

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

AMPEREX TECHNOLOGY LTD.
Petitioner,

v.

SEMICONDUCTOR ENERGY LABORATORY CO., LTD.,
Patent Owner

Case IPR2023-01016
Patent No. 10,741,828

PATENT OWNER'S PRELIMINARY RESPONSE

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PATENT OWNER'S EXHIBIT LIST

- EXHIBIT-2001 Declaration of Dr. Brett Lucht
- EXHIBIT-2002 *Curriculum Vitae* of Dr. Brett Lucht
- EXHIBIT-2003 Li et al., *Fracture Behavior in Battery Materials*, J. Phys. Energy 2 (2020)
- EXHIBIT-2004 Li et al., *Cathode Materials Modified by Surface Coating for Lithium Ion Batteries*, Electrochimica Acta 51, 3872–83 (2006)
- EXHIBIT-2005 Takada, *Progress and Prospective of Solid-State Lithium Batteries*, Acta Materiala 61, 759–70 (2013)
- EXHIBIT-2006 Xu, et al., *Lithium Transport Through Lithium-Ion Battery Cathode Coatings*, J. Mater. Chem. A. 3, 17248–72 (2015)
- EXHIBIT-2007 Jayasree, et al., *Nanoscale-Engineered LiCoO₂ as a High Energy Cathode for Wide Temperature Lithium-Ion Battery Applications—Role of Coating Chemistry and Thickness*, Nanotechnology 33, 1–19 (2022)
- EXHIBIT-2008 Ahaliabadeh, et al., *Extensive Comparison of Doping and Coating Strategies for Ni-Rich Positive Electrode Materials*, J. Power Sources 540, 1–23 (2022)
- EXHIBIT-2009 Han, et al., *Influence of Coating Protocols on Alumina-Coated Cathode Material: Atomic Layer Deposition versus Wet-Chemical Coating*, J. Electrochem. Soc. 166, A3679–84 (2019)
- EXHIBIT-2010 Yamamoto, et al., *Stabilization of the Electronic Structure at the Cathode/Electrolyte Interface via MgO Ultra-thin Layer during Lithium-ions Insertion/Extraction*, Electrochemistry 82, 891–96 (2014)

I. INTRODUCTION

The Board should deny institution of the Petition for *Inter Partes* Review (“IPR”) of U.S. Patent No. 10,741,828 (“the ’828 Patent”) for multiple reasons.

First, on the merits, the Petition fails to show that any of the alleged prior art, or combinations thereof, discloses or renders obvious that “the representative element and the fluorine are present in a crack portion observed from a TEM image” (as recited in independent claim 1) or that “the representative element and the fluorine are present in a portion which includes crystal defects observed from a TEM image” (as recited in independent claim 5). Indeed, in the arguments advanced in Grounds 1 and 4 of the Petition, Petitioner does not and cannot identify even ***a single portion*** of Shim (Ex. 1005), Lee (Ex. 1006), or Fujiki (Ex. 1008) disclosing that the claimed elements are present “in a crack portion” or “in a portion which includes crystal defects.” Instead, Petitioner and its declarant, Dr. Hayes, look outside the prior art in the grounds themselves to a single allegedly corroborating document—Fey (Ex. 1016)—to support their assumption that a POSITA would have “understood” these features to be present in Shim, Lee, and Fujiki. *See, e.g.*, Pet., 54 (“[A] POSITA would have understood that magnesium . . . will become ingrained into the crack potions of Shim’s particle. *See* Ex. 1016, 4 . . .”); Pet., 55 (“Shim . . . discloses fluorine in Shim’s coating, and a POSITA would have understood that such

coating material would be present in crack portions. *See* Ex. 1005, Fig. 2(b); Ex. 1016, 4.”); Pet., 76 (“A POSITA would have understood that such fluorine in Fujiki’s coating would be present in the crack portions because coating materials were known to become lodged inside such cracks. *See* Ex. 1016, 4 . . .”); *see also* Ex. 1003, ¶¶ 163–64, 238.

As Dr. Lucht explains, however, the Petition’s and Dr. Hayes’s reliance on Fey is misplaced. Fey is not concerned with comparative coating materials, and its MgAl_2O_4 coating *does not even include fluorine*. Ex. 2001, ¶ 63. Fey never addresses whether fluorine would behave in the same way as MgAl_2O_4 to become present in a crack portion as alleged. Indeed, Fey does not even establish that the MgAl_2O_4 coating material it does discuss—which does not include fluorine—is present in a crack portion, but merely speculates as to the cause of Fey’s experimental results. *See* Ex. 1016, 4 (“In the case of the coated cathodes, changes in the surface texture . . . *could have* enabled the particles of the coating material to become ingrained in the crevices and cracks on the cathode surface.”) (emphasis added). Fey’s speculation regarding MgAl_2O_4 fails to show that the claimed elements—including *fluorine*—would be present in a crack portion observed from a transmission electron microscopy (TEM) image.

With respect to the claimed *representative element* (e.g., magnesium), Petitioner further relies on an ambiguous figure in Shim as allegedly demonstrating that the representative element is present in a crack portion (or a portion which includes crystal defects) observed from a TEM image. *See* Pet., 53–55 (discussing Fig. 2(b) of Shim); *id.* 76–77; Ex. 1003, ¶ 162; *id.*, ¶ 238. But Fig. 2(b) of Shim does not include any TEM image, Shim never mentions crack portions or portions which include crystal defects whatsoever (much less in the relevant figure), and Petitioner’s speculation about Fig. 2(b) of Shim is technically implausible. Petitioner’s additional arguments that (i) Shim’s disclosure of doping the bulk of the PEAM particle with magnesium would necessarily result in crack portions that contain magnesium (*see* Pet., 53), and (ii) Fujiki’s disclosure of magnesium being diffused throughout the inside of the particle would result in magnesium being present in crack portions (*see id.*, 75–76) are also deficient for reasons described below (Section VI).

Second, apart from the substantive deficiencies, Petitioner fails to meet its burden of demonstrating, *with particularity*, that Shim (Ex. 1005), Lee (Ex. 1006), and Yu (Ex. 1007) are prior art printed publications that were publicly accessible before the critical date of the ’828 Patent. The Petition in fact makes no argument and addresses no evidence whatsoever that shows Shim, Lee, or Yu were accessible

to an interested searcher before the critical date. To the contrary, the Petition does no more than make a bare assertion of the alleged publication dates of these references, directly contravening the requirements expressed in *Hulu, LLC v. Sound View Innovations, LLC*, IPR2018-01039, Paper 29 at 13 (PTAB Dec. 20, 2019) (precedential) (“the statute requires that *the Petition* identify *with particularity* the grounds for institution *and evidence supporting such grounds*”) (first and third emphases added). And although the Petition includes a single citation to the Babbitt Declaration (Ex. 1033), the declaration is substantively deficient for reasons described below (Section VII), and the Petition’s failure to discuss any publication evidence itself amounts to an improper incorporation by reference.

Finally, institution should be denied since the Office has already considered prior art during original examination of the ’828 Patent that is substantially the same as the references that Petitioner now relies upon in Grounds 1 and 4 of the Petition. Shim was presented to the Patent Office in an Information Disclosure Statement (IDS), and the Office did not err in allowing the ’828 Patent over Shim. In addition, the teachings of Shim, Lee, and Fujiki are cumulative to references that were *specifically cited and addressed* by the Examiner, including Liu (Ex. 1019), which the Examiner identified as “[t]he closest prior art of record.” See Ex. 1002, 1346–

47. The Petition failed to identify any error in the Examiner's allowance of the '828 Patent over Liu, and is thus deficient.

II. OVERVIEW OF THE '828 PATENT

The '828 Patent describes positive electrode active materials (PEAMs), which can be used, for example, in lithium-ion secondary batteries. *See* Ex. 1001, 1:66–2:18; Ex. 2001, ¶¶ 34–45. One problem for PEAMs used in lithium-ion batteries is the cracking and breaking of PEAM particles after repeated charge and discharge cycles. Such cracking and breaking of PEAM particles “make[] a new surface of the positive electrode active material exposed” and cause the surface to be “in contact with an electrolyte solution to cause a decomposition reaction,” which leads to degrading of the “charge and discharge characteristics” of the battery. Ex. 1001, 4:4–9. Previously, protective coating films were applied to the surfaces of the PEAM particles to prevent the cracking and breaking of the PEAM particles. *Id.* at 4:10–12. These prior coating techniques, however, suffered from the drawback that they were not sufficiently able to protect all solvent-exposed surfaces of the PEAM particles. *See, e.g., id.* at 4:14–18.

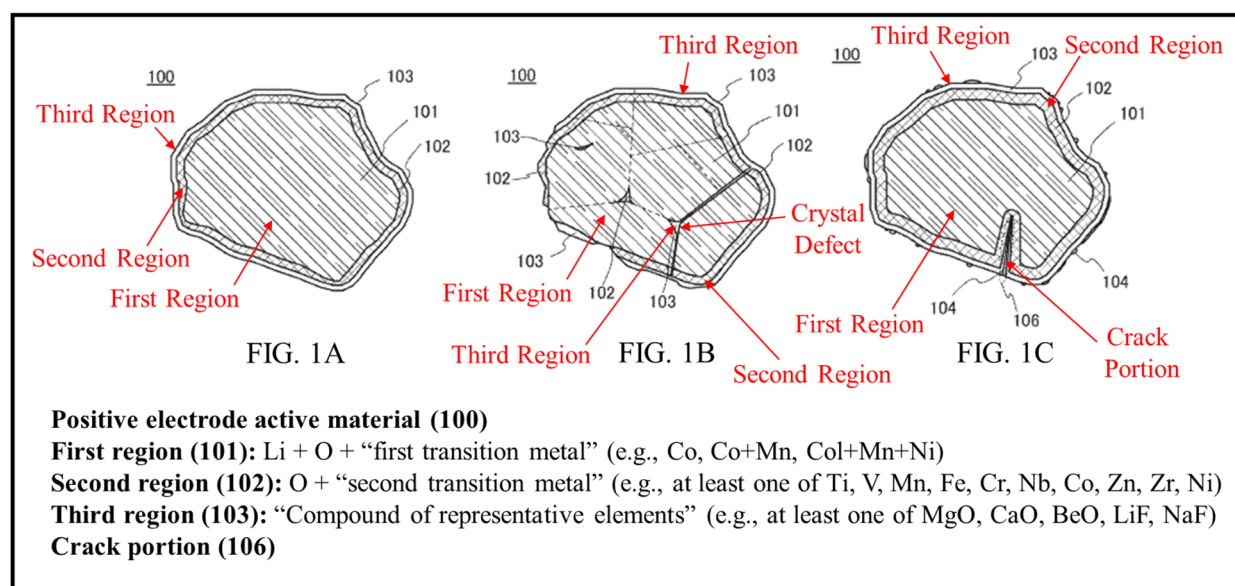
In view of these shortcomings, the inventors proposed novel protective layers that could be used in PEAM particles to mitigate deleterious effects of crack portions and crystal defects in the PEAM particle. *Id.*, 24:24–36. Rather than using

conventional approaches that can coat the outside of the particle but excludes certain surfaces, e.g., surfaces of crack portions, the inventors instead proposed to form a protective layer over surface regions of the PEAM particle—including the surfaces of crack portions—by segregating protective components (e.g., magnesium and fluorine) from within the particle and bringing those components to surface regions of the particle to form the protective layer. *Id.*, 23:60–24:5, 24:24–36. Another added benefit of this process is that it can also segregate the protective components into the vicinity of crystal defects within the PEAM particle, further improving the stability of the crystal structure of the PEAM. *Id.*, 24:11–23, Claim 5.

