

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

LG ENERGY SOLUTION, LTD.,
Petitioner,

v.

MOLECULAR REBAR DESIGN LLC,
Patent Owner.

Case IPR2024-01006
Patent 8,808,909

PETITIONER'S REPLY TO PATENT OWNER'S RESPONSE

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LIST OF EXHIBITS

- LGES-1001 U.S. Patent No. 8,808,909 (“the ’909 Patent”)
- LGES-1002 Excerpts from Prosecution History of the ’909 Patent (“the Prosecution History”)
- LGES-1003 Declaration of Dr. Yu Zhu
- LGES-1004 U.S. Patent Pub. No. 2004/0160156 (“Ohata”)
- LGES-1005 “Multi-walled carbon nanotubes functionalized by carboxylic groups: Activation of TiO₂ (anatase) and phosphate olivines (LiMnPO₄; LiFePO₄) for electrochemical Li-storage.” Ladislav Kavan et al. Journal of Power Sources 195 (2010) 5360-5369 (“Kavan”)
- LGES-1006 U.S. Patent Pub. No. 2010/0136431 (“Lee”)
- LGES-1007 U.S. Patent Pub. No. 2010/0124713 (“Farrugia”)
- LGES-1008 U.S. Patent Pub. No. 2012/0064409 (“Zhamu”)
- LGES-1009 “Chemical oxidation of multiwalled carbon nanotubes.” V. Datsyuk et al. Carbon 46 (2008) 833-840 (“Datsyuk”)
- LGES-1010 “Surface and structural characterization of multi-walled carbon nanotubes following different oxidative treatments.” Kevin A. Wepasnick, et al. Carbon 49 (2011) 24-36 (“Wepasnick”)
- LGES-1011-1013 Reserved
- LGES-1014 “Surface modified multi-walled carbon nanotubes in CNT/epoxy-composites.” Florian H. Gojny, Jacek Nastalczyk, Zbigniew Roslaniec, Karl Schulte. Chemical Physics Letters 370 (2003)

820–824 (“Gojny”)

LGES-1015 “Sonochemical Oxidation of Multiwalled Carbon Nanotubes.”

Yangchuan Xing, Liang Li, Charles C. Chusuei, and Robert V.

Hull. *Langmuir* 2005, 21, 4185-4190 (“Xing”)

LGES-1016-1024 Reserved

LGES-1025 “The structure and property characteristics of
amorphous/nanocrystalline silicon produced by ball milling.” T.D.
Shen, et al. *Journal of Materials Research* 10 (1995), 139-149
 (“Shen”)

LGES-1026 “Crystal-amorphous phase transition induced by ball-milling in
silicon.” E. Gaffet, M. Harmelin. *Journal of the Less Common
Metals* 157 (1990), 201-222 (“Gaffet”)

LGES-1027 U.S. Patent No. 9,012,073 (“Kumar”)

LGES-1028 U.S. Patent No. 9,190,694 (“Lopez”)

LGES-1029 U.S. Patent No. 7,851,085 (“Obravac”)

LGES-1030 “Labeling the Defects of Single-Walled Carbon Nanotubes Using
Titanium Dioxide Nanoparticles.” Xiaohong Li, Jiali Niu, Jin
Zhang, Hulin Li, and Zhongfan Liu. *The Journal of Physical
Chemistry B* 107 (2003) 2453-2458 (“X. Li”)

LGES-1031 Excerpts from Prosecution History of EP2724403B1

LGES-1032 U.S. Patent No. 8,241,794 (“Sheem”)

LGES-1033 “TiO₂ rutile—An alternative anode material for safe lithium-ion
batteries.” M. Pfanzelt, P. Kubiak. *Journal of Power Sources* 106

- (2011) 6815-6821 (“Pfanzelt”)
- LGES-1034 U.S. Patent Pub. No. 2011/0159366A1 (“Nakura”)
- LGES-1035 U.S. Patent Pub. No. 2009/0117463A1 (“Takezawa”)
- LGES-1036 Reserved
- LGES-1037 “Preparation of Nanocomposites of Metals, Metal Oxides, and Carbon Nanotubes via Self-Assembly.” Jing Li, Songbai Tang, Li Lu, and Hua Chun Zeng. Journal of the American Chemical Society 129 (2007) 9401-9409 (“J. Li”)
- LGES-1038 “Enhanced photocatalytic activity of mesoporous TiO₂ aggregates by embedding carbon nanotubes as electron-transfer channel.” J. Yu, T. Ma, S. Liu. Phys. Chem. Chem. Phys. 13 (2011) 3491–3501 (“Yu”)
- LGES-1039 “Long-time low-impact ball milling of multi-wall carbon nanotubes.” A. Kukovecz, T. Kanyo, Z. Konya, I. Kiricsi. Carbon 43 (2005) 994-1000. (“Kukovecz”)
- LGES-1040 “Green energy storage materials: Nanostructured TiO₂ and Sn-based anodes for lithium-ion batteries.” D. Deng, M. Kim, J. Lee, J. Cho. Energy & Environmental Sciences 2 (2009) 818-837 (“Deng”)
- LGES-1041 “Hydrothermal synthesis of lithium iron phosphate.” J. Chen, M. Whittingham. Electrochemistry Communications 8 (2006) 855-858 (“Chen”)
- LGES-1042 “The preparation and electrochemical performances of LiFePO₄-

multiwalled nanotubes composite cathode materials for lithium ion batteries.” Y. Feng. *Materials Chemistry and Physics* 121 (2010) 302-307 (“Feng”)

LGES-1043 “Preparation of Single-Walled Carbon Nanotube/Silicon Composites and Their Lithium Storage Properties.” J-Y. Eom, H-S. Kwon. *Applied Materials & Interfaces* 3 (2011) 1015-1021 (“Eom”)

LGES-1044 A. Hirsch. “Functionalization of Single-Walled Carbon Nanotubes” *Angew. Chem. Int. Ed.* 2002, 41, No. 11, 1853-1859 (“Hirsch”)

LGES-1045-1049 Reserved

LGES-1050 *Molecular Rebar Design, LLC, and Black Diamond Structures, LLC v. LG Energy Solution, Ltd.*, Plaintiffs’ Disclosure of Asserted Claims and Infringement, 2:24-cv-00107-JRG

