3 has a *first depth* of about 1 nm and a *second depth* of

about 63 nm. Figure 5 does not show the *second depth* of Test 2, as its profile does not reach a point of 50% of maximum concentration in the data provided.

[521] Claim 57 states that the *second depth* of the powder of the claimed process "is such that" the *raw reactive metal powder* has a flowability less than 40 s. As with Claim 21, Claim 57 does not specify a specific particle size distribution for the flowability test. The reference to the *second depth* being "such that" the powder has the desired flowability appears intended to mean that if a powder has the desired flowability, then the *second depth* of the powder, assuming it has one, meets this element of the claim, with the claimed flow time being "attributed to the thickness of the depletion layer," to use Dr. Mostaghimi's language: Barnes First Report, para 496; Mostaghimi First Report, para 140.

[522] Claims 58 to 60 depend from Claim 57 and add limitations on the *second depth* of 40 nm (Claims 58 and 59) or 60 nm (Claim 60). Claims 59 and 60 also add the limitation that the component from the *additive gas* is oxygen.

[523] I note that neither Claim 57 nor any claim depending from it put any limitation on the *first depth*, such that it appears to be used simply as a point for defining the maximum concentration of the component from the *additive gas*.

(f) *Claims 64 and 65*

[524] Claim 64 is similar to Claim 57, but does not refer to the use of an *additive gas*. Rather, as in Claim 9, it refers to the atomization taking place with an *atomizing gas*, and the *depletion*

layer including an *additive component*. The element from Claim 57 reproduced above appears in the same language in Claim 64, but using the term *additive component* in place of *component from the additive gas* or *component*.

[525] As with Claim 9, the claim does not specify the source of the *additive component*: Barnes First Report, paras 500–501; Mostaghimi First Report, para 142. However, the POSITA would read Claim 64 in the context of Claim 65, which adds the limitation that "the *additive component* of the *depletion layer* <u>from the *atomizing gas*</u> is oxygen" [emphasis added]. Notably, Claim 65 is not expressed as adding a limitation that the *additive component* of the *depletion layer* come from the *atomizing gas*. Rather, the limitation is that the *additive component* of the *depletion layer* from the *atomizing gas* is oxygen. I therefore agree with Dr. Mostaghimi that the POSITA would understand Claim 64 to mean that the *additive component* in the *depletion layer* comes from the *atomizing gas*: Mostaghimi Second Report, para 123.

[526] However, I disagree with his assertion that this means that the *atomizing gas* "may be a mixture of an atomizing gas and an additive gas": Mostaghimi Second Report, para 123. The '236 Patent makes a clear distinction between an *atomizing gas* and an *atomization mixture*, which includes both an *atomizing gas* and an *additive gas*. If the *atomizing gas* itself could simply be a mixture of an *atomizing gas* and an *additive gas*, then the term *atomization mixture*, and indeed the term *additive gas*, would be redundant. At the same time, as mentioned above, the POSITA would understand that the *atomizing gas* could include more than one gas. I note that a mixture of two gases used to atomize molten metal does exactly the same thing in the real world whether one calls it an *atomizing gas* or an *atomization mixture* containing an *atomizing gas* and an *additive gas*.

(g) *Claims 66 to 69*

[527] As discussed above, Claim 66 also adopts a "50% of maximum concentration" approach to the depth of the *depletion layer*, although it does so in language that does not use the *first depth* and *second depth* found in Claims 57 and 64:

> forming, with said additive gas, a depletion layer including a component from the additive gas, the <u>depletion layer persisting at a normalized concentration value of at least 50% additive gas atoms</u> to a depth at which said raw reactive metal powder has a flowability less than 40 s, measured according to ASTM B213.

[528] Mr. Barnes and Dr. Mostaghimi agreed that the *depletion layer* of Claim 66 would have to continue (persist) in a manner that the *normalized concentration value* of the atoms from the *additive gas* remained above 50% to a given depth: Barnes First Report, paras 504–505; Mostaghimi First Report, para 144. Like Claims 57 and 64, Claim 66 refers to the 50% of concentration value persisting to a depth "at which" the powder has a flowability less than 40 s: Barnes First Report, para 506.

[529] Dependent Claims 67 to 69 add the limitation that the depth is at least 40 nm (Claims 67 and 68) or at least 60 nm (Claim 69).

(h) *Claims 73 to 89*

[530] Claim 73 is an independent claim to an atomization manufacturing process that involves "controlling" an amount of *additive gas* that contacts the *heated reactive metal source* during atomization, to control a depth of the *depletion layer*. As Mr. Barnes points out, the claim does not set out how to control the amount of *additive gas* to control the depth of the *depletion layer*: Barnes First Report, para 513.

[531] Claims 74 to 76 depend from Claim 73 and add limitations on controlling the depth of the *depletion layer* involving controlling thermal conditions of the *raw reactive metal powder* (Claim 74); or controlling the amount of *additive gas* so that the *raw reactive metal powder* remains within specification limits regarding the maximum amount of *additive gas* atoms in the powder (Claims 75 and 76), with Claim 76 focusing on the specifications for oxygen in titanium or titanium allow powder. Claims 77 to 79 depend from any of Claims 73 to 76, adding limitations on the identity of the *additive gas* and/or the component of the *depletion layer* from the *additive gas*.

[532] Claims 79 to 82 depend from Claim 76 and add limitations directed to the specifications for other elements based on the AMS 4998, similar to those found in Claim 21.

[533] Claim 83 also depends from Claim 76, and adds a limitation of controlling the amount of *additive gas* “such that” the *raw reactive metal powder* has a flowability less than 40 s. Neither independent Claim 73 nor the other claims depending from it include the flowability limitation: Barnes First Report, para 509.

[534] Claim 84 depends from any one of Claims 73 to 82 and involves controlling the amount of *additive gas* to control the depth of the *depletion layer* to be less than a *predetermined value*. Claims 85 and 86 define the *predetermined value* as 100 nm and 80 nm respectively, while Claims 87 to 89 add limitations on the minimum depth of the *depletion layer* of 20 nm, 30 nm, and 40 nm respectively.

[535] None of Claims 73 to 89 specify how to determine the depth of the *depletion layer*, either through the “50% of maximum concentration” method or through any other method.

(i) *Claims 90 and 98*

[536] Independent Claims 90 and 98 claim *atomization systems*, rather than processes. The claimed systems include various components, including a *plasma source* to atomize the *metal source* with an *atomization mixture* containing an *atomizing gas* and an *additive gas*, with the system being configured to control the *atomizing gas* to control formation of a *depletion layer* that includes a component of the *additive gas*. The two claims differ in that Claim 98 adds a requirement that the system be configured to control the flowability of the powder.

(j) *Claim 104*

[537] Claim 104 is the final independent claim of the ’236 Patent. It provides for an atomization process entailing contacting a *heated reactive metal source* with an *atomizing gas* from a *plasma source* and an *additive gas* within the *atomization zone*, forming a *depletion layer* that includes a component of the *additive gas*.

