UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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LG ENERGY SOLUTION, LTD.,
Petitioner

v.

MOLECULAR REBAR DESIGN, LLC,
Patent Owner

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Case IPR2024-01013
U.S. Patent No. 10,153,483

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PATENT OWNER'S RESPONSE

LGES 1044
LGES v. MRD
IPR2024-01012

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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	RESERVED
MRD-2022	RESERVED
MRD-2023	RESERVED
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	U.S. Patent No. 8,974,957
MRD-2028	U.S. Patent Application Publication No. 2024/0274804
MRD-2029 to MRD-2034	RESERVED
MRD-2035	U.S. Patent No. 10,273,403
MRD-2036	U.S. Patent No. 10,374,254
MRD-2037	Aleksander Cholewinski et al., *Polymer Binders: Characterization and Development toward Aqueous Electrode Fabrication for Sustainability*, 13 POLYMERS 631 (2021).
MRD-2038	RESERVED
MRD-2039	U.S. Patent No. 8,557,351

I. Introduction

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

Ohata-Kavan is the lynchpin for all grounds. However, 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 required by all claims. *Infra* Section V.A.2. Petitioner similarly fails to show that the active material is "ionically" attached to the surface of the CNTs, as more specifically required by claims 1, 7, and 9. *Infra* Section V.B.

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 plausibly carry its burden with respect to claim 8. *Infra* Section V.C. Petitioner's expert concedes that claim 8 imparts very specific spacing requirements between discrete CNTs at the nanoscale. 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.

II. Level of Ordinary Skill

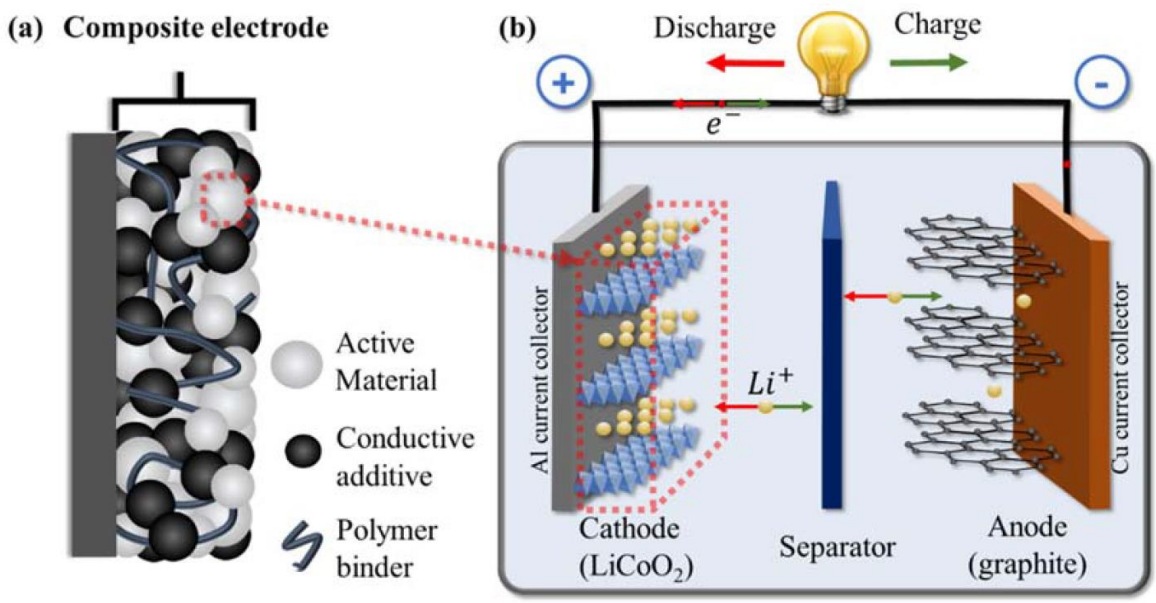
Patent Owner applies Petitioner's proposed definition of a POSITA for purposes of this proceeding only. Patent Owner's technical expert, Dr. Deborah Chung, has a Bachelor's Degree in Engineering and Applied Science and a Master's Degree in Engineering Science from the California Institute of Technology. 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 ’483 Patent is directed toward lithium-ion batteries, particularly compositions that makeup the electrode (either the cathode or anode) of lithium-ion batteries. LGES-1001, 2:37-47.

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.

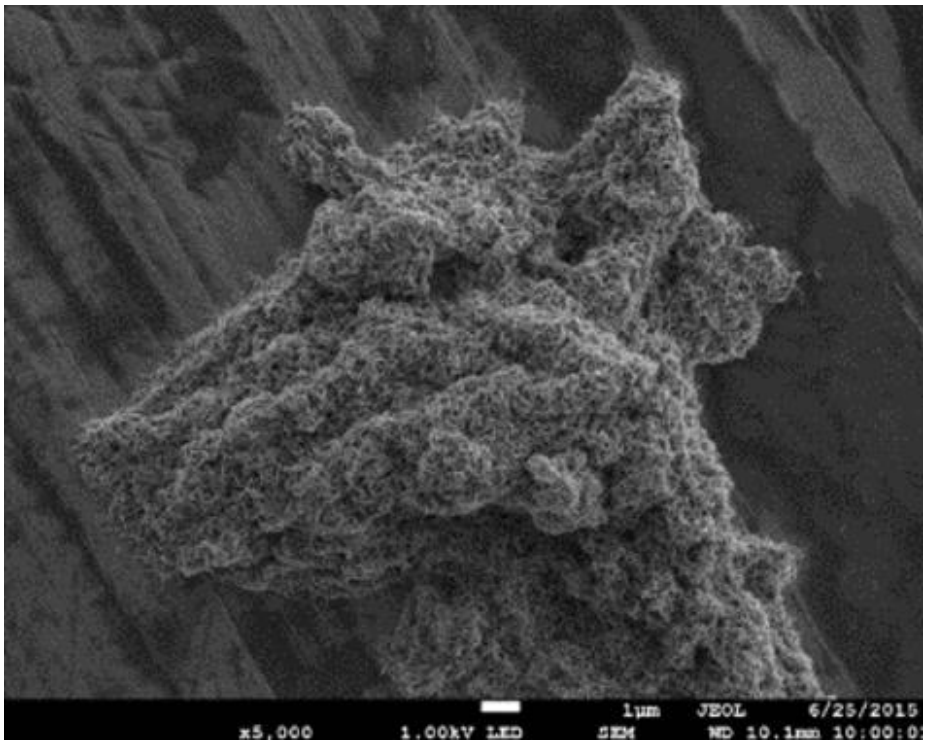
The binder (2) acts as a “glue” to hold the active material particles together,

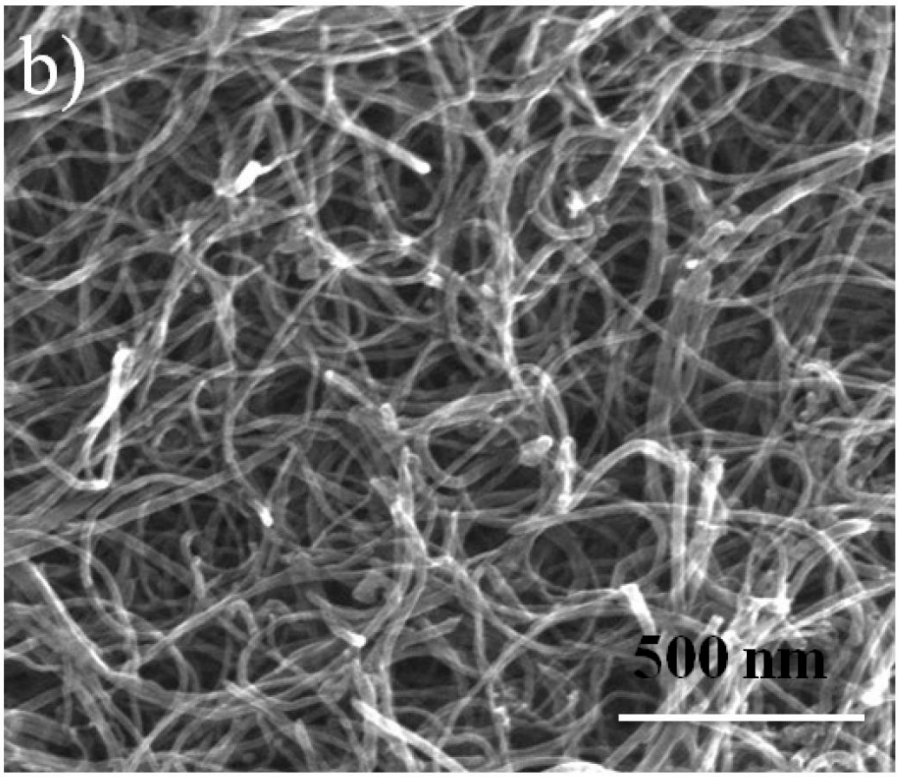
as well as to attach the active material to the current collector, providing mechanical strength to the composite as a whole. *Id*. ¶59.