LGES-1051 Declaration of June Ann Munford (Kavan)

LGES-1052 Declaration of June Ann Munford (Wepasnick)

LGES-1053 *Molecular Rebar Design, LLC, et al. v. LG Energy Solution, Ltd.*, Sample Docket Control Order, 2:24-cv-00107-JRG

LGES-1054 Deposition Transcript of Dr. Deborah Chung in IPR2024-01006 (’909 Patent)

LGES-1055 Deposition Transcript of Dr. Deborah Chung in IPR2024-01005 (’649 Patent)

LGES-1056 Supplemental Declaration of Dr. Yu Zhu

LGES-1057	Patent Owner's Response in IPR2024-01005 ('649 Patent)
LGES-1058	Declaration of Dr. Yu Zhu in IPR2024-01013 ('483 Patent)
LGES-1059	"Increase the Mechanical Performance of Polyvinylidene Fluoride (PVDF)." M. Hou. Cheng. Advanced Materials Research Vols. 393-395 (2012) ("Hou").
LGES-1060	Patent Owner's Response in IPR2024-01012 ('282 Patent)
LGES-1061	U.S. Patent Pub. No. 2007/0060708 ("Wang")
LGES-1062	"Alternative solvents for Lithium-Nickel-Cobalt-Manganese-Oxide electrode fabrication for lithium-ion-cells." F. Heim et al. Journal of Power Sources 558 (2023) 232546 ("Heim")
LGES-1063	US Patent No. 8,540,902 ("Xing")
LGES-1064-1099	Reserved
LGES-1100	Exhibit LGES-1100 in IPR2024-01005

The Patent Owner Response (“POR”) fails to rebut the Petition’s showing that claims 1-8 are unpatentable over Ohata-Kavan and Lee-Wepasnick. Patent Owner’s (“PO”) arguments are based on technically inaccurate explanations, misinterpretations or misrepresentations of the relied-upon references, and legally deficient rebuttals to positions advanced in the Petition. PO’s arguments are unavailing and the Challenged Claims should be found unpatentable.

I. CLAIM CONSTRUCTION – “DISCRETE”

The Petition did not present a claim construction for the term “discrete.” Although PO similarly did not explicitly offer a construction, it contends—incorrectly—that Petitioner did, asserting that Petitioner’s position is that “discrete” nanotubes must be “‘fully isolated’ or ‘separated’ from one another.” POR, 51-52. PO then adopts this purported construction and applies it throughout the POR.

First, this is a blatant misrepresentation of Petitioner’s position. Second, it is inconsistent with the ’909 Patent itself, which provides no support for such a narrow interpretation.¹

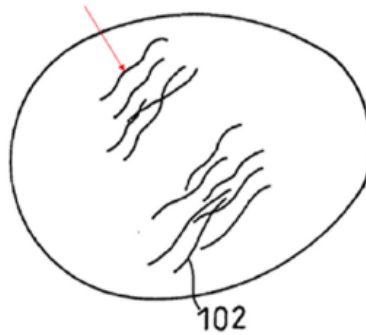
¹ Notably, in IPR2024-01005, PO does offer an explicit construction for the term “discrete” as meaning “carbon nanotubes that are separate and distinct from other

A. PO quotes Petitioner’s expert out of context in attempting to substantiate its position

PO’s citation to statements made by Petitioner’s expert, Dr. Zhu, regarding the term “discrete” omits critical context. *See* POR, 51-52. Dr. Zhu’s agreement that he was “identifying that nanotube [indicated in the figure *infra*] as discrete because it’s fully isolated from the other nanotubes” (MRD-2024, 10:21-11:12) is not, as PO would like to believe, a definition requiring that a nanotube necessarily must be isolated to be discrete. Instead, refers to this particular example. In fact, while the term “discrete” surely encompasses individually isolated nanotubes, the term “discrete” is not limited to only individually isolated nanotubes. LGES-1056, ¶5; *see infra* §§I.B-C.

nanotubes; not attached to other nanotubes.” LGES-1057, 8; *see* LGES-1060, 14 (presenting a similar construction in IPR2024-01012). When questioned at deposition in IPR2024-01005, PO’s expert, Dr. Chung confirmed that she applied the same definition of “discrete” in that proceeding as she has done here. *See* LGES-1055, 118:14-24. To the extent that this explicit construction, instead, is PO’s interpretation of the term “discrete,” it, too, is inconsistent with the plain language of the ’909 Patent and should not be adopted.

"discrete, non-agglomerated, and exfoliated
carbon nanotubes"



LGES-1058, 50

B. The '909 Patent does not support that discrete nanotubes must be fully isolated or separated from one another

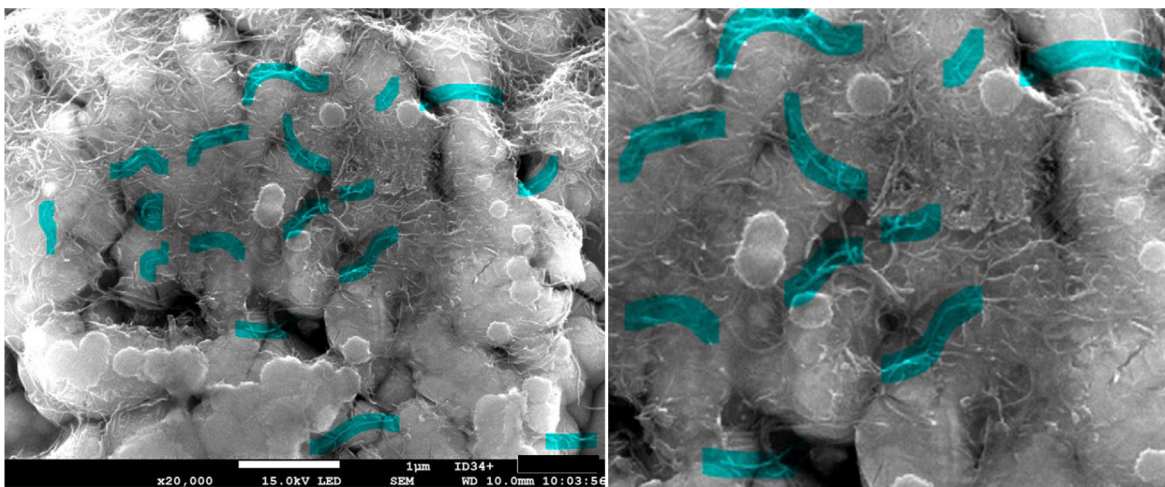
The '909 Patent is unambiguous: "[t]he term 'discrete carbon nanotubes' as used herein refers to carbon nanotubes *capable of being separated* to give individual tubes." LGES-1001, 3:47-49 (emphasis added). Tellingly, PO quotes this very sentence, but only in part, stating that the '909 Patent confirms that "'discrete' CNTs are 'separated to give individual tubes.'" POR, 52. PO's stealthy omission of the key phrase "*capable of*" (LGES-1001, 3:47-49) unjustifiably changes the meaning of this statement, which, when read in its entirety, cannot support PO's narrow interpretation of the term "discrete."

