

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 IPR2023-01349
Patent No. 11,043,660

PATENT OWNER'S PRELIMINARY RESPONSE

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PATENT OWNER'S EXHIBIT LIST

EXHIBIT-2001	Declaration of Dr. Brett Lucht
EXHIBIT-2002	<i>Curriculum Vitae</i> of Dr. Brett Lucht
EXHIBIT-2003	Glinski et al., <i>Catalytic Activity of High-Surface-Area Amorphous MgO Obtained from Upsalite</i> , Catalysts, 11, 1338 MDPI (2021)
EXHIBIT-2004	Zhang et al., <i>Oxygen Loss in Layered Oxide Cathodes for Li-Ion Batteries: Mechanisms, Effects, and Migration</i> , ACS Chemical Reviews, 2021
EXHIBIT-2005	He et al., <i>The intrinsic behavior of lithium fluoride in solid electrolyte interphases on lithium</i> , PNAS, Vol. 117 (1) 73-79, Jan. 7, 2020
EXHIBIT-2006	Xu et al., <i>Lithium transport through lithium-ion battery cathode coatings</i> , J. Mater. Chem. A. 3, 17248–72 (2015)
EXHIBIT-2007	Chauque et al., <i>Lithium titanate as anode material for lithium ion batteries: Synthesis, posttreatment and its electrochemical response</i> , J. of Electroanalytical Chem., 799 (2017) 142-155
EXHIBIT-2008	Ahaliabadeh et al., <i>Extensive comparison of doping and coating strategies for Ni-rich positive electrode materials</i> , J. Power Sources 540, 1–23 (2022)
EXHIBIT-2009	Zhu et al., <i>Epitaxial growth of an atom-thin layer on a $\text{LiNi}_{0.5}\text{Mn}_{1.5}\text{O}_4$ cathode for stable Li-ion battery cycling</i> , 13 Nature Comm'n. 13:1565 (2022)
EXHIBIT-2010	Pagani et al., <i>Epitaxial Thin Films as a Model System for Li-Ion Conductivity in $\text{Li}_4\text{Ti}_5\text{O}_{12}$</i> , ACS Appl. Mater. Interfaces, 10, 44494–44500 (2018)
EXHIBIT-2011	International Publication No. WO2010/139404 (“Ellenwood”)

- EXHIBIT-2012 Lettieri et al., *Critical issues in the heteroepitaxial growth of alkaline-earth oxides on silicon*, 20 J. Vacuum Sci. Tech. A, 20, 1332 (2002)
- EXHIBIT-2013 Shim et al., *Effects of MgO Coating on the Structural and Electrochemical Characteristics of LiCoO₂ as Cathode Materials for Lithium Ion Battery*, 26 Chem. Mater. 2537-2543 (2014) (“Shim 3”)
- EXHIBIT-2014 U.S. Patent No. 6,514,640 to Armand et al.
- EXHIBIT-2015 U.S. Patent No. 9,871,246 to Kim et al.
- EXHIBIT-2016 RESERVED
- EXHIBIT-2017 Guo et al., *Ultra-low voltage control of magnetic properties in amorphous MgO*, 111 Appl. Phys. Lett. 192402 (2017)
- EXHIBIT-2018 U.S. Publication No. 2012/0258358 (“Yura”)
- EXHIBIT-2019 Shim et al., *Characterization of Spinel Li_xCo₂O₄-Coated LiCoO₂ Prepared with Post-Thermal Treatment as a Cathode Material for Lithium Ion Batteries*, 27 Chem. Mater. 27, 3273-3279 (2015)
- EXHIBIT-2020 Ohring et al., *Chapter 8: Epitaxy*, in “Materials Science of Thin Films, Deposition and Structure,” 2nd Edition, 419-494 (2002)
- EXHIBIT-2021 Pohler et al., *Seed layer stimulated growth of crystalline high Al containing (Al,Cr)₂O₃ coatings deposited by cathodic arc evaporation*, Thin Solid Films 550, 95-104 (2014)

CLAIM LISTING

Limitation	Claim Language
[1pre]	A lithium-ion secondary battery comprising
[1.1]	...a positive electrode, the positive electrode comprising a positive electrode active material particle comprising lithium cobaltate,
[1.2]	...wherein the positive electrode active material particle comprises a first region and a second region,
[1.3]	...wherein the first region comprises a layered rock-salt crystal structure,
[1.4]	...wherein the second region comprises a rock-salt crystal structure,
[1.5]	...wherein the second region covers at least a first part of the first region,
[1.6]	...wherein the positive electrode active material particle comprises titanium, magnesium, fluorine, and oxygen in the second region, and
[1.7]	...wherein a crystal orientation of at least a second part of the first region and a crystal orientation of at least a part of the second region are substantially aligned with each other.
[2]	The lithium-ion secondary battery according to claim 1, wherein the titanium, the magnesium, the fluorine, and the oxygen are provided in a range from the surface of the positive electrode active material particle to a depth of 5 nm.
[3.1]	The lithium-ion secondary battery according to claim 1, wherein the positive electrode further comprises a conductive additive, and
[3.2]	...wherein the conductive additive comprises carbon fiber, graphene or multilayer graphene.
[4]	The lithium-ion secondary battery according to claim 1, wherein a relative value of a concentration of the titanium is greater than or equal to 0.05 and less than or equal to 0.4 when the surface of the positive electrode active material particle is subjected to an XPS analysis and a concentration of cobalt is defined as 1.

Limitation	Claim Language
[5]	The lithium-ion secondary battery according to claim 1, wherein a relative value of a concentration of the magnesium is greater than or equal to 0.4 and less than or equal to 1.5 when the surface of the positive electrode active material particle is subjected to an XPS analysis and a concentration of cobalt is defined as 1.
[6pre]	A lithium-ion secondary battery comprising
[6.1]	... a positive electrode, the positive electrode comprising a positive electrode active material particle comprising lithium cobaltate,
[6.2]	... wherein the positive electrode active material particle comprises a first region and a second region,
[6.3]	... wherein the first region comprises a layered rock-salt crystal structure,
[6.4]	... wherein the second region comprises a rock-salt crystal structure,
[6.5]	... wherein the positive electrode active material particle comprises titanium, magnesium, fluorine, and oxygen in the second region,
[6.6]	... wherein the second region extends from a surface of the positive electrode active material particle to an inside of the positive electrode active material particle where magnesium detected by a line analysis of energy dispersive X-ray spectroscopy (EDX) in a depth direction is $\frac{1}{5}$ of a maximum peak of the magnesium in the line analysis, and
[6.7]	... wherein a crystal orientation of at least a part of the first region and a crystal orientation of at least a part of the second region are substantially aligned with each other.
[7]	The lithium-ion secondary battery according to claim 6, wherein the titanium, the magnesium, the fluorine, and the oxygen are provided in a range from the surface of the positive electrode active material particle to a depth of 5 nm.
[8.1]	The lithium-ion secondary battery according to claim 6, wherein the positive electrode further comprises a conductive additive, and
[8.2]	wherein the conductive additive comprises carbon fiber, graphene or multilayer graphene.

Limitation	Claim Language
[9]	The lithium-ion secondary battery according to claim 6, wherein a relative value of a concentration of the titanium is greater than or equal to 0.05 and less than or equal to 0.4 when the surface of the positive electrode active material particle is subjected to an XPS analysis and a concentration of cobalt is defined as 1.
[10]	The lithium-ion secondary battery according to claim 6, wherein a relative value of a concentration of the magnesium is greater than or equal to 0.4 and less than or equal to 1.5 when the surface of the positive electrode active material particle is subjected to an XPS analysis and a concentration of cobalt is defined as 1.

I. INTRODUCTION

The Board should deny institution of the Petition for *Inter Partes* Review (“IPR”) of U.S. Patent No. 11,043,660 (“the ’660 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 a positive electrode active material (“PEAM”) particle with a “second region that comprises a rock-salt crystal structure,” (as recited in independent claims 1 and 6), that the second region “comprises titanium, magnesium, fluorine, and oxygen,” (claims 1, 6), that the crystal orientations of the first and second regions are substantially aligned with each other, (claims 1, 6), or that magnesium is detected by energy dispersive X-ray (EDX) spectroscopy to reach 1/5 of its maximum peak within the particle, (claim 6).

The Petition’s Ground I contentions are based on primary reference Blangero, i.e., a reference that admits outright that its surface layer has an “inhomogeneous composition” and that the “[a]uthors could not indisputably establish the chemical nature of the oxides formed at the surface,” and thus are left to “speculate” about the possible compounds on the surface. EX-1005, [0062]. To address the “rock-salt crystal structure” limitation, Petitioner nevertheless argues that Blangero’s surface has magnesium oxide (MgO), lithium fluoride (LiF), and/or lithium titanium oxide. But Blangero does not disclose any of these

compounds on the surface with any degree of certainty, let alone that, if present, each also has a rock-salt crystal structure, as opposed to an amorphous non-crystalline structure or a spinel structure. Petitioner attempts to combine Blangero with Shim, but provides no information on how these two different methods would or could be combined, let alone what the result of the combination would look like. Petitioner also ignores that Shim and Shim's progeny teach that the *spinel* structure is the more desirable crystal structure for a cathode coating. Having therefore failed to show the required crystal structures, Petitioner cannot show that the claimed substantial alignment of the crystal structure in the first and second region is present.

The Petition's Ground II prior art is likewise deficient. The Ground II contentions are based on primary reference Cho, a patent application, and secondary reference Kim, a scientific article underlying Cho and containing largely the same disclosures. All of the data in Cho and Kim is directed to an embodiment that contains lithium, nickel, cobalt, manganese, and oxygen; no magnesium, titanium, or fluorine is mentioned at all. To reach the magnesium and titanium limitations, Petitioner plucks these elements from a laundry list of compounds in Cho, without any motivation for why these two would be selected over the others, particularly over the manganese and nickel used in the examples. Worse yet, to

reach the fluorine limitation, the Petition relies on a theory of decomposition from the LiPF_6 electrolyte solution, ignoring that Cho's coating is specifically designed to **prevent** decomposition, which decreases the cathode's performance. Having failed to establish the presence of the required elements, Petitioner further fails to establish that, if these elements were present in Cho, that they would result in the claimed crystal structure or the claimed crystal alignment between the first and second regions. Finally, given the lack of magnesium in any of Cho's or Kim's examples, the Petition's argument that they somehow disclose the required magnesium distribution (decreasing to 1/5 of the peak concentration) in independent claim 6 is baseless, and contradicted by spectra demonstrating roughly constant distribution of metals within Cho's particles. Petitioner has not met its burden with respect to any independent claim of the '660 Patent.

Second, apart from the substantive deficiencies, Petitioner fails to meet its burden of demonstrating, **with particularity**, that Yamamoto (EX-1007) and Kim (EX-1009) are prior art printed publications that were publicly accessible before the critical date of the '660 Patent, and the Petition should be denied on that independent basis. The Petition should also be denied because it fails to identify its grounds with particularity, improperly relying on "and/or" language that results in at least fourteen different combinations being alleged in total. The Petition's

lack of clarity “deprives Patent Owner of a fair opportunity to respond fully to the Petition and does not lend itself to informed evaluation by the panel.” *Smith & Nephew, Inc. v. Conformis, Inc.*, IPR2017-00545, Paper 8, 12-13 (PTAB July 13, 2017) (denying institution).

Finally, institution should be denied since the Office has already considered prior art during original examination of the ’660 Patent that is substantially the same as the references that Petitioner now relies upon in all Grounds of the Petition. The Petition failed to identify any material error in the Examiner’s allowance of the ’660 Patent, and is thus deficient.

II. OVERVIEW OF THE ’660 PATENT

The ’660 Patent describes positive electrode active materials (PEAMs), which can be used, for example, in lithium-ion secondary batteries. *See* EX-1001, 2:15-35; EX-2001, ¶¶31-42. 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 degradation of the “charge and discharge characteristics” of the battery. EX-1001, 4:22-28. Previously, protective coating films were applied to

the PEAM surface to prevent this cracking and breaking. *Id.*, 4:29-31. These prior coating techniques, however, suffered from the drawback that they were not able to sufficiently protect all solvent-exposed surfaces of the PEAM. *See, e.g., id.*, 4:32-36.

