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
U.S. Patent 8,808,909

_____

PATENT OWNER'S RESPONSE

LGES 1042
LGES v. MRD
IPR2024-01012

TABLE OF CONTENTS

I. Introduction 7
II. Level of Ordinary Skill 8
III. Overview of Technology 9
A. Overview of Electrodes 9
B. Efforts to Improve Electrical Conductivity 10
C. The ’909 Patent 13
IV. Claim Construction 17
V. Ground 1: Ohata-Kavan Does Not Render Any Claim Unpatentable. 18
A. Independent Claim 1 18
1. Petitioner overlooks the critical fact that the “masterbatch” process embeds the CNTs in resin to form the binder. 20
2. Petitioner fails to demonstrate that Ohata-Kavan teaches or renders obvious “ion active material attached to their [carbon nanotubes] surface.” 28
3. Petitioner fails to demonstrate a motivation to combine to obtain “oxidation levels from 1% to 15%” based on Kavan. 44
4. Petitioner fails to demonstrate a reasonable expectation of success. 51
5. Petitioner fails to demonstrate that Ohata-Kavan teaches or renders obvious “discrete carbon nanotubes.” 51
B. Dependent Claim 6. 59
1. “the carbon nanotubes are uniformly dispersed…” 59
2. “wherein the carbon nanotubes are uniformly dispersed without clustering on a dimension scale of less than 1 micrometer” 62
VI. Grounds 2A/B: Lee-Wepasnick Does Not Render Any Claim Unpatentable 69
A. Independent Claim 1 69
1. Lee-Wepasnick does not render obvious “discrete” carbon nanotubes. 69

a. The Board should affirm its preliminary determination that Petitioner failed to carry its burden. 69

b. Even if Petitioner is permitted to attempt to retroactively address defects in its Petition, Petitioner still cannot carry its burden. 72

2. Lee-Wepasnick does not render obvious the claimed aspect ratio. 78

B. Dependent Claim 6 81

VII. Conclusion 82

EXHIBIT LIST

Exhibit No.	Description
MRD-2006	Declaration of Dr. Deborah D.L. Chung, Ph.D.
MRD-2007	WEBSTER'S NEW WORLD COLLEGE DICTIONARY (4th ed. 1999), various definitions
MRD-2008	U.S. Patent No. 8,703,009 ("Liu-009")
MRD-2009	Mengxuan Zhang et al., *Binder Assisted Dispersion of Agglomerated Carbon Nanotubes for Efficiently Establishing Conductive Networks in Cathodes of Li-Ion Batteries*, 8 ENERGY TECHNOLOGY 2000589 (2020).
MRD-2010	Varrla Eswaraiah et al., *Morphological, Thermal, Electrical and Electromechanical Properties of Polyvinylidene Fluoride (PVDF)-Functionalized Carbon Nanotube Composites (Preprint)*, AFRL-RX-WP-TP-2012-0277 INDIAN INSTITUTE OF TECHNOLOGY CHENNAI (2012).
MRD-2011	B. V. Bahaskara Rao et al., *Fabrication and Evaluation of Thin Layer PVDF Composites Using MWCNT Reinforcement: Mechanical, Electrical and Enhanced Electromagnetic Interference Shielding Properties*, 6 AIP ADVANCES 065107 (2016).
MRD-2012	Viraj Bhingardive et al., *Polyvinylidene Fluoride Based Lightweight and Corrosion Resistant Electromagnetic Shielding Materials*, 5 RSC ADV. 35909 (2015).
MRD-2013	Ming Wang et al., *The Influence of Polyvinylidene Fluoride (PVDF) Binder Properties on* $LiNi0_{.33}\ Co_{0.33}\ Mn_{0.33}\ O_2$ *(NMC) Electrodes Made by a Dry-Powder-Coating Process*, 166 JOURNAL OF THE ELECTROCHEMICAL SOCIETY A2151 (2019).

Exhibit No.	Description
MRD-2014	Soumyaranjan Mishra et al., *Synthesis of PVDF/CNT and Their Functionalized Composites for Studying Their Electrical Properties to Analyze Their Applicability in Actuation & Sensing*, 509 COLLOIDS AND SURFACES A: PHYSICOCHEMICAL AND ENGINEERING ASPECTS 684 (2016).
MRD-2015	U.S. Patent No. 6,869,724
MRD-2016	Lizhi Wen et al., *Effect of Conductive Material Morphology on Spherical Lithium Iron Phosphate*, 8 NANOMATERIALS 904 (2018).
MRD-2017	U.S. Patent Application Publication No. 2014/0319429 ("Nicolas-429")
MRD-2018	U.S. Patent Application Publication No. 2011/0256454 ("Nicolas-454")
MRD-2019	U.S. Patent Application Publication No. 2012/0058255 ("Gan")
MRD-2020	Wener Bauer et al., *Rheological Properties and Stability of NMP Based Cathode Slurries for Lithium Ion Batteries*, 40 CERAMICS INTERNATIONAL 4591 (2013).
MRD-2021	CN Patent Application Publication No. 101714627
MRD-2022	Certified English Translation of CN Patent Application Publication No. 101714627
MRD-2023	Declaration of Dr. Yu Zhu in IPR2024-01013, dated June 12, 2024
MRD-2024	Deposition Transcript of Dr. Yu Zhu in IPR2024-01013, dated March 14, 2025
MRD-2025	Deposition Transcript of Dr. Yu Zhu in IPR2024-01006, dated March 21, 2025
MRD-2026	Deposition Transcript of Dr. Yu Zhu in IPR2024-01011, dated March 21, 2025

Exhibit No.	Description
MRD-2027	RESERVED
MRD-2028	U.S. Patent Application Publication No. 2024/0274804
MRD-2029 to MRD-2036	RESERVED
MRD-2037	Aleksander Cholewinski et al., *Polymer Binders: Characterization and Development toward Aqueous Electrode Fabrication for Sustainability*, 13 POLYMERS 631 (2021).

I. Introduction

Patent Owner presents substantial new evidence and arguments demonstrating that Petitioner fails to carry its burden of proving unpatentability of any claim.

Ground 1 (Ohata-Kavan) is fundamentally flawed. First, Petitioner overlooks the fact that the "masterbatch" process of Ohata—which is relied on in Ohata-Kavan—immerses the oxidized carbon nanotubes ("CNTs") in resin *before* mixing them with active material. *Infra* Section V.A.1. This coats the CNTs with resin, preventing the active material from "attaching to the[] surface" of the CNTs as claimed. *Infra* Section V.A.2. Second, a POSITA would have had no motivation to oxidize Ohata's CNTs pursuant to Kavan, or a reasonable expectation of success in achieving the claimed invention, given that Ohata-Kavan prevents the attachment required by the claim and precludes all of the benefits described in Kavan from being realized. *Infra* Section V.A.3-4. Third, Petitioner fails to demonstrate that Ohata-Kavan achieves "discrete" CNTs, instead falsely equating "discrete" CNTs to "dispersed" CNTs. *Infra* Section V.A.5. But because these are two fundamentally different concepts, the presence of the latter cannot prove the former. Fourth, Petitioner cannot carry its burden with respect to claim 6, which Petitioner's expert concedes imparts very specific spacing requirements between discrete CNTs at the nanoscale. *Infra* Section V.B. Yet, the sole basis for Petitioner's invalidity theory is a cartoon "schematic" drawing having no scale, no dimensions, and no indication

that either was intended to be conveyed. This dimensionless drawing cannot, as a matter of law, demonstrate unpatentability.

Ground 2 (Lee-Wepasnick) is also deeply flawed. First, Petitioner fails to adequately explain how Lee-Wepasnick can teach "discrete" CNTs given that Lee repeatedly states that its nanoparticles are "agglomerated." *Infra* Section VI.A.1.a. Nor can Petitioner reconcile this text with the schematic figure purportedly showing discrete CNTs. *Infra* Section VI.A.1.b. Second, Lee-Wepasnick does not render obvious the claimed aspect ratio of 10-500, because Lee's remarkably broad range of 10-10,000 fails to provide an ordinary motivation to optimize the range. *Infra* Section VI.A.2. Third, Petitioner makes the same type of schematic-figure-based assertion against claim 6 that it made based on the cartoon figure of Ohata-Kavan. *Infra* Section VI.B.

II. Level of Ordinary Skill

Patent Owner applies Petitioner's proposed definition of a POSITA for purposes of this proceeding only. Patent Owner's technical expert, Dr. Deborah Chung, has a Bachelor's Degree in Engineering and Applied Science and a Master's Degree in Engineering Science from the California Institute of Technology. MRD-2006 ¶4. Dr. Chung also has a Master's Degree in Materials Science and a Doctorate in Materials Science from the Massachusetts Institute of Technology. *Id*. A central

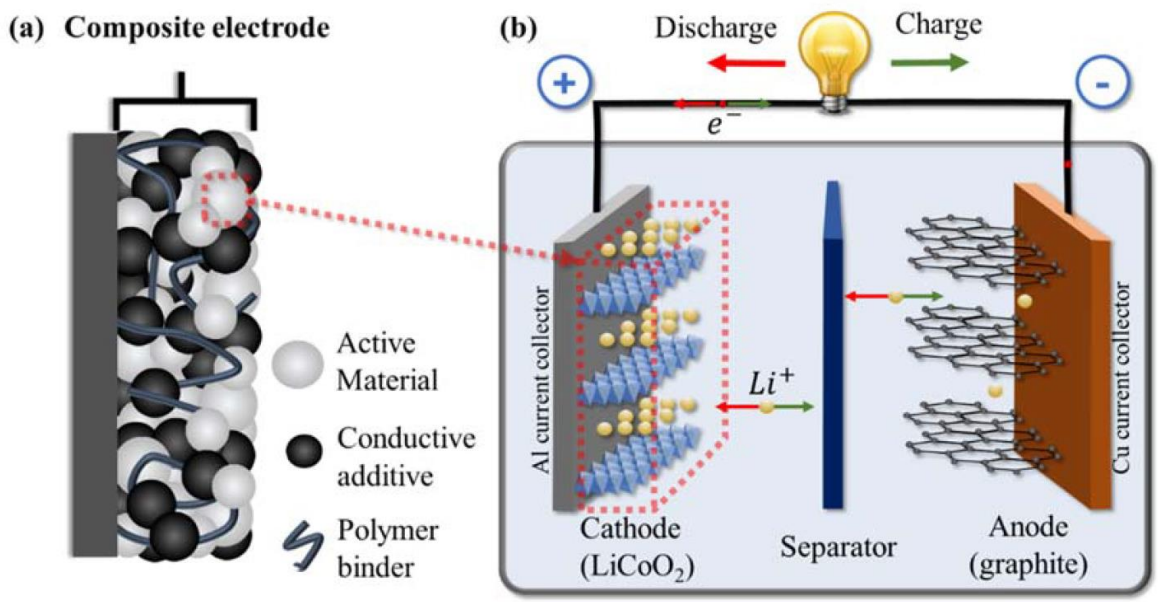
focus of Dr. Chung's decades of technical experience has been studying CNTs. *Id.* ¶¶6-17. Thus, Dr. Chung qualifies as a POSITA.

III. Overview of Technology

The '909 Patent is directed toward lithium-ion batteries, particularly compositions that makeup the electrode (either the cathode or anode) of lithium-ion batteries. LGES-1001, 2:32-42.

A. Overview of Electrodes

In reference to the schematic below, an electrode (cathode or anode) comprises three key parts: (1) the active material, (2) a binder, and (3) a conductive additive. MRD-2037, 2. The depicted cathode is on a current collector:



Id. The active material (1) is the electrochemically active component that directly participates in the reactions that allow the battery to store and release energy, which

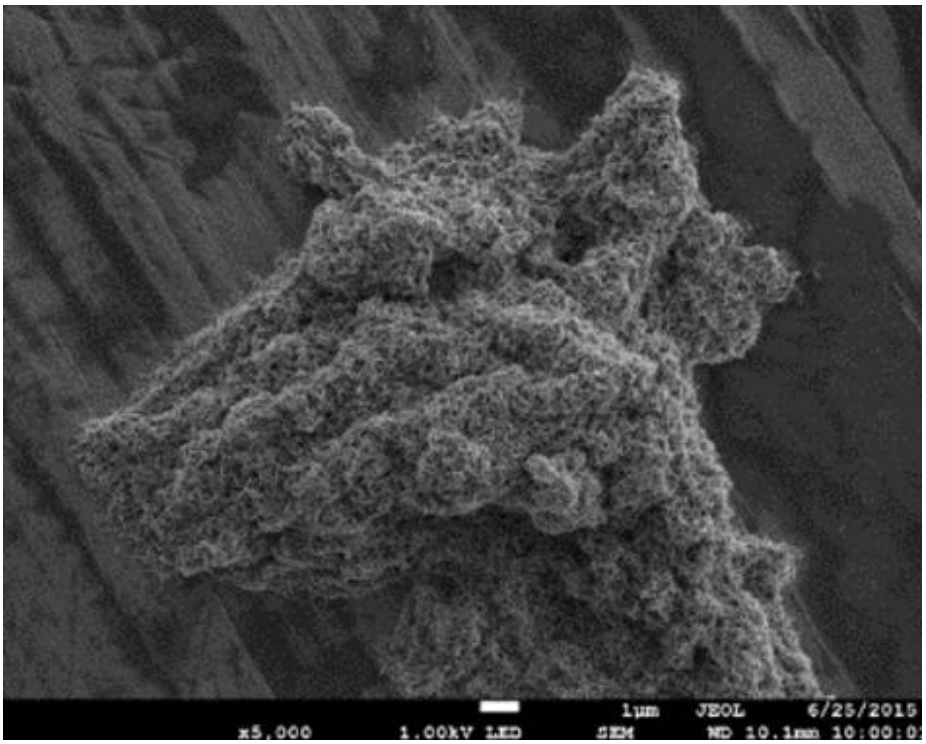
involves the active material expanding and contracting during charging and discharging. MRD-2006 ¶58.

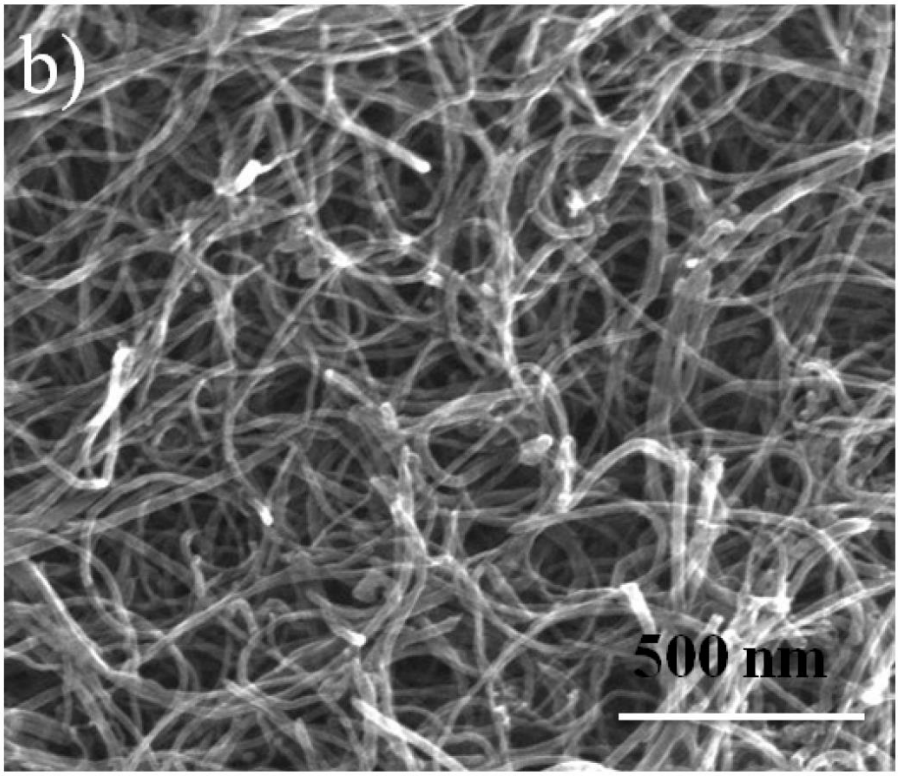
The binder (2) acts as a "glue" to hold the active material particles together, as well as to attach the active material to the current collector, providing mechanical strength to the composite as a whole. *Id*. ¶59.

A conductive agent (3) is typically included in the electrode composition to help provide a continuous, electrically conductive path in the electrode composition between the active material, improving conductivity. *Id*. ¶¶60-61.

B. Efforts to Improve Electrical Conductivity

At the time of the invention, it was common to use carbon black as the conductive agent to try and form a continuous conductive network in lithium-ion battery electrodes. *Id.* ¶62 (citing LGES-1004 ¶¶[0002]-[0003]). However, CNTs were of particular interest because of their high electrical conductivity and mechanical strength relative to carbon black, making them prime candidates for use as conductive agents. *Id.* ¶¶62-63 (citing MRD-2022 ¶¶[0005]-[0006], [0009]). However, one of the key challenges with CNTs is that they are created as highly entangled bundles ("raw" bundles). *Id.* ¶63. Scanning electron microscopy ("SEM") images are provided below as an example of how CNTs present as a highly entangled mass in their raw state:





Id. (citing MRD-2010, 15, Fig. 2(b)).

This excessive bundling presented several problems, including higher resistance due to the number of CNT-to-CNT contact points and considerable difficulty in dispersing the CNTs throughout the electrode composition. *Id*. ¶64. The inability to adequately disperse CNTs throughout the electrode composition can result in agglomeration, leading to local discontinuities (e.g., voids) in the conductive network of the composition. *Id.* (citing MRD-2019 ¶[0027]).

At the time of the invention, a key focus of those seeking to leverage CNTs as a conductive agent was trying to form the most effective continuous (also called "percolated") conductive network. *Id*. ¶¶65-66 (citing MRD-2022 ¶¶[0005], [0009]-[0010] (hereafter "Cheng");[1] MRD-2019 ¶[0041] (hereafter "Gan")). Figure 5 of Gan depicts CNTs that have been dispersed to form a "continuous" or "percolated" CNT network:

[1] MRD-2022 is a certified copy of an English translation of MRD-2021.