Notably, while this statement in the '909 Patent encompasses nanotubes that are already separated, it is not so limited. Both PO's implicit construction (framed misleading as Petitioner's position) and PO's explicit construction in IPR2024-

01005 are inconsistent with this statement in the '909 Patent, and instead present an overly narrow interpretation that should not be adopted.

C. Requiring “discrete” nanotubes to be isolated contradicts PO’s own positions in co-pending litigation

PO’s narrow construction is undermined by its own infringement contentions, in which PO alleged that the SEM images below depict “discrete” carbon nanotubes; the allegedly discrete nanotubes they highlight clearly depict nanotubes touching each other (original highlighting by PO). *See* LGES-1050, 33; LGES-1056, ¶6-7.



LGES-1050, 33 (original at left, cropped and magnified at right)

PO has thus acknowledged that “discrete” nanotubes need not be physically separated. PO cannot maintain such contradictory positions simultaneously—advocating for one interpretation here and an entirely different interpretation in district court proceedings. This contradiction alone highlights the implausibility

and inconsistency of PO's assertion that discrete nanotubes must be individually isolated.

II. OHATA-KAVAN

A. PO's assertions that the electrode active material is not in contact with the nanotubes in the Ohata-Kavan composition are unphysical and inconsistent with Ohata's disclosure

PO's interpretation of Ohata's morphology as having nanotubes fully embedded in the electrode material, thus precluding attachment between nanotubes and active material particles, runs counter to Ohata's objective of using nanotubes to provide "an excellent conductive path in an electrode." LGES-1004, [0016]. In fact, it was well-understood—and indeed acknowledged by Dr. Chung—that contact between nanotubes and active material is necessary for functional electrode materials. *See* LGES-1054, 17:1-15, 16:2-12; LGES-1056, ¶8.

1. PO's theory that there is no contact between nanotubes and electrode active material is illogical and technically inaccurate

PO argues that the Ohata-Kavan nanotubes are "fully embedded within and coated by the resin matrix," which "prevent[s] the active material from attaching to the surface of the CNTs." POR, 36, 43-44. This is illogical. A composition in which there was no contact between nanotubes and active material, as PO proposes, would simply be non-functional as a battery electrode material. LGES-1056, ¶9.

It is well-established that in battery electrode materials, there must be electrical contact between the active material and the conductive additive, to enable current flow through the electrode. *See* LGES-1056, ¶10 (citing MRD-2017, [0094]; MRD-2018, [0092]). Indeed, Dr. Chung readily acknowledged this to be the case, explaining at deposition that “the conductive additive *needs to be in physical contact with the active material* so that the charges can come out or go in of this active material particle.” LGES-1054, 17:1-15. Said another way, without contact between the conductive additive (*e.g.*, nanotubes) and the active material, the electrode material would be inoperable in a battery. *See* LGES-1054, 16:2-12 , 36:18-37:5 (“you need to have a plurality of nanotubes coming together and making electrical contact between one another -- that is, touching one another ... so as -- as a whole, the network would provide a continuous electrically conductive path.”).

Given this basic physical operation of battery electrodes, the folly of PO’s position becomes apparent. PO argues that a “resin layer separat[es] the active material from the surface of the CNTs” such that “it is impossible for the active material to attach to the surface of the CNTs.” POR, 44. This makes no sense. PO acknowledges that PVDF binder is non-conductive. *See* LGES-1054, 37:22-25 (“PVDF is not conductive”); POR, 19. A configuration in which CNTs are fully embedded within a non-conductive resin and thus electrically isolated from the

active material is not viable and is inconsistent with battery fabrication practices that are specifically intended to enhance conductivity. LGES-1056, ¶¶11, 15-16.

Moreover, PO's position is incompatible with Ohata's stated goal of improving electrical conductivity of electrode materials. Ohata aims to use nanotubes to "form an excellent conductive path in an electrode." LGES-1004, [0016]. Yet this could not happen in PO's hypothetical structure: nanotubes that are "fully embedded" within a non-conductive binder and thus not able to contact one another or the active material particles, as PO proposes (*see* POR, 19), would be unable to provide such a conductive path. LGES-1056, ¶12. Instead, as Dr. Zhu explains and as acknowledged by Dr. Chung, an electrode material without contact between nanotubes and active material would be non-functional, while Ohata's material has good electrochemical performance. *Id.*; LGES-1054, 14:15-18:16; LGES-1004, Table 3; LGES-1056, ¶12.

2. The solubility of Ohata's binder in NMP belies PO's argument that Ohata's nanotubes remain fully embedded in the binder matrix

Even to the extent that Ohata's nanotubes are fully embedded within the PVDF binder of the masterbatch, that embedding would not withstand processing to prepare the electrode material mixture paste. LGES-1056, ¶21. Ohata's masterbatch is mixed with active material particles and NMP, and "[t]he masterbatch *was easily dissolved* in [NMP]." LGES-1004, [0032]. Indeed, that

the PVDF binder of Ohata's masterbatch is readily soluble in NMP was well-known. LGES-1056, ¶13-21 (citing LGES-1061, [0004]; LGES-1062, 2). The solubility of PVDF in NMP refutes PO's allegation that even after processing with NMP, the nanotubes remain "fully embedded within and coated by the resin matrix." POR, 43-44. And in fact, dissolution of PVDF makes sense given the need for physical contact between the nanotubes and active material discussed *supra*. LGES-1056, ¶22.