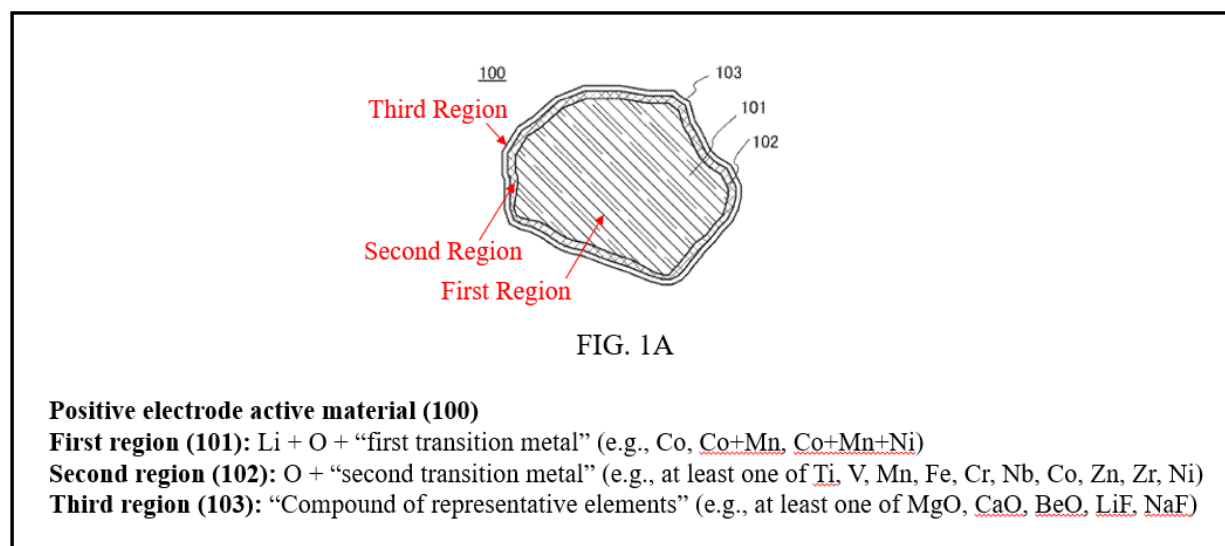
In view of these shortcomings, the inventors proposed novel protective layers that could be used in PEAM particles to mitigate deleterious effects of crack portions and crystal defects in the PEAM particle. EX-1001, 24:43-55. As an example of the approach proposed by the inventors, the '660 Patent discloses a PEAM particle having a first region, a second region, and a third region. *See id.*, 10:12-13:57. The first region 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.*, 10:24-26, 10:29-31. The first region “preferably has a layered rock-salt crystal structure.” *Id.*, 10:27-28. The second region 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.*, 11:6-16. The second region “preferably has a rock-salt crystal structure,” and “preferably has a crystal structure which is the same as that of the third region[.]” *Id.*, 11:22-

23, 11:59-61. The third region 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.*, 12:18-25. The third region—which can include fluorine and a representative element such as magnesium—is provided as an example of a protective layer of the PEAM particle. *See id.*, 12:28-32 (“[F]or the third region..., 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.*, 12:34-37 (“The positive electrode active material...includes the third region...in a superficial portion to improve stability in charging and discharging of the secondary battery.”); *see also id.*, Figs. 5C, 6D (showing that the third region includes fluorine and magnesium). The third region “preferably has a rock-salt crystal structure,” like the second region. *Id.*, 12:61-63.

The '660 Patent explains that “a state where structures of two-dimensional interfaces have similarity is referred to as ‘epitaxy,’” and “a state where three-dimensional structures have similarity or orientations are crystallographically the same is referred to as ‘topotaxy.’” EX-1001, 9:34-41. Topotaxy is observed when “orientations of crystals in two regions...are substantially aligned with each other.” *Id.*, 9:41-44. The '660 Patent describes that the second region is “preferably

formed by heteroepitaxial growth from the first region,” and the third region is “preferably formed by heteroepitaxial growth from the second region[.]” *Id.*, 13:59-62. The ’660 Patent explains that “[a] region formed by heteroepitaxial growth becomes topotaxy which has crystal orientations substantially three-dimensionally aligned with those of a region serving as a base,” meaning that “the first region... the second region... and the third region... can be topotaxy.” *Id.*, 13:62-67.

The different regions of the PEAM are summarized in annotated FIG. 1A:



EX-1001, Fig. 1A (annotated)

The formation, and hence presence, of a protective layer, such as the third region, yields protection where conventional coatings did not. EX-2001, ¶38. For example, Figs. 5A–5C and 6A–6D of the ’660 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. EX-1001, 10:49-53, 23:54-24:24, 27:20-28:37. As a protective layer, the third region “improve[s] stability in charging and discharging of the secondary battery.” *Id.*, 12:34-37. 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.*, 65:48-52.

III. OVERVIEW OF THE CITED REFERENCES

A. Blangero

Blangero is a published patent application directed to a “cathode material having a high packing density, a high rate performance, improved discharge capacity and showing high stability during extended cycling at high charge voltage.” EX-1005, [0059]; EX-2001, ¶¶43-49. Blangero states that a need existed in the art for “high capacity LiCoO_2 based cathodes which can be cycled in a stable manner in real cells at higher voltages.” *Id.*, [0005]. Prior art approaches identified in Blangero involved coating methods, such as “LiF protective coatings,” but these coatings were problematic because “coated dense LiCoO_2

often has a lower reversible capacity, so that a part of the gain of energy density by charging to higher voltage is annulled by lower intrinsic capacity.” *Id.*, [0006]; EX-2001, ¶43.

Blangero’s approach to this problem was to develop a “lithium metal oxide powder” that can be used “as a cathode material in a rechargeable battery,” consisting of (i) “a core material consisting of the elements Li, a metal M and oxygen,” where the metal M “has the formula $M = \text{Co}_{1-a}\text{M}'_a$,” and M’ is “either one or more metals of the group consisting of Al, Ga and B,” and (ii) “a surface layer consisting of a mixture of the elements of the core material and inorganic N oxide particles, wherein N is either one or more metals of the group consisting of Mg, Ti, Fe, Cu, Ca, Ba, Y, Sn, Sb, Na, Zn, Zr and Si.” *Id.*, [0009]; *see also id.*, [0059]; EX-2001, ¶44. The “core material has hexagonal layered crystal structure described as an ordered rock salt-type crystal structure with space group R-3m.” EX-1005, [0060]. The “existence of a defect-free core is an inherent feature of the cathode material of the actual invention.” EX-1005, [0061]; *see also id.*, [0085]-[0086].

Blangero identifies that in one embodiment, the powder has the “general formula $\text{LiCo}_{1-a-b}\text{M}'_a\text{M}''_b\text{O}_2$,” where “M’ compris[es] either one or more elements from the group Al, Mg, Ti, Fe, Cu, Ca, Ba, Y, B, Sn, Sb, Na, Ga, Zn” and “...M”

compris[es] either one or more elements from the group F, P, S, Zr.” *Id.*, [0011].

“The elements F, P, and S may be present on the surface under the form of LiF, Li₃PO₄ and Li₂SO₄.” *Id.*

Blangero describes a method for manufacturing the claimed lithium metal oxide powder, involving (i) “providing a first mixture consisting of a first M-comprising and a first Li-comprising precursor powder,” (ii) “sintering the first mixture in an oxygen comprising atmosphere at a temperature T₁ of at least 600°C, thereby obtaining a Li-enriched lithium metal oxide compound, the metal being M,” (iii) “providing a second M-comprising precursor powder,” (iv) “mixing the Li-enriched lithium metal oxide compound and the second M-comprising precursor powder, thereby obtaining a second mixture,” and (v) “sintering the second mixture in an oxygen comprising atmosphere at a temperature T₂ of at least 600°C.” *Id.*, [0016]-[0020]; *see also id.*, [0021]-[0026], [0027]-[0032]. In other words, during manufacturing, the powder undergoes two separate mixing and sintering (i.e. heating) steps. EX-2001, ¶46.

Blangero notes that the invention’s surface layer “has an inhomogeneous composition compared to the core with a compositional gradient of the different M, M’, Li and O elements.” EX-1005, [0062]. The surface is “enriched of elements N such as Mg, Ti, Fe, Cu, Ca, Ba, Y, Sn, Sb, Na, Zn, Zr and Si and, in one

embodiment, is formed by segregation from the core and accumulation of these metal dopants at the surface of the particles,” whereas “[i]n the core, these dopants are substantially absent.” *Id.* Critically, Blangero notes that the “[a]uthors could not indisputably establish the chemical nature of the oxides formed at the surface and therefore speculate that, for example in the case of Mg, Si and Ti doping, possible forms, but not limited to, are LiMO_2 , MgO , CoO , $\text{Co}_{1-\phi}\text{Mg}_\phi\text{O}\dots$, Co_3O_4 , $\text{Mg}_\delta\text{Co}_{3-\delta}\text{O}_4\dots$, TiO_2 , Li_2TiO_3 , SiO_2 , $\text{Li}_\epsilon\text{Si}_\lambda\text{O}_\pi[\cdot]$ ” *Id.*

Blangero compares a cathode produced using a prior art process and a cathode produced using Blangero’s process. Blangero obtains a “state of the art titanium and magnesium doped LiCoO_2 (noted LCO-1)” using a “standard high temperature solid state synthesis (=the first firing step) by mixing the precursor with Li_2CO_3 .” *Id.*, [0109]. LCO-1 “is also referred to as the lithium doped cobalt oxide ‘parent’ of Example 1 and Example 2.” *Id.* To prepare Example 1 of Blangero’s invention, “95 mol % of LCO-1 and 5 mol % of 0.25 mol% Ti and 0.5 mol % Mg doped $\text{Co}(\text{OH})_2$ ” were mixed, then “placed in an alumina crucible and heated (=the second firing step) at 925°C for 12 hours under constant air flow.” *Id.*, [0110]. The “chemical composition of the surfaces of the particles of LCO-1 and Ex1” was investigated using X-Ray Photoelectron Spectroscopy (XPS)

Analysis. *Id.*, [0129]; *see also id.*, Fig. 4a and 4b. The results are shown in Table 3, reproduced below:

TABLE 3		
elemental composition of the surface of the grains of LCO-1 and Ex1.		
at. %	LCO-1	Ex1
Li	21.7	15.3
Co	8.7	12.0
O	41.9	37.5
C	23.1	26.5
S	1.3	0.8
Ca	0.6	0.1
F	0.9	0.4
Ti	0.9	1.1
Na	0.3	0.3
Si	Below detection limit	1.1
P	0.4	0.6
Mg	Below detection limit	4.4

Id., [0129]. Notably, Example 1 showed increased amounts of cobalt (Co), titanium (Ti), and magnesium (Mg), and decreasing amounts of lithium (Li), oxygen (O), and fluorine (F) on the surface as compared to the prior art LCO-1 composition. The dependent claims demonstrate that F, P, and S, present as LiF, Li₃PO₄, and Li₂SO₄, are contaminants intended to be limited. *See id.*, cl. 37 (“The lithium metal oxide powder of claim 33, wherein the surface layer further comprises less than 2000 ppm of one or more of LiF, Li₃PO₄ and Li₂SO₄”); *see also id.*, cl. 62; EX-2001, ¶48. Blangero does not explain where the fluorine that is detected in Table 3 originates, or indicate that its presence is intentional or desirable. EX-2001, ¶48.

Blangero also used XPS to analyze the “evolution of Mg and Ti as function of particle depth” for Example 1 “by means of XPS depth profiling as shown on FIG. 8.” EX-1005, [0135]. Depth profiling showed that the “concentration of Mg and Ti decreases rapidly over the first 50 nm of the particles,” but the amounts “do not decrease down to zero[.]” *Id.* Notably, Blangero does not disclose the alignment of the crystal orientation of the core and surface materials, or whether the core and surface material orientations are aligned with each other.

B. Shim

Shim is a published patent application directed to a “positive active material for a rechargeable lithium battery having excellent cycle-life characteristics.” EX-1006, [0008]; *id.*, Abstract; EX-2001, ¶¶50-53. Specifically, Shim teaches that the positive active material “includes a lithium intercalation compound; and a lithium titanium oxide...on the surface of the lithium intercalation compound” with the formula “ $\text{Li}_{4-x}\text{M}_x\text{Ti}_y\text{O}_{12-z}$.” *Id.*, [0011]; *see also id.*, [0053]. In this formula, “M is an element selected from Mg, Al, Ga, La, Tb, Gd, Ce, Pr, Nd, Sm, Ba, Sr, Ca, and combinations thereof.” *Id.*, [0016]; *see also id.*, [0056]. The “lithium intercalation compound may be an M-doped compound, where M is selected from Mg, Al, Ti, La, Tb, Gd, Ce, Pr, Nd, Sm, Ba, Sr, Ca, and combinations thereof.” *Id.*, [0019]. Shim teaches that the “lithium titanium oxide may be positioned on the surface of

the lithium intercalation compound in a form of an island coating,” where “island coating” is defined as “a discontinuous coating formed of spherical, semi-spherical, non-spherical, or amorphous shape particles.” *Id.*, [0058]. The “resulting positive active material exhibits improved ion conductivity and electric conductivity,” and “thus, excellent rate capability and cycle-life characteristics during the charge and discharge of the battery may be obtained.” *Id.*, [0059].

The positive active material disclosed in Shim is prepared by “mixing a titanium compound-containing liquid and a lithium intercalation compound to prepare a mixture; drying the resulting mixture to obtain a dried product; and heat-treating (e.g., by firing) the dried product.” *Id.*, [0067]. The “titanium compound” “may be titanium butoxide, titanium isopropoxide, titanium dioxide, or a combination thereof.” *Id.*, [0069]. Shim teaches that the concentration of the titanium compound in the titanium compound-containing liquid should be “of about 1.5 wt% to about 3.0 wt%, based on the total amount of the liquid,” in order to successfully form a compound “on the surface of the lithium intercalation compound.” *Id.*, [0070]-[0071]. If the concentration is out of this range, “undesired impurities such as, for example, M-doped Li_2TiO_3 and/or the like may be formed.” *Id.* Similarly, Shim teaches that “a mixing ratio of the titanium compound and the lithium intercalation compound may be a weight ratio ranging

from about 0.0092:1 to about 0.073:1,” leads to an improvement in “capacity characteristics,” whereas using ratios outside this range can lead to a decrease in capacity. *Id.*, [0074].

Shim further teaches that “a starting material that generally remains as an impurity during the manufacturing of a lithium intercalation compound (for example, Li_2CO_3 remaining during the manufacturing of LiCoO_2), reacts with a titanium compound to form a lithium titanium oxide, such that a doping element M (initially doped on the lithium intercalation compound) is then doped on the lithium titanium oxide.” *Id.*, [0077].

Shim discloses a series of Examples of the invention along with Comparative Examples presumably from the prior art. Shim discloses several scanning transmission electron microscope (STEM) images showing cross-sections of the active material. Petitioner relies on two STEM images in Figures 4B and 5B to demonstrate the alignment of the crystal structure between the coating regions and the lithium intercalation regions. *See, e.g.*, Pet., 35-36 (reproducing and annotating EX-1006, Fig. 4B, 5B). But these images are taken of Comparative Examples 2 and 6, respectively, and not of Shim’s invention. *See* EX-1006, [0134]-[0135]. Indeed, Comparative Examples 2 and 6 use a titanium butoxide ethanol solution with a concentration of 0.46 wt% and 1.35 wt%, respectively, both

below the 1.5 wt % to 3.0 wt% range that Shim teaches can be used successfully to form the titanium compound on the surface of the lithium intercalation compound. *See id.*, [0070]-[0071]; EX-2001, ¶53.