(k) *Other dependent claims*

[538] The other various dependent claims in the ’236 Patent add limitations that parallel those discussed above and/or present no construction issues, including limitations on the *additive gas* and/or the component from the *additive gas* in the *depletion layer*; the depth of the *depletion layer*; the total amount of the component from the *additive gas* in the powder; the flowability parameters; the *plasma source*; and the *heated reactive metal source*.

B. *Validity*

(1) Ambiguity

(a) *Process claims: Claims 1 to 89 and 104 to 140*

[539] Each of the process claims of the ’236 Patent requires, as an essential element, that the process involve forming a *depletion layer*. In each case, to know the scope of the claim, that is, to “know in advance whether or not something would be within the claims,” the POSITA needs to be able to understand what a *depletion layer* is and to assess whether a given process involves forming a *depletion layer* within the scope of the claim.

[540] I have concluded above that the POSITA would understand the *depletion layer* to (a) be different and distinct from a *native oxide layer*; and (b) contain a component from the *additive gas* (or an *additive component*, for Claims 9 and 64 and their dependent claims, or an *additive element*, for Claim 39 and its dependent claims) in addition to the metal of the *reactive metal source*, in a concentration that depletes over the course of the layer.

[541] However, as noted above, simply being able to restate aspects of the claim element in other language does not answer the question of ambiguity. The question is whether the claim “defines distinctly and in explicit terms the subject-matter of the invention” in a way to allow the POSITA to know what falls inside it and what does not: *Patent Act*, s 27(4); *Free World Trust* at para 41.

[542] For the reasons set out below, I conclude that the process claims of the ’236 Patent that do not specify a manner of determining the existence of a *depletion layer* do not allow the POSITA to know what falls inside them and what does not. These claims are invalid for ambiguity. This covers all of the process claims except (a) Claims 58 to 60; (b) Claims 62 and 63, as they depend from one of Claims 58 to 60; (c) Claims 67 to 69; (d) Claims 71 and 72, as they depend from Claim 67; and (e) Claims 109 and 115 to 117 as they depend from one of the foregoing claims [the Unambiguous Claims].

(i) *The Unambiguous Claims*

[543] As discussed above, each of independent Claims 57, 64, and 66 specifies a method of determining the parameters of the *depletion layer*, namely the “50% of maximum concentration” method. In Claims 57 and 64, this is specified through the definition of a *first depth* and a *second depth,* with the *second depth* being the depth at which the *depleted concentration* of the component from the *additive gas* (Claim 57) or the *additive component* (Claim 64) is at 50% of the maximum concentration. In Claim 66, the *depletion layer* must persist at a normalized concentration value of at least 50% *additive gas* atoms to a given depth. Claims 57 and 67 then have dependent claims that set out, using the “50% of maximum concentration” method, the requisite depth of the *depletion layer*, either “at least 40 nm” (Claims 58, 59, 67, 68 and claims that depend from them) or “at least 60 nm” (Claims 60 and 69 and claims that depend from them).

[544] While Tekna asserts that all of the claims of the ’236 Patent are invalid for ambiguity, Mr. Barnes excepted from his conclusions on ambiguity based on the *depletion layer* those

claims that specify how to determine the existence of a *depletion layer* by setting out how to identify the boundaries of the *depletion layer* and defining its depth, namely Claims 58 to 60 and 67 to 69: Barnes First Report, paras 877–881. I agree with Mr. Barnes that these claims are not ambiguous. Claim 58, for example, specifies that the *second depth* is at least 40 nm. The POSITA would understand how to determine the *second depth* of the *depletion layer* and would be able to determine whether it is greater or lesser than 40 nm. The POSITA would be able to know whether or not a process is within the claim. These claims are not ambiguous.

[545] Although Mr. Barnes does not refer to them, the claims that depend from Claims 58 to 60 or 67 to 69 and add further limitations as to the *additive gas* and the component of the *depletion layer* from the *additive gas* (Claims 62, 63, 71 and 72); the type of atomization (Claim 109); or the *heated reactive metal source* (Claims 115 to 117) are similarly not ambiguous as they depend directly or indirectly from one of Claims 58 to 60 or 67 to 69.

(ii) *The other process claims are ambiguous*

[546] Independent Claims 57, 64, and 66 specify a method for determining the parameters of the *depletion layer*, namely the “50% of maximum concentration” approach discussed above. However, Claims 57 and 64 only state that the depth of the *depletion layer* (the *second depth*) is “such that” the powder has the given flowability of less than 40 s, while Claim 66 similarly states that the *depletion layer* persists at a normalized concentration value of at least 50% *additive gas* atoms to a depth “at which” the powder has a flowability less than 40 s.

[547] As set out above, the POSITA would understand these claims to mean that if a powder has the given flowability, then the *depletion layer* is sufficiently deep to meet this element of the claim, with the claimed flow time being “attributed to the thickness of the depletion layer”: Mostaghimi First Report, para 140. In essence, the claims require not that the *depletion layer* has a defined numerical depth for the *second depth*, but that it has a *depletion layer* whose depth provides the desired flowability, regardless of how deep that is. As Mr. Barnes and Dr. Mostaghimi each recognize, the claims suggest a functional relationship between the *second depth* and the flowability: Mostaghimi First Report, para 140; Barnes First Report, paras 496, 506.

[548] “Functional claiming,” that is, defining an element of a claim through reference to a result rather than another parameter, or “claiming in terms of a desired result,” is in principle permissible in Canada: *Schering-Plough* at para 60, citing *Burton Parsons Chemicals Inc et al v Hewlett-Packard (Canada) Ltd et al*, [1972] FCJ No 1126 at para 23. However, doing so may “put inventors in dangerous waters” in that the claims may be broader than the invention, ambiguous, or claim inoperable species: *Schering-Plough* at para 134; *Burton Parsons* at para 23.

[549] In the present case, the effective meaning of these claims is that there is a *depletion layer*, and in particular one whose 50% concentration *second depth* meets the parameters of the claim in any case where the powder resulting from the process has the desired flowability, regardless of where the 50% concentration point is. However, as the POSITA would understand, the effective result of this would be that the *depletion layer* element of the claim is meaningless, as any

atomization process that involves using an *additive gas* that results in the desired flowability would, by definition, have a *depletion layer*.

[550] As Justice Binnie noted at paragraph 32 of *Free World Trust*, the ingenuity of a patent lies not in the identification of a desirable result, but in teaching one particular means to achieve it, and a claim cannot be stretched to allow a patentee to monopolize anything that achieves the desirable result. The "particular means" identified in the '236 Patent is the use of an *additive gas* to obtain a *depletion layer*. Yet Claims 57, 64, and 66 provide the POSITA with no understanding of the *depletion layer* except that the desired result is obtained. As Justice Snider concluded in *Schering-Plough*, while functional claims may certainly exist, claims in which an essential element is defined so as to cover any product or process that achieves the desired result are "beyond any acceptable functional claim": *Schering-Plough* at paras 135–138.

