

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ASCEND ELEMENTS, INC.,
Petitioner,

v.

DUESENFELD GMBH,
Patent Owner.

IPR2024-00948
Patent 11,050,097

Before MEREDITH C. PETRAVICK, CHRISTPHER M. KAISER, and KEVIN
W. CHERRY, *Administrative Patent Judges*.

DECLARATION OF WALTER VAN SCHALKWIJK , PH.D.

I, Walter van Schalkwijk declare as follows:

I. INTRODUCTION

1. I have been retained by Ascend Elements to provide analysis and opinions in connection with its Reply to Patent Owner's Response in the above captioned *inter partes* review proceeding. I have been asked to provide my opinion on the topics discussed herein, in response to arguments raised by Patent Owner and its expert, Mr. Vani Dantam..

2. I am being compensated for my time at the rate of \$895 per hour. I have no interest in the outcome of this proceeding and the payment of my fees is in no way contingent on my providing any particular opinions.

3. If requested, I am prepared to explain (in a deposition or at a trial before the Patent Trial and Appeal Board (the "Board")) the technology disclosed in the '097 Patent—including the state of the art in the relevant timeframe. Similarly, I am prepared to explain the technology disclosed in the Hanisch (U.S. Patent No. 9,780,419), Hayashi (U.S. Patent No. 9,843,077), and Shin (U.S. Patent No. 10,396,408) references, and in any other prior art references cited herein. This may include, among other things, background information on lithium battery design and recycling processes.

4. My educational and professional background, along with my expert witness experience were set forth in the declaration I previously submitted in this proceeding as EX1003.

II. MATERIALS REVIEWED

5. In preparing this declaration, I reviewed and considered U.S. Patent No. 11,050,097 ("the '097 patent"), and the prior art and other materials cited herein. I have also reviewed Mr. Dantam's declarations and deposition transcript (Exs. EX2022, EX1024, EX1031), the Exhibits cited by Patent Owner and Mr. Dantam, Patent Owner's Response (Paper 18), Patent Owner's Contingent Motion to Amend (Paper 21) in this proceeding, and EX1030.

6. I may use these documents and information, or other information obtained during the course of this proceeding, as well as representative charts, graphs, schematics and diagrams, animations, and models based on those documents and information, to support and to explain my testimony.

7. My opinions are based in part on a review and analysis of the above-mentioned documents and materials. I have also drawn on my education, experience, and knowledge of basic engineering and design principles in forming my opinions.

8. In conducting my analysis, I have applied the same understandings of the relevant art, a person of ordinary skill in the art ("POSITA"), legal standards, and claim construction that I set forth in my earlier declaration. EX1003, ¶¶ 13-28

III. RESPONSE TO ARGUMENTS

A. A POSITA Would Have Understood The "Dry Cell Fragments" Formed By Hanisch's Pre-Dryer To Have Be Fully Dry And Inactivated

9. Independent Claim 1 recites "inactivating the comminuted material such that an inactivated comminuted material is obtained" (claim 1[b]) and "wherein the inactivating step is performed by drying the comminuted material" (claim 1[d]). Mr. Dantam opines that "the purpose of the pre-drying step in Hanisch '419 is not to inactivate the comminuted material..." and therefore that Hanisch's pre-drying step does not disclose these limitations. EX2022, ¶¶77-86. I disagree.

10. As an initial matter, Mr. Dantam is wrong that "Hanisch '491 teaches that the battery material goes from the pre-dryer to the decomposition oven...." EX2022, ¶81. This is demonstrably false, as Hanisch expressly discloses that *before it ever reaches the decomposition oven*, the battery material goes from the pre-dryer to a separator (which may include both a magnetic separator and an eddy flow separator) and to a zigzag classifier. EX1004, e.g., 5:64-6:2 ("A separator 38 is set up in the direction of material flow behind the pre-dryer 28, which comprises a magnetic separator and, if necessary, an eddy flow separator also. The magnetic material is removed via a discharge pipe 40. Non-magnetic material arrives at a classifier 42, for example a zigzag classifier."). In other words, Mr. Dantam's opinion that "there is no need to take the caution and incur the cost to dry the material to the endpoint result of inactivation" (EX2022, ¶81) is based on a fundamental

misrepresentation of Hanisch's disclosed system. Likewise, Mr. Dantam's opinion that the term "pre-dryer" indicates to a POSITA that comminuted material is not dried for a sufficiently long time to inactivate also is wrong. (EX2022, ¶ 80.) In fact, a POSITA would have understood that forming "dry" cell fragments—especially ones that must go through the separators and classifiers—necessarily means all the volatile electrolyte solvent, i.e. the bulk liquid components of the electrolytes, has been removed. And this is the point of Hanisch's "pre-drying" process, materials are dried before the processing step so they can effectively and safely be processed by the zigzag classifier and eddy current separator. "Dry cell fragments" is therefore the endpoint of Hanisch's low-temperature pre-drying process.