C. Yamamoto

Yamamoto is a research article that describes coating a LiCoO_2 thin-film model electrode with magnesium oxide (MgO) to “improve[] the durability of the cathode during high-potential cycling.” EX-1007, 1; EX-2001, ¶¶54-55.

Yamamoto tests two MgO coatings: one deposited onto the LiCoO_2 films for 30 seconds at room temperature (RT-MgO-LCO), and one deposited onto the LiCoO_2 films for 60 seconds at high temperature, 700°C (HT-MgO-LCO). *Id.* Yamamoto characterized the thin films using, among other techniques, energy dispersive X-ray spectroscopy (EDX). *Id.*, 1-2. The EDX scan “detected a Mg containing layer of approximately 5 nm in thickness outside Co containing layer for the RT-MgO-LCO,” as shown in Figure 1(b), while the HT-MgO-LCO instead “has a Mg layer within the LiCoO_2 surface,” (data not shown). *Id.*, 2.

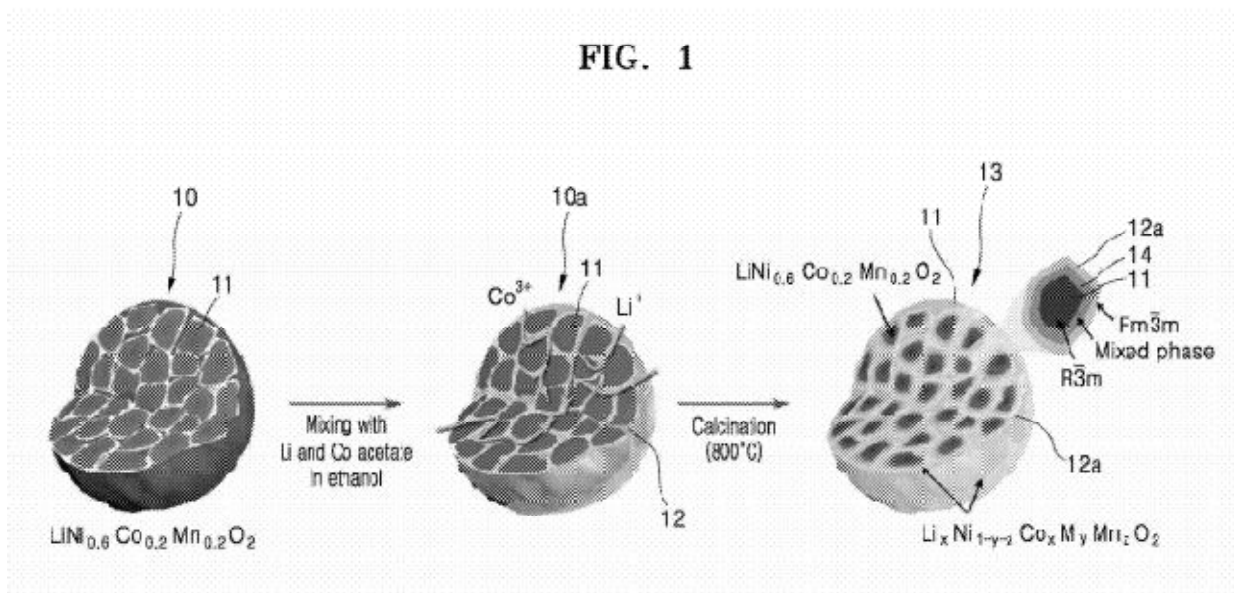
Yamamoto concludes that the “temperature of MgO coating influences the surface structure of LiCoO_2 .” *Id.*, 3. Specifically, in “the RT-MgO-LCO, the MgO layer only covers LiCoO_2 surface, leading to unfavorable increase in the interfacial resistance,” whereas in the “HT-MgO-LCO, the solid solution of Mg

stabilizes the interfacial structure upon cycling at high potentials.” *Id.*, 4; EX-2001, ¶55.

D. Cho

Cho is a patent directed to a “composite cathode active material, including a nickel-based lithium transition metal oxide secondary particle.” EX-1008, Abstract; EX-2001, ¶¶56-58. The “nickel-based lithium transition metal oxide secondary particle includ[es] a coating layer containing lithium and cobalt on a surface of a primary particle of the secondary particle[.]” EX-1008, Abstract.

Figure 1 (reproduced below) illustrates Cho’s “nickel-based lithium transition metal oxide secondary particle 10” showing “an agglomerate of primary particles 11.” EX-1008, 6:42-46. Exemplary nickel-based lithium transition metal oxide secondary particles **10** include $\text{LiNi}_{0.6}\text{Co}_{0.2}\text{Mn}_{0.2}\text{O}_2$ (NCM622), $\text{LiNi}_{0.5}\text{Co}_{0.3}\text{Mn}_{0.2}\text{O}_2$, or $\text{LiNi}_{0.5}\text{Co}_{0.2}\text{Mn}_{0.3}\text{O}_2$. EX-1008, 6:46-49.



EX-1008, Fig. 1.

Cho's "cathode may include at least one technical feature, such as composition and particle diameter, that is different from the composite cathode active material in addition to the composite cathode active material," such as "cathode active material used in the art." EX-1008, 9:16-20. Exemplary cathode active material used in the art includes "a lithium cobalt oxide, a lithium nickel cobalt manganese oxide, a lithium nickel cobalt aluminum oxide, a lithium iron phosphate, or a lithium manganese oxide." *Id.*, 9:21-26.

E. Kim

Kim is a research article that describes a new coating method for alleviating surface degradation of $\text{LiNi}_{0.6}\text{Co}_{0.2}\text{Mn}_{0.2}\text{O}_2$ cathode material. EX-1009, 2111; EX-

2001, ¶59. Kim is the article underlying the Cho patent and contains several figures that are identical to those found in Cho. *Compare, e.g.*, 008, Figs. 1, 4A, 4B, 7A, *with* EX-1009, 2112-2113 (Figs. 1a, 1b, 1c, 2d).

IV. PERSON OF ORDINARY SKILL IN THE ART

The Petition contends that “[a] POSITA at the time of the ’660 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., 20. For purposes of the analysis in this POPR, and without conceding agreement, Patent Owner and Patent Owner’s expert have applied Petitioner’s definition.¹ EX-2001, ¶¶29-30. Even under Petitioner’s definition, the Petition fails to show that any claim would have been obvious before the critical date.

¹ Patent Owner applied the level of skill for a POSITA set forth in the Petition, and *not* the level of skill set forth by Petitioner’s expert, Dr. Hayes, which differ. *Compare* Pet., 20 *with* EX-1003, ¶109.

V. CLAIM CONSTRUCTION

Patent Owner does not offer any claim constructions at this time because the deficiencies in the Petition do not turn on claim construction. Patent Owner reserves all rights to raise additional arguments and claim constructions if IPR is instituted.

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

The Petition challenges different sets of claims of the '660 Patent on six grounds. *See* Pet., 5-6. For the reasons described in detail below, all of the Petition grounds against independent claims 1 and 6 are deficient and institution should be denied.²

A. Ground I is Deficient for Failing to Show that Blangero Alone or in Combination with Shim or Yamamoto Renders Obvious Independent Claims 1 and 6

Ground 1 is deficient for several reasons. EX-2001, ¶¶60-96. First, with respect to both independent claims 1 and 6, Petitioner's argument that Blangero

² Patent Owner does not agree that any dependent claim is obvious, but reserves argument on dependent claims should the IPR be instituted.

discloses a “rock-salt crystal structure” amounts to nothing more than speculation that is inconsistent with Blangero’s own disclosures. Second, Petitioner has not met its burden to show that Blangero and Shim, when combined, disclose the relative crystal orientations claimed in independent claims 1 and 6. Third, with respect to claim 6, Petitioner has not demonstrated that distribution of particles in Blangero would be represented by Yamamoto’s EDX line analysis to meet the claimed magnesium distribution in the second region.

For the reasons described below, the Petition’s Ground I challenges against independent claims 1 and 6 are deficient and institution should be denied.

1. The Petition Fails to Show that Blangero Alone or in Combination with Shim Discloses a “Second Region that Comprises a Rock-Salt Crystal Structure” (Elements 1.4, 6.4)

Petitioner alleges that three separate disclosures from Blangero teach a second region that comprises a rock-salt crystal structure for Ground I.A and I.B—namely, (i) magnesium oxide (MgO), (ii) lithium fluoride (LiF), or (iii) “TiO₂, that may also be lithiated[.]” Pet., 27-30. But Petitioner has not met its burden to show that any of these three compounds are present in the second region, let alone that any are present with a rock-salt crystal structure. EX-2001, ¶¶61-75.

- a. Petitioner has not demonstrated that MgO is present in Blangero or necessarily has a rock-salt crystal structure

Petitioner argues “Blangero discloses that its PEAM material includes a surface layer comprising MgO due to ‘segregation from the core’” and “[a] POSITA would have known that at least the MgO portion of Blangero’s coating would have a rock-salt crystal (i.e. NaCl) structure.” Pet., 27-28.

But Petitioner’s argument is based only on speculation, as it would not have been obvious to a POSITA that MgO is present in Blangero’s coating based on its disclosure. Instead, Blangero explicitly states that the surface layer is inhomogeneous and of indeterminate composition:

The surface layer has an *inhomogeneous composition* compared to the core with a *compositional gradient* of the different M, M’, Li and O elements... Authors *could not indisputably establish the chemical nature of the oxides formed at the surface* and therefore *speculate* that, for example in the case of Mg, Si and Ti doping, *possible forms*, but not limited to, are LiMO_2 , **MgO**, CoO , $\text{Co}_{1-\varphi}\text{Mg}_\varphi\text{O}$ with $\varphi \leq 1$, Co_3O_4 , $\text{Mg}_\delta\text{Co}_{3-\delta}\text{O}_4$ with $\delta \leq 1$, TiO_2 , **Li₂TiO₃**, SiO_2 , $\text{Li}_\varepsilon\text{Si}_\lambda\text{O}_\pi$ with $2 \leq \varepsilon \leq 8$, $1 \leq \lambda \leq 2$ and $3 \leq \pi \leq 7$ [.]

EX-1005, [0062].³

Applying hindsight, Petitioner plucks MgO from a laundry list of M’ or M” metal elements and N dopants that Blangero identifies as possibilities, but admits could not be “indisputably establish[ed].” *Id.* For example, Blangero discloses

³ All emphasis added unless otherwise noted.

that “[t]he surface layer has an inhomogeneous composition compared to the core with a compositional gradient of the different M, M’, Li and O elements” and that “[t]he surface is enriched of elements N such as Mg, Ti, Fe, Cu, Ca, Ba, Y, Sn, Sb, Na, Zn, Zr and Si and...formed by segregation from the core and accumulation of these metal dopants at the surface of the particles” in which “elements F, P and S may be present on the surface.” *Id.*; *see also id.*, [0011]. In picking out MgO from these lists, Petitioner misrepresents Blangero’s disclosure of MgO. For example, Petitioner summarizes paragraph 59 as “describing Mg and Ti oxides at a ‘surface layer,’” (Pet., 27), when what paragraph 59 says is “one or more metals of the group consisting of Mg, Ti, Fe, Cu, Ca, Ba, Y, Sn, Sb, Na, Zn, Zr and Si,” (EX-1005, [0059]). EX-2001, ¶63-64. Petitioner’s selection of magnesium from this laundry list is impermissible hindsight. *See Sanofi-Aventis U.S., LLC v. Dr. Reddy’s Lab’ys, Inc.*, 933 F.3d 1367, 1378-79 (Fed. Cir. 2019) (finding argument “emblematic of hindsight reasoning” where the “references investigated a diverse set of substitutions” and experts “cherry-picked data in the references”).

Additionally, Petitioner erroneously assumes that it would have been obvious that MgO, to the extent present at all, would only form a rock-salt crystal structure. But to the contrary, MgO is known to be available in amorphous forms. *See e.g.*, EX-2003, 1; EX-2017, 2. Accordingly, Petitioner has failed to explain

why Blangero's "speculate[d]" MgO, if present, would necessarily have a rock-salt crystal structure. EX-1005, [0062]. In fact, Blangero's disclosure that the surface layer "has an inhomogeneous composition" would lead a POSITA to infer that the structure was *not* an ordered rock-salt crystal structure, but rather amorphous instead. EX-2001, ¶65.

At best, Petitioner can allege (incorrectly) that MgO, if present in Blangero, would *inherently* form a rock-salt crystal structure. But Petitioner fails to meet the requisite legal burden for establishing inherency. The Federal Circuit has cautioned that "the use of inherency, a doctrine originally rooted in anticipation, must be carefully circumscribed in the context of obviousness." *PAR Pharm., Inc. v. TWI Pharms., Inc.*, 773 F.3d 1186, 1195 (Fed. Cir. 2014). "[T]o rely on inherency to establish the existence of a claim limitation in the prior art in an obviousness analysis," Petitioner must meet a "high standard," specifically that "the limitation at issue *necessarily must be present*, or the natural result of the combination of elements explicitly disclosed by the prior art." *Id.* at 1195-96 (emphasis added). Inherency "may not be established by probabilities or possibilities" and "[t]he mere fact that a certain thing may result from a given set of circumstances is not sufficient." *Id.* at 1196 (cleaned up).

