

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

LG ENERGY SOLUTION, LTD.,
SAMSUNG ELECTRONICS CO., LTD. and
SAMSUNG ELECTRONICS AMERICA, INC.,
Petitioner

v.

MOLECULAR REBAR DESIGN, LLC,
Patent Owner

Case IPR2024-01006¹

U.S. Patent 8,808,909

PATENT OWNER'S SUR-REPLY

¹ Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc. were joined as parties to this proceeding via a Motion for Joinder in IPR2025-00356.

TABLE OF CONTENTS

I.	CLAIM CONSTRUCTION.....	7
A.	Petitioner Attempts to Rewrite Dr. Zhu’s Unequivocal Testimony.	7
B.	Petitioner’s New Construction is Implausible.	10
C.	Petitioner Mischaracterizes the Infringement Contentions.....	10
II.	OHATA-KAVAN.....	14
A.	Petitioner Fails to Demonstrate Ohata-Kavan Achieves CNTs Having “Active Material ... Attached to Their Surface”	14
1.	Petitioner’s “physical contact” and “insulation” theories are false.....	14
2.	Petitioner’s “complete dissolution” theory is false.	19
B.	Petitioner’s Motivations to Combine Are Flawed.	25
C.	Petitioner Has Not Shown Ohata-Kavan Achieves “Discrete” CNTs....	25
D.	Claim 6.	27
1.	“uniformly dispersed”	27
2.	“without clustering on a dimension scale of less than about 1 micrometer”	29
III.	LEE-WESPASNICK	32
A.	Lee-Wespasnick Does Not Render Obvious “Discrete” Nanotubes	32
1.	Petitioner attempts to shift blame for the Petition’s failures.	32
2.	Petitioner misrepresents PO’s position and makes unsubstantiated inferences.....	32
3.	Petitioner improperly disregards the relevance of Figure 6.	34
4.	Petitioner misrepresents PO’s arguments on the accuracy Figures 1 and 3 and Lee’s 5,000 aspect ratio.	35
5.	Petitioner mischaracterizes “thermal treatment.”.....	35
6.	Petitioner’s oxidation argument is unsubstantiated.....	36
B.	Lee-Wespasnick Does Not Render Obvious the Claimed Aspect Ratio.	37
C.	Claim 6	38

EXHIBIT LIST

Exhibit No.	Description
MRD-2001	Denial of Motion to Stay in parallel civil suit in EDTX
MRD-2002	Docket Control Order in parallel civil suit in EDTX
MRD-2003	Micah J. Green, “Analysis and measurement of carbon nanotube dispersions: nanodispersion versus macrodispersion.” Polym Int 2010; 59; 1319-1322
MRD-2004	Excerpts from Defendants’ P.R. 3-3 Invalidity Contentions in parallel civil suit in EDTX
MRD-2005	H. Golnabi, “Carbon nanotube research developments in terms of published papers and patents, synthesis and production,” Scientia Iranica, Vol. 19, Issue 6, Dec. 2012, pp. 2012-2022
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., <i>Binder Assisted Dispersion of Agglomerated Carbon Nanotubes for Efficiently Establishing Conductive Networks in Cathodes of Li-Ion Batteries</i> , 8 ENERGY TECHNOLOGY 2000589 (2020).
MRD-2010	Varrla Eswaraiah et al., <i>Morphological, Thermal, Electrical and Electromechanical Properties of Polyvinylidene Fluoride (PVDF)-Functionalized Carbon Nanotube Composites (Preprint)</i> , AFRL-RX-WP-TP-2012-0277 INDIAN INSTITUTE OF TECHNOLOGY CHENNAI (2012).

Exhibit No.	Description
MRD-2011	B. V. Bahaskara Rao et al., <i>Fabrication and Evaluation of Thin Layer PVDF Composites Using MWCNT Reinforcement: Mechanical, Electrical and Enhanced Electromagnetic Interference Shielding Properties</i> , 6 AIP ADVANCES 065107 (2016).
MRD-2012	Viraj Bhingardive et al., <i>Polyvinylidene Fluoride Based Lightweight and Corrosion Resistant Electromagnetic Shielding Materials</i> , 5 RSC Adv. 35909 (2015).
MRD-2013	Ming Wang et al., <i>The Influence of Polyvinylidene Fluoride (PVDF) Binder Properties on LiNi_{0.33} Co_{0.33} Mn_{0.33} O₂ (NMC) Electrodes Made by a Dry-Powder-Coating Process</i> , 166 JOURNAL OF THE ELECTROCHEMICAL SOCIETY A2151 (2019).
MRD-2014	Soumyaranjan Mishra et al., <i>Synthesis of PVDF/CNT and Their Functionalized Composites for Studying Their Electrical Properties to Analyze Their Applicability in Actuation & Sensing</i> , 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., <i>Effect of Conductive Material Morphology on Spherical Lithium Iron Phosphate</i> , 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., <i>Rheological Properties and Stability of NMP Based Cathode Slurries for Lithium Ion Batteries</i> , 40 CERAMICS INTERNATIONAL 4591 (2013).

Exhibit No.	Description
MRD-2021	CN Patent Application Publication No. 101714627
MRD-2022	Certified English Translation of CN Patent Application Publication No. 101714627
MRD-2023	Declaration of Dr. Yu Zhu in IPR2024-01013, dated June 12, 2024
MRD-2024	Deposition Transcript of Dr. Yu Zhu in IPR2024-01013, dated March 14, 2025
MRD-2025	Deposition Transcript of Dr. Yu Zhu in IPR2024-01006, dated March 21, 2025
MRD-2026	Deposition Transcript of Dr. Yu Zhu in IPR2024-01011, dated March 21, 2025
MRD-2027	RESERVED
MRD-2028	U.S. Patent Application Publication No. 2024/0274804
MRD-2029 to MRD-2036	RESERVED
MRD-2037	Aleksander Cholewinski et al., <i>Polymer Binders: Characterization and Development toward Aqueous Electrode Fabrication for Sustainability</i> , 13 POLYMERS 631 (2021).
MRD-2038 to MRD-2042	RESERVED
MRD-2043	Deposition Transcript of Dr. Yu Zhu in IPR2024-01013, dated August 11, 2025
MRD-2044	Deposition Transcript of Dr. Yu Zhu in IPR2024-01006, dated August 12, 2025

Exhibit No.	Description
MRD-2045	Deposition Transcript of Dr. Yu Zhu in IPR2024-01011, dated August 12, 2025

I. CLAIM CONSTRUCTION

Petitioner interpreted “discrete” CNTs as those “fully isolated” from others, consistent with the ordinary meaning *separate*, distinct and *not attached* to one another. Patent Owner Response (Paper 16, “POR”), 14, 51-52.² PO demonstrated Ohata-Kavan fails to teach this, so Petitioner now seeks to retroactively broaden “discrete” CNTs to mean those merely “*capable of* being separated to give individual tubes” so that *any* CNT qualifies. Petitioner Reply (Paper 21, “Reply”), 3.³ This improper new construction is unsupported.

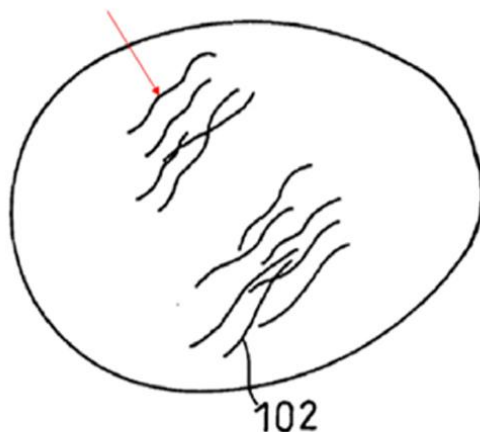
A. Petitioner Attempts to Rewrite Dr. Zhu’s Unequivocal Testimony.

Dr. Zhu testified that he identified the CNT in Ohata’s Figure 1(b) (reproduced below) as “discrete” “because it’s fully isolated from the other nanotubes.” MRD-2024, 10:21-11:12.

² Contrary to Petitioner’s suggestion (Reply, 1 n.1), PO’s original assertion that “discrete” CNTs are “individually dispersed and *separate from* other CNTs” (POR, 14) is consistent with its construction in IPR2024-1005. Express construction was originally unnecessary because the parties applied the term consistently. POR, 14, 51-52.