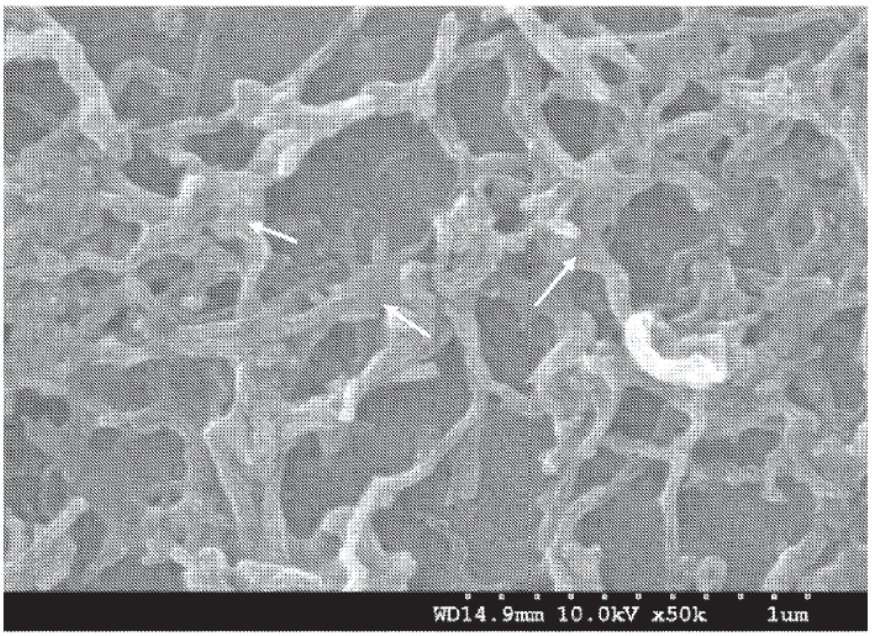


FIG.5

Id.; MRD-2010, 12 (explaining that "electrons can travel easily from one tube to another tube without any obstacle" when touching). To achieve these continuous networks of CNTs, a primary goal was to disentangle them to improve their dispersion, resulting in a CNT network that is better distributed throughout the overall composition. MRD-2006 ¶66 (citing MRD-2019 ¶¶[0019]-[0021]; MRD-2022 ¶[0010]).

C. The '909 Patent

While the conventional wisdom at the time was to achieve a network of interconnected CNTs (i.e., a "continuous" network) between active material particles, the inventors made the unconventional discovery that discrete CNTs

provide major advantages when the active material crystals are attached (e.g., ionically or covalently bonded) to the surface of the CNTs via oxidation. *Id*. ¶67 (citing LGES-1001, 1:46-59). As the Patent explains, "discrete" CNTs are those that are individually dispersed and separate from other CNTs. *Id.* (citing LGES-1001, 1:40-44 (describing "discrete carbon nanotubes" as "individual uniformly dispersed tubes"), 3:47-49 (explaining that "discrete carbon nanotubes" refers to CNTs being "separated to give individual tubes"), FIG. 1 (depicting individual tubes separate from any other tube); MRD-2007, 8 (defining "discrete" as "separate and distinct; not attached to others; unrelated"); MRD-2024, 11:4-8 (Dr. Zhu testifying that CNTs are discrete "because" they are "fully isolated" from one another), 12:17-13:22 (testifying that "discrete" CNTs are "separated from each other")).

The inventors discovered that the microcracking of active material crystals—*e.g.*, due to expansion/contraction during charging/discharging—could be "retarded" by binding the active material crystals to the surface of discrete CNTs. *Id*. ¶68 (citing LGES-1001, 1:47-58). These discrete CNTs provide mechanical strength to prevent cracking from occurring. *Id*. Additionally, they can bridge across fractured parts of active material, more freely interact with active material than interconnected CNTs that form a continuous network, and be used instead of carbon coatings having numerous drawbacks. *Id.* (citing MRD-2028 ¶[0042]; LGES-1001, 1:59-2:3).

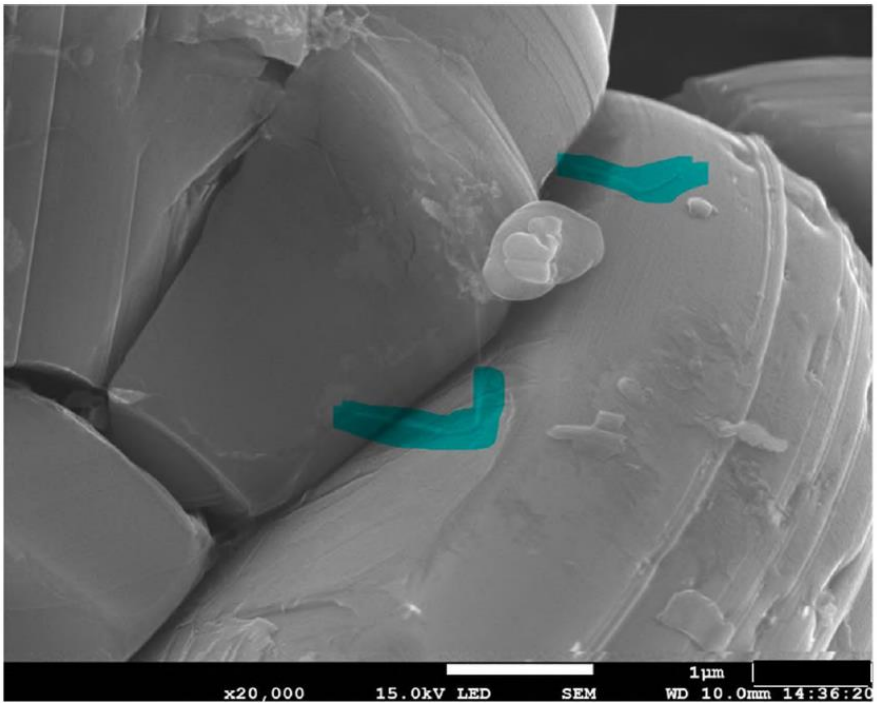
Thus, while those in the art at the time were seeking to achieve a continuous network of CNTs for electrodes, the inventors ***took the opposite approach by seeking to achieve discrete CNTs*** with active material attached to their surfaces. *Id.* ¶69. This provides numerous improvements, including "improved capacity, electron and ion conductivity and mechanical strength," "support and spatial stabilization of" active material particles, "improved heat transfer media to avoid thermally-induced runaway," "structural strength to the paste during manufacturing and high surface area per weight of" active material "to provide good energy density." *Id.* (quoting LGES-1001, 2:4-24). "The uniform dispersion of discrete tubes will also provide a more uniform voltage gradient…." *Id.* (quoting LGES-1001, 2:24-28).

The specification explains that "[d]uring the process of making discrete carbon nanotubes …, the nanotubes are cut into segments and the residual catalyst particles … are dissolved." LGES-1001, 3:66-4:4. Cutting of the tubes "helps with exfoliation," which refers to disentangling as between CNTs so that they can be separated or isolated from one another. MRD-2006 ¶70. The inventors also explain that "[p]roper selection of the carbon nanotube feed stock" allows more control in achieving discrete CNTs and that the preferred selection "is where the internal catalyst sites are evenly spaced." *Id.* (quoting LGES-1001, 4:6-15).

After applying this unique process, CNTs having an aspect ratio of 10-500 are oxidized to add functional groups to their surface, and the oxidized CNTs are mixed

directly with an active material (along with other materials), so that the active material can attach to the added functional groups. *Id.* ¶71 (citing LGES-1001, 4:43-57). In every example, the surface of the oxidized CNTs is fully exposed to the active material, which allows for the active material to form a strong bond to the surface of the CNTs via the added functional groups. *Id.* (citing LGES-1001, 5:5-6:67).

The ’909 Patent thus discloses a novel process for creating well-dispersed, discrete, oxidized CNTs with active material particles attached to their surface, which among other things reduces retardation of the active material crystals. *Id.* ¶72. While improved dispersibility is one factor for achieving discrete CNTs, dispersibility and discreteness are fundamentally difference concepts. *Id.* Indeed, much of the cited prior art focuses heavily on improved dispersibility to achieve a ***continuous*** *network* of CNTs, which are by definition, not discrete because they are interconnected. *Id.* The inventors’ discovery—discrete CNTs having active material attached their surface, and the benefits associated therewith—ran contrary to this conventional wisdom and is now being used throughout the lithium-ion battery industry. *Id.* For example, LGES and Samsung rely on discrete CNTs (blue) to retard cracking of active material crystals in their lithium ion batteries:



LGES-1050, 32. This is fundamentally different than the prior art concept of interconnecting CNTs to form a continuous or percolated conductive network between active material particles. MRD-2006 ¶72.

IV. Claim Construction

The Board is required to construe "only those terms … that are in controversy, and only to the extent necessary to resolve the controversy." *Realtime Data, LLC v. Iancu*, 912 F.3d 1368, 1375 (Fed. Cir. 2019). Because Petitioner fails to demonstrate unpatentability pursuant to its own application of the claim language, no construction is required.

V. Ground 1: Ohata-Kavan Does Not Render Any Claim Unpatentable.

A. Independent Claim 1

Petitioner acknowledges that Ohata does not disclose oxidized CNTs. Pet., 7. To account for this feature, Petitioner argues that it would have been obvious to oxidize the CNTs of Ohata (pursuant to Kavan) and then use the oxidized CNTs to create the "masterbatch" of Ohata. *Id*., 7-8. Petitioner further argues that it would have been obvious to then use the masterbatch to produce electrode material mixture pastes pursuant to Ohata but using $LiFePO_4$ or $LiMnPO_4$ for the positive electrode and TiO_2 for the negative electrode (as taught by Kavan). *Id.*, 8. Petitioner argues that a POSITA would have been motivated to oxidize the CNTs of Ohata when used with these active materials, because it would provide several benefits, such as allowing the active materials to attach to the CNTs' functional groups. *See id.*, 8-11. However, Petitioner improperly ignores critical teachings from Ohata that wholly undermine its assertion that the combination possesses all limitations of the challenged claims and the alleged motivations to combine.

Petitioner repeatedly states that the purpose of Ohata's "masterbatch" is to "unravel[] and straighten[]" the CNTs by blending them with a resin. *Id*., 5, 7, 10, 20. However, Petitioner simply ignores, or perhaps overlooks, that Ohata also clearly teaches that the "masterbatch" is the binder for the electrodes of its lithium-ion

batteries. *Infra* Section V.A.1. Such binder acts as a viscous "glue" that binds the active material particles together, providing increased mechanical strength during handling, charging, and discharging. Ohata recognizes, however, that resin binders are poorly conductive but can be improved by embedding CNTs within the binder particles. Thus, Ohata proposes creating a binder via its masterbatch process, where the "proper amount of the carbon nanotubes contained in the masterbatch is 5 to 20 parts ***by weight per 100 parts by weight of the resin***."[2] LGES-1004 ¶[0006]. Consequently, in Ohata, the masterbatch ***is*** the binder. It is only *after* the CNTs are embedded in the resin binder that the active material is mixed with the masterbatch. This fact fundamentally undermines the Ohata-Kavan combination.

First, the active materials of Ohata-Kavan cannot be "attached to the[] surface" of the oxidized CNTs as required by claim 1. *Infra* Section V.A.2. The masterbatch process of Ohata-Kavan results in CNTs ***fully embedded within, and coated by, the fluorocarbon resin matrix***, preventing the later mixed active material from attaching to the CNT surfaces. In fact, CNTs and fluorocarbon resin have an affinity toward one another, ensuring full coverage of the CNT surfaces with the resin. This design is purposeful in Ohata, because the masterbatch, with its high concentration of resin as compared to the concentration of CNTs, *is the binder* for

[2] All emphasis is added unless otherwise indicated.

the active material. As such, even assuming the active material is "attached" to the surface of the oxidized CNTs in Kavan *alone*, the same cannot be said of ***Ohata-Kavan***.

Second, there would have been no motivation to oxidize the CNTs pursuant to Kavan, as the benefits of oxidation described by Kavan only apply if the CNT surfaces *are exposed* to the active material. *Infra* Section V.A.3. Indeed, there is no rationale for oxidizing CNTs to add functional groups to facilitate attachment to the active material (as taught by Kavan), only to then turn around and cover those functional groups in resin to prevent attachment.

Third, Petitioner fails to demonstrate a reasonable expectation of success in achieving the claimed invention. *Infra* Section V.A.4. There would have been no expectation of achieving discrete CNTs with active material "attached to their surface" given that the CNTs are covered in resin.

Fourth, Ohata-Kavan does not teach "discrete" CNTs. *Infra* Section V.A.5. To the contrary, Ohata-Kavan seeks to achieve a *continuous* network of CNTs to improve electrical conductivity, which would have been understood to be fundamentally undermined by the goal of discrete CNTs.

1. Petitioner overlooks the critical fact that the "masterbatch" process embeds the CNTs in resin to form the binder.

Petitioner vaguely describes Ohata as preparing "composites of carbon

nanotubes and either positive or negative electrode active materials for use as electrodes in lithium ion batteries." Pet., 5. However, Ohata is doing something more specific and significant to the issues here—Ohata is creating an improved resin binder by ***embedding CNTs within the resin matrix*** to form its masterbatch. MRD-2006 ¶74 (citing LGES-1004 ¶¶[0005]-[0006], [0030]); MRD-2024, 58:5-10 (admitting Ohata is "embedding" conductive material "within the resin"). It is only *after* the CNTs are embedded in the masterbatch resin that they are *then* mixed with the active material to prepare the electrodes for the battery. *Id*. (citing LGES-1004 ¶¶[0005], [0032], [0046]). This is clear from the plain teachings of Ohata.

Turning first to the "Background of the Invention," Ohata explains that it was known to mix an "active material with a conductive material and ***a binder*** to form a paste," but that if the amount of conductive material is large "battery capacity will be decreased." LGES-1004 ¶[0002]. To address this drawback, Ohata teaches that it was known to perform "a masterbatch process, whereby a conductive material [e.g., carbon black] is uniformly predispersed ***in a binder***, in the production of a positive electrode ...." *Id*. In other words, the "conductive material" is predispersed in the "binder" to create a more conductive ***binder***. MRD-2006 ¶76. The binder is then mixed with the active material to bind the active material together as part of an electrode mixture material paste. *Id*. A POSITA would understand that binders typically have low electrical conductivity, and that embedding a conductive material

(e.g., carbon black) in the binder matrix increases its conductivity. *Id*. ¶77. Thus, the term "masterbatch" as used in Ohata, refers to ***a binder*** with embedded conductive material. *Id*. ¶76.

U.S. Patent No. 8,703,009 (MRD-2008, "Liu-009") provides an example of the type of conductive glue-like "masterbatch" process that Ohata describes. *Id*. ¶78. Figure 6 below is a "cartoon" from Liu-009 showing "how ... active material is glued together by conductive glue" comprising carbon black embedded in polyvinylidene fluoride ("PVDF") resin. *Id*. (quoting MRD-2008, 4:16-17, 6:25-29 11:28-32); MRD-2024, 33:21-34:1.

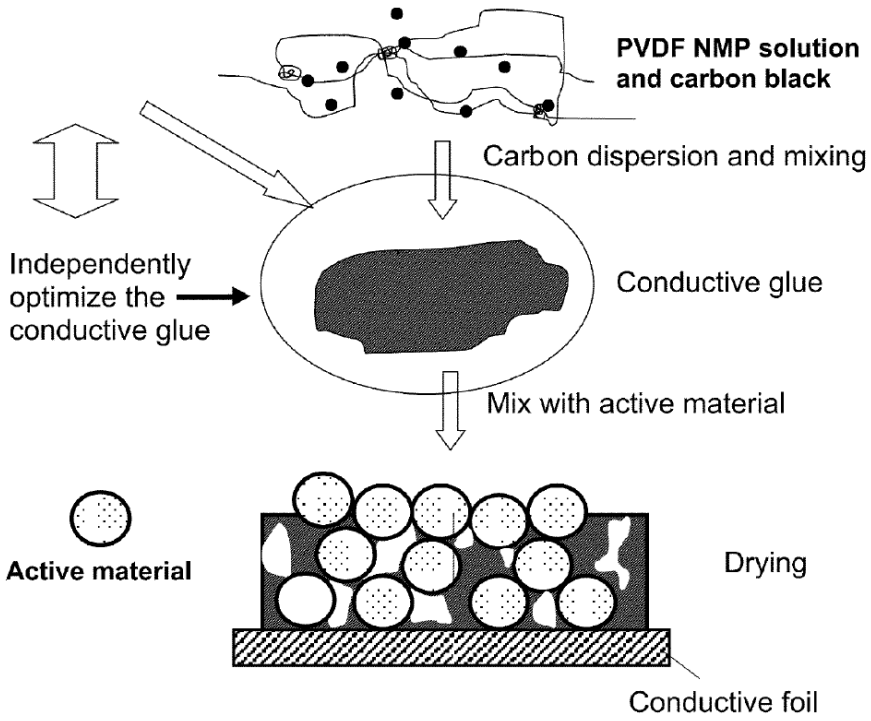


FIG. 6

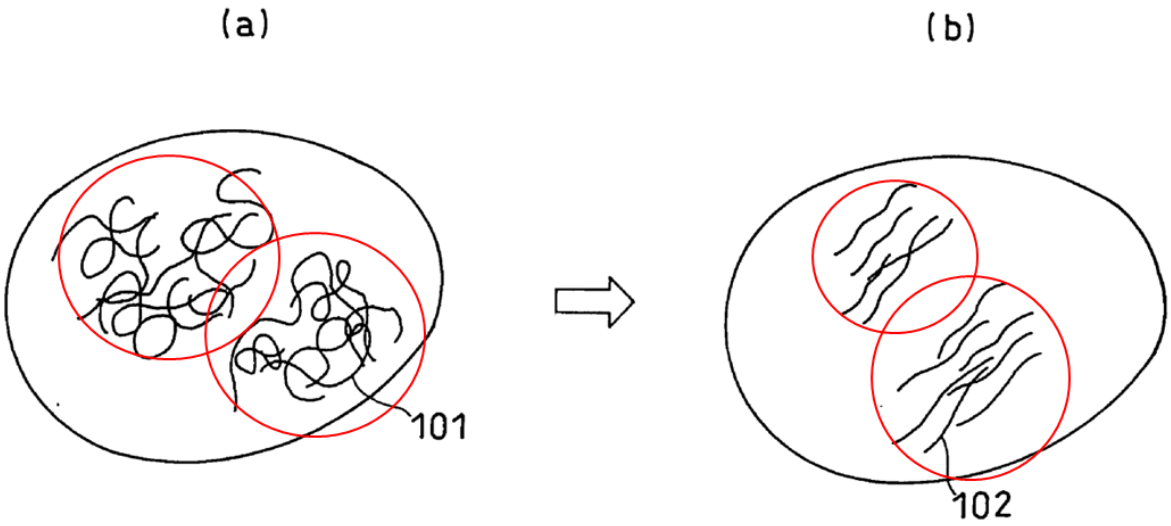
Ohata teaches that in a masterbatch comprising carbon black and powdered graphite, the primary particles "are linked into a chain to form a conductive path," which "is likely to be damaged by shearing force" during the masterbatch process. LGES-1004 ¶[0003]. In other words, the carbon black and powered graphite are chained together to form a continuous conductive network within the binder, but that improvement is limited because the carbon black network can break during blending. MRD-2006 ¶79 (citing LGES-1004 ¶[0003]). "For this reason, the use of the masterbatch process to uniformly disperse the conductive material ***in a binder*** does not yield an electrode superior in conductivity." LGES-1004 ¶[0003]. Thus, the problem Ohata is attempting to overcome is the breakage of conductive chains of carbon black in a binder. MRD-2006 ¶¶80-81.