Moreover, PO's position that "the PVDF coating would be more strongly bound to the oxidized CNTs" is inconsistent with literature reports of a weak interaction between functionalized nanotubes and PVDF. LGES-1056, ¶23 (citing LGES-1059, 5). Given this weak interaction, and the high solubility of PVDF in NMP, a POSITA would have recognized that NMP can in fact substantially remove PVDF from the CNT surface, enabling attachment of active material particles to the nanotubes. *Id.*

3. PO's own corroborating references refute its theory of complete embedding of Ohata's nanotubes in the binder material

PO's mechanistic explanation for why Ohata's nanotubes purportedly remain embedded in the binder is also refuted by general knowledge of the art, evidenced even by PO's own corroborating references. LGES-1056, ¶24.

For instance, PO cites MRD-2017's Figure 2 to argue that carbon nanotubes remain embedded in PVDF "domains," even after NMP dissolution, thereby preventing contact with active material. MRD-2006, ¶123. But PO's interpretation of this figure is speculative and contradicted by MRD-2017's own disclosure. Specifically, MRD-2017 explains that CNTs "form electrical bridges between the active material particles," and this explanation is supported by experimental results indicating that the CNTs are not, in fact, electrically isolated. MRD-2017, [0094], *see* [0123]-[0125]; LGES-1056, ¶25. That is, in MRD-2017, CNTs physically contact the active material, rather than being insulated from the active material, as PO contends. LGES-1056, ¶¶23-24; *see also* MRD-2018, [0092], [0131].

Dr. Chung's own testimony confirms that PO's interpretation of MRD-2017 cannot be sustained. She admitted that Figure 2 is "not very clear," and indeed was unable to identify a single carbon nanotube in the image. LGES-1054, 53:7-57:2. Dr. Chung's statement that CNTs are "hidden inside these domains" is not grounded in what the figure shows, but rather on speculation that contradicts both the image and the specification. LGES-1054, 53:7-57:2. Nor does interpreting Figure 2 in light of the specification, as Dr. Chung proposes, save PO's position. *See* LGES-1054, 54:16-55:10. The specification of MRD-2017 confirms that

CNTs are not embedded and isolated, but instead dispersed and connected to the active material. MRD-2017, [0094], [0123].

Other references PO attempts to use to corroborate its embedded nanotubes theory are likewise insufficient. For instance, MRD-2018 states that CNTs “form electrical bridges between the particles of active material.” (MRD-2018, [0092], [0131]), undermining PO’s assertion that the CNTs become embedded or isolated within the PVDF matrix. LGES-1056, ¶26.

PO’s reliance on MRD-2008 is likewise misplaced and contradicted by the reference itself. PO cites MRD-2008 as describing a “glue-like” process in which carbon black is “embedded in PVDF resin,” analogizing it to the Ohata-Kavan structure. POR, 22. But if the conductive carbon black were truly embedded within PVDF to the point of being isolated from the active material—as PO suggests—the resulting structure would lack the necessary conductivity to function as an electrode. LGES-1056, ¶¶27-30.

B. The nanotubes in the Ohata-Kavan composition are discrete

PO argues that the Ohata-Kavan composition would not include discrete nanotubes because of the presence of a continuous network of nanotubes, but this argument relies on PO’s overly restrictive construction for “discrete.” The term “discrete” does not preclude a network of nanotubes, *e.g.*, in point-to-point contact, providing a conductive pathway through the electrode material, as is the case in

Ohata-Kavan. Indeed, the '909 Patent itself indicates that discrete nanotubes enhance conductivity, well-aligned with the purpose of the Ohata-Kavan nanotubes. LGES-1056, ¶31; *See* LGES-1001, 1:44-50, 2:24-28, 2:4-11, 2:12-17, Table 1.

PO takes issue with the Petition's "reliance on cartoon Figure 1 of Ohata." POR, 53. To be sure, Figure 1 is just a schematic diagram, but one that the Petition demonstrated would have been understood as representing the discrete nanotubes of Ohata's composition. *See* Petition, 20-22. Regardless, PO's myopic focus on Fig. 1 ignores what the Board already recognized at institution (Institution Decision, 17): the Petition relied upon not only Ohata's Fig. 1, but also numerous other citations, bolstered by explanation and expert corroboration, to demonstrate that the nanotubes in the combination are discrete. *See* Petition, 19-22; LGES-1003, ¶¶80-83. Indeed, PO's main objection to the Petition's showing of discreteness in the Ohata-Kavan nanotubes appears to be based not in any criticism of Ohata, but instead in its own excessively narrow interpretation of what constitutes a discrete nanotube.

PO further attempts to argue against the discreteness of the Ohata-Kavan nanotubes fail in their reliance on Gan (MRD-2019)—an entirely different reference. For instance, in addressing the Petition's explanation that oxidation further promotes that the nanotubes are discrete, PO cites to Gan, which, it alleges,

“teaches that functionalized CNTs within a polymer will be drawn closer together ... facilitating the formation of a continuous network.” POR, 58-59 (citing MRD-2019, [0018]-[0021]). Yet as noted *supra*, a continuous, conductive network of nanotubes is consistent with a population of discrete nanotubes, *e.g.*, nanotubes in point-to-point contact. Even to the extent that Gan is relevant to the structure of the Ohata-Kavan composition (which PO has not established), the morphology of Gan’s nanotube network does not demonstrate absence of discrete nanotubes in Ohata-Kavan. LGES-1056, ¶32.

Separately, PO also appears to argue that the Ohata-Kavan nanotubes would be arranged as shown in Gan’s SEM images. *See* POR, 53-54. But PO’s reliance on Gan’s FIG. 5, which illustrates networks of non-oxidized nanotubes, has not been demonstrated by PO to inform POSITA’s views as to oxidized nanotubes within a Ohata-Kavan composition. *See* MRD-2019, [0014]. Indeed, a POSITA would not have drawn any conclusions about the arrangement of the Ohata-Kavan nanotubes from this image of an entirely different material, fabricated in an entirely different way. LGES-1056, ¶33.

C. PO fails to refute the Petition’s several distinct motivations for the Ohata-Kavan combination

The Petition presented six distinct motivations underpinning the Ohata-Kavan combination. PO’s sole objection to several of these motivations is rooted in its mischaracterization of the nanotubes as being fully embedded within the

resin matrix, which, as discussed *supra*, is not the case. And PO's arguments against the other motivations advanced in the Petition are also deficient, leaving PO with no viable rebuttal to the robust Ohata-Kavan combination.