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 LGES-1011 ¶¶[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 LGES-1011 ¶¶[0005], [0009]-[0010]; MRD-2019 ¶[0041]). Figure 5 of MRD-2019 (hereafter "Gan") depicts CNTs that have been dispersed to form a "continuous" or "percolated" CNT network:

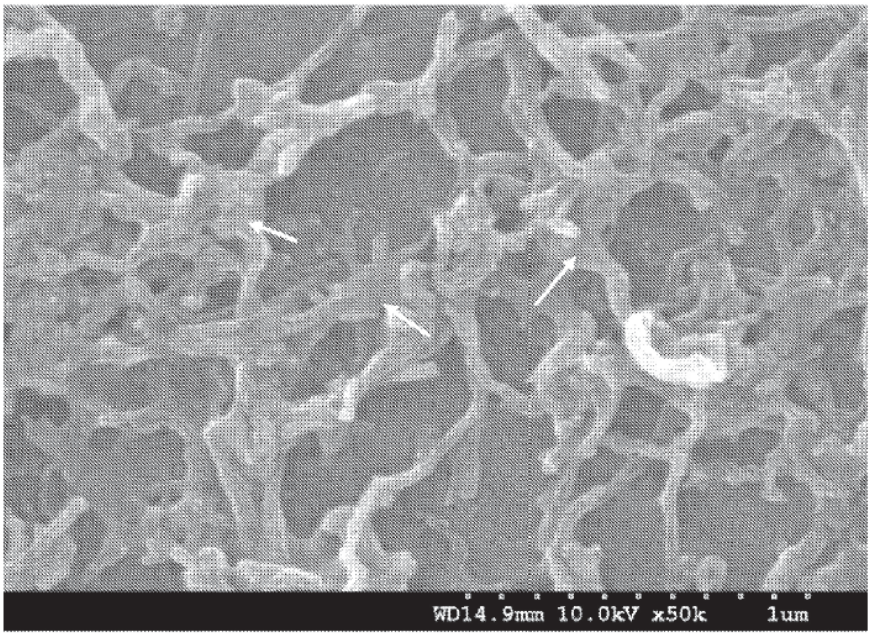


FIG.5

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]; LGES-1011 ¶[0010]).

C. The '483 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, 1:46-58). As the Patent explains, "discrete" CNTs are those that are individually dispersed and separate from other CNTs. *Id.* (citing LGES-1001, 1:41-43 (describing "discrete carbon nanotubes" as "individual uniformly dispersed tubes"), 3:53-55 (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, 1:46-58). 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).

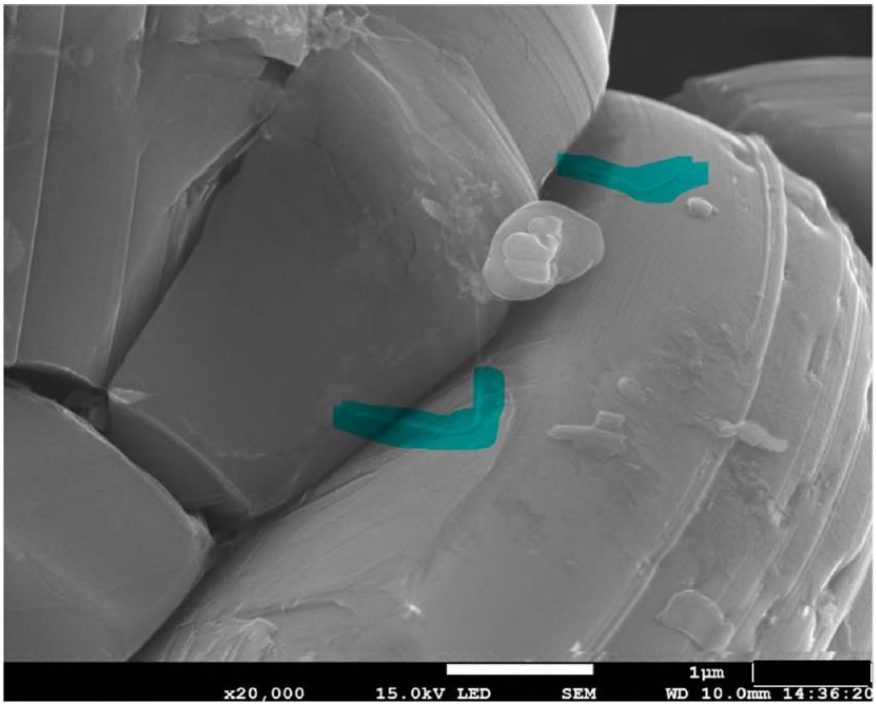
Thus, while those in the art at the time were seeking to achieve a continuous network of CNTs for electrodes, the inventors ***took the opposite approach by seeking to achieve discrete CNTs*** with active material attached to their surfaces. *Id*. ¶69. This provides numerous improvements, including "improved 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, 2:4-26). "The uniform dispersion of discrete tubes will also provide a more uniform voltage gradient…." *Id.* (quoting LGES-1001, 2:26-31).

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, 4:6-13. 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, 5:10-7:3). 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.*

The ’483 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. Ohata-Kavan Does Not Render Any Claim Unpatentable.

All grounds are fundamentally premised on Ohata-Kavan teaching or rendering obvious certain claim limitations. Pet., 1. Because Ohata-Kavan fails to disclose several of those limitations, Petitioner cannot carry its burden with respect to any ground.

A. No Independent Claim has been shown to be obvious.

Petitioner acknowledges that Ohata does not disclose oxidized CNTs. Pet., 18. 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*., 18-19. 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 (as taught by Kavan). *Id.*, 19-21. 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.*, 21-23. 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*., 10, 19, 32-33, 35. 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***."[1] 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.[2]

First, the active materials of Ohata-Kavan cannot be "attached to the[]

[1] All emphasis is added unless otherwise indicated.

[2] Although Petitioner relies on Gong or Liu (Ground 1) or Ichinose (Ground 2) in combination with Ohata-Kavan, neither Gong, Liu, nor Ichinose is relied on to address the "attached" or "oxidized" limitations. Thus, these other references do not remedy the defects addressed herein.

surface" of the oxidized CNTs as required by all independent claims. *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 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*** because the masterbatch process fully covers the CNTs in resin before the CNTs are mixed with the active material.

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 in Ohata-Kavan, preventing the claimed attachment from occurring.

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 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., 10. 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 the drawback of decreased capacity, 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.

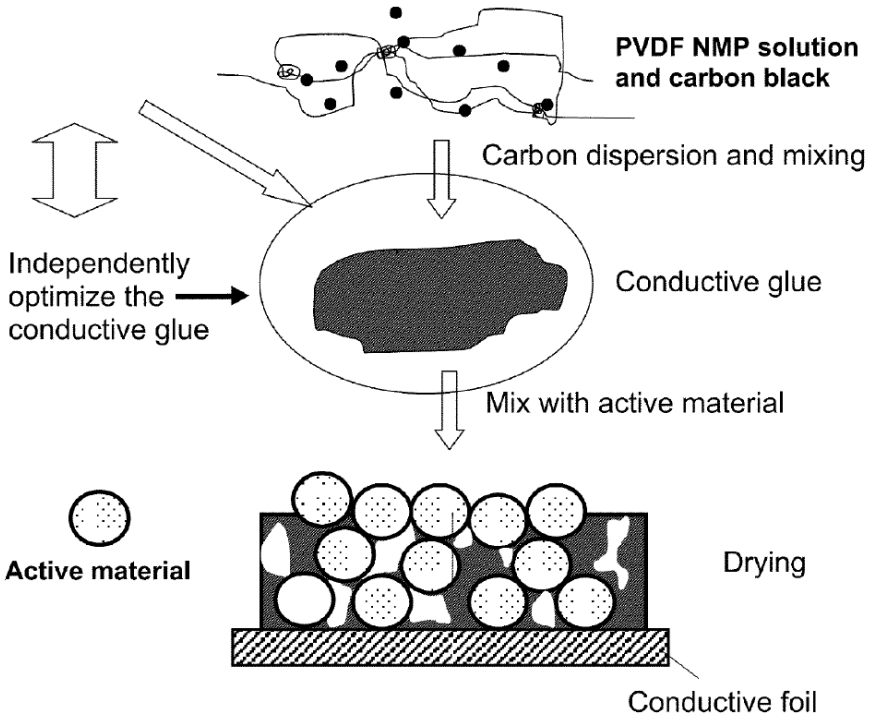


FIG. 6

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.

