

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

LG ENERGY SOLUTION, LTD.,
Petitioner,

v.

MOLECULAR REBAR DESIGN LLC,
Patent Owner.

Case IPR2024-01005
Patent 9,636,649

PETITIONER'S REPLY TO PATENT OWNER'S RESPONSE

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LIST OF EXHIBITS

- LGES-1001 U.S. Patent No. 9,636,649 (“the ’649 Patent”)
- LGES-1002 Excerpts from Prosecution History of the ’649 Patent (“the Prosecution History”)
- LGES-1003 Declaration of Dr. Samuel P. Gido
- LGES-1004 U.S. Patent Pub. No. 2010/0197832 (“Sun”)
- LGES-1005 U.S. Patent No. 7,091,120 (“Buretea”)
- LGES-1006 U.S. Patent Pub. No. 2010/0016473 (“Kaji”)
- LGES-1007 U.S. Patent Pub. No. 2010/0124713 (“Farrugia”)
- LGES-1008 U.S. Patent Pub. No. 2003/0213939 (“Narayan”)
- LGES-1009 U.S. Patent No. 5,079,123 (“Nanya”)
- LGES-1010 U.S. Patent Pub. No. 2010/0009165 (“Patel”)
- LGES-1011 U.S. Patent Pub. No. 2011/0272856 (“Rasmussen”)
- LGES-1012 U.S. Patent Pub. No. 2008/0315453 (“Molitor”)
- LGES-1013 Japanese Unexamined Patent Application No. 2009-235650 (“Matsushita”)
- LGES-1014 “Surface modified multi-walled carbon nanotubes in CNT/epoxy-composites.” Florian H. Gojny, Jacek Nastalczyk, Zbigniew Roslaniec, Karl Schulte. Chemical Physics Letters 370 (2003) 820–824 (“Gojny”)
- LGES-1015 “Sonochemical Oxidation of Multiwalled Carbon Nanotubes.” Yangchuan Xing, Liang Li, Charles C. Chusuei, and Robert V.

	Hull. Langmuir 2005, 21, 4185-4190 (“Xing”)
LGES-1016	U.S. Patent No. 7,807,127 (“Forohar”)
LGES-1017	U.S. Patent Pub. No. 2009/0168301 (“Viswanathan”)
LGES-1018	Reserved
LGES-1019	U.S. Patent Pub. No. 2010/0006152 (“Hatton”)
LGES-1020	U.S. Patent No. 9,327,054 (“Sundara”)
LGES-1021	U.S. Patent Pub. No. 2012/0058255A1 (“Gan”)
LGES-1022	U.S. Patent Pub. No. 2007/0259994 (“Tour”)
LGES-1023	Reserved
LGES-1024	EP Patent No. EP 2 139 630 (“Bergmark”)
LGES-1025	U.S. Patent No. 7,163,973 (“Ahsan”)
LGES-1026	U.S. Patent No. 7,846,998 (“Akagi”)
LGES-1027	U.S. Patent Pub. No. 2006/0014873 (“Ikezawa”)
LGES-1028	U.S. Patent Pub. No. 2011/0183253 (“Aga”)
LGES-1029	U.S. Patent No. 3,471,395 (“Sumner”)
LGES-1030	U.S. Patent No. 4,625,761 (“Uchida”)
LGES-1031	“Characterization of Zirconium Phosphate/Polycation Thin Films Grown by Sequential Adsorption Reactions” Hyuk-Nyun Kim, Steven W. Keller, Thomas E. Mallouk, Johannes Schmitt, and Gero Decher. <i>Chem. Mater.</i> , Vol. 9, No. 6, 1997
LGES-1032	“The IUPAC Rules for Naming Organic Molecules” Stanislaw Skonieczny. <i>Journal of Chemical Education</i> . Vol. 83 No. 11, pp.

	1633-1637 (2006) (“Skonieczny”)
LGES-1033	U.S. Patent No. 8,282,725 (“Shimomura”)
LGES-1034	U.S. Patent No. 6,569,231 (“Mathias”)
LGES-1035	Reserved
LGES-1036	U.S. Patent No. 7,749,682 (“Miyabe”)
LGES-1037	U.S. Patent No. 7,959,280 (“Koike”)
LGES-1038	U.S. Patent No. 6,544,326 (“Itou”)
LGES-1039	U.S. Patent No. 5,458,681 (“Hasegawa”)
LGES-1040	U.S. Patent No. 5,750,304 (“Yamaguchi”)
LGES-1041	A. Hirsch. “Functionalization of Single-Walled Carbon Nanotubes” <i>Angew. Chem. Int. Ed.</i> 2002, 41, No. 11, 1853-1859
LGES-1042	N. Canter. “Mold-release agents and coatings.” <i>Tribology & Lubrication Technology</i> 2008, 31-38 (“Canter”)
LGES-1043	J.E. Plevyak and L.A. Sobieski. “Improved RIM Processing with Silicone Internal Mold Release Technology.” <i>Journal of Cellular Plastics</i> 1984, 363-368 (“Plevyak”)
LGES-1044	Reserved
LGES-1045	B.D. Cullity. “Elements of X-Ray Diffraction.” Addison-Wesley Publishing Company, Inc. 1978. P. 86-87 (“Cullity”)
LGES-1046	U.S. Patent Pub. No. 2009/0200517 (“El Bounia”)
LGES-1047	P. C. Hiemenz, T.P. Lodge. “Polymer Chemistry, Second Edition.” CRC Press 2007. Chapters 2 and 10 (“Hiemenz”)

