In the Matter Of:

LG ENERGY vs MOLECULAR REBAR

IPR2024-01013

YU ZHU PHD

August 11, 2025

MRD EX. 2043
LGES v MRD
IPR2024-01011

J13276853 eb

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Case IPR2024-01013
U.S. Patent 10,153,483

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

VS.

MOLECULAR REBAR DESIGN, LLC,
Patent Owner

VIDEOCONFERENCED DEPOSITION OF YU ZHU, PhD

Date Edith A. Boggs, CSR

8-11-2025 HOUSTON, TEXAS

DEPOSITION OF YU ZHU, PhD

DEPOSITION AND ANSWERS of YU ZHU, PhD, taken before Edith A. Boggs, a certified shorthand reporter in Harris County for the State of Texas, taken via videoconference with the witness appearing from Akron, Ohio, on the 11th day of August, 2025, between the hours of 9:01 a.m. and 9:38 a.m.

A P P E A R A N C E S

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REPORTED REMOTELY BY:

Ms. Edith A. Boggs

EXAMINATION INDEX

QUESTIONS BY PAGE

Mr. Zinda 5

INDEX OF EXHIBITS

NO. MARKED DESCRIPTION

None

YU ZHU, PhD

was called as a witness and, being first duly sworn by the notary, testified as follows:

EXAMINATION

Q. (BY MR. ZINDA) Good morning, Dr. Zhu. How are you doing?

A. Very good. Good morning, Stephen.

Q. It's good to see you again. And I know, obviously, you've been deposed multiple times in these proceedings alone, but I just want to go over some ground rules again just to refresh your memory. We may not need to do that for the other depositions this week, but if you don't understand a question, could you please let me know?

A. Yes.

Q. And if you don't tell me that you misunderstand or need clarification, I'm going to understand that you understood the question. Does that make sense?

A. Yes.

Q. And, of course, your counsel may object to certain questions I've asked, but you have to answer unless they object on the basis of privilege. Do you understand that?

A. Yes, I understand.

Q. And, of course, we'll take breaks. Just

whenever you think you need to take a break, let me know. All I ask is that you don't ask for a break in the middle of a question, while there's a question pending. Does that make sense?

A. Yes, that does make sense.

Q. Do you have any documents with you?

A. Yeah, I have my declaration with me.

Q. And is that -- well, let me break it up.

Do you have any physical documents with you?

A. Yes.

Q. Do they have any markings or any notes on them?

A. No. It's just the printed declaration documents.

Q. And do you have any other -- other than your declaration, do you have any other physical documents with you?

A. No.

Q. Okay. And if you need, I can also upload exhibits to the chat room if we need to, but I'm assuming you probably have those available as well.

A. Yes.

Q. Okay. So, Dr. Zhu, can I get you to turn to your declaration, which is LGES 1056. And if it's hard to hear me, I've got a bad case of --

A. Stephen, I just want to make sure, I have two declarations, so which one you are referring to?

Q. Sure. It should be LGES 1056, which is titled Supplemental Declaration of Dr. Yu Zhu.

A. Okay. That's the second one. Yes.

Q. And if I could get you to go to Page 5. It's the bottom -- there's two different page numbers on these documents. I'm talking about --

A. Yeah, there's two different pages. Okay.

Q. Page 5 should have an image of LGES 1003, Page 50.

A. Uh-huh.

Q. And that appears to be an image of Figure 1B from Ohata; is that correct?

A. Yes. That's correct.

Q. Okay. And in this figure, you've added a red arrow. Do you see that red arrow?

A. Yes.

Q. And that red arrow is pointing -- would you agree that that red arrow is pointing to a fully isolated carbon nanotube?

MR. IN: Objection, form.

A. Yeah, that one I have already noted on my declaration. It's a discrete, nonagglomerated and exfoliated carbon nanotube.