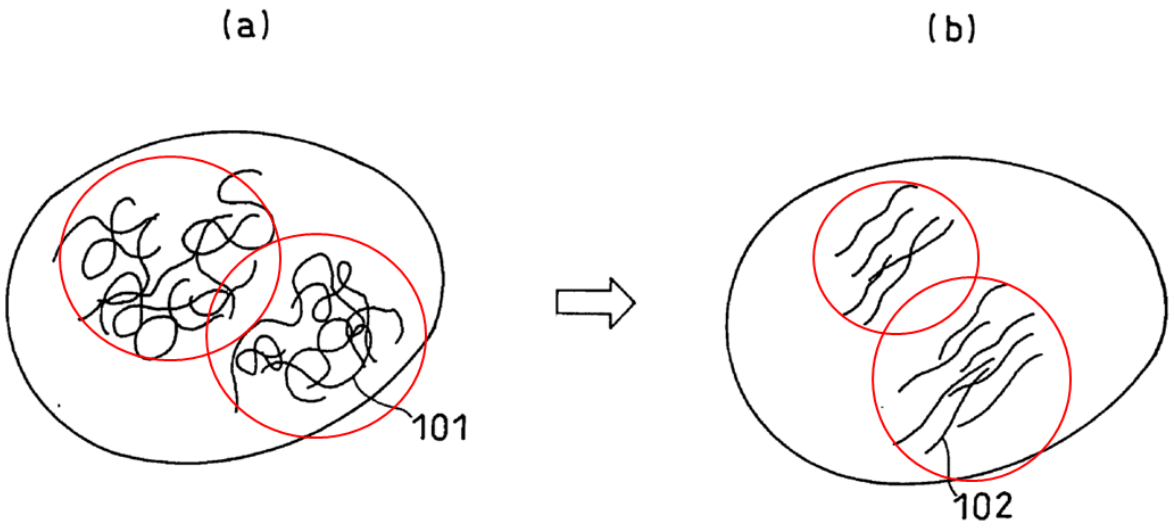
"In view of this" drawback, Ohata prepares its own "masterbatch" comprising a large amount of resin and small amount of CNTs. LGES-1004 ¶¶[0004]-[0005]. "Unlike carbon black and powdered graphite, a conductive path to be formed by carbon nanotubes is not damaged by shearing force," allowing "an electrode 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 that during the masterbatch process, 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*.

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*. ¶95.

Examples 2 to 8 follow the steps of 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 (TiO_2, $LiMnPO_4$, or $LiFePO_4$) 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). ("Nanotubes were dispersed in water under short

sonication. To this solution a powder material … was added … and stirred overnight. The suspension was subsequently evaporated to dryness. The electrodes were prepared as follows: powder precursor material, either pure or carbon-containing (see above) was mixed with 5 wt% of polyvinylidene fluoride (PVDF) dissolved in N-methyl-2-pyrrolidone.”)). 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 ’483 Patent mixes naked oxidized CNTs with the active material in all examples for this same reason. *Id*. (citing LGES-1001, 5:10-7:3).

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 “lithium 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., 42-44. Specifically, Petitioner argues that, "the ion active materials of Kavan (e.g., $LiFePO_4$) would be … attached to the surface of Ohata-Kavan's nanotubes." *Id*., 43. Petitioner states that "the phosphate olivine crystals of the combination are attached to the nanotube surface due at least in part to the surface oxidation of the nanotubes" *Id*., 42-43 (citing LGES-1005, 2 ("The surface oxidation of carbon nanotubes … was sometimes mentioned to improve ***the anchoring of*** … LiMPO4.")). 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 discrete 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., 18. 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).

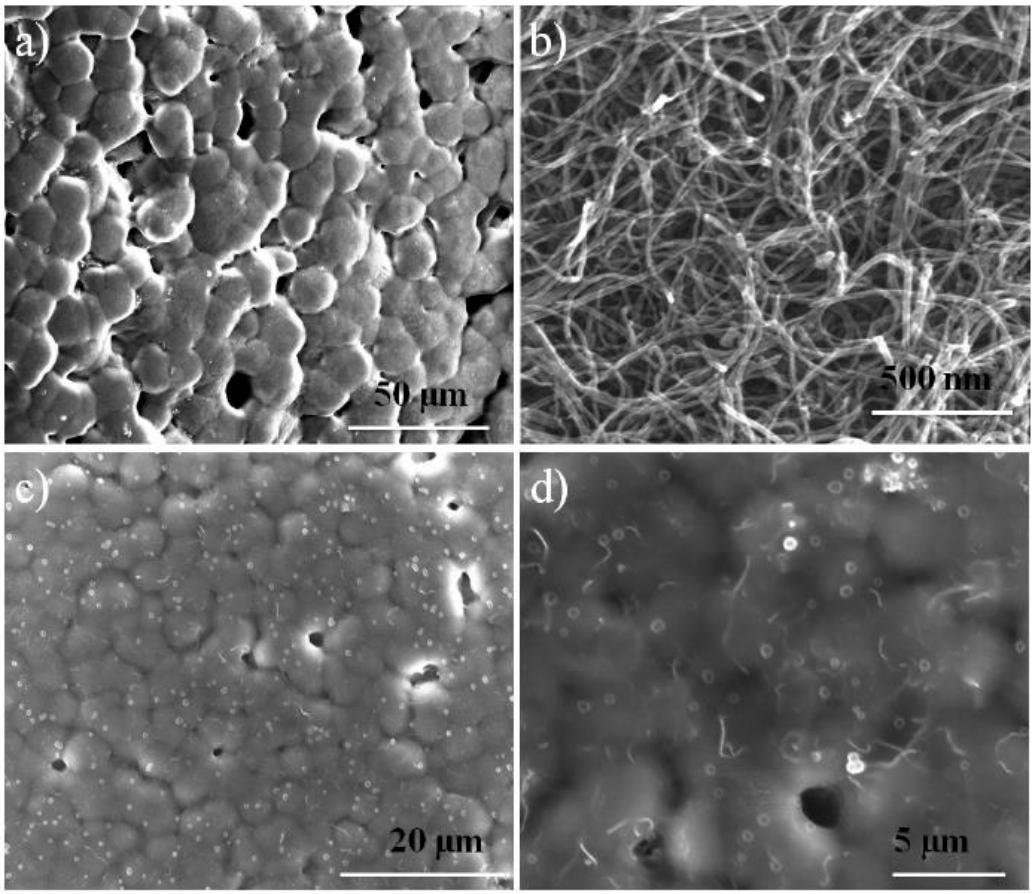
It is Petitioner's burden to demonstrate that Ohata-Kavan teaches lithium ion

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., 10, 19, 32-33, 35; *see also* 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; *see 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 all grounds, 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) of MRD-2010:



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 and coated by the PVDF matrix. *Id.* (citing MRD-2010, 11-12 (explaining that "[w]hen sufficient concentration is there, CNTs start forming network and connectivity ***in the matrix*** so that drastic rise in conductivity was observed in the composite" and "microspheres of polymer have been formed throughout the composites and carbon nanotubes are homogeneously dispersed **within** the polymer 3D scaffold")). 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 (explaining that at 2 wt% of CNTs a "conductive network" is formed due to the "percolation behavior")).