³ All emphases herein added, unless otherwise indicated.

“discrete, non-agglomerated, and exfoliated
carbon nanotubes”

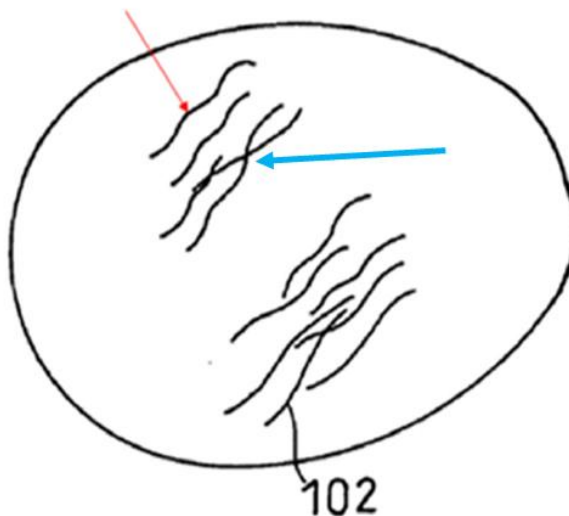


LGES-1004, Fig. 1(b) (annotated)

He further testified discrete CNTs “have been *separated from each other*” and responded “yeah” when asked “discrete [CNTs] are non-bundled nanotubes *that are separate from each other*, correct?” *Id.*, 12:20-13:20.

Dr. Zhu was not quoted “out of context.” Reply, 2. He was given multiple opportunities to provide the meaning of discrete CNTs “in [his] own words” but avoided responding, stating “I think *we don’t really need to have a definition for this.*” MRD-2024, 8:15-9:15. His understanding of “discrete” was thus elicited using his application to the art. Notably, he did not testify that he identified the CNT “because” it is “*capable of* being separated.” If that was his understanding, he would have identified the CNTs that appear to be attached (blue arrow):

“discrete, non-agglomerated, and exfoliated carbon nanotubes”



LGES-1004, Fig. 1(b) (annotated)

His supplemental testimony contradicts his prior testimony, is ambiguous and wrong. For example, he noncommittally testifies that “a fully isolated carbon nanotube that is not touching any other nanotube is *likely* ‘discrete’” and “*can be* discrete” (LGES-1056 ¶7), even though such a nanotube *is clearly* discrete under either party’s interpretation. Moreover, in an effort to undo the damage caused by his prior testimony, he offered the absurd opinion that “*fully* isolated” CNTs can be attached to other CNTs. MRD-2043, 11:2-20. But even Petitioner admits that “*fully* isolated” CNTs are “*individually isolated*.” Reply, 2.

B. Petitioner's New Construction is Implausible.

Under Petitioner's new construction *any* CNT would qualify as "discrete", as all CNTs are "capable of" being separated. MRD-2043, 12:7-13, 13:13-20 (admitting the CNTs in Ohata's Figure 1(a) are not "discrete" but there "***is always a potential***"). This construction would not "giv[e] effect" to "discrete." *See Info-Hold v. Muzak LLC*, 783 F.3d 1365, 1373 (Fed. Cir. 2015).

This construction is also inconsistent with the specification, which teaches there is a "***process of making*** discrete carbon nanotubes." LGES-1001, 3:66-67. It also teaches "the carbon nanotubes previously employed are ***not considered to be*** essentially discrete, i.e., ***individual*** uniformly dispersed tubes. *Id.*, 1:42-44. Thus, "discrete" CNTs must ***actually be*** separate individual tubes.

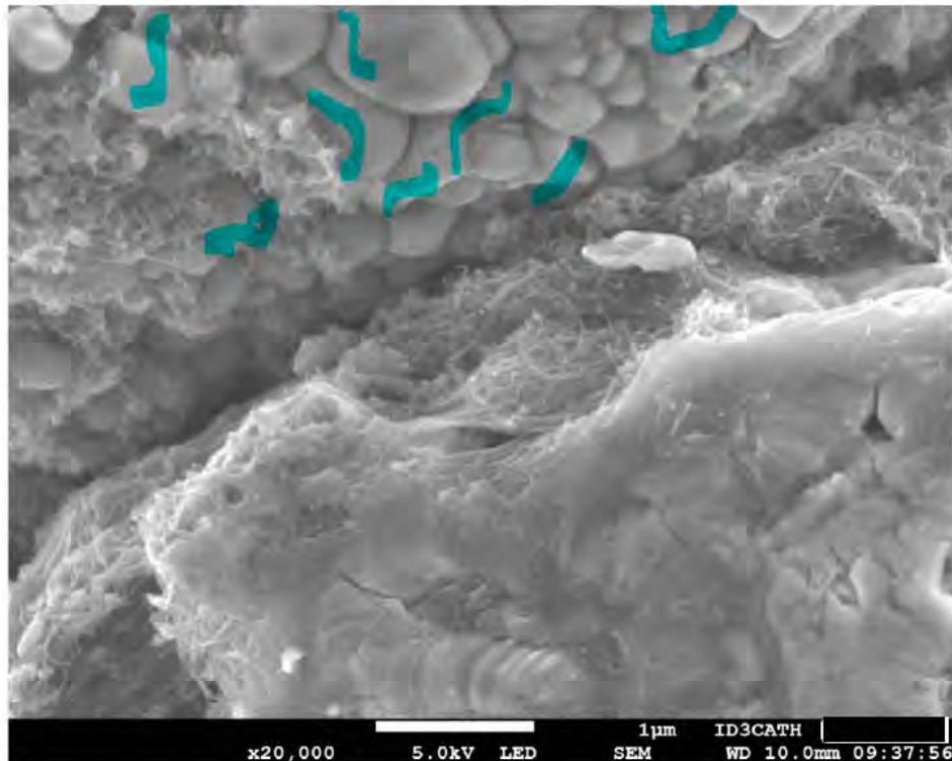
Petitioner's new construction contradicts it and its expert's position in IPR2024-01005. *See* IPR2024-01005, Paper 2, 12-13 (alleging "discrete" CNTs "***lack[] direct association with other nanotubes*** along substantially the length of the nanotubes."); IPR2024-1005, MRD-2011, 8:3-9:22 (confirming). While "discrete" CNTs are not attached to other CNTs, Petitioner's position there demonstrates that it understands "discrete" CNTs are not simply "capable of" being separated.

C. Petitioner Mischaracterizes the Infringement Contentions.

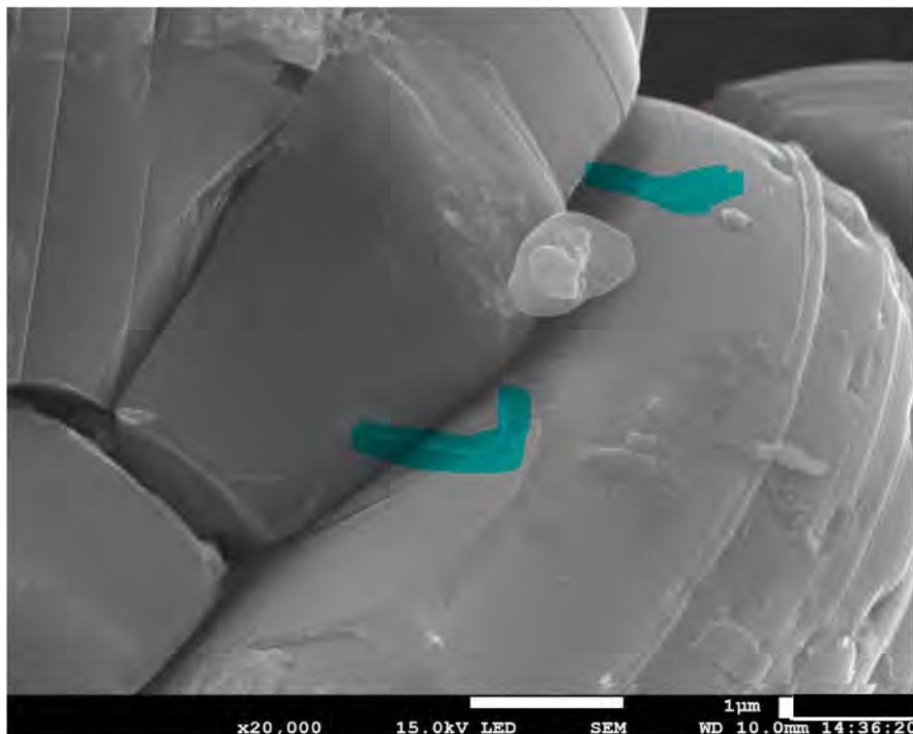
SEM images are two-dimensional images of ***a three-dimensional space***, meaning that at lower-magnifications CNTs that *appear* to be attached because they

overlap are not necessarily attached or touching. LGES-1055, 127:21-128:12. Petitioner “agree[s]” (*id.*, 128:3-9) and relies on this “commonsense principle” in IPR2024-01005 (Paper 23, 19-20).