1. PO's objections to the Petition's motivations to combine Ohata and Kavan are premised on its incorrect theory that nanotubes are fully embedded in the binder

PO's argument that "[a] POSITA would have had no motivation to oxidize the CNTs of Ohata pursuant to Kavan, because ... the masterbatch process would destroy all benefits described by Kavan" (POR, 44-45) is premised on PO's flawed understanding of the Ohata-Kavan nanotubes as being fully embedded in the resin. But as established above, this is not accurate. When the structure of the Ohata-Kavan composition is properly understood to involve contact between nanotubes and active material particles, PO's objections to the motivations set forth in the Petition are revealed to be without merit.

Indeed, PO specifically acknowledges that its sole objection to the "first three alleged reasons" for the combination advanced in the Petition is because "[a]ll three reasons are premised on the active material being able to 'anchor' to the functional groups of the oxidized CNTs." POR, 46. But as discussed *supra* (see §II.A), this is not correct: the active material is, in fact, able to anchor to the functional groups on the nanotubes. Accordingly, PO's objections amount to nothing more than a non-sequitur.

The Petition also explained that oxidized nanotubes would promote dispersion of the nanotubes in the composite. Petition, 10. PO asserts that this improved dispersibility is because in Kavan, the functional groups “enhance[] the CNTs’ interaction with water,” while in the Ohata-Kavan composition, “the naked oxidized CNTs are not exposed to water, but instead are first covered in resin,” and thus that “Kavan does not support the assertion that oxidizing the resin-covered CNTs of Ohata-Kavan would improve dispersibility.” POR, 47.

PO’s argument is wrong. First, the Ohata-Kavan nanotubes are not embedded in resin. Second, PO is factually wrong in stating that Kavan uses only water as the dispersion medium. In fact, Kavan uses NMP as the solvent for PVDF and for slurry formation during electrode fabrication. *See* LGES-1005, 2. Third, in Ohata-Kavan, the masterbatch is mixed with NMP and active material, as taught by Ohata. *See* LGES-1004, [0032]; Petition, 7; LGES-1056, ¶35. To the extent that PO views Kavan as teaching dispersibility in water alone, this is nonetheless relevant to the dispersibility of oxidized nanotubes in NMP given that both NMP and water are polar solvents. LGES-1056, ¶35. That is, a POSITA would have recognized that functionalized nanotubes have improved dispersibility not only in water, but also in other polar solvents such as NMP. *Id.*

With regard to the dispersion of nanotubes, MRD also argues that “Ohata already achieves uniform dispersal without oxidation,” and thus “there would have

been no motivation to oxidize to improve dispersion.” POR, 47-48. But PO cites to Ohata’s description of uniform dispersion of nanotubes in its masterbatch. Even if there were no room for improvement in the dispersion of nanotubes in the masterbatch (which is not necessarily true), PO ignores that the presence of oxidative functionalities on the nanotubes would still promote dispersion of the nanotubes in the later-formed NMP slurry. LGES-1056, ¶¶36-37.

Notably, PO’s only arguments against the first three motivations advanced in the Petition assume there is no contact between nanotubes and active material particles; PO does not even attempt to argue that the Petition’s motivations would be inapplicable to a composition in which nanotubes are in contact with the active material particles. And because this is the morphology of the Ohata-Kavan composition, these three motivations stand effectively un rebutted.

2. PO’s objection to the Petition’s identification of purification as a motivation for the Ohata-Kavan combination is legally improper

Regarding the Petition’s explanation that oxidation can remove impurities (*see* Petition, 11), PO argues that “nothing in Ohata or Kavan teaches or suggests that the CNTs have impurities.” POR, 48. This is not the correct analysis. Ohata need not have recognized that its nanotubes possess impurities for the reduction of impurities to motivate the combination. *See Intel Corp. v. PACT XPP Schweiz AG*, 61 F.4th 1373, 1380 (Fed. Cir. 2023) (“Additionally, ‘universal’ motivations

known in a particular field to improve technology provide ‘a motivation to combine prior art references *even absent any hint of suggestion* in the references themselves.’” (citing *Intel Corp. v. Qualcomm Inc.*, 21 F.4th 784, 797 (Fed. Cir. 2021)) (emphasis original)).

And as to PO’s statement that impurities are not a concern because “Kavan teaches that it uses ‘purified’ CNTs” (POR, 48), this is beside the point: the Petition “uses Ohata as a starting point,” not Kavan. Petition, 7.

3. PO overlooks that the Petition’s motivations for the Ohata-Kavan combination are rooted in specific oxidation levels

PO’s argument that “Petitioner cannot rely on motivations to oxidize generally” without addressing “whether there was a motivation to use oxidized CNTs at the claimed level of 1% to 15%” (POR, 48) ignores the context underpinning the motivations advanced in the Petition. That is, PO overlooks that the first three reasons advanced in the Petition (*see* Petition, 8-10) are drawn specifically from Kavan’s results, which indicate performance improvements achieved not when using generic oxidized nanotubes, but when using nanotubes oxidized at particular oxidation levels falling within the claimed range.

4. Ohata does not discourage or teach away from oxidation of nanotubes

PO’s assertion that “oxidizing CNTs adversely affects their desirable intrinsic properties, further discouraging a POSITA from oxidizing per Kavan”

(POR, 45; *see* 50) is not sufficient to undermine the Ohata-Kavan combination.

But a POSITA would have known how to balance competing advantages and disadvantages. *See* LGES-1003, ¶49. More generally, the mere existence of a disadvantage to a modification does not negate other established motivations for a POSITA to pursue a combination, here the Ohata-Kavan combination. *See Medichem, S.A. v. Rolabo, S.L.*, 437 F.3d 1157, 1165 (Fed. Cir. 2006) (“a given course of action often has simultaneous advantages and disadvantages, and this does not necessarily obviate motivation to combine”); *Winner Int’l Royalty Corp. v. Wang*, 202 F.3d 1340, 1349 n.8 (Fed. Cir. 2000).