As an example of the approach proposed by the inventors, the '828 Patent discloses a PEAM particle 100 having a first region 101, a second region 102, and a third region 103. *See id.*, 9:30–39. The first region 101 contains “a composite oxide of lithium and a first transition metal,” wherein the first transition metal can be cobalt only (Co); cobalt and manganese (Mn); or cobalt, manganese, and nickel (Ni). *Id.*, 10:5–12. The second region 102 contains “an oxide of a second transition metal,” wherein the second transition metal can be a non-stoichiometric metal such as at least one of titanium (Ti), vanadium (V), manganese, iron (Fe), chromium (Cr), niobium (Nb), cobalt, zinc (Zn), zirconium (Zr), nickel, and the like. *Id.*, 10:52–62. The third region 103 contains “a compound of representative elements” such as at

least one of magnesium oxide (MgO), calcium oxide (CaO), beryllium oxide (BeO), lithium fluoride (LiF), and sodium fluoride (NaF). *Id.*, 11:64–12:4. The third region 103—which can include fluorine and a representative element such as magnesium—is provided as an example of a protective layer of the PEAM particle 100. *See id.*, 12:7–11 (“[F]or the third region 103, a material which is hardly changed electrochemically in the process of charging and discharging and is not easily transformed by contact with the electrolyte solution is preferably used.”); *id.*, 12:14–17 (“The positive electrode active material 100 includes the third region 103 in a superficial portion to improve stability in charging and discharging of the secondary battery.”); *see also* Figs. 5C, 6D (showing that the third region 103 includes fluorine and magnesium).

This information is summarized in annotated FIGS. 1A-1C, reproduced below.



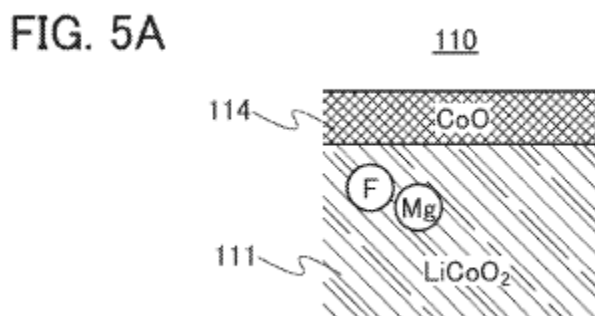
Ex. 1001, Figs. 1A–1C (annotated)

Significantly, the '828 Patent discloses (and shows in Figs. 1A–1C) that “the third region 103 may be present in a portion which includes crystal defects or a crack portion in the positive electrode active material 100 or in the vicinity thereof.” *Id.*, 9:51–54. According to the specification, a “crystal defect” enclosed within a crystal structure refers to a “defect[] which can be observed from a TEM image and the like, that is, a structure in which another element enters crystal, a cavity, and the like.” *Id.*, 9:55–58. Separately, “a crack portion refers to a crack or a break formed in a particle like a crack portion 106 illustrated in Fig. 1C, for example.” *Id.*, 9:58–60.

The formation, and hence presence, of a protective layer, such as the third region 103 in crack portions and portions which include crystal defects, yields

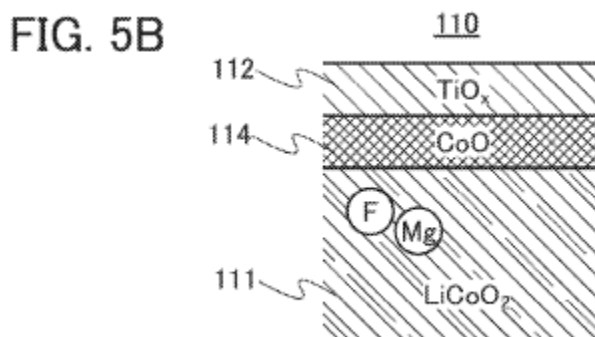
protections in these areas where conventional coatings did not. Ex. 2001, ¶ 40. For example, Figs. 5A–5C and 6A–6D of the '828 Patent illustrate a segregation model of elements contained in a PEAM particle, showing how during a manufacturing process that involves heating (e.g., at 500°C to 1200°C), representative elements such as magnesium (Mg) and fluorine (F) can unexpectedly segregate towards a superficial portion of the PEAM particle to form the third region 103. Ex. 1001, 10:29–33, 23:36–24:5, 27:1–28:17.

In more detail, and starting, for example, with Fig. 5A of the '828 Patent, a particle 110 can start with a cobalt oxide layer 114 in contact with a region 111 containing lithium cobaltate, magnesium, and fluorine. *Id.*, 22:33–37, 22:52–54.



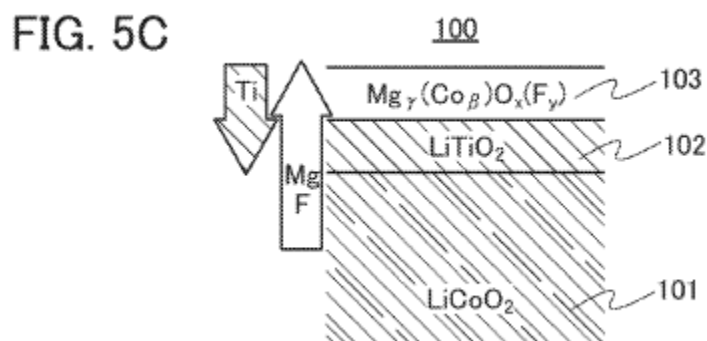
Ex. 1001, Fig. 5A

The particle 110 can then be coated with a material containing titanium (e.g., a titanium oxide) using a sol-gel method to produce the state of the particle 110 shown in Fig. 5B. *Id.*, 22:38–43.



Ex. 1001, Fig. 5B

Then, the particle 110 coated with the layer 112 containing titanium can be heated, for example, at 800°C for two hours to form the PEAM 100 shown in Fig. 5C. *Id.*, 22:44–54. The heating can cause the titanium in the layer 112 to diffuse into the inside of the particle 110, and simultaneously causes the magnesium and fluorine contained in the region 111 to segregate on a surface region of the particle (not only on an exterior surface of the particle, but also “in the vicinity of crystal defects” and “in [a] crack portion”). *Id.*; *see also id.*, 24:11–36. This heating process can form the second region 102 and the third region 103 of the PEAM 100. *Id.*, 24:43–51. As described above, the third region 103 can serve as a protective layer, “improv[ing] stability in charging and discharging of the secondary battery.” *Id.*, 12:14–17.



Ex. 1001, Fig. 5C

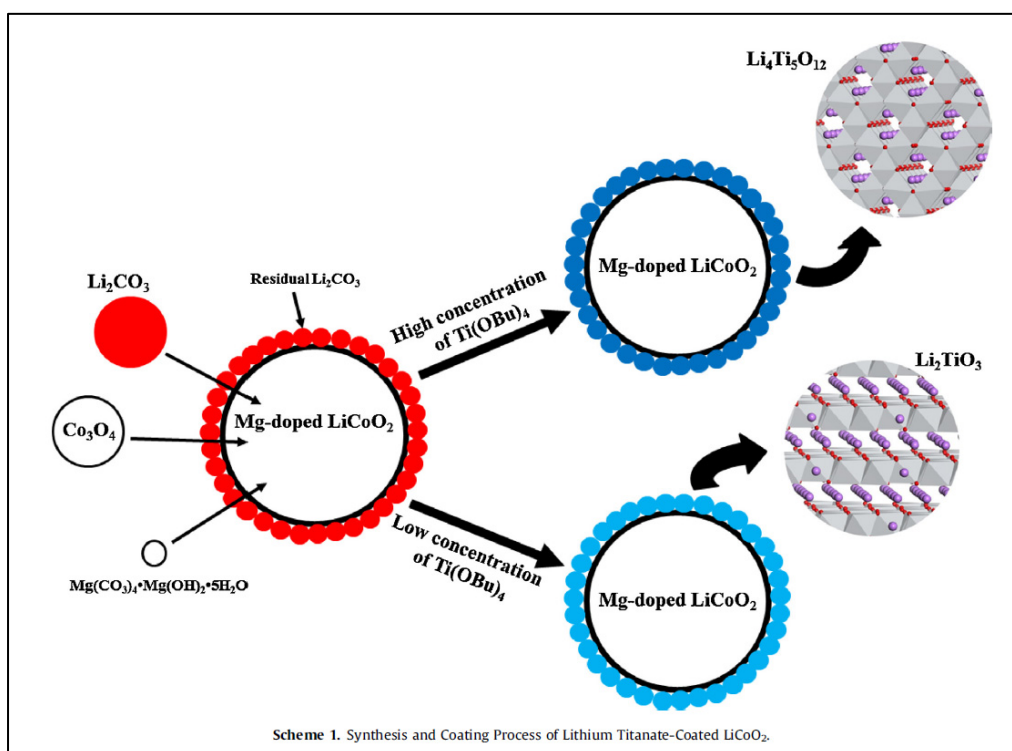
As examples in the '828 Patent, a comparison of Figs. 39A, 39B1, 39B2, 39C1, 39C2, 39D1, 39D2, 39E1, and 39E2 with Figs. 40A, 40B1, 40B2, 40C1, 40C2, 40D1, 40D2, 40E1, and 40E2 further provides empirical evidence that through heating, Mg can become segregated in a crack portion of the PEAM observed from a TEM image. *See id.*, 63:1–32 (“[I]n Sample 06 before heating, segregation of magnesium is not observed on the surfaces of the particles or in the crack portion. In contrast, in Sample 07 after heating, segregation of magnesium is observed both on the surfaces of the particles and in the crack portion.”). An embodiment of the resulting PEAM particle formed through this process was demonstrated by the inventors to “show[] excellent initial charge and discharge capacity, rate characteristics, and cycle characteristics.” *Id.*, 65:29–33.

III. OVERVIEW OF THE CITED REFERENCES

A. Shim

Shim, the primary reference applied in Grounds 1–3 of the Petition, is a research article that describes a study involving lithium titanate coatings for LiCoO_2 cathode materials with Mg doping. Ex. 1005, 1; 2001, ¶¶ 46–50. Shim begins by describing the motivation for the study, recognizing that successful coatings for cathode materials such as ZrO_2 , SiO_2 , ZnO , Al_2O_3 , $\text{Al}(\text{OH})_3$, AlPO_4 , and AlF_3 have only one stable valence state at ambient condition, enabling active materials to obtain “enhanced stability” (e.g., minimizing degradation and consequent capacity fade during cycling). Ex. 1005, 1. Despite enhanced stability, however, Shim notes that these coating materials “generally exhibit poor lithium ion conduction,” and this drawback has motivated alternative proposals for “inorganic materials containing lithium ions” such as Li_2TiO_3 and $\text{Li}_4\text{Ti}_5\text{O}_{12}$ coatings. *Id.*; Ex. 2001, ¶ 46.

In accord with the shift away from traditional coatings with low Li ion conduction, Shim discloses (i) manufacturing cathode materials by coating Mg-doped LiCoO_2 with lithium titanate using a sol-gel technique, (ii) characterizing the resulting materials, and (iii) measuring the electrochemical performance of cells that were prepared using the manufactured cathode materials. Ex. 1005, 2–3. A diagram of the cathode materials manufactured in Shim is reproduced below.