LGES-1048	J. Mijovic, E. M. Pearce, and C.-C. Foun. “Fluoroelastomer-Modified Thermoset Resins.” <i>Advances in Chemistry</i> ; American Chemical Society 1984, 293-307 (“Mijovic”)
LGES-1049	U.S. Patent No. 4,421,878 (“Close”)
LGES-1050	<i>Molecular Rebar Design, LLC, and Black Diamond Structures, LLC v. LG Energy Solution, Ltd.</i> , Plaintiffs’ Disclosure of Asserted Claims and Infringement, 2:24-cv-00107-JRG
LGES-1051	U.S. Patent Pub. No. 2006/0124028 (“Huang”)
LGES-1052	Reserved
LGES-1053	<i>Molecular Rebar Design, LLC, et al. v. LG Energy Solution, Ltd.</i> , Sample Docket Control Order, 2:24-cv-00107-JRG
LGES-1054	Deposition Transcript of Dr. Deborah Chung in IPR2024-01006 (’909 Patent)
LGES-1055	Deposition Transcript of Dr. Deborah Chung in IPR2024-01005 (’649 Patent)
LGES-1056	Reserved
LGES-1057	Reserved
LGES-1058	Reserved
LGES-1059	Supplemental Declaration of Dr. Samuel P. Gido
LGES-1060	Dictionary definition of “discrete,” Webster’s Dictionary (2009).
LGES-1061	U.S. Patent No. 10,153,483
LGES-1062	“Percolation and gel-like behavior of multiwalled carbon

nanotube/polypropylene composites influenced by nanotube aspect ratio.” Yongzheng Pan, Lin Li. *Polymer*, 54 (2013) 1218-1226.

(“Pan”)

LGES-1063 “Correlations between Percolation Threshold, Dispersion State, and Aspect Ratio of Carbon Nanotubes.” Jing Li, Peng-Cheng Ma, Wing Sze Chow, Chi Kai To, Ben Zhong Tang, J.-K. Kim. *Advanced Functional Materials* 2007, 17, 3207–3215. (“Li”)

LGES-1064 “The effect of the aspect ratio of carbon nanotubes on their effective reinforcement modulus in an epoxy matrix.” Alfonso Martone, Gabriella Faiella, Vincenza Antonucci, Michele Giordano, Mauro Zarrelli. *Composites Science and Technology* 71 (2011) 1117–1123. (“Martone”)

LGES-1065 “Discrete carbon nanotubes increase lead acid battery charge acceptance and performance.” Steven W. Swogger, Paul Everill, D.P. Dubey, Nanjan Sugumaran. *Journal of Power Sources* 261 (2014) 55-63. (“Swogger”)

LGES-1066 “Effects of the Dispersion State and Aspect Ratio of Carbon Nanotubes on Their Electrical Percolation Threshold in a Polymer” H.D. Bao et al., *J. of Applied Polymer Science* 128 (1), 735-740, 2013. (“Bao”)

LGES-1067 “Effect of multi-walled carbon nanotube aspect ratio on mechanical and electrical properties of epoxy-based

nanocomposites” M.R. Ayatollahi et al., Polymer Testing 30
(2011) 548–556. (“Ayatollahi”)

LGES-1068 Deposition Transcript of Dr. Deborah D. L. Chung in IPR2024-
01012 (’282 Patent)

LGES-1069 Dictionary definition of “discrete,” Merriam-Webster’s Collegiate
Dictionary, Eleventh Edition (2009).

LGES-1070 Patent Owner’s Response in IPR2024-01006 (’909 Patent)

LGES-1071 Patent Owner’s Response in IPR2024-01011 (’924 Patent)

LGES-1072 Patent Owner’s Response in IPR2024-01013 (’483 Patent)

LGES-1073-1099 Reserved

LGES-1100 Deposition exhibit

The Patent Owner Response (“POR”) fails to rebut the Petition’s showing that claims 1-23 are unpatentable over both Sun and Farrugia-Narayan. Patent Owner’s (“PO”) arguments are largely rooted in a narrow—and unsupported—construction for the term “discrete,” and when the flaws in this construction are revealed, PO’s arguments collapse. Other of PO’s arguments fail due to their lack of recognition of the full teachings of the art, or of the Petition’s application of the art to the Challenged Claims. PO’s arguments are unavailing and the Challenged Claims should be found unpatentable.

I. PO’S CLAIM CONSTRUCTION POSITION IS INCONSISTENT AND UNSUPPORTED

PO proposes that the plain and ordinary meaning of “discrete carbon nanotubes” should be “carbon nanotubes that are separate and distinct from other nanotubes; not attached to other nanotubes.” POR, 8. But as demonstrated below, PO’s proposal is flawed, unsupported, and directly contradicted, *inter alia*, by the intrinsic record, relevant dictionary definitions, and even its own infringement contentions. Once PO’s strained and unsupported construction attempt is debunked, remaining arguments, too, quickly collapse. Ultimately, because the Challenged Claims are obvious under any reasonable interpretation of “discrete

carbon nanotubes,” Petitioner maintains that no formal claim construction is necessary.¹

A. PO’s stated construction for “discrete” is inconsistent with the ’649 Patent itself and with common usage of the term in the art

The narrowness of PO’s construction is simply inconsistent with not only the ’649 Patent itself, but also with abundant extrinsic evidence indicative of common usage of the term “discrete.”

1. PO’s construction is unjustifiably narrow in view of the ’649 Patent

The ’649 Patent describes “discrete individual fibers” as “not entangled as a mass.” LGES-1001, 5:39-40. It says nothing prohibiting discrete nanotubes from being attached to one another, or from touching one another, and as such it

¹ Patent Owner and its expert, Dr. Chung, applies the same definition of “discrete” across all five pending IPR proceedings (IPR2024-01006, IPR2024-01011, IPR2024-01013, IPR2024-01005, IPR2024-01012). *See, e.g.*, LGES-1055, 118:14-24. But while PO contends that “claim construction [of discrete] is necessary” in the instant proceeding (POR, 8), it says that “no construction is required” (LGES-1070, 17; LGES-1071, 17; LGES-1072, 16) for the same term in IPR2024-01006, IPR2024-01011, and IPR2024-01013. Petitioner agrees that no formal construction is necessary.

provides no support for PO's assertion that discrete nanotubes are "not attached to other nanotubes" (POR, 8) or "not touching" one another (LGES-1055, 89:8-9).