Moreover, PO is incorrect in asserting that Ohata “teaches away from exposing the naked CNTs to the active material.” POR, 50. As already discussed, Ohata does, in fact, expose the CNTs to the active material by way of the dissolution of the masterbatch resin by NMP, and a reference cannot teach away from its own teaching. But the details of PO’s argument reveal PO’s attempt to obscure this reality. In presenting its teaching away argument, PO cites to Ohata’s indication that when incorporating a resin “during the step of preparing an electrode material mixture paste, the addition of the carbon nanotubes is difficult.” POR, 50, citing LGES-1004, [0021]. But while this speaks to challenges of adding nanotubes after masterbatch formation, it nevertheless affirmatively anticipates

their addition. As Dr. Zhu explained, resin can be applied at any stage based on “common sense” and that there is no “definitive order.” *See* MRD-2024, 50-51.

D. PO’s arguments against the POSITA’s expectation of success are rooted in its misunderstanding of the Ohata-Kavan composition

PO argues that “implicit in all of Petitioner’s ‘reasons’ for a reasonable expectation of success is the incorrect assumption that Ohata-Kavan exposes the CNTs to the active material.” POR, 51. But because the nanotubes are, in fact, directly exposed to the active material, as discussed above, PO’s objections are unjustified. And PO fails to provide any rebuttal to the Petition’s proposition that a POSITA would have expected success in the context of oxidized nanotubes promoting better attachment with active material particles, as is the case in the properly framed Ohata-Kavan combination.

E. Claim 6 is obvious over Ohata-Kavan

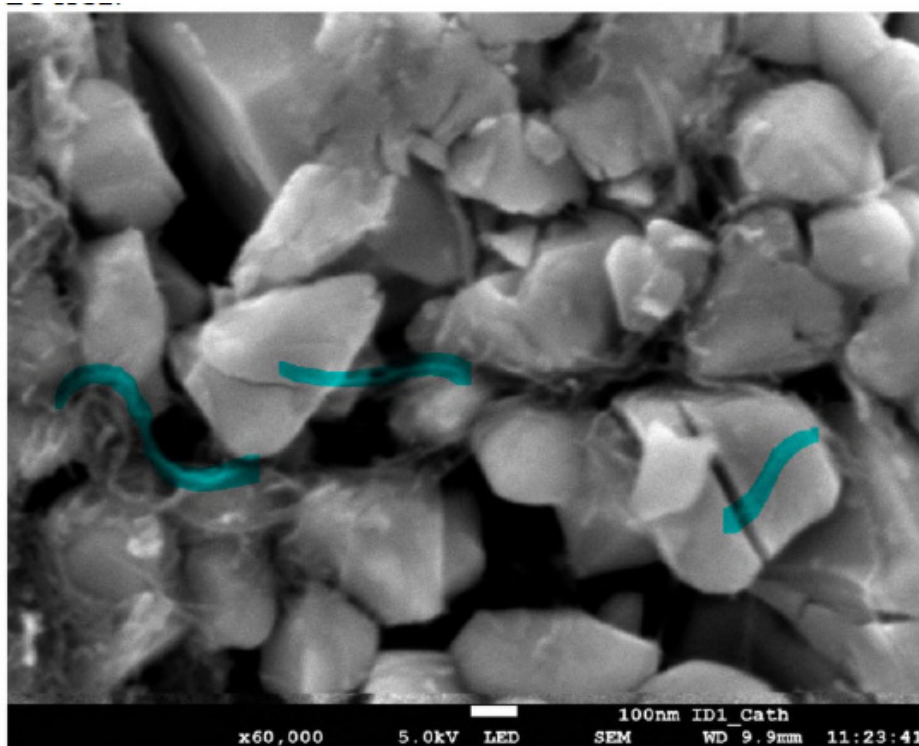
In Ohata’s masterbatch process, carbon nanotubes are the additive (*see* LGES-1004, [0015]-[0016]), and thus, as explained in the Petition, a POSITA would have expected the nanotubes to be uniformly dispersed. *See* Petition, 33-36. PO’s objection to this position fails for two reasons. First, it overlooks that a masterbatch process is a conventional approach known to “uniformly disperse” an additive in a matrix. LGES-1004, [0003]; *see* LGES-1063, 7:61-67; LGES-1056, ¶38. Second, its assertions misrepresent Ohata. In particular, PO’s citation to Ohata at [0021] to argue that “Ohata describes the difficulty of dispersing CNTs in

resin” (POR, 61) fails to acknowledge that the indicated difficulty is contextualized to the context of “add[ing] a resin during the step of preparing an electrode material mixture paste,” not in the context of a masterbatch. LGES-1004, [0021]. Furthermore, PO’s citation to Ohata at [0019] (*see* POR, 61) omits that Ohata’s reference to low dispersibility of nanotubes in resin is not a generic statement, but instead is specific to the case “when the length of the carbon nanotubes is large.” LGES-1004, [0019].

Moreover, PO’s objection to the Petition’s demonstration that the Ohata-Kavan nanotubes are dispersed “without clustering on a dimension scale less than 1 micrometer” overlooks key aspects of the Petition’s application of Ohata to claim 6. *See* POR, 64-65. First, PO fails to address the Petition’s explanation that a POSITA would have found this to be obvious given the size range of Ohata’s nanotubes and Ohata’s explicit disclosure that the nanotubes are “dispersed.” *See* Petition, 34-35. And second, PO fails to contend with the role of Ohata’s masterbatch process in enabling dispersion of nanotubes, which again, given the size range of Ohata’s nanotubes, would have rendered obvious the claimed scale of dispersion. *See id.*; LGES-1056, ¶38.

Notably, as mentioned in the Petition, the prior art cannot be held to a stricter standard of disclosure than what is disclosed in the specification of the patent itself. *See In re Epstein*, 32 F.3d 1559, 1568 (Fed. Cir. 1994). PO appears

to recognize this, pointing in its infringement contentions for claim 6 to nanotubes that are clearly not “uniformly” dispersed. This image highlights PO’s inconsistencies on this claim: it looks to require theoretical uniformity for purposes of evading prior art while seeking relief from the same requirement when attempting to apply the claims to accused products.