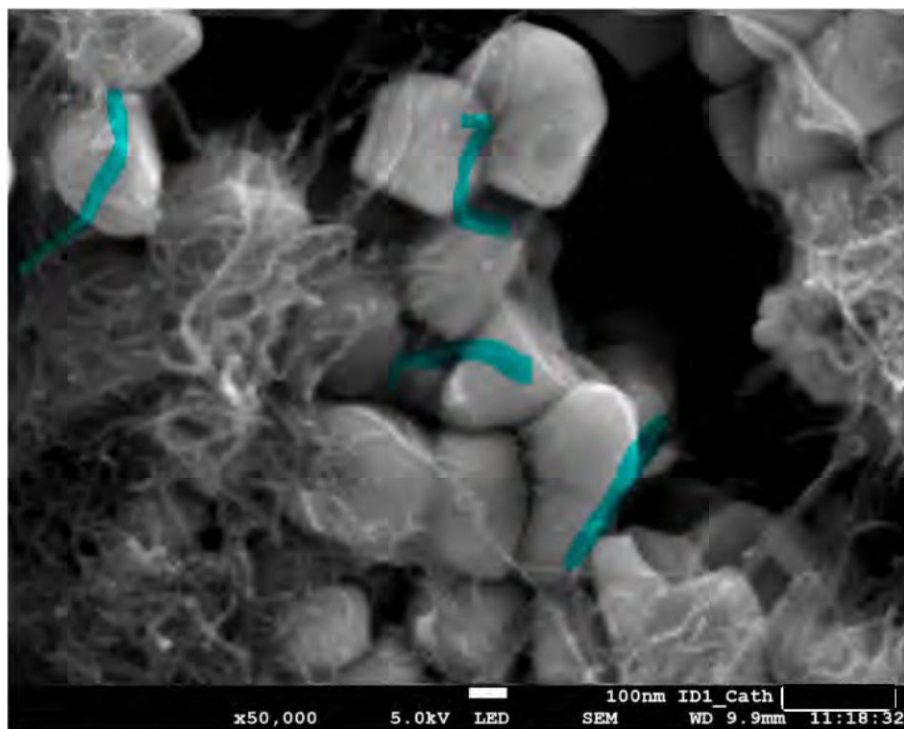
Despite this, Petitioner cherry-picks lower-magnification SEM images from the many taken and misleadingly relies on this optical illusion. Reply, 4. However, the other SEM images show that PO consistently identified “discrete” CNTs (blue) in accordance with the plain and ordinary meaning:



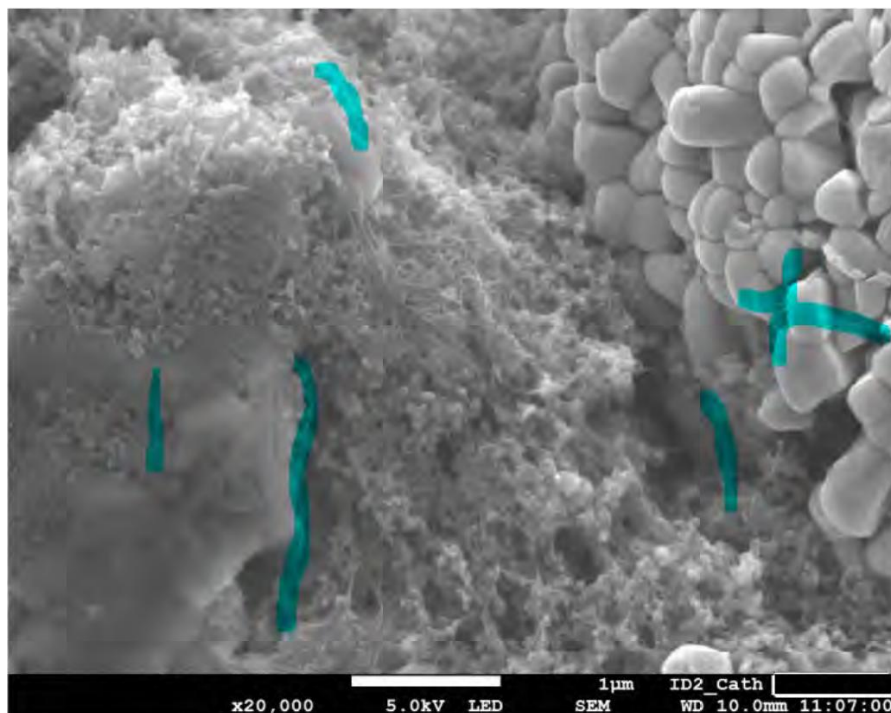
LGES-1033, 31.



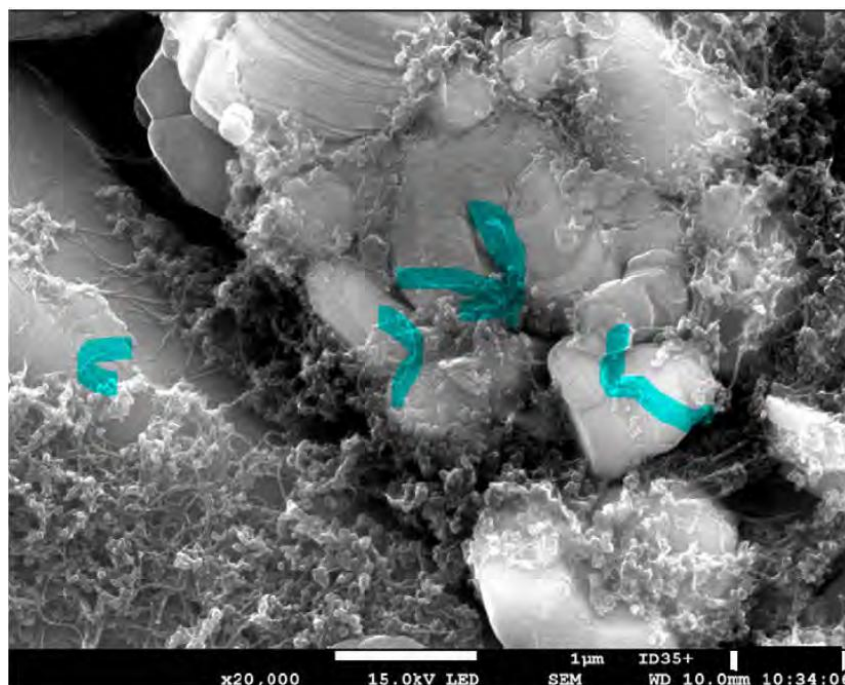
Id., 32.



Id., 29.



Id., 30.



Id., 34.

The Board should thus “decline to adopt Petitioner’s conclusory assumptions” based on the infringement contentions. *Globus Medical v. Spinelogik*, IPR2025-00226, Paper 9, 11 (July 14, 2025).

II. OHATA-KAVAN

A. Petitioner Fails to Demonstrate Ohata-Kavan Achieves CNTs Having “Active Material ... Attached to Their Surface”

Petitioner does not dispute that if the CNTs of the electrode-paste are fully coated by resin, Ohata-Kavan fails to achieve the claimed “attachment.” Petitioner instead argues they cannot be fully coated because (1) there must be direct **physical** contact for electrical conductivity and (2) the solvent of Ohata-Kavan would dissolve the resin from the CNTs. Reply, 5-10.

1. Petitioner’s “physical contact” and “insulation” theories are false.

While “[i]t is well-established that ... there must be electrical contact between the active material and the conductive additive, to enable current flow” (*id.*, 6), Petitioner disingenuously conflates electrical contact with **physical** contact by arguing that the latter is required for the former. However, **Physical** contact is not required for there to be electrical contact due to the scientific principles of “electron tunneling” and “the percolation threshold.”

a. Petitioner ignores “electron tunneling.”