Q. (BY MR. ZINDA) Okay. But would you agree with me that the carbon nanotube that that arrow is pointing to is a fully isolated carbon nanotube?

MR. IN: Same objection.

A. Yeah, as I said, it's a discrete, nonagglomerated and exfoliated carbon nanotube. I didn't say the word of isolated.

Q. (BY MR. ZINDA) You've never described that nanotube that you've identified with the red arrow as fully isolated?

MR. IN: Objection, form.

A. I said exfoliated.

Q. (BY MR. ZINDA) So -- well, let me ask you this question: Is the carbon nanotube that you've identified with the red arrow, is that a fully isolated carbon nanotube?

A. Well, I already answered your question. I said it is discrete, nonagglomerated and exfoliated carbon nanotubes, and this is one example of that carbon nanotube. I did not make any other description on that.

Q. Dr. Zhu, I'm going to ask you again. Is the carbon nanotube that you've identified with the red arrow a fully isolated carbon nanotube?

MR. IN: Objection, form.

A. Yeah, as I just answered, what I said here is a

discrete, nonagglomerated and exfoliated carbon nanotube.

Q. (BY MR. ZINDA) I'm going to ask you again, Dr. Zhu. I'm not asking you what you said in your declaration right here. I'm asking you can you tell me whether or not the carbon nanotube that you've identified with the red arrow is a fully isolated carbon nanotube?

MR. IN: Objection, form.

A. Yeah, that's -- I just answered you a couple of times. When I describe that nanotube, I use a red arrow to point out it's discrete, nonagglomerated and exfoliated carbon nanotube, with no other additional description except that.

Q. (BY MR. ZINDA) Do you know one way or the other whether or not that carbon nanotube identified by the red arrow is fully isolated?

A. Yeah, I said it's exfoliated and nonagglomerated and discrete, yeah.

Q. But I'm not asking you about that, Dr. Zhu. You're simply not answering my question. I'm asking you a simple yes or no question.

You've been retained as an expert, correct?

A. Yes, I'm an expert. So that's why I use expert language to describe the situation I have described in

my declaration. So that is already written very clearly on my description, and this is stated as a discrete, nonagglomerated and exfoliated carbon nanotube, which is pointed out by that red arrow from that LGES 1003, 50. So that's my expert comment on what is the status of that nanotube.

Q. But can you tell me whether or not the nanotube identified with the red arrow is a fully isolated nanotube?

MR. IN: Objection, form.

A. I think this nanotube is described as discrete and nonagglomerated and exfoliated carbon nanotube, and that is the most accurate description based on my expert view.

MR. ZINDA: All right. I'm going to move to strike as nonresponsive.

Q. (BY MR. ZINDA) It's clear that you're just not going to answer the question, Dr. Zhu, but I'll ask you one more time, though.

Have you ever described that nanotube with the red arrow pointing to it as a fully isolated carbon nanotube?

A. I think I answered this question for multiple times, and this a discrete and nonagglomerated and exfoliated carbon nanotube based on my expert view on

this content.

Q. What is a fully isolated carbon nanotube?

A. The fully isolated carbon nanotube is like one of the examples showing on that image, which means that the nanotube is not forming any bundles or as many as the carbon nanotubes.

Q. So does a fully isolated carbon nanotube have to be separate from other nanotubes?

MR. IN: Objection, form.

A. This doesn't mean that it was completely separated and not in contact with any other carbon nanotube, but they are exfoliated and they are separated largely.

Q. (BY MR. ZINDA) So it's your testimony that a fully isolated carbon nanotube can be attached to another nanotube?

A. A fully isolated nanotube is a -- it's a status of the nanotube when it was compared with bundled and agglomerated nanotubes. So it has largely separated from other nanotubes.

Q. Can I get you, Dr. Zhu, to pull out LGES 1004, which is the Ohata reference.

A. Okay. Give me a second.

Okay. Yeah, I opened LGES 1004.