LGES-1050, 55

III. LEE-WEPASNICK

A. PO’s arguments that the Lee-Wepasnick nanotubes are not discrete are based on mischaracterizations of Lee’s disclosure

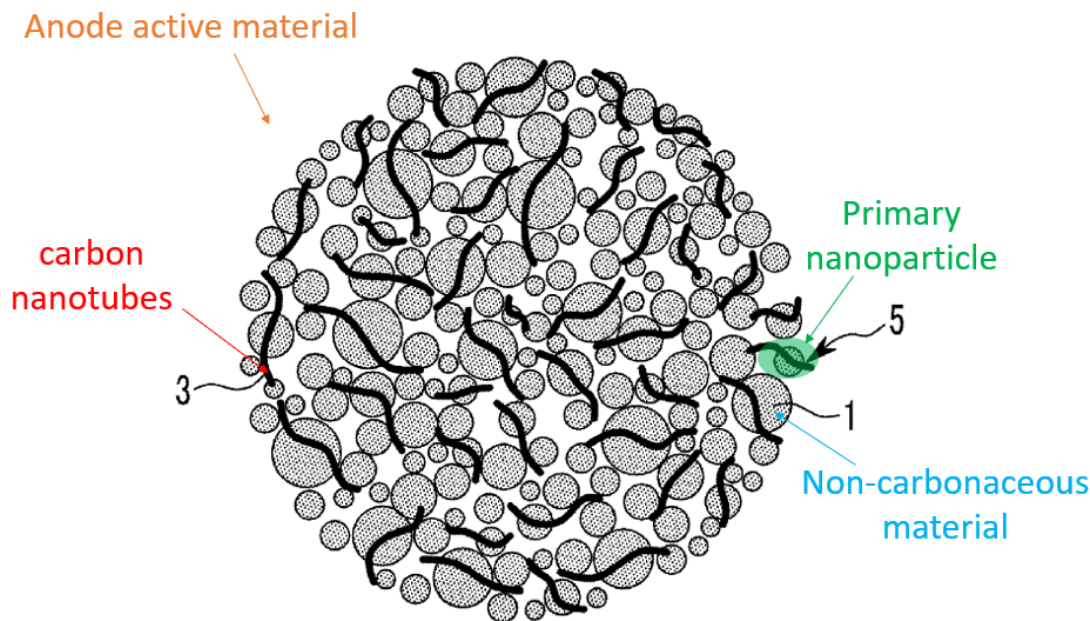
None of PO’s objections to the Petition’s showing of discrete nanotubes in the Lee-Wepasnick combination is viable, at least because each relies on a misinterpretation of Lee or of the nature of the Lee-Wepasnick combination.

1. PO's assumption that Lee's nanotubes are agglomerated misrepresents Lee's teachings

PO's allegation that the Petition's "failure to sufficiently explain or demonstrate how Lee can teach 'discrete' CNTs given the repeated teachings of 'agglomeration' is fatal to the Lee based grounds" (POR, 71) is based on a fundamental misunderstanding of Lee's structure.²

Lee's primary nanoparticles (5, green *infra*) are composed of nanotubes 3 "bound to [] non-carbonaceous material" 1. LGES-1006, [0040]; LGES-1056, ¶¶39-40.

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² The Institution Decision indicates a similar misunderstanding. See Institution Decision, 33.

Excerpt from Lee, Fig. 1

PO does not contest that the nanotubes in the primary nanoparticles are discrete. Instead, PO takes issue with the agglomeration of primary nanoparticles into secondary nanoparticles. LGES-1006, Abstract. But this agglomeration does not imply that the nanotubes are no longer discrete. Agglomeration in this context refers to assembly of primary nanoparticles into secondary nanoparticles—not agglomeration of nanotubes with themselves. *See* LGES-1006, [0040]. Indeed, nanotubes in Lee’s primary particles are prevented from agglomerating with one another because they are already bound, as discrete nanotubes, to the non-carbonaceous material. LGES-1056, ¶39. Nothing in Lee indicates that the primary nanoparticles are disassembled prior to agglomeration such that the nanotubes would be available to agglomerate with one another—nor has Patent Owner alleged that this occurs.

2. PO’s reliance on Lee’s Fig. 6 SEM image is unfounded

PO’s reliance on Lee’s Fig. 6 to conclude that Lee’s nanotubes are “grouped together” (POR, 73-74) is undermined by Dr. Chung’s admissions that this figure is unsuitable to support such a determination. At deposition, Dr. Chung conceded that “the image is really low in quality ... and it’s hard to see the features there.” LGES-1054, 66:2567:1-. Moreover, even to the extent that this figure does show a bundle of “numerous CNTs intertwined with each other,” as PO contends (POR,

74), its existence does not preclude that other, discrete nanotubes, consistent with the morphology of Lee's composition. Indeed, PO acknowledges that "POSITA cannot see what a distance representing a 1 nm diameter [nanotube] looks [like]" (POR, 74), meaning that discrete nanotubes would not necessarily even be visible. In fact, given the scale and admitted poor quality of this figure, it is simply not reliable as to the presence or absence of discrete nanotubes in the composition—and certainly not for conclusions that contradict Lee's teachings elsewhere regarding the structure of its composition.

3. PO's attempts to cast doubt on the Petition's reliance on Lee's schematic diagrams are inaccurate

PO argues that size "inconsistencies" between Lee's schematics and Lee's Fig. 6 "evidence ... that Lee's depiction of the nanotubes in its schematics is "impossible." POR, 75-77.

First, the Petition did not rely on either the scale of Lee's schematic diagrams or the specific placement of the nanotubes in demonstrating that the Lee-Wepasnick nanotubes are discrete, and thus PO's objections are unjustified.

Moreover, as discussed above, discrete nanotubes would not even be visible in Lee's Fig. 6 and thus no conclusions regarding the relative size of nanotubes and non-carbonaceous material can be drawn from that image.

Substantively, PO's apparent demand that the size relationship between nanotubes and the other material be the same between the schematics and the Fig. 6 SEM image once again demonstrates PO's failure to grasp the fundamental structure of the Lee-Wepasnick material. The Lee-Wepasnick composition includes secondary nanoparticles composed of agglomerates of primary nanoparticles, which in turn are composed of nanotubes and non-carbonaceous material. In Fig. 1, as PO notes, the nanotubes "have a length longer than the length of the non-carbonaceous material 1." POR, 76. But in Fig. 1, the nanotubes also have a length that is less than the size of the agglomerated secondary particle, consistent with what PO observes about the Fig. 6 SEM image. There is no inconsistency.