"In view of this" drawback, Ohata prepares its own "masterbatch" comprising a large amount of resin and small amount of CNTs. LGES-1004 ¶¶[0004]-[0005]. "Unlike carbon black and powdered graphite, a conductive path to be formed by carbon nanotubes is not damaged by shearing force," allowing "an electrode superior in conductivity." *Id.* ¶[0015]. Thus, Ohata teaches that it is attempting to create an improved conductive binder ("masterbatch") by predispersing electrically conductive CNTs in the resin. MRD-2006 ¶¶82-84. The binder is then further mixed with an electrode active material to bind the active material together and form an electrode active material paste. *Id*. ¶84 (citing LGES-1004 ¶¶[0005], [0023]).

Consistent with these teachings, the first step in all embodiments of Ohata is to prepare the "masterbatch," which is "5 to 20 parts by weight [of CNTs] per ***100 parts by weight of the resin***." *Id*. ¶85 (quoting LGES-1004 ¶¶[0005]-[0006]). In other words, the lowest end of the range is 5% by weight of CNTs to 95% by weight of resin and the highest end is 20% by weight of CNTs to 80% by weight of resin. *Id*. Thus, resin makes up the overwhelming majority of the masterbatch binder. *Id*.

In reference to annotated cartoon Figure 1(a) depicting two groups (red circles) of CNTs, Ohata teaches that "carbon nanotubes 101 are tangled and twisted with one another before they are blended with a resin" as part of the masterbatch process. LGES-1004 ¶[0016]. Ohata contends the CNTs are "unraveled and straightened by blending them with a resin, as shown in FIG. 1(*b*)." *Id*.

FIG. 1



Thus, one of the purposes of blending CNTs with resin is to unravel and straighten them so that they are "expected to form an excellent conductive path," "serve[] to increase the mechanical strength of the electrode plate," and may "produce a secondary battery excellent in cycle characteristics." MRD-2006 ¶¶86-87 (quoting LGES-1004 ¶¶[0016]-[0017], [0021]). However, the ***other*** important reason for the masterbatch process is to use the masterbatch as a binder with embedded conductive material (i.e., the CNTs). *Id*. ¶87.

Although Ohata provides 15 examples of a positive and/or negative electrode prepared using the masterbatch, **Example 1** serves as the basis for most examples. *Id*. ¶88. In that example, the masterbatch is prepared by blending 15 parts by weight of CNTs and ***85 parts by weight PVDF*** using an extruder. *Id*. ¶89 (citing LGES-1004 ¶[0030]). The masterbatch—again consisting largely of resin—is then used to prepare a "positive electrode material mixture paste" by mixing 3.3 parts by weight of the masterbatch with $LiCoO_2$ as an active material with 45 parts by weight of N-methyl-2-pyrrolidone ("NMP"), which is used to disperse the masterbatch into the mixture paste. *Id*. (citing LGES-1004 ¶¶[[0030], [0032]). Ohata does not teach mixing additional resin with the positive electrode material mixture in this example, but instead relies solely on the masterbatch as the binder. *Id*. ¶95.

The negative electrode is also created, but without using the masterbatch at all. *Id*. ¶90 (citing LGES-1004 ¶[0034]). Instead, "3 parts by weight of styrene butadiene

rubber" is used "as a binder." *Id.* Thus, in Example 1 the positive electrode uses the masterbatch as the binder and the negative electrode uses a different binder. *Id*. This is because the masterbatch *is the binder* in the positive electrode example, while a different binder is used for the negative electrode. *Id.*

Examples 2 to 8 follow Example 1, except for the differences reflected in Table 1. *Id*. ¶91 (citing LGES-1004 ¶[0040]). Thus, these examples also include a masterbatch comprising at least 80 parts resin and at least 15 parts CNTs. *Id.*

Example 9 follows Example 1, except that vinylidene fluoride-hexafluoropropylene copolymer is used as a resin for the masterbatch instead of PVDF. *Id*. ¶92 (citing LGES-1004 ¶[0041]).

Examples 10 to 14 follow Example 1, except that the CNTs have different diameters and aspect ratios as reflected in Table 2. *Id*. ¶93 (citing LGES-1004 ¶[0042]).

Example 15 prepares a negative electrode using the same masterbatch from Example 1. *Id*. ¶94 (citing LGES-1004 ¶[0046]). The corresponding positive electrode is created using PVDF alone as the binder, instead of the masterbatch. *Id*. (citing LGES-1004 ¶[0044]).

Ohata thus teaches that its "masterbatch" is ***a binder with embedded CNTs*** that is used to hold the active material together. *Id*. ¶95. The process of Ohata is fundamentally different than the process of Kavan. *Id*. ¶96. Unlike Ohata, Kavan

does not (i) immerse its oxidized CNTs in resin to form a binder as an initial step and (ii) ***then*** mix the resin-covered CNTs with the active materials. *Id*. Instead, Kavan prepares a "powder precursor material" by first mixing its oxidized CNTs with *water* and an active material powder and stirring overnight, which leaves the CNT surfaces exposed (or "naked") ***so that the active material can attach to their surfaces to achieve the benefits described by Kavan***. *Id*. (citing LGES-1005, 2). Thus, in Kavan, the naked oxidized CNTs and active material are pre-mixed into a powder ***before*** mixing that powder with the PVDF, so that the active material can take advantage of the functional groups of the oxidized CNTs by "anchoring." *Id*. ¶97. Likewise, the '909 Patent mixes naked oxidized CNTs with the active material in all examples for this same reason. *Id*. (citing LGES-1001, 5:5-6:67).

In contrast, Ohata believed that dispersing the naked CNTs with the active material is "difficult taking the dispersibility of the carbon nanotubes in the resin into consideration." *Id*. ¶98 (quoting LGES-1004 ¶[0021]). Thus, Ohata chose a fundamentally different approach to dispersibility that involved first ***embedding the CNTs in the resin*** binder and ***then*** mixing the binder with the active material to achieve better dispersion. *Id*. This indisputable fact is problematic for Petitioner's Ohata-Kavan combination as further explained below.

2. Petitioner fails to demonstrate that Ohata-Kavan teaches or renders obvious "ion active material attached to their [carbon nanotubes] surface."

Petitioner alleges that Ohata-Kavan results in CNTs with lithium ion active material that is "***attached to the[] surface***" of the CNTs. Pet., 23, 25. Specifically, Petitioner argues that the oxidation creates functional groups on the surface of the CNTs, which results in covalent bonds between the active material and the surface or, additionally or alternatively, that there are Van der Waals forces and hydrogen bonds between the TiO_2 particles and functional groups resulting in the claimed attachment. *Id.*, 23-24. Petitioner cites to Kavan to support both assertions. *Id.* Petitioner thus relies on the disclosed "anchoring" benefits of ***Kavan alone*** to support its position that the active material of ***Ohata-Kavan*** is "attached to the[] surface" of the CNTs. MRD-2006 ¶99. However, as explained in Section V.A.1 above, there is a critical difference between how Kavan ***alone*** and the Ohata-Kavan ***combination*** prepare their electrode material mixtures. *Id.* ¶100.

In Ohata-Kavan, Petitioner begins with the masterbatch process ***to initially create a binder with embedded CNTs*** as taught by Ohata. Pet., 7-8. Kavan, on the other hand, does not teach or suggest any form of masterbatch process, and certainly does not fully immerse its nanotubes in resin like Ohata. MRD-2006 ¶¶101-102. Instead, Kavan mixes its naked oxidized CNTs with active material and water, so that the CNTs are fully exposed to the active material to allow the active material to

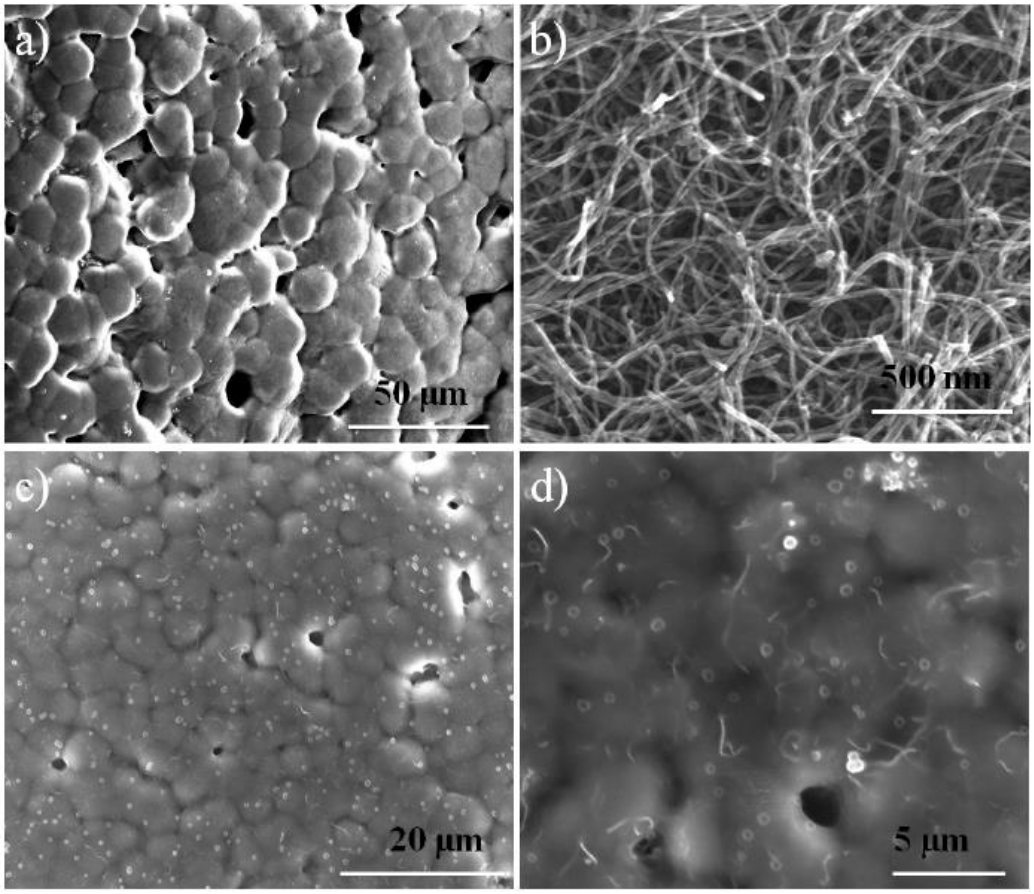
attach to the functional groups of the CNTs. *Id*. ¶102 (citing LGES-1005, 2).

It is Petitioner's burden to demonstrate that Ohata-Kavan teaches lithium ion active materials "attached to the[] surface" of oxidized discrete CNTs. However, Petitioner fails to account for the Ohata-Kavan "masterbatch" fully immersing and blending the CNTs in fluorocarbon resin as an initial step ***to form the binder*** for the electrode material mixture paste. *Id*. ¶103. Instead, Petitioner appears to believe that the only reason Ohata is creating the masterbatch is to straighten and unravel the CNTs. Pet., 5, 7, 10, 20; MRD-2024, 42:25-44:22 (Dr. Zhu failing to acknowledge that the purpose of the masterbatch is to serve as binder). However, when Ohata is read in context and for all that it teaches, it is indisputable that the primary purpose of the masterbatch is to act as the binder that holds the active material together. MRD-2006 ¶103; *Artic Cat Inc. v. Bombardier Rec. Prods.*, 876 F.3d 1350, 1360 (Fed. Cir. 2017) ("[I]t is error to fail to consider the entirety of the art."). This oversight is fatal to Ohata-Kavan, because the masterbatch process results in resin coating the surface of the oxidized CNTs, preventing the active material from "attaching to the surface." MRD-2006 ¶104.

When a small proportion of nanotubes (e.g., 5-20 parts by weight) are mixed with a large proportion of fluorocarbon resin (e.g., 100 parts by weight) as taught by Ohata, the nanotubes become embedded within, and are fully coated by, the resin. *Id*. ¶105 (citing MRD-2009, 2 ("In a CNT–PVDF–NMP suspension, PVDF

molecular chains would ***coat onto CNT surface due to the strong interaction between PVDF and CNTs***.”); LGES-1014, 3 (explaining that functionalized CNTs become “***completely covered*** with matrix” when mixed with resin); MRD-2024, 65:21-66:9 (admitting that the resin covers a “significant amount” of CNT surface)). Numerous objective references prove this point.

As one example, field emission scanning electron micrographs (FESEM) of a composite of 2% by weight functionalized multi-wall CNTs (“f-CNT”) to 98% by weight PVDF are depicted below in the excerpt of Figure 2(c)-(d):



Id. ¶106 (citing MRD-2010, 15). PVDF is a fluorocarbon resin used in the

masterbatch of Ohata. *Id*. (citing LGES-1004 ¶[0022]). Figure 2(a) depicts the PVDF and Figure 2(b) depicts the f-CNTs. *Id*. Figures 2(c) and (d) depict the functionalized CNT-PVDF composite, which shows the nanotubes embedded within the PVDF matrix. *Id.* (citing MRD-2010, 11-12). The dark circles in FIGS. 2(c) and (d) are voids in the PVDF matrix. *Id*. The CNT networking beneath the surface of the resin is not visible due to its opaque nature, but the CNTs closer to the surface are visible and are clearly embedded within the PVDF matrix. *Id.* ¶¶108-109 (citing MRD-2010, 11-12 ("microspheres of polymer have been formed throughout the composites and *carbon nanotubes are homogeneously dispersed* ***within*** *the polymer 3D scaffold*.")).

In another example, multi-wall CNTs were ultrasonically dispersed and then mixed with a solution of PVDF in dimethyl sulfoxide (a solvent) to obtain 3%, 5% and 9% by weight of CNTs in PVDF. MRD-2011, 2-3. Each weight percentage falls within the 5 to 20 parts by weight range of Ohata. MRD-2006 ¶110. The FESEM results are depicted below in Figure 1:

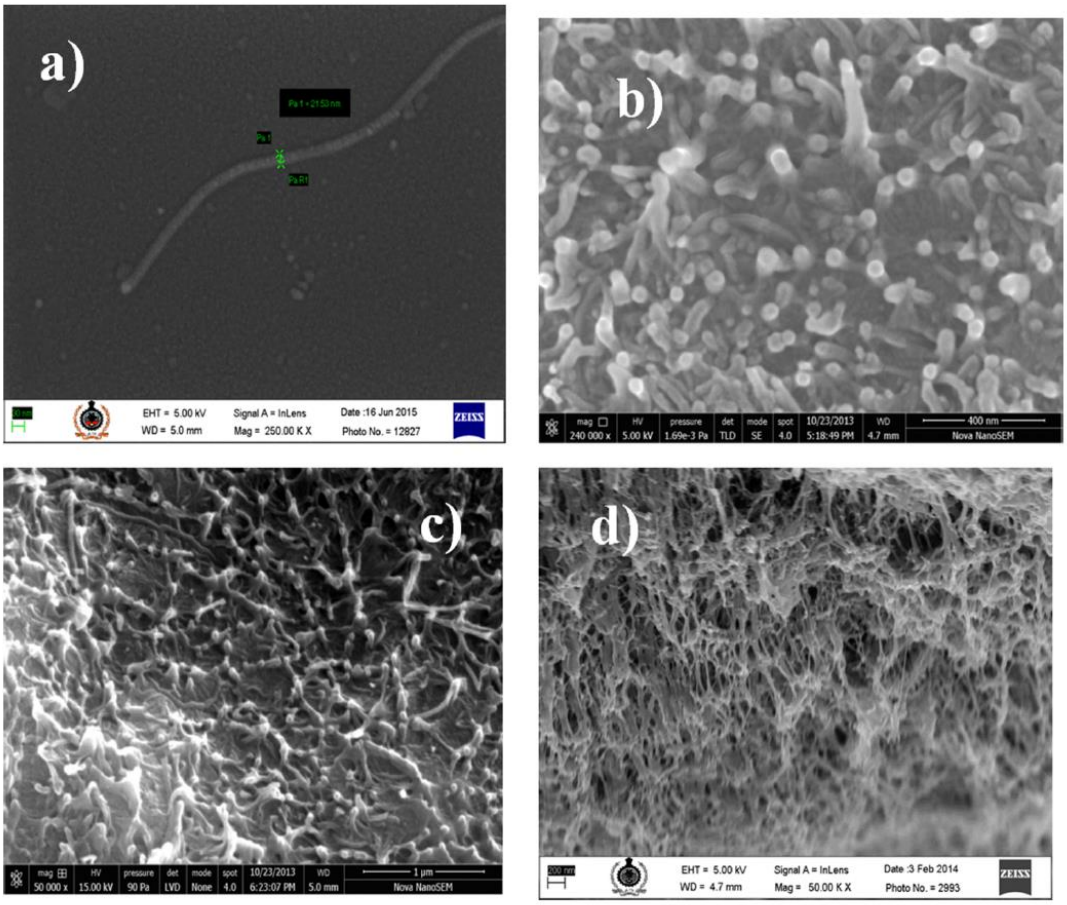
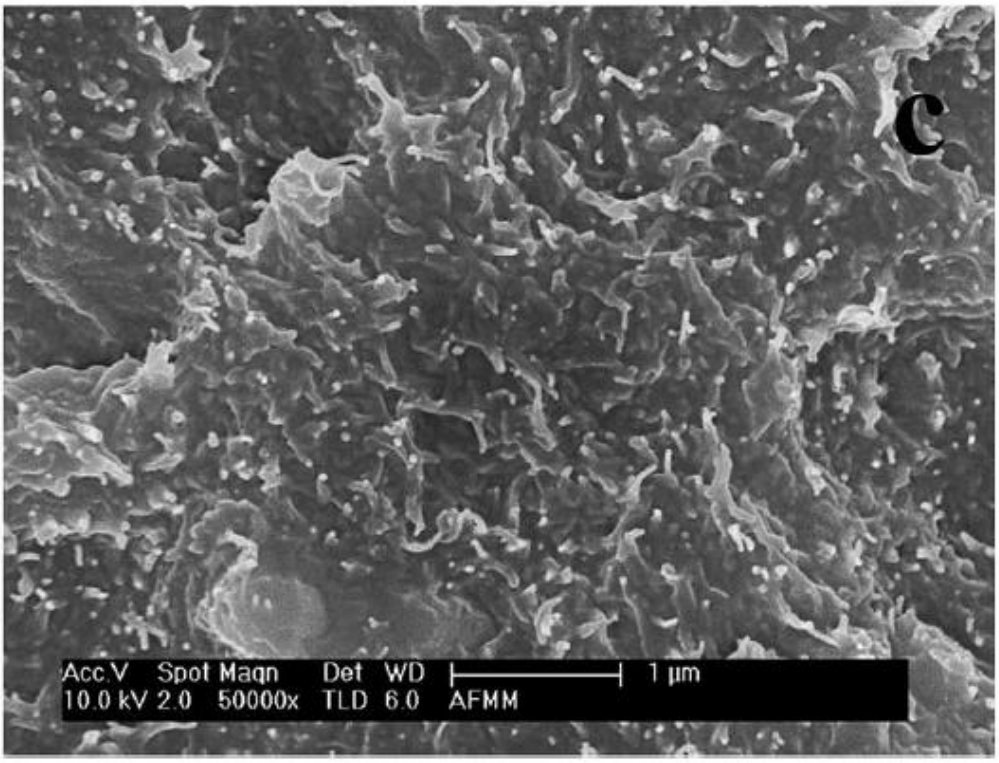


FIG. 1. FE-SEM images of MWCNT in the PVDF matrix. (a) shows a single MWCNT, and images of well dispersed MWCNTs for 3wt%, 5wt% and 9wt% samples in the PVDF matrix are shown in b),c) and d) respectively.