MRD-2010 is a scientific publication involving functionalized CNTs (2 wt%)

immersed in PVDF (98 wt%). MRD-2010, 9. Despite being fully embedded in PVDF, “electronics can **easily** travel from one tube to another tube without any obstacle (**through tunneling**)” when the “CNTs are touching each other **or very close** ($[<]2nm$ *[sic]* in distance).” *Id.*, 12; see also MRD-2012, 5 (describing “tunneling of electrons” as a “conduction mechanism” in PVDF-CNT mixtures); MRD-2043, 14:8-16 (explaining electron tunneling).

Dr. Chung likewise explained that “for nanotube A and nanotube B to be in electrical contact, they have to be **extremely close** to one another.... I just mean **not exactly contacting**, just ... a tiny little microscopic **gap** at the point of so-called touching.” LGES-1055, 114:19-115:20; see also *id.*, 122:24-123:9.

Tunneling thus allows electrons to pass from point-to-point even when separated by a resin layer, despite the lack of **physical** contact. Indeed, a composite having a high ratio of PVDF:CNTs—as in Ohata-Kavan’s masterbatch—would not adequately function if **physical** contact was required.

b. Petitioner ignores “the percolation threshold.”

It is undisputed Ohata-Kavan embeds CNTs within PVDF to form a composite (PVDF-CNT binder) exhibiting increased electrical conductivity. POR, 20-23. This involves mixing a sufficient amount of CNTs (conductive filler) with PVDF (non-conductive binder) to reach the “percolation threshold”—*i.e.*, where conductivity is increased such that the **overall** composite exhibits “metal-like

behavior” rather than the “insulator-like” property of PDVF. *See* MRD-2011, 2, 4, 7-8 (“This theory of percolation threshold is well documented”); MRD-2044, 8:15-9:18 (explaining percolation threshold); MRD-2014, 4; LGES-2021 ¶[0035]. This is achieved by small amounts of CNT. MRD-2011, 7 (threshold “approache[d]” at **5wt% CNTs** in PVDF); MRD-2012, 5 (“conductivity of insulating PVDF has increased” by magnitudes “with the addition of **3wt% CNTs**”); LGES-2021 ¶[0027] (**5wt%** achieves “significant increases in the electrical conductivity”).

Dr. Chung likewise explained that the CNT-PVDF masterbatch binder of Ohata-Kavan must be considered as “one unit” because it “is a composite material with the resin as the matrix and the nanotubes as a filler” such that the “electrical conductivity [of the composite] is much increased.” LGES-1054, 38:9-25; *id.*, 37:6-20, 39:2-40:20.

Ohata-Kavan’s masterbatch binder would thus exhibit a “metal-like” conductive behavior due to the presence of CNTs, allowing electrons to travel throughout the **entire** binder, including the PVDF layer between the active material and CNTs. LGES-1004 ¶[0021] (teaching **5-20wt%** of CNTs in PVDF).

c. No evidence supports Petitioner’s theories.

Although Dr. Zhu acknowledges electron tunneling and the percolation threshold (MRD-2044, 7:21-9:18), he accounts for neither. He instead offers the unsubstantiated theory that physical contact is required “due to the relatively low

intrinsic electrical conductivity of the active material.” LGES-1056 ¶10 (cited by Reply, 6).

For one, he provides no evidence that active material has “low intrinsic electrical conductivity.” He quotes MRD-2017 and MRD-2018, but those quotes refer to “electrical bridges” not **physical** bridges. Moreover, he contradictorily testified that active material can have “good” electrical conductivity. MRD-2043, 15:9-22; MRD-2044, 10:4-10. Even if there was low intrinsic conductivity, electrical conductivity would still exist due to electron tunneling and the percolation threshold. *Supra* Section II.A.1.a-b.

Petitioner resorts to an out-of-context quote portraying Dr. Chung as agreeing “**physical** contact” is required for electrical conductivity. Reply, 6 (quoting LGES-1054, 17:1-15). But she *unequivocally and repeatedly* testified that **physical** contact is not required for electrical conductivity, as supported by the evidence above. LGES-1055, 114:19-115:20, 122:24-123:9; LGES-1054, 38:9-40:20, 37:6-20 (answering “no” when asked if “nanotubes would also need to make contact with the active particle itself, right?”).

Petitioner also omits context. Dr. Chung explained that the **physical** term “touching” is sometimes loosely used to describe electrical contact. See LGES-1055, 114:19-115:1 (explaining that even if there is a “little microscopic gap at the point of *so-called touching*” electrical conductivity exists), 47:4-10; LGES-1054, 36:24-

37:5.

Petitioner also quotes her testimony about “electrical conduction linkages,” an “electrically conductive path,” and “electrical contact” Reply, 6 (citing LGES-1054, 16:2-12, 36:18-37:5). But electrical contact does not require **physical** contact.

Petitioner’s assertion that “PO’s position is incompatible with Ohata’s stated goal” of enhanced conductivity (Reply, 7) is premised on it disregarding the principles of electron tunneling and the percolation threshold.

Petitioner also relies extensively on Dr. Zhu’s parroting of arguments in the Reply. *Compare* Reply, 5-7 with LGES-1056 ¶¶9-12. Such testimony is entitled to no weight. *See Xerox v. Bytemark*, IPR2022-00624, Paper 9 (Aug. 24, 2022) (precedential). Regardless, his testimony is unsubstantiated.

MRD-2017 and MRD-2018 (cited by LGES-1056 ¶¶10-11) merely show electrical—not **physical**—bridges are required. The cited sentence (LGES-1001, 2:4-5) merely states that discrete CNTs can help overcome low electrical conduction due to expansion and contract of active material particles, which occurs by preventing and reducing cracking. POR, 13-17. The cited portions of MRD-2008, LGES-1004, and LGES-1005 merely teach that improved conductivity is a goal of electrodes—not that CNTs must be in **physical** contact with active material to provide *electrical* conductivity.

Thus, Petitioner’s theory that the “basic operation” requires **physical contact**

is false. Reply, 6. This theory is further undermined by Petitioner's (incorrect) assertion that Ohata-Kavan achieves CNTs that are spaced apart by at least 1 micrometer. *Infra* Section II.D. If physical contact was required, Ohata-Kavan would not seek spaced apart CNTs (as Petitioner alleges). This theory is also undermined by Petitioner's position in IPR2024-01012 (Paper 22, 18) that electrical contact exists between CNTs in the Son reference, even where the tubes allegedly **"do not touch each other."**

2. Petitioner's "complete dissolution" theory is false.

a. No evidence supports this theory.

Overwhelming evidence shows NMP would not remove PVDF from the surface of the oxidized CNTs of Ohata-Kavan, including MRD-2020, 6-7 (explaining the PVDF layer **"prevents direct contact** of particle surfaces"), MRD-2014, 1:31-34 (teaching PVDF dissolved in solvent tends **to coat** particles of the active material and **the conductive agent**"), and MRD-2014, 8 (showing PVDF domains as product of NMP dissolution). POR, 36-44.

Petitioner fails to address this evidence, instead mischaracterizing Ohata's teaching that "the masterbatch was easily dissolved in [NMP]" to mean the PVDF coating is removed by the NMP. Reply, 7. However, the evidence shows that NMP "dissolution" does not remove PVDF from the CNTs' surfaces. Ohata describes NMP as a "dispersion medium" (LGES-1004 ¶[0046]), "easily" dissolving refers to

how NMP disperses the PVDF **as domains** so they can act as globules of conductive glue. MRD-2006 ¶¶118-126. These domains are visible in numerous exhibits. POR, 36-44.

Petitioner’s exhibits provide no support for its dissolution theory. LGES-1061 and LGES-1062 merely teach PVDF is soluble in NMP. Reply, 7-8. But there is no dispute PVDF is soluble by NMP—that allows the PVDF to be **dispersed as domains** of glue. MRD-2006 ¶118. Neither reference proves otherwise.