11. **Zigzag Classifiers.** Zigzag air classifiers have been utilized to separate lithium-ion battery ("LIB") components based on differences in density and particle behavior. For instance, Accurec Recycling GmbH's process involved dismantling batteries, followed by mechanical processing to remove plastics. The remaining materials were then subjected to various separators, including zigzag classifiers, to segregate metallic fractions such as iron–nickel, aluminum, and aluminum–copper mixtures.¹

¹ Julien, C.M.; Mauger, A.; Zaghib, K.; Groult, H. Comparative issues of cathode materials for Li-ion batteries. *Inorganics* **2014**, 2, 132–154.

12. **Eddy Current Separators.** Eddy current separators (ECS) have been employed to separate non-ferrous metals like aluminum and copper from non-metallic materials in LIB recycling. The ECS operates by inducing eddy currents in conductive materials, creating opposing magnetic fields that propel these metals away from non-conductive materials. This technique has been effective in enhancing the purity of recovered metals and is considered a dry process suitable for electrochemically inactive materials. EX1033.

13. **Magnetic Separators.** Magnetic separation has been applied to extract ferrous components from LIB waste streams. After initial crushing and sieving, magnetic separators can efficiently remove iron-containing materials, facilitating the subsequent separation of non-ferrous metals and other components. This method is particularly useful in the early stages of LIB recycling to reduce the complexity of the material stream. EX1034, EX1035.

14. These mechanical separation techniques have been integral to LIB recycling processes developed before 2015, offering efficient methods for processing dry, electrochemically inactive materials.

15. Thus, as a POSITA would have understood, the fact that battery material goes from the pre-dryer to the separators and classifier means that the battery material must have been fully dried to the point of inactivation. This is for the simple reasons that the separators and classifier (i) would not work effectively with still wet

material, and (ii) would be dangerous to use with still-active battery material. In other words, the disclosed flow of battery material in Hanisch confirms that "dry cell fragments" are properly understood as fully dry with no liquid electrolyte.

16. Classifiers are used to separate materials based on size and density. However, *active* lithium-ion battery materials contain volatile electrolytes that can ignite if exposed to heat or friction during classification. EX1036. Further, lithium-ion batteries are prone to "thermal runaway", a chain reaction of uncontrolled heating that can lead to fire or explosion. EX1037. Mechanical damage, overheating, or exposure to moisture can trigger this reaction. EX1038. Even after extinguishing a lithium-ion battery fire, there is a risk of "re-ignition". Active comminuted lithium-ion battery material will have bits of anode, anode, cathode, and separator mixed and in contact with each other and liquid electrolyte would exacerbate these risks. Handling still wet and active comminuted lithium-ion battery material through separators and classifiers (like air classifiers, cyclones, or sieves) presents serious safety risks, especially related to thermal runaway and fire hazard. For example, residual electrolyte reactivity may result in fire or explosion within the separator/classifier because wet battery material still containing volatile organic solvents from the electrolyte (*e.g.*, EC, DEC, DMC) can vaporize and ignite under friction or heat. Similarly, as a POSITA would have understood, if lithium metal (or lithiated graphite) is still present and exposed to moisture or air, it reacts violently

—producing heat and hydrogen gas, which can cause thermal runaway. In addition, many classifiers or separators use high-speed airflows or rotating parts, which could generate sparks or heat sufficient to ignite materials—especially if the particles are fine and dry out mid-process.

17. Likewise, dampness in the battery material flowing through the separators and classifiers can inhibit the effectiveness of these systems. For example, Moisture in comminuted material can alter its conductivity, potentially affecting the efficiency of eddy current separation. Damp material tends to clump together due to surface tension imparted by free or adsorbed organic solvents from the battery electrolyte, making it difficult for individual particles to separate properly. This can hinder the effectiveness of sorting processes, including eddy current classification. Similarly, damp material can impact how particles move through the zigzag classifier's airflow. If the classifier sorts particles by size and weight—as is typical—then dampness and clumping can also impact the effectiveness of the classifier.

18. Thus, based on the fact that Hanisch uses the "pre-dryer" to fully dry material before putting it through separators and classifiers, a POSITA would have understood the "dry cell fragments" formed by Hanisch's low temperature dryer to be fully dry and inactivated.