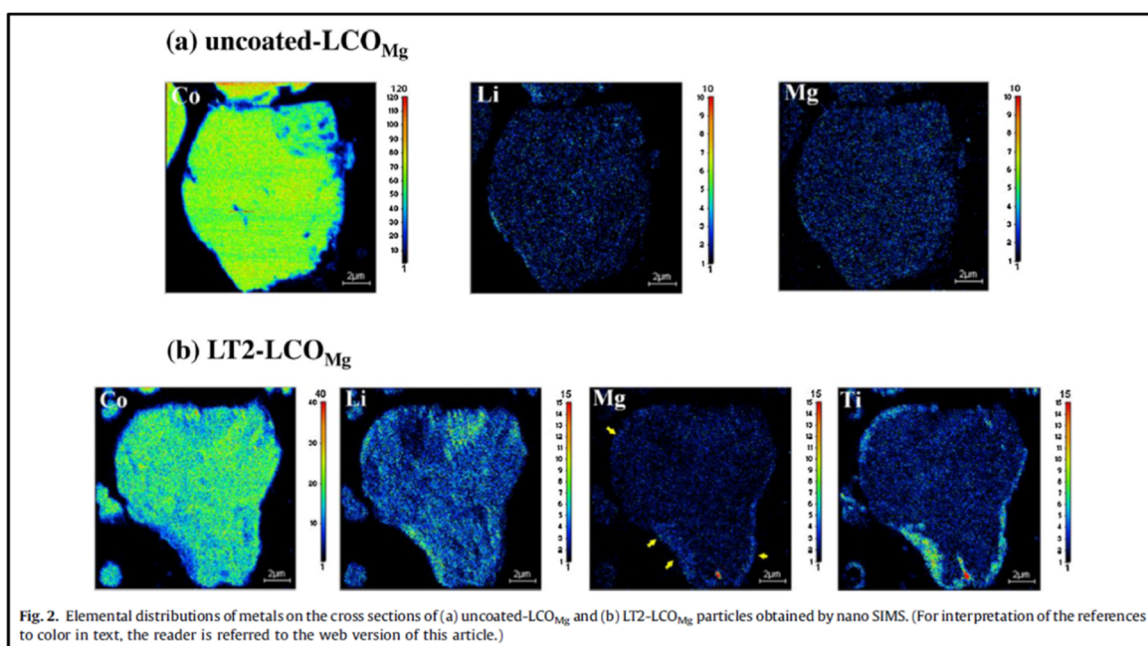


Ex. 1005, 2 (“Scheme 1”)

Nowhere does Shim disclose PEAMs with “crack portions” or portions that include crystal defects. Shim instead focuses its discussion of “degradation mechanisms” of layered cathode materials on “the dissolution of transition metal ions into the electrolytes when the electrode is delithiated,” the shearing of the MO₂ layer at the delithiated state from the electrode surface, oxygen loss, and side reactions with electrolytes. *Id.*, 1. None of these degradation mechanisms constitutes a crack portion or a portion that includes crystal defects. Ex. 2001, ¶ 48. Shim also makes reference to “structural changes of the [coating] materials after

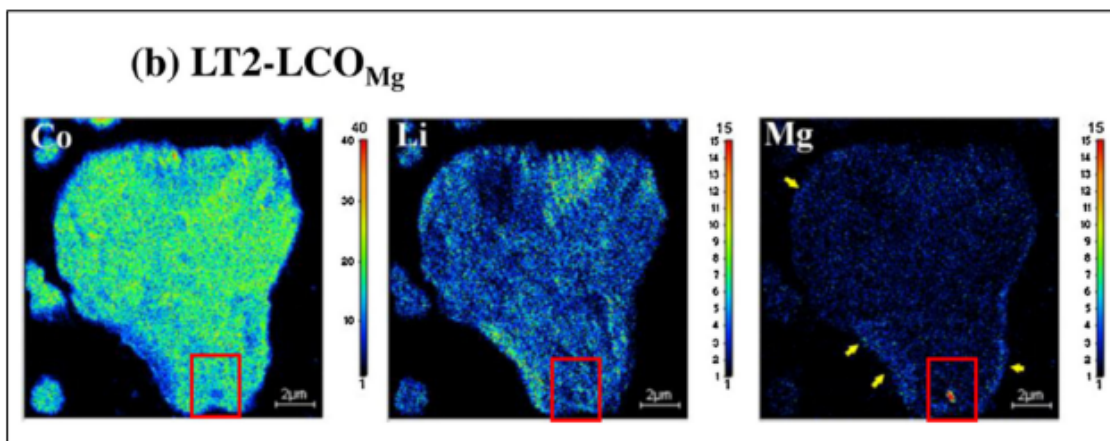
charging” (Ex. 1005, 6) and “the irreversible transformation of Li_2TiO_3 and the structure consistency of $\text{Li}_4\text{Ti}_5\text{O}_{12}$ with cycling” (*id.*, 7). However, again, Shim’s disclosures are limited to merely general descriptions that lack any reference to cracks and crystal defects—not to mention the claimed subject matter such as crack portions of a PEAM particle or portions that include crystal defects.

Finally, Shim discloses elemental distributions of metals on the cross-section of its uncoated- LCO_{Mg} and coated $\text{LT2-LCO}_{\text{Mg}}$ PEAM particles obtained by nanoscale secondary ion mass spectrometry (nano SIMS):



Ex. 1005, Fig. 2

Petitioner identifies and annotates a feature shown in Fig. 2(b) of Shim (reproduced below) and speculates that this feature constitutes a “crack portion” that contains a high concentration of magnesium. *See* Pet., 53–55; Ex. 1003, ¶ 162.

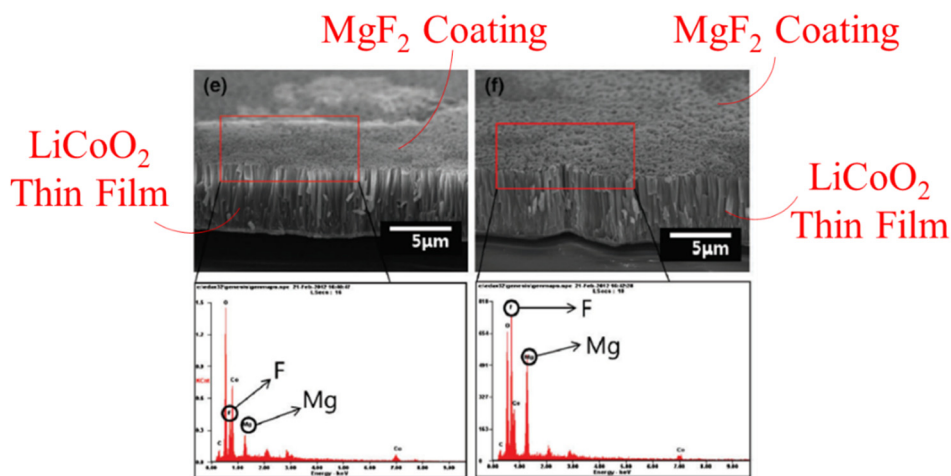


Ex. 1005, Fig. 2(b) (annotated by Petitioner)

However, the region pointed out by Petitioner is never even mentioned by Shim as an area of interest, and it is certainly not identified as a crack portion. Nor is it a crack portion “observed from a TEM image,” as recited in independent claims 1 and 5 of the ’828 Patent. As Dr. Lucht points out, the region pointed out by Petitioner in Fig. 2(b) of Shim is ambiguous and could simply be a manufacturing impurity (e.g., from poor mixing of starting materials). Ex. 2001, ¶ 50. In any case, the region cannot be identified, with reasonable confidence, as a crack portion, particularly without any support from Shim to support this interpretation.

B. Lee

Lee, a secondary reference in Grounds 1–3, is a research article that describes using MgF_2 as a coating material to improve the electrochemical properties of a LiCoO_2 film cathode. *See* Ex. 1006, 1; Ex. 2001, ¶¶ 51–52. In particular, Lee states that the inspiration for using a MgF_2 coating came from “the fact that other fluorides, such as AlF_3 , were very effective in modifying cathode surfaces.” Ex. 1006, 1. In the study, Lee discloses (i) manufacturing cathode materials by coating pristine LiCoO_2 thin film with MgF_2 using a spin-coating technique, (ii) observing the coating layers, and (iii) measuring the electrochemical properties of the coated LiCoO_2 thin films “to investigate the effectiveness of the MgF_2 surface modification.” *Id.*, 1–2. Imagery of the MgF_2 -coated cathode materials tested by Lee is shown in annotated Figs. 1(e) and 1(f) of Lee (reproduced below).



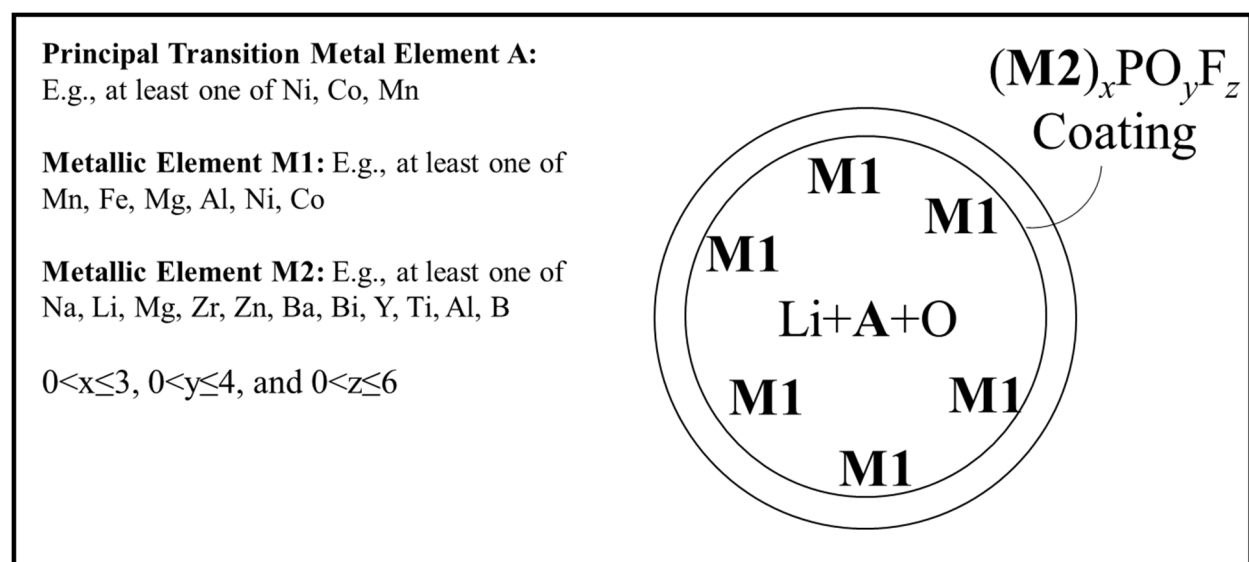
Ex. 1006, Figs. 1(e) and 1(f) (annotated)

Like Shim, Lee never discloses PEAMs with crack portions or portions that include crystal defects. Lee merely describes the problem of “acid-containing electrolyte attack[ing] the surface of the cathode during cycling,” (*id.*, 4), which can lead to dissolution of transition metals and the formation of an unwanted interface layer that can deteriorate the electrochemical properties of a cathode. Ex. 2001, ¶ 52.

C. Fujiki

Fujiki, the primary reference applied in Grounds 4–6 of the Petition, is a patent reference directed to a PEAM that includes (i) a “principal transition metal element A,” (ii) “at least one metallic element M1” that is different from principal transition metal element A and is “present at least at part of a surface of a lithium-containing transition metal oxide containing the principal transition metal element A,” and (iii) “a compound of a metallic element M2 [that is] different from the metallic element M1 [and] is present in a coating manner or in the vicinity of the lithium-containing transition metal oxide.” *See* Ex. 1008, Abstract; Ex. 2001, ¶¶ 53–54. The principal transition metal element A can be “at least one selected from the group consisting of at least Ni, Co and Mn.” Ex. 1008, 4: 60–61. The metallic element M1 can be “at least one element which can be substituted for the principal transition metal element A on a solid solution basis” such as “at least one element selected from the group consisting of Mn, Fe, Mg, Al, Ni, and Co.” *Id.*,

5:6–10. And finally, the metallic element M2 can be “at least one element selected from the group consisting of Na, Li, Mg, Zr, Zn, Ba, Bi, Y, Ti, Al, and B,” which “has the function of stabilizing the crystal structure of the compound oxide particles at the time of charging.” *Id.*, 5:29–35. For example, Fujiki discloses that it is preferable that the metallic element M2 is “present in the state of a coating” and is “in the form of a metallic salt, a metallic oxide or a metallic halide” such as a metallic salt represented by the formula: $(M2)_xPO_yF_z$, where $0 < x \leq 3$, $0 < y \leq 4$, and $0 < z \leq 6$. *Id.*, 5:35–61. The generalized cathode material that Fujiki discloses is illustrated by Dr. Lucht in the diagram below.