Petitioner also argues “that the PVDF binder of Ohata’s masterbatch is readily soluble in NMP **was well-known.**” Reply, 7-8 (citing LGES-1056 ¶¶13-20). However, the Reply does not explain this argument, instead offhandedly citing paragraphs 13-20 of Dr. Zhu’s declaration. This improperly relies on large swaths of testimony as the explanation **required to be in the Reply**. See *Cisco Sys. v. Cation Techs.*, IPR2014-00454, Paper 12, 10 (Aug. 29, 2014) (designated precedential).

Even if considered, it is unsubstantiated. Although Dr. Zhu cites LGES-1062, 2 and LGES-1004 to support that “PVDF is fully dissolvable in NMP at concentrations greater than or equal to 10% by weight” (LGES-1056 ¶14), neither supports his statement and he fails to provide *any* explanation as to how they do.

Dr. Zhu alleges “aggregated undissolved [PVDF] particles in NMP solution ... is a strict condition that a POSITA would try to avoid.” LGES-1056 ¶15. He fails

to provide ***any explanation or evidence*** supporting this. His conclusory assertion defies commonsense, as aggregates (domains) of PVDF-CNT are *necessary* for the binder to serve its primary function of holding the constituent parts of the electrode together. POR, 36-37; LGES-1054, 13:5-20. Fully dissolved PVDF would be too thinly dispersed to hold anything together.

Even if “aggregates” were something “to avoid,” Dr. Zhu fails to provide any evidence NMP would remove the “molecular layer” of resin-coating. POR, 44 (citing MRD-2006 ¶126); *See e.g.*, MRD-2009, 2 (“PVDF...would ***coat onto CNT surface*** due to the strong interaction between PVDF and CNTs.”); LGES-1014, 3 (f-CNTs become “***completely covered*** with [resin-]matrix”). Indeed, even Dr. Zhu acknowledged PVDF would cover “a ***significant*** amount” of CNT surface (MRD-2024, 65:21-66:9), which is inconsistent with his new “full dissolution” theory.

The contention that there is a “weak” PVDF-CNT interaction (LGES-1056 ¶18) is based on a misleading quote from LGES-1059, 5 stating “the interaction between CNTs and PVDF was ***relative[ly]*** weak.” But the key word here is “relatively,” i.e., weak ***as compared to*** (not generally) the interaction between OMLS/PVDF. LGES-1059, 4-6. Indeed, other evidence confirms he is mistaken. *See* MRD-2009, 2; MRD-2006 ¶115. And even if he was correct, that would not demonstrate NMP would remove PVDF from the CNTs.

Dr. Zhu’s testimony about MRD-2010 is a red-herring. LGES-1056 ¶¶20-21.

PO did not rely on MRD-2010 to evidence the effects of NMP, but to show that the masterbatch process would fully embed the f-CNTs in resin. PO, 30-31. PO cited **other** exhibits showing NMP disperses PVDF as domains, which Dr. Zhu tellingly does not address in paragraphs 20-21. *Id.*, 36-44.

b. Petitioner fails to refute PO's evidence.

MRD-2014 to MRD-2018 and MRD-2020 demonstrate that NMP disperses PVDF as domains or islands. POR, 36-44. Petitioner alleges "PO's own corroborating references refute its theory," yet fails to address much of this evidence. Petitioner instead focuses on select exhibits out-of-context.

Petitioner argues MRD-2017's reference to "electrical bridges between the active material particles," and the conductivity level reflected in the experimental results, proves that there must be **physical** contact. Reply, 9. However, **physical** contact is not required for electrical bridges. *Supra* Section II.A.1.

Dr. Chung's testimony is not "contradicted" by MRD-2017. Reply, 9. In attacking her for testifying she was "unable to identify" CNTs, Petitioner misses the point. CNTs are not visible because the "**domains include in them the CNTs...** and these domains are dispersed around the lithium-ion phosphate." LGES-1054, 54:6-15. This evidences they are fully embedded within the PVDF-matrix.

Paragraphs [0094] and [0123] of MRD-2017 do not "confirm[]" that CNTs are not embedded and isolated, but instead dispersed and connected to the active

material.” Reply, 9-10. Dr. Zhu’s entire argument is that the “reasonable conductivity” discussed “would be impossible if the CNTs were completely electrically isolated.” LGES-1056 ¶26. But PO has never taken the position that the CNTs and active material are “electrically” isolated—merely that **physical** contact between them is not required for there to be electrical conductivity.⁴

Petitioner’s focus on MRD-2008 is an intentional distraction. Reply, 10. MRD-2008 was relied on solely as evidence that (1) mixing PVDF with conductive agent results in conductive glue even after mixing with NMP and (2) PVDF “bonds” to conductive agent. POR, 22, 34. PO did not rely on MRD-2008 to show the oxidized CNTs of the masterbatch would be fully embedded in the resin, because MRD-2008 uses *significantly smaller* ratios of PVDF:conductive-filler. MRD-2008, 9:6-9 (discussing CB:PVDF ratios of 0.5:1, 0.8:1, and 1:1). Regardless, Petitioner’s argument that if the conductive carbon black were truly embedded it would be “isolated ... from the active material” recycles the incorrect theory that direct **physical** contact is required for electrical conductivity. Reply, 10.

Similarly, nothing in MRD-2008 “makes clear” its conductivity improvements come from physically contacting the carbon black with active

⁴ Petitioner’s attacks against MRD-2018 are substantively identical to those against MRD-2017 and are flawed for the same reasons.

material. LGES-1056 ¶¶27-30 (improperly incorporated-by-reference by Reply, 10). To the contrary, MRD-2008 explains that “[c]onventional thinking is that when the ratio of **non-conductive** binder is increased, at a given acetylene black concentration, **the interface impedance will increase.**” MRD-2008, 10:33-36. However, the “findings shown here **indicate the opposite of conventional thinking.**” *Id.*, 10:36-47. Consequently, when MRD-2008 teaches the “improvement in performance realized when using **greater amounts of binder** relative to CB ... may be attributed to the improved **interface electronic conductivity**” (MRD-2008, 10:27-32), it is referring to the percolation threshold improving conductivity of the entire binder, increasing conductivity of the binder-active material interface. And, again, even if MRD-2008 taught conductive black particles **physically** contact the active particles (it does not), MRD-2008 uses significantly lower ratios of PVDF:conductive-filler than Ohata-Kavan. *Id.*, 9:6-9. It is not evidence that the same alleged contact would occur in Ohata-Kavan.

Dr. Zhu quotes MRD-2008 at 11:13-17. LGES-1056 ¶30. But it plainly undermines him—the carbon black “branch structure” is “**integrate[d]**” **into the “PVDF coatings”** and “**is coated with PVDF polymer.**” He suggests this teaching fails to evidence CNTS would be “coated” in the same way (LGES-1056 ¶31); the evidence proves otherwise. POR, 29-34, 36-43. Even if MRD-2008 is ignored, Petitioner fails to address much of the other evidence supporting PO’s position.

B. Petitioner's Motivations to Combine Are Flawed.

Petitioner's rebuttal regarding "motivations for the Ohata-Kavan combination" and "expectation of success" is premised on Petitioner demonstrating the CNTs of Ohata-Kavan would not be "fully embedded within the resin matrix." Reply, 12-18. Petitioner hasn't shown this (*supra* Section II.A)—Petitioner's rebuttal fails.

C. Petitioner Has Not Shown Ohata-Kavan Achieves "Discrete" CNTs.

Petitioner does not dispute that if "discrete" CNTs preclude attachment between CNTs, Ohata-Kavan fails to render this limitation obvious. Reply, 10-12. Petitioner instead incorrectly maintains that "discrete" CNTs "do[]" not preclude a network of nanotubes." *Id.* But because they do, Petitioner fails to show this limitation. *Supra* Section I.

That the '924 Patent and Ohata-Kavan are "well-aligned" in seeking to "enhance conductivity" provides no support for Petitioner. Reply, 11. Discrete CNTs "enhance conductivity" primarily by ***preventing and bridging cracks*** in active particles (POR, 14-17), which is fundamentally different than the "enhanced conductivity" Ohata-Kavan seeks via a ***via a network of interconnected CNTs*** (POR, 10-13).

Petitioner complains of "PO's myopic focus on Fig. 1" of Ohata (Reply, 11), but Petitioner relied almost exclusively on that figure as evidence of "discrete"

CNTs. Petition, 19-22. Regardless, Petitioner conspicuously avoids responding to a key point—“Petitioner fails to demonstrate that [the masterbatch CNTs] would remain discrete after *being further mixed* with the active material to create the *electrode material mixture paste*.” POR, 54-55. Petitioner cannot carry its burden because its arguments focus on the *masterbatch* of Ohata-Kavan, not the *electrode mixture paste* containing active material.