MRD-2011, 3. As shown in Figures 1(b)-(d), at all three weight percentages the CNTs are heavily embedded within the PVDF matrix—the CNTs are coated by PVDF. MRD-2006 ¶¶111-112 (citing MRD-2011, 3 ("Figure 1 shows the field-emission SEM micrographs of the MWCNTs ***in PVDF matrix***.")). In Figure 1(b) at 400 nm scale, the CNTs with a diameter of ~15 nm appear as thick "fingers" about 50 nm larger in diameter than the CNTs themselves, evidencing that they are heavily coated by PVDF. *Id*. ¶112. In Figure 1(c) at a 1 µm scale, the nanotubes also appear

thick (about 100 nm in diameter), again evidencing the presence of PVDF covering the CNTs. *Id*. In Figure 1(d) at a 200 nm scale, there are visible CNTs that appear as if they are trapped in a "web," which is the PVDF matrix. *Id*.

In yet another example, an SEM image depicts 3% by weight of multiwalled CNTs mixed with PVDF:



Id. ¶113 (citing MRD-2012, 6). The CNTs are embedded "in PVDF matrix," which presents as a viscous substance. *Id.* (quoting MRD-2012, 3; MRD-2013, 3 (Figure 2 showing how PVDF presents as blob-like domains of the matrix)).

Each of these references demonstrates that the masterbatch of Ohata-Kavan would result in oxidized CNTs heavily coated with binder resin to form a viscous

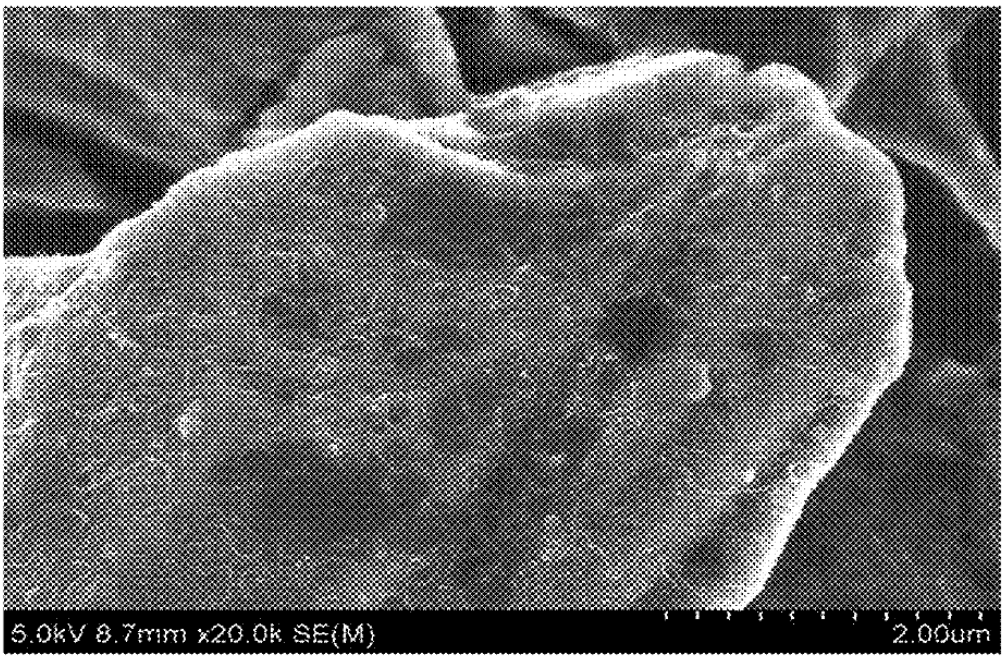
"glue" like material, similar to the glue of Figure 6 of Liu-009. *Id*. ¶114. Indeed, Liu-009 states that, when carbon black is mixed with PVDF prior to adding the active material, the PVDF will be "bonded to" the carbon black. *Id*. (citing MRD-2008, 7:55-62) (explaining that "the binder has previously and preferentially ***bonded to the CB [i.e., carbon black]***")). A POSITA would understand that PVDF molecules likewise bond to oxidized CNTs due to the dipole-dipole interactions between the highly polar fluorine atoms of the PVDF molecules and the presence of functional groups on the surface of the oxidized CNTs. *Id*. ¶115. This interaction allows for significant interfacial adhesion between PVDF and oxidized CNTs. *Id*. In other words, the oxidized CNTs would not only be heavily embedded and coated with the PVDF matrix, but the PVDF coating would be more strongly bound to the oxidized CNTs due to these interactions. *Id*. (citing MRD-2009, 2 ("In a CNT–PVDF–NMP suspension, PVDF molecular chains would ***coat onto CNT surface due to the strong interaction between PVDF and CNTs***.")). Importantly, Dr. Zhu testified that he was unaware of this important interaction between PVDF and oxidized CNTs. MRD-2024, 45:16-46:14.

Therefore, a POSITA would understand that the proposed combination of Ohata-Kavan would result in a masterbatch comprising oxidized CNTs that are fully coated with the fluorocarbon resin. *Id*. ¶116. This is the intentional design of Ohata, because the masterbatch acts as the binder but with embedded CNTs to improve

binder conductivity. *Id*. Ohata *wants* its CNTs to be embedded within and coated by the resin particles, while the exterior of the binder remains exposed to the active material to glue the active materials together. *Id*.

As a comparison point, the SEM image below provides an example of CNTs in contact along the surface of an active material particle:

FIG. 4



Id. ¶117 (citing MRD-2028 ¶¶[0114]-[0115]). However, this example follows a process more similar to Kavan's, where naked CNTs are mixed simultaneously with active material—not a "masterbatch" process that immerses the CNTs in resin before mixing the CNTs with the active material. *Id*. (citing MRD-2028 ¶[0108]). The result shown above is simply not possible in Ohata-Kavan due to its unique masterbatch

process. *Id*.

The subsequent steps of Ohata-Kavan do not change the fact the CNTs are coated by resin. After the masterbatch is prepared, it is used to form the electrode material mixture paste. *Id*. ¶118 (citing LGES-1004 ¶[0005]). This involves using the masterbatch as the binder by mixing it with a "dispersion medium" (e.g., NMP) and active material to form the electrode material mixture paste. *Id*. (citing LGES-1004 ¶¶[0023]-[0024], [0046]). For instance, in Example 1, Ohata discloses mixing 3.3 parts by weight of the masterbatch with 100 parts by weight of active material and 45 parts by weight of NMP. *Id*. (citing LGES-1004 ¶[0032]). NMP is a solvent that disperses the PVDF by dissolving it to break the matrix up into PVDF domains (or "islands") so that the domains can be dispersed throughout the electrode material mixture, providing local glue-like bonds between adjacent active material particles. *Id*. In other words, smaller binder particles are dispersed throughout the electrode mixture, but the CNTs are still embedded within and coated by PVDF that is bonded to the CNTs. *Id*. ¶119. Indeed, the Ohata-Kavan masterbatch process does not teach or suggest filtering PVDF after creation of the electrode paste, which would be required to eliminate the PVDF domains. *Id*.; MRD-2024, 41:5-25. Thus, dispersing PVDF having an embedded conductive agent (e.g., CNTs) using organic solvent (e.g., NMP) still leaves the conductive agent "coat[ed]" with PVDF. *Id*. (citing MRD-2015, 1:31-34 ("PVDF dissolved in the organic solvent ***tends to coat*** particles

of the active material and ***the conductive agent***, so that PVDF is not distributed effectively between these particles.”)).

Additional references further prove this point. FESEM images Figures 2 and 3 (reproduced below) show that even after PVDF and CNTs have been mixed with NMP, the CNTs are still heavily embedded within and coated by the PVDF:

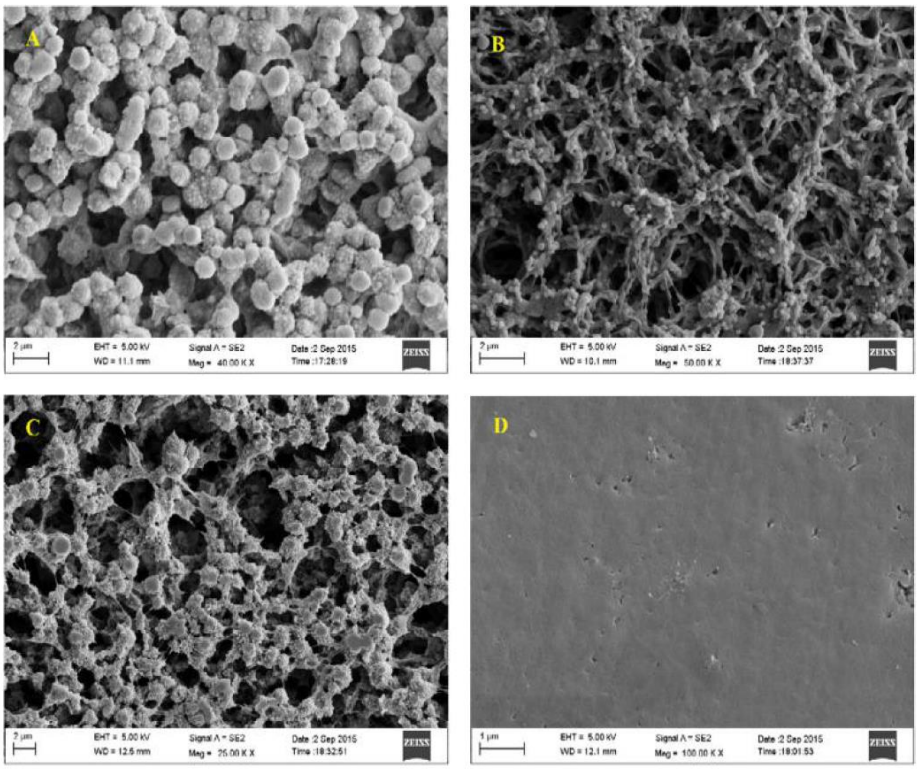


Fig. 2. (A–D): FESEM image of (A) PVDF, (B) PVDF with CNT, (C) PVDF with carbonic acid functionalised CNT and (D) PVDF with sulphonic acid functionalised CNT.

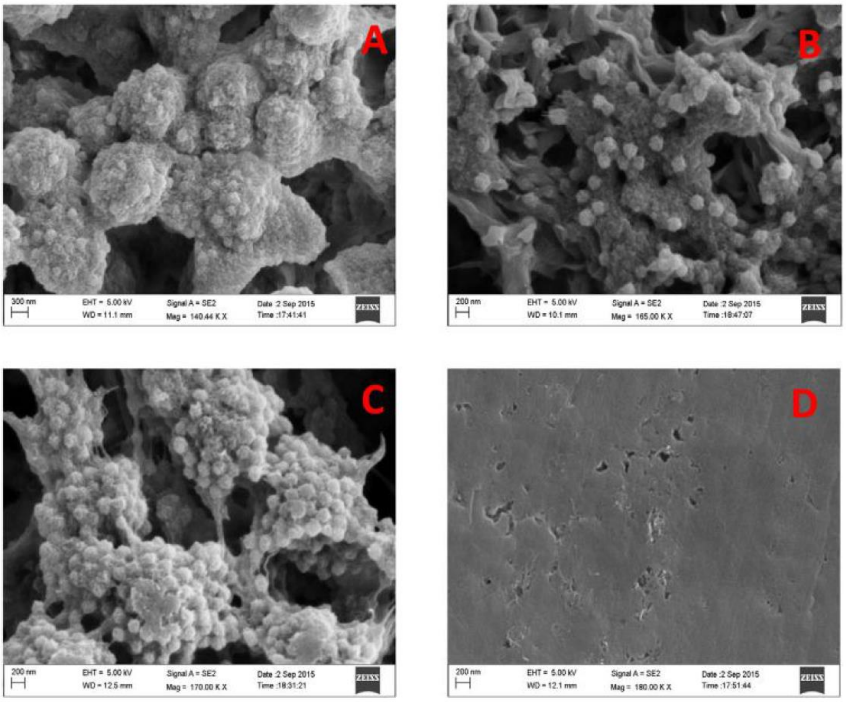


Fig. 3. (A–D) High Magnification FESEM image of (A) PVDF, (B) PVDF with CNT, (C) PVDF with carbonic acid functionalised CNT and (D) PVDF with sulphonic acid functionalised CNT.

Id. ¶120 (citing MRD-2014, 8). The "grainy" features in Figures 2(B), 2(C), 3(B) and 3(C) are the CNT-containing PVDF domains. *Id*. Additional, higher magnification FESEM images of Figure 3 show the PVDF matrix coating the CNTs more clearly. *Id*. Similarly, once the CNTs of the Ohata-Kavan masterbatch are blended with the resin, the entire surface of the CNTs becomes covered with resin, which is not removed by the solvent used during the electrode material mixture process. *Id*. ¶121.

An SEM image shown in Figure 2(f) below is of an electrode comprising CNTs (2% by weight), PVDF (3% by weight), and $LiFePO_4$ (95% by weight):

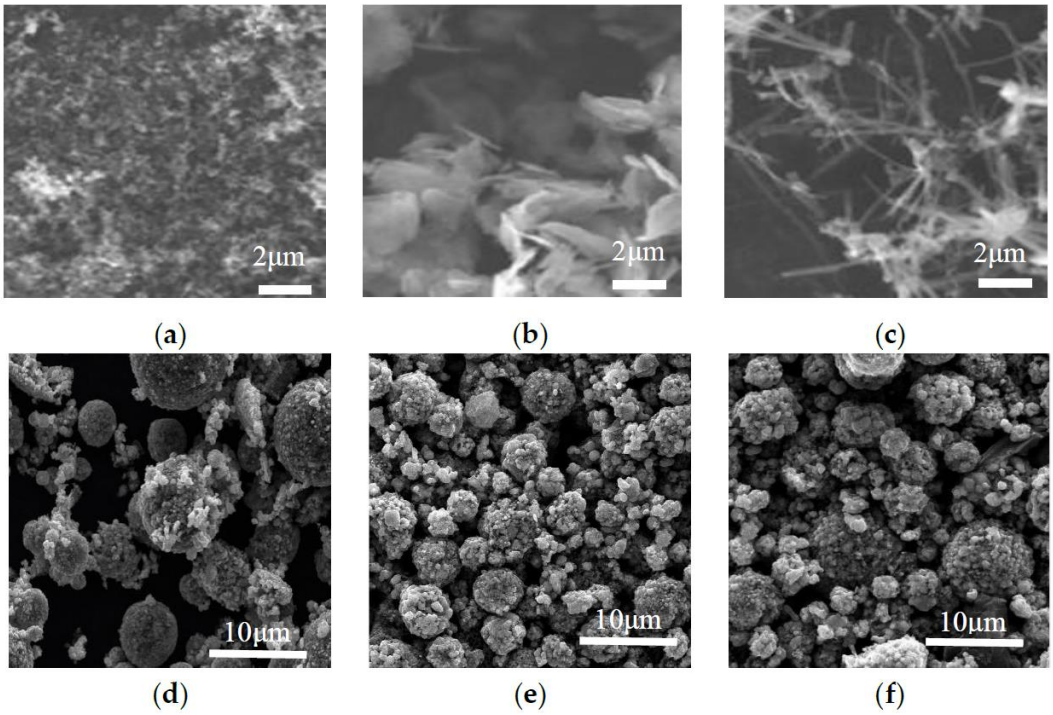


Figure 2. SEM of conductive agents and electrodes with different conductive materials: the surface morphologies of Super-P and KS-15 (**a**); the surface morphologies of graphene (**b**); the surface morphologies of carbon nanotube (**c**); the electrodes image of Super-P and KS-15 (**d**); the electrodes image of graphene (**e**); the electrodes image of carbon nanotubes (**f**).

Id. ¶122 (citing MRD-2016, 2, 4). Although this process does not follow the "masterbatch" process of Ohata where the CNTs are mixed with PVDF first, the results here demonstrate that mixing NMP solvent with PVDF resin does not eliminate the PVDF domains or coatings that exist. *Id*.