Ex. 2001, ¶ 53

Like Shim and Lee, Fujiki is also silent with respect to PEAMs with crack portions or portions that include crystal defects. Although Fujiki mentions the

“deterioration of a positive electrode active material” (Ex. 1008, 3:34–39) and the role of M2 in “stabilizing the crystal structure of the compound oxide particles at the time of charging” (*id.*, 5:32–35), none of these general statements amount to a disclosure of a crack portion of a PEAM particle or a portion that includes crystal defects. Ex. 2001, ¶ 54.

IV. PERSON OF ORDINARY SKILL IN THE ART

The Petition contends that “[a] POSITA at the time of the ’828 Patent would have at least a bachelor’s degree in chemistry, chemical engineering, or materials science and at least five years of experience in the field of batteries and battery materials,” and further contends that “[i]ndividuals with different education and additional experience could still be of ordinary skill in the art if that additional experience compensates for a deficit in their education and experience.” Pet., 33. For purposes of the analysis in this POPR, and without conceding agreement, Patent Owner and Patent Owner’s expert have applied Petitioner’s proposed level

of skill for a POSITA.¹ Ex. 2001, ¶¶ 32–33. Even under Petitioner’s proposal, the Petition fails to show that any claim would have been obvious before the critical date.

V. CLAIM CONSTRUCTION

Patent Owner does not formally construe any claim terms at this time because the particular deficiencies in the Petition highlighted in this POPR do not turn on claim construction. Patent Owner nonetheless reserves all rights to raise additional arguments and claim constructions at a later time in this proceeding if IPR is instituted.

VI. THE PETITION FAILS TO DEMONSTRATE A REASONABLE LIKELIHOOD OF PREVAILING AGAINST AT LEAST ONE CHALLENGED CLAIM

The Petition challenges claims 1, 4, 5, and 8 of the ’828 Patent on two separate grounds. Ground 1 alleges that Shim alone or in combination with Lee renders obvious that “the representative element and the fluorine are present in a crack portion observed from a TEM image” (independent claim 1) and that “the

¹ Patent Owner notes that it has applied the level of skill for a POSITA set forth in the Petition, and *not* the level of skill set forth by Petitioner’s own expert, Dr. Hayes, which contradict each other. *Compare* Pet. 33–34 *with* Ex. 1003, ¶ 89.

representative element and the fluorine are present in a portion which includes crystal defects observed from a TEM image” (independent claim 5). Ground 4 makes similar obviousness allegations, but relies instead on Fujiki.

For the reasons described in detail below, all of the Petition grounds against independent claims 1 and 5 are deficient and institution should be denied.

A. Ground 1 is Deficient for Failing to Show that Shim Alone or in Combination with Lee Renders Obvious that “the Representative Element and the Fluorine are Present in a Crack Portion [or a Portion Which Includes Crystal Defects] Observed from a TEM Image”

Ground 1 is deficient for several reasons. Ex. 2001, ¶¶ 55–56. First, with respect to independent claim 1, the Petition fails to show that Shim alone or in combination with Lee renders obvious *fluorine* present in a crack portion observed from a TEM image. Second, with respect to claim 1, the Petition fails to show that Shim alone or in combination with Lee renders obvious *the representative element* (e.g., magnesium) present in a crack portion observed from a TEM image. Third, with respect to independent claim 5, the Petition fails to show that Shim alone or in combination with Lee renders obvious the representative element and fluorine present *in a portion which includes crystal defects* observed from a TEM image. Each of these deficiencies is explained in further detail below.

1. The Petition Fails to Show that Shim Alone or in Combination with Lee Renders Obvious Fluorine Present in a Crack Portion Observed from a TEM Image (Claim 1)

a. Shim and Lee are Deficient

The Petition erroneously asserts that since Shim alone or in combination with Lee renders obvious a fluorine-containing coating, a POSITA would have “understood” that fluorine would likewise be present in crack portions. Pet., 55; Ex. 2001, ¶¶ 57–61. Although Shim and Lee do not render obvious an applicable fluorine-containing coating in the first place, even if that were the case, the Petition fails to establish that it would be obvious for fluorine from any such coating to be present in a crack portion.² As noted above in Sections III.A and III.B, Shim and Lee do not disclose crack portions whatsoever, and they certainly do not disclose or render obvious fluorine present in said crack portions. Shim instead focuses on

² Patent Owner does not concede that an element or coating material that merely becomes ingrained in a crack portion or a crystal defect is necessarily “present” in the crack portion or crystal defect as alleged in the Petition. In this POPR, we focus on other deficiencies in the Petition’s analysis even as Patent Owner reserves all rights to raise additional arguments and identify additional deficiencies in the Petition’s analysis at a later point in the proceeding.

other types of “degradation mechanisms,” such as “the dissolution of transition metal ions into the electrolytes,” or merely provides general descriptions that lack any reference to crack portions and crystal defects. Ex. 1005, 1. As Dr. Lucht explains, because there are many modes of degradation associated with a particle and cracks are a particular type of defect, a general description of degradation does not equate to the presence of crack portions. Ex. 2001, ¶ 59.

Moreover, nothing in Shim identifies the structure shown in its Fig. 2(b) as being a “crack portion” (*see supra* Section III.A); this is based on mere speculation by Petitioner and its declarant, and it does not address other plausible alternatives such as the introduction of contaminants during manufacturing of the PEAM particle or manufacturing impurities caused by poor mixing of the starting materials. Ex. 2001, ¶ 60. Furthermore, Lee fails to remedy the deficiencies of Shim as it similarly never discloses crack portions and only vaguely describes the “dissolution of transition metals.” Ex. 1006, 4.

In short, the Petition fails to identify *even a single prior art reference* that discloses or suggests the presence of fluorine in a crack portion. Petitioner has not demonstrated a reasonable likelihood of prevailing given that these key claim features are entirely absent from the teachings of the relied upon alleged prior art.

b. The Petitioner's Improper Reliance on Fey Fails to Cure the Deficiencies in Shim and Lee

Petitioner attempts to skirt around the deficiencies of Shim and Lee through reliance on Fey (Ex. 1016, 4)—a reference that is not even combined in either Grounds 1 or 4. *See, e.g.*, Pet., 25, 51, 54–55. Putting aside the impropriety of Petitioner's reliance on Fey for key claim features without even attempting to integrate Fey into the proposed prior art combinations, the evidence here confirms that Fey does not cure the deficiencies of Shim and/or Lee. Ex. 2001, ¶¶ 62–69.

For context, Fey describes experiments performed on a cathode material comprising LiCoO_2 coated with MgAl_2O_4 —*a coating that does not include any fluorine*—and speculates that an applied cycling process “could have” enabled particles of the MgAl_2O_4 coating material to “become ingrained in the crevices and cracks on the cathode surface.” Ex. 1016, 4. But Fey never discusses *fluorine* being present in a crack portion of a PEAM particle, nor does Fey or Petitioner address whether a fluorine-containing coating would behave similarly to a MgAl_2O_4 coating. Indeed, nothing in Fey even demonstrates that its own *MgAl_2O_4 coating* is present in a crack portion; Fey only *hypothesizes* this possible phenomenon as a potential explanation for the specific results of Fey's cyclic voltammetric experiment. *Id.* (“In the case of the coated cathodes, changes in the

surface texture resulting from the contraction and expansion of the lattice during the cycling process *could have* enabled the particles of the coating material to become ingrained in the crevices and cracks on the cathode surface.”); Ex. 2001, ¶¶ 63-65.

Despite the gaps in Fey, the Petition nonetheless relies on testimony from Dr. Hayes that “through the same mechanism . . . fluoride in the coating layer would also become present in the ‘crack portion’ of the PEAM particle” shown in Fig. 2(b) of Shim. Pet., 55; Ex. 1003, ¶¶ 164–65. However, Dr. Hayes’s assertion is entirely conclusory and he never addresses at all how differences in coating materials might affect their ability to become ingrained in crack portions in the PEAM particle. Nor does Dr. Hayes address the fact that Fey itself only speculates as to the ingrainings of MgAl_2O_4 in crevices and cracks. The Petition is entirely devoid of evidence necessary to establish that a fluorine-containing coating material would behave similarly to coatings having different chemistries such as MgAl_2O_4 . The Petition instead oversimplifies the materials science involved in the prior art devices and obscures many of the real-world complexities that would preclude a POSITA from reasonably expecting fluorine-containing coatings to behave similarly to other coating materials such as MgAl_2O_4 . Ex. 2001, ¶¶ 65–69. The Petition’s unreliable and oversimplified analysis is evident for several reasons.

First, the Petition fails to address complexities in the formation of fractures in PEAM particles that would affect whether a particular coating material becomes ingrained in crack portions. *Id.*, ¶67. It is well-established that the composition of PEAM particles can substantially influence the formation of cracks in a cathode surface. *See* Ex. 2003, 13 (describing how the composition of electrode materials can affect the fracture of battery materials, for example, influencing the abundance and severity of cracks in the particle). Even if one were to consider Petitioner’s position that “Shim’s PEAM degradation caused by cycling . . . refers to cracks” (Pet., 51 (citing Ex. 1005, 1)),³ Petitioner’s analysis is flawed because it fails to address that the susceptibility of PEAMs to cracking is dependent on a range of factors including “[p]article size, material composition, pre-existing defects, state-of-charge heterogeneity, cycling time, cutoff voltage, [and] temperature.” Ex. 2003, 19 (annotated Table 1, reproduced below). Therefore, unlike Petitioner and Dr. Hayes, a POSITA would not automatically assume from Fey’s conjecture regarding MgAl_2O_4 possibly becoming ingrained in crevices and cracks of Fey’s

³ Patent Owner does not concede that Petitioner is correct in asserting, based on Shim (Ex. 1005, 1), that PEAM degradation caused by cycling refers to cracks.

cathode that fluorine-containing PEAM particles would behave similarly in Shim and Lee. Petitioner's failure to recognize or address any of these differences amounts to a gross over-simplification of the technical field and is a far cry from the particularized analysis that the Board requires for institution. There is simply no evidence available to support the range of assumptions and logical inferences underlying Petitioner's reliance on Fey.