Recognizing this, Petitioner seeks to shift the burden to PO by arguing that Gan (MRD-2019) “does not demonstrate *absence of* discrete nanotubes” in the electrode material mixture. Reply, 12. However, it is Petitioner’s burden to first prove *the presence of* discrete CNTs in the *electrode mixture*.

Because Gan disproves Figure 1(b) as representative of how the CNTs of Ohata-Kavan would appear in the *electrode mixture*, Petitioner attempts to dismiss it as an “entirely different reference.” *Id.*, 11. But Petitioner relies on Gan to try and invalidate claims in IPR2024-01011 (Paper 2, 36-42), proving Gan is far more relevant than Petitioner alleges.

Petitioner argues the arrangement of CNTs in Gan’s SEM images are irrelevant because they are not oxidized. Reply, 12. But a POSITA would have expected those CNTs to be *more interconnected* when oxidized because Gan teaches functionalization “draw[s] the *CNTs closer together*.” POR, 57.

Petitioner’s assertion that a POSITA would not have “drawn any conclusions”

based on Gan is premised on Dr. Zhu's conclusory parroting. *Compare* Reply, 12 with LGES-1056 ¶33. Indeed, just like Ohata-Kavan, Gan mixes a large volume of polymer with a small amount of CNTs to form an interconnected network of CNTs.

D. Claim 6

1. “uniformly dispersed”

Petitioner does not dispute that the reference to “uniformly predispersed” in Ohata (LGES-1004 ¶[0002])—the **sole** basis for Petitioner's position that Ohata-Kavan satisfies this limitation (POR, 59-62)—is from a sentence discussing carbon black, not the CNT-based masterbatch process of Ohata. Reply, 18-19. Recognizing it misunderstood that sentence as referring to CNTs, Petitioner mischaracterizes the Petition to try and improperly gap-fill with new theories.

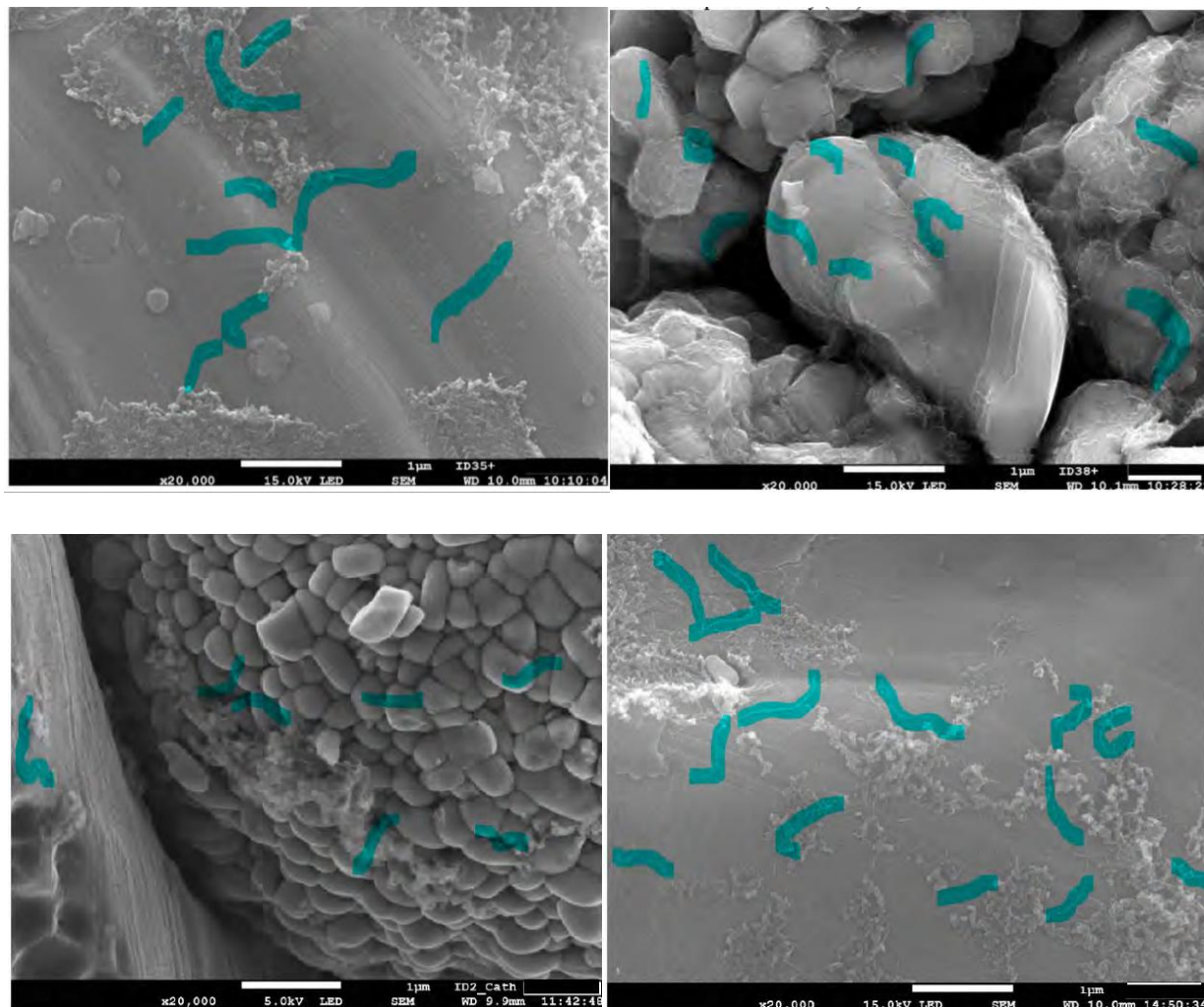
Petitioner now argues that “a POSITA would have expected the nanotubes in Ohata's masterbatch to be uniformly predispersed.” *Id.*, 18 (citing Petition, 33-36). But the Petition never argued this—the Petition argued Ohata expressly teaches “uniformly predispersed” CNTs based on a misreading of ¶[0002] and merely alleged it would be “obvious” that they would “**remain** uniformly dispersed” after mixing with active material. Petition, 33-34.

Petitioner also offers the new theory that “a masterbatch process is a *conventional approach* known to ‘uniformly disperse.’” Reply, 18. Petitioner does not cite the Petition, because this theory was never advanced. Indeed, if Petitioner

had included arguments on this point, it would not need to cite new evidence (LGES-1063). And while the Reply cites ¶[0003] of Ohata, that paragraph is about carbon black, not CNTs.

Petitioner attacks PO as “misrepresent[ing]” that “Ohata describes the difficulty of dispersing CNTs in resin,” despite PO quoting Ohata. Reply, 18-19. Regardless, it is undisputed that dispersing CNTs was notoriously difficult (even in resin), undermining Petitioner’s effort to rely on a quote about the dispersibility of carbon black as indicative CNT dispersibility. POR, 10-13; LGES-2022 ¶[0073]; MRD-2019 ¶[0027].

Petitioner alleges PO’s infringement contentions are “inconsistent” with its position in these proceedings but does not explain how. Reply, 19-20. This is nothing more than an attempt to detract from Petitioner’s misreading of ¶[0002]. Even if the SEM could be interpreted as *appearing* “inconsistent,” that would be because Petitioner cherry-picked a single SEM focused on a small area of a composition containing *billions* of CNTs. When the images are viewed holistically, it cannot be disputed that the discrete CNTs (blue) are uniformly dispersed:



See e.g., LGES-1050, 60, 61, 63, 65.

Petitioner's persistently false characterization and reliance on *Epstein* should be rejected. Reply, 19; POR, 62-63.