As another example, U.S. Patent Application Publication No. 2014/0319429 ("Nicolas-429") specifically identifies Ohata and drawbacks of its masterbatch process. *Id.* ¶123 (citing MRD-2017 ¶¶[0009]-[0010]). Nicolas-429 proposed its own "masterbatch" process. In Example 3, the process uses "5% by weight of CNTs, 1% by weight of PVP, 0.8% by weight of PVDF and 93.2% by weight of NMP" to

form a paste, which is then mixed with LiFePO4. *Id.* (citing MRD-2017 ¶¶[0111]-[0118]). As shown in Figure 2 below, large domains of PVDF exist despite the use of a solvent (NMP) to disperse the PVDF:

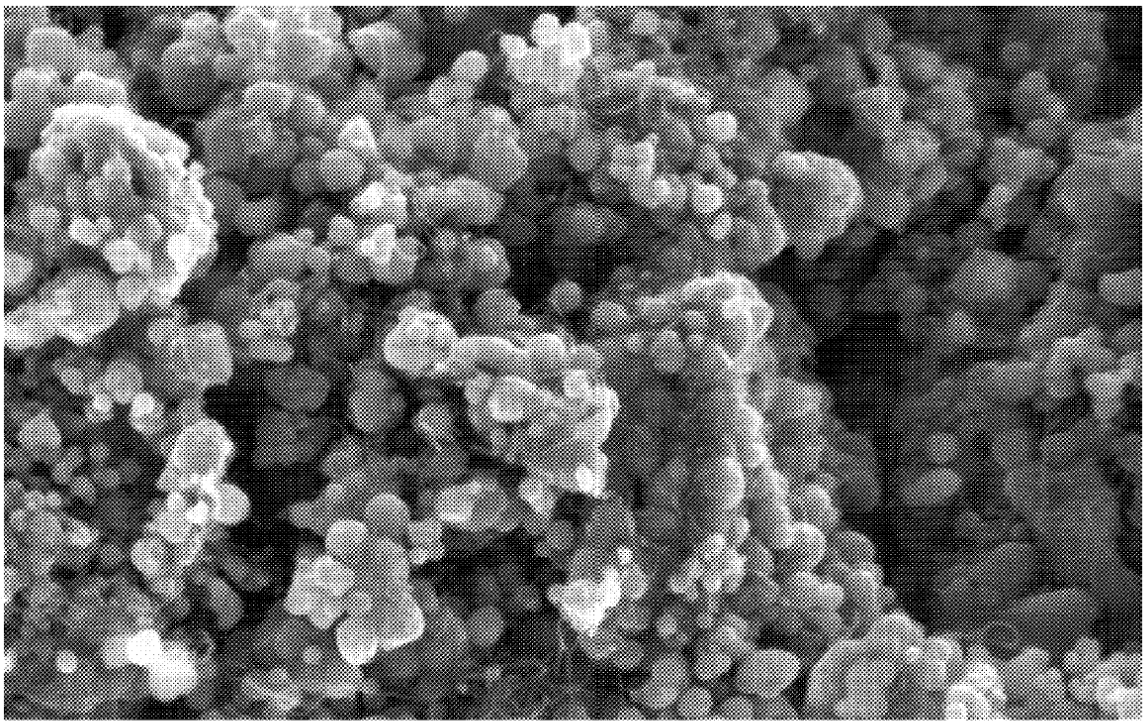


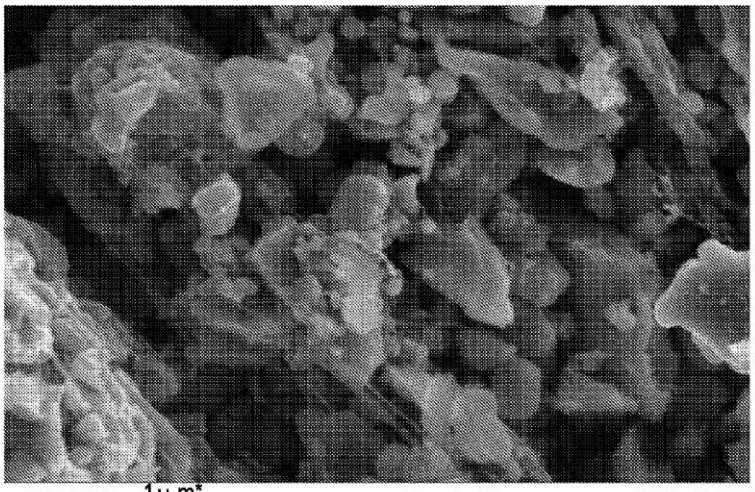
FIGURE 2

Id. Nicolas-429 states that Figure 2 shows "CNTs are well dispersed ***around*** the micrometric $LiFePO_4$/C particles." MRD-2017 ¶[0123]. A POSITA would understand that they are "around" the particles but not attached to the particles, because they are embedded within PVDF domains that prevents the active material

from attaching to the surface of the CNTs. MRD-2006 ¶123.[3] A POSITA would expect the same result in Ohata-Kavan. *Id.*

Another reference, U.S. Patent Publication No. 2011/0256454 ("Nicolas-454"), also references Ohata's masterbatch process. *Id*. ¶124 (citing MRD-2018 ¶¶[0010]-[0011]). In FIGS. 2A and 2B, Nicolas-454 provides SEM images of its own masterbatch (comprising CNTs and PVDF) mixed with NMP and an active material ($LiFePO_4$):

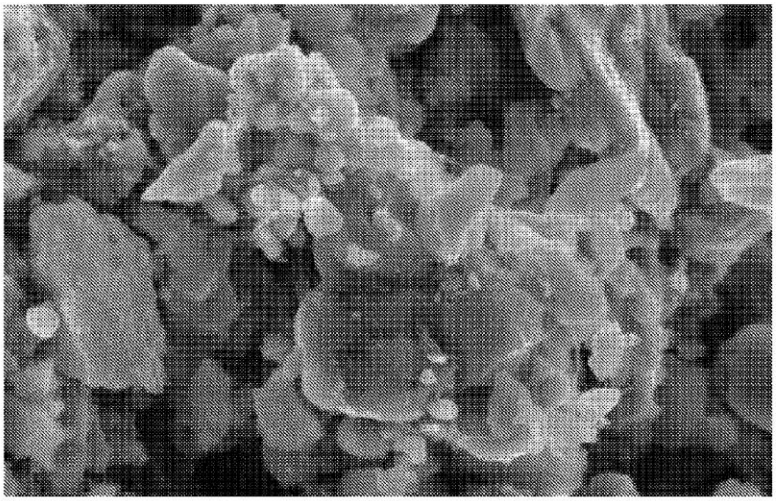
FIG. 2A



Mag = 50.00 KX 1μm* Sample ID= EHT = 5.00kV
Output To = Default PrinterDate: 22 Feb 2010
File Name = YL-1035-015-minicer tranche-05.jpg GRL
WD = 3.9mm Aperture Size= 30.00μm Detector = InLens User Name = PORTAIL

[3] Contrast this with LGES's accused products, where discrete CNTs can very clearly be seen attached to the surface of the active material. *See e.g.*, LGES-1050, 32.

FIG. 2B



Mag = 50.00 KX 1μ m* Sample ID= EHT = 5.00kV
Output To = Default Printer Date: 22 Feb 2010
File Name = YL-1035-015-minicer tranche-12.jpg GRL
WD = 4.1mm Aperture Size= 30.00μm Detector = InLens User Name = PORTAIL

Id. ¶124 (citing MRD-2018, ¶¶[0121]-[0131]). The CNTs are fully embedded within the PVDF domains. *Id*.

Finally, the SEM image below shows "cathode particles with adhering PVDF/carbon black clusters" after NMP mixing:

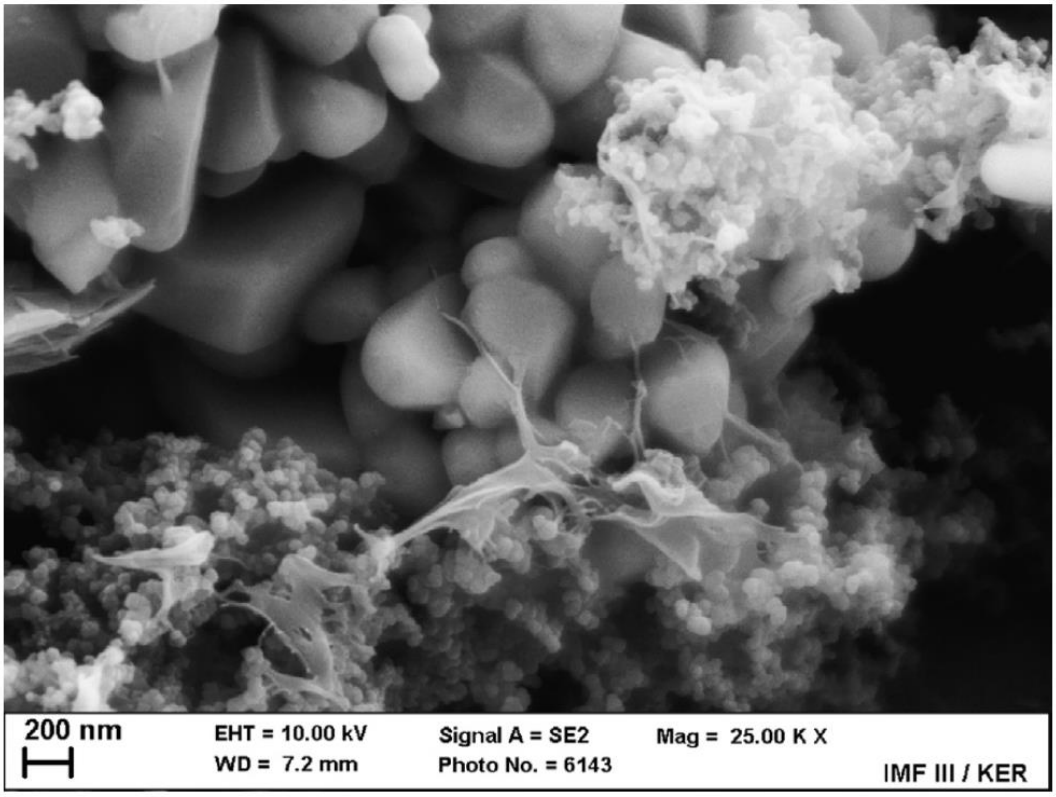


Fig. 13. SEM micrograph of a NMC cathode particles with adhering PVDF/ carbon black clusters.

Id. ¶125 (citing MRD-2020, 7). The carbon black clusters are shown to be entrained in the PVDF domains, which present as web-like or cloudy structures that the carbon black particles are embedded in. *Id*. The article teaches that mixing the carbon black with the binder first results in a "gel formation" and "***PVDF polymer layer***" that "***prevents direct contact*** of particle surfaces." *Id.* (citing MRD-2020, 6-7).

The foregoing evidence demonstrates that oxidized CNTs made pursuant to the masterbatch process of Ohata-Kavan would be fully embedded within and coated by the resin matrix, preventing the active material from attaching to the surface of

the CNTs. *Id*. ¶126. Instead, the active material would essentially be glued to the surface ***of the resin layer*** separating the active material from the surface of the CNTs. *Id*. The resin layers would exist at the molecular layer of the CNTs, meaning that it is impossible for the active material to attach to the surface of the CNTs. *Id*. Petitioner overlooks this critical fact in its obviousness analysis, incorrectly assuming that the sole reason for the "masterbatch" process of Ohata-Kavan is to create discrete CNTs. *Id*. ¶127. However, unlike the '909 Patent and Kavan, which expose naked oxidized CNTs to the active material during mixing, Ohata-Kavan covers the CNTs with resin and prevents the claimed attachment from occurring. *Id*. Indeed, when asked whether immersing oxidized CNTs in resin would prevent attachment, Dr. Zhu tellingly gave a lengthy non-response. MRD-2024, 36:8-37:25.[4]

3. Petitioner fails to demonstrate a motivation to combine to obtain "oxidation levels from 1% to 15%" based on Kavan.

A POSITA would have had no motivation to oxidize the CNTs of Ohata pursuant to Kavan, because he or she would have readily understood that the

[4] Apparently recognizing that he overlooked the unique masterbatch process of Ohata-Kavan, Dr. Zhu offered the implausible testimony that the order of mixing materials for an electrode is irrelevant. MRD-2024, 50:7-51:4. But anyone that has ever baked—never mind created complex lithium battery compositions—knows that the order of mixing is often critical. MRD-2006 ¶127, n.5.

masterbatch process of Ohata-Kavan would mitigate the benefits described by Kavan. MRD-2006 ¶129. The functional groups associated with the oxidization would be completely covered in resin, preventing the lithium ion active material from "anchoring" to the surface of the CNTs. *Supra* V.A.2. A POSITA would have found it illogical to oxidize Ohata's CNTs based on Kavan, given that the masterbatch process would destroy all benefits described by Kavan. MRD-2006 ¶129.

A POSITA would have also understood that oxidizing CNTs adversely affects their desirable intrinsic properties, further discouraging a POSITA from oxidizing per Kavan. *Id.* ¶130. It was known that "while a greater degree of functionalization may improve the dispersibility of the CNTs, such improvement *may come at a decrease in intrinsic properties of the pristine CNTs*." *Id.* (citing MRD-2019 ¶[0024]). This includes shortening the CNTs, reducing electrical conductivity, and even potentially causing the CNTs to split apart. *Id.* (citing LGES-1009, 1-2; MRD-2024, 19:13-17, 22:1-24:3). Although a POSITA may have determined, as Kavan did, that the benefits of "anchoring" provided by oxidation offset these drawbacks, those benefits simply ***do not exist*** in Ohata-Kavan due to the masterbatch process. *Id*.

Petitioner's "reasons for the combination" fail because they ignore the effects of the masterbatch process. *Id*. ¶131. The "first" reason is that "oxidized nanotubes

provide a 'beneficial effect of nanotube networking'" when "the combination paste is a negative electrode material mixture paste having TiO_2 as the active material." Pet., 8-9. The "second" reason is that "oxidized nanotubes 'exhibit better affinity towards TiO_2.'" *Id.*, 9. And the "third" reason is that when a phosphate olivine is used as the active material, "electrochemical performance of an electrode is improved by oxidized nanotubes." *Id*. All three reasons are premised on the active material ***being able to "anchor" to the functional groups*** of the oxidized CNTs. MRD-2006 ¶132.

In Kavan, this anchoring occurs because the ***naked*** oxidized CNTs are *mixed directly* with the active material in water. *Id*. ¶133 (citing LGES-1005, 2). Likewise, the '909 Patent teaches mixing naked oxidized CNTs with the active material to facilitate attachment. *Id.* (citing LGES-1001, 2:4-16; 5:11-20). In contrast to both Kavan and the '909 Patent, in Ohata-Kavan the CNTs are *first* covered in resin during the masterbatch process, preventing this anchoring from occurring. *Id*. Consequently, none of the first three alleged reasons support a motivation to combine.

The "fourth" reason is that "a POSITA would have been motivated … to have well-dispersed nanotubes in the composite." Pet., 10. As with the first three reasons, this reason is fundamentally undermined by the masterbatch process. MRD-2006 ¶134. A POSITA would understand that the improved dispersion described in Kavan

is due to the functional groups interacting with water. *Id.* Specifically, the functional groups added via oxidation are polar, hydrophilic functional groups on the surface of the CNTs, which enhances the CNTs' interaction with water, helping to reduce aggregation and promote dispersion. *Id*. (citing MRD-2024, 27:17-28:5) (Dr. Zhu discussing how functional groups are hydrophilic)). In Ohata-Kavan, the naked oxidized CNTs are not exposed to water, but instead are first covered in resin. *Id*. Because Kavan only teaches that naked oxidized CNTs mixed with water can help improve dispersion, Kavan does not support the assertion that oxidizing the resin-covered CNTs of Ohata-Kavan would improve dispersibility. *Id*. And even if oxidation *generally* would have been understood to help disperse CNTs in the resin of Ohata-Kavan, Petitioner still fails to show obviousness, because the only basis for alleged obviousness of the claimed ***oxidation level*** is Kavan—which relies on a fundamentally different interaction between water and the functional groups (not the resin and the functional groups). *Id*. ¶135.

The "fourth" reason also lacks merit, because Petitioner contends that Ohata alone *already* achieves uniformly dispersed CNTs. Pet., 20 (arguing in Ohata "a conductive material is ***uniformly predispersed*** in a binder"') (quoting LGES-1004 ¶[0002])). Because Petitioner alleges that Ohata already achieves uniform dispersal without oxidation, there would have been no motivation to oxidize to improve

dispersion. MRD-2006 ¶136. This is particularly so given that it was well-known that oxidation would adversely affect the intrinsic properties of CNTs. *Id*.

The "fifth" reason is that oxidation can help purify the CNTs. Pet., 11. But nothing in Ohata or Kavan teaches or suggests that the CNTs have impurities. MRD-2006 ¶137. To the contrary, Kavan teaches that it uses "purified" CNTs, which refers to CNTs lacking impurities. *Id*. (citing LGES-1005, 2 ("For oxidative functionalization, 1g of *purified* nanotubes was mixed….")). Thus, there is no evidence to support this "purification" motivation.

Petitioner further contends that "a POSITA would have been motivated to use oxidized nanotubes in the Ohata-Kavan paste." Pet., 8. But the issue is not simply whether a POSITA would have been motivated "to use oxidized nanotubes," but whether there was a motivation to use oxidized CNTs ***at the claimed level of 1% to 15%***. Petitioner cannot rely on motivations to oxidize *generally.* The only basis for the assertion that ***the claimed range*** was obvious is based on Kavan's oxidation level—but that oxidation level is premised on the goal of "anchoring" to provide the described benefits. Because the Ohata-Kavan masterbatch process precludes these benefits from coming to fruition, Petitioner fails to provide any motivation for oxidizing at claimed level. Further, given the well-known disadvantages of oxidizing CNTs, and that a POSITA understood that the "anchoring" benefits of Kavan would

not be achieved in Ohata-Kavan, a POSITA would have further lacked motivation to oxidize at Kavan's levels. MRD-2006 ¶138.

The "sixth" reason is essentially a rehash of the first five, couched in terms of applying a known technique to a known structure ready for improvement to yield predictable results. Pet., 11. This reason is thus inadequate for at least the reasons discussed above. Indeed, the so-called "predictable results" based on functionalization of the carbon nanotubes simply ignores the effects of the Ohata-Kavan masterbatch process, which fundamentally undermines the motivations. *See Depuy Spine, Inc.*, 567 F.3d at 1326 ("[T]he 'predictable result' discussed in [*KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398 (2007)] refers not only to the expectation that prior art elements are capable of being physically combined, but also that the combination ***would have worked for its intended purpose***."). There is simply no evidence that oxidizing at the levels taught by Kavan would have worked for its intended "anchoring" purpose in Ohata-Kavan when accounting for the effects of the masterbatch process. MRD-2006 ¶139.