Table 1. Comparisons of the fracture mechanism, fracture effects, and factors affecting the fracture for anodes, cathodes, and SSEs.					
	Anodes			Cathodes	SSEs
	Alloying	Intercalation (graphite)	Conversion	Intercalation	NASICONs, garnets, sulfides
Fracture mechanism	Two-phase-coherency stress, anisotropic reaction kinetics	Stress induced by volume change, gas formation, cointercalation of solvated ion	Structure reorganization and volume change	Concentration gradient stress and two-phase-coherency stress	Stress induced by growth of interphase or volume expansion of active material
Fracture effect	Specific area of active material increases, impeded diffusion of ions and electrons	Exfoliation, impedance increase, capacity fade	Structure pulverization, decayed capacity, inferior cycling stability.	Resistance increase, capacity fading	Porosity increases, impedance increases, overpotential increase
Factors affecting fracture	Size, morphology, crystallinity, C-rate	Mechanical properties, Solvent type	Morphology, material composition, structure	Particle size, material composition, pre-existing defects, state-of-charge heterogeneity, cycling time, cutoff voltage, temperature	Mechanical properties, crystallinity, defects

Ex. 2003, Table 1 (annotated)

Second, a POSITA would have known that different coating materials can have meaningfully different properties that would impact their ability to become ingrained in crack portions. *See, e.g.*, Ex. 2001, ¶ 68; Ex. 2004, 2–5 (describing many coating materials for cathode materials, including their different properties, different coating processes, and mechanisms of action); Ex. 2005, Table 2 (showing that even coatings made of the same elements in different ratios such as $\text{Li}_4\text{Ti}_5\text{O}_{12}$ and $\text{Li}_2\text{Ti}_2\text{O}_5$ can have different properties); Ex. 1005, 8 (showing, once again, that coatings made of the same elements in different ratios such as Li_2TiO_3 and $\text{Li}_4\text{Ti}_5\text{O}_{12}$ can have different properties, with $\text{Li}_4\text{Ti}_5\text{O}_{12}$ showing “much better electrochemical performances as a coating material” due to “its excellent stability during charging/discharging”); Ex. 2006, Table 1 (showing different properties between fluoride coatings such as AlF_3 and oxide coatings such as Al_2O_3); Ex. 2007, 1–2 (demonstrating different properties for metal oxide and metal fluoride coatings and noting that “comparison of different coating chemistries on LCO across literature is not quite straight forward due to variations in parent material preparation method, coating method, coating thickness, differences in particle size, differences in rates tested, etc.”). Given these many known differences between coatings of different chemical compositions, Dr. Hayes’s conclusory assertion that a POSITA would expect a fluorine-containing coating material to behave similarly

to coatings having different chemistries such as Fey's MgAl_2O_4 coating is unsupported. In fact, Dr. Lucht explains that differences in even basic chemical properties, such as electronegativity profiles, can affect how these coatings react and move in identical settings. Ex. 2001, ¶ 68.

Third, the Petition overlooks how differences in coating manufacturing processes can also result in coatings with different properties that would impact their ability to become ingrained in crack portions. Ex. 2001, ¶ 69; *see also, e.g.*, Ex. 2008, 5–6 (comparing solid state, co-precipitation, sol-gel, hydrothermal, combustion, and spray-drying methods of synthesizing electrode materials and noting that “[d]ifferent synthesis methods have important effects on the morphology and structure properties of final products.”); Ex. 2009, 1 (proving that “different coating protocols have critical influences on the atomic and chemical structures of surface alumina coatings as well as the electrochemical performance of the coated cathodes”); Ex. 2010, 1 (demonstrating that even cathodes coated with similar MgO coatings and prepared using similar pulsed laser deposition techniques yielded different morphology effects depending on the temperature at which coating occurs). According to Dr. Lucht, even simple differences between coatings such as variations in thickness resulting from different coating processes can affect the ability of coatings to become ingrained in cracks and crevices in the

way that Petitioner alleges. Ex. 2001, ¶ 69. Therefore, given the significant influence that coating manufacturing processes can have on coating properties, the Petition's and Dr. Hayes's conclusory analyses fail to establish a reasonable likelihood that a POSITA would expect Shim's sol-gel-formed coating (Ex. 1005, 2) or Lee's spin-coating-formed coating (Ex. 1006, 1) to behave similarly in allegedly becoming ingrained in cracks/crevices to Fey's "semi-alkoxide sol-gel"-formed coating despite having many differences including heating temperatures and times (Ex. 1016, 1–2).

For all of these reasons, Fey fails to cure the deficiencies in Shim and Lee and cannot be relied upon to support Petitioner's obviousness allegations.

c. The Petition Fails to Demonstrate Inherency, or Even that the Fluorine Present in a Crack Portion Would be Predictable in any PEAM Particle Based on Shim and Lee

Absent any express disclosure from Shim or Lee (or Fey) of fluorine present in a crack portion of a PEAM particle, the Petition can at best be understood as making the argument that such features are inherent in the alleged prior art. But this is not the case. The evidence here confirms that fluorine will not necessarily be in crack portions in the prior art devices, and in any event, such features would not have been predictable. Ex. 2001, ¶¶ 70–71.

According to the Federal Circuit, to supply a missing claim limitation based on inherency, “the limitation at issue ***necessarily*** must be present’ in order to be disclosed by the reference.” *Southwire Co. v. Cerro Wire LLC*, 870 F.3d 1306, 1311 (Fed. Cir. 2017). That is not the case here. Fey discloses a cathode material comprising LiCoO_2 coated with MgAl_2O_4 using a sol-gel procedure. Ex. 1016, 1. Fey’s cathode material was studied in an experiment using cyclic voltammetry, and in discussion of the experimental results, the authors hypothesized that “[i]n the case of the coated cathodes, changes in the surface texture resulting from the contraction and expansion of the lattice during the cycling process ***could have*** enabled the particles of the coating material to become ingrained in the crevices and cracks on the cathode surface.” Ex. 1016, 4 (emphasis added).

Fey’s speculation here falls well short of Petitioner’s burden of showing that fluorine would be necessarily present in the alleged crack portions of Shim’s particle, or that such an outcome would even be predictable. Fey does not say that particles of the coating material are always or ***necessarily*** present in the crevices and cracks of a cathode material. Nor is the statement in Fey a general statement that ***any coating material***, deposited using ***any process*** must necessarily be present in the crevices and cracks. On the contrary, as noted above, the fracture behavior in PEAMs is complex and can be affected by a range of factors including “[p]article

size, material composition, pre-existing defects, state-of-charge heterogeneity, cycling time, cutoff voltage, [and] temperature.” Ex. 2003, 19. Accordingly, a POSITA would not have understood that Fey’s speculation about fracture behavior in a non-fluorine-containing MgAl_2O_4 -coated PEAM particle (subject to very specific manufacturing processes and experimental conditions) would *necessarily* generalize to fluorine-containing PEAM particles and result in the presence of fluorine in a crack portion.

For these reasons, the presence of fluorine in a crack portion was neither inherent nor predictable in the cited references before the ’828 Patent.

2. The Petition Fails to Show that Shim Alone or in Combination with Lee Renders Obvious a Representative Element Present in a Crack Portion Observed from a TEM Image (Claim 1)

The Petition identifies magnesium as an example of the claimed “representative element” and offers two theories for why Shim discloses or renders obvious that the magnesium would be present in a crack portion of Shim’s particle. Neither theory is tenable. Ex. 2001, ¶¶ 72–81.

Under the *first theory*, Petitioner refers to Shim’s alleged disclosure of magnesium diffusing into a coating of the PEAM particle and argues that a POSITA would have understood that “after having diffused into the coating,”

magnesium would “become ingrained into the crack portions of Shim’s [PEAM] particle.” Pet., 53–54. Relatedly, Petitioner argues that if Shim’s particle were combined with Lee’s MgF_2 coating, then the magnesium in this coating would also be found in the crack portion. *Id.*, 55; Ex. 2001, ¶ 73.

Petitioner’s first theory is deficient for similar reasons as Petitioner’s flawed assumption that fluorine would be present in a crack portion. *See supra* Section VI.A.1; *see also* Ex. 2001, ¶¶ 73–79. For example, neither Shim nor Lee disclose crack portions whatsoever, and therefore they cannot possibly disclose the representative element (e.g., magnesium) present in said crack portions. Again, Shim and Lee both focus solely on other types of “degradation mechanisms” and provide only general descriptions that lack any references to crack portions or portions which include crystal defects. *See* Ex. 1005, 1; Ex. 1006, 4.

The Petition identifies Fig. 2(b) of Shim as allegedly showing magnesium ingrained in a crack portion. Pet., 54–55. In Petitioner’s annotated version of the figure, reproduced below, Petitioner refers to the portion of Shim’s PEAM particle indicated by the red box as a “crack portion” and notes the presence of magnesium in this portion of the PEAM particle. *Id.* However, Shim never identifies the relevant region as a crack portion, and in fact, does not mention the presence of any cracks in the PEAM particle whatsoever. The Petition simply fails to offer any

evidence or reasoning to support its assumption that the identified region in Fig.

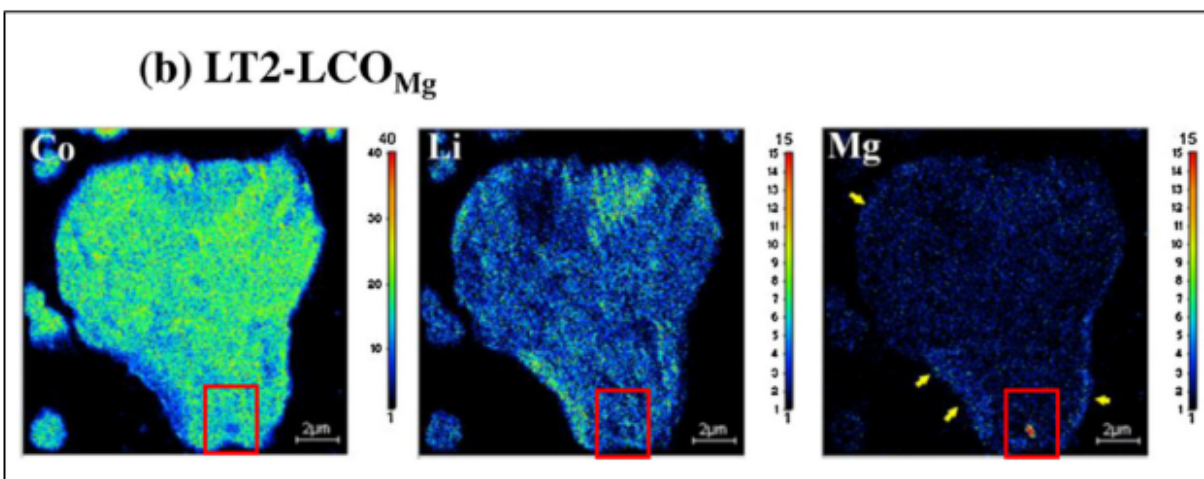
2(b) of Shim is a crack portion (e.g., as opposed to other plausible alternatives such as a manufacturing impurity caused by poor mixing of the starting materials, a contaminant introduced during the manufacturing process, etc.). *See* Ex. 2001,

¶ 75. Petitioner appears to argue that the identified region in Shim's particle represents coating material that is ingrained in a crack portion as a result of the process conjectured in Fey. Pet., 54. But this makes little sense. If the high concentration of Mg found in the identified region originated from the alleged coating material, then one would expect the region to have a similar concentration of Mg as the alleged coating material on the PEAM particle's surface. But, as Dr. Lucht points out, the concentration of Mg in the identified region is *many multiples higher* than the concentration of Mg at the particle surface. Ex. 2001,

¶ 76. Petitioner does not even attempt to explain away this discrepancy. On top of this, Fey hypothesizes that such embedding of coating material occurs "with the application of a[n] [electrochemical] load or upon thermal cycling," (Ex. 1016, 4), and Petitioner argues that "Shim's PEAM degradation caused by cycling . . . refers

to cracks” (Pet., 51 (citing Ex. 1005, 1)).⁴ However, Shim *never* discloses subjecting its PEAM particles to an electrochemical or thermal cycling process, and thus presumably generated the nano SIMS image of Fig. 2(b) on particles having no cycling history, leaving *no opportunity* for the speculated process proposed by Fey to even occur. Fig. 2(b) of Shim was also imaged using nano SIMS (a technique used to measure elemental and isotopic compositions of a sample rather than structural features) and thus, at the very least, these images do not represent “a crack portion *observed from a TEM image.*” The Petition is thus deficient for failing to show how Shim alone or in combination with Lee discloses or renders obvious “the representative element . . . present in a crack portion observed from a TEM image.”

⁴ See *supra* note 3.