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:

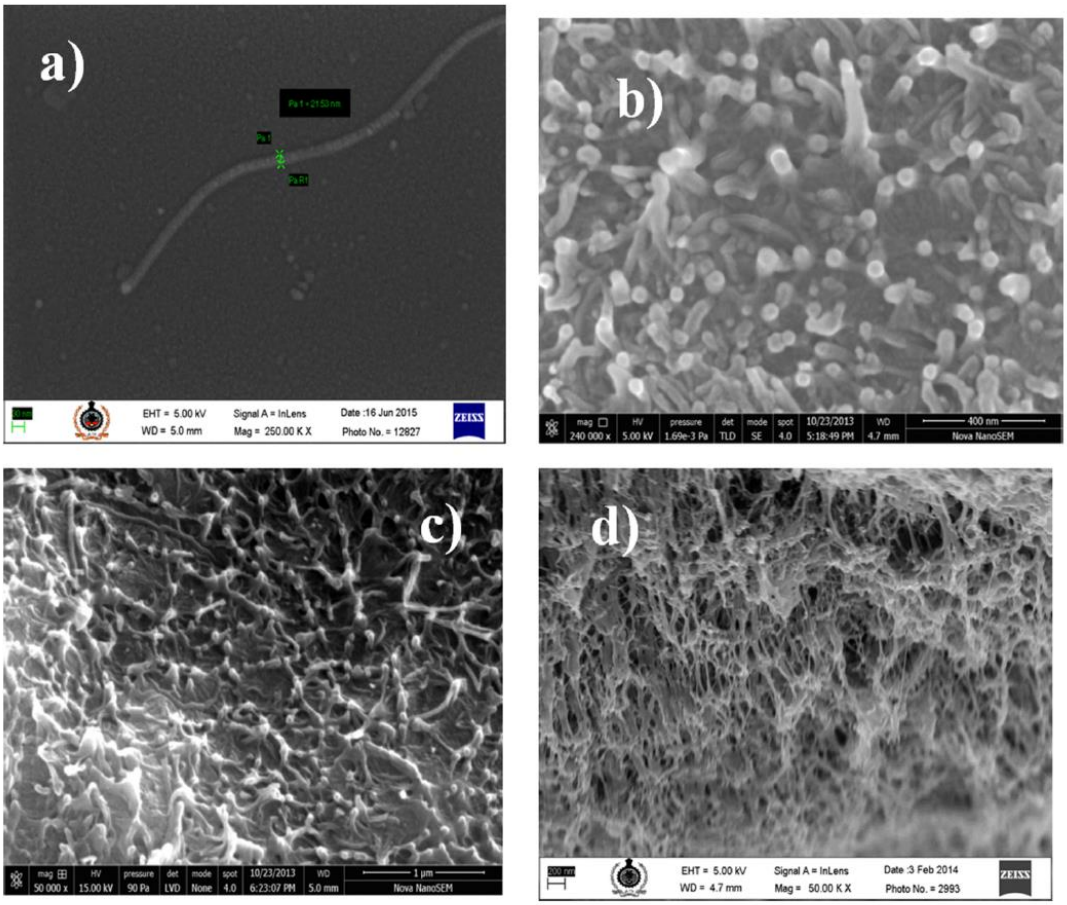
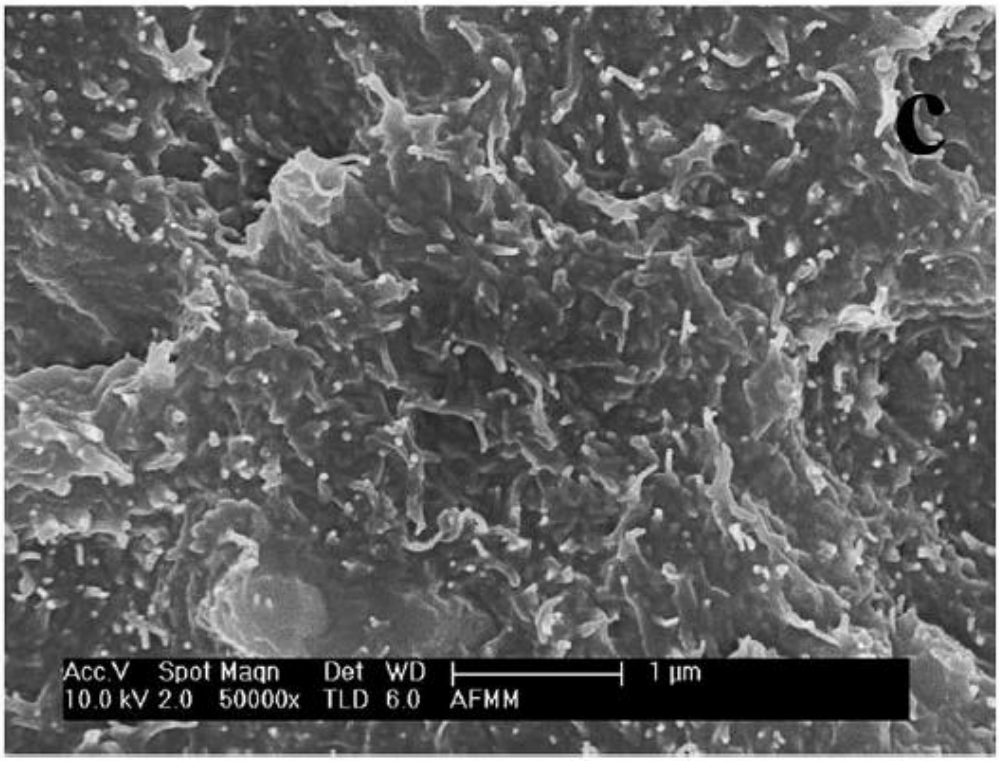


FIG. 1. FE-SEM images of MWCNT in the PVDF matrix. (a) shows a single MWCNT, and images of well dispersed MWCNTs for 3wt%, 5wt% and 9wt% samples in the PVDF matrix are shown in b),c) and d) respectively.

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

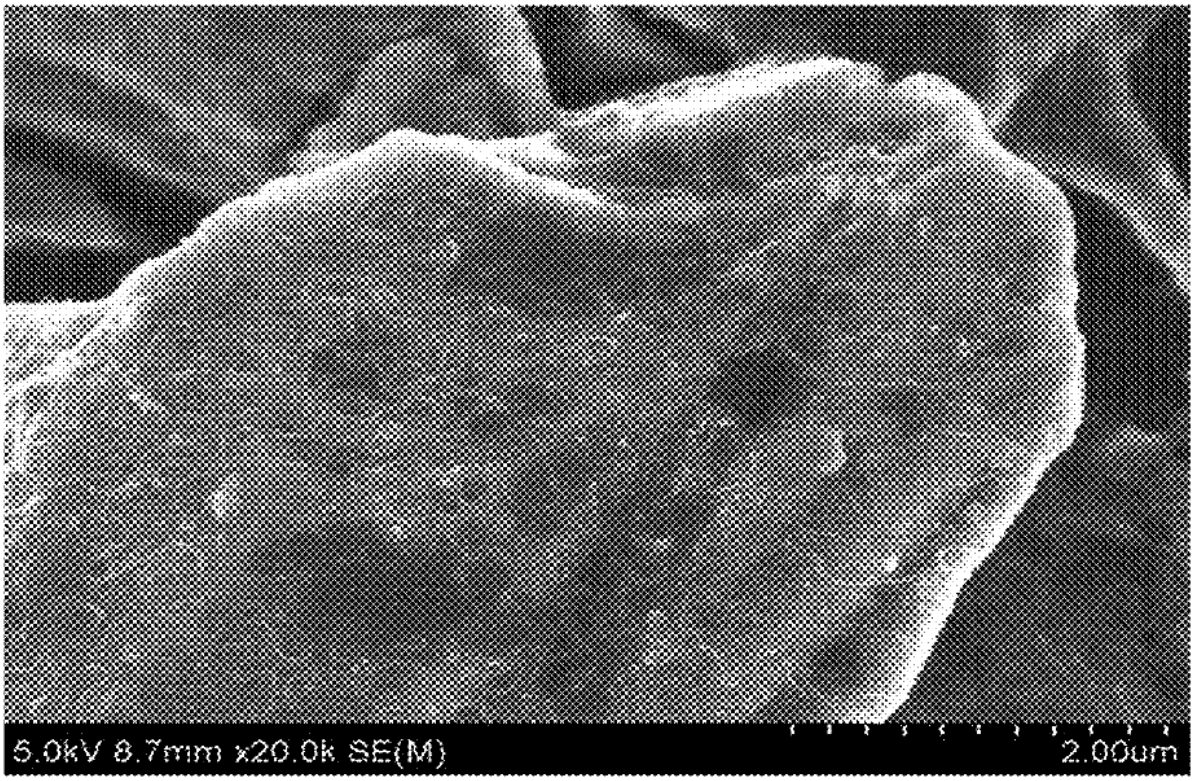
"glue" like material, similar to the glue of Figure 6 of Liu-009. *Id*. ¶114. Indeed, Liu-009 states that, when carbon black is mixed with PVDF prior to adding the active material, the PVDF will be "bonded to" the carbon black. *Id*. (citing MRD-2008, 7:55-62) (explaining that "the binder has previously 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, for the positive electrode of 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*. (citing LGES-1004 ¶[0046] (referring to NMP "as a dispersion medium")).