[551] I note that Justice Snider's conclusion was one of overbreadth, rather than ambiguity. In the present case, the ambiguity concern raised by Mr. Barnes (and Associate Chief Justice Camilien Noël in *Burton Parsons*) seems applicable as the POSITA would have no way of understanding what processes fell within the scope of Claims 57, 64, or 66 on the basis of the *depletion layer* element. It may be that the concepts of ambiguity and overbreadth overlap in a case such as this: *Seedlings (FCA)* at paras 50–52; *Western Oilfield* at paras 128–130. In any event, whether the failure of a claim to define "distinctly and in explicit terms the subject-matter of the invention" is termed ambiguity or overbreadth is not material to the claim's validity: *Patent Act*, s 27(4). In my view, independent Claims 57, 64, or 66 are invalid for ambiguity or,

alternatively, overbreadth. The same holds for dependent Claims 61, 65, and 70, which add limitations that do not resolve the ambiguity concerns.

[552] The remaining process claims of the ’236 Patent do not tell the POSITA how to determine the existence or parameters of a *depletion layer*. For the reasons discussed above at paragraph [498], the POSITA would not simply import into these claims the methodology set out in independent Claims 57, 64, or 66. Nor, for the reasons discussed at paragraphs [480] to [493], would the POSITA understand the claims to have the construction that AP&C promotes, namely that a *depletion layer* exists in a particle if the oxygen concentration profile has a higher “tail” than (*i.e.*, an oxygen concentration profile that lies above that of) a particle made without *additive gas*. The result is that these claims also leave the POSITA with no way of assessing whether a particle of powder has a *depletion layer* within the meaning of the claim or not.

[553] This includes those claims that require the *depletion layer* to have a depth that is less than or at least a given parameter, expressed in nanometres, without specifying how to determine the depth of the *depletion layer*, namely Claims 2, 10, 18 to 20, 85 to 89, 110 to 114, and 118, as well as claims that depend from them (*e.g.*, Claims 3 to 8 as they depend from Claim 2). For the POSITA to assess whether a process falls inside or outside these claims, they must be able to determine the depth of the *depletion layer* to compare it to the given numerical parameter. However, the POSITA would not know how to determine that depth for the purpose of these claims.

[554] As discussed above, the various methods proposed by AP&C's experts to determine where the *depletion layer* would be understood to begin and end, and thereby determine its depth, are unsupported by the '236 Patent. These include either incorporating limitations found in other claims in the '236 Patent (the "50% of maximum concentration" method) or using methods that are found nowhere in the'236 Patent or the CGK, and are inconsistent with Figure 5 (the "rate of decline is effectively zero" method proposed by Dr. Mostaghimi or the "23% of maximum concentration" method proposed by Dr. Cima): see paragraphs [265] to [271] above; Mostaghimi Second Report, paras 428–430. AP&C and its experts presented no convincing explanation why the POSITA would adopt any of these conflicting methods based on the '236 Patent or its claims.

[555] I note that Dr. Mostaghimi's discussion of infringement of Claims 2 and 10 of the '236 Patent states that the fact that the *depletion layer* is less than 100 nm can be seen from the Tascon Report, in which "the depletion layer is observed well below 20 arbitrary units": Mostaghimi Second Report, paras 543, 551. Dr. Mostaghimi gives no explanation whatsoever of how he made this determination, *i.e.*, where he considered the *depletion layer* to end, or how it differed from the *native oxide layer*. While AP&C does not now assert infringement of Claims 2 and 10, I consider Dr. Mostaghimi's apparent inability to identify the basis for his assessment of the depth of the *depletion layer* telling.

[556] This inability was also seen in Dr. Mostaghimi's cross-examination. His response to a question asking how the POSITA would determine whether the *depletion layer* met the depth parameters of "at least 20 nm", "at least 30 nm" or "at least 40 nm," found in Claims 18 to 20 of

the ’236 Patent, was remarkable primarily for its incomprehensibility and its absence of a clear response:

> Me DUPONT: What about claims that have a specific measurement? So let’s say, for example, at least 20 nanometres, at least 30 nanometres, at least 40 nanometres. How do -- what do I do then?
>
> DR. MOSTAGHIMI: If you go back, we said that the depletion layer is thicker than the native oxide layer. So presumably, this is still the case here, basically. So thicker in the patent, it talks about 100 nanometres, 80 nanometres, 20 nanometres. So the depth of this profile has been described in the patent, basically, several times, basically. And in comparison to the native oxide layer, it’s much thicker, basically.
>
> So one would assume that this is the case. And Figure 5 also demonstrates that.
>
> [Transcript, Day 11, p 137.]

[557] Despite Dr. Mostaghimi’s reference to Figure 5, he conceded in response to follow up questions that Figure 5 could not be used in terms of depth measurements: Transcript, Day 11, pp 137–138. These further questions similarly confirmed the absence of any justified explanation as to how the POSITA would determine the depth of the *depletion layer*: Transcript, Day 11, pp 137–139.

[558] I agree with Tekna that the POSITA reviewing Figure 5 of the’236 Patent would be unable to understand how it assists in determining the depth of the *depletion layer*. Neither the figure nor the discussion of it explains how to determine the depth of the *depletion layer*. Indeed, as noted above, paragraph 179* of the disclosure indicates that the depletion layer “has a depth of the order of 100 nm,” while Figure 5 itself stops at 80 nm for Tests 1, 3, and 4, and at 70 nm for Test 2.

[559] I therefore conclude the POSITA would be unable to determine, based on the claims of the ’236 Patent, its disclosure, or their CGK, whether a particle has a *depletion layer* of the given depth or not for the purposes of these claims. These claims do not “defin[e] distinctly and in explicit terms the subject-matter of the invention for which an exclusive privilege or property is claimed” and they are invalid for ambiguity: *Patent Act*, s 27(4); *Pharmascience Apixaban* at para 61.

[560] The same is true for those claims that do not refer to the depth of the *depletion layer*, namely Claims 1, 9, 21 to 56, and 104 to 108 as well as other claims that depend from them (*e.g.*, Claims 3 to 8 as they depend from Claim 1, and Claims 124 to 140 as they depend from Claims 1 or 104). As set out above, these claims do not contain any limitation on the *depletion layer* at all beyond the use of the term *depletion* and the requirement that the layer include a component from the *additive gas*, an *additive component* or an *additive element*.

[561] I agree with AP&C that in the absence of any given depth parameter, these claims do not incorporate a requirement that the *depletion layer* have a specific, defined, or measurable depth: Transcript, Day 15, pp 72–73. However, the POSITA would still consider that the *depletion layer* is a layer rather than the entirety of the particle, and would still need some way to determine when a process meets the essential elements of the claim(s) and when it does not, *i.e.*, when a particle made by the process has a *depletion layer* and when it does not.