In addition to the lack of motivation, Ohata teaches away from the combination. "A reference may be said to teach away when a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out in the reference, or would be led in a direction divergent from the path that was taken by the applicant." *In re Gurley*, 27 F.3d 551, 553 (Fed. Cir. 1994). "The degree

of teaching away will of course depend on the particular facts; in general, a reference will teach away if it suggests that the line of development flowing from the reference's disclosure is unlikely to be productive of the result sought by the applicant." *Id*.; *Par Pharm., Inc. v. Twi Pharms., Inc*., 773 F.3d 1186, 1198 (Fed. Cir. 2014). "An inference of nonobviousness is especially strong where the prior art's teachings undermine the very reason being proffered as to why a person of ordinary skill would have combined the known elements." *DePuy Spine, Inc. v. Medtronic Sofamor Danek, Inc*., 567 F.3d 1314, 1326 (Fed. Cir. 2009).

First, Ohata teaches that "[a]lthough it is possible to add a resin during the step of preparing an electrode material mixture paste, the addition of the carbon nanotubes ***is difficult***, ***taking the dispersibility of the carbon nanotubes in the resin into consideration***." LGES, 1004 ¶[0021]. Thus, Ohata teaches away from exposing the naked CNTs to the active material, which is how Kavan "anchors" the active material to the oxidized CNTs. MRD-2006 ¶¶140-141 (citing LGES-1005, 2).

Second, a POSITA would be discouraged from oxidizing Ohata's CNTs pursuant to Kavan, because it would have been understood that the benefits of "anchoring" taught by Kavan would not be achieved because the masterbatch process covers the CNTs in resin. *Id*. ¶142. This is particularly true given that oxidizing the CNTs per Kavan would come at the cost of damaging the intrinsic properties while providing none of the benefits taught by Kavan. *Id*.

4. Petitioner fails to demonstrate a reasonable expectation of success.

The reasonable expectation of success requirement "refers to the likelihood of success in combining reference to meet the limitations ***of the claimed invention***." *Intelligent Bio-Systems, Inc. v. Illumina Cambridge, Ltd.*, 821 F.3d 1359, 1367 (Fed. Cir. 2016). A POSITA would have had no reasonable expectation of success in combining Ohata-Kavan such that the lithium ion active materials are "attached to th[e] surface" of the oxidized CNTs as claimed. MRD-2006 ¶143. Petitioner was required to demonstrate a reasonable expectation of success *in the Petition*, but instead simply ignored the fact that Ohata-Kavan embeds the oxidized CNTs in resin before mixing with the active material. Indeed, 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 like Kavan. *Id* ¶144. A POSITA would have had no expectation of success when considering that the oxidized CNTs would be covered in resin, preventing the attachment described by Kavan. *Id*.

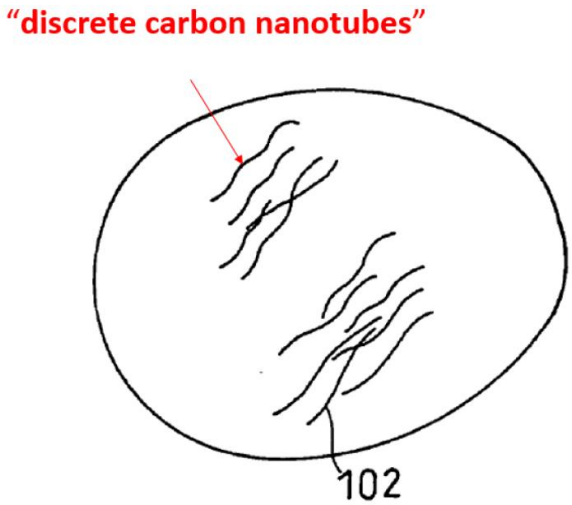
5. Petitioner fails to demonstrate that Ohata-Kavan teaches or renders obvious "discrete carbon nanotubes."

Petitioner proposes that "discrete" CNTs means "generally individually distinct nanotubes" (Pet., 21-22) that are "fully isolated" or "separated" from one another. MRD-2023 ¶[0083]; MRD-2024, 11:4-8 (testifying that CNTs are

"discrete" "because" they are "fully isolated" from one another), 12:17-13:22 (testifying that "discrete" CNTs are "separated from each other"). This is consistent with the plain and ordinary meaning of "discrete," as evidenced by its usage in the specification and the common meaning of "discrete." MRD-2006 ¶¶145-146 (citing LGES-1001, 1:40-44 ("discrete, i.e., individual, uniformly dispersed tubes"), 3:47-49 ("discrete" CNTs are "separated to give individual tubes"); MRD-2007, 8 (defining "discrete" as "separate and distinct; not attached to others; unrelated")).

Petitioner alleges that Ohata-Kavan achieves "discrete" CNTs. Pet., 19-20. Petitioner relies on Ohata's statement that its CNTs "are tangled and twisted with one another" but then are "***unraveled and straightened***" by blending them with a resin as part of the masterbatch process. *Id*., 20 (emphasis in original) (citing LGES-1004 ¶[0015]). Petitioner argues "that a POSITA would have found it obvious that at least some of these 'unraveled and straightened carbon nanotubes' are discrete because they are generally ***'dispersed'*** as individual nanotubes in the resin." *Id.*

Petitioner annotates Figure 1(b) of Ohata (reproduced below) to identify CNTs that it contends are "discrete."



Pet., 21.

Petitioner fails to carry its burden of demonstrating that Ohata-Kavan results in "discrete" CNTs. As an initial matter, Petitioner's reliance on cartoon Figure 1 of Ohata is misplaced. Ohata itself calls Figure 1 a "schematic" diagram, which conceptually illustrates the ***concept*** of disentangling CNTs by shearing. MRD-2006 ¶¶147-148 (citing LGES-1004 ¶¶[0012]-[0013]). A POSITA would not rely on such a schematic as a real-world representation of actual masterbatch results. *Id*. ¶148. It would instead be understood for what it is—an illustration intended to conceptually depict the well-known concept of CNT disentanglement via shear forces. *Id.*

A POSITA would understand that the actual results of Ohata's masterbatch process would be reflected by SEM or TEM images, similar to how both the '909 Patent and Kavan evidence their findings. *Id*. ¶149. Indeed, Figure 1(b) depicts the CNTs as somehow being oriented in nearly the exact same direction and generally

parallel to one another, rather than at random orientations, which is implausible. *Id*. ¶¶149-150. A POSITA would know that Figure 1 is an unrealistic, conceptual drawing. *Id.* For example, an actual SEM image from Gan shows CNTs mixed in a resin to form a conductive polymer composite:

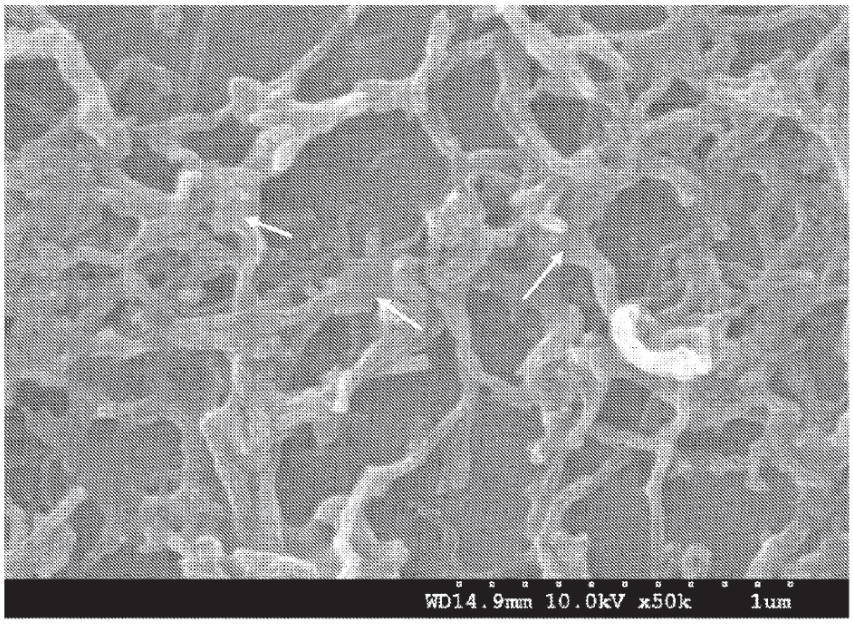


FIG.5

Id. (citing MRD-2019, ¶¶[0014], [0041]). Although Gan does not purport to achieve discrete CNTs, this image shows how the CNTs of Ohata's masterbatch would be randomly oriented, facilitating the formation of a continuous network of CNTs embedded within the binder that glues the active material together. *Id*.

Even if the Board accepts Figure 1 of Ohata as representative of how the CNTs would present in the masterbatch, Petitioner fails to demonstrate that they would

remain discrete after ***being further mixed*** with the active material to create the electrode material mixture paste. A POSITA would understand that the goal of Ohata is to create a continuous network of CNTs embedded in the binder, providing improved electrical conductivity between active material particles. *Id*. ¶151 (citing LGES-1004 ¶[0004] ("it is an object of the present invention to provide an electrode superior in ***conductivity*** with a small amount of conductive material"), ¶¶[0018]-[0020] (explaining that when the CNT's diameter is too large, the CNT's length is too short, or the aspect ratio is too small, "excellent ***conductive paths*** may not be formed in some electrodes.")). This was a well-known and common goal for electrodes at the time of the invention. *Id*. (citing MRD-2022 ¶[0005]); MRD-2019 ¶[0041])).

Consistent with this goal, Ohata teaches a prior method of pre-dispersing carbon black (i.e., a "conducting material") in resin binder as part of a "masterbatch" process. *Id*. ¶152 (citing LGES-1004 ¶[0002]). The linked "chain" of carbon black forms a continuous "conductive path" in the binder, which increases electrical conductivity. *Id*. (citing LGES-1004 ¶[0003]). Ohata teaches, however, that the shearing force associated with mixing the masterbatch breaks the conductive path, and therefore, "does not yield an electrode superior in conductivity." *Id*.

Ohata's proposed solution to this problem is to use CNTs to form the continuous network rather than carbon black. *Id*. (citing LGES-1004 ¶[0015]).

Nothing suggests that Ohata was seeking to achieve discrete CNTs as part of its electrode material mixture paste, as this would create gaps in the conductive network contrary to Ohata's express goal of creating an "electrode superior ***in conductivity***" and conventional wisdom at the time. *Id*.

A POSITA would instead understand that the only reason Ohata seeks to "unravel" and "straighten" the CNTs is so that they can be better dispersed to form a continuous network better distributed throughout the binder. *Id*. ¶153. This is because it was well-known that heavier entanglement of CNTs "is undesirable because it results in formation of voids and aggregates in the composition which adversely effects the ***electrical conductivity properties*** of the composite...." *Id*. (quoting MRD-2019 ¶[0027]; citing MRD-2022 ¶[0073] (explaining CNT agglomeration makes it "difficult to form an effective conductive network")). Just as a heavily wound spiderweb is more difficult to spread apart, heavily entangled CNTs make it more difficult to disperse a CNT network. *Id*. Ohata seeks better dispersion of its CNTs so that it can provide a ***continuous network*** of CNTs throughout the entire binder, not to achieve discrete CNTs attached to the surface of active material. *Id*.

Even if the *masterbatch* of Ohata-Kavan would comprise discrete CNTs, Petitioner fails to demonstrate that the same can be said of the *electrode material mixture paste*, which is created by mixing the masterbatch with the active material

and a dispersion medium. *Id*. ¶154 (citing LGES-1004 ¶[0023]). As evidenced by Figure 5 of Gan below, the random orientation of CNTs in a fluid facilitates the CNTs connecting to one another to forming a continuous conductive network. *Id*. (citing MRD-2019 ¶¶[0014], [0041]).

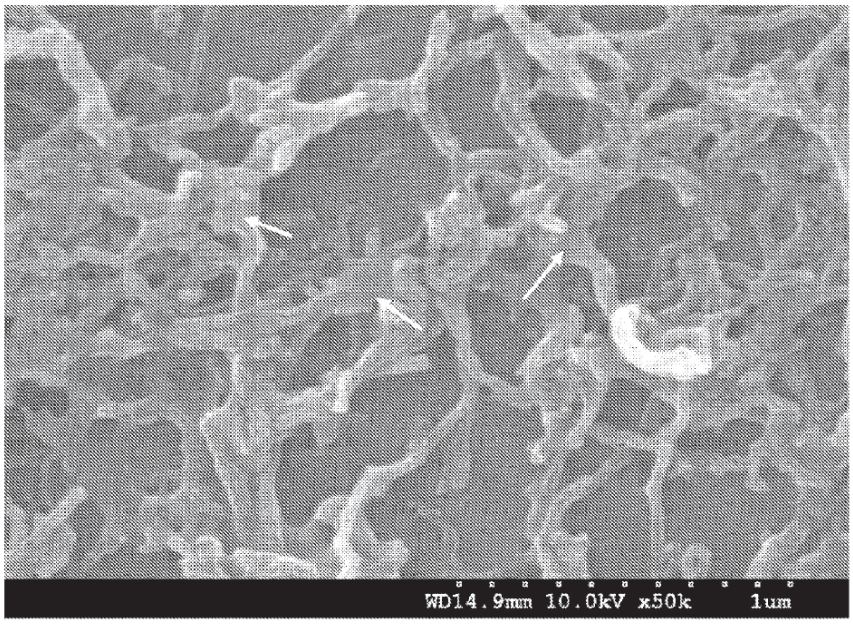


FIG.5

The formation of a continuous conductive network is only further facilitated when *oxidized* CNTs are mixed in a polymer (e.g., the resin of Ohata-Kavan), because the functionalization of the CNTs "[r]educes contact resistance between CNTs incorporated into the conductive polymer material by ***drawing the CNTs close together***" and "[p]rovides a ***conductive bridge between*** CNTs." *Id*. ¶155 (quoting MRD-2019 ¶¶[0018]-[0021]); MRD-2026, 50:17-53:6 (agreeing). The formation of

a continuous network of CNTs is a primary goal of Ohata—it *wants* the CNTs to be interconnected to form a continuous network to improve conductivity. *Id*. And the only reason Ohata teaches "unraveling" and "straightening" the CNTs is to make it easier to disperse them through the binder so that a continuous network is achieved throughout the entire binder—avoiding network "voids." *Id*. In view of the above, Petitioner fails to demonstrate by a preponderance of the evidence that the *electrode material mixture paste* of Ohata-Kavan would comprise discrete CNTs. *Id*.

Apparently recognizing that its invalidity theory based on Figure 1 of Ohata is tenuous, Petitioner also "alternatively/additionally" argues that "a POSITA would have understood or found obvious that the nanotubes in the combination composition are **discrete** because, at least in some instances, oxidation of nanotubes can help promote non-agglomeration of nanotubes." Pet., 21 (emphasis in original). According to Petitioner and its expert, oxidizing CNTs necessarily results in "discrete" CNTs. *Id.*, 21-22. Petitioner fails to provide sufficient evidence to prove this assertion.

While oxidation of CNTs can improve their dispersibility, CNTs that are dispersed (even uniformly dispersed) are not necessarily "discrete." MRD-2006 ¶¶156-157. For example, CNTs forming a continuous network (i.e., the clear goal of Ohata) throughout an entire composition are "dispersed" throughout the composition even though the CNTs are interconnected (i.e., **not** "discrete"). *Id*. In fact, Gan

teaches that functionalized CNTs within a polymer will be drawn closer together and provide a conductive bridge between CNTs, facilitating the formation of a continuous network. *Id*. (citing MRD-2019 ¶¶[0018]-[0021]). Dr. Zhu agrees with Gan and admits that both of these effects result in CNTs ***in contact with one another*** to form a ***continuous*** conductive network. MRD-2026, 50:17-53:6. It is unsurprising then that Petitioner provides no objective evidence to support its assertion that merely oxidizing CNTs *necessarily* achieves discreteness. Kavan itself depict CNTs that have been oxidized, yet Petitioner does not contend they are discrete. LGES-1005, 3 (Fig. 2, top right). Consequently, there is no basis for the assertion that oxidation of CNTs, in and of itself, somehow achieves discrete CNTs. Petitioner's attempt to rely on oxidation alone to demonstrate beyond a preponderance of the evidence that the electrode material mixture paste of Ohata-Kavan would achieve "discrete" CNTs should be rejected. MRD-2006 ¶157.

B. Dependent Claim 6.

All dependent claims are patentable over Ohata-Kavan for the reasons discussed above. However, Petitioner also fails to demonstrate the specific limitations of claim 6 are disclosed.

1. "the carbon nanotubes are uniformly dispersed…"

Ohata-Kavan does not teach or render obvious discrete CNTs that are

"uniformly dispersed."[5] Petitioner relies solely on Ohata's teaching that "a conductive material is *uniformly predispersed* in a binder," arguing that blending the electrode active material with a dispersion medium to form an electrode material mixture paste (as taught by Ohata) "would allow the nanotubes in the resulting paste to remain ***uniformly dispersed***, as they are in the masterbatch." Pet., 34. Petitioner's invalidity theory is fundamentally flawed because Ohata never teaches that ***its masterbatch*** (made up of CNTs and resin) is "uniformly" predispersed. MRD-2006 ¶162.

Petitioner quotes from the background of Ohata, which explains that it was known that "conductive material [carbon black or powdered graphite] is uniformly predispersed in a binder" to form a masterbatch. Pet., 33 (quoting LGES-1004 ¶[0002]). However, this is describing a different, prior art masterbatch process—not the masterbatch process relied on by Petitioner for invalidity. MRD-2006 ¶163; MRD-2024, 46:15-47:16 (admitting Ohata's reference to "uniformly predispersed" refers to carbon black). Ohata's background further teaches "the use of the

[5] The Petition does not provide an express interpretation of this term. However, Dr. Zhu testified that it "means that the nanotube does not form any initial bundled stricture. Instead, they will disperse in the medium ***with certain distance between*** nanotube." MRD-2024, 17:14-22. This is consistent with the ordinary meaning of "uniformly dispersed" as spread consistently. MRD-2006 ¶161.

masterbatch process to uniformly disperse the conductive material in a binder does ***not*** yield an electrode superior in conductivity," only further confirming that the reference to "uniform" dispersal is about the inferior masterbatch comprising carbon black or powdered graphite—not CNTs. MRD-2006 ¶163 (citing LGES-1004 ¶[0003]).