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 material mixture paste, which would be required to eliminate the PVDF domains from the paste. *Id*.; MRD-

2024, 41:5-25 (Dr. Zhu testifying that the resin is not eliminated). 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) from MRD-2014 show that even after PVDF and CNTs have been mixed with NMP, the CNTs are still heavily embedded within and coated by the PVDF:

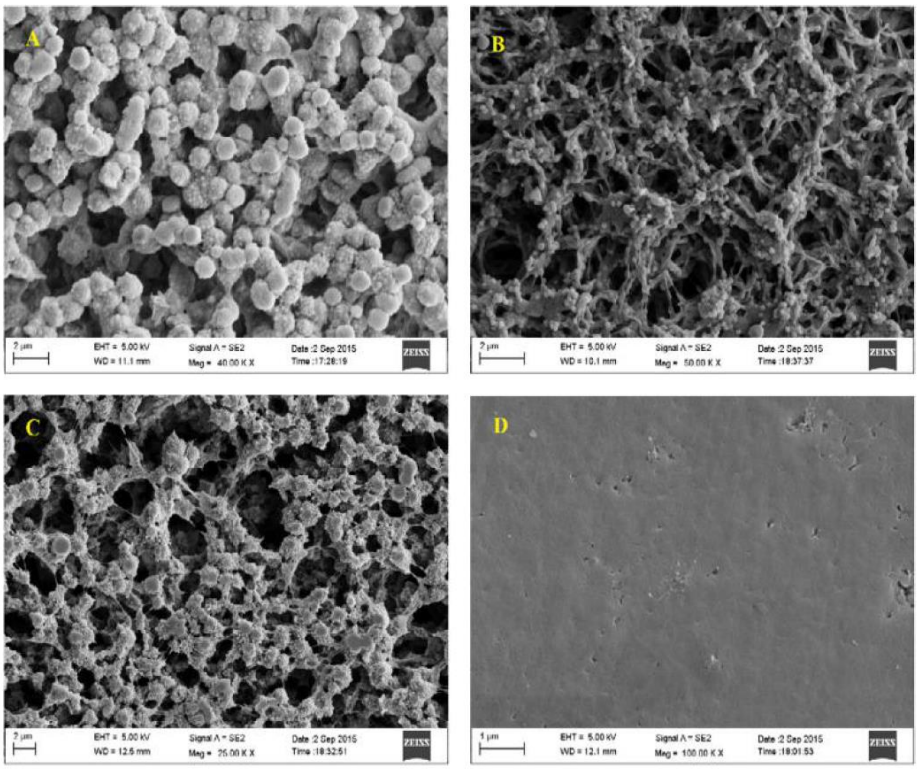


Fig. 2. (A–D): FESEM image of (A) PVDF, (B) PVDF with CNT, (C) PVDF with carbonic acid functionalised CNT and (D) PVDF with sulphonic acid functionalised CNT.

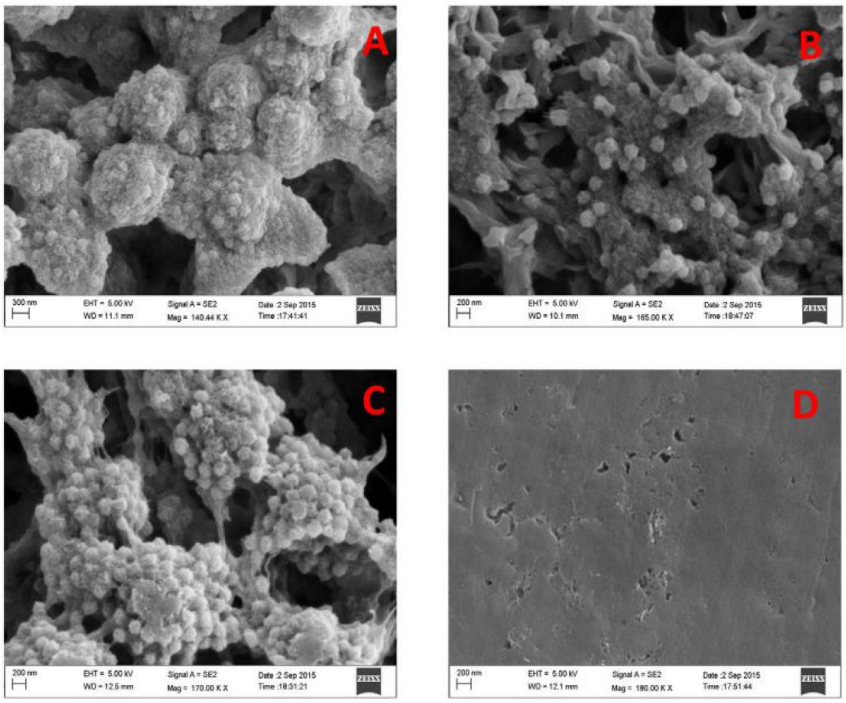


Fig. 3. (A–D) High Magnification FESEM image of (A) PVDF, (B) PVDF with CNT, (C) PVDF with carbonic acid functionalised CNT and (D) PVDF with sulphonic acid functionalised CNT.

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):

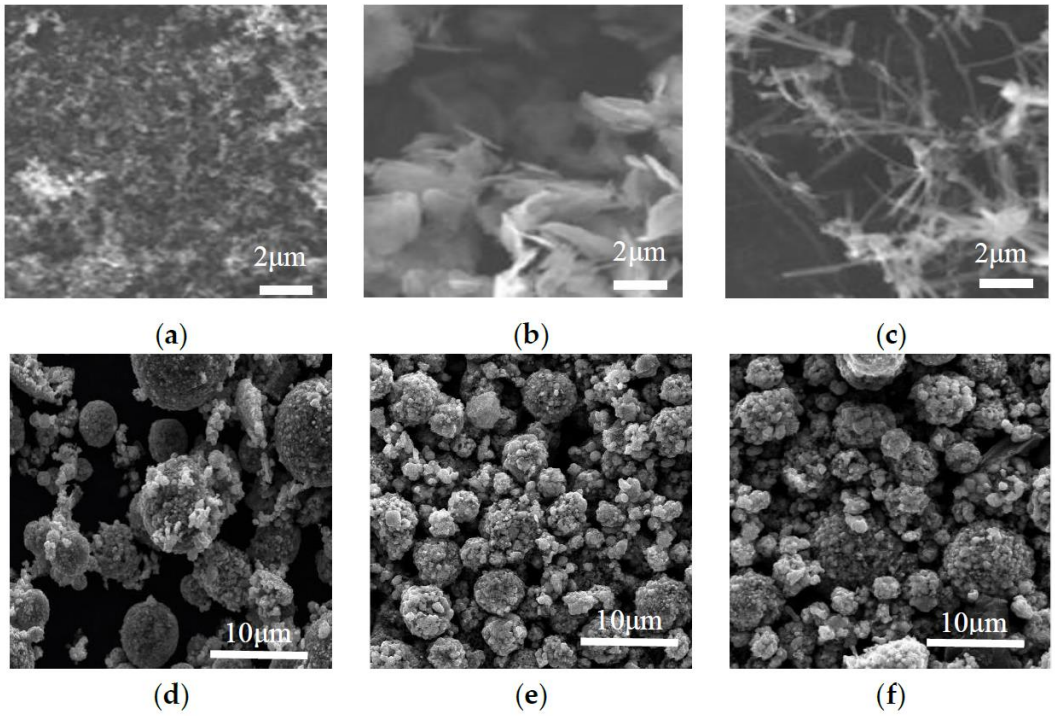


Figure 2. SEM of conductive agents and electrodes with different conductive materials: the surface morphologies of Super-P and KS-15 (**a**); the surface morphologies of graphene (**b**); the surface morphologies of carbon nanotube (**c**); the electrodes image of Super-P and KS-15 (**d**); the electrodes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