[562] As discussed above, the POSITA would not understand that a particle has a *depletion layer*, by definition, in every case where an *additive gas* is used and the powder has the defined

flowability parameters. Dr. Mostaghimi suggested this was the case in cross-examination, although AP&C ultimately did not take this position in final argument: Confidential Transcript, Day 12, pp 61–62; Transcript, Day 11, pp 134–135; Day 16, pp 77–81. If this were so, the inclusion of the *depletion layer* element would be redundant and could be written out of the claims. Yet the parties, and their experts, agree that the existence of the *depletion layer* is central to the patent as a whole and essential to its claims: see Transcript, Day 11, pp 102, 105, 116.

[563] Indeed, AP&C itself recognizes that the existence of a *depletion layer* cannot be determined simply by the presence or absence of the desired flowability. Its primary argument is that the existence of the *depletion layer* depends on a comparison of the oxygen profile of a particle to that of a particle made without *additive gas*, not an assessment of flowability. Further, in order to counter certain overbreadth arguments, AP&C expressly argues that the POSITA would understand that the presence of a *depletion layer* does not guarantee a certain level of flowability (*i.e.*, particles of a powder can have a *depletion layer* without having a defined flowability). Rather, the *depletion layer* would simply give an "improved flowability when compared to that same powder without a depletion layer": AP&C Closing Argument, para 427. While this argument confirms that the POSITA would understand that some powders do not have a *depletion layer*, it does not assist in distinguishing between those that do and those that do not.

[564] Nonetheless, as discussed above, much of the analysis of AP&C's experts appears to be premised on precisely this approach of equating the existence of flowability with the existence of a *depletion layer*, and thereby effectively reading the requirement of a *depletion layer* out of the claims. Indeed, it underlies the important assumptions the experts made that the positive and

negative controls used in AP&C’s infringement analysis, namely that the samples used as a positive control had a *depletion layer* (since they showed flowability), while the negative controls did not (since they showed no flowability despite, in one case, having an *additive gas*).

[565] I have discussed above at some length the reasons why I reject the proposition that the POSITA would understand the existence of a *depletion layer* to be determined through a comparison between the oxygen profiles of a particle under review and a different particle made without *additive gas*. I need not repeat that discussion here.

[566] The result is that the POSITA, despite their willingness to understand and the purposive approach they would take to the claims, would be left with no understanding, based on the claims of the ’236 Patent, the disclosure of the patent, or their CGK, as to how to determine whether or not a powder particle has a *depletion layer* falling within the scope of the claims that do not refer at all to the depth of the *depletion layer*. It would therefore be impossible for the POSITA to know whether or not a process for producing a metal powder would fall within these claims of the ’236 Patent.

[567] The same applies to Claim 73 and its dependent claims. Claim 73 requires the existence of a *depletion layer* without specifying how to determine whether one exists. It therefore suffers from the ambiguity described above. Claim 73 also requires the process to comprise controlling the amount of *additive gas* so as to “control a depth” or “control the depth” of the *depletion layer*, without specifying how to determine that depth. Inherently, for the POSITA to be able to “control the depth” of the *depletion layer* they must have some method for determining the

existence of the *depletion layer* and its depth. Yet these claims set out no method for doing so and, for the reasons expressed above, the POSITA would have no basis to imply a method for doing so into the claims in construing them. As a result, the POSITA would have no ability to determine whether a particular process involved "control[ling] the depth" of the *depletion layer* as they would have no ability to determine whether controlling the amount of the *additive gas* had any impact on the depth of the *depletion layer*.

[568] Again, despite the POSITA's willingness to understand, they would be left with no ability to determine whether or not a process fell within Claim 73 or its dependent claims.

[569] I therefore conclude Tekna has met its onus to establish that (a) Claims 1 to 57, 61, 64 to 66, 70, 73 to 89, 104 to 108, 110 to 114, 118 to 123, and 129 to 140; (b) Claims 62 and 63, as they depend from one of Claims 57 or 61; (c) Claims 71 and 72, as they depend from Claim 66; and (d) Claims 109 and 115 to 117 as they depend from claims other than Claims 58 to 60, 67 to 69, 71 and 72 as they depend from Claim 67, are invalid for ambiguity.

(b) *System claims: Claims 90 to 103 and 141 to 147*

[570] Each of the system claims (Claims 90 to 103 and 141 to 147) includes the essential element that the system be "configured to control an *atomizing gas* in the *atomizing mixture* to control formation of a *depletion layer*." In each case, to know the scope of the claim, that is, to "know in advance whether or not something would be within the claims," the POSITA would need to know what a *depletion layer* is and be able to assess whether a given system is configured to control formation of a *depletion layer* within the scope of the claim.

[571] In my view, and for the same reasons given in respect of the process claims addressed above, I conclude that the POSITA reading the system claims purposively and with a mind willing to understand would be simply unable to understand how to determine whether a system is configured to control formation of a *depletion layer*. None of these claims set out how to determine the existence of a *depletion layer* and, for the reasons given above, the POSITA would be unable to understand how to make such a determination. Without an ability to determine whether a *depletion layer* has been formed or not, it is impossible to determine whether a system is configured to control the formation of such a *depletion layer*.

[572] I therefore conclude that Tekna has met its burden to show that each of the system claims of the ’236 Patent is invalid for ambiguity.

(2) Insufficiency

[573] As noted above, Tekna described its ambiguity arguments, in respect of both the ’502 Patent and the ’236 Patent as arguments going to “insufficiency/ambiguity.” Again, the parties’ arguments on ambiguity and insufficiency largely overlap, so there is little additional value to a supplementary finding that the ambiguous claims of the ’236 Patent are also invalid for insufficiency. However, I again note my agreement that a POSITA would be unable to put the ’236 Patent into practice as it relates to the Claims other than the unambiguous claims, since they would be unable to tell whether their process or system resulted in a powder with a *depletion layer* within the meaning of those claims, and thus unable to tell how to produce (or avoid producing) such a layer.

(3) Other argued grounds of invalidity

[574] Tekna also argues that the claims of the ’236 Patent are invalid for inutility and for overbreadth. Given my conclusions on ambiguity, I need not address all of these arguments. However, I will address them briefly specifically as they pertain to those claims I have concluded are not invalid for ambiguity, *i.e.*, the Unambiguous Claims.

(a) *Inutility*

[575] To be patentable, an invention must be “new and useful”: *Patent Act*, s 2 (“invention”): *AstraZeneca Canada Inc v Apotex Inc*, 2017 SCC 36 [*AstraZeneca Esomeprazole*] at para 26. As the parties agree, for an invention to be “useful,” the subject-matter of the invention must be capable of a practical purpose, *i.e.*, an actual result: *AstraZeneca Esomeprazole* at paras 52–54. There is no prescribed degree of usefulness required, such that a “scintilla of utility” will do: *AstraZeneca Esomeprazole* at para 55. An invention’s usefulness must be demonstrated or soundly predicted at the time of the patent application: *AstraZeneca Esomeprazole* at para 56.