B. Hanisch in view of the knowledge of a POSITA renders obvious "wherein the drying occurs at a maximum pressure of 300hPA" (claims 1[e], 12[d])

19. Mr. Dantam recognizes that Hanisch discloses high-temperature decomposition heating under vacuum conditions, for at least the goal of excluding atmospheric oxygen from the chamber, as this would minimize risk of copper and aluminum oxidization. EX2022, ¶ 68. Hanisch recognizes this means "copper can thus be retrieved with a high degree of purity as a valuable element." EX1004, 4:6-18.

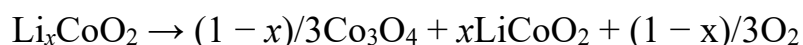
20. I disagree with Mr. Dantam that a POSITA would have been motivated to minimize the pressure differential between the ambient atmosphere and that in the pyrolysis chamber, since this would run counter to the goal of minimizing the introduction of available oxygen that could cause copper oxidization. Indeed, the fact that Hanisch teaches an alternative embodiment in which inert gas is introduced into the pyrolysis chamber is consistent with the goal of reducing to a minimum the available oxygen in the atmosphere of the pyrolysis chamber. EX1004, 4:6-8.

21. And Mr. Dantam also seems to ignore that within the pyrolysis chamber, oxygen is can be present due to contributions from atmosphere, but is also bound up in many of the materials being subjected to the high temperature decomposition, and can be released into the chamber in forms that will react with copper to cause oxidization, and this makes it even more critical that the oxygen

contributed by the atmosphere in the chamber be controlled. For example, in lithium-ion batteries one oxygen containing material is the cathode active material (bonded to the Al foil) prior to the pyrolysis chamber. As I noted in my previous declaration, such cathode materials include lithium metal oxides like LiCoO₂. EX1003, ¶¶33-34.

22. LiCoO₂, like many such lithium metal oxides, is normally thermally stable at the range of temperatures disclosed in Hanisch for the decomposition heating of 350-800°C, but during regular cycling and use of the battery, Li ions can be lost to the anode (EX1003, ¶¶62-63) and this delithiated LiCoO₂ can be thermally labile at temperatures ranging from 200-350°C. EX1030, 1. That reaction proceeds as follows, and leads to the production of, among other things, free molecules of oxygen that can react with copper:

delithiated Li_xCoO₂ (x = 0.49–0.9)



EX1030, 1. Although the fraction of this thermally labile LiCoO₂ is typically reduced by discharging of cathode materials prior to recycling, it remains possible that a small portion of that species will remain in the comminuted material being processed by the high temperature decomposition oven, and when decomposed, that material will undergo the reaction above, contributing to the release of reactive species of oxygen that can contribute to oxidization of copper. This can be a non-

trivial amount of oxygen when not completely controlled by discharging the batteries, and thus use of vacuum pressure becomes an important way of limiting the amount of oxygen available to react with the copper.

23. One can estimate the relative abundance of atmospheric oxygen in a hypothetical chamber. For example, assuming a hypothetical 1 liter chamber and a standard lithium ion 21700 cylindrical cell, and accounting for oxygen that can be released from the materials being dried in the pyrolysis oven, one can calculate that at one atmosphere and 300°C, the chamber contains 2.7×10^{21} molecules of oxygen, at 300 hPa it contains 8×10^{20} oxygen molecules, and under a strong vacuum of 0.0000133 hPa, there would be 3.5×10^{13} oxygen molecules.

24. Using the Ideal Gas Law, $n = PV/RT$, one can compute the number of oxygen molecules in the chamber atmosphere at a given air pressure. At 300 hPa, $P = 47.25$ torr (300 hPa), and $V = 1$ liter, $T = 573.15$ K (300°C), and $R = 62.364$ L-torr/mol-K, $n =$ is 0.001321902894 moles of oxygen, which is multiplied by Avogadro's number, 6.022×10^{23} (the number of molecules in a mole) to determine the number of molecules of oxygen in the chamber atmosphere, which is 8×10^{20} . Doing the same computation for a vacuum of 1.33×10^{-5} (1×10^{-5} torr) gives 3.5×10^{13} oxygen molecules in the chamber atmosphere, and 2.7×10^{21} oxygen molecules at one atmosphere.

25. This calculation shows that if one uses a pressure of 300 hPa for the high temperature decomposition heating, there will be roughly 3-4 fold less oxygen (8×10^{20} molecules) from the chamber atmosphere than compared to 1 atmosphere of pressure (2.7×10^{21} molecules), whereas the use of vacuum pressure of 0.0000133 hPa would have up to nearly eight orders of magnitude less oxygen (3.5×10^{13}) available from the chamber atmosphere to react with the copper. This awareness would have been within the knowledge of a POSITA as of at least 2011, in my opinion.