Petitioner has not met this exacting standard. Petitioner has offered only an unsupported assumption that MgO is present in rock-salt crystal structure, when the nature of its formation, to the extent it is there at all, could also have led to a disordered or amorphous crystal structure. EX-2001, ¶66. Therefore, Petitioner's reliance on inherency for this element in its obviousness analysis is improper. *PersonalWeb Techs., LLC v. Apple, Inc.*, 917 F.3d 1376, 1382–83 (Fed. Cir. 2019) (reversing the PTAB's obviousness determination because it was only “possible” that the prior art contained an inherent limitation—and “mere possibility is not enough” to show an inherent limitation).

b. Petitioner has not demonstrated that LiF is present in Blangero or has a rock-salt crystal structure

Petitioner next argues that “Blangero’s disclosure of lithium fluoride (LiF) ‘on the surface’ of the particle discloses this limitation.” Pet., 28. But Petitioner ignores that, when discussing the prior art, Blangero noted that coated LiCoO_2 “often has a lower reversible capacity,” including when “LiF protective coatings” were used, and sought to improve over such prior art coatings. See EX-1005, [0006]-[0008]. Indeed, one of Petitioner’s own secondary references confirms that “LiF is an undesired product of the electrolyte degradation...due to its low permeability to Li-ions and electrons” which can “deteriorate the performance of the cathode.” EX-1021, 2; see also EX-2004, 5-6. Thus, a POSITA would not

have been motivated to select a LiF coating to apply to Blangero's surface layer.

EX-2001, ¶¶67-70.

Blangero's disclosure that "[t]he elements F, P and S *may be present* on the surface under the form of LiF, Li₃PO₄ and Li₂SO₄" is not sufficient to meet Petitioner's burden either. EX-1005, [0011]. Petitioner argues "Blangero makes clear that such LiF is in the 'surface layer' in addition to oxides of magnesium and/or titanium," (Pet., 29), indicating that Petitioner believes that LiF is present in Blangero's coating as well as oxides of magnesium and/or titanium. But as discussed above, Petitioner's position is based on speculation, as Blangero explicitly states in its disclosure that "[a]uthors *could not indisputably establish the chemical nature of the oxides formed at the surface*[" EX-1005, [0062].

While Blangero indicates that "F...*may* be present on the surface under the form of LiF," it fails to conclusively demonstrate that LiF *is* present on the PEAM surface.

Id., [0011]; EX-2001, ¶68. Indeed, while fluorine is identified by X-Ray Photoelectron Spectroscopy (XPS) in Table 3, the corresponding spectrum in Figure 5(b) does *not* identify LiF, but rather identifies Li₂CO₃ and LiCoO₂. EX-1005, Fig. 5(b); EX-2001, ¶68.

Furthermore, Petitioner assumes, without evidence, that LiF, if present at all in Blangero's surface, has a rock-salt crystal structure. But LiF (just like MgO)

was known to also be available in amorphous forms. *See e.g.*, EX-2005, 4-5 (identifying “an amorphous outer layer” of LiF “which likely consists of organic/polymeric species from electrolyte decomposition”); EX-2004, 5-6 (“The Li_2CO_3 together with LiF can form an *amorphous* SEI layer coated on the particle surface...which reduces the ionic conductivity of the cathode surface and undermines the connectivity between neighboring cathode particles.”). Indeed, here, Petitioner argues that LiF would result from “electrolyte decomposition,” through the “hydrolysis of LiPF_6 ,” an electrolyte salt, making it even more likely that LiF would be deposited in amorphous form, rather than in an ordered rock-salt crystal structure. *See* Pet., 12 (citing EX-1021, 1); EX-2001, ¶69. Accordingly, Petitioner fails to meet its burden to demonstrate that LiF is present, let alone present with a rock-salt crystal structure.

At best, Petitioner can allege (again, incorrectly) that LiF, to the extent it is present in Blangero, would *inherently* form a rock-salt crystal structure. But, just as with MgO, Petitioner fails to meet the requisite legal burden for establishing inherency, i.e., that LiF “*necessarily must be present*” in rock-salt crystal structure form. *PAR Pharm.*, 773 F.3d at 1195-96; *id.*, 1196. Petitioner has not met this exacting standard for LiF, offering only an unsupported assumption that LiF is present, and is present in rock-salt crystal structure, when the its formation through

decomposition of the electrolyte formulation could also have led to a disordered or amorphous crystal structure. EX-2001, ¶70. Therefore, Petitioner cannot rely on inherency here to meet its burden. *See PersonalWeb*, 917 F.3d at 1382–83.

c. Petitioner has not demonstrated that lithium titanium oxide is present in Blangero or has a rock-salt crystal structure

Petitioner argues that “Blangero renders this limitation at least obvious in view of its surface layer further comprising ‘TiO₂, that may also be lithiated,’ or lithium titanate.” Pet., 29 (citing EX-1005, [0094], [0059], [0062]).

Petitioner’s position is again based on speculation, as it would not have been obvious to a POSITA that lithium titanium oxide is in fact present in Blangero’s coating based on its disclosure. Blangero never shows an example with lithium titanium oxide present in the surface layer. Instead, based on hindsight, Petitioner alleges that lithium titanium oxide is present based on an expansive list of possible combinations derived from laundry lists of possible metal elements and N dopants that might be present on the surface, but “could not indisputably [be] establish[ed.]” EX-1005, [0062]. Therefore, the disclosure of “TiO₂” or “Li₂TiO₃”

as possibilities is not enough for Petitioner to meet its burden of showing that lithium titanium oxide is present in Blangero's surface layer. EX-2001, ¶¶71-75.

Petitioner also again erroneously assumes that the form of any lithium titanium oxide present on a cathode surface will be a rock-salt crystal structure. But lithium titanium oxide can be amorphous. *See e.g.*, EX-2007, 4. Petitioner has failed to explain why the "speculate[d]" forms of lithium titanium oxide, if even present in Blangero, would necessarily be present in a rock-salt crystal structure. Furthermore, since Blangero's list of "speculate[d]" "possible forms" includes compounds that lack a rock-salt crystal structure, such as Co_3O_4 , it would not have been obvious to a POSITA that lithium titanium oxide would necessarily be required to have a rock-salt crystal structure if found on Blangero's surface.

Additionally, contrary to Petitioner's assertion, (Pet., 29-30), a POSITA would not have been motivated to change the crystal structure disclosed in Blangero based on the description in Wang's 2012 study (EX-1029), because Blangero and Wang have different substrate materials. Petitioner points to Fig. 4(c) and 4(d) in Wang to allege that there is a motivation to combine LiTiO_2 coating, which can sometimes have a rock-salt crystal structure, with a PEAM in Blangero because LiTiO_2 has better characteristics than the Li_2TiO_3 species disclosed in Blangero. But Wang teaches the use of LNCM (e.g.,

$\text{LiNi}_{0.5}\text{Co}_{0.2}\text{Mn}_{0.3}\text{O}_2$), which *itself* is coated with LiTiO_2 . EX-1029, 4 (“...the coated LNCM microspheres are described as surface- LiTiO_2 -rich microspheres, with $\text{Li}[\text{Ni}_x\text{Mn}_y\text{Ti}_{1-x-y}]\text{O}_2$ domains in the surface layer. This unique coating layer indicates a strong interaction between LiTiO_2 and the host structure”). From this disclosure, a POSITA would have understood that Wang describes characteristics caused by a **combination** of a coating material made of LiTiO_2 and LNCM with a specific host structure. Because the LiCoO_2 substrate in Blangero is a different substrate from the LNCM substrate in Wang, it would not have been obvious to a POSITA that the effect shown in Wang would have occurred when LiTiO_2 was used with a different substrate—i.e., applied to LiCoO_2 . EX-2001, ¶74.

Finally, as discussed above, at best, Petitioner incorrectly alleges that lithium titanium oxide, if present in Blangero, would *inherently* form a rock-salt crystal structure. But, just as with MgO and LiF , Petitioner fails to meet the requisite legal burden for establishing inherency, i.e., that lithium titanium oxide “***necessarily must be present***” in rock-salt crystal structure form. *PAR Pharm.*, 773 F.3d at 1195-96; *id.*, 1196. Petitioner has not met this exacting standard for lithium titanium oxide, offering only an unsupported assumption that lithium titanium oxide is (i) present and (ii) has a rock-salt crystal structure. EX-2001,

¶75. Therefore, Petitioner cannot rely on inherency here to meet its burden. *See PersonalWeb*, 917 F.3d at 1382–83.

2. The Petition Fails to Show that Blangero Alone or in Combination with Shim Renders Obvious the Claimed Relative Crystal Orientation (Elements 1.7 and 6.7)

Petitioner provides no evidence from Blangero showing “wherein a crystal orientation of at least a second part of the first region and a crystal orientation of at least a part of the second region are substantially aligned with each other.” EX-1001, cl. 1; *see also* cl. 6. While Petitioner relies on principles of epitaxy to disclose this limitation, Blangero is silent with regard to epitaxy being applicable in any of its compositions, and a POSITA would not have found Blangero’s conditions to facilitate epitaxial growth. EX-2001, ¶¶76-79.

Because Blangero is silent as to alignment of the crystal structure of its surface and core, Petitioner relies upon importing the crystal structure alignment from another reference, Shim, without explaining how or why Shim and Blangero would be combined, or why a POSITA would have expected the same crystal structure or alignment when Shim and Blangero use markedly different processes. EX-2001, ¶¶80-85. Additionally, Petitioner ignores that Shim also teaches a *spinel* structured compound for use in its coating that has more desirable properties. *Id.*, ¶¶86-90.

a. A POSITA would not have understood Blangero to disclose the claimed crystal alignment

Petitioner's assertion that "a POSITA would have understood that Blangero's first region (comprising LiCoO_2) and second region (comprising Li_2TiO_3 and MgO in part) are in substantial alignment due to the principles of epitaxy" is not supported by the evidence. Pet., 33. As a preliminary matter, as noted above, Petitioner's assumption that either Li_2TiO_3 or MgO is present in the second (surface) region is unsupported by Blangero's disclosures. Next, Blangero is silent as to either epitaxy or toptaxy. Epitaxy refers to a two-dimensional type of crystal growth or material deposition in which new crystalline layers are formed with one or more well-defined orientations with respect to the crystalline seed layer. See EX-2009, 2; EX-2001, ¶78. Three-dimensional growth is more correctly referred to as toptaxy. See EX-1001, 9:34-44. A POSITA would have understood that not all growth on a given surface is epitaxial/toptaxial, and that epitaxial/toptaxial growth requires specific conditions that facilitate that type of growth. EX-2001, ¶78; see e.g., EX-2010, 2, 6 (epitaxial growth achieved on MgO single crystal films but not on MgO polycrystalline films); EX-2020, 5 ("differences in film and substrate chemistry and coefficient of thermal expansion can strongly influence the electronic properties and perfection of the interface"); EX-2021, 7 (discussing "main preconditions" needed to stimulate epitaxial

growth); EX-2012, 3 (noting considerations for achieving epitaxy). An amorphous surface layer would not lend itself to epitaxial/topotaxial growth, and would be unlikely to have alignment with the “first region,” or core. EX-2001, ¶78; EX-2012, 3 (formation of “amorphous” material “will in a worst case, eliminate epitaxy”); EX-2020, 7 (“crystalline metals deposited on amorphous substrates” yields “resulting films [that] are quite defective.”).

Although Petitioner points to another Shim reference (EX-1032, “Shim 2015”) to explain that Li_2TiO_3 can be epitaxially grown on the surface of LiCoO_2 , Petitioner ignores the different fabrication methods used in Blangero and Shim. It would **not** have been obvious to a POSITA that Li_2TiO_3 could (or would) have grown epitaxially/topotaxially on the surface of LiCoO_2 in Blangero, particularly if the surface of Blangero was at least partially amorphous. EX-2001, ¶79. Furthermore, Petitioner failed to address why a POSITA would have **necessarily** expected similar results despite significant differences in the coating processes used by Blangero and Shim, discussed below. *PAR Pharm.*, 773 F.3d at 1195-96.

- b. The Petition does not explain how a POSITA would have combined Shim and Blangero to maintain Shim’s crystal structure alignment

Petitioner alleges that “a POSITA would have been motivated to use Shim’s Li_2TiO_3 coating layer in Blangero’s particle, as this coating layer would be in

substantial alignment with Blangero's LiCoO_2 layer," (Pet., 36-37), but this allegation is unsupported by the record. The Petition fails to clearly articulate *how* a POSITA would "use" Shim's coating in Blangero's process, depriving Patent Owner of the specificity required to address the proposed combination. For instance, if the "use" of Shim's coating means that the coating would be **added** to Blangero's existing surface layer, nothing in Shim nor in Blangero teaches or suggests that Shim's coating would be in substantial alignment with Blangero's disclosed surface layer. EX-1005, [0062]. Indeed, this type of combination would be a hybrid composition that is neither contemplated by nor supported by the data provided by Shim or Blangero because Shim and Blangero are directed to different types of coating, and do not contemplate being combined with other coating techniques. EX-2001, ¶80. And even if contemplated, nothing in Shim or Blangero suggests a reasonable expectation of success in combining the two methods and achieving alignment between portions of the first and second regions. *Id.* Indeed, if Shim's coating was **added** to Blangero, Petitioner has not explained what would be the "first" region or the "second" region in the hybrid composition containing both Blangero and Shim's coatings. *Id.*

Alternately, if Petitioner meant instead to **substitute** Blangero's surface layer with Shim's Li_2TiO_3 coating layer, such a modification would not have been

obvious to a POSITA because Blangero's method of fabrication is starkly different from Shim's. EX-2001, ¶81. In Example 1, Blangero states that LCO-1 was prepared "according to the process explained in WO2010-139404." EX-1005, [0109] (citing EX-2011 ("Ellenwood")). Ellenwood states that prior to its invention, there were "two major preparation routes to prepare...monolithic LiCoO_2 ," one of which involved using "a source of cobalt (like Co_3O_4) with relatively small particle[s] is mixed with a source of lithium (like Li_2CO_3) and fired at sufficient high temperature with a sufficient excess of lithium." EX-2011, 2:15-17. Ellenwood explains that this method "basically results in a failure." *Id.*, 2:23. Ellenwood then goes on to explain the method of its invention, which involves a "precursor compound consisting of either one or more of a non-sintered agglomerated cobalt oxide, hydroxide and oxy-hydroxide powder" with a specific particle size. *Id.*, 3:30-4:2. Indeed, Blangero identifies that it uses $\text{Co}(\text{OH})_2$ as its precursor. EX-1005, [0109].