Ex. 1005, Fig. 2(b) (annotated)

Second, the Petitioner’s reliance on Fey fails to cure the deficiencies in Shim and Lee. At the outset, and as noted above in Section VI.A.1.b, Fey is not formally part of either Grounds 1 or 4, and Petitioner’s attempt to backdoor this reference in to the prior art combinations in Grounds 1 and 4 is improper and should be rejected. *See Adaptics Limited v. Perfect Company*, IPR2018-01596, Paper 20, 20–23 (P.T.A.B. Mar. 6, 2019) (Informative Decision) (cautioning against “catch-all” arguments and using “additional documents” to “fill gaps in the asserted references.”). Moreover, Petitioner fails to provide any evidence to support why a POSITA would expect the diffused magnesium in Shim or the MgF₂ coating in Lee to behave similarly to other coating materials such as Fey’s MgAl₂O₄ coating by becoming ingrained or lodged in a crack portion. Similar to the arguments included

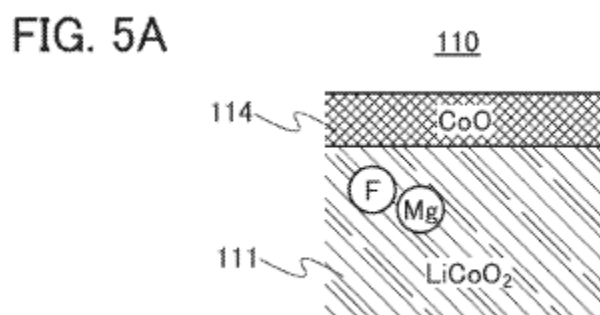
in Section VI.A.1.b, Petitioner's bare assertion that a POSITA would understand this ignores the complexities of how fractures form in PEAM particles; it ignores the fact that coatings with differing chemical compositions can have different properties; and it ignores the fact that different coating manufacturing processes can yield coatings with different properties—all of which can affect the likelihood that a particular coating material becomes ingrained in a crack portion. Ex. 2001, ¶¶ 65–69, 78. Petitioner's failure to recognize these nuances is a gross simplification of the technical field and a fatal deficiency of the Petition.

Third, the Petition fails to demonstrate that any element in the coating material of a PEAM would *inherently* be present in a crack portion (e.g., by inherently becoming ingrained in crevices and cracks on the cathode surface). *Id.*, ¶ 79. As explained in reference to fluorine in Section VI.A.1.c, Fey's limited disclosure is also far from sufficient to establish that magnesium would be necessarily present in the alleged crack portions of Shim's particle. Fey does not say that particles of the coating material are always or *necessarily* present in the crevices and cracks of a cathode material. Nor does Fey provide a general statement that *any coating material* (including non-MgAl₂O₄ coatings), deposited using *any process* must necessarily be present in the crevices and cracks of a PEAM particle. On the contrary, coatings with different chemistries frequently

result in different fracture behavior that would affect the likelihood that coating materials become ingrained in a crack portion. *See* Ex. 2003, 13. Indeed, the fracture behavior in PEAM particles is complex and can be affected by several factors. *Id.*, 19 (annotated Table 1). Therefore, a POSITA would not understand that Fey's conjecture regarding fracture behavior in a MgAl_2O_4 -coated PEAM particle (subject to very specific manufacturing processes and experimental conditions) would necessarily generalize to PEAM particles with other magnesium-based coatings (e.g., Shim's Mg diffused dopant or Lee's MgF_2 coating), resulting in the presence of magnesium in a crack portion.

Under Petitioner's *second theory* for why Shim discloses or renders obvious that the magnesium is present in a crack portion, Petitioner argues that since Shim discloses doping the bulk of the PEAM particle with magnesium, any crack portions of Shim's particle would necessarily contain magnesium. Pet., 53. Petitioner argues that since Shim discloses doping the bulk of the PEAM particle with magnesium, magnesium must therefore be "present throughout the entire particle," indicating that "crack portions of Shim's PEAM particle . . . necessarily contain magnesium." (Ex. 1003, ¶¶ 160–61; Pet., 53.) However, Shim does not mention crack portions in its PEAM particle whatsoever, and Shim certainly does not disclose crack portions observed from a TEM image. Ex. 2001, ¶ 80.

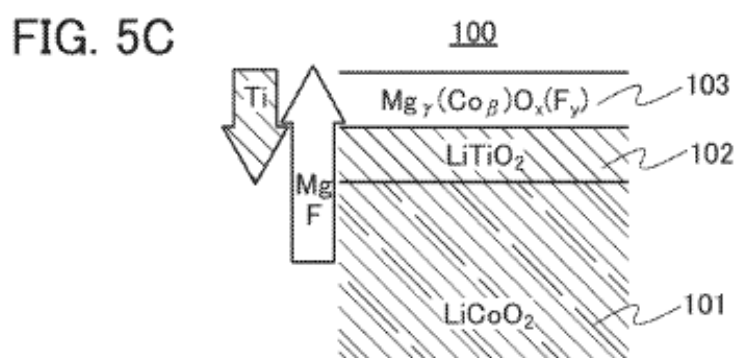
Moreover, the Petition fails to explain how the mere doping of the bulk of a PEAM particle would render its presence in a crack portion observed from a TEM image obvious in the context of the '828 Patent. *Id.*, ¶ 81. Recall that the '828 Patent describes that a particle 110 can include magnesium and fluorine throughout an internal region 111. Ex. 1001, 22:9–16, Fig. 5A (reproduced below).



Ex. 1001, Fig. 5A

However, the '828 Patent does ***not*** consider this distribution of magnesium and fluorine throughout the particle 110 to constitute the presence of magnesium or fluorine in a crack portion. Rather, the '828 Patent discloses that the representative element (in this example, magnesium) is “in the vicinity of crystal defects” (*id.*, 24:11–23) or “in the crack portion” (*id.*, 24:24–27) ***after the magnesium (and fluorine) is segregated through heating*** (*id.*). See also *id.*, 22:9–54; *id.*, FIG. 5C (reproduced below) (showing how the third region 103 is formed on a surface region of the particle 110 through the segregation of the magnesium and fluorine

by heating at 800°C for two hours); *id.*, 9:47–60 (stating that “the third region 103 may be present in a portion which includes crystal defects or a crack portion in the positive electrode active material 100”). Accordingly, Petitioner’s theory that the mere doping of magnesium in the bulk of the PEAM particle would make it present in a crack portion is wrong and inconsistent with the disclosure of the ’828 Patent.



Ex. 1001, Fig. 5C

For at least these additional reasons, the Petition is deficient for failing to show how Shim renders obvious “the representative element . . . present in a crack portion observed from a TEM image.”

3. **The Petition Fails to Show that Shim Alone or in Combination with Lee Renders Obvious a Representative Element and Fluorine Present in a Portion Which Includes Crystal Defects Observed from a TEM Image (Claim 5)**

While independent claim 1 of the '828 Patent recites that the representative element and the fluorine are present in a “crack portion,” independent claim 5 recites that the representative element and the fluorine are present in a “portion which includes crystal defects.” Ex. 2001, ¶ 82. Petitioner attempts to address this claim limitation by arguing (i) that “cracks are a type of crystal defect,” (ii) that a crack portion “necessarily includes crystal defects,” and (iii) that Shim’s disclosure of oxygen loss from the lattice structure and reactions between the lattice and the electrolytes are examples of crystal defects. Pet., 57–59. However, Petitioner does not provide any separate reasons that the claimed “representative element” or “fluorine” would be present in a portion which include crystal defects *as distinct* from being present in a crack portion. Ex. 2001, ¶ 83. Therefore, assuming—as Petitioner asserts—that cracks and crystal defects can be conflated, Ground 1 is deficient with respect to independent claim 5 for at least the same reasons that Shim alone or in combination with Lee does not render obvious that the

representative element and the fluorine are present in a crack portion (as recited in claim 1). *See supra* Sections VI.A.1 and VI.A.2; Ex. 2001, ¶ 84.⁵

B. Ground 4 is Deficient for Failing to Show that Fujiki Renders Obvious that “the Representative Element and the Fluorine are Present in a Crack Portion [or a Portion Which Includes Crystal Defects] Observed from a TEM Image”

Ground 4 is deficient for several reasons similar to those discussed above in relation to Ground 1. Ex. 2001, ¶ 85. First, for example, and with respect to independent claim 1, the Petition fails to show that Fujiki renders obvious *fluorine* present in a crack portion observed from a TEM image. Second, with respect to claim 1, the Petition fails to show that Fujiki renders obvious *the representative element* (e.g., magnesium) present in a crack portion observed from a TEM image. Third, with respect to independent claim 5, the Petition fails to show that Fujiki renders obvious the representative element and fluorine present *in a portion which*

⁵ Patent Owner does not concede that a “crack portion” can be conflated with a portion which includes crystal defects,” and, as mentioned above, Patent Owner reserves all rights to propose constructions at a later time in this and other proceeding(s) involving the ’828 Patent.

includes crystal defects observed from a TEM image. Each of these deficiencies is explained in further detail below.

1. The Petition Fails to Show that Fujiki Renders Obvious Fluorine Present in a Crack Portion Observed from a TEM Image (Claim 1)

a. Fujiki is Deficient

The Petition asserts that since Fujiki renders obvious a fluorine-containing coating, a POSITA would have understood that fluorine would likewise be found in crack portions. Pet., 76; Ex. 2001, ¶ 86. As noted above in Section III.C, Fujiki never discusses a crack or a crack portion—let alone fluorine being present in a crack portion—and the Petition’s attempts to rectify these deficiencies fail for substantially the same reasons discussed above in Ground 1. *Id.*, ¶ 87. Petitioner cannot be said to have demonstrated a reasonable likelihood of prevailing on the obviousness allegations against the challenged claims when key claim features are entirely absent from the teachings of the relied upon alleged prior art. *Id.*

b. The Petition’s Improper Reliance on Fey Fails to Cure the Deficiencies in Fujiki

Just as in Ground 1, Petitioner attempts to skirt around the deficiencies of Fujiki through reliance on Fey (Ex. 1016, 4)—a reference that is not formally part of either Grounds 1 or 4. *See* Pet., 76. But Fey still does not cure the deficiencies of Fujiki. Ex. 2001, ¶¶ 88–94. As described above, Fey describes experiments

performed on a cathode material comprising LiCoO_2 coated with MgAl_2O_4 —*a coating that does not include any fluorine*—and merely speculates that an applied cycling process “could have” enabled particles of the MgAl_2O_4 coating material to “become ingrained in the crevices and cracks on the cathode surface.” Ex. 1016, 4. Fey never discusses *fluorine* being present in a crack portion of a PEAM particle, nor does Fey address whether a fluorine-containing coating would behave similarly to a MgAl_2O_4 coating. Indeed, nothing in Fey even shows its own *MgAl_2O_4 coating* is actually present in a crack portion; Fey only hypothesizes this possible phenomenon as a potential explanation for the specific results of Fey’s cyclic voltammetric experiment. *Id.* (“In the case of the coated cathodes, changes in the surface texture resulting from the contraction and expansion of the lattice during the cycling process *could have* enabled the particles of the coating material to become ingrained in the crevices and cracks on the cathode surface.”) (emphasis added).

Despite the gaps in Fey, the Petition nonetheless relies on testimony from Dr. Hayes that extrapolates from the comments made in Fey and the alleged crack portion shown in Fig. 2(b) of Shim to assert that “fluorine in Fujiki’s coating would be present in the crack portions because coating materials were known to become lodged inside such cracks.” Pet., 76; Ex. 1003, ¶ 238. However, Dr.