26. The contribution of oxygen from species such as thermally labile delithiated LiCoO_2 being heated to decomposition temperature can be non-trivial, and while that contribution can be minimized by effective discharging (which minimizes the abundance of species such as thermally labile delithiated LiCoO_2) the use of vacuum during pyrolysis is a main way a POSITA would be able to limit the release of available oxygen that could react with and oxidize the copper.

27. In view of Hanisch's disclosure that it is beneficial to avoid copper oxidization during the high temperature drying stage to be able to retrieve pure copper (EX1004, 4:6-18), coupled with the knowledge of a POSITA that vacuum pressures below 300 hPa have ever fewer amounts of available oxygen to react with and oxidize copper, I disagree with Mr. Dantam that a POSITA would have considered it preferable to minimize the pressure differential between the ambient

atmosphere and that in the pyrolysis chamber, and instead, would have considered it preferable to use pressures lower than 300 hPa, to minimize the levels of available oxygen that could react with and cause oxidization of copper.

C. When Performing the Method in Hanisch as A Continuous Process, a POSITA Would Have Had A Reasonable Expectation of Success in Using Vacuum Seals to Achieve the Levels of Vacuum Disclosed in Hayashi

28. I disagree with Mr. Dantam's conclusion regarding a POSITA's consideration of seals, such as rotary airlocks, in the context of performing the method in Hanisch as a continuous process. EX2022, ¶¶152-159.

29. Mr. Dantam's conclusions appear based in part on his characterization of particular systems he was involved with, where these systems were used for battery manufacturing and not recycling processes. EX2022, ¶157. While it may have been the case that the rotary airlocks used in the systems Mr. Dantam worked with, his description of those systems merely notes that the preferred configurations used pressure differences of less than a few hundred hPa. EX2022, ¶157. But Mr. Dantam does not explain why a POSITA would have considered it impossible or beyond their skill to devise a rotary airlock system that would allow one to practice the method in Hanisch as a continuous process, at the pressures of less than 300hPa.

30. For example, Mr. Dantam asserts that "the battery material is coarse, and so the material would not fill the pockets of the rotary valve fully, leading to high displacement leakage." EX2022, ¶ 157. Yet Mr. Dantam provides no details

of what "coarse" means, what threshold of "coarseness" is involved in the risk of leaks, whether a POSITA would be incapable of developing a process in which comminuted battery material is finer than such a threshold level of coarseness, or why a POSITA would be incapable of otherwise addressing the risk of leaks.

31. I note that Mr. Dantam mentions studies in which a chamber, pressurized to 1.5 bar (1500 hPa) ended up depressurizing to ambient levels bar (~1000 hPa) via a rotary airlock over 50 mins. EX2022, p 155; EX2025. But this test involved a single pressurization effort, whereas the constraints of the pyrolysis system in Hanisch would likely involve the need to constantly draw off-gasses from the chamber, and thus a POSITA would have understood that a vacuum was continually being pulled from the chamber, rather than a single depressurization as in the study Mr. Dantam mentions.

32. Even if one assumed that a single rotary airlock would be difficult to use across the pressure differences needed to maintain less than 300 hPa in a drying chamber, one possible approach would be to use a series of such airlocks, and Mr. Dantam does not explain why such an arrangement would have been considered beyond the skill of a POSITA.

33. For example, a first rotary airlock could be used as a transition from, for example, one atmosphere of pressure to a reduced pressure that would minimize any risk leakages in the airlock, and a second airlock would allow the transition

between that initially reduced pressure to a final pressure less than 300 hPa. This arrangement would also have benefits of modularity, where parts of the system could be more easily isolated for inspection, maintenance, and repair. Such a series architecture would also address Mr. Dantam's concerns about the exponential increase in energy needed to maintain a given vacuum, since it could be energetically cheaper to maintain the two smaller pressure differentials than it to maintain a single, larger pressure differential.

IV. PATENT OWNER'S CONTINGENT MOTION TO AMEND

A. Ground 1: Substitute Claims 22-31 Would Have Been Obvious in View of Hanisch Alone or in Combination with Dunagan and in View of the Knowledge of a POSITA²

1. Claims 22 and 26 (Substitute for Independent Claims 1 and 12) Would Have Been Obvious

34. Substitute claims 22 and 26 add to independent claims 1 and 12 the requirements of "wherein the drying uses a drying device operated in batch mode" and "a drying device operated in batch mode," respectively. This limitation is disclosed by Hanisch. Hanisch discloses a drying device that may operate in batch mode, including by stating that its "method according to invention is *preferably*

² Each of the substitute claims includes the limitations of claims 1 or 12. The limitations of claims 1 and 12 are obvious for all of the reasons explained in my initial declaration.

performed as continual process and not in batches." EX1004, 3:27-28 (emphasis added). In other words, while the process of Hanisch may preferably be performed as a continual process, Hanisch also discloses that it may be performed in batches.