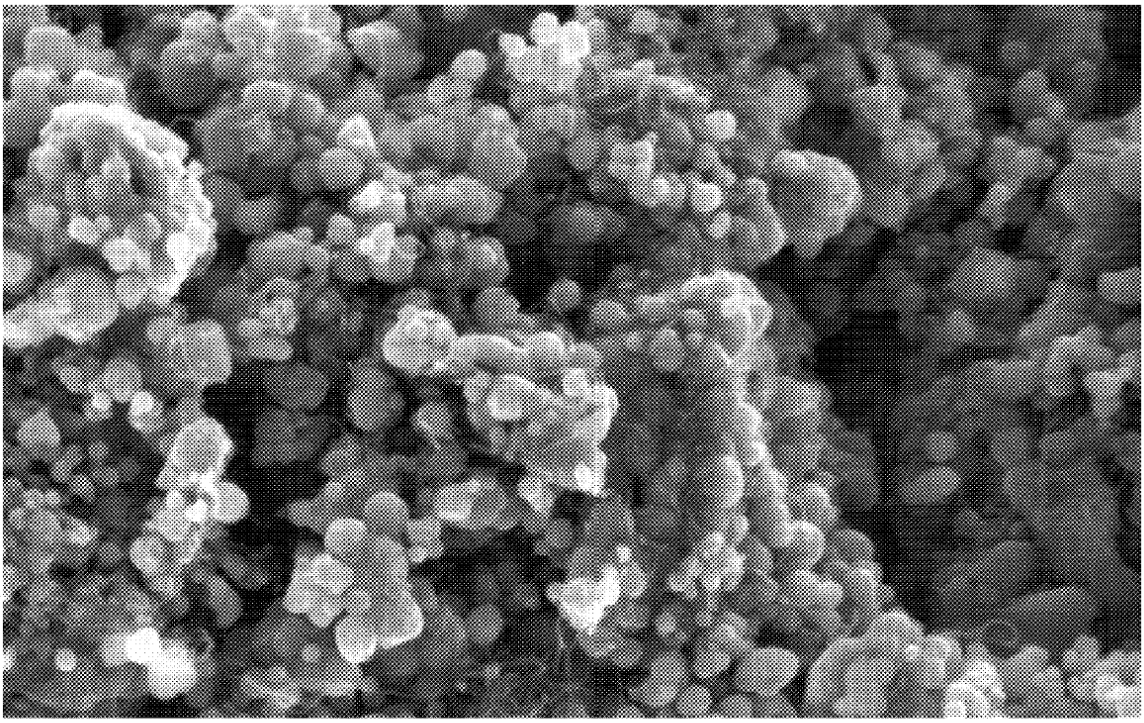


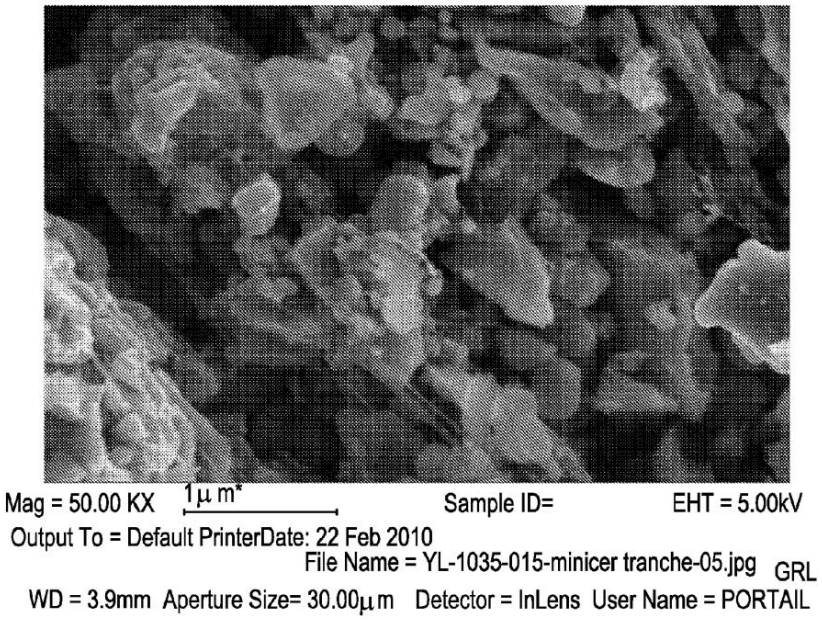
FIGURE 2

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.*

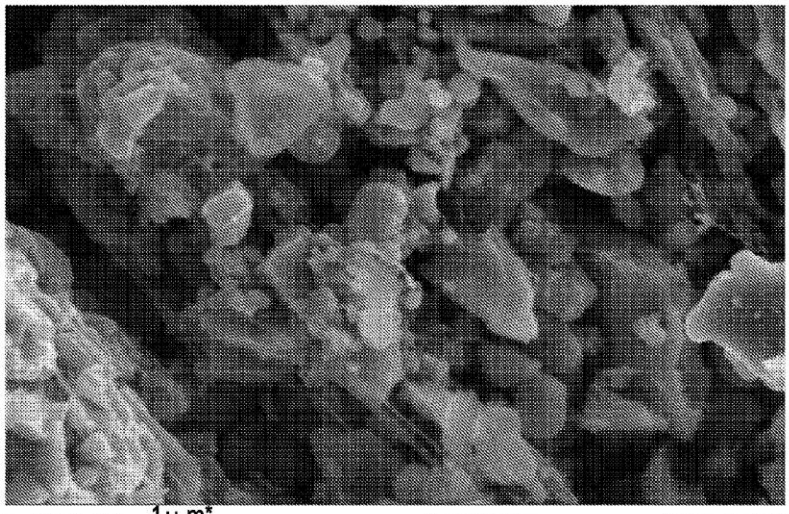
Another reference, U.S. Patent Publication No. 2011/0256454 ("Nicolas-454"), also references Ohata's masterbatch process. *Id*. ¶124 (citing MRD-2018 ¶¶[0010]-[0011]). In FIGS. 2A and 2B, Nicolas-454 provides SEM images of its own masterbatch (comprising CNTs and PVDF) mixed with NMP and an active material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

FIG. 2A



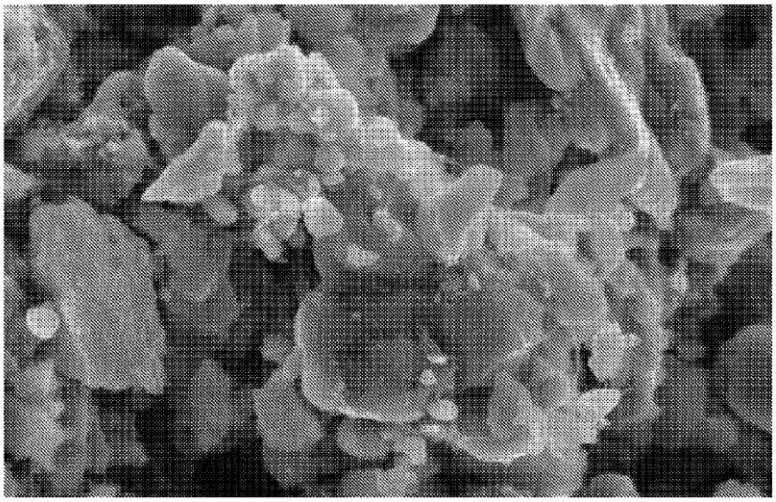
[3] Contrast this with LGES's accused products, where discrete CNTs can very clearly be seen attached to the surface of the active material. *See e.g.*, LGES-1050, 32, 35.

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

FIG. 2B



Mag = 50.00 KX 1μm* 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:

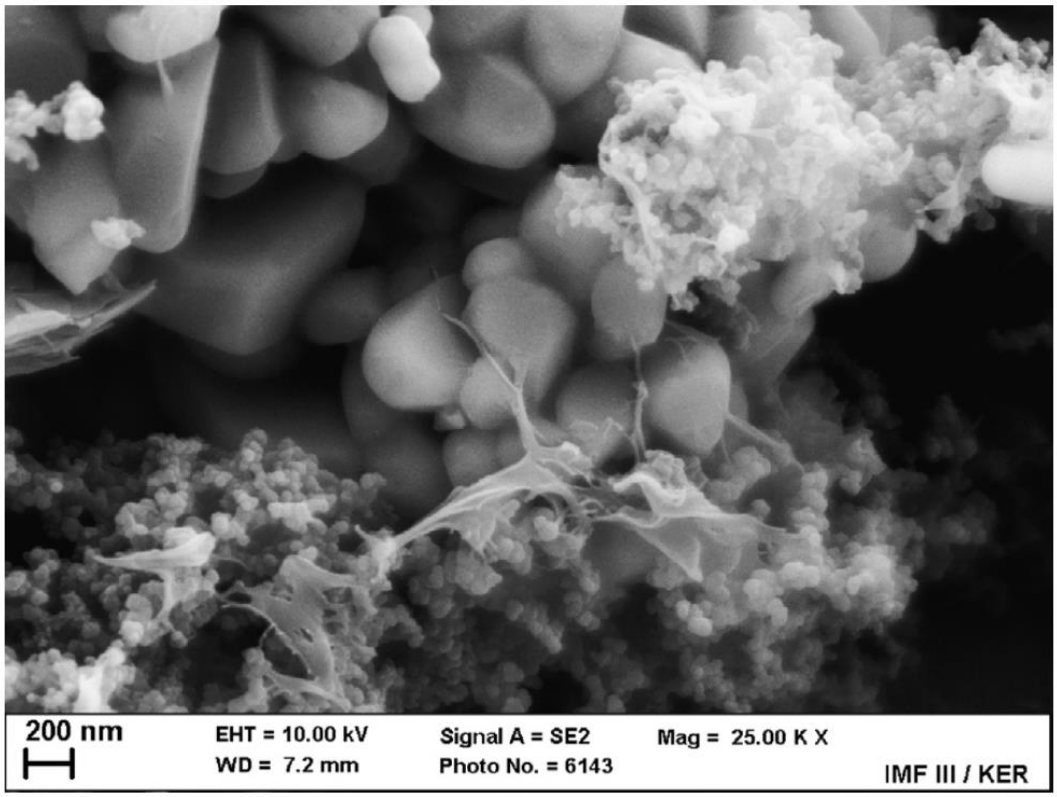


Fig. 13. SEM micrograph of a NMC cathode particles with adhering PVDF/ carbon black clusters.