Hayes's assertion is entirely conclusory and never addresses at all how differences in coating materials might affect their ability to become ingrained in crack portions of a PEAM particle. Nor does Dr. Hayes's assertion address the fact that Fey itself only speculates as to the ingrainings of MgAl_2O_4 in crevices and cracks. Petitioner provides *no evidence* to support why a POSITA would expect a fluorine-containing coating material to behave similarly to coatings having different chemistries such as MgAl_2O_4 , and therefore fails to establish even a *prima facie* case of obviousness. In fact, Petitioner's position substantially oversimplifies the materials science involved in the prior art devices and obscures many of the real-world complexities that would preclude a POSITA from reasonably expecting fluorine-containing coatings to behave similarly to other coating materials such as MgAl_2O_4 . Ex. 2001, ¶¶ 88–94.

First, the Petition fails to address complexities in the formation of fractures in PEAM particles that would affect whether a particular coating material becomes ingrained in crack portions of the cathode surface. It is well-established that the composition of PEAM particles can substantially influence the formation of cracks in a cathode surface. *See* Ex. 2003, 13 (describing how the composition of electrode materials can affect the fracture of battery materials, for example, influencing the abundance and severity of cracks in the particle). Even if one were

to consider Petitioner's position that "Shim's PEAM degradation caused by cycling . . . refers to cracks" (Pet., 51 (citing Ex. 1005, 1)),⁶ Petitioner's analysis is flawed because it fails to address that the susceptibility of PEAMs to cracking is dependent on a range of factors including "[p]article size, material composition, pre-existing defects, state-of-charge heterogeneity, cycling time, cutoff voltage, [and] temperature." Ex. 2003, 19 (annotated Table 1). Therefore, unlike Petitioner and Dr. Hayes, a POSITA would not automatically assume from Fey's conjecture regarding MgAl_2O_4 possibly becoming ingrained in crevices and cracks of Fey's cathode that fluorine-containing PEAM particles would behave similarly in Fujiki. Ex. 2001, ¶ 93. Petitioner's failure to recognize or address any of these differences amounts to a gross over-simplification of the technical field and is a far cry from the particularized analysis that the Board requires for institution. There is simply no evidence available to support the range of assumptions and logical inferences underlying Petitioner's reliance on Fey.

Second, a POSITA would have known that different coating materials can have meaningfully different properties that would impact their ability to become

⁶ See *supra* note 3.

ingrained in crevices and cracks. *See e.g.*, Ex. 2004, 2–5 (describing many coating materials for cathode materials, including their different properties, different coating processes, and mechanisms of action); Ex. 2005, Table 2 (showing that even coatings made of the same elements in different ratios such as $\text{Li}_4\text{Ti}_5\text{O}_{12}$ and $\text{Li}_2\text{Ti}_2\text{O}_5$ can have different properties); Ex. 1005, 8 (showing, once again, that coatings made of the same elements in different ratios such as Li_2TiO_3 and $\text{Li}_4\text{Ti}_5\text{O}_{12}$ can have different properties, with $\text{Li}_4\text{Ti}_5\text{O}_{12}$ showing “much better electrochemical performances as a coating material” due to “its excellent stability during charging/discharging”); Ex. 2006, Table 1 (showing different properties between fluoride coatings such as AlF_3 and oxide coatings such as Al_2O_3); Ex. 2007, 1–2 (demonstrating different properties for metal oxide and metal fluoride coatings and noting that “comparison of different coating chemistries on LCO across literature is not quite straight forward due to variations in parent material preparation method, coating method, coating thickness, differences in particle size, differences in rates tested, etc.”). Given these many known differences between coatings of different chemical compositions, Dr. Hayes’s conclusory assertion that a POSITA would expect a fluorine-containing coating material to behave similarly to coatings having different chemistries such as Fey’s MgAl_2O_4 coating is unsupported. In fact, Dr. Lucht suggests that the opposite would be true due to

differences in even basic chemical properties such as electronegativity profiles, which can affect how these coatings react and move in identical settings. Ex. 2001, ¶ 94.

In view of all the foregoing considerations, Petitioner's oversimplified and unsupported assertion that a POSITA would understand Fujiki's fluorine-containing coating to behave similarly to, for example, Fey's MgAl_2O_4 coating simply does not pass muster. The Petition has not even established a *prima facie* case of obviousness due to this lack of evidence, and it certainly has not met Petitioner's burden of demonstrating a reasonable likelihood of prevailing on the obviousness allegations.

c. The Petition Fails to Demonstrate Inherency, or Even that the Fluorine Present in a Crack Portion Would be Predictable in any PEAM Particle Based on Fujiki

Absent any express disclosure from Fujiki (or Fey) that fluorine would be present in a crack portion of a PEAM particle, at best, the Petition can be understood as making the argument that such features are inherent in the alleged prior art. Not so. The evidence in fact demonstrates that fluorine would not necessarily be in crack portions in the prior art devices, and a POSITA would not reasonably have expected this outcome. Ex. 2001, ¶¶ 95–97.

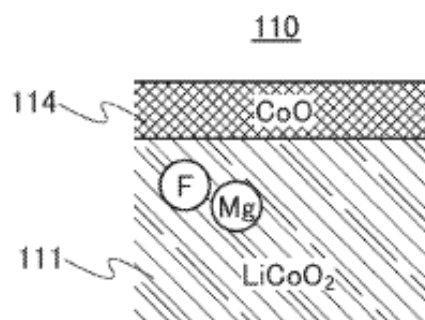
For similar reasons as discussed above (*see supra* Section VI.B.1.b), Fey's limited disclosure is far from sufficient to establish that fluorine would be necessarily present in crack portions of Fujiki's particle (which Petitioner assumes exist). Fey does not say that particles of the coating material are always or ***necessarily*** present in the crevices and cracks of a cathode material. Nor is the statement in Fey a general statement that ***any coating material***, deposited using ***any process*** must necessarily be present in the crevices and cracks. On the contrary, as noted above, the fracture behavior in PEAMs is quite complex and can be affected by a range of factors including "[p]article size, material composition, pre-existing defects, state-of-charge heterogeneity, cycling time, cutoff voltage, [and] temperature." Ex. 2003, 19. Accordingly, a POSITA would not have understood that Fey's speculation about fracture behavior in a non-fluorine-containing MgAl_2O_4 -coated PEAM particle (subject to very specific manufacturing processes and experimental conditions) would ***necessarily*** generalize to fluorine-containing PEAM particles and result in the presence of fluorine in a crack portion. Ex. 2001, ¶¶ 95–97. For this reason, not even inherency cannot be relied upon to save Petitioner from the deficiencies in the disclosure of Fujiki.

2. The Petition Fails to Show that Fujiki Renders Obvious a Representative Element Present in a Crack Portion Observed from a TEM Image (Claim 1)

With respect to the claimed “representative element,” Petitioner uses magnesium as an example of the representative element and points out that Fujiki discloses that “metallic element M1” can be magnesium and is “present throughout the particle—from the surface to the interior.” Pet., 75; Ex. 2001, ¶ 98. Petitioner then argues that based on the distribution of magnesium throughout Fujiki’s PEAM particle, a POSITA would understand that crack portions of Fujiki’s PEAM particle would contain magnesium. Pet., 76. However, Fujiki does not mention crack portions in its PEAM particle whatsoever (*see supra* Section III.C), and Fujiki certainly does not disclose crack portions observed from a TEM image. Ex. 2001, ¶ 99.

Moreover, the Petition fails to explain how the mere diffusion of magnesium throughout Fujiki’s PEAM particle would—in the context of the ’828 Patent—render obvious the presence of magnesium in a crack portion observed from a TEM image. *Id.*, ¶¶ 98–100. Similarly to Fujiki, the ’828 Patent describes that a particle 110 can include magnesium and fluorine throughout an internal region 111. Ex. 1001, 22:9–16, Fig. 5A (reproduced below).

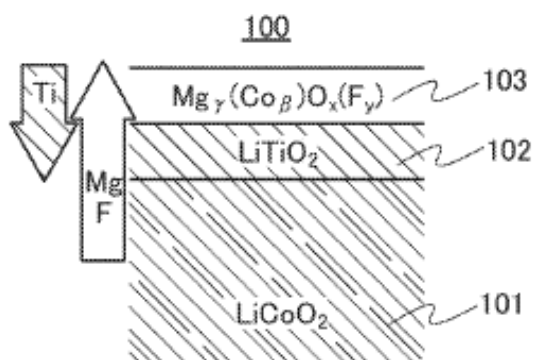
FIG. 5A



Ex. 1001, Fig. 5A

However, the '828 Patent does ***not*** consider this distribution of magnesium and fluorine throughout the particle 110 to constitute the presence of magnesium or fluorine in a crack portion. Rather, the '828 Patent discloses that the representative element (in this example, magnesium) is “in the vicinity of crystal defects” (*id.*, 24:11–23) or “in the crack portion” (*id.*, 24:24–27) ***after the magnesium (and fluorine) is segregated through heating*** (*id.*). See also *id.*, 22:9–54; *id.*, FIG. 5C (reproduced below) (showing how the third region 103 is formed on a surface region of the particle 110 through the segregation of the magnesium and fluorine by heating at 800°C for two hours); *id.*, 9:47–60 (stating that “the third region 103 may be present in a portion which includes crystal defects or a crack portion in the positive electrode active material 100”). Petitioner’s theory of obviousness is therefore inconsistent with the disclosure of the '828 Patent.

FIG. 5C



Ex. 1001, Fig. 5C

For at least these additional reasons, the Petition is deficient for failing to show how Fujiki renders obvious “the representative element . . . present in a crack portion observed from a TEM image.” Ex. 2001, ¶¶ 98–100.

3. The Petition Fails to Show that Fujiki Renders Obvious a Representative Element and Fluorine Present in a Portion Which Includes Crystal Defects Observed from a TEM Image (Claim 5)

While independent claim 1 of the '828 Patent recites that the representative element and the fluorine are present in a “crack portion,” independent claim 5 recites that the representative element and the fluorine are present in a “portion which includes crystal defects.” Petitioner attempts to address this claim limitation by arguing (i) that a crack portion is simply “an example of a crystal defect” and (ii) that since Fujiki renders obvious a crack portion observed from a TEM image, it likewise renders obvious a crystal defect observed from a TEM image. Pet., 78–

79. Petitioner also argues that since Fujiki discloses that metallic element M2 has the function of stabilizing the crystal structure of the compound oxide particles at the time of charging, Fujiki “recognized that defects occur in the crystal structure of LiCoO₂.” *Id.*, 79.

Just as in Ground 1, here, Petitioner does not provide any separate reasons that the claimed “representative element” or “fluorine” would be present in a portion which include crystal defects *as distinct* from being present in a crack portion. Therefore, assuming—as Petitioner asserts—that cracks and crystal defects can be conflated, Ground 4 would be deficient with respect to independent claim 5 for at least the same reasons that Fujiki does not render obvious that the representative element and the fluorine are present in a crack portion (as recited in claim 1). Ex. 2001, ¶¶ 101–103; *see supra* Sections VI.B.1 and VI.B.2.⁷

VII. THE PETITION SHOULD BE DENIED FOR FAILING TO PROVIDE SUFFICIENT EVIDENCE TO ESTABLISH THAT SHIM, LEE, AND YU ARE PRIOR ART PRINTED PUBLICATIONS

Institution should be denied for the additional reason that Petitioner has failed to meet its required burden of showing that each of Shim, Lee, and Yu

⁷ *See supra* note 5.

qualify as prior art printed publications that were publicly accessible before the critical date of the '828 Patent.

A. Petitioner Must Identify, *With Particularity*, Evidence Sufficient to Establish a Reasonable Likelihood that Each Reference was Publicly Accessible Before the Critical Date of the '828 Patent.

