

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 IPR2024-01011 (US Patent No. 8,968,924)

Ref. 18768-0210IP5

VIDEOCONFERENCE DEPOSITION OF

DEBORAH D.L. CHUNG, Ph.D.

INDIVIDUALLY AND ON BEHALF OF

PATENT OWNER

JULY 1, 2025

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12:40 