Shim, on the other hand, uses Co_3O_4 as its cobalt source. *See* EX-1006, [119] (" Li_2CO_3 , Co_3O_4 and Mg were mixed."); *id.*, [0129] (Example 1 preparing PEAM "according to the same (or substantially the same) method as in Comparative Example 2."). In other words, Shim uses the cobalt source that Ellenwood—i.e., Blangero's cited method—teaches "basically results in a failure."

EX-2011, 2:15-23. Thus, a POSITA familiar with Blangero and Ellenwood would simply not have been motivated to use Shim's method at all. EX-2001, ¶82.

Further, even assuming that using Co_3O_4 does not result in total "failure," it is likely that, at minimum, a POSITA would have expected the features of the lithium cobalt oxide to differ between Blangero's and Shim's processes.

Moreover, differences between Blangero and Shim's respective coating processes would also be expected to affect the resulting PEAM. For example, while Blangero's second step uses solid state synthesis (i.e. adding and heating solid precursors) to create its coating, Shim uses a solution phase reaction with titanium butoxide. *See* EX-1005, [0111]; EX-1006, [0129]; EX-2001, ¶83; *compare also* EX-1005, [0109]-[0110], *with* EX-1006, [0119]-[0122], [0130].

Additionally, as noted above, epitaxial/topotaxial growth is highly process dependent. EX-2001, ¶84; EX-2010, 2, 6; EX-2020, 5; EX-2021, 7; EX-2012, 3. Epitaxial and topotaxial growth generally depends on the surface conditions, but Petitioner has not established the surface conditions of Blangero or Shim, let alone demonstrated that they are similar. EX-2001, ¶84. Moreover, a POSITA would not have expected epitaxial/topotaxial growth, or the same type of crystal orientation based on the fabrication differences between Blangero and Shim discussed above. Petitioner does not address the significant differences in the

methods of fabrication (or how a POSITA would have combined them, if at all), and, thus, has failed to meet its burden to show that the claimed crystal alignment limitation was obvious over the prior art.

Therefore, Petitioner has not demonstrated that it would have been obvious to a POSITA that epitaxial growth of Shim's Li_2TiO_3 on the surface of Blangero's LiCoO_2 would have *necessarily* occurred based on the teachings of Shim due to the different processes used by Blangero and Shim. EX-2001, ¶85; *PAR Pharm.*, 773 F.3d at 1195-96.

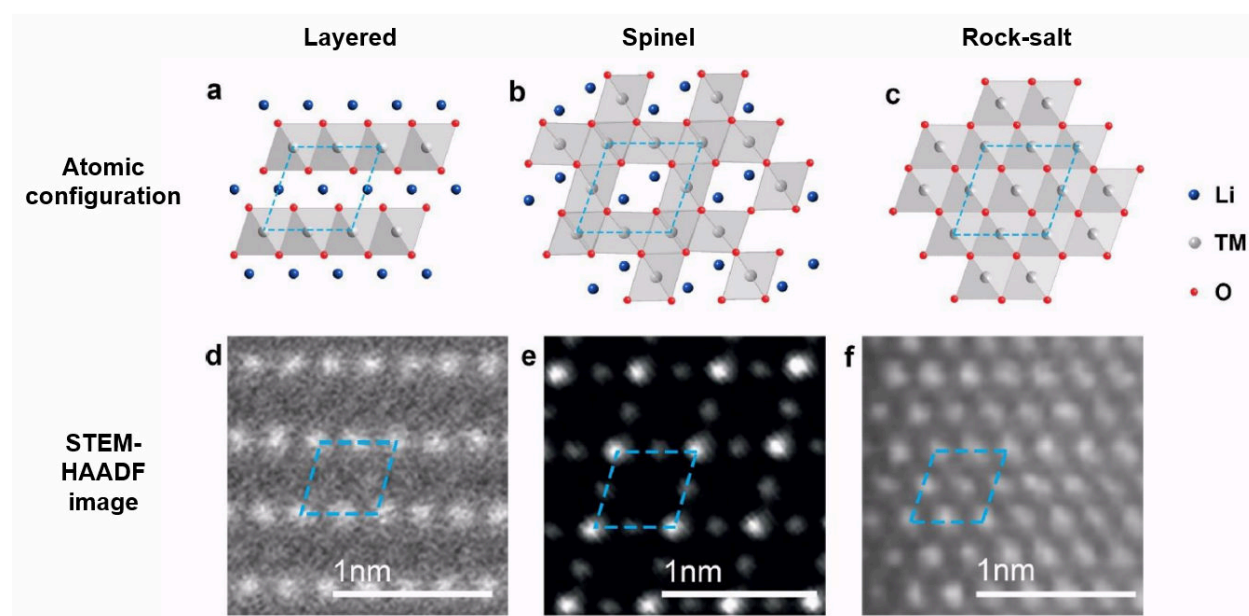
c. Shim teaches the use of a spinel crystal structure in the lithium titanium oxide coating

The Petition alleges that “Shim discloses a coating (*i.e.*, second region) containing Li_2TiO_3 and magnesium (similar to Blangero's second region) with a crystal structure in substantial alignment with that of Shim's LiCoO_2 (*i.e.*, first region),” reproducing Figures 4B and 5B from Shim. Pet., 34-36; EX-2001, ¶86.

As an initial matter, these two figures show the results from using *prior art* coating methods, not Shim's invention that the Petition otherwise relies upon. Figures 4B and 5B are the results of Comparative Examples 2 and 6. See EX-1006, [0035], [0038]; EX-2001, ¶87.

More importantly, to the extent that Figures 4B and 5B disclose either a layered rock-salt crystal structure or a rock-salt crystal structure, Shim does not

suggest using only those crystal structures in its coating. To the contrary, Shim instead teaches that the lithium titanium oxide “may be a compound having a *spinel* structure[.]” EX-1006, [0061]; *see also id.*, [0017] (“The lithium titanium oxide may have a spinel structure.”). A spinel structure is distinct from the layered rock-salt crystal structure and the rock-salt crystal structure required by the claims of the ’660 Patent, as shown below:



Adapted from EX-2004, 6⁴; *see also* EX-1032, 2 (Scheme 1); EX-2001, ¶88.

⁴ STEM-HAADF, or scanning transmission electron microscope high-angle annular dark field imaging, is an imaging technique used to identify atomic structure.

Critically, Shim teaches that “unlike the compound having a layered structure,” a compound with a spinel structure “can remain stable (without a structural transition) during charge and discharge.” EX-1006, [0061]. Thus, a POSITA would understand Shim to teach that a spinel structure is not only a possible crystal structure, but, further, that the spinel structure is the preferred crystal structure for a coating. EX-2001, ¶88.

Shim’s preference for spinel crystal structures is evidenced by additional articles published by Shim,⁵ which confirm the benefits of using a coating material with a spinel structure. Petitioner even cites as one of its own exhibits a 2015 paper by Shim (EX-1032, “Shim 2015”) that “revealed that two completely different lithium titanate phases (monoclinic Li_2TiO_3 and spinel $\text{Li}_4\text{T}_5\text{O}_{12}$) can be obtained as the coating materials depending on the concentration of a titanium source.” EX-1032, 1. Of the two coating materials, Shim 2015 explains that the spinel structured compound is superior, “secur[ing] better electrochemical performances than the Li_2TiO_3 [.]” *Id.*; *see also id.*, 5 (“[S]pinel $\text{Li}_4\text{T}_5\text{O}_{12}$...

⁵ Both Shim 2015 and Shim 3 were disclosed to the Examiner during prosecution of the application that issued as the ’660 Patent. *See* EX-1002, 263-265, 308-310.

provides better performances for LiCoO_2 cathode than...monoclinic Li_2TiO_3 "); *id.*, 8 (noting "excellent stability" of "spinel $\text{Li}_4\text{Ti}_5\text{O}_{12}$ " and "much better electrochemical performances" than "monoclinic Li_2TiO_3 "). Shim 2015 explains that the "discrepancy in effectiveness of the coatings" comes from the "structural or phase stability during cycling[.]" *Id.*, 5. Another article by Shim, (EX-2019 "Shim 3") notes that "spinel materials are attractive in terms of their high Li^+ ion conductivity and good thermal stability" and they relieve "the difficulties associated with a Li-rich cathode, such as the operation voltage delay and thermal instability[.]" EX-2019, 1; *see also id.*, 4, 6-7; EX-2001, ¶89. Petitioner wholly ignores the disclosures of a spinel structure in Shim. As such, the Petition fails to explain why a POSITA considering the Shim references would select a layered rock-salt crystal structure instead of the spinel structure that Shim and its progeny teach is superior. EX-2001, ¶89.

Therefore, Petitioner has not met its burden to demonstrate that the combination of Blangero and Shim disclose or otherwise render obvious the claimed crystal structure alignment. *Id.*, ¶90.

3. The Petition Fails to Show that Blangero Alone or in Combination with Shim and/or Yamamoto Renders Obvious the Claimed Magnesium Distribution (Element 6.6)

Petitioner's assertion that "Blangero renders [Element 6.6] obvious either alone or in combination with Shim and/or Yamamoto," (Pet., 51), overlooks key differences between Blangero and Yamamoto⁶ that prevent Yamamoto's disclosure from applying to Blangero's PEAM. EX-2001, ¶91-96.

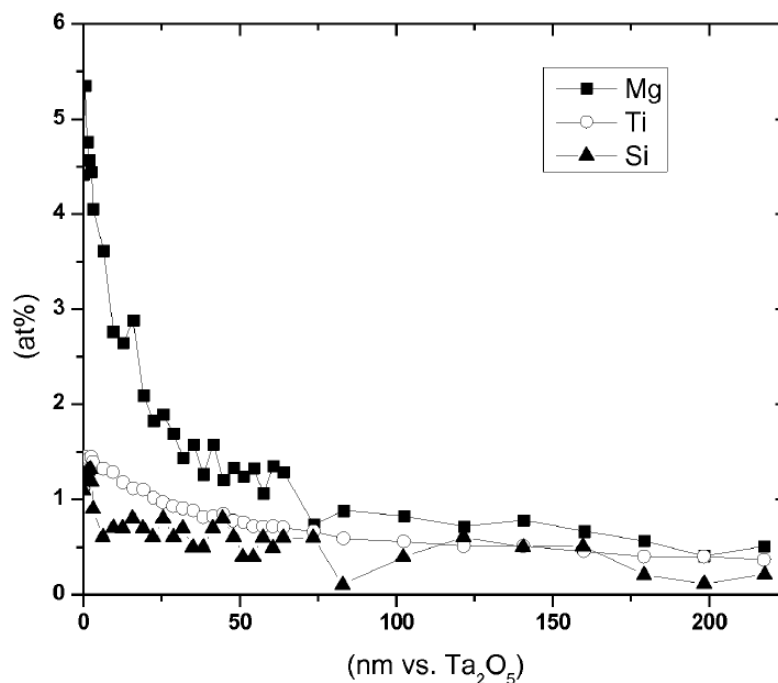
First, Blangero does not disclose measurements using energy dispersive X-ray (EDX) spectroscopy, as required by Element 6.6. *See* EX-1001, cl. 6. Instead, Blangero discloses the use of XPS, a different technique. EX-2001, ¶92. The results of Blangero's XPS and Yamamoto's EDX spectroscopy highlight the fact that Blangero and Yamamoto disclose different coating methods that result in different distributions of magnesium on the cathode surface. Yamamoto teaches a method for depositing MgO on "LiCoO₂ thin-film electrodes prepared via pulsed laser deposition[.]" EX-1007, 1. In contrast, Blangero does not use pulsed laser deposition, but instead uses a solid state synthesis method. EX-1005, [0109]. Additionally, Yamamoto's MgO coating is not necessarily the same as Blangero's coating because, as discussed at length above, Blangero's "[a]uthors ***could not***

⁶ Petitioner does not cite any specific disclosure in Shim (EX-1006) for Element 6.6, despite including Shim in the ground.

indisputably establish the chemical nature of the oxides formed at the surface

and...*possible forms*...not limited to...*MgO*[.]” EX-1005, [0062]. Therefore, the same flawed assumption that is fatal to Petitioner’s obviousness analysis of a rock-salt layer (Elements 1.4 and 6.4) and the alignment of the first and second regions (Elements 1.7 and 6.7) is equally fatal to Element 6.6. EX-2001, ¶92.