35. Substitute claims 22 and 26 also add the limitation that "the claim is limited to drying after comminution." I explained in my initial declaration that Hanisch discloses drying after comminution. *See* EX1003, ¶¶74, 87-103, 132. For example, Hanisch discloses that "[t]he active material separation system preferably possesses a pre-dryer which is set up in the material flow, behind the cell crushing device and before the oven." EX1004, 4:55-57.

36. Substitute claim 26 also adds the limitation that "the drying device operates with a pressure of 300 hPa or less." Independent claim 1 similarly claims that "the drying occurs at a maximum pressure of 300 hPa," and I explained in my initial declaration that this limitation is rendered obvious by the prior art. *See* EX1003, ¶¶79, 81, 110-16, 145-52.

37. Accordingly, in my opinion, substitute claims 22 and 26 would have been obvious in view of Hanisch alone or in combination with Dunagan in view of the Knowledge of a POSITA.

2. Claims 23, 25, 27 (Substitute for Dependent Claims 2, 8, 13) Would Have Been Obvious

38. Claims 23, 25, and 27 add the limitation "(d) producing, during the drying, a gaseous electrolyte component recoverable by condensation" / "the drying

device configured to produce a gaseous electrolyte component recoverable by condensation." As I explained in my initial declaration, Hanisch discloses that [t]he pre-dryer 28 comprises a circulation pump 32 and a condenser 34 for condensing electrolyte, which can be removed via the pipe 36." EX1004, 5:59-61; *see also id.* at cl. 5; EX1003, ¶93. A POSITA would have understood that the condenser 34 on the pre-dryer is for condensing back to a liquid the gaseous electrolyte that had evaporated from the comminuted batteries in the pre-dryer 28. *See* EX1003, ¶¶74, 92, 93.

39. Substitute claim 25 also includes the limitation "wherein the drying occurs at temperature of 80°C or less." As I explained in my initial declaration, Hanisch discloses drying at temperatures of 80°C or less. EX1003, ¶¶74, 127-128, 157; EX1004, 3:65-4:5.

40. Claims 23, 25, and 27 also include one or more of the following limitations, all of which are disclosed or rendered obvious for the reasons described in the preceding sections: "wherein the drying uses a drying device operated in batch mode" / "a drying device operated in batch mode" (Section V.A.1); "and the claim is limited to drying after comminution" (Section V.A.1); "the drying device operates with a pressure of 300 hPa or less" (Section V.A.1).

41. Accordingly, in my opinion, substitute claims 23, 25, and 27 would have been obvious in view of Hanisch alone or in combination with Dunagan in view of the Knowledge of a POSITA.

3. Claims 24, 28, 29 (Substitute for Dependent Claims 3, 10, 19) Would Have Been Obvious

42. Substitute claims 24, 28, and 29 add the limitations of "wherein the drying is such that the comminuted material is dried until an electrolyte content in the comminuted material is so low that an electrochemical reaction is impossible or only to a negligibly small extent" / "by drying such that the comminuted material is dried until an electrolyte content in the comminuted material is so low that an electrochemical reaction is impossible or only to a negligibly small extent." Original dependent claim 2 of the '097 Patent similarly claims "wherein the comminuted material is dried until an electrolyte content in the comminuted material is so low that an electrochemical reaction is impossible." As I explained in my initial declaration, Hanisch in combination with Dunagan in view of the knowledge of a POSITA renders obvious this limitation. *See* EX1003, ¶¶117-121; *see also* EX1003, ¶¶67-68, 121.

43. Claims 24, 28, and 29 also include one or more of the following limitations, all of which are disclosed or rendered obvious for the reasons described in the preceding sections: "wherein the drying uses a drying device operated in batch mode" / "a drying device operated in batch mode" (Section V.A.1); "and the claim is

limited to drying after comminution" (Section V.A.1); "the drying device operates with a pressure of 300 hPa or less" (Section V.A.1); "the drying device configured to produce a gaseous electrolyte component recoverable by condensation" (Section III.A.2); "the drying occurs at temperature of 80°C or less" (Section V.A.2).

44. Accordingly, in my opinion, substitute claims 24, 28, and 29 would have been obvious in view of Hanisch alone or in combination with Dunagan in view of the Knowledge of a POSITA.