[576] To establish utility on the basis of a sound prediction, there must be a factual basis for the prediction; the inventor must have an articulable and sound line of reasoning from which the desired result can be inferred from the factual basis; and there must be proper disclosure: *Apotex Inc v Wellcome Foundation Ltd*, 2002 SCC 77 at para 70. Utility is established at the time the patent is applied for, and cannot be supported by evidence occurring after the filing date: *Bell Helicopter Textron Canada Limitée v Eurocopter, SAS*, 2013 FCA 219 at para 131.

[577] Tekna's argument that the '236 Patent lacks utility has a number of aspects. The first relates essentially to issues of thermochemistry. It says the scientific theory put forward in the patent regarding the electrical charge of the *depletion layer* and the *native oxide layer* is scientifically unsound. It further says the *native oxide layer* on a particle essentially acts as a barrier to the introduction of oxygen into a particle, and that any oxygen below the *native oxide layer* would be present as elemental oxygen. It suggests, based on the evidence of Mr. Barnes and Mr. Shallenberger, that what is referred to in the patent as a *depletion layer* may simply be a thicker oxide layer.

[578] The second aspect of Tekna's argument relates to the experimental data, including the results presented in the patent and other results in the inventors' possession. Tekna asserts that the different tests presented as Experiment 1 were not conducted under the same experimental conditions, despite the claim to this effect in the patent, and that the experiment therefore did not isolate relevant variables. It notes that the depth estimates shown in Figure 5 are only estimates rather than a direct measure and that, in any case, ToF-SIMS is a flawed method for determining the presence of a *depletion layer* or assessing the presence of subsurface oxygen. It also notes the inventors did not include in Figure 5 other test results, obtained at the same time, including a sample that showed good flowability, but had an oxygen concentration profile like that of Tests 1 and 2: Exhibits 124, 128, 131, 132; Confidential Transcript, Day 9, pp 64–75. It argues that the test results that were available to the inventors but not disclosed show a lack of correlation between (a) the use of *additive gas* and the presence of a *depletion layer* as AP&C describes it; and (b) the presence of a *depletion layer* and good flowability. It ultimately contends that Figure 5 and the patent's description of it are "misleading at best, if not plainly false," and that

the experiments as a whole show that “the invention does not always work, […] if at all”: Tekna Closing Argument, paras 121, 146.

[579] The third aspect of Tekna’s inutility argument relates to its own experimental testing using TEM-EDS. It asserts that the results of this testing do not show a *depletion layer,* either observable through the TEM or measurable using the EDS data, in any of the samples. It argues that the more likely explanation is that there is no *depletion layer* in any of the samples tested, and that the small variations in ToF-SIMS profiles are attributable to distortions and/or the thickness of the oxide layer.

[580] Finally, Tekna argues that AP&C had not demonstrated utility at the filing date, given the lack of correlation between the use of *additive gas*, the creation of a *depletion layer*, and the asserted improvement in powder flowability. It notes that the subsequent Tascon ToF-SIMS testing post-dated the filing date and, in any case, does not establish a correlation. Ultimately, Tekna claims that the invention “simply does not work as described and claimed in the patents.”

[581] None of Tekna’s arguments are directed specifically to the claims in the ’236 Patent that set out a method for assessing the presence and depth of a *depletion layer* and a parameter for that depth, *i.e.*, the Unambiguous Claims. Mr. Barnes’ discussion of the TEM-EDS test results conducted on the AP&C powder samples that came from the four tests in Example 1 of the patent does indicate that the TEM-EDS oxygen profile for those samples drops below 50% of the maximum concentration within the first 5–10 nm: Barnes First Report, para 806. At the same time, Mr. Barnes’ opinion on inutility recognizes that “a limited number of the dependent claims

of the 236 Patent" allow for a distinction between Tests 1 and 2 and Tests 3 and 4 based on the ToF-SIMS results presented in Figure 5, citing Claim 67 as an example: Barnes First Report, paras 808–817; Transcript, Day 5, p 37.

[582] In my view, the inventors had experimental results that showed (a) a flowability difference between Tests 1 and 2 on the one hand and Tests 3 and 4 on the other; (b) ToF-SIMS oxygen profiles that could be distinguished on the basis of where the oxygen concentration passed the 50% of maximum concentration. As can be seen in Figure 5, Tests 1 and 2 pass the 50% mark below 30 nm, while Tests 3 and 4 pass that mark above 60 nm. While the depth measurements may be only an approximation (apparently done by Polytechnique Montréal at the time), I am not satisfied that this approximation was unreasonable or results in the data being entirely unreliable: Transcript, Day 10, pp 32–33; Day 11, pp 137–138; '236 Patent, para 179*; Exhibit 124, p 2; Confidential Transcript, Day 8, p 98.

[583] The criticisms by Tekna's experts of experiments discussed in the '502 Patent and presented in Figure 5 do raise concerns. The *additive gas* conditions for Test 3 are presented inaccurately; it is unknown whether the particular tested powder particle of Test 3 was produced with or without *additive gas*; and the inventors did not present other test data that they had and that may be viewed as confounding: Confidential Transcript, Day 9, pp 48–51, 64–75, 97–101; Exhibits 124, 128, 131, 132. The experiments could certainly have been better designed to isolate variables to demonstrate that the use of *additive gas* and the nature, presence and parameters of a *depletion layer* were correlated to improvements in flowability. However, as AP&C points out, the standard required of demonstrated utility is not that of peer-reviewed scientific literature:

Apotex Inc v Janssen Inc, 2021 FCA 45 at para 49; *Astrazeneca Canada Inc v Mylan Pharmaceuticals ULC*, 2011 FC 1023 at paras 161–168, aff'd 2012 FCA 109.

[584] On balance, despite Tekna's criticisms and the shortcomings in the experiments and the patent's description of them, I am not satisfied that Tekna has met its onus to show that the Unambiguous Claims lack utility.

(b) *Overbreadth*

[585] Tekna argues that the Unambiguous Claims, along with other claims, are broader than the invention because they omit one or more essential features of the invention: *Seedlings (FCA)* at para 54. In the context of overbreadth, what is "essential" to the invention is a different concept than the essential elements of a claim: *Aux Sable Liquid Products LP v JL Energy Transportation Inc*, 2019 FC 581 at paras 72–74; *Seedlings (FCA)* at paras 54, 60. The question for purposes of assessing overbreadth is whether the feature is "so key to the invention described in the disclosure that a claim that omits it encompasses embodiments that were not contemplated in the disclosure": *Seedlings (FCA)* at para 54.