“There is no presumption in favor of finding a reference to be a ‘printed publication,’” and “the burden is on the petitioner” to meet the evidentiary standard for determining whether a reference is a printed publication. *Hulu, LLC v. Sound View Innovations, LLC*, IPR2018-01039, Paper 29 at 16 (PTAB Dec. 20, 2019) (precedential). More specifically, *Hulu* explains that “at the institution stage, the petition must identify, with particularity, evidence sufficient to establish a reasonable likelihood that the reference was publicly accessible before the critical date of the challenged patent and therefore that there is a reasonable likelihood that it qualifies as a printed publication.” *Id.*, 13. The standard articulated in *Hulu* stems directly from the statutory requirement for “the *petition* [to] identif[y], *in writing and with particularity*, . . . *the evidence* that supports the grounds for the challenge to each claim[]” 35 U.S.C. § 312(a).

For the reasons discussed in further detail below, the Petition fails to address any evidence—let alone with particularity—showing that Shim, Lee, or Yu were

publicly accessible before the critical date. The Petition thus falls plainly short of the standard required by *Hulu* and § 312(a), and institution should be denied.

B. Petitioner Fails to Meet its Burden under *Hulu* of Demonstrating “With Particularity” that Shim, Lee, and Yu Were Publicly Accessible Before the Critical Date of the ’828 patent.

Here, the Petition contains no more than a bare assertion of assumed publication dates of Shim, Lee, and Yu (Pet., 10–11) that allegedly qualify these references as prior art, but the Petition includes no reasoning or discussion of evidence in support of these assertions. This approach directly contradicts the Board’s instruction in *Hulu*, which requires *the Petition* to identify “*with particularity*” evidence sufficient to establish a reasonable likelihood that each reference was publicly accessible before the critical date of the ’828 patent. A bare assertion of a publication date without more is insufficient on its face to satisfy the standard set forth in *Hulu*.

Petitioner appears to cite the Babbitt declaration (Ex. 1033) to support the alleged publication dates of Shim, Lee, and Yu, but the Babbitt declaration is never discussed in the Petition itself, and the citation thus amounts to an improper incorporation by reference of discussion that would otherwise circumvent the Petition’s word count limit. In any event, the substance of the Babbitt declaration is deficient for failing to address the legal requirements of public accessibility as

set forth in *Hulu*. Babbitt merely states that Exhibits 1005, 1006, and 1007 are “true and correct cop[ies]” of Shim, Lee, and Yu respectively—which might speak to authentication but not to the relevant issue of public accessibility—and then simply parrots the publication date listed in each obtained record. In *Hulu*, the Board did not hold that any particular indicia on the face of the reference *per se* is sufficient at the institution stage, *id.* at 17, so Petitioner’s sole reliance on a purported publication date is clearly insufficient. Moreover, in *Axis Commc’ns AB v. Avigilon Fortress Corp.*, IPR2019-00235, Paper 24, 16 (PTAB Jul. 26, 2020) (denying institution), the Board found that it need not even **consider** indicia on the face of a reference in cases where—like here—the Petition merely states a purported publication date without presenting any arguments that other indicia on the face of the reference is evidence of publication. Petitioner’s failure to point out or establish the meaning of such indicia, including the “available online” date on the face of Shim, Lee, and Yu is therefore a procedural deficiency that is grounds for denial of institution.

Babbitt offers no evidence that the dates listed at the URLs linked in the declaration refer to dates that the papers were made available to the public. Babbitt likewise offers no evidence that an ordinary searcher would have been able to locate the references by the alleged dates, and no evidence that the references were

actually disseminated to the public before the critical date of the '828 patent. In fact, Babbitt, as an employee of Petitioner's law firm, is not in an impartial position to even proffer such evidence. For example, in *Jiangsu Sainty Sumex Tools Corp. Ltd. v. Milwaukee Electric Tool Corp.*, IPR2021-00373, Paper 19, 14 (PTAB Jul. 6, 2021) (denying institution), the Board found that the *Hulu* standard had not been met by Petitioner's technical witnesses "corroborat[ing] their testimony about the publication dates [of website pages] by simply accepting certain dates . . . that appear on [the] website pages allegedly captured by themselves from "the 'Wayback Machine'" internet archive." Instead, the Board suggested that the Petitioner in *Jiangsu Sainty Sumex* should have presented persuasive evidence such as "sworn testimony from the Office Manager and Custodian of records at the Internet Archive" to confirm the proffered publication dates of the allegedly captured documents. *Id.* Similarly, in *Adam Agan Ltd. v. Bayer Cropscience LP*, PGR2022-00057, Paper 9, 31–32 (PTAB Feb. 13, 2023) (denying institution), the Board found that relying on a "dc.date.avalable" (*sic*) indicia for the publication date of a dissertation was insufficient "[w]ithout any additional evidence such as testimonial evidence from someone with knowledge about what this electronic record means in terms of the public accessibility of the reference." Here, the Petition is deficient for analogous reasons. The *Hulu* standard

has not been met by Petitioner's mere proffering of purported publication dates that appear on retrieved online records without any additional evidence about their validity or the public accessibility of the relevant art. For at least this reason, the Petition should be denied institution.

VIII. THE PETITION SHOULD BE DENIED UNDER 35 U.S.C. § 325(d) FOR RELYING ON PREVIOUSLY CONSIDERED PRIOR ART AND ARGUMENTS

A. Legal Standard

35 U.S.C. § 325(d) states that, in determining whether to institute an IPR, “the Director may take into account whether, and reject the [IPR] petition or request because, the same or substantially the same prior art or arguments previously were presented to the Office.” In *Advanced Bionics, LLC v. MED-EL Elektromedizinische Geräte GmbH*, IPR2019-01469, Paper 6, 7 (Feb. 13, 2020) (precedential), the PTAB established a “two-part framework” for determining whether § 325(d) applies: “(1) whether the same or substantially the same art previously was presented to the [Patent] Office or whether the same or substantially the same arguments previously were presented to the Office; and (2) if either condition of first part of the framework is satisfied, whether the [IPR] petitioner has demonstrated that the Office erred in a manner material to the patentability of challenged claims.” *Id.*, 8. According to *Advanced Bionics*, “[i]f a

condition in the first part of the framework is satisfied and the petitioner fails to make a showing of material error, the Director generally will exercise discretion not to institute inter partes review. If reasonable minds can disagree regarding the purported treatment of the art or arguments, it cannot be said that the Office erred in a manner material to patentability.” *Id.*, 8–9.

B. Shim was Presented to the Patent Office in an Information Disclosure Statement (IDS) and the Office Did Not Err in a Manner Material to Patentability.

Ground 1 relies on Shim alone or in combination with Lee. However, Shim was cited in an IDS submitted to the Patent Office on June 19, 2020. This IDS was signed by Examiner Sean P. Cullen, Ph.D., with a “Date Considered” date of June 22, 2020. Therefore, Shim satisfies the first part of the *Advanced Bionics* framework for determining whether § 325(d) applies. The same art that Petitioner now raises was already presented to the Patent Office.

The Examiner did not err in allowing the application that issued as the ’828 Patent over Shim. For all of the reasons against Ground 1 provided above, it is evident that Shim fails to disclose or render obvious any claim of the ’828 Patent. Therefore, according to the PTAB in *Advanced Bionics*, “it *cannot* be said that the Office erred in a manner material to patentability.” *Id.*, 9. Since Shim satisfies the

two-part *Advanced Bionics* framework, it would be appropriate for the Director to exercise discretion to deny institution for Ground 1.

C. Shim, Lee, and Fujiki are Merely Cumulative to Liu (CN 102610806), Which Was Considered by the Examiner and Identified as “the Closest Prior Art of Record”

Grounds 1 and 4 rely on Shim, Lee, and Fujiki. However, in the prosecution history of the '828 Patent, the Examiner considered prior art that was substantially similar to Shim, Lee, and Fujiki, and the Petitioner has not sufficiently shown that the Office erred in a manner material to the patentability of the challenged claims. Indeed, the Petition does not address Liu at all.

In the Notice of Allowability dated May 20, 2020, the Examiner cited Liu (CN 102610806A) (Ex. 1019) as “[t]he closest prior art of record,” and noted that “Liu discloses a lithium-ion secondary battery, comprising a positive electrode active material layer comprising a positive active material particle comprising a first transition metal, a second transition metal, a representative element, and fluorine.” Ex. 1002, 1346–47. In particular, Liu discloses a method for obtaining a positive electrode active material with a chemical composition of $\text{Li}_{1.01} \text{Co}_{0.99} \text{Mg}_{0.005} \text{Al}_{0.005} \text{Ti}_{0.01} \text{O}_{1.995} \text{F}_{0.005}$ (Ex. 1019, 11), which reads onto the “first transition metal” (e.g., Co), the “second transition metal” (e.g., Ti), the “representative element” (e.g., Mg), and “fluorine.” Thus, to the extent that Shim, Lee, and Fujiki

are relied upon to disclose the “first transition metal,” “second transition metal,” “representative element,” and “fluorine,” these references are merely cumulative to Liu, which was specifically addressed in the Examiner’s reasons for allowance. Liu also discloses coatings for PEAM particles and the known benefits of such coatings, for example, for improving cycle performance. *See, e.g.*, Ex. 1019, 6–7 (“A large number of documents have reported that the coating can inhibit the lattice expansion to a certain extent, therefore, the coated LiCoO_2 has better cycle performance at 4.45 or less . . .”). Thus, to the extent that Shim, Lee, and Fujiki are relied upon to disclose coating layers and their benefits, these references are still merely cumulative to Liu. Indeed, Shim, Lee, and Fujiki (as well as Fey) do not disclose anything material to the patentability of the ’828 Patent claims that is not merely cumulative to what is disclosed in Liu.

The Examiner found that Liu did not disclose “a positive electrode active material particle comprising a representative element and fluorine present in a portion that include [*sic*] crystal defects or a crack portion in the positive electrode active material particle.” (Ex. 1002, 1346–47.) Although Petitioner argues that Shim, Lee, and Fujiki disclose or render obvious these additional features, it is important to note that, like Liu, none of these references *explicitly* discloses these features. Instead, as described above, the Petitioner’s arguments with respect to the

foregoing features focus on what the Petitioner alleges a POSITA would *implicitly* understand based upon the disclosures of Shim, Lee, and Fujiki. What this ultimately amounts to is Petitioner either (i) implicitly arguing that the missing limitations are inherent in Shim, Lee, and Fujiki without satisfying the legal requirements for inherency or (ii) attempting to shoehorn in the disclosures of additional corroborating references such as Fey (Ex. 1016) that were not properly included in the grounds. Examination of the actual disclosures of Shim, Lee, and Fujiki, reveals that their disclosures are substantially the same as Liu, and therefore suffer from the same deficiencies. Thus, Shim, Lee, and Fujiki are merely cumulative to art already considered by the Office, satisfying the first part of the *Advanced Bionics* framework.

The Petitioner also failed to carry its burden of identifying any error in the Examiner's allowance of the '828 Patent over Liu, as required by the second prong of the *Advanced Bionics* framework. Therefore, it would be appropriate for the Director to exercise discretion to deny institution for Grounds 1 and 4.

IX. CONCLUSION

Petitioner has failed to demonstrate a reasonable likelihood of prevailing against at least one Challenged Claim in any of Grounds 1-6. The Board should decline to institute *inter partes* review.

Respectfully submitted,

Date: September 15, 2023

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CERTIFICATION UNDER 37 CFR § 42.24(d)

Under the provisions of 37 CFR § 42.24(d), the undersigned hereby certifies that the word count for the foregoing Patent Owner's Preliminary Response to Petition totals 12,356, which is less than the 14,000 allowed under 37 CFR § 42.24(b)(1).

Respectfully submitted,

Date: September 15, 2023

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CERTIFICATION OF SERVICE

Pursuant to 37 CFR § 42.6(e), the undersigned certifies that on September 15, 2023, a complete and entire copy of this Patent Owner's Preliminary Response were provided via email to the Petitioner by serving the correspondence address of record as follows:

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