4. Claims 30, 31 (Substitute for Dependent Claims 7, 9) Would Have Been Obvious

45. Substitute dependent claims 30 and 31 add the limitations of "wherein the drying occurs at a temperature such that almost no Hydrogen Fluoride is produced." Hanisch renders this limitation obvious. As explained in my initial declaration, a POSITA would have understood that drying at low temperatures would prevent the production of Hydrogen Fluoride. *See* EX1003, ¶¶68, 114. For example, as I previously explained, lower temperatures during LiPF₆ evaporation, for example, have long been known to be desirable given the reduction of hydrogen fluoride formation from the electrolyte. EX1005, 1:20-24, 2:2-27. This comes from the understanding of the basic Arrhenius relationship in thermodynamics. This relationship, which is guided by pre-exponential and activation energy factors, means that rates of reaction slow by approximately half when the temperature is reduced by 10 degrees Celsius, or approximately double if the temperature is

increased by 10 degrees Celsius. Thus, lower temperatures reduce the rate of the LiPF_6 hydrolysis reaction that forms toxic HF, thereby slowing HF formation.

46. The '097 Patent similarly recognizes that drying at low temperatures prevents the production of Hydrogen Fluoride. For example, the '097 Patent states that that "[t]he drying preferably occurs at a maximum temperature of 80°C.: this produces almost no hydrogen fluoride." EX1001, 5:7-8. Accordingly, it is my opinion that it would have been a known principle to a POSITA at the time of the '097 Patent that drying electrolyte at lower temperatures prevents the formation of Hydrogen Fluoride.

47. Hanisch recognizes this principle in teaching that "[t]he method preferably comprises the step that, before heating the cell fragments up to the decomposition temperature, the cell fragments are dried at a drying temperature, so that dry cell fragments and drying vapours are formed, whereby the drying vapours are at least partly condensed. This has the advantage that the electrolyte solvent can be retrieved. It is therefore advantageous for the drying temperature to be below 100°C, in particular below 80°C." EX1004, 3:65-4:5. By teaching drying at temperatures "below 100°C, in particular below 80°C," a POSITA would have understood that almost no Hydrogen Fluoride is produced in the drying process of Hanisch, as acknowledged by the '097 Patent.

48. Claims 30 and 31 also include the following limitations, all of which are disclosed or rendered obvious for the reasons described in the preceding sections: "wherein the drying uses a drying device operated in batch mode" / "a drying device operated in batch mode" (Section V.A.1); "and the claim is limited to drying after comminution" (Section V.A.1); "the drying device operates with a pressure of 300 hPa or less" (Section V.A.1); "(d) producing, during the drying, a gaseous electrolyte component recoverable by condensation" / "the drying device configured to produce a gaseous electrolyte component recoverable by condensation" (Section V.A.2); "by drying such that the comminuted material is dried until an electrolyte content in the comminuted material is so low that an electrochemical reaction is impossible or only to a negligibly small extent" (Section V.A.3).

49. Accordingly, in my opinion, substitute claims 30 and 31 would have been obvious in view of Hanisch alone or in combination with Dunagan in view of the Knowledge of a POSITA.

B. Ground 2: Substitute Claims 22-31 Would Have Been Obvious in View of Hanisch Alone or in View of Dunagan, and in Further View of the Teachings of Hayashi or Shin³

1. Claims 22 and 26 (Substitute for Independent Claims 1 and 12) Would Have Been Obvious

50. Substitute claims 22 and 26 add to independent claims 1 and 12 the requirements of "wherein the drying uses a drying device operated in batch mode" and "a drying device operated in batch mode," respectively. Hanisch discloses a drying device that may operate in batch mode, including by stating that its "method according to invention is *preferably* performed as continual process and not in batches." EX1004, 3:27-28 (emphasis added).

51. Further, I understand that PO and Mr. Dantam admit that Hayashi and Shin can operate as batch processes. For example, PO states that "Hayashi teaches processing a single cell of a battery at a time (i.e., *in a batch process*, not a continuous process)." POR, 28 (citing EX1006, 9:37-40) (emphasis added). Mr. Dantam also states that Hayashi "is a batch process." EX2022, ¶162. As one example of Hayashi operating as a batch process with a single cell of a battery at a time, Hayashi discloses that "[t]he large-sized battery cell for an automobile (the

³ Each of the substitute claims includes the limitations of claims 1 or 12. The limitations of claims 1 and 12 are obvious for all of the reasons explained in my initial declaration.

lithium-ion battery, 1.66 kg) was discharged, the packaging sheet was peeled off, the safety valve was opened, and 18 g of water was added." *See* EX1006, 9:37-40. For the reasons I previously explained, the batch process of Hayashi would have been combined with the disclosures of Hanisch. *See, e.g.*, EX1003, ¶¶150-52, 168-69.