4. PO's aspect ratio argument ignores that Lee's disclosed aspect ratio overlaps with the aspect ratio of the claimed discrete nanotubes

PO's argument that "an aspect ratio of at least 5,000 would almost certainly preclude the possibility of any discrete CNTs" (POR, 74) is a blatant misrepresentation of Petition. Nowhere does the Petition even mention the range "at least 5,000" (POR, 74). The Lee-Wepasnick nanotubes have an aspect ratio of 10-10,000. *See* Petition, 64. Even if larger aspect ratio nanotubes may be more subject to entanglement than smaller aspect ratio nanotubes, the Lee-Wepasnick nanotubes still encompass the claimed range of aspect ratios, which the '909 Patent

confirms are capable of being discrete. Indeed, PO appears to acknowledge that its position lacks merit, qualifying its objection with the statement that distinct CNTs “would likely not be achievable *at certain aspect ratios*”—but not at all aspect ratios—“within Lee’s very broad range.” POR, 75 (emphasis added).

5. PO’s argument about thermal treatment is also premised on a misunderstanding of the Lee-Wepasnick composition

PO’s argument that as a result of Lee’s thermal drying process, “the organic solvent evaporates ... resulting in CNT agglomerates” (POR, 75) ignores that the thermal treatment is not applied to the nanotubes alone, but to the nanotubes together with the non-carbonaceous material. In Lee’s process, prior to drying, “the non-carbonaceous material ... bind with the hollow carbon nanofibers, thus forming the primary nanoparticles.” LGES-1006, [0063]. Only then is the drying conducted. *Id.*, [0060]. In the context of drying a material that is “strongly bound together” (*id.*, [0063]), PO’s error becomes apparent: there is no “collapse of the assembly of CNTs” (POR, 75), because there is no assembly of CNTs to begin with. Instead, the drying operates on primary nanoparticles—*i.e.*, nanotubes bound to non-carbonaceous material—that, through the drying process, agglomerate into secondary particles. *See* LGES-1006, [0061].

Notably, Lee indicates the importance of this nanotube-non-carbonaceous material binding in enabling “the structure of the anode active material [to] be

maintained.” LGES-1006, [0063]. To the extent PO’s arguments regarding the purported existence of an “assembly of CNTs” is predicated on an implicit assumption that the structure of Lee’s primary nanoparticles is somehow destroyed through the drying process, this assumption is inconsistent with Lee.

6. The Petition demonstrated that oxidation in the combination promoted discrete nanotubes

PO’s argument that “Petitioner fails to explain how oxidation can help with dispersion of Lee’s CNTs” (POR, 77) overlooks that the Petition addressed this very question, explaining that the presence of functional groups on the nanotubes prevents agglomeration. *See* LGES-1003, ¶163. That is, for instance, functionalized nanotubes that are “mixed in an organic solvent” along with non-carbonaceous material (LGES-1006, [0060]), as in Lee, are sterically hindered from agglomerating into bundles, and instead remain as generally individually distinct nanotubes.

B. PO has failed to demonstrate criticality of the claimed range of aspect ratios

PO’s argument that “Petitioner cannot rely on Lee’s incredibly broad aspect ratio range to render the claims obvious” (POR, 78) fails to establish any meaningful difference between nanotubes having an aspect ratio of 10-500 (as claimed) range and 10-10,000 (as in the Lee-Wepasnick nanotubes).

The law of overlapping ranges is clear. “A *prima facie* case of obviousness typically exists when the ranges of a claimed composition overlap the ranges disclosed in the prior art.” *In re Peterson*, 315 F.3d 1325, 1329 (Fed. Cir. 2003). This is the case here: the claimed 10-500 aspect ratio range overlaps—and indeed falls completely within—the Lee-Wepasnick 10-10,000 range. *See Peterson*, 315 F.3d at 1330 (“In fact, when, as here, the claimed ranges are completely encompassed by the prior art, the conclusion is even more compelling than in cases of mere overlap”).

The *prima facie* obviousness of an overlapping range can be rebutted “by showing that the claimed range achieves unexpected results relative to the prior art range.” *In re Woodruff*, 919 F.2d 1575, 1578 (Fed. Cir. 1990). But PO has not done this. Instead, PO has merely offered generic statements alleging “significant differences resulting in materially different structure and behaviors” (POR, 80), without providing any evidence that these effects (to the extent they exist at all) are specific to the particular claimed range.

PO’s arguments that “due to the numerous significant differences in the structure and behavior, there would have been no motivation to try to optimize Lee-Wepasnick’s remarkably broad range” are similarly deficient. Generic complaints about the breadth of the Lee-Wepasnick range is not factual evidence of unexpected results. *See In re Geisler*, 116 F.3d 1465, 1470 (Fed. Cir. 1997) (“it

is well settled that unexpected results *must be established by factual evidence*” (citing *In re Antonie*, 559 F.2d 618, 620, 195 USPQ 6, 8 (CCPA 1977)) (emphasis added)). PO has provided no such demonstration of criticality, nor provided any evidence tied to the claimed range. As such, PO’s arguments are insufficient.

C. Claim 6 is obvious over Lee-Wepasnick

PO’s position that the Petition’s reliance on Lee’s Figure 1 is “legally improper” (POR, 81) ignores that the Petition did not assert explicit disclosure of the uniform distribution of nanotubes, but instead showed a POSITA would have found it to be obvious in view of that schematic, coupled with “the dispersed nature of the nanotubes” of the combination. Petition, 76-77. PO’s arguments fail to rebut the obviousness theory advanced in the Petition.

IV. CONCLUSION

For all the foregoing reasons, Petitioner respectfully submits that the Board should find the Challenged Claims unpatentable.

Respectfully submitted,

Date: July 14, 2025

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CERTIFICATION UNDER 37 CFR § 42.24(d)

Under the provisions of 37 CFR § 42.24(d), the undersigned hereby certifies that the word count for the foregoing Petitioners' Reply to Patent Owner's Response totals 5,588, which is less than the 5,600 allowed under 37 CFR § 42.24.

Respectfully submitted,

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CERTIFICATE OF SERVICE

Pursuant to 37 CFR § 42.6(e), the undersigned certifies that on July 14, 2025, a complete and entire copy of the Petitioner's Reply to Patent Owner's Response and Accompanying Exhibits were provided by email to the Patent Owner by serving the correspondence addresses of record as follows:

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