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 '483 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]

[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.

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 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 oxidation 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*. ¶XX. The "first" reason is that when a phosphate olivine is used as the active material, "electrochemical performance of an electrode is improved by oxidized nanotubes." Pet., 21-22. This reason is 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 '483 Patent teaches mixing naked oxidized CNTs with the active material to facilitate attachment. *Id.* (citing LGES-1001, 2:4-16; 5:15-24). In contrast to both Kavan and the '483 Patent, in Ohata-Kavan the CNTs are *first* covered in resin during the masterbatch process, preventing this anchoring from occurring. *Id.* Consequently, the first reason does not support a motivation to combine.

The "second" reason is that "a POSITA would have been motivated to use oxidized nanotubes in furtherance of Ohata's goal to have well-dispersed nanotubes in the composite." Pet., 22. As with the first reason, this reason is also 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 (e.g., —COOH or —OH) 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 "second" reason lacks merit, because Petitioner contends that Ohata alone *already* achieves uniformly dispersed CNTs. Pet., 56 (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 the CNTs to allegedly 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 "third" reason is that oxidation can help purify the CNTs. Pet., 23. 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 a POSITA would understand to refer 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 electrode material mixture paste." Pet., 23. 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%.% by weight of the CNT***. 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 "fourth" reason is essentially a rehash of the first three, couched in terms of applying a known technique to a known structure ready for improvement to yield predictable results. Pet., 23. 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.*; *see also 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). Upon reading Ohata, a POSITA "would be led in a direction divergent from the path that was taken by the applicant." *In re Gurley*, 27 F.3d at 553. Specifically, a POSITA would be strongly discouraged from following Kavan for at least two reasons.

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 alone. *Id*. ¶144. However, the combination follows the fundamentally different masterbatch process. There is no evidence in the record that a POSITA would have had a reasonable expectation of success when considering that the oxidized CNTs would be covered in resin, preventing the ion active material from accessing the

functional groups to attach to the surface of the oxidized CNTs (as described by Kavan).As such, Petitioner fails to carry its burden of demonstrating that there was a reasonable expectation of success in combining Ohata-Kavan to achieve active materials that are "attached to their surface" of the oxidized, discrete nanotubes.

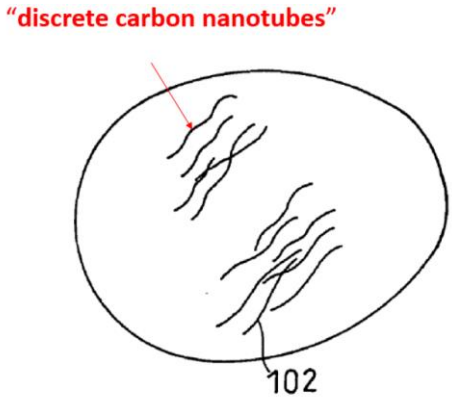
5. Petitioner fails to demonstrate that Ohata-Kavan teaches or renders obvious "discrete carbon nanotubes."

Petitioner proposes that "discrete" CNTs means "generally individually distinct nanotubes" (Pet., 37) that are "fully isolated" or "separated" from one another. LGES-1003 ¶[0083] ("[L]ooking again to Ohata's illustrative example, provided below, it can be seen that most of the nanotubes are depicted as being discrete, non-agglomerated, and exfoliated. Indeed, a POSITA would have understood a carbon nanotube that is, as shown below, ***fully isolated from each other*** to be discrete, non-agglomerated, and exfoliated."); 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, 1:39-43 ("discrete, i.e., individual, uniformly dispersed tubes"), 3:52-55 ("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., 34. 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*., 35 (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.*, 35-36.

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



Pet., 36; LGES-1004 ¶[0013]; MRD-2024, 11:4-8 (testifying that CNTs are “discrete” “because” they are “fully isolated” from one another).

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 '483 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:

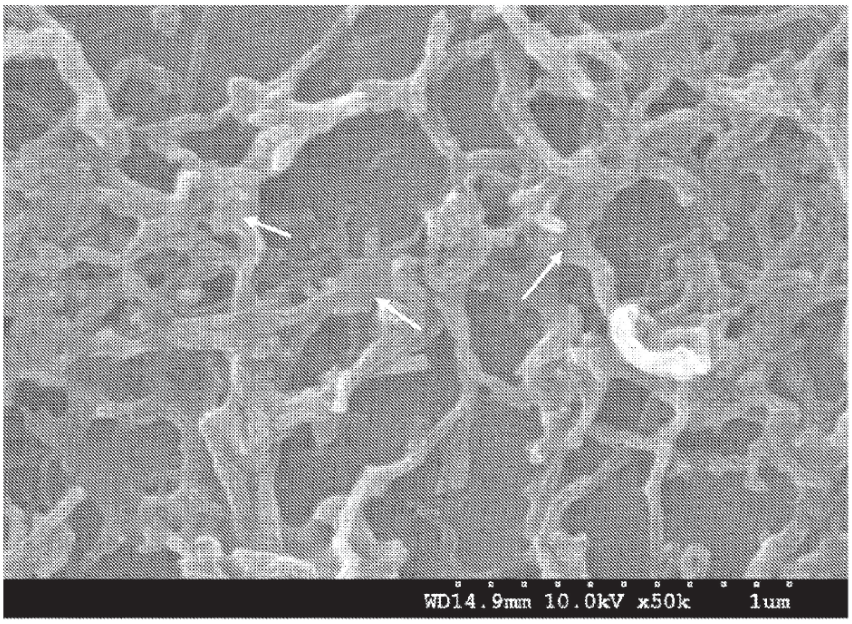


FIG.5

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 the active material particles. *Id*. ¶151

(citing LGES-1004 ¶[0004] (explaining that "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 LGES-1011 ¶[0005] ("Carbon nanotubes have good electrical conductivity, and the fibrous structure thereof can better connect electrode active materials into a ***continuous 'network'*** that is ***electrically conductive***…."); MRD-2019 ¶[0041] (explaining that the "presence of such ***continuous*** conductive path through the composite is believed to be a reason why the electrical conductivity of the conductive polymer material increases when CNTs are present.").

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*. (quoting LGES-1004 ¶¶[0004], [0015]).

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 LGES-1011 ¶[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 (e.g., to retard cracking of the active material during charging/discharging). *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 (reproduced 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]).

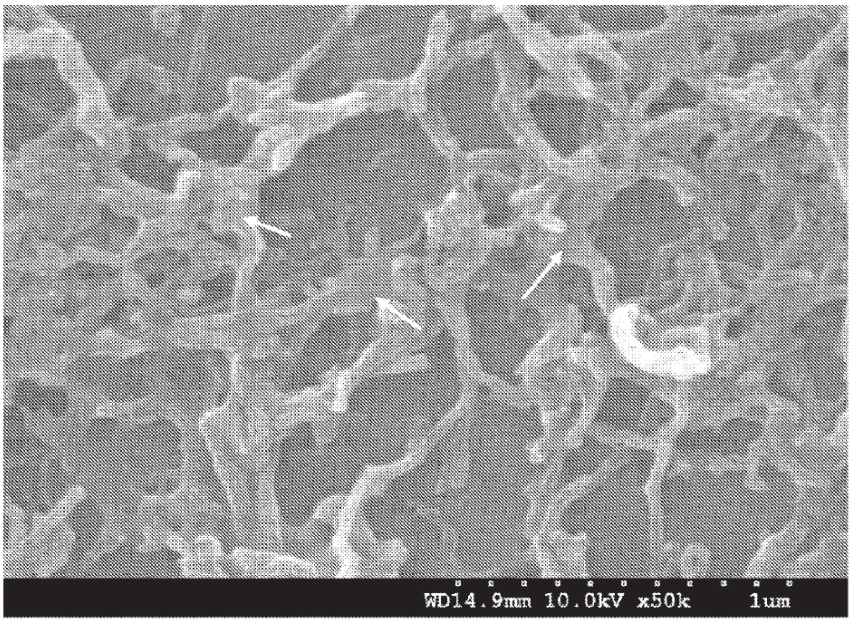


FIG.5

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 (Dr. Zhu agreeing with these effects). 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/non-agglomerated/exfoliated** 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.*, 37 (making the generalized statement that "oxidized nanotubes in the combination can be present as generally individually distinct nanotubes,"). 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. Independent Claims 1, 7, and 9 have not been shown to be obvious.