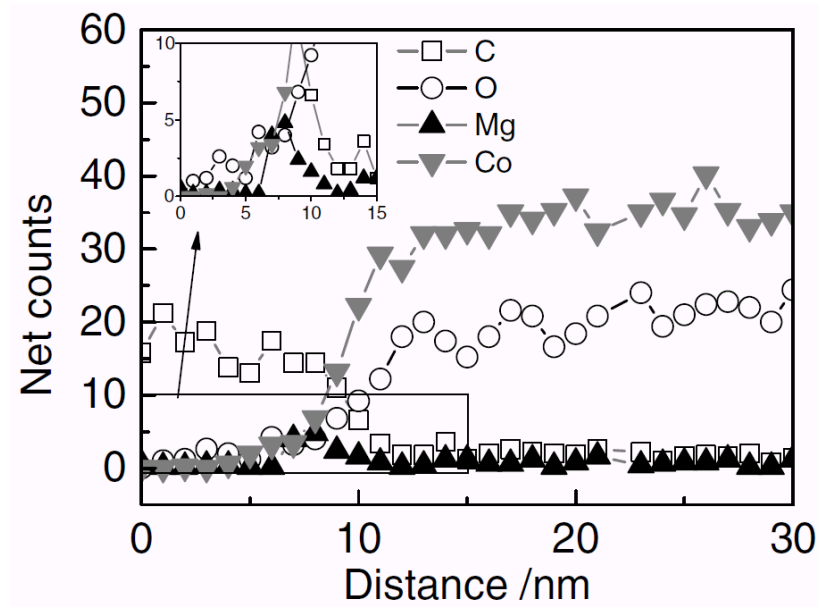
The respective data of Blangero and Yamamoto further demonstrate that the two coating methods yield different results. Blangero’s Figure 8 demonstrates that magnesium is present in substantial quantities (>1 at %) as far as 70 nm into the surface:



EX-1005, Fig. 8.

Petitioner acknowledges this result. See Pet., 46-47; EX-2001, ¶93.

Yamamoto's EDX spectrum, on the other hand, demonstrates that Yamamoto's coating technique resulted in magnesium being found in a narrow band just near the surface:



EX-1007, Fig. 1(b); *see also id.*, 2 (“The EDX scan detected a Mg containing layer of approximately 5 nm in thickness.”). Thus, Yamamoto's and Blangero's methods result in significantly different distributions of magnesium. EX-2001, ¶94. Petitioner's allegation that “Blangero corroborates Yamamoto's EDX line scan analysis” is therefore flawed. Pet., 46.

Petitioner has therefore not met its burden to show that claim 6 is obvious. EX-2001, ¶95.

B. Ground II is Deficient for Failing to Show that Cho Alone or in Combination with Kim Renders Obvious Independent Claims 1 and 6

Ground 2 is also deficient for multiple reasons. EX-2001, ¶96-119. First, with respect to both independent claims 1 and 6, Petitioner's argument that Cho or Kim disclose a PEAM containing titanium, magnesium, fluorine, and oxygen is unsupported by their own disclosures, which never disclose fluorine present in the PEAM, and only disclose magnesium and titanium in a long laundry list of potential metals to use in the PEAM. Cho and Kim teach using nickel and manganese instead. Second, because Cho and Kim do not disclose the claimed elements, they do not support a finding that when the claimed elements are present, they are present in either the claimed crystal structure or with the alignment of the crystal structure between the first and second regions claimed in independent claims 1 and 6. Third, with respect to claim 6, the EDX spectra disclosed by Cho and Kim fail to show the claimed distribution of magnesium (as no magnesium is present), and further suggest that even if magnesium were present, it would not be present in the claimed distribution. Rather than decreasing to 1/5 of peak magnesium, Cho and Kim's data indicates that the compound would have relatively constant distribution within the PEAM. *Id.*

For the reasons described below, the Petition's Ground II challenges against independent claims 1 and 6 are deficient and institution should be denied.

1. Petition Fails to Show that Cho Alone or in Combination with Kim Renders Obvious “the [PEAM] Comprises Titanium, Magnesium, Fluorine, and Oxygen in the Second Region” (Elements 1.6 and 6.5)

a. Petitioner has not demonstrated that fluorine is present in Cho or Kim

None of the examples in Cho and Kim contemplate the inclusion of fluorine in a second region (e.g., the coating layer) of the particle. EX-2001, ¶97-102. Petitioner does not argue otherwise.

Instead, Petitioner argues that Cho “teaches that the second region comprises fluorine, especially in view of a LiPF_6 electrolyte,” and therefore “[a] POSITA would have understood that such reactions with LiPF_6 would lead to the formation of a fluorine-coating layer on the cathode surface.” Pet., 68. Additionally, Petitioner argues that because Kim “explains that ‘a new solid electrolyte interface (SEI) layer, comprising *decomposition products of the electrolyte*, is formed along the active surface of the primary particles (grains) developed by the microcracks’ of the cathode material,” “when LiPF_6 is used in the electrolyte (as both Kim and Cho teach), Kim teaches that fluorine-containing layer is formed on the particle.” Pet., 68-69 (citing to EX-1009, 2–3).

Contrary to Petitioner’s arguments, Cho and Kim fail to disclose any particle having a second region (e.g., coating layer) containing fluorine. Petitioner’s

assertion that a SEI layer containing fluorine is formed on the particle when decomposition occurs conflicts with Cho and Kim's teachings, which are directed to **preventing** the formation of a SEI by using a coating (e.g., a Li/Co solution) to treat the outer surface of the particles. *See e.g.*, EX-1009, 2 ("The ***SEI layers on the surface of the grains inhibit electron and lithium transport***...thus diminishing the electrical performance."); EX-1008, 4:15-20 ("When the primary particles contact the electrolyte, a resistance layer, such as a ***solid electrolyte interphase (SEI) layer, may be formed*** on a surface of the primary particles, and the ***electrochemical characteristics*** of the cathode active material may ***deteriorate***"). Neither Cho nor Kim discloses or suggests that fluorine from decomposition is present in the second region of the particle because they teach protective surface coatings designed to **prevent** such degradation, and, in turn, **prevent** fluorine from being deposited on the particle surface. *Id.* It was well known in the art that fluorine deposition was undesirable, and even harmful, to a cathode surface. *See* EX-1021, 2; *see also* EX-2004, 5-6; EX-2001, ¶99. For at least this reason, a POSITA would have understood that the presence of fluorine was undesirable and would have sought to avoid fluorine deposition.

Petitioner next argues that Cho discloses a second region containing fluorine because Cho's "coating layer may include [] a product obtained by a sol-gel

reaction of compositions including a *lithium salt*,” conflating this disclosure with Cho’s earlier disclosure of using LiPF_6 in electrolyte solutions. Pet., 68 (emphasis in original). But Petitioner’s arguments here are flawed as well.

Contrary to Petitioner’s arguments, when a POSITA reads Cho as a whole, it is clear that Cho teaches using certain salts in its coating layer, such as lithium salts and cobalt salts that contain “each a nitrate, a sulfate, a chloride, or an acetate” and “each of which contains lithium and cobalt.” EX-1008, 6:23-28; *see also id.*, 6:50-55 (“The...particle **10** may be mixed with an ethanol solution including a lithium salt, such as lithium acetate, and a cobalt salt”). In contrast, later discussion of LiPF_6 is about using lithium salts in electrolyte solutions—*not* in the formation of Cho’s coating layer. *Id.*, 12:12-34 (“[A]n electrolyte may be prepared... The organic electrolytic solution may be prepared by dissolving a lithium salt in an organic solvent... Examples of the lithium salt include LiPF_6 [.]”). Accordingly, Petitioner fails to show that Cho discloses or suggests the inclusion of fluorine in its second region (e.g. coating layer). EX-2001, ¶101.

Ultimately, Petitioner’s argument that fluorine is present amounts to another attempt to rely on inherency without proper support. Petitioner has provided no actual evidence that fluorine is deposited, let alone that it forms the claimed crystal structure and alignment. Petitioner has not shown that fluorine “necessarily must

be present,” or “necessarily must be present” in rock-salt crystal structure form. *PAR Pharm.*, 773 F.3d at 1195-96; *id.*, 1196. Petitioner has offered, again, only unsupported assumptions, and therefore cannot rely on inherency to meet its burden. EX-2001, ¶102; *PersonalWeb*, 917 F.3d at 1382–83.

b. Petitioner has not demonstrated that Mg or Ti are present in Cho and Kim

Petitioner alleges that Cho teaches elements 1.6 and 6.5 because “Cho teaches that its ‘coating layer may include a coating element compound, such as an *oxide* of a coating element,’ including Mg and Ti, ‘or a mixture thereof.’” Pet., 68.

Petitioner’s arguments are deficient. EX-2001, ¶103-105. As mentioned earlier, Cho is the patent underlying the Kim article, and both Cho and Kim show experimental data collected from LiNiCoMnO₂-based cathodes that include a coating that, notably, contains no magnesium or titanium, let alone fluorine. In fact, Kim does not disclose magnesium or titanium at all. Yet Petitioner maps Cho’s “coating layer 12a” to the claimed second region, despite the fact that none of the examples in Cho or Kim have a coating layer that contains magnesium, titanium, or fluorine. EX-2001, ¶104; EX-1008, 14:59-60, 15:12-14, 15:23-24, 15:50-52; EX-1009, 2. Thus, a POSITA would not have found it obvious to have arrived at the claimed “second region” composition based on the teachings of Cho and Kim.

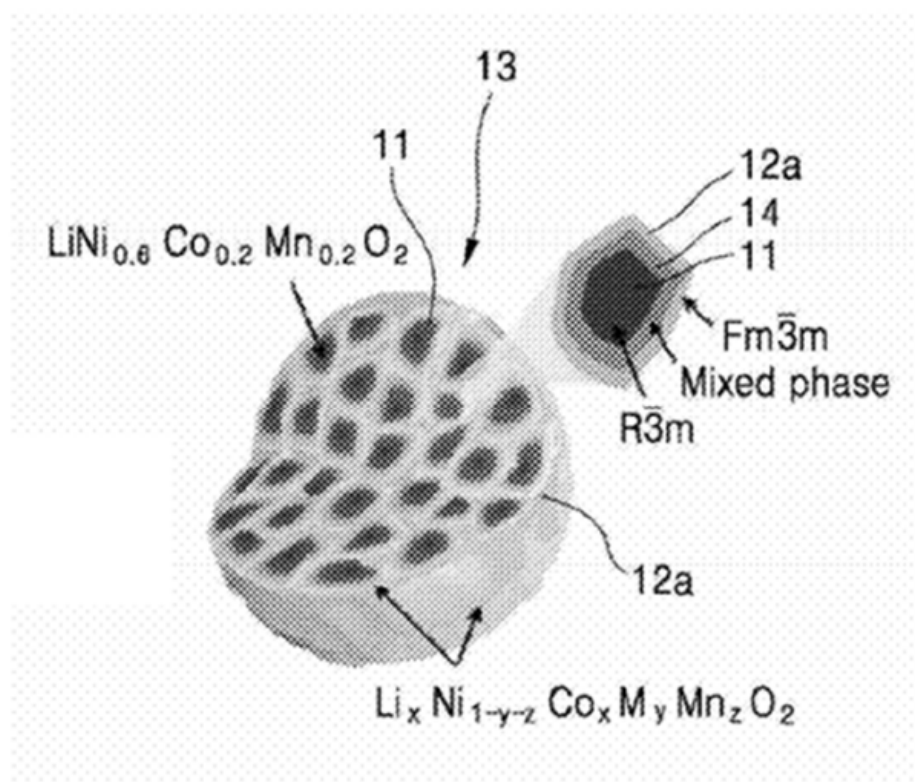
To reach the '660 Patent's claim limitation, Petitioner relies on impermissible hindsight to cherry pick magnesium and titanium from an expansive list of metals and combinations of metals provided in Cho's disclosure—lists that are found nowhere in Kim. *Sanofi-Aventis*, 933 F.3d at 1378-79. Cho discloses that its “coating layer may include a compound represented by Formula 2:”



where “M is a transition metal” can include at least 17 individual metals such as “one or more of Mg, Ca, Sr, Ba, Ti, Zr, Nb, Mo, W, Zn, Al, Si, Mn, Cr, Fe, V, or a rare earth element.” EX-1008, 7:55-60, 7:38-39. And while magnesium (Mg) and titanium (Ti) are listed as potential transition metals, the number of possible combinations resulting from 17 potential transition metals in a formulation would be vast—theoretically resulting in millions of possible combinations, and that is without further accounting for other potential main elements (e.g., Li, Ni, Co, Mn, O₂). EX-2001, ¶105. Petitioner provides no rationale for why a POSITA would choose either magnesium or titanium, or to use them together, particularly when all of Cho and Kim's examples consistently use nickel and manganese instead.

2. Petition Fails to Show that Cho Alone or in Combination with Kim Renders Obvious that “[a] First Region Comprises a Layered Rock-Salt Crystal Structure” and “[a] Second Region Comprises a Rock-Salt Crystal Structure” (Elements 1.3-1.4 and 6.3-6.4)

Petitioner alleges that Cho discloses a “first region [that] comprises a layered rock-salt crystal structure” and “second region [that] comprises a rock-salt crystal structure” because “Cho’s first region has ‘a layered structure (a space structure of R-3m),’” and “Cho’s second region has ‘coating layer 12a’ with ‘rock-salt layer structure (a space group of Fm-3m),’” as depicted in Figure 1 (reproduced below).
Pet., 63-67; EX-1008, 7:7–14.



EX-1008, Fig. 1 (excerpted).

Petitioner’s arguments are unfounded for multiple reasons. EX-2001, ¶¶106-109.

First, Petitioner's fixation on Cho's Figure 1 is misleading to the extent it suggests that Cho's only disclosure is of a layered rock-salt crystal structure (i.e., space group R-3m) and a rock-salt crystal structure (i.e., space group Fm-3m). Inspection of Cho's Figure 1 shows that this example is specific to nickel-based active compositions, and more specifically, NCM compositions (i.e., LiMO_2 , with $\text{M} = \text{Ni, Co, and Mn}$). EX-1008, 7:7-10 ("As shown in FIG. 1...a *coating layer 12a contains NCM* having a rock-salt layer structure (a space group of Fm3m) on a surface of the primary particle"); *see also* 6:53-65. But it was well-known that many of the cathode active materials disclosed by Cho, such as lithium iron phosphate (LiFePO_4), do *not* have a layered rock-salt crystal structure. EX-1008, 9:7-58; *see also* EX-2014, 13:55-56 ("Electrode materials with the olivine structure LiFePO_4 (triphylite)"); EX-2015, 1:60-63 (" LiFePO_4 [has] been most widely studied among olivine-structured compounds."); EX-2001, ¶107.