While Ohata does teach that carbon black can be "uniformly dispersed" as part of ***a prior art*** masterbatch, Ohata does not teach or suggest the same with respect to ***its*** masterbatch, which comprises CNTs (not carbon black) mixed with resin. *Id*. ¶164 (citing LGES-1004 ¶[0005] ("The present invention relates to ... a masterbatch comprising at least carbon nanotubes and a resin;")). To the contrary, Ohata describes the difficulty of dispersing CNTs in resin. *Id*. (citing LGES-1004 ¶¶[0021] ("the addition of the carbon nanotubes is difficult, taking the dispersibility of the carbon nanotubes in the resin into consideration"); [0019] ("the dispersibility of the carbon nanotubes in the resin may be slightly low")).

Given that the sole basis for Petitioner's assertion that Ohata-Kavan teaches "uniformly dispersed" CNTs is a statement from Ohata about a masterbatch comprising <u>carbon black</u> and resin—***not*** the masterbatch comprising <u>CNTs</u> and resin—Petitioner is left without any credible evidence that the Ohata-Kavan electrode material mixture paste would achieve "uniformly dispersed" discrete CNTs. *Id*. ¶165. In fact, it was well-known that mixing oxidized CNTs in resin draws

"the CNTs closer together," which is inconsistent with Petitioner's assertion (erroneously based on a quote about the wrong masterbatch process) that the CNTs would have been "uniformly dispersed." *Id.* (quoting MRD-2019 ¶[0020]).

2. "wherein the carbon nanotubes are uniformly dispersed without clustering on a dimension scale of less than 1 micrometer"

Petitioner fails to demonstrate that Ohata-Kavan satisfies this limitation. As an initial matter, Petitioner provides no express construction or even attempts to explain its understanding of this claim term. Petitioner tries to justify its failure to address its meaning by arguing that "[t]he '909 Patent provides no substantive discussion of this feature" and arguing that it "is inappropriate to hold the prior art to a stricter standard of disclosure than what is disclosed in the specification of the patent itself." Pet., 34, n.6 (citing *In re Epstein*, 32 F.3d 1559, 1568 (Fed. Cir. 1994)). Petitioner's justification is meritless.

The issue in *Epstein* was whether an undetailed disclosure in the prior art was adequate to ***enable*** the prior art. The Federal Circuit found that the patentee's own undetailed disclosure supported a finding that a POSITA would have "known ***how to implement*** the features of the references and would have concluded that the reference disclosures would have been ***enabling***" despite their scant disclosures. *In re Epstein*, 32 F.3d at 1568. Thus, the issue in *Epstein* related to whether the prior art enabled the features <u>*that were plainly disclosed*</u>. *Id*.

Epstein does not stand for the proposition that a patentee is permitted to *intentionally avoid* addressing the meaning of a term it contends is disclosed in the prior art. Indeed, "a petition for an inter partes review must identify *how each challenged claim is to be construed* and *how the construed claim is unpatentable*." *See Infinera Corp. v. Core Optical Technologies, LLC*, IPR2018-01259, Paper 9 at 18 (P.T.A.B. Jan. 14, 2019). Petitioner's reliance on the inapplicable *Epstein* decision is all but an admission that it has failed to comply with this requirement.

Nor does *Epstein* support Petitioner's other implicit suggestion that because the specification does not use the language "uniformly dispersed without clustering on a dimension scale of less than 1 micrometer" in reference to a specific figure, that somehow means that Petitioner is not required to demonstrate that the prior art teaches this limitation. In *Epstein* there was no dispute that the prior art ***actually disclosed*** the claim limitation at issue—the issue was whether the prior art was enabling. Petitioner is thus required to demonstrate—by a preponderance of the evidence—that Ohata-Kavan ***actually discloses*** CNTs that meet this limitation. *See Google LLC. v. Nobots LLC*, IPR2022-00940, Paper 38, 26-27 (P.T.A.B. Nov. 29, 2023) (rejecting petitioner's argument, based on *Epstein*, that an alleged "lack of ***<u>any</u>*** description" in the specification of a claim feature alleviated petitioner of its burden of "showing that a particular claim limitation was recognized in the prior art").

Petitioner is also wrong that the specification of the challenged patent provides

no guidance as to the meaning of this phrase. MRD-2006 ¶168. The specification discloses this feature. *Id.* (citing LGES-1001, 3:23-27). Petitioner's own expert admits that the claim requires the CNTs to be at least 1 micrometer apart, thereby delineating what qualifies as "without clustering." MRD-2024, 16:6-17:6 (explaining that the claim limitation means that the CNTs "have significant distance between them" and that a POSITA considers "dispersed carbon nanotube[s] actually have a distance of around 1 micrometer"); *Id.*, 17:23-18:2; *see also* MRD-2025, 8:1-25. And Figure 2 of the '909 Patent provides an example of an SEM image at a 30,000x magnification with a dimension scale of 1 micrometer showing CNTs that are spaced apart. MRD-2006 ¶168.

Petitioner fails to provide any credible evidence that Ohata-Kavan teaches or suggests this limitation, which requires examining CNTs under a microscope *with a dimension scale*. *Id.* ¶169. Instead, Petitioner argues that Ohata's cartoon Figure 1(b) "shows that the nanotubes are dispersed ***without clustering***," and then leaps to the wholly unsupported conclusion that a POSITA would know this to mean that "the nanotubes are dispersed **without clustering on a dimension scale less than 1 micrometer**." Pet., 34-35. Petitioner fails to explain how a ***cartoon*** figure that is clearly not drawn to scale and does not represent *actual* results somehow meets this limitation. MRD-2006 ¶169. Petitioner instead improperly equates Figure 1(b) allegedly showing no clustering as automatically meaning the dimension scale

requirement is met. *Id.*

Recognizing this problem, Petitioner next argues that a POSITA would somehow understand Figure 1(b) of Ohata to disclose CNTs that are both: (1) at least one micrometer apart; and (2) do not form clusters of greater than 1 micrometer in size. Pet., 35. This argument is absurd. For one, Ohata itself refers to Figure 1(b) as a "schematic," which is a very poorly sketched cartoon providing a conceptual illustration of how CNTs can be disentangled via shear forces. MRD-2006 ¶171 (citing LGES-1004 ¶[0013]). A POSITA would readily understand that Figure 1(b) is not a realistic depiction of CNTs. *Id*. But even if that were not true, a POSITA would certainly understand that the cartoon is too abstract to be relied on for purposes of comparing ***distances at the nanoscale scale*** required by the claim. *Id*.

Petitioner admits that Figure 1(b) has no scale. Pet., 35. Despite this, Petitioner asserts that "a POSITA would have been able to estimate the scale based on Ohata's disclosure that the nanotubes have an average length of 1 to 100 μm." *Id*. Petitioner then concludes "for nanotubes having a length of 100 μm, the space between the nanotubes is depicted as greater than 1 μm" and that this estimation shows "the nanotubes are dispersed without clustering on a dimension scale less than 1 micrometer." *Id*. However, "it is well established that patent drawings do not define the precise proportions of the elements and may not be relied on to show particular sizes ***if the specification is completely silent on the issue***." *See White v. H.J. Heinz*

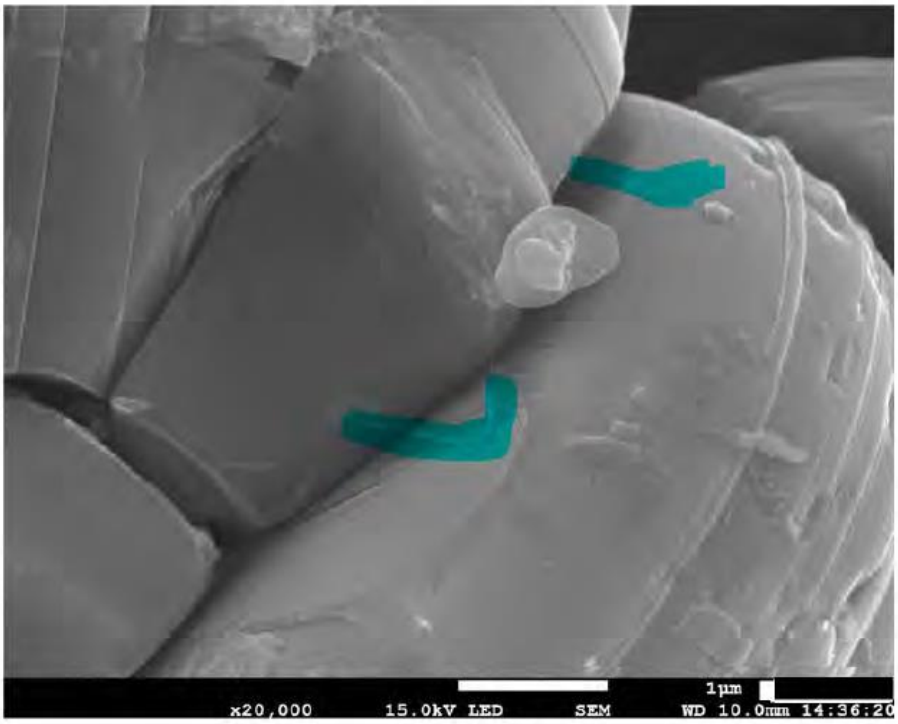
Co., 640 F. Appx 930 at 934 (quoting *Hockerson-Halberstadt, Inc. v. Avia Grp. Int'l*, 222 F.3d 951, 956 (Fed. Cir. 2000)); *see also Source Vagabond Sys. v. Hydrapak, Inc.*, 753 F.3d 1291, 1300 (Fed. Cir. 2014) (rejecting argument that the "relative sizes shown in the drawings rebut the Court's finding" based on *Hockerson*); *Plantronics, Inc. v. Aliph, Inc.*, 724 F.3d 1343, 1351 (Fed. Cir. 2013) (rejecting argument that figures show "elongated" stabilizer members because specification was completely silent on whether the drawings were intended to be proportional or to scale). There is nothing in Ohata supporting the notion that Figure 1(b) is intended to be drawn to scale or that the cartoon CNTs are supposed to be of any particular size. MRD-2006 ¶172.

Moreover, Petitioner's position is illogical, because Ohata provides a broad ***range*** of potential dimensions for its CNTs. LGES-1004 ¶[0019]. Figure 1(b) cannot plausibly be intended to be drawn at scale because it cannot represent ***a range*** of CNT dimensions. MRD-2006 ¶173. Further, if those same cartoon CNTs had a 1 µm average length, rather than the 100 µm cherry-picked by Petitioner, the space between them would be much less than 1µm. *Id*. But of course, it is impossible for anyone to determine a particular size or relative dimensions for the cartoon CNTs, because Figure 1 is clearly not intended to be either. *Id*. Moreover, Ohata teaches that the diameter of the nanotubes should be no greater than 0.1 µm, which means CNTs with a 100 µm length (as proposed by Petitioner) would have aspect ratios of

at least 1,000—outside the claimed 1-500 range. LGES-1004 ¶[0018].

Even if it were legally permissible for Petitioner to rely on the cartoon figure (it is not), Petitioner cannot dispute that Figure 1(b) allegedly depicts the *masterbatch*, **not** the *electrode material mixture paste* containing the active ion material. MRD-2006 ¶170. Even assuming Figure 1(b) could somehow be relied on for this limitation, it would not demonstrate that the CNTs *remain* "without clustering" as claimed once mixed with the active material. *Id*. Indeed, it was well-known that mixing oxidized CNTs in resin draws "the CNTs closer together." *Id*. (citing MRD-2019 ¶[0020]). Consequently, a POSITA would not expect the spacing and arrangement of CNTs in an SEM image of the masterbatch to be the same or even similar once mixed with the active material. *Id.*

Because Ohata's disclosures are insufficient, a POSITA would understand that experimentation would be required, such as by taking an SEM image of the paste under a microscope. *Id*. ¶174. Indeed, Dr. Zhu acknowledged that there are several ways he *could have* supported his assertion (e.g., microscope, XPS). MRD-2025, 9:1-12:9. Instead, he offers the unsubstantiated testimony that a POSITA would have a "general understanding" that this limitation was met. *Id.*, 12:2-13:6. Petitioner *could have* attempted to meet its burden of proof by performing experimentation, similar to how Patent Owner substantiated its infringement theory as shown below:



LGES-1050, 32. Petitioner instead chose to rely entirely on a cartoon figure. Because Petitioner provides no credible evidence that Ohata-Kavan would meet this limitation, Petitioner fails to carry its burden. Indeed, the evidence shows that mixing CNTs with resin—as proposed in Ohata-Kavan—would actually draw them closer together, which is inconsistent with the goal of requiring a certain degree of spacing. MRD-2006 ¶175.

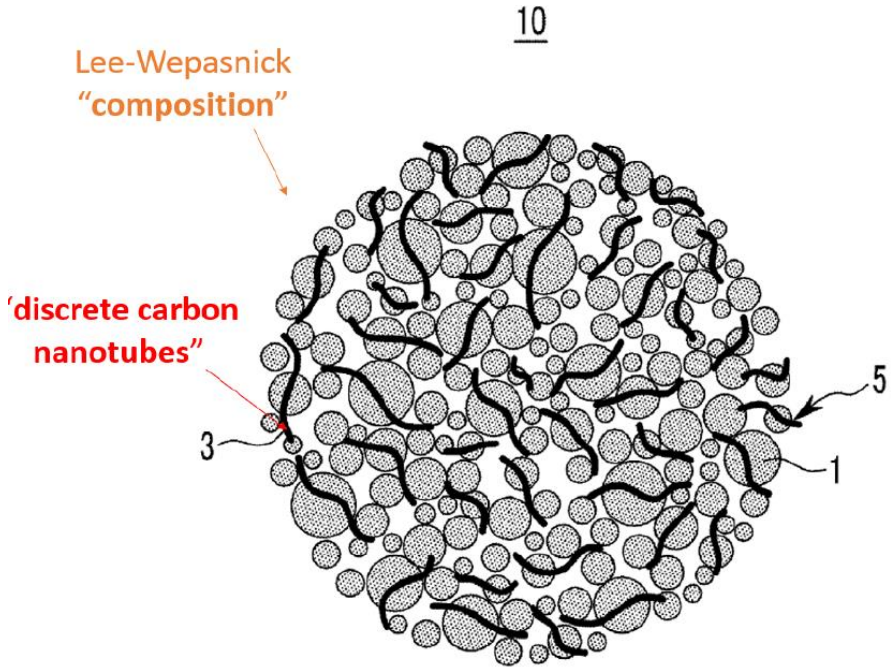
VI. Grounds 2A/B: Lee-Wepasnick Does Not Render Any Claim Unpatentable

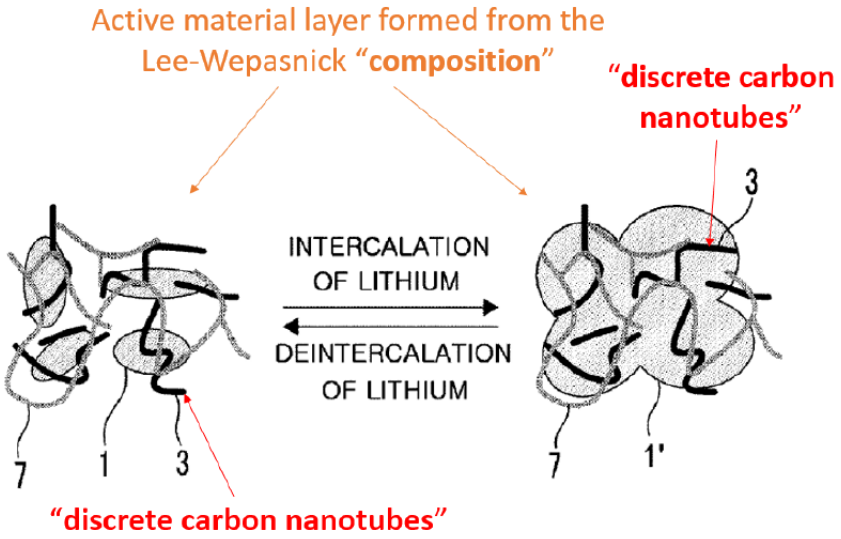
A. Independent Claim 1

1. Lee-Wepasnick does not render obvious "discrete" carbon nanotubes.

a. The Board should affirm its preliminary determination that Petitioner failed to carry its burden.

Petitioner argues that "discrete" CNTs are "generally individually distinct (e.g., ***non-agglomerated***) nanotubes." Pet., 53. In an effort to satisfy this limitation, Petitioner relies on annotated "schematic views" from Figures 1 and 3 of Lee, as shown below. *Id*., 39-40.





However, the thrust of Lee is to use an anode active material "that includes secondary particles formed of ***agglomerated*** primary nanoparticles. MRD-2006 ¶177. The primary nanoparticles include a non-carbonaceous material *bound with hollow carbon nanofibers*." LGES-1006, Abstract; *see also* ¶¶[0014]–[0016], [0040], [0045].

In the Institution Decision, the Board found:

> Petitioner acknowledges these disclosures in Lee (*see* Pet. 42, 48, 52), but ***never sufficiently addresses them***. For example, Petitioner ***fails to reconcile*** Lee's teachings regarding agglomeration of particles with its assertion that Figures 1 and 3 of Lee show discrete, non-agglomerated carbon nanotubes. Absent additional information, we decline to draw the same conclusion Petitioner does, particularly in view of Lee's disclosures regarding agglomeration. Petitioner cites to paragraphs 162 and 167 of the Zhu declaration to support the assertions in the Petition, but ***these paragraphs simply restate what is provided in the Petition***, offering no additional support. Pet. 53–54, 56.

Institution Decision (Paper 8, "DI"), 34. The Board also found that the relevant paragraphs of the Zhu declaration merely "restate what is in the Petition" without providing additional support. *Id.* The Board determined that Petitioner's "speculation" that Lee somehow has discrete carbon nanotubes is "directly contrary to the teachings throughout Lee of 'agglomerated' nanoparticles' and further that "Lee's teaching regarding agglomerated nanoparticles is particularly relevant considering Petitioner's qualification that oxidation 'can' help promote non-agglomeration 'in some instances.'" *Id.*

Petitioner's argument regarding dispersal of nanofibers was "similarly problematic," as there is "difficulty discerning, on this record, how a composition with agglomerated nanoparticles and including a polymer binder can provide discrete carbon nanotubes" and the relevant portions of the Zhu declaration "offers no more than the information presented in the Petition. *Id.* (citing Pet. 56-57).