2. “without clustering on a dimension scale of less than about 1 micrometer”

It is undisputed this limitation requires a certain amount of spacing between CNTs. POR, 64; Reply, 18-20. Petitioner's obviousness theory was premised on Ohata's cartoon Figure 1(b) having “scale.” POR, 64-65. PO demonstrated,

however, that nothing in Ohata teaches or suggests this figure is intended to be drawn to scale. *Id.*, 65-66. As the Reply does not dispute this, Petitioner's invalidity theory fails as a matter of law. *Id.*

Recognizing this, Petitioner again mischaracterizes the Petition to try to gap-fill. Petitioner argues that "PO fails to address the Petition's explanation that a POSITA would have found this to be obvious given the size range of Ohata's nanotubes and Ohata's explicit disclosure that the nanotubes are 'dispersed.'" Reply, 27 (citing Petition, 34-35). That is not what the Petition argued. The Petition argued that "although no scale is provided for the Fig. 1(b) schematic illustration, ***POSITA would have been able to estimate the scale*** based on Ohata's disclosures that the nanotubes 'have an average length of 1 to 100um'.... For instance, for nanotubes having a length of 100 μm , the space between the nanotubes is depicted as greater than 1 μm" Petition, 43. Thus, the Petition ***premised its argument on Figure 1(b)*** and only relied on the disclosed CNT lengths to "**estimate the scale**" of that figure. Petitioner did not rely on the size of the CNTs alone as now falsely alleged.

Petitioner also argues "PO fails to contend with the role of Ohata's masterbatch process in enabling dispersion of nanotubes, which again, given the size range of Ohata's nanotubes, ***would have rendered obvious the claimed scale of dispersion.***" Reply, 19 (citing Petition, 34-35). Again, Petitioner never argued that

this limitation was obvious based solely on Ohata teaching “dispersion” and the disclosed size of the CNTs—Petitioner’s argument was premised on Figure 1(b)’s “scale.” Petition, 34-36.

Petitioner’s apparent position that the vague notion of “dispersing” CNTs necessarily renders obvious CNTs that are spaced ***at least 1um apart*** is implausible on its face. CNTs can be dispersed—even “uniformly dispersed”—while still forming a highly intertwined network of CNTs. *See e.g.*, MRD-2019 ¶¶[0026], [0041] (explaining CNTs can be “uniformly dispers[ed]” in polymer to form a “random interconnected network” of CNTs).

Petitioner’s theory that Ohata-Kavan meets this limitation is also fundamentally undermined by its new arguments on the “attached” limitation. Petitioner argues (mistakenly) **physical** contact (i.e., no space separation) is required to achieve electrical conductivity (Reply, 5), but for this limitation Petitioner argues it is “obvious” the CNTs would be spaced apart in Ohata-Kavan (i.e., not in physical contact). Reply, 19; Petition, 35. However, if “physical contact” was required (as falsely alleged), Ohata-Kavan would not seek CNTs spaced apart (as also falsely alleged).

Petitioner also fails to address that (1) under its 100µm assumption, the CNTs would have an aspect ratio outside the claimed range, or (2) even if the CNTs met this limitation in the “masterbatch,” that does not evidence they meet this limitation

in the electrode paste. POR, 66-67. Nor does Petitioner dispute that it *could have* performed experiments to try to demonstrate this limitation is met. *Id.*, 67-68.

III. LEE-WESPASNICK

A. Lee-Wespasnick Does Not Render Obvious “Discrete” Nanotubes

1. Petitioner attempts to shift blame for the Petition’s failures.

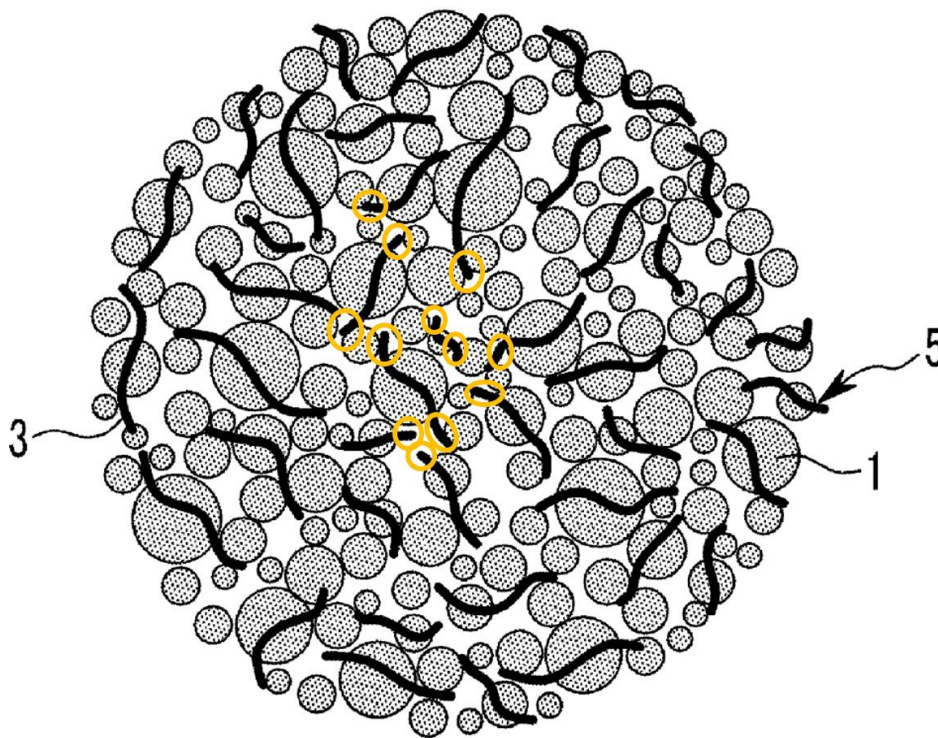
The DI correctly determined Petitioner failed to carry its burden on Lee-Wespasnick. POR, 69-72. Petitioner now seeks to shift blame to PO and the Board for “fundamental[lly] misunderstanding” Lee. Reply, 21, n.2. Even if a “misunderstanding” exists (it does not), it would be solely attributable to the Petition’s failure to offer arguments “with particularity, not opacity,” “make [its] case in the[] petition,” and clearly explain how its art satisfies the claims. *Microsoft*, 860 Fed. Appx. at 713; *Intelligent*, 821 F.3d at 1369; 37 § 42.104(b)(5). The original determination should be confirmed.

2. Petitioner misrepresents PO’s position and makes unsubstantiated inferences.

Petitioner represents “PO does not contest that the nanotubes in the primary nanoparticles are discrete.” Reply, 22. False. PO argued a POSITA considering Lee as a whole would understand each thick squiggly-line in Figure 1 to represent intertwined CNTs. POR, 75, n.6. Indeed, element 3 is referred to as “carbon nanofibers”—i.e., **plural** not singular. LGES-1006 ¶[0044].

Petitioner also argues the nanotubes are incapable of “agglomerating” because “they are already bound to the non-carbonaceous material.” Reply, 22. The only “evidence” Petitioner offers in support is the unsubstantiated testimony of Dr. Zhu. LGES-1056 ¶¶39-40. Regardless, Petitioner is wrong. Figure 1 depicts the CNTs extending well beyond the individual carbonaceous particles (examples circled in orange below):

10



Petitioner fails to explain why the CNTs are unable to agglomerate given that the they *have significant portions not bound within the non-carbonaceous material*.

Indeed, agglomeration of the non-carbonaceous material 1 would necessarily draw the CNTs together, resulting in their “agglomeration.” POR, 75. Thus, the primary nanoparticles need not be “disassembled” to agglomerate (Reply, 22)—the unbound portions of CNTs still agglomerate.

3. Petitioner improperly disregards the relevance of Figure 6.

Figure 6 of Lee depicts intertwined CNTs, which appear as a thick fibrous material. POR, 73. This is consistent with a POSITA’s understanding of the thick squiggly-lines of Figure 1 representing intertwined CNTs. Petitioner contends that the figure is “unsuitable,” but tellingly *fails to provide any testimony from Dr. Zhu to support that contention*. Reply, 22. Petitioner instead resorts to mischaracterizing Dr. Chung as testifying the image is “unsuitable.” *Id.* But she merely testified that Figure 6 has low image quality—not that it prevented her from identifying intertwined CNTs. LGES-1054, 66:5-67:3.