Thus, while it might have been understood that Cho's Figure 1 and its examples are specific to crystal structures associated with nickel-based composite cathode active material, it would not have been obvious to a POSITA that those same crystal structures would be applicable to *other* "cathode active material[s]" known in the art. EX-1008, 9:16-20, 9:21-22; EX-2001, ¶108. Accordingly, a POSITA would not have understood or found obvious that the known cathode

active materials disclosed by Cho, such as lithium cobaltate, exhibit the same crystal structures as those associated with Cho's specific nickel-based active materials. EX-2001, ¶108.

Second, the formulations depicted in Figure 1 are missing critical elements from the '660 Patent's claim limitations that a POSITA would understand were likely to affect the crystal structure. For example, Cho's Figure 1 does not include fluorine, as required by claims 1 and 6 and discussed above. Moreover, Petitioner points to nothing in Cho that suggests that the claimed second region, which requires titanium, magnesium, fluorine, and oxygen all together, would have the same crystal structure shown in Cho's limited depiction. EX-2001, ¶109.

For example, to the extent that Petitioner argues that "second region comprises fluorine...in view of a LiPF_6 electrolyte" because "[a] POSITA would have understood that such reactions of LiPF_6 would lead to the formation of a fluorine-coating layer on the cathode surface," nothing in Cho nor Kim teaches or suggests that fluorine is present in the second region, or that it originates from a decomposition product of LiPF_6 , let alone that it has the claimed rock-salt crystal structure. Pet., 68; EX-2001, ¶110. The Petition entirely fails to address whether or how fluorine deposited through a decomposition process would have been expected to result in a rock-salt crystal structure. As discussed above, to the extent

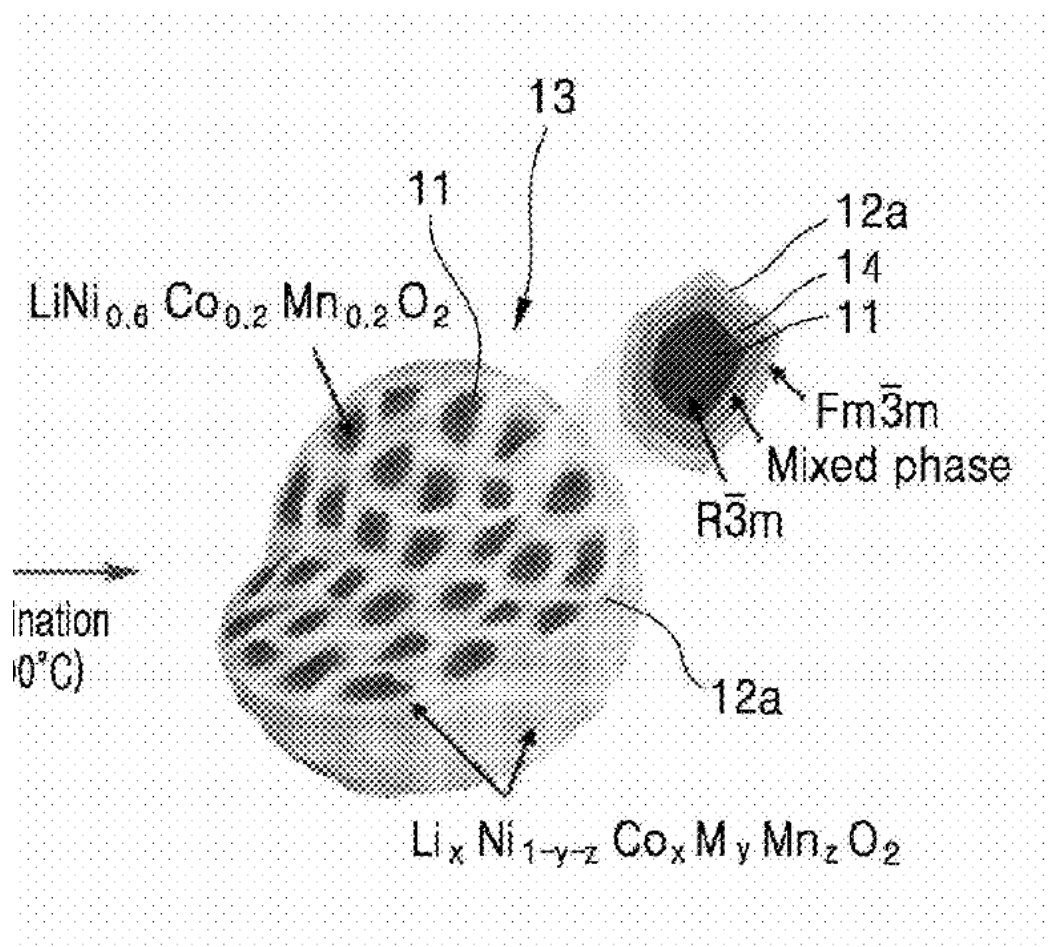
Petitioner argues that fluorine is deposited on the surface in the form of LiF, a POSITA would have understood that LiF can also be amorphous, and therefore is not limited to rock-salt crystal structure. *See* EX-2005, 4-5; EX-2004, 5-6; EX-2001, ¶110.

3. Petition Fails to Show that Cho Alone or in Combination with Kim Renders Obvious the Claimed Relative Crystal Structure (Elements 1.7 and 6.7)

Petitioner alleges that Cho discloses Elements 1.7 and 6.7 because “Cho teaches a ‘cation-mixing layer’ that is also part of the second region, since it comprises the coating and ‘ha[s] a rock-salt phase,’” (Pet., 66 (citing EX-1008, 5:48–52)), and because “Cho’s Figure 7C demonstrates substantial alignment between the rock-salt crystal of the second region (cation mixing layer) and the layered rock-salt crystal of the first region,” (Pet., 69). However, Petitioner’s arguments are flawed. EX-2001, ¶¶111-114.

Contrary to Petitioner’s assertions, Cho’s “cation-mixing layer” is not part of Cho’s coating layer. EX-2001, ¶¶112. Petitioner conflates Cho and Kim’s disclosure of the “cation-mixing layer” and the “coating layer.” To be clear, Cho discloses that “the coating layer [is] formed on a surface of the primary particle,”

and that the primary particle itself—i.e., not the coating layer—can have a cation-mixing layer. EX-1008, 5:51-53 (“A surface phase *of the primary particle* may be a cation-mixing layer having a rock-salt phase”). Additionally, Cho explains that “[a]n intermediate region 14 having a mixed phase may be formed *between* the primary particle 11 and the coating layer 12a.” *Id.*, 7:12-14. But again, the “intermediate region 14” is distinguished as being a *separate* region from Cho’s coating layer. *See id.*, Fig. 1, Claim 11 (“a mixed phase is *between* the primary particle and the coating layer.”). Elsewhere, Petitioner acknowledges that the “mixed phase” is formed *between* Cho’s first and second regions, (Pet., 63), stating “Cho teaches a first region with space group R-3m and second region 12a with space group Fm-3m. Moreover, *Cho teaches a ‘mixed phase’ formed between the two regions*,” and referencing Figure 1:



EX-1008, Fig. 1

However, even if Cho’s “intermediate layer” were part of Cho’s second region, i.e., the coating layer (which it is not), Petitioner’s allegation that Cho and Kim render obvious Elements 1.7 and 6.7 still fails. Pet., 69-70. Kim discloses that the crystal orientation of the first region (i.e., surface of the primary particles) and the second region (e.g., coating layer) associated with Ni-rich cathodes of the Cho-Kim combination would be *dissimilar* because the surface layer is composed of “primary particles (grains) [that] are aggregated” and “have different

crystallographic orientation and slip planes.” EX-1009, 1 (“The Ni-rich cathode materials...are composed of round-shape secondary particles in which many micrometer-sized *primary particles (grains) are aggregated*” and “all these primary particles have *different crystallographic orientation and slip planes*, anisotropic lattice volume expansion or contraction between the grains during lithium intercalation or deintercalation”). It would not have been obvious to a POSITA that any coating layer (or even an intermediate layer) would be in the same crystal orientation with an underlying second region made up of an aggregated underlying substrate having a multitude of “different crystallographic orientation and slip planes.” EX-2001, ¶113.

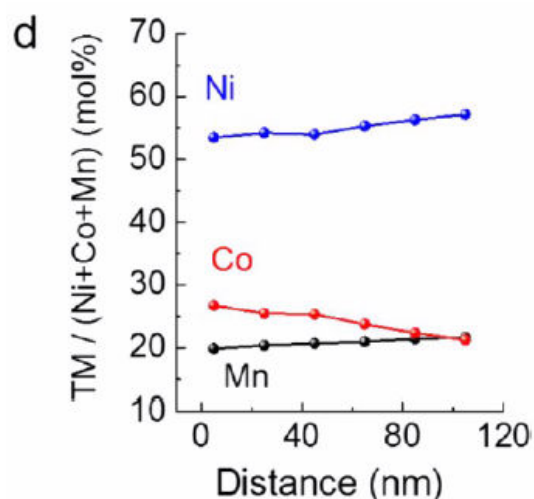
Lastly, Petitioner also points to Figure 8B, but this figure is irrelevant. Figure 8B shows “Comparative Example 1”, which are *uncoated* NCM particles instead of the NCM particles that include a coating layer, which Petitioner mapped to as the “second region” in the claims. *See* Pet., 63 (“Cho teaches a...second region 12a with space group Fm-3m.”) (citing to EX-1008, Fig. 1); EX-2001, ¶114.

4. Petition Fails to Show that Cho Alone or in Combination with Kim and/or Yamamoto Renders Obvious the Claimed Magnesium Distribution (Element 6.6)

Element 6.6 requires Petitioner to show that some combination of Cho, Kim, and Yamamoto discloses “wherein the second region extends from a surface of the

positive electrode active material particle to an inside of the positive electrode active material particle where magnesium detected by a line analysis of energy dispersive X-ray spectroscopy (EDX) in a depth direction is $\frac{1}{5}$ of a maximum peak of the magnesium in the line analysis[.]” EX-1001, cl. 6. Petitioner argues that “Cho renders this element obvious.” Pet., 82. But as discussed above, Cho does not disclose a *single* example using magnesium; instead both Cho and Kim, the scientific article underlying Cho, *only* include data using nickel and manganese. See EX-1008, 14:59-60, 15:12-14, 15:23-24, 15:50-16:5; EX-1009, 2112. Kim is completely silent as to magnesium, and the only place magnesium can be found in Cho is in a laundry list of over seventeen different potential transition metals. EX-1008, 7:55-60, 7:38-39. Therefore, neither Cho nor Kim can disclose the required distribution of magnesium. EX-2001, ¶¶115-120.

Additionally, to the extent magnesium is somehow incorporated into Cho or Kim’s particles, the evidence in Cho and Kim indicates that the concentration of magnesium would more likely be *constant* across the particle. In Kim’s Figure 1 (similar to Cho’s Figures 5B and 6B), EDX spectra show roughly constant amounts of nickel, cobalt, and manganese, as deep as 100 nm into Kim’s particle:



EX-1009, 2.

Assuming, as Petitioner argues, that magnesium is substituted for either nickel or manganese, the above figure suggests the distribution would be relatively *constant*. EX-2001, ¶116. Petitioner points to no evidence in Cho or Kim suggesting that, if magnesium were present, then at any point in the particle it would reach 1/5 of the maximum peak as required by the claims. Therefore, Petitioner's argument that "the concentration of magnesium in a PEAM particle is a result-effective variable whose optimization could have been discovered by routine optimization" is simply wrong. Pet., 83. The concentration and distribution of magnesium is process-dependent. EX-2001, ¶116.

Petitioner is instead forced to rely upon Yamamoto's EDX line analysis. But Petitioner provides no explanation for how a POSITA would combine Yamamoto with Cho, when they disclose different coating materials and different

coating techniques. On the one hand, Yamamoto only discloses using MgO as a coating material. Cho discloses a coating that includes Li, Ni, Co, Mn, and O. Further, if Petitioner's argument is credited, then Cho discloses an even more complex coating that also includes Mg, Ti, and F. But Cho never discloses a MgO coating. Comparing Yamamoto and Cho's coatings is therefore comparing apples to oranges. EX-2001, ¶117.

Similarly, Yamamoto and Cho disclose entirely different coating processes. Cho uses a "mixed ethanol solution with dissolved lithium and cobalt precursors." EX-1009, 2; EX-1008, 14:23-56. Yamamoto, on the other hand, uses "pulsed laser deposition" to apply extremely thin coatings of MgO. EX-1007, 1-2. Petitioner provides no explanation for how these two techniques could possibly be combined, or why a POSITA would combine them. EX-2001, ¶118. Petitioner provides a cursory argument that their "complementary teachings" "would have involved routine implementation with no technical risks," (Pet., 79), but that boilerplate language provides no information about how a POSITA would implement the alleged combination. Petitioner has not met its burden to show that Cho and Yamamoto should (or even could) be combined.

To the extent Petitioner relies on Yamamoto's EDX line analysis results, Petitioner provides no rationale for why a POSITA would rely on Yamamoto's

EDX results when Cho itself discloses EDX results for its particles. Petitioner provides no explanation for how or why Yamamoto’s EDX line analysis would apply to Cho, particularly when Cho’s own EDX line analysis is markedly different. EX-2001, ¶119.

Finally, Petitioner’s argument that “a POSITA would have been motivated to combine Cho and Yamamoto for the reasons explained in Section X.B.1,” (Pet., 83), falls flat because Section X.B.1 discusses a different set of prior art—i.e., a combination of Blangero, Shim and Yamamoto—and therefore is not applicable to the combination of Cho, Kim, and Yamamoto. EX-2001, ¶120.