All independent claims require that the lithium ion active material is "attached" to the surface of the discrete CNTs. However, independent claims 1, 7 and 9 further require that the lithium ion active material is "ionically" attached to the surface. In addition to Petitioner failing to demonstrate that Ohata-Kavan results in lithium ion active material "attached" to the surface of the discrete CNTs (*supra* Section V.A.2), Petitioner also fails to demonstrate that there would be "ionic" attachment.

Petitioner asserts that "it was well-known that the oxidized nanotubes, as in Ohata-Kavan, 'have a negative electrostatic charge on the outer surface of the nanotube wall' and, thus, a POSITA would have recognized that such 'negative electrostatic charge on the outer surface of the nanotube wall' would be used to enhance attachment of positively charged metal ions in the ion active material (e.g., $LiFePO_4$) to the nanotube surface via an ionic/electrostatic interaction." Pet., 43-44 (quoting LGES-1024 ¶[0057]; citing LGES-1030; LGES-1003 ¶95)). This argument is again premised on Petitioner improperly disregarding the fact that Ohata-Kavan results in oxidized CNTs coated in resin, which prevents the active material from attaching to the surface of the CNTs. MRD-2006 ¶159. Because there is no "attachment" as claimed, there can be no "ionic" attachment. *Id*.

Moreover, a POSITA would understand that no ionic bonding would exist as

between the active material (TiO_2, $LiMnPO_4$, or $LiFePO_4$), the resin, or the oxidized CNTs. *Id*. ¶160. Specifically, the bond between the oxidized CNTs and resin would be Van der Waals forces, and the bond between the active material and resin would likewise be Van der Waals forces. *Id*. Van der Waals forces are not ionic bonds, but rather are distance-dependent interactions between atoms or molecules that do not result from a chemical electronic bond. *Id*. Van der Waals forces are very weak electrostatic forces between neutral molecules that fall in the category of "secondary" bonds. *Id*. Ionic bonds are considered "primary" bonds (along with covalent bonds) that chemically bond positively and negatively charged molecules together to create a bond much stronger than Van der Waals forces. *Id*. ¶161 (citing MRD-2027, 6:47-51) (LG Chem. Ltd.'s patent teaching that "the secondary particles are preferably formed by aggregating the primary particles ***via physical bonds*** such as van der Waals attraction ***rather than chemical bonds such as covalent or ionic bonds***."); MRD-2036, 15:18-21 ("organic material is bonded to the surface of the inorganic material by covalent, ionic, electrostatic, ***or*** van Der Waals bonds."); MRD-2035, 1:61-62 ("surface species may be associated with the surface of the particle by at least one of a covalent bond, an ionic bond, van der Waals interactions"); MRD-2039, Abstract (describing adherence by "one or more of covalent bonds, ionic bonds ***and*** Van der Waals forces")). Consequently, Van der Waals forces do not constitute ionic bonds and are consistently categorized as

distinct from ionic bonds.

C. Independent Claim 8 has not been shown to be obvious.

Petitioner fails to show that independent claim 8 is unpatentable for the reasons set forth above. *Supra* Section V.A. In addition, Petitioner fails to demonstrate that Ohata-Kavan teaches or renders obvious that "the carbon nanotubes are uniformly dispersed without clustering on a dimension scale of less than about 1 micrometer."

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., 57. Petitioner's invalidity theory is fundamentally flawed because Ohata never teaches that ***its***

[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 rather than bundled." MRD-2024, 17:14-22. This is consistent with the ordinary meaning of "uniformly dispersed" as spread consistently. MRD-2006 ¶163.

masterbatch (made up of CNTs and resin) is "uniformly" predispersed. MRD-2006 ¶164.

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., 56 (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 ¶165; MRD-2024, 46:15-47:16 (Dr. Zhu admitting that Ohata's reference to "uniformly predispersed" refers to carbon black). Ohata's background further teaches "the use of the 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 ¶165 (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*. ¶166 (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 carbon black and resin—***not*** the masterbatch comprising CNTs and resin—Petitioner is left without any credible evidence that the Ohata-Kavan electrode material mixture paste would achieve "uniformly dispersed" discrete CNTs. *Id*. ¶167. 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 '483 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., 57, n.11 (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*.

Contrary to what Petitioner suggests, *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) (citing 37 C.F.R. § 42.104(b)(3), (4) and denying institution). 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. Indeed, 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 ***any*** description" in the specification of a claim feature alleviated petitioner of its evidentiary 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 ¶170. The specification discloses this feature. *Id.* (citing LGES-1001, 3:26-32. 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.*, 16:23-18:2; *see also* MRD-2025, 8:1-25. And Figure 2 of the '483 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 ¶170.

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.* ¶171. 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., 57-58. 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 ¶171. Petitioner instead improperly equates Figure 1(b) to 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., 58. 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 ¶173 (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*.

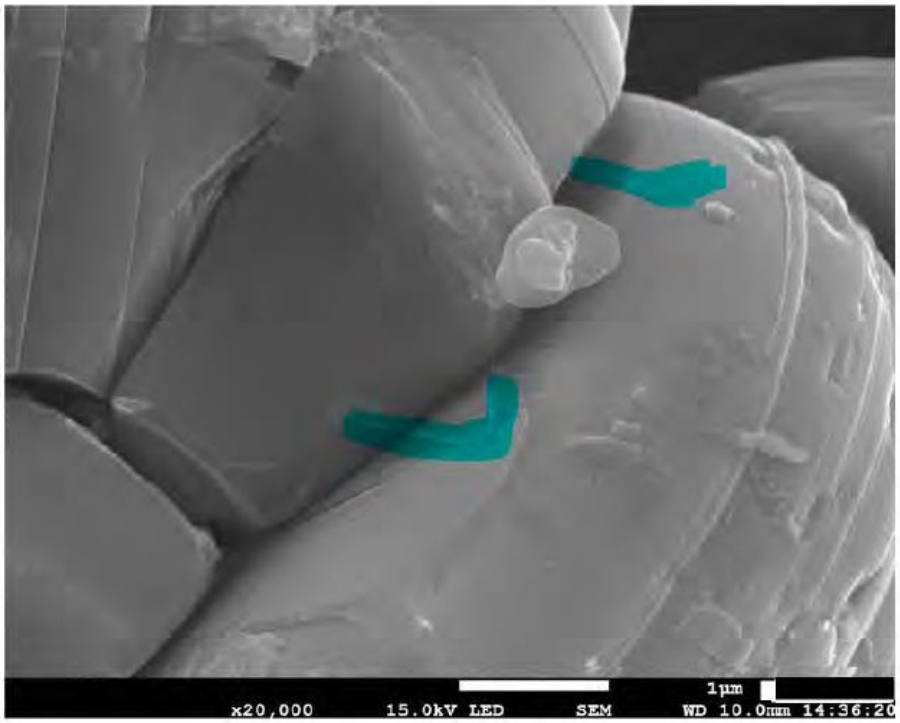
Petitioner ultimately admits that Figure 1(b) has no scale. Pet., 58. Despite this, Petitioner asserts that "a POSITA would have been able to estimate the scale based on Ohata's disclosure that the nanotubes have an average length of 1 to 100 μm." *Id*. Petitioner then concludes "for nanotubes having 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 ¶¶171, 174.

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 ¶175. 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 10-500 range. *Id.* (citing 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 ¶172 (citing LGES-1004, 2). 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*. ¶176. 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 and taking SEM images, similar to how Patent Owner substantiated its infringement theory:



LGES-1050, 32. Petitioner instead chose to rely entirely on a cartoon figure. MRD-¶¶171, 173-175. 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 ¶176.

VI. Conclusion

For the reasons above, the Petition fails to demonstrate beyond a preponderance of the evidence that any Challenged 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 12,304 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)
IPR18768-0210IP6@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