52. As to Shin, PO states that Shin's process "is all done in the context of a single batch, after which the accumulated battery material is removed from the reaction reservoir and transferred to a crusher" and "[t]hus, Shin's approach is essentially performed on a batch basis, not a continuous process." POR, 51-52. For the reasons I previously explained, the batch process of Shin would have been combined with the disclosures of Hanisch. *See, e.g.*, EX1003, ¶¶150-52, 168-69.

53. Substitute claim 26 also adds the limitation that "the drying device operates with a pressure of 300 hPa or less." Independent claim 1 similarly claims that "the drying occurs at a maximum pressure of 300 hPa." EX1001, cl. 1. Hanisch alone or in view of Dunagan, and in further view of Hayashi or Shin renders obvious this limitation for the reasons I explained in my initial declaration. *See* EX1003, ¶¶145-52.

54. Accordingly, claims 22 and 26 would have been obvious in view of Hanisch alone or in view of Dunagan, and in further view of Hayashi or Shin.

**2. Claims 23, 25, 27 (Substitute for Dependent Claims 2, 8, 13)
Would Have Been Obvious**

55. It is my opinion that Hanisch alone or in view of Dunagan, and in further view of Hayashi or Shin renders obvious the limitation "(d) producing, during the drying, a gaseous electrolyte component recoverable by condensation" / "the drying device configured to produce a gaseous electrolyte component recoverable by condensation." Specifically, Hayashi discloses gasification of electrolyte and condensing the generated gas with a cooling pipe.

56. For example, Hayashi's claim 1 refers to a "method for processing a fluorine-containing electrolyte solution including a volatile fluorine compound and a volatile organic solvent" where the method comprises "a gasification step of gasifying volatile components included in the electrolyte solution" as well as "an organic solvent recovery step of recovering the organic solvent in the gas." EX1006, cl. 1. Claim 5 depends from claim 1 and includes the additional limitation that the "organic solvent is recovered by condensing the gas passed through the filling layer." EX1006, cl. 5. Claim 7 depends from claims 5 and 1 and recites the additional limitation that, in the gasification step, the "electrolyte solution is heated at 80° C. to 150° C. under the reduced pressure of less than or equal to 1 kPa, thereby the volatile components are gasified." EX1006, cl. 7.

57. Hayashi further explains that, after heating battery cells and vaporizing the generated gas, "[t]he generated gas was condensed in the cooling pipe (4° C.),

and was captured in a capturing bottle." EX1006, 10:27-44. Hayashi provides additional detail regarding the condensation process, explaining, for example, that "[t]he generated gas was sequentially introduced to the cooling pipe (4° C.), and the water cooling trap (liquid amount 300 mL), and was captured. The captured gas was allowed to stand at room temperature and was separated into the water phase and the organic phase." EX1006, 9:37-49; *see also id.*, 9:37-10:26, 10:50-11:7.

58. As I explained in my initial declaration, Hanisch discloses producing a gaseous electrolyte component recoverable by condensation. *See* EX1003, ¶¶74, 92, 93. Accordingly, it is my opinion that Hanisch discloses the limitations of substitute claims 23, 25, and 27. However, to the extent that Hanisch does not disclose this limitation, a POSITA would have been motivated to incorporate Hayashi's teachings regarding condensation of the gaseous electrolyte with the teachings of Hanisch. As one example, a POSITA would have seen it beneficial to condense the gaseous electrolyte for recovery and reuse of resources.

59. A POSITA would have also understood that condensing the gaseous electrolyte would have been beneficial for supporting environmental and safety objectives. For example, condensing the electrolyte would prevent electrolyte from accumulating in the air. Accumulation of gaseous electrolyte solvents in the air would contribute to explosion hazards as well as hazards from the production of

toxic substances, and accordingly, a POSITA would have found condensation to be beneficial.

60. A POSITA would understand how to combine Hayashi's condensation method and equipment with Hanisch, where Hanisch discloses that "[t]he pre-dryer 28 comprises a circulation "pump 32 and a condenser 34 for condensing electrolyte, which can be removed via the pipe 36." EX1004, 5:59-61.

61. All other limitations of claims 23, 25, and 27 are disclosed or rendered obvious for the reasons described above in Section V.A and/or further above in Section V.B.

62. Accordingly, claims 23, 25, and 27 would have been obvious in view of Hanisch alone or in view of Dunagan, and in further view of Hayashi or Shin.