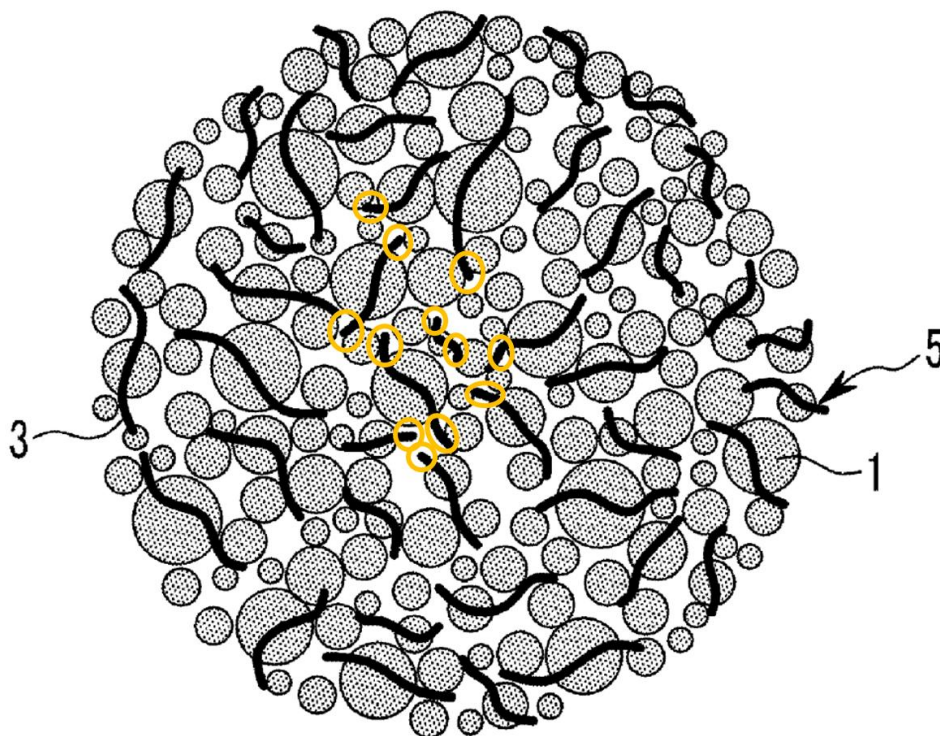
Petitioner argues the existence of bundled CNTs in Figure 6 “does not preclude” discrete CNTs. Reply, 22-23. This is irrelevant—what is relevant is what Lee *actually discloses*. Figure 6 *only shows* intertwined CNTs, consistent with the thick squiggly-lines of Figure 1 representing intertwined CNTs. The parties agree Figure 6 does not show discrete CNTs, and Petitioner cannot rely on this *absence* as somehow evidencing the *existence* of discrete CNTs.

**4. Petitioner misrepresents PO's arguments on the accuracy
Figures 1 and 3 and Lee's 5,000 aspect ratio.**

PO explained why Figures 1 and 3 are unrealistic “schematic” views. POR, 72-75. This included explaining that interpreting those figures to depict discrete CNTs is inconsistent with the higher CNT aspect ratios (e.g., 5,000) disclosed by Lee's text. POR, 74-75. Indeed, those figures cannot possibly be depicting “discrete” CNTs, because Lee teaches aspect ratios so large it would be impractical to achieve discrete CNTs in its composition. Consequently, PO did not “misrepresent” that Petitioner proposed CNTs with a 5,000 aspect ratio in Lee-Wespasnick. Reply, 24.

**5. Petitioner mischaracterizes Lee-Wespasnick's “thermal
treatment.”**

Dr. Chung explained how the CNTs would agglomerate after the mandatory thermal drying process. POR, 75 (citing MRD-2006 ¶¶185-86). Dr. Zhu offers no testimony to rebut this. Instead, Petitioner offers the attorney-argument that PO “ignores that the thermal treatment is not applied to the nanotubes alone, but to the nanotubes together with the non-carbonaceous material” and that CNTs cannot collapse “because there is no assembly of CNTs to begin with.” Reply, 25. This is contradicted by Figure 1 of Lee, which depicts (1) space between the squiggly-lines and (2) the squiggly-lines (alleged “discrete” CNTs) having significant portions **not** “bound” within the non-carbonaceous material (examples in yellow):

10

Thus, there is significant amount of space for the squiggly-lines 3 to agglomerate together when the primary particles 5 agglomerate due to thermal drying.

6. Petitioner’s oxidation argument is unsubstantiated.

The Board expressed “concerns about Petitioner’s argument that the oxidation of nanotubes can help promote non-agglomeration of the nanotubes *in the context of Lee*.” DI, 34. Petitioner failed to explain how this is so. POR, 77. Petitioner now alleges it “addressed this very question,” but merely cites back to Dr. Zhu’s declaration explaining how oxidation helps disperse prevent agglomeration *in the context of Ohata-Kavan*. Reply, 26 (citing LGES-1003 ¶163). Petitioner also argues

that “functionalized nanotubes ... as in Lee, are sterically hindered from agglomerating” and remain “as generally individually distinct nanotubes” *Id.* (citing LGES-1006 ¶[0060]). The citation does not support this, and so this is mere attorney-argument.

B. Lee-Wespanick Does Not Render Obvious the Claimed Aspect ratio.

Lee-Wespanick’s broad range (10-10,000) fails to render the claimed range (10-500) obvious given the *undisputed* major structural and behavioral differences between those ranges and the lack of an ordinary motivation to optimize the range. POR, 78-81. Petitioner has no meaningful response, so it resorts to a misstatement of the “law of overlapping ranges.”

Petitioner quotes *In re Peterson*: “A *prima facie* case of obviousness typically exists when the ranges of a claimed composition overlap the ranges disclosed in the prior art,” and **assumes** that a *prima facie* case automatically exists here because the ranges overlap. Reply, 27. Petitioner then argues, because it has allegedly established a *prima facie* case, PO must rebut it by demonstrating the claimed range “achieves unexpected results relative to the prior art range.” *Id.*

The problem is, Petitioner has not established a *prima facie* case. While “[a] *prima facie* case of obviousness **typically** exists when the ranges ... overlap,” that is not so where “the disclosed range is so broad as to encompass a very large number

of possible distinct compositions.” *Genetics*, 655 F.3d at 1306. Consistent with this precedent, PO explained why Petitioner failed to establish a *prima facie* case. POR, 78-79 (the broad range “is insufficient to show *prima facie* obviousness”).

Rather than rebut this, Petitioner misstates the law by arguing PO is required to show “unexpected results” so that it can off-handedly dismiss PO’s arguments and evidence as “generic statements” and “[g]eneric complaints.” Reply, 27-28. But PO is not required to show unexpected here because Petitioner has not made a *prima facie* showing. Given that Petitioner has offered no arguments or evidence to rebut PO’s showing of key structural and behavioral differences, Petitioner fails to make the *prima facie* showing and the burden of showing “unexpected results” has not shifted to PO.

C. Claim 6

Petitioner argues “the Petition did not assert explicit disclosure of the ***uniform distribution*** of nanotubes” Reply, 36. But Petitioner intentionally avoids addressing the fact that this claim requires more than “uniform” distribution—it requires ***at least 1 micrometer of spacing***. POR, 63-64.

Petitioner does not dispute that its invalidity theory on this requirement is premised on the “schematic” of Figure 1. Reply, 28. However, given that this figure has no scale and nothing indicates it was intended to have scale, reliance on that figure as showing this specific requirement is improper for the same reasons

discussed as to Ohata-Kavan.

Petitioner’s reliance on the vaguely-described “dispersed nature of the nanotubes” (Reply, 28) is insufficient to show—***by a preponderance of the evidence***—that Lee-Wespasnick would achieve ***the very specific level of dispersion*** required. There are varying degrees of dispersion, and this claim requires a ***very specific*** level of dispersion that can only be confirmed via experimentation (e.g., SEM analysis)—not unsubstantiated speculation. POR, 82.

Dated: August 25, 2025

Respectfully,

/Stephen Zinda/

Stephen Zinda (Reg. #67,272)
Counsel for PO

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 5,599 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 August 25, 2025, the foregoing document was served via electronic mail on the following attorneys of record at the indicated e-mail address, which Petitioner has consented to electronic service for:

Andrew Sommer (Reg. No. 53,932)
Heath J. Briggs (Reg. No. 54,919)
Julie P. Bookbinder (Reg. No. 56,940)
Trenton A. Ward (Reg. No. 59,157)
Kathryn E. Albanese (Reg. No. 78,153)
Samsung-MRD-IPRs@gtlaw.com
GREENBERG TRAURIG, LLP

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

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

/Stephen D. Zinda/

Stephen D. Zinda