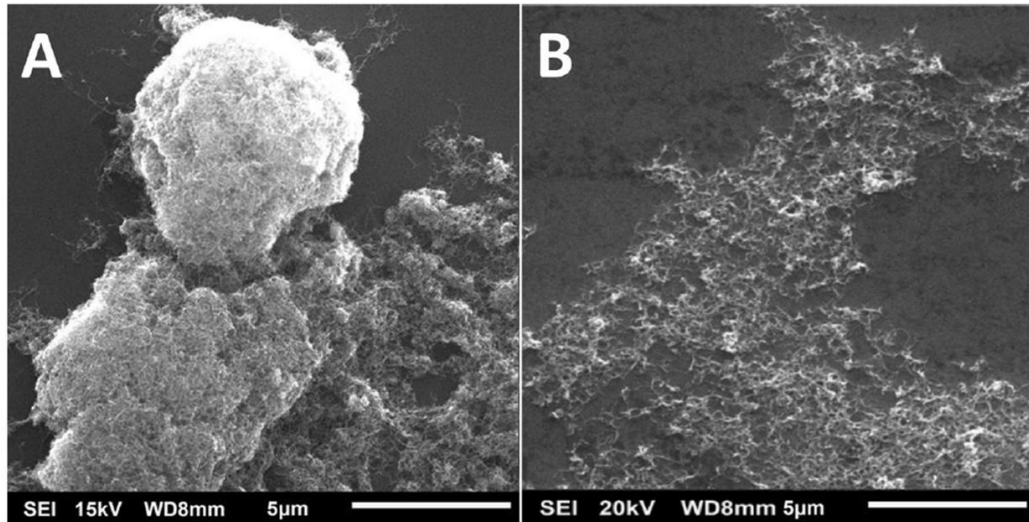
Notably, '649 Patent instructs that to the extent a dictionary is needed for claim construction, "Webster's Dictionary, 3rd Edition, 2009" should be used. LGES-1001, 5:1-3. Yet PO ignores this prescription, instead citing a *different* dictionary, Webster's New World College Dictionary, 4th Edition, 1999 (MRD-2012; see POR, 9), in an attempt to support its construction. Remarkably, this difference in dictionaries is not a meaningless one: the prescribed dictionary defines "discrete" as merely "individually distinct" (LGES-1060, 3), and does not include the "not attached to others" (MRD-2012, 4) phrase that PO was able to find only in its single dictionary from 1999. Another Webster dictionary from the prescribed 2009 time period likewise does not mention "not attached to others." LGES-1069, 3. Yet PO's expert, Dr. Chung, consulted with only the single (wrong) 1999 dictionary that PO's counsel provided her with. LGES-1068, 19:6-20:8. Patent Owner offers no other evidence to support its bold claim that "discrete" nanotubes cannot touch each other. See LGES-1068, 101:7-102:19. Thus, PO is thus unjustified in adding this non-attachment criterion into its proposed construction.

Moreover, as explained by Dr. Gido, because of the high aspect ratio of carbon nanotubes, it is simply not possible to have even a very small concentration

of nanotubes without them crossing and contacting one another. LGES-1059, ¶5-16. Yet that the '649 Patent nevertheless refers to its nanotubes as “discrete,” indicating that PO’s construction of “discrete,” that prohibits physical contact between nanotubes, is misaligned with the morphology that a POSITA would understand to be present in the '649 Patent’s compositions. *Id.*

2. PO’s construction does not comport with common usage of the term “discrete”

PO’s construction for discrete is also at odds with the usage of the term “discrete” in the art. For instance, Fig. 1A of Swogger (LGES-1065), reproduced below, illustrates “bundled carbon nanotubes,” in contrast with the “***discrete, untangled*** carbon nanotubes” of Fig. 1B. LGES-1065, 3 (emphasis added). Swogger’s description of the Fig. 1B nanotubes as “discrete” is a clear indication that the common usage of this term encompasses non-bundled nanotubes that nevertheless can still cross and contact one another. LGES-1059, ¶17.



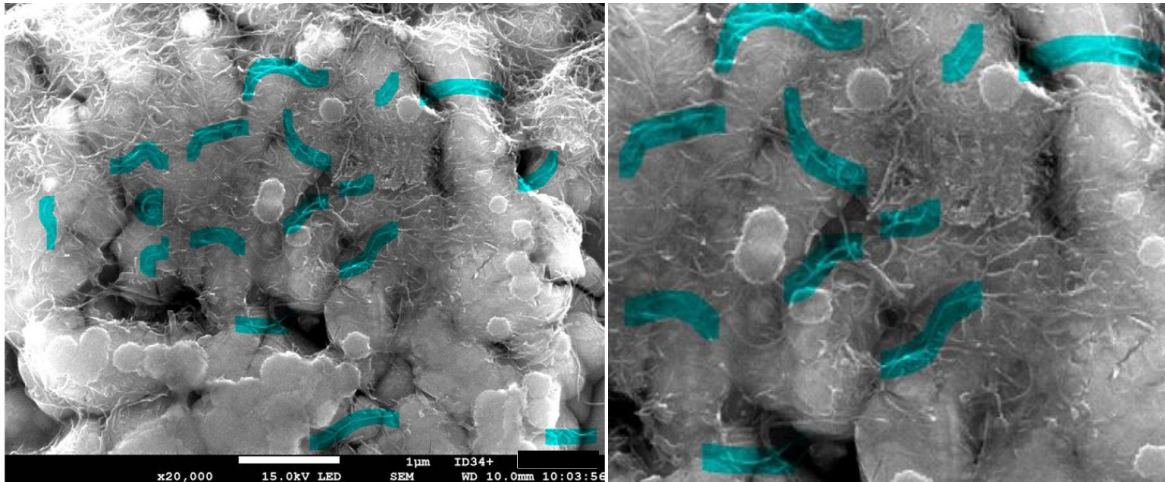
Excerpt from Swogger, Fig. 1A-1B (showing “entangled tubes” at left, “discrete, untangled carbon nanotubes” at right)

Farrugia similarly uses the term “discrete” to describe its source nanotubes. LGES-1007, [0024]. Dr. Chung confirmed that Farrugia’s starting material is in the form of a powder. See LGES-1055, 157:2-158:1. That is, Farrugia sources a powder of discrete nanotubes. It is common sense that nanotubes in a powder touch one another. PO’s assertion that no contact is permitted between discrete nanotubes is utterly inconsistent with the clear usage of the term “discrete” in Farrugia’s disclosure.