[586] Tekna argues the Unambiguous Claims are overbroad because they do not include limitations as to (a) temperature; (b) the presence of a *native oxide layer*; and (c) the particle size distribution for the flowability requirement. For the following reasons, I conclude the Unambiguous Claims are not overbroad.

[587] With respect to temperature, Tekna notes Dr. Mostaghimi’s evidence regarding the importance of temperature as a parameter in creating a *depletion layer,* and to flowability issues AP&C experienced after equipment changes resulted in a drop in the atomization temperature: Transcript, Day 11, pp 40–43; Confidential Transcript, Day 12, pp 52, 57–61; Confidential Transcript, Day 9, pp 7–11. It asserts that a sufficiently high temperature is essential to the formation of a *depletion layer* and thus to the invention, and that by failing to include a temperature component in the claims (with the exception of Claim 74 of the ’236 Patent), the patent is overbroad.

[588] The scientific evidence before the Court is clear that temperature is an important factor both in the extent and speed of reaction between a reactive gas such as oxygen and a reactive metal such as titanium, and to the rate of diffusion of a component of the gas (whether in the form of an oxide or oxygen) into a metal particle. However, the evidence is also clear that various other process parameters also affect these mechanisms, including the concentration of the gas, the velocity of the gas, and the resulting particle size: Transcript, Day 11, pp 40–43. These other factors are also referred to in the disclosure: ’236 Patent, paras 38, 162–164*.

[589] I am satisfied the POSITA reviewing the ’236 Patent would understand that adjusting process parameters such as temperature, gas concentration, and velocity would affect the concentration of the reactive gas in the particle, including the depth at which the concentration passes the threshold of 50% of maximum concentration. In my view, however, these are matters going to the POSITA’s ability to work the invention, rather than a specific temperature being essential to the invention itself. Put another way, the essential aspects of the invention are the use

of an *additive gas* and the formation of a *depletion layer* so as to improve flowability. How this is achieved is through the adjustment of relevant parameters including, importantly, temperature, but also gas concentration and other parameters: Mostaghimi Second Report, para 312. The situation is thus different to that in *Aux Sable*, where the inclusion of an ethane or propane additive and obtaining a reduced "zMw product" was the very essence of the invention disclosed and described in the disclosure, and claims that omitted these requirements were thus overbroad: *Aux Sable* at paras 58–61, 66–74.

[590] With respect to the presence of a *native oxide layer*, Tekna asserts that the presence of two layers (the *native oxide layer* and the *depletion layer*) is an essential element of the invention. It cites Dr. Mostaghimi's agreement with the suggestion that the core of the invention of both the '502 Patent and the '236 Patent is the formation of the two layers: Transcript, Day 11, pp 104–105. It also cites the discussion in the disclosure of the interaction between the layers and the stoichiometry and charges of those layers: '236 Patent, at paras 156–161*. Tekna contrasts the claims of the '502 Patent, which all require a *native oxide layer,* with those of the '236 Patent, most of which do not. It therefore asserts that the existence of a *native oxide layer* is an essential feature of the invention disclosed. It also asserts that since the inventors never made a particle without a *native oxide layer*, it is an essential aspect of the invention actually made. In either case, it argues that claims that do not require a *native oxide layer* are broader than the invention and invalid.

[591] In my view, the '236 Patent and its claims must be viewed independently rather than in comparison with the '502 Patent. While the claims of the '502 Patent all include a *native oxide layer* as an essential element, this does not necessarily mean that the presence of a *native oxide*

layer is essential to the invention of the ’236 Patent as that concept is used in the assessment of overbreadth. The disclosure of the ’236 Patent makes clear that the question of interaction between the two layers is a scientific theory by which the inventors do not intend to be bound. This suggests that, notwithstanding Dr. Mostaghimi’s contrary view, the interaction between the layers is not the “core” or essence of the invention of the ’236 Patent. Other aspects of the disclosure refer to the *depletion layer* without reference to the *native oxide layer*, including notably paragraphs 178 and 179* discussing the results of Experiment 1 and Figure 5. Further, as AP&C points out, the ’236 Patent refers to the use of other *additive gases*, such as nitrogen, which would not create a *native oxide layer*: ’236 Patent, paras 111–112, 132, 147*, Claims 74, 75.

[592] Nor does the fact that AP&C only made powders with a *native oxide layer* mean that the *native oxide layer* is an essential part of the invention or that claims not referring to the layer are inherently broader than the invention made. This is particularly so where the creation of such a layer is largely inherent in the manufacturing process (the presence of a passivation layer being both common and important for safety reasons).

[593] The ’236 Patent clearly distinguishes the *depletion layer* from the *native oxide layer*, both in the disclosure and the claims, as discussed above. However, a fair reading of the ’236 Patent as a whole indicates that the *depletion layer* is essential to the invention, but the *native oxide layer* is not.

[594] With respect to the flowability parameters, Tekna argues that a flowability parameter without a particle size distribution is “meaningless” and that the claim is therefore broader than

the invention disclosed. It refers to the experts’ agreement that flowability is dependent on particle size distribution: Barnes First Report, para 182(b); Agreed Statement of Facts, para 15; ’236 Patent, para 45*. As discussed above at paragraphs [511] to [512], the POSITA would consider those claims of the ’236 Patent that do not specify the particle size distribution to which the flowability parameter applies to refer to the powder manufactured by the process as a whole and not to a particular cut of the powder (and not, as Dr. Mostaghimi contended, to “any reasonable particle size distribution”). I cannot conclude that the claims are “meaningless” in a manner that makes them overbroad.

[595] While Mr. Barnes raised other concerns about overbreadth, Tekna did not pursue these arguments in closing submissions, and I will therefore not address them.

[596] I therefore conclude that Tekna has not shown that the Unambiguous Claims are invalid for being overbroad.

C. *Infringement*

(1) Asserted claims and areas of agreement

[597] As with the ’502 Patent, the parties agree that Tekna’s (a) atomization of aluminum alloy powders ($AlSi_7Mg$ and $AlSi_{10}Mg$ powders) on its plasma atomization system known as “TAP-S4”; (b) vaporization processes to manufacture nanopowders; and (c) spheroidization processes without the use of “additive” or “passivation” gas, do not infringe any of the claims of the ’236 Patent: Agreed Statement of Facts, paras 58, 147, 150–151.

[598] AP&C also agrees that Tekna’s atomization processes for the manufacture of Ti-6Al-4V metal powders do not infringe Claims 15, 27, 33–38, 51–65, 71, 73–89, 91, 93–96, 107, 115, 117, 121–123, 125, 127–128, 134, 138–141, 143, and 145–147 of the ’236 Patent, again assuming the process has not changed since May 2017: Agreed Statement of Facts, para 149. AP&C’s admissions in this regard are premised on Tekna’s processes not having changed since November 2017 (for the atomization) or May 2017 (for the vaporization and spheroidization), about which the Court had no evidence. AP&C does not object to the issuance of a declaration of non-infringement in respect of these claims on this basis.