Petitioner'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. Indeed, "[a]rguments in a petition must be made with particularity, not opacity." *Microsoft Corp. v. FG SRC, LLC*, 860 Fed. Appx. 708, 713 (Fed. Cir. 2021). "Unlike district court litigation—where parties have greater freedom to revise and develop their arguments over time and in response to newly discovered material—the expedited nature of IPRs bring with it an obligation for petitioners ***to***

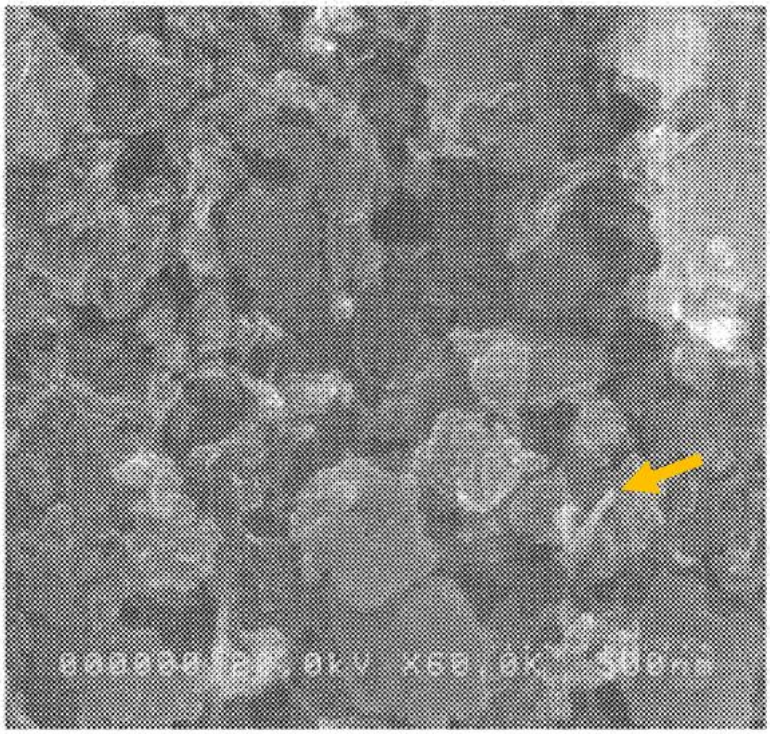
make their case in their petition to institute. While the Board's requirements are strict ones, they are requirements of which petitioners are aware when they seek to institute an IPR." *Intelligent Bio-Sys.*, 821 F.3d at 1369. Because the Petition fails to sufficiently explain how Lee teaches or discloses "discrete" CNTs, and because it is impermissible for Petitioner to use its reply in an attempt to supplement its Petition to provide a sufficient explanation now, Petitioner cannot carry its burden as to the Lee grounds.

b. Even if Petitioner is permitted to attempt to retroactively address defects in its Petition, Petitioner still cannot carry its burden.

Petitioner cannot "reconcile Lee's teachings regarding agglomeration of particles with its assertion that Figures 1 and 3 of Lee show discrete, non-agglomerated carbon nanotubes" (DI, 34) because the text of Lee plainly contradicts the figures. MRD-2006 ¶177 (citing LGES-1006, Abstract, ¶¶[0014]-[0016], [0040], [0045]). Lee teaches that Figures 1 and 3 are "schematic views," which a POSITA would understand to be abstract visual representations, not realistic depictions. *Id*. ¶178 (citing LGES-1006 ¶¶[0023], [0025]). While such schematics may help conceptually show how structures are intended to interact and function, they are by definition not representative of the real world, as evidenced by Lee's vastly different SEM images. *Id*. ¶179.

Although Petitioner alleges that these schematics demonstrate "discrete" CNTs, that is clearly untrue based on the SEM image in Figure 6 (annotated below), which is of the anode active material composition prepared in Example 1. *Id*. ¶180 (citing LGES-1006 ¶[0028]). At a 60,000x magnification level, it shows fibrous-looking material (e.g., orange arrow) associated with several clusters of silicon particles:

FIG. 6



Id. A POSITA would know that this anode active material uses single wall carbon nanotubes ("SWCNT"), because the "carbon nanotubes had an average diameter of 1 nm ...." *Id*. ¶181 (quoting LGES-1006 ¶[0083]). Because Example 1 of Lee uses

SWCNTs with an average diameter of 1 nm and based on the scale bar representing a distance of 500 nm, the fibrous-looking material would be understood to represent numerous CNTs intertwined with each other, forming SWCNT bundles. *Id*.

If there were discrete SWCNTs shown in Figure 6, ***each*** allegedly discrete SWCNTs would need to be 1/500th the size of the scale bar shown to see a distance representing a 1 nm diameter. *Id*. ¶182. However, a POSITA cannot see what a distance representing a 1 nm diameter looks, because the scale bar is much too coarse in connection with the magnification level. *Id*. The fact that SWCNTs are visible at all means they must be grouped together or intertwined with each other. *Id*.

Moreover, Figures 1 and 3 of Lee are unreliable given the incredibly broad CNT aspect ratio range of "about 10 to about 10,000" disclosed in Lee. *Id*. ¶183 (citing LGES-1006 ¶[0047]). A POSITA would have understood that the number of entanglements and degree of dispersibility of CNTs is affected by the aspect ratio and that an aspect ratio of at least 5,000 would almost certainly preclude the possibility of any discrete CNTs in Lee-Wespasnick. *Id*. Thus, a POSITA would

know that distinct CNTs (as purportedly shown in FIGS. 1 and 3) would likely not be achievable at certain aspect ratios within Lee's very broad range. *Id*.[6]

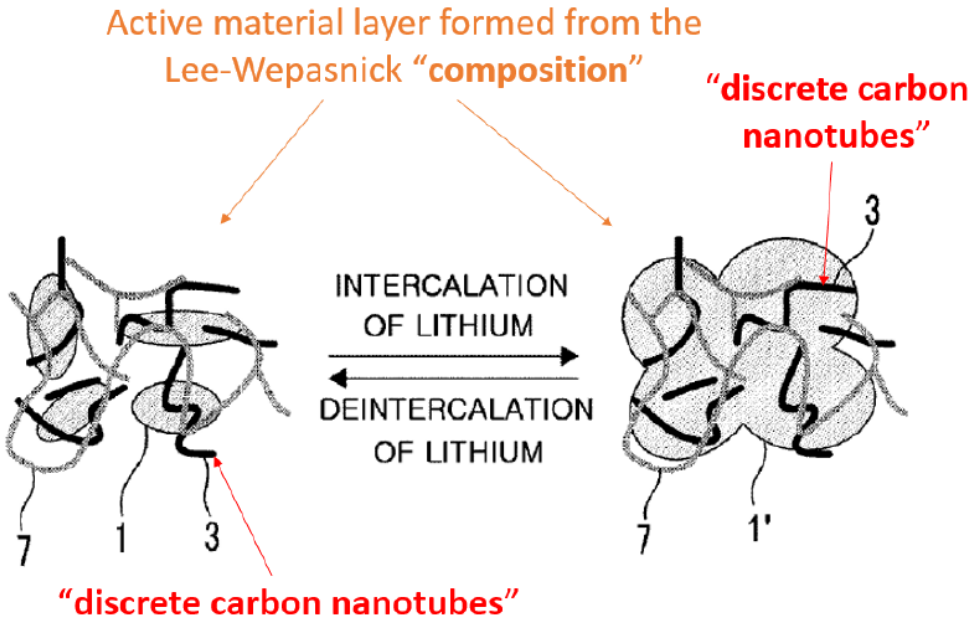
A POSITA would also understand that the process of making the anode active material in Lee-Wepasnick includes a mandatory thermal drying step that "may be performed at about 80˚C., for about 24 hours." *Id*. ¶185 (quoting LGES-1006 ¶¶ [0061], [0083]). The purpose of this thermal drying step is to evaporate the organic solvent that was mixed with the non-carbonaceous material and CNTs in Lee-Wepasnick. *Id*. During and upon completion of Lee's thermal drying, the organic solvent evaporates and leaves the assembly of CNTs. *Id*. ¶186. This results in the collapse of the assembly of CNTs that draws the CNTs closer together, resulting in CNT agglomerates. *Id*. The agglomeration would make achieving discrete CNTs much more difficult, further calling Figures 1 and 3 into question. *Id*.

Moreover, the clear inconsistencies between FIGs. 1 and 3 when compared to the SEM image in Figure 6 further evidence that the schematic drawings are

[6] Given this, a POSITA would understand that for Figures 1 and 3 to be reconciled with the "agglomerated" teachings of the text of Lee, each of the thick single black lines that Petitioner individually labels "discrete carbon nanotubes" cannot be interpreted to mean a single CNT but rather bundles of CNTs. MRD-2006 ¶184.

inaccurate.[7] *Id*. ¶187. In Figure 1, the carbon nanotubes 3 (black squiggly lines) have a length longer than the length of the non-carbonaceous material 1. *Id*. ¶188. But in Figure 6's SEM image, some of the carbon nanotubes have lengths that are shorter than the lengths of some of the non-carbonaceous material. *Id*.

In Figure 3 of Lee (annotated by Petitioner below), the size, shape, orientation, and position of each of the CNTs in the collection of CNTs on the left side of Figure 3 compared to those on the right side of Figure 3, are identical—even though the left side corresponds to before charging of the anode and the right side corresponds to the after charging of the anode. *Id*. ¶189.



[7] At the relatively low magnification level of 1,000x used in Figure 7, CNTs are not visible. MRD-2006 ¶187, n.11.

The notion that the size, shape, orientation and position of each of the CNTs and depicted polymer strings are identical for the left and right sides is impossible, because the anode physically expands and contracts. *Id*. ¶¶190-193.

Petitioner's assertion that Lee-Wepasnick's CNTs would be discrete "because, at least in some instances, oxidation of nanotubes can help promote non-agglomeration of the nanotubes" is misplaced. Pet., 54. The Board stated that it has "concerns about Petitioner's argument that the oxidation of nanotubes can help promote non-agglomeration of the nanotubes in the context of Lee." DI, 34. Rightfully so, because Petitioner failed to show that the CNTs are non-agglomerated in Lee-Wepasnick, even if they are oxidized. MRD-2006 ¶194. Petitioner can only point to Lee's drawings in Figures 1 and 3 as its sole source of evidence to purportedly show "discrete" CNTs, but as discussed above, those figures are merely schematic views that are contradicted by the plain text of Lee and the SEM image of Figure 6. Moreover, Petitioner fails to explain how oxidation can help with dispersion of Lee's CNTs, which are "bounded" with agglomerated primary nanoparticles. *Id.*

Finally, Petitioner argues that "the nanotubes in the combination anode active material composition are discrete based on Lee's teaching that '[t]he electron donor group' of the polymer binder in the anode active material composition 'aids the dispersal of the hollow carbon nanofibers.'" Pet., 56. However, Petitioner is arguing

that since the polymer binder aids in dispersal of the CNTs, that somehow means that they are discrete. *Id*. But "dispersal" of carbon nanotubes does not necessarily cause the carbon nanotubes to be "discrete." MRD-2006 ¶195. Dispersal of carbon nanotubes relates to how the carbon nanotubes are spread in a medium or a composition. *Id*. Discrete carbon nanotubes are nanotubes that are individual, separate, and distinct. *Id*.; *see also* MRD-2023 ¶83 (explaining that "discrete" carbon nanotubes are "fully isolated" from other nanotubes). Thus, even assuming that the polymer binder "aids the dispersal of carbon nanofibers," that does not mean they are discrete. MRD-2006 ¶195. In fact, it was well-known that mixing CNTs with resin would "draw the CNTs closer together," which helps form a *continuous* network of CNTs rather than *discrete* CNTs. *Id*. (citing MRD-2019 ¶¶[0018]-[0021]).

2. Lee-Wepasnick does not render obvious the claimed aspect ratio.

Petitioner argues that Lee-Wepasnick "presents a *prima facie* case and renders obvious the recited range of aspect ratios" because the "claimed range of aspect ratios (10-500) overlaps with the range of aspect ratios (10-10,000) described by Lee." Pet., 64-65. However, Petitioner cannot rely on Lee's incredibly broad aspect ratio range to render the claims obvious.

If a claimed range is narrow (10 to 500) and the prior art range is overlapping and broad (about 10 to about 10,000), such a broad range is insufficient to show

prima facie obviousness, if the *structure* of a CNT with an aspect ratio of 10-10,000 is different from the *structure* of a CNT with an aspect ratio of 10-500. *See Genetics Inst., LLC v. Novartis Vaccines & Diagnostics, Inc.*, 655 F. 3d 1291, 1304-07 (Fed. Cir. 2011). "Our case law is clear that the ***structure of a claimed compound and its properties*** are inseparable for purposes of § 103." *Id*. at 1307 (citing *Sanofi-Synthelabo v. Apotex, Inc*., 550 F.3d 1075, 1086 (Fed. Cir. 2008)). This is because an overly broad range fails to provide an ordinary motivation to optimize the range. *Id*. at 1306-07.

In *Genetics*, the Federal Circuit found that proteins in the claimed patent versus the prior art differed *structurally* in terms of the size of the permitted amino acid deletions, the location of the permitted amino acid deletions, and the degree of allowable amino acid substitutions. *Id.* at 1306. Because of such *structural* differences, and considering that the prior art patent disclosed a broad range of 68,000 protein variants comprising 2,332 amino acids, there was no motivation for a POSITA to perform routine experimentation to discover an optimum range. *Id*. In affirming the district court, the Federal Circuit found that where the disclosed range was so broad as to encompass a very large number of possible distinct compositions a showing of obviousness was not made. *Id*. at 1306-07.

Here, with respect to the highest end of Lee's disclosed aspect ratio (10,000) compared to the highest end of the claimed aspect ratio (500)—***a key structural***

difference—Lee teaches 9,500 more potential aspect ratios compared to the claimed aspect ratio. MRD-2006 ¶197 (citing LGES-1006 ¶[0047]). Additionally, the highest aspect ratio disclosed in Lee is 20x larger than the highest aspect ratio in the claimed invention. *Id*. These are significant differences resulting in materially different structure and behaviors. *Id*.

A POSITA would understand that, at a given diameter, a larger aspect ratio CNT (e.g., 5,000) versus a smaller aspect ratio CNT (e.g., 500) is not only a key structural difference in the CNTs, but can lead to the following effects on the structure and behavior of the CNTs: (1) increase in the number of bends, including increase in the likelihood of bending; (2) increase in the number of entanglements; (3) increase in the number of CNT-CNT contact points; (4) increase in the likelihood of achieving a percolated network (i.e., a continuous conductive path due to the CNT-CNT contact points); (5) increase in electrical conductivity; (6) decrease in dispersibility, reducing the likelihood of achieving discrete or uniformly dispersed CNTs; and (7) increase in the number of CNT defects. *Id*. ¶¶198-201. Conversely, the smaller aspect ratio may lead to opposite effects. *Id*.

As in *Genetics*, 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 to identify the claimed range. *Id.* ¶202. The differences in structure and behavior are "nontrivial differences" that directly affect

the resulting structure and behavior of the CNTs. *Id*. Lee cannot deprive the inventors of their invention by disclosing an excessively broad and unhelpful range that would require undue experimentation to identify the optimal claimed ranged.

B. Dependent Claim 6

As with Ohata-Kavan, Petitioner fails to provide any credible evidence that Lee-Wepasnick discloses claim 6. Petitioner first argues that because the CNTs of Lee-Wepasnick are allegedly "generally individually distinct nanotubes., e.g., they are dispersed in the composition," this necessarily means that they are "uniformly dispersed." Pet., 76. This is plainly not true, because discrete CNTs do not have to be uniformly dispersed. *See supra*, Section V.A.5. Indeed, claim 6 further limits the discrete CNTs of claim 1 to being "uniformly dispersed," proving as much. MRD-2006 ¶203. And even if they could somehow be interpreted to have the same meaning, this argument is insufficient to demonstrate that the CNTs would be dispersed without clustering "on a dimension scale less than 1 micrometer."

Recognizing this, Petitioner next relies on Lee's "schematic view" in Figure 1 to argue that "because there is substantially no clustering, a POSITA would have understood that the nanotubes are dispersed without clustering ***on a dimension scale less than 1 micrometer***." Pet., 76-77. However, that figure has no scale bar or magnification level and there is simply no evidence that figure is drawn to scale, rendering Petitioner's reliance legally improper. MRD-2006 ¶204; *supra* Section

V.B.2. To the contrary, a POSITA would understand that a "schematic" view is not intended to be drawn to scale and would never rely on such a drawing to determine dimensions or relative proportions. MRD-2006 ¶204. Figure 1 is not even consistent with Lee-Wepasnick's SEM images, only further proving this point. *Supra* Section VI.A.1.b. In fact, Petitioner does not even allege, as it did with Ohata's cartoon figure, that Lee's Figure 1 would be understood to be drawn to scale.

Ultimately, because Petitioner only offers the Board conclusory assertions based on a "schematic" figure, Petitioner cannot carry its burden. Petitioner *could have* experimented as proof, but it chose to rely on a figure that is plainly labeled a "schematic view" that does not even align with the SEM images provided in Lee. MRD-2006 ¶205.

VII. Conclusion

For the reasons above, Petitioner fails to demonstrate beyond a preponderance of the evidence that any claim is unpatentable.

Dated: March 31, 2025

Respectfully submitted,

/*Stephen D. Zinda*/
Stephen D. Zinda (Reg. No. 67,272)
Counsel for Patent Owner

CERTIFICATE OF COMPLIANCE

The undersigned certifies that this document complies with the type-volume limitations set forth in 37 C.F.R. § 42.24 *et seq.* This document, excluding those portions excluded under § 42.24(a)(1), contains 13,971 words as calculated by the program used in creating it.

/*Stephen D. Zinda*/
Stephen D. Zinda

CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. §§ 42.6(e)(4), the undersigned certifies that on March 31, 2025, a copy of the foregoing document (*Patent Owner's Response*, including all Exhibits), was served via electronic mail on all attorneys of record at the email addresses provided for electronic service listed in Petitioner's mandatory notices, as set forth below:

W. Karl Renner (Reg. No. 41,265)
IPR18768-0210IP4@fr.com

Timothy Riffe (Reg. No. 43,881)
Hyun Jin In (Reg. No. 70,014)
Gretchen A. DeVries (Reg. No. 72,505)
PTABInbound@fr.com

FISH & RICHARDSON P.C.

/*Stephen D. Zinda*/
Stephen D. Zinda