VII. THE PETITION SHOULD BE DENIED FOR FAILING TO PROVIDE SUFFICIENT EVIDENCE TO ESTABLISH THAT YAMAMOTO AND KIM ARE PRINTED PUBLICATIONS

Institution should be denied for the additional reason that Petitioner has failed to meet its required burden of showing that Yamamoto and Kim each qualify as prior art printed publications that were publicly accessible before the critical date of the ’660 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, 16 (PTAB Dec. 20, 2019)

(precedential). “[A]t 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[.]” *Id.*, 13; *see also* 35 U.S.C. § 312(a)(3).

Here, the Petition fails to address any evidence, let alone “with particularity,” that either Yamamoto or Kim were publicly accessible before the critical date. The Petition instead makes a bare assertion that Yamamoto and Kim are prior art references that published on certain dates without any explanation of the basis for those dates. Pet., 4-5 This approach directly contradicts *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 ’660 patent.

Petitioner submits a declaration from Ms. Babbitt (EX-1041)—an employee of Petitioner’s counsel’s law firm—that identifies the publication dates for Yamamoto and Kim provided on pp. 4-5 of the Petition. But Ms. Babbitt’s declaration is never discussed in the Petition, and the Petition’s single citation to the declaration without more amounts to an improper incorporation by reference and a blatant attempt to circumvent the Petition’s word count limit. *Microsoft Corp. v. ThroughPuter, Inc.*, IPR2023-00852, Paper 15 at p. 6, FN5 (PTAB Oct.

11, 2023) (“the incorporation of arguments [into the petition] arising from” librarian declarations is prohibited by 37 C.F.R. § 42.6(a)(3) to “eliminate abuses”).

Even if Ms. Babbitt’s declaration were credited (which it should not be), it still fails to address the legal requirements for public accessibility. The declaration states only that Exhibits 1007 and 1009 are “true and correct cop[ies]” of Yamamoto and Kim while parroting the dates printed on the face of the documents. But this language speaks merely to authentication under the Federal Rules of Evidence rather than the requirements for public accessibility under *Hulu*. In *Hulu*, the Board did not hold that any particular indicia on the face of the reference is sufficient *per se* at institution. *Hulu*, 17. In *Axis Communications AB v. Avigilon Fortress Corp.*, 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. IPR2019-00235, Paper 24, 16 (PTAB June 26, 2020) (denying institution). Petitioner’s mere proffer of dates that appear on documents retrieved online without any additional evidence regarding the validity of the dates, whether an interested searcher would have been able to locate and access the documents by the Critical Date, or whether the documents were actually

disseminated to the public before the Critical Date is simply not enough for Petitioner to meet its burden under *Hulu*. Institution should be denied.

VIII. THE PETITION SHOULD BE DENIED BECAUSE IT FAILS TO IDENTIFY “WITH PARTICULARITY” THE GROUNDS FOR EACH CHALLENGE

Under 35 U.S.C. §312(a), the Board may consider a Petition only if it “identifies, in writing and with particularity, each claim challenged, the grounds on which the challenge to each claim is based, and the evidence that supports the grounds for the challenge to each claim.” *See also* 37 C.F.R. §42.104(b)(5); 37 C.F.R. §42.22(a)(2); *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016) (“In an IPR, the petitioner has the burden from the onset to show with particularity why the patent it challenges is unpatentable.”). Here, the Grounds are based on five references presented in an amalgamation of “alone or in combination with,” as well as “and/or” alternative permutations, without explanation as to how exactly the primary reference is being modified in each of the various permutations or, more importantly, how the resulting combination would operate. The Petition therefore fails to satisfy this statutory requirement, and institution should be denied.

The Petition attempts to rely on permutations of five references, yet fails to support any of these permutations “with particularity.” *See, e.g.* Pet., 5-6. Instead,

each ground is presented as a grab bag of prior art parts. “The lack of clarity in Petitioner’s presentation deprives Patent Owner of a fair opportunity to respond fully to the Petition and does not lend itself to informed evaluation by the panel.”

Smith & Nephew, Inc. v. Conformis, Inc., IPR2017-00545, Paper 8, 12-13 (PTAB July 13, 2017) (denying institution).

Critically, it is Petitioner’s burden, not the responsibility of the Board or the Patent Owner to piece together disparate teachings in a multitude of references presented in combination “and/or” in the alternative. *See id.*, 13 (“we decline to parse through the Petition and attempt to develop arguments on Petitioner’s behalf supporting a ground of unpatentability that relies on [multiple references] in the alternative”); *Securus Techs., Inc. v. Global Tel-Link Corp.*, IPR2015-00153, Paper 12, 8 (PTAB May 1, 2015) (Petition “must make all arguments accessible to the judges, rather than ask them to play archaeologist with the record”) (internal quotation omitted); *LaVelle Indus., Inc. v. Danco, Inc.*, IPR2017-00159, Paper 18, 8 n.2 (PTAB May 4, 2017) (denying institution and explaining that “[t]he function of the Board is not to comb through a petitioner’s arguments in order to decipher the strongest argument or to determine the strongest combination of references to challenge the claims”); *see United States v. Dunkel*, 927 F.2d 955, 956 (7th Cir. 1991) (“Judges are not like pigs, hunting for truffles buried in briefs.”).

The failure of the Petition to set forth the Grounds “with particularity” is especially apparent when considering the numerous combinations disguised as 6 grounds (I.A-II.D). *Medtronic, Inc. v. Barry*, IPR2014-01210, Paper 10, 6 (PTAB Feb. 10, 2015) (denying institution and stating that “[c]hallenges framed this way constitute multiple, separate grounds”). The 6 Grounds (I.A-II.D) amount to at least 14 different permutations of combining the two sets of multiple ground references:

- 1) Blangero
- 2) Blangero and Shim
- 3) Blangero, Shim, and Yamamoto
- 4) Blangero and Yamamoto
- 5) Cho
- 6) Cho and Kim
- 7) Cho, Kim, and Blangero
- 8) Cho and Blangero
- 9) Cho, Kim, and Yamamoto
- 10) Cho and Yamamoto
- 11) Cho, Kim, Yamamoto and Blangero
- 12) Cho, Kim, and Blangero
- 13) Cho and Blangero
- 14) Cho, Yamamoto and Blangero

Additionally, these fourteen different combinations do not include the corroborating background references that Petitioner relies upon for various arguments. When those references are considered, the number of potential combinations increases exponentially. Because the Petition does not set forth its grounds with particularity, institution should be denied.

IX. THE BOARD SHOULD EXERCISE ITS DISCRETION UNDER 35 U.S.C. § 325(d) TO DENY INSTITUTION⁷

A. Legal Standard

In *Advanced Bionics, LLC v. MED-EL Elektromedizinische Geräte GmbH*, the PTAB established a “two-part framework” for determining whether 35 U.S.C. §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.” IPR2019-01469, Paper 6 (PTAB Feb. 13, 2020) (precedential). “If 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.

⁷ Regarding the Board’s discretion under 35 U.S.C. § 314(a), a scheduling order for the parallel district court litigation has not yet issued. Patent Owner reserves all rights to seek briefing on *Fintiv*-related issues should a scheduling order issue.

B. Blangero and Yamamoto Were Presented to the Patent Office and the Office Did Not Err in a Manner Material to Patentability.

Petitioner's Ground I.A and I.B rely on Blangero alone or in combination with Shim and/or Yamamoto. Petitioner's Ground II.B, II.C, and II.D rely on Cho alone or in combination with Kim, Blangero, and/or Yamamoto. But both Blangero and Yamamoto were cited in IDS forms submitted to the Patent Office on December 21, 2020 and August 3, 2020, and were considered by the Examiner on January 5, 2021 and September 15, 2020, respectively.⁸ See EX-1002, 265, 1041, 1310, 1331. Therefore, the first part of the *Advanced Bionics* framework is satisfied.

The Examiner did not err in allowing the application that issued as the '660 Patent over Blangero and Yamamoto. For all of the reasons explained above, Blangero and Yamamoto fail to disclose or render obvious any claim of the '660 Patent. Therefore, "it *cannot* be said that the Office erred in a manner material to patentability." *Advanced Bionics*, Paper 6, 9. Since Blangero and Yamamoto

⁸ Additionally, three articles related to Shim were also submitted on an IDS and considered by the Examiner. See EX-1002, 263-265, 308-310 (disclosing EX-1032, EX-2013, and EX-2019).

satisfy the two-part *Advanced Bionics* framework, the Board should exercise its discretion and deny institution.

C. Petitioner's Prior Art Is Cumulative to Yura (US20120258358A1) and Liu (CN 102610806)

In the prosecution history of the '660 Patent, the Examiner considered prior art that was substantially similar to the combinations of (i) Blangero, Shim, and Yamamoto and (ii) Cho, Kim and Yamamoto, as well as knowledge and references that would have been known to a POSITA at the time and Petitioner has not shown that the Office erred in a manner material to the patentability of challenged claims. Indeed, Petitioner barely addresses §325(d). Pet., 6-7.

In the Notice of Allowability dated February 22, 2021, the Examiner cited Yura (US 2012/0258358 A1) as “[t]he closest prior art of record,” and noted that:

Yura discloses a lithium-ion secondary battery (1) comprising a positive electrode (2), the positive electrode (2) comprising a positive electrode active material particle comprising lithium cobaltate, wherein the positive electrode active material particle comprising a first region and a second region, wherein the first region comprises a layered rock-salt crystal structure, wherein the second region comprises a rock-salt crystal structure, wherein the second region covers at least a first part of the first region, wherein a crystal orientation of at least a second part of the first region and a crystal orientation of at least a part of the second region are substantially aligned with each other.

EX-1002, 1363 (internal citations omitted). Thus, to the extent that Petitioner relies upon Blangero, Shim, Yamamoto, Cho, or Kim to disclose these features, these references are merely cumulative to Yura, (EX-2018), which was specifically addressed in the Examiner's reasons for allowance. *See* EX-2018, Fig. 3, [0018], [0061]-[0062]. Additionally, to the extent Petitioner relies upon Blangero, Shim, Yamamoto, Cho or Kim to disclose coating layers and their benefits, these references are still merely cumulative to Yura.

The Examiner found that Yura did not disclose “wherein the positive electrode active material particle comprises titanium, magnesium, fluorine, and oxygen in the second region.” EX-1002, 1363. Although Petitioner argues that Blangero, Shim, Yamamoto, Cho, or Kim disclose or render obvious this additional feature, it is critical to note that, like Yura, none of these references *explicitly* discloses these features in combination with the claimed crystal structure alignment. Instead, as described above, Petitioner's arguments with respect to the foregoing features focus on what a POSITA would *implicitly* understand based upon the combination of the disclosures in (i) Blangero, Shim, and Yamamoto or (ii) Cho, Kim and Yamamoto. In other words, although Petitioner claims that these combinations disclose features that the Examiner did not find in Yura, their disclosures are no different than Yura's disclosure. Thus, Blangero, Shim,

Yamamoto, Cho and Kim are merely cumulative to art already considered by the Office, satisfying the first part of the *Advanced Bionics* framework.

Additionally, earlier in prosecution, on September 21, 2020, the Examiner rejected the claims over Liu (CN 102610806), finding that Liu disclosed a PEAM “compris[ing] titanium, magnesium, fluorine, and oxygen in a range from a surface of the positive electrode active material particle to an inside of the positive electrode active material particle where a concentration of the magnesium which is detected by analysis in a depth direction is 1/5 of a peak[.]” EX-1002, 277-278 (citing Liu (*id.*, 317-340)). Thus, this same claimed composition was considered by the Examiner when it allowed the claims over Liu. For this additional reason, Petitioner’s art is 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 material error in the Examiner’s allowance of the ’660 Patent over Yura and Liu, as required by the second prong of the *Advanced Bionics* framework. Therefore, the Board should exercise its discretion and deny institution of the Petition.

X. CONCLUSION

For the foregoing reasons, Patent Owner requests that the Board deny institution of the Petition.

Respectfully submitted,

Date: December 19, 2023

/Nicholas W. Stephens/

Nicholas W. Stephens, Reg. No. 74,320

Grace J. Kim, Reg. No. 71,977

Casey M. Kraning, *pro hac vice*

Fish & Richardson P.C.

60 South Sixth Street, Suite 3200

Minneapolis, MN 55402

T: 202-783-5070

F: 877-769-7945

CERTIFICATION UNDER 37 C.F.R. §42.24(d)

Under the provisions of 37 C.F.R. §42.24(d), the undersigned hereby certifies that the word count for the foregoing Patent Owner's Preliminary Response to Petition totals 13,938 which is less than the 14,000 allowed under C.F.R. §42.24(b)(1).

Date: December 19, 2023

/Nicholas W. Stephens/

Nicholas W. Stephens, Reg. No. 74,320

Grace J. Kim, Reg. No. 71,977

Casey M. Kraning, *pro hac vice*

Fish & Richardson P.C.

60 South Sixth Street, Suite 3200

Minneapolis, MN 55402

T: 202-783-5070

F: 877-769-7945

CERTIFICATE OF SERVICE

Pursuant to 37 CFR § 42.6(e), the undersigned certifies that on December 19, 2023, complete and entire copies of this Patent Owner's Preliminary Response and its supporting exhibits were provided via email to the Petitioner by serving the correspondence address of record as follows:

Yimeng Dou, Reg. No. 69,770
W. Todd Baker, Reg. No. 45,265

KIRKLAND & ELLIS LLP
ATL_IPR@kirkland.com

/Crena Pacheco/
Crena Pacheco
Fish & Richardson P.C.
60 South Sixth Street, Suite 3200
Minneapolis, MN 55402
pacheco@fr.com