[599] AP&C asserts, as the narrowest four claims of the ’236 Patent infringed by Tekna, two process claims and two system claims, namely: (a) Claim 116, as it depends from Claims 109, 7 or 8, and 1 (with or without Claim 3); (b) Claim 116, as it depends from Claims 109, 28 or 29, 24, and 21; (c) Claim 142, as it depends from Claims 97, 92, and 90; and (d) Claim 144, as it depends from Claims 142 and 98.

[600] I note that AP&C also included in the first of these asserted claims reference to dependent Claim 124. However, Claim 124 only depends from Claims 1, 57, 66, 73, and 104 and not from Claims 109, 7, or 8. As the limitation in Claim 124 (the *raw reactive metal powder* contains less than 1800 ppm of oxygen) is not a point of contention, I have simply removed it from AP&C’s asserted dependencies for the first claim.

[601] The first allegation is thus that Tekna’s process for producing metal powders constitutes the *reactive metal powder atomization manufacturing process* of Claim 1, in which the *additive gas* is oxygen (Claim 7) or an oxygen-containing gas (Claim 8) and the component of the

depletion layer from the *additive gas* is oxygen (both Claims 7 and 8); the manufacturing process is a plasma atomization process (Claim 109); and the heated *reactive metal* source is a wire (Claim 116); with or without the step of forming a *native oxide layer* by exposing the powder to atmosphere containing oxygen (Claim 3). The second allegation is that Tekna's process constitutes the *reactive metal powder atomization manufacturing process* of Claim 21, in which the powder comprises a particle size distribution of 10 to 53 µm having a flowability less than 40 s (Claim 24); the *additive gas* is oxygen (Claim 28) or contains oxygen (Claim 29); the manufacturing process is a plasma atomization process (Claim 109); and the heated *reactive metal source* is a wire (Claim 116).

[602] The third allegation is that the system Tekna uses to produce metal powders constitutes the *atomization system* of Claim 90, in which the plasma source is a radio frequency [RF] plasma torch (Claim 92); the additive gas and the component of the *depletion layer* from the *additive gas* are both oxygen (Claim 97); and the *heated reactive metal source* is a wire (Claim 142). The fourth allegation is that Tekna's system constitutes the *atomization system* of Claim 98, in which the *heated reactive metal source* is a wire (Claim 142) and the plasma source is an RF plasma torch (Claim 144).

[603] Again, AP&C notes that if these narrower claims are infringed, then any of the broader claims on which they are based will necessarily also be infringed. I take this to effectively be an assertion that the broader claims are also infringed, including ultimately independent Claims 1, 21, 90, and 98.

[604] Tekna agrees that its atomization process to produce Ti-6Al-4V powders includes, on some but not necessarily all occurrences when its process is carried out, all of the essential elements of the asserted process claims except for (i) those pertaining to the *depletion layer*; and (ii) the step of forming a *native oxide layer* in dependent Claim 3: Agreed Statement of Facts, paras 153–154.

[605] Tekna's agreement as set out in the Agreed Statement of Facts does not include admissions with respect to the system claims. However, Tekna's only substantial ground of dispute on the infringement issues, in addition to the validity of the claims, relates to the *depletion layer*. AP&C's assertions with respect to the system claims are essentially that if Tekna infringes the asserted process claims, then it "follows" that the asserted system claims are also infringed, since Tekna's system involves the ability to control the amount of *atomizing gas* in the *atomizing mixture*. Tekna does not dispute this.

(2) The asserted claims are not infringed

[606] AP&C does not assert that any of the Unambiguous Claims are infringed. All of the Unambiguous Claims require the process to comprise either the formation of a *depletion layer* that has a *second depth* that is at least 40 nm (Claims 58 and 59 and claims depending therefrom) or at least 60 nm (Claim 60 and claims depending therefrom) or a *depletion layer* that persists at a normalized concentration value of at least 50% *additive gas* atoms to a depth of at least 40 nm (Claims 67 and 68 and claims depending therefrom) or at least 60 nm (Claim 69 and claims depending therefrom). As is seen in the ToF-SIMS results such as those presented at

paragraph [391] above, the Tekna powder samples all have oxygen concentration profiles in which the point of 50% of maximum concentration is passed well below 40 nm.

[607] With respect to the asserted claims, as stated above, an invalid patent claim cannot be infringed: *Seedlings (FCA)* at para 74. My finding that the claims of the ’236 Patent other than the Unambiguous Claims are invalid is therefore also determinative of the issue of infringement.

[608] As noted in respect of the ’502 Patent, it is difficult in the circumstances of a conclusion of invalidity on grounds of ambiguity to conduct an infringement analysis in the alternative, as the very issue is the impossibility of determining the scope of the claims. I therefore again address the question of infringement in the context of the evidence presented and whether it might show infringement on the various theories presented regarding the meaning of the *depletion layer*.

[609] I have discussed above at paragraphs [385] to [456] the evidence put forward by the parties on the issue of infringement. As noted, the parties and experts generally referred to the evidence as speaking to the existence of a *depletion layer* and thus to the infringement of the two patents, without distinguishing between the ’502 Patent and ’236 Patent. For example, Dr. Mostaghimi’s evidence regarding the existence of a *depletion layer* in accordance with the claims of the ’236 Patent simply incorporated by reference his discussion of the Tascon ToF-SIMS testing in respect of the ’502 Patent: Mostaghimi Second Report, paras 497, 535, 541–542. Similarly, AP&C’s arguments based on the ToF-SIMS testing were put forward in respect of the *depletion layer* element in the asserted claims of both the ’502 and ’236 Patents: AP&C Closing Argument, paras 320–342.

[610] For essentially the reasons given at paragraphs [394] to [415], [422], and [426] to [456] above, I conclude the evidence does not demonstrate that Tekna has infringed the asserted claims of the ’236 Patent. I omit from this reference the discussion above regarding the requirement in the claims of the ’502 Patent that the *depletion layer* be *deeper and thicker* than the *native oxide layer* (*e.g.*, paragraphs [416] to [421]). Nonetheless, the same conclusions regarding the unestablished premise that AP&C’s “positive controls” have a *depletion layer* while the “negative controls” do not applies in respect of the *depletion layer* of the ’236 Patent. Similarly, the concerns with AP&C’s approach of comparing Tekna’s product not to the patent and its claims, but to samples of AP&C’s product, and with the arbitrariness and subjectivity of the infringement analysis, are equally applicable in respect of the ’236 Patent.

[611] I therefore conclude that AP&C’s evidence based on the Tascon Report, the ToF-SIMS profiles contained therein, and their experts’ analysis of those profiles, do not demonstrate infringement, even on the various conflicting theories presented regarding the scope of the asserted claims of the ’236 Patent, each of which contains, as an essential element, either the formation of a *depletion layer* or a system configured to control the formation of a *depletion layer*. Similarly, the TEM-EDS testing presented by Tekna provides a further basis to conclude that the evidence does not establish that Tekna has infringed the claims of the ’236 Patent.