Q. And then if I could get you to turn to

Figure 1.

A. Yes.

Q. Okay. So we'll look at Figure 1. Figure 1B, you've testified that Figure 1B depicts discrete carbon nanotubes, correct?

A. Figure 1B is -- yeah.

Q. But you would agree with me that Figure 1A does not depict discrete carbon nanotubes, correct?

A. Figure 1A is an entangled carbon nanotube.

Q. Right. But does Figure 1A depict discrete carbon nanotubes?

A. It's not a discrete carbon nanotube. Figure 1A is not a discrete carbon nanotube.

Q. And would you agree with me that the nanotubes in Figure 1A are capable of being separated to give individual tubes?

A. As I just said, Figure 1A is entangled. Entangled means nanotube are actually woven together and they have many contact. They are typically not regarded as exfoliated carbon nanotube.

Q. Right. I understand that. But are the nanotubes in Figure 1A capable of being separated to give individual tubes?

MR. IN: Objection, form.

A. The status showing in Figure 1A are nanotubes

that are entangled. They are not separated from each another.

Q. (BY MR. ZINDA) But are they capable of being separated from each other?

MR. IN: Objection, form.

A. Well, when you say they are capable or not separated each other, I think this is depending on how you treat other nanotubes and how the nanotube was processed. So there is no definite answer about whether entangled nanotube are capable to be separated. It depends on many things, like what is preparation procedure to separate those nanotubes. So --

Q. (BY MR. ZINDA) Right. But if you apply the -- if you apply the appropriate process, isn't it true that any carbon nanotube is capable of being separated from another carbon nanotube?

MR. IN: Objection, form.

A. The carbon nanotube -- or the entangled carbon nanotube in Figure 1A, if it was under right procedure, there is always a potential to be separated.

Q. (BY MR. ZINDA) Right. In other words, if you apply the appropriate process, entangled carbon nanotubes are capable of being separated to give individual nanotubes, correct?

MR. IN: Objection, mischaracterizes.

A. It depends on the conditions. So there's usually no universal answer for such a status. So this is depending on, as I said, the processing technique used and initial stages of the entanglement and you possibly can achieve a separated status, you possibly cannot achieve a separated status. So that condition is complicated.

Q. (BY MR. ZINDA) Have you ever heard of a concept known as electron tunneling?

A. Yes.

Q. What is electron tunneling, in your opinion?

A. Electron tunneling is a microscopic phenomenon and, typically, the electron can transport from one place to another place to create empty spaces. A lot of times it's vacuum and without any conducting materials between them.

Q. Have you ever heard of a concept known as the percolation threshold?

A. Yes.

Q. What is --

A. I've heard.

Q. What is your understanding of the percolation threshold?

A. The percolation threshold is basically a volume percentage of a feeler in a composite system, and when

1 those feeler volume percentage reach a specific volume
2 out of the total volume of the composite and the feeler
3 can form a connected network, and that threshold was
4 typically called a percolation threshold.
5 Q. Can active material have a high electrical
6 conductivity?
7 MR. IN: Objection, form.
8 A. Can you repeat the question? I didn't hear.
9 Q. (BY MR. ZINDA) Can active material have high
10 electrical conductivity?
11 MR. IN: Same objection.
12 A. So are you referring to active material used in
13 the lithium-ion battery?
14 Q. (BY MR. ZINDA) Correct.
15 A. So the intrinsic conductivity of acting
16 materials in the lithium-ion battery, depending on what
17 electrode you are referring to, some of them have good
18 intrinsic conductivity, for example, the graphite
19 materials, and some materials does not have good
20 intrinsic electronic conductivity, such as some oxide
21 materials. So this question is -- it's depending on
22 which exactly electrode you are referring to.
23 Q. Okay. What is a scanning electron microscope
24 image?
25 A. A scanning electron microscope image is

basically a scanning microscopic technique, and this is the image formed by electrons and samples under generally a vacuum condition and the electrons which was bounced back and was collected by the detector, and the detector will generate an image of the surface of the sum typically.