3. Claims 24, 28, 29 (Substitute for Claims 3, 10, 19)

63. The limitations of claims 30 and 31 are disclosed or rendered obvious for the reasons described above in Section V.A and/or further above in Section V.B.

4. Claims 30, 31 (Substitute for Claims 7, 9)

64. The limitations of claims 30 and 31 are disclosed or rendered obvious for the reasons described above in Section V.A and/or further above in Section V.B.

C. Claims 22-31 – the Scope of the Limitation "inactivating the comminuted material" / "an inactivation device comprising a drying device configured to inactivate the comminuted material" Is Not Clear with Reasonable Certainty to a POSITA

65. The scope of the "inactivating" limitations in substitute claims 22-31 is not clear with reasonable certainty to a POSITA because a POSITA would not have understood from the '097 Patent the outer boundaries of when comminuted material is considered "inactivated."

66. The specification of the '097 patent provides various metrics by which *drying* may be measured, but none of these various metrics indicate the outer boundaries of whether the material is *inactivated*. For example, the metrics in the specification for drying include whether there is a build-up of heat in the material, including that "[t]he comminuted material is preferably *dried* for so long that a 50 kg amount of comminuted material, which is contained in a compacted form in a 50 litre drum, does not experience a build-up of heat." *See* EX1001, 4:19-27 (emphasis added). The specification also provides as a metric that "[i]t is beneficial if the comminuted material is *dried* until the electrolyte content of organic components that are volatile at 80° C. has a maximum value of 3% by weight." *See* EX1001, 4:28-32 (emphasis added). The specification also states that "[t]he *drying* is preferably conducted for so long that the accumulated content of organic carbonates from the electrolyte that are volatile at 80° C. falls short of 3% by volume in the atmosphere above the comminuted material." *See* EX1001, 4:37-40 (emphasis

added). The specification also states that "[t]he comminuted material is preferably *dried* until an electrolyte content in the comminuted material is so low that an electrochemical reaction is impossible." *See* EX1001, 4:5-18 (emphasis added).

67. The specification does not state that any of these metrics measure whether the material is *inactivated*, and accordingly, the specification and the claims do not provide guidance as to the outer boundaries of "inactivation." I understand that PO also compounds this confusion through its various statements to the Patent Office regarding the meaning of the term "inactivation." For example, PO has stated that inactivation is merely "the endpoint result of drying, but not specif[ic] [to] the particular metric of drying that must be reached," POR, 10, and also that "inactivated" should *not* be defined synonymously with drying but that it must be understood as "safe for transport," EX1029, 9.

68. Therefore, it is my opinion that the outer boundaries of this limitation would not be clear with reasonable certainty to a POSITA.

D. Claims 30, 31 – the Scope of the Limitation "almost no Hydrogen Fluoride is produced" Is Not Clear with Reasonable Certainty to a POSITA

69. The scope of the limitation "almost no Hydrogen Fluoride is produced" as recited in substitute claims 30 and 31 is not clear with reasonable certainty to a POSITA because a POSITA would not understand when "almost no Hydrogen Fluoride is produced."

70. The claims and the specification of the '097 Patent provide no guidance as to when "almost no" Hydrogen Fluoride is produced. I have reviewed the portions of the specification that PO points to for support for this limitation, and none of those portions of the specification provide guidance to a POSITA as to when a threshold for "almost no" Hydrogen Fluoride has been reached.

71. For example, PO points to a portion of the specification that states, "[t]he drying preferably occurs at a maximum temperature of 80°C: this produces almost no hydrogen fluoride." EX2054, 7:33-8:1. This statement does not provide any guidance to a POSITA as to the threshold for "almost no" Hydrogen Fluoride, instead it simply states the conclusion that "almost no hydrogen fluoride" is produced.

72. PO also points to a portion of the specification that states: "The organic carbonate content is preferably so small that the formation of a significant amount of fluorophosphates can be ruled out." EX2054, 2:21-3:4. This portion of the specification provides no guidance as to what a "significant amount" of fluorophosphates are or whether "almost no" Hydrogen Fluoride has been produced.

73. Finally, PO points to a portion of the specification that states that "formation of hydrogen fluoride is hindered" through the disclosed method and that it is "beneficial to prevent the development of hydrogen fluoride." EX2054, 4:18-

25. Again, this statement does not provide any guidance to a POSITA as to the threshold for "almost no" Hydrogen Fluoride.

74. Accordingly, the specification and the claims fail to provide guidance, and the boundaries of this limitation would not be clear with reasonable certainty to a POSITA.

75. I declare under penalty of perjury that the foregoing is true and correct.

Executed this 9th day of May, 2025 in Duvall, WA.



Walter van Schalkwijk