B. PO’s Construction Contradicts Its Own Positions in Co-pending Litigation

PO’s narrow construction is further undermined by its own infringement contentions, in which PO alleged that the SEM images below depict “discrete” carbon nanotubes; the alleged nanotubes they highlight clearly depict nanotubes

touching each other (original highlighting by PO). See LGES-1050, 28-42; LGES-1059, ¶18-19.



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

PO has thus acknowledged that “discrete” nanotubes need not be physically separated. LGES-1059, ¶18-19. PO cannot maintain such contradictory positions simultaneously—advocating for one interpretation here and an entirely different interpretation in district court proceedings. This contradiction alone highlights the implausibility and inconsistency of PO’s claim construction.

C. PO has not clearly articulated the bounds of its construction

At deposition, Dr. Chung provided confirmation of her position that “discreteness means *no touching*.” LGES-1055, 88:9 (emphasis added). Beyond this clarification, though, Dr. Chung presented often conflicting testimony that raises significant questions about the scope of PO’s construction.

For instance, Dr. Chung was uncertain whether electrical contact (or lack thereof) is an aspect of discreteness. She testified that nanotubes that are discrete must not be in electrical contact with one another, stating that, “[a]s long as a part of it [a nanotube] is making a contact, particularly an electrical contact, with another nanotube, then that makes this particular nanotube not discrete.” LGES-1055, 95:17-20. Yet she later reversed herself, testifying that discrete nanotubes may be in electrical contact: “it’s still discrete even though there might be an electrical effect due to the proximity” between two nanotubes. *Id.*, 124:15-16. And at still another point, she testified that electrical contact between nanotubes has no bearing on discreteness, stating that “in the plain and ordinary meaning of discreteness, it doesn’t specify whether that contact is -- the electrical contact or not an electrical contact.” *Id.*, 113:2-4.

Dr. Chung’s testimony reveals that the bounds of PO’s proposed construction of “discrete” are not well-defined and unclear even to its own expert, who was forced to provide inconsistent and nonsensical testimony in an attempt to defend the same. These ambiguities reveal a lack of clarity that is fatal to PO’s proposed construction.

D. PO's citations to Dr. Zhu's opinions are misplaced and not supported by record evidence

First, PO's reliance on Dr. Zhu's opinion in an effort to support its proposed construction for "discrete" (see POR, 9-10) is inappropriate and misplaced. For one thing, Dr. Zhu has not provided any opinion regarding the '649 Patent.

Moreover, Dr. Zhu's testimony (in that entirely different proceeding for an unrelated patent) cited by PO refers to "discrete, non-agglomerated, and exfoliated carbon nanotubes." POR, 10. The limited context supplied by PO provides no way to discern whether Dr. Zhu's opinions reflect his understanding of the meaning of the term "discrete" in a vacuum.

Furthermore, PO simply mischaracterizes the statement it quotes from Dr. Zhu's declaration. While Dr. Zhu may have agreed that a nanotube that is "fully isolated from nanotubes" can be discrete (POR, 9), this in no way constitutes an admission that a nanotube must necessarily be fully isolated to be considered discrete. As Dr. Guido aptly explains, just as a carbon nanotube is undeniably a nanotube without all nanotubes needing to be carbon nanotubes, a fully isolated nanotube can be discrete without all discrete nanotubes needing to be fully isolated. LGES-1059, ¶19.

To the extent PO intends to rely on Dr. Zhu's testimony in that entirely different proceeding to support its construction of "discrete," it is notable that the

patent at issue in that proceeding specifies that “[t]he term ‘discrete carbon nanotubes’ as used herein refers to carbon nanotubes *capable of being separated* to give individual tubes.” LGES-1061, 3:53-55.

Second, PO claims to cite to “his [Dr. Zhu’s] deposition testimony,” offering a multitude of quotes it attributes to Dr. Zhu. POR, 10-11 (citing MRD-2010). But the quotations PO reproduces (POR, 10-11) are not present in MRD-2010. And MRD-2010 is not even Dr. Zhu’s deposition testimony, as PO asserts. And The statements relied upon by PO here are not in evidence and should be disregarded.

With Patent Owner’s flawed claim construction dismantled, its remaining arguments related to “discrete” quickly collapse. Indeed, its patentability position relies on an artificially narrowed interpretation of “discrete carbon nanotube fibers,” unsupported by intrinsic or extrinsic evidence and contradicted by its own infringement position.

II. OBVIOUSNESS OVER SUN

A. Sun’s compositions encompass dispersions of discrete MWNTs

PO’s arguments that Sun does not teach dispersions of discrete MWNTs improperly ignore vast swaths of Sun’s disclosure and are detached from the reality of Sun’s experimental results. In particular, PO attempts to cast doubt on Sun’s experimental results—just one aspect of Sun’s complete disclosure—in its

attempt to call into question Sun’s robust description of dispersions of discrete MWNTs. But contrary to PO’s assertions, Sun *does* demonstrate experimental preparation of dispersions containing discrete MWNTs. And even if Sun’s experiments were determined to be unsuccessful (they are not), PO errs in ignoring the remainder of Sun’s disclosure, which explicitly describes dispersions of discrete MWNTs.

1. PO’s objections to Sun’s experimental results are semantic, not substantive

PO’s argument—that “Sun performs its experiment on SWCNTs separately from MWCNTs and gets fundamentally different results” (POR, 14)—is rooted not in the actual content of Sun’s disclosure, but instead in semantics.

Sun describes an experiment that obtained “dispersed MWNTs and fully exfoliated ZrP nanoplatelets,” and the Petition established that a POSITA would have found it obvious, from this disclosure and based on their knowledge, that this dispersion contains at least some discrete nanotubes. LGES-1004, [0068]; *see* Petition, 12-13. PO attempts to establish otherwise, by remarking that “Sun does not state that it achieved fully exfoliated MWCNTs; Sun only claims that the ***nanoplatelets*** are fully exfoliated.” POR, 22. In doing so, PO’s objection is rooted in Sun’s description of an image used to illustrate the dispersion of MWNTs created through its experiment, due to a purported failure to use magic words - the

absence of the phrase “fully exfoliated” in describing the MWNTs shown by the image.

But the issue does not turn on the presence or absence of these magic words, as PO has failed to offer evidence to substantiate its claim of “Sun admit[ting] that it was unable to achieve discrete MWCNTs.” POR, 21.

On the contrary, Sun explicitly acknowledges its success in producing dispersions of discrete MWNTs, describing that its TEM images “clearly suggest that through the aqueous dispersion, organic redispersion approach, both *MWNTs* and nanoplatelets can be fully *dispersed down to individual level* in epoxy matrices.” LGES-1004, [0069].

PO acknowledges this statement, but once again quibbles about word choice, pointing to Sun’s use of the word “suggest,” this time arguing that “Sun expressly concedes that he was unable to achieve fully exfoliated MWCNTs.” POR, 25. But PO provides no substantive reason to doubt Sun’s results, and PO otherwise offers insufficient evidence to establish that a POSITA would lack confidence in Sun’s reported data. As discussed by Dr. Gido, a POSITA would, in fact, have recognized Sun’s success. See LGES-1003, ¶¶36, 40, 57.

PO draws a similarly unsupported conclusion about Sun’s purported lack of success in generating discrete MWNTs based on Sun’s Figs. 6a and 6b TEM images of MWNT-containing nanocomposites. See POR, 25. Dr. Chung

acknowledges that these images are of such “poor quality” that “it is very difficult to discern MWCNTs,” yet nevertheless claims, incongruously, to have determined that “these images clearly do not show discrete MWNTs.” MRD-2006, ¶86; see LGES-1055, 131:13-132:6, 133:14-21. This conclusion is flawed: it is based solely on Sun’s annotations of these images rather than on their content and it directly contradicts Sun’s explanation of what is shown in these images.

Specifically, PO states that “Sun only has ‘arrows indicating exfoliated ZrP nanoplatelets’ in FIGs. 6a and 6b, and no arrows calling out CNTs at all,” and relies on the lack of an arrow indicating nanotubes to conclude that Sun failed to create a dispersion of discrete MWNTs. POR, 25. But the mere absence of an arrow pointing to CNTs is not evidence sufficient to demonstrate that discrete nanotubes are absent. And it is certainly insufficient to justify contradicting Sun’s explicit teaching that these TEM images demonstrate success in producing MWNTs “dispersed down to *individual level*.” LGES-1004, [0069].²

² Notably, in her related deposition for U.S. Patent 8,808,909, Dr. Chung similarly indicated that when faced with a low-quality microscopy image, “I have to believe what the inventor says.” LGES-1054, 25:20-26:6. Yet conveniently, in analyzing Figs. 6a-6b of Sun, she chooses instead to not believe Sun’s unequivocal statement about the presence of individual nanotubes.

2. PO fails to engage with Sun's general disclosure of dispersions of MWNTs

PO's argument that "a POSITA would understand that Sun's 'conceptual scheme' in FIG. 1 is a teaching applicable to SWCNTs, but is *not* a teaching applicable to MWCNTs" (POR, 26) is unjustified both due to its reliance on the above-noted mischaracterization of Sun's experimental results as well as because it ignores other aspects of Sun's disclosure.

First, PO bases its characterization of Fig. 1 as allegedly limited only to SWNTs on "these [experimental] results (success with SWCNTs and failure with MWCNTs)." POR, 26. But as already established, this is simply wrong: Sun's experimental results do not indicate "failure with MWCNTs" (*id.*), as PO asserts. PO's conclusion that Fig. 1 is "only applicable to SWCNTs" (POR, 27) is thus based on flawed facts.

But even setting aside the question of Sun's experimental success, PO's attempt to frame Sun's Fig. 1 as "only applicable to SWCNTs" (POR, 27) is fundamentally inconsistent with Sun's unambiguous statement that "the carbon nanotubes comprise single walled carbon nanotubes (SWNTs) or multi-walled carbon nanotubes (MWNTs)." LGES-1004, [0038]. Whether or not Sun succeeded in generating dispersions of discrete MWNTs, there is no legal basis for ignoring this explicit disclosure indicating the applicability of Fig. 1 to MWNTs.

See In re Snow, 471 F.2d 1400, 1403 (Ct. Cust. & Pat. App. 1973) (“All the disclosure in a reference, ***not just the specific examples***, must be evaluated for what it fairly teaches those of ordinary skill in the art.”) (emphasis added); *In re Boe*, 355 F.2d 961, 964 (Ct. Cust. & Pat. App. 1966) (“All of the disclosure in a reference must be evaluated for what they fairly teach one of ordinary skill in the art.”). That is, Sun’s disclosure encompasses not only experimentally produced dispersions of MWNTs, but also abundant description of these compositions that render the claims obvious even in the absence of the experimental results. PO’s discounting of Sun’s description of MWNTs is legally improper.

3. PO’s mechanistic surface area explanation for Sun’s purported inability to create discrete MWNTs is untenable

Regarding Sun’s alleged failure to achieve discrete MWNTs, PO states that “a POSITA would not be surprised that a procedure leveraging specific surface area, such as one counting on the mechanical forces of nanoplatelets attached to the outside surface of CNTs for disentangling the CNTs, would not be as successful with CNTs having low specific surface area (MWCNTs) as it might be for CNTs having high specific surface area (SWCNTs).” (POR, 27). But this is simply backwards: high specific surface area materials are in fact often more difficult to disperse than lower surface area materials, due at least in part to stronger interactions (*e.g.*, increased van der Waals forces between high specific

surface area CNTs) which promote aggregation or bundling of the CNTs. LGES-1059, ¶20.

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

PO's argument that "Petitioner cannot rely on Sun's incredibly broad aspect ratio range to render the Challenged Claims as obvious" (POR, 28) explicitly ignores the Board's Institution Decision and fails to establish that there is any meaningful difference between nanotubes having an aspect ratio in the claimed 25-500 range and Sun's nanotubes, which have an aspect ratio of "at least about 10" or "at least about 20." LGES-1004, [0038].

As the Board has already noted, the law of overlapping ranges is clear. "A *prima facie* case of obviousness typically exists when the ranges of a claimed composition overlap the ranges disclosed in the prior art." *In re Peterson*, 315 F.3d 1325, 1329 (Fed. Cir. 2003); *see also* Pap. 9 at 26-27. This is the case here: the claimed 25-500 aspect ratio range overlaps Sun's "at least about 10" and "at least about 20" ranges. Indeed, that the claimed range falls completely within both of these ranges, making the obviousness of the claimed range even more compelling. *See Peterson*, 315 F.3d at 1330 ("In fact, when, as here, the claimed ranges are completely encompassed by the prior art, the conclusion is even more compelling than in cases of mere overlap").

The *prima facie* obviousness of an overlapping range can be rebutted: “the applicant must show that the particular range is critical, generally by showing that the claimed range achieves unexpected results relative to the prior art range.” *In re Woodruff*, 919 F.2d 1575, 1578 (Fed. Cir. 1990). But PO has not done this. Instead, PO has merely offered generic statements alleging “differences relating to the structure and/or behavior of the oxidized CNTs of Sun versus the oxidized CNTs in the claimed invention” (POR, 31), without providing any evidence that these effects (to the extent they exist at all) are specific to the particular claimed range.

PO’s arguments that “due to the numerous significant differences in the structure and behavior ..., there is no motivation for a POSITA to try to optimize to find a narrower aspect ratio within Sun’s remarkably broad range” (POR, 34) are similarly deficient. Generic complaints about the breadth of Sun’s range is not factual evidence of unexpected results that would justify patentability of the claimed range. *See In re Geisler*, 116 F.3d 1465, 1470 (Fed. Cir. 1997) (“Only if the ‘results of optimizing a variable’ are ‘unexpectedly good’ can a patent be obtained for the claimed critical range ... Furthermore, it is well settled that unexpected results ***must be established by factual evidence***” (citing *In re Antonie*, 559 F.2d 618, 620, 195 USPQ 6, 8 (CCPA 1977)) (emphasis added)). PO has

provided no such demonstration of criticality, nor provided any evidence tied to the claimed range. As such, PO's arguments are insufficient.

Moreover, PO's assertions that "[h]aving to test over potentially thousands of different aspect ratios where structure and behavior of the MWCNTs vary widely ... is undue experimentation" (POR, 39) is inconsistent with the reality of nanotube experimentation. For instance, as Dr. Gido explains (and as Dr. Chung agreed when questioned at deposition), no sample of carbon nanotubes is monodisperse in aspect ratio, and as such, testing the structure and behavior of nanotubes for each integer value aspect ratio—as PO proposes would be necessary—is unrealistic and nonviable. LGES-1059, ¶24-36; LGES-1055, 155:19-156:2.

C. Sun is an enabling disclosure

As an initial matter, PO is incorrect in its assertion that Sun presents "failed results with MWCNTs," and thus its assumption that "further testing and alterations to Sun's disclosed methods" would be necessary "in order to actually achieve a dispersion of discrete, MWCNTs." POR, 35. That is, Sun conducted successful results achieving dispersion of MWNTs "down to individual level." LGES-1004, [0069]. As such, Sun is unequivocally enabled.

But even if Sun were understood not to have actually produced dispersions of discrete MWNTs (which it does), that lack of experimental results does not render Sun a non-enabling disclosure.

Importantly, experimental demonstration of a result is not a necessary requirement for a disclosure to be enabling. Prior art is presumed to be enabling absent a compelling reason otherwise, which PO has not provided. *See In re Sasse*, 629 F.2d 675, 681 (C.C.P.A. 1980). Here, beyond its experiments, Sun provides both a general process description (*see* LGES-1004, [0042]-[0052]) as well as a detailed discussion of the mechanism by which the MWNTs are rendered discrete in its dispersions (*e.g.*, by interaction with nanoplatelets; *see id.*, [0044]). These disclosures—which together provide a roadmap toward both making a dispersion of MWNTs and understanding the physics of that dispersion—should not be discounted even if an experimental sample was not generated. And with these disclosures properly taken into account, Sun does, in fact, provide sufficient detail to inform a POSITA regarding MWNT dispersions.

PO appears to demand that Sun disclose “what alterations would need to be made to achieve the same SWCNT result with the fundamentally different MWCNTs,” complaining that Sun’s disclosed methods are “unspecific.” POR, 35, 37. First, this is not the correct standard. *See In re Sasse*, 629 F.2d at 681. And second, this is simply not an accurate characterization of Sun’s disclosure. Sun

provides a detailed experimental protocol for creation of dispersions of MWNTs. See LGES-1004, [0054]-[0058]. To the extent that slight adjustments to the process may improve nanotube dispersion, this would have been well within the skill of a POSITA. LGES-1059, ¶21-23.

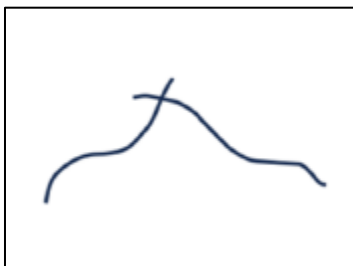
D. Dependent claim 2 is obvious over Sun

PO's sole argument is that "Petitioner's assertion ... is not based on any actual technical analysis or data." POR, 41. However, PO fails to engage with the substantive points raised in the Petition, let alone offer any meaningful rebuttal. Notably, PO has *no response* to Petitioner's design choice argument, which is not "pure speculation," as PO contends (POR, 41), but instead a fully supported legal argument demonstrating obviousness of claim 2.

E. Dependent claim 3 is obvious over Sun

PO's argument against the Petition's showing of the obviousness of claim 3 (see POR, 41) is based on a flawed understanding of Sun's microscope images. PO argues that Fig. 6b of Sun "shows MWCNTs entangled with each other" and thus "not able to 'flow freely relative to another nanotube in the dispersion.'" POR, 42-43. However, in a two-dimensional projection of a three-dimensional sample, such as the microscope image of Sun's Fig. 6b, nanotubes that appear to cross in 2-D may, in fact, be present on entirely different planes and thus not in contact at all.

PO's own expert concedes the commonsense principle that the discreteness of nanotubes cannot be determined from a two-dimensional projection. Indeed, when Dr. Chung was asked at deposition and whether the carbon nanotubes in the below schematic are discrete, she responded that "[t]here's a third dimension that's not shown, you know. If you just look at two-dimensional view, it looks like that they are in physical contact. But if one looks at the third dimension as well, they might not be." LGES-1055, 127:22-128:1.



LGES-1100, 2

PO's error is fundamental, and when PO's basis for relying on Sun's Fig. 6b is refuted, PO is left with no substantive argument to counter the Petition's showing that Sun's nanotubes are free-flowing.

F. Dependent claims 6 and 7 are obvious over Sun

PO argues that Sun's aqueous dispersion with a nanotube concentration of "at least 1 wt%...essentially...teaches 99% of all physically possible weight percentages." POR, 43. However, PO provides no indication that there is anything critical about its claimed range of weight percentages, nor that its claimed range

provides any unexpected results. *See Peterson*, 315 F.3d at 1329-1330; *Woodruff*, 919 F.2d at 1578. As such, PO has failed to rebut the Petition's *prima facie* showing of obviousness.

Regarding Sun's epoxy nanocomposite, PO's statement that "[t]he only concrete weight percentages for MWCNTS actually given by Sun are the 'final MWNT concentration of 0.2 and 0.4 wt% in epoxy nanocomposites'" is wrong. *See* POR, 43. Sun provides multiple ranges of weight percentages: a general disclosure of "concentration of nanotubes in the epoxy is between about 0.01 wt% and 50 wt%" as a suitable range of weight percentages, as well as specific values of "0.2 and 0.4 wt%" for its experiments. LGES-1004 [0045], [0058]. PO focuses only on the latter, arguing that there are structural and behavioral differences that exist between the claimed weight percentages and Sun's 0.2 and 0.4 wt% values. *See* POR, 43–44. Even if these structural and behavioral differences exist (which Petitioner does not necessarily concede), PO utterly neglects to address Sun's disclosure of the 0.01-50 wt% range. That is, Sun clearly contemplates nanotubes present in a weight percentage range spanning the full extent of these purported structural and behavioral issues, indicating suitability of Sun's composition over that *entire* range, contrary to PO's assertions otherwise.

III. OBVIOUSNESS OVER FARRUGIA-NARAYAN

A. The Farrugia-Narayan compositions encompass dispersions of discrete MWNTs

PO's arguments center on Farrugia-Narayan's purported lack of discrete CNTs because of Farrugia's desire for "improved conductivity." POR, 51. This argument lacks merit. But importantly, this argument pertains only to the nanotube/polymer composite and the toner of the Farrugia-Narayan combination; it is entirely inapplicable to the unpolymerized mixture of CNTs and monomer. And PO provides no other arguments that are pertinent to this unpolymerized mixture. To prevail in its allegation that the nanotubes in the Farrugia-Narayan combination are not discrete, PO would have had to demonstrate absence of discrete CNTs not only in the toner, but also in the unpolymerized mixture and the CNT/polymer composite. It has done none of these.

1. PO did not contest that the Farrugia-Narayan unpolymerized mixture contains discrete nanotubes

The Petition demonstrated that "the *unpolymerized mixture* that is cured to form the nanotube/polymer composite is a dispersion" containing discrete nanotubes. Petition, 52, 55 (emphasis added). PO's argument that "the CNTs would not be discrete *in the final composition* because the goal of Farrugia-Narayan is to form a continuous network of interconnected CNTs to provide improved conductivity" (POR, 50-51) is not applicable to the unpolymerized mixture. That is, while Farrugia describes the relevance of improved electrical

conductivity in its nanotube/polymer composite and in its toner, it expresses no such preference for the unpolymerized mixture. Thus, PO's arguments regarding improved conductivity have no bearing on the Farrugia-Narayan unpolymerized mixture, and are insufficient to rebut the Petition's demonstration of discrete nanotubes in this unpolymerized mixture.

Any subsequent arguments PO attempts to present to rebut the Petition's showing that the unpolymerized mixture contains discrete CNTs will be untimely. *See* 37 C.F.R. § 42.23(b) ("A sur-reply may only respond to arguments raised in the corresponding reply"); *Google LLC v. Uniloc 2017 LLC*, Case IPR2020-00447, Paper 24 at 14 (PTAB May 11, 2021).

2. PO's arguments against discrete nanotubes in the Farrugia-Narayan composite and toner are based on its faulty claim construction

PO's argument regarding the purported lack of discrete nanotubes in the Farrugia-Narayan nanotube/polymer composite and toner (*see* POR, 47-51) is unsustainable because of its reliance on an overly restrictive construction for "discrete." The term "discrete" does not preclude a network of nanotubes, *e.g.*, in point-to-point contact, to provide a conductive pathway through the electrode material, as PO itself acknowledges is the case in the Farrugia-Narayan composition. *See* POR, 50-51; LGES-1007, [0018]. PO's citation to Gan in an attempt to corroborate that "functionalization would lead to an increase in the

interconnectivity” (POR, 50) falls flat because Gan’s composition is different from the Farrugia-Narayan composition, and because it incorrectly assumes that an electrically conductive network of nanotubes is inconsistent with the presence of “discrete” nanotubes.

Notably, PO has provided no credible explanation for why, when starting with “discrete nanotubes” (LGES-1007, [0024]), the nanotubes would no longer be discrete in the interim composite or in the final toner, instead grounding its arguments fully within its overly narrow claim construction to assert, wrongly, that satisfaction of Farrugia’s objective of “increasing electrical conductivity” (POR, 48) is necessarily incompatible with the presence of discrete nanotubes.

B. Farrugia is an enabling disclosure

Farrugia starts with discrete nanotubes. *See* LGES-1007, [0024]; POR, 52. PO’s enablement argument appears to be that Farrugia does not teach how to “maintain[] that discreteness” when the nanotubes are incorporated into a toner. POR, 52. But neither does Farrugia describe any process steps that demand formation of bundles of entangled nanotubes, as PO appears to believe. *See id.* The heart of PO’s argument remains its mistaken assumption that discrete nanotubes in the Farrugia-Narayan toner “would be directly counter to their explicitly stated purpose, which is to enhance conductivity through percolation.”

POR, 52. But as established *supra*, the presence of a percolated network of nanotubes does not imply absence of discrete nanotubes.

Prior art is presumed to be enabling absent a compelling reason otherwise, which PO has not provided. *See In re Sasse*, 629 F.2d 675, 681 (C.C.P.A. 1980). Moreover, in obviousness, “a reference need not be enabled; it qualifies as a prior art, regardless, for whatever is disclosed therein.” *Amgen Inc. v. Hoechst Marion Roussel, Inc.*, 314 F.3d 1313, 1357 (Fed. Cir. 2003); *Canon Inc. et al. v. HS Asset and Technology, LLC*, IPR2018-00499, Paper 19 at 27-28 (July 23, 2019) (citing *Symbol Techs., Inc. v. Opticon, Inc.*, 935 F.2d 1569, 1578 (Fed. Cir. 1991) (“obviousness references do not need to be enabling”)). PO’s attempt to cast doubt on Farrugia’s enablement of discrete nanotubes should be rejected: Farrugia can be relied upon for its undisputed disclosure of discrete nanotubes as a starting material.

Importantly, this argument pertains only to the toner, which is the composition fabricated through Farrugia’s “emulsion/aggregation process.” POR, 52. PO presents ***no challenge*** to Farrugia’s enablement with respect to the unpolymerized mixture or the nanotube/polymer composite, both of which the Petition alternatively identified as dispersions. *See* Petition, 52-53. That is, PO has not argued against viability of the unpolymerized mixture and the nanotube-polymer composite dispersions containing discrete nanotubes.

C. Farrugia and Narayan do not teach away from the claimed range of aspect ratios

PO's argument that "Farrugia explicitly teaches away from using small aspect ratios" (POR, 55) mischaracterizes Farrugia (and ignores that the Board already explicitly rejected this argument, *see* Institution Decision, 26-27). Farrugia does not state that "large aspect ratios are better," as PO contends (*id.*, 54), and certainly does not teach that the 25-500 range is "sub-optimal." *Id.*, 55. Instead, Farrugia simply indicates that nanotubes are desirable because of their large aspect ratio. *See* LGES-1007, [0018]. That is, all carbon nanotubes have a large aspect ratio simply by virtue of the fact that they are nanotubes, as confirmed by Dr. Chung. *See* LGES-1055, 47:5-6 ("Compared to short carbon fiber, the carbon nanotube tends to have larger aspect ratio").

It is in this context—Farrugia's desire for nanotubes—that a POSITA would have looked to Narayan for suitable aspect ratios to achieve objectives expressed by Farrugia. *See* Petition, 48-50.

As to Narayan, PO again ignores the Institution Decision, repeating its argument that Narayan's most preferred embodiment is outside of the claimed range. *See* POR, 55. But even disclosure of a less preferred embodiment is sufficient. *See Merck & Co. v. Biocraft Lab'ys, Inc.*, 874 F.2d 804, 807 (Fed. Cir. 1989). It is improper to ignore Narayan's explicit disclosure of aspect ratio ranges

of “greater than or equal to about 5,” “greater than or equal to about 10,” and “greater than or equal to about 100” (LGES-1008, [0014]; *see* Petition, 48) for the sole reason that a different range is deemed to be preferred.

D. Dependent claim 2 is obvious over Farrugia-Narayan

PO’s argument that 70% of the nanotubes being discrete “would be detrimental to ... [the] intended results” of Farrugia and Narayan (POR, 58) suffers from the same flaw that infects the majority of PO’s arguments against this ground: it relies on unjustifiably narrow construction for discrete. As established *supra*, there is no inconsistency between discrete nanotubes and a conductive network of nanotubes. PO provides no substantive rebuttal to the Petition’s demonstration that substantially all of the nanotubes in the Farrugia-Narayan dispersions are discrete, nor to the Petition’s alternative showing that such a level of discreteness would have been mere design choice. *See* Petition, 63-64.

Moreover, PO’s argument that nanotubes in a network are not discrete does not implicate the Farrugia-Narayan unpolymerized mixture, and thus the obviousness of claim 2 in view of the Farrugia-Narayan unpolymerized mixture still stands.

E. Dependent claim 3 is obvious over Farrugia-Narayan

PO’s argument that the nanotubes “would not be discrete after (1) the emulsion/aggregation process; and (2) the coagulation of the emulsion

aggregation” (POR, 59-60)—once again repeats its earlier mistake of addressing only the Farrugia-Narayan toner, neglecting the unpolymerized mixture and the nanotube/polymer composite, also identified as dispersions. PO has presented ***no argument*** against the presence of free flowing particles in, *e.g.*, the Farrugia-Narayan unpolymerized mixture. Regardless of the viability of PO’s argument, the Petition’s challenge to claim 3 stands unrebutted.

IV. CONCLUSION

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

Respectfully submitted,

Date: July 14, 2025

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CERTIFICATION UNDER 37 CFR § 42.24(d)

Under the provisions of 37 CFR § 42.24(d), the undersigned hereby certifies that the word count for the foregoing Petitioners' Reply to Patent Owner's Response totals 5,567, which is less than the 5,600 allowed under 37 CFR § 42.24.

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CERTIFICATE OF SERVICE

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

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