Q. And an SEM image, that is a two-dimensional projection of a three-dimensional sample, correct?

A. That is actually exploring the surface of the sample. So you've got the surface, which is the sample. It's not necessary to be exactly on the same plane, but it's on the surface of the sample.

Q. Right. But would nanotubes -- would you agree that nanotubes that appear to cross in an SEM image may, in fact, be present on an entirely different plane and, thus, not in contact at all?

A. Well, for SEM, that's -- it's possible, but usually it's not true because SEM may explore the surface of your sample. So they are exploring the surface information of your nanometers, which is pretty much in a similar range of the carbon nanotube diameter. So if you see the cross of a nanotube on the SEM image, usually it's an indication there are physical contact between those carbon nanotubes, yeah.

Q. But it's also possible that the carbon

nanotubes that appear to cross may be at different depths in the image, correct?

A. Well, that -- that part would be difficult to achieve because the materials that you observed under SEM has a different capability to allow the electron to explore the depths of the surface. So usually it's not that high as compared with the diameter of the nanotube. So I would regard for majority of the SEM pictures, if there is a cross between carbon nanotube, there is likely a contact between those tubes.

MR. ZINDA: I have no further questions. I'll pass the witness.

MR. IN: Could we take a ten-minute -- sorry -- 15-minute break? Would that be okay?

MR. ZINDA: That's fine with me.

(Short recess.)

MR. IN: No further questions from petitioner. Thank you.

(Whereupon at 9:38 a.m. the deposition was concluded.)

ERRATA SHEET

Correction	Page	Line

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I, YU ZHU, PhD, have read the foregoing deposition and hereby affix my signature that same is true and correct, except as noted above.

_____
YU ZHU, PhD

THE STATE OF _____
COUNTY OF _____

Before me, _____, on this day personally appeared YU ZHU, PhD, known to me (or proved to me under oath or through _____) (description of identity card or other document) to be the person whose name is subscribed to the foregoing instrument and acknowledged to me that they executed the same for the purposes and consideration therein expressed.

Given under my hand and seal of office this _____ day of _____, _____.

_____
NOTARY PUBLIC IN AND FOR
THE STATE OF _____

STATE OF TEXAS *
COUNTY OF HARRIS *

I, the undersigned certified shorthand reporter and notary public in and for the State of Texas, certify that the facts stated in the foregoing pages are true and correct.

I further certify that I am neither attorney or counsel for, nor related to or employed by, any of the parties to the action in which this deposition is taken and, further, that I am not a relative or employee of any counsel employed by the parties hereto, or financially interested in the action.

SUBSCRIBED AND SWORN TO under my hand and seal of office on this the 11th day of August, 2025.

Edith A. Boggs

EDITH A. BOGGS, CSR
Certified Shorthand Reporter and
Notary Public in and for
the State of Texas

Notary Expires: 7-21-2028
Certificate No. 3022
Expiration date: 7-31-2026
Esquire Deposition Solutions, LLC
Registration No. 3

Reference No.: 13276853

Case: LG ENERGY vs MOLECULAR REBAR

DECLARATION UNDER PENALTY OF PERJURY

I declare under penalty of perjury that I have read the entire transcript of my Deposition taken in the captioned matter or the same has been read to me, and the same is true and accurate, save and except for changes and/or corrections, if any, as indicated by me on the DEPOSITION ERRATA SHEET hereof, with the understanding that I offer these changes as if still under oath.

_____

Yu Zhu PhD

NOTARIZATION OF CHANGES

(If Required)

Subscribed and sworn to on the _____ day of

_____, 20____ before me,

(Notary Sign)_____

(Print Name) Notary Public,

in and for the State of _____

Reference No.: 13276853
Case: LG ENERGY vs MOLECULAR REBAR

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