D. *Conclusion*

[612] For the above reasons, I conclude that the claims of the ’236 Patent other than the Unambiguous Claims are invalid, and that AP&C has not demonstrated that Tekna has infringed any claims of the ’236 Patent.

VI. Conclusion

[613] As noted at the outset of these reasons, the claims of a patent perform a crucial role in providing notice to the public of the subject-matter of the claimed invention and thus the scope of the patent's protection. It is therefore important that the claims set out that scope with sufficient clarity to allow the public to know what constitutes infringement and what does not. Where claims fail to do so—where they fail to define distinctly and in explicit terms the subject-matter of the invention—they may be invalid.

[614] Claims construction may be a difficult and technical exercise. This does not alone make a claim ambiguous or render it invalid. Claims are not to be read with an overly critical eye or with a mind seeking to misunderstand. However, if an inventor fails to include in the claims, as fairly and purposively construed by the skilled person in light of their common general knowledge, sufficient information to allow that person to know what does and what does not fall within the scope of the claims, such a self-inflicted wound cannot be corrected by imposing or reading in new standards or points of reference that are not found in the patent and cannot be reasonably understood from the claim language as drafted.

[615] In the present case, with a few exceptions, the inventors of the '502 and '236 Patents have failed to define the scope of their patent in a way that permits the public, or the Court, to know its boundaries. While AP&C now tries to introduce into the claims a comparative testing approach that it says allows the POSITA to understand its boundaries, that approach does not

stem from a reasonable purposive construction of the claims of either patent as drafted. It is also one that itself introduces arbitrariness and subjectivity.

VII. Disposition and Costs

[616] For the foregoing reasons, I find all of the claims of the Canadian Patent 3,003,502 to be invalid and not to have been infringed by Tekna.

[617] I also find the following claims of Canadian Patent 3,051,236 to be invalid: (a) Claims 1 to 57, 61, 64 to 66, 70, 73 to 108, 110 to 114, 118 to 123, and 129 to 147; (b) Claims 62 and 63, as they depend from one of Claims 57 or 61; (c) Claims 71 and 72, as they depend from Claim 66; and (d) Claims 109 and 115 to 117 as they depend from one of the foregoing claims. The following claims of Canadian Patent 3,051,236 are valid: (a) Claims 58 to 60; (b) Claims 62 and 63, as they depend from one of Claims 58 to 60; (c) Claims 67 to 69; (d) Claims 71 and 72, as they depend from Claim 67; and (e) Claims 109 and 115 to 117 as they depend from one of the foregoing claims. None of the claims of Canadian Patent 3,051,236 has been infringed by Tekna.

[618] Tekna's action seeking declarations of invalidity and non-infringement in respect of the Canadian Patent 3,003,502 is granted. AP&C's counterclaim seeking declarations that Tekna has infringed the Canadian Patent 3,003,502 and Canadian Patent 3,051,236 is dismissed. Tekna's counterclaim to counterclaim seeking a declaration that Canadian Patent 3,051,236 is invalid is granted in part.

[619] I encourage the parties to discuss and agree on costs. I propose to give them 20 days in which to do so. If they are unable to do so, they may make written submissions on costs in accordance with the following schedule:

- within 40 days of the issuance of the public version of this judgment, Tekna may file submissions not to exceed 15 pages, to which it may attach a bill of costs as an appendix;

- within 20 days of receipt of Tekna’s submissions, AP&C may file submissions not to exceed 15 pages, to which it may attach as an appendix a bill of costs and/or a submission, not to exceed two pages, addressing specific line items in Tekna’s bill of costs (if filed); and

- within 10 days of receipt of AP&C’s submissions, Tekna may file reply submissions not to exceed 5 pages.

[620] If the parties require additional time to discuss and agree on costs or to make submissions, they may file an informal request to this effect in letter format.

[621] This proceeding is the subject of a confidentiality order issued pursuant to Rule 151 of the *Federal Courts Rules*, SOR/98-106. A confidential version of these reasons is being released to the parties to allow them to identify any confidential information they consider should be redacted before releasing the public version.

JUDGMENT IN T-126-19

THIS COURT'S JUDGMENT is that

1. The action herein is granted, the counterclaim herein is dismissed, and the counterclaim to counterclaim is granted in part.

2. Canadian Patent 3,003,502 is declared to be and to have always been invalid and void.

3. Tekna Plasma Systems Inc is declared not to have infringed Canadian Patent 3,003,502.

4. Claims 1 to 57, 61, 64 to 66, 70, 73 to 108, 110 to 114, 118 to 123, and 129 to 147 of Canadian Patent 3,051,236 are declared to be and to have always been invalid and void.

5. Claims 58, 59, 60, 67, 68, and 69 of Canadian Patent 3,051,236 are valid.

6. Claims 62 and 63 of Canadian Patent 3,051,236 are valid insofar as they depend from one of Claims 58, 59, or 60, and are otherwise invalid.

7. Claims 71 and 72, of Canadian Patent 3,051,236 are valid insofar as they depend from Claim 67, and are otherwise invalid.

8. Claims 109, 115, 116, and 117 are valid as they depend from the Claims identified as valid in paragraphs 5, 6, or 7, and are otherwise invalid.

9. Tekna Plasma Systems Inc is declared not to have infringed any claim of Canadian Patent 3,051,236.

10. The parties may make submissions on costs in accordance with the schedule given in the reasons.

“Nicholas McHaffie”
Judge

FEDERAL COURT

SOLICITORS OF RECORD

DOCKET:	T-126-19
STYLE OF CAUSE:	TEKNA PLASMA SYSTEMS INC v AP&C ADVANCED POWDERS & COATINGS INC
PLACE OF HEARING:	MONTREAL, QUEBEC
DATE OF HEARING:	OCTOBER 17-27, 31, NOVEMBER 1, 2, 4, 9-10, 2022
JUDGMENT AND REASONS:	MCHAFFIE J.
DATED:	JUNE 7, 2024

APPEARANCES:

François Guay Jeremy Want Jean-Sebastien Dupont Julien Verneau Matthew Burt Audrey Berteau	FOR THE PLAINTIFF / DEFENDANT BY COUNTERCLAIM
Andrew Brodkin Benjamin Hackett Rick Tuzi Sarah Stothart	FOR THE DEFENDANT / PLAINTIFF BY COUNTERCLAIM

SOLICITORS OF RECORD:

Smart & Biggar LLP Montreal, Quebec	FOR THE PLAINTIFF / DEFENDANT BY COUNTERCLAIM
Goodmans LLP Toronto, Ontario	FOR THE DEFENDANT / PLAINTIFF BY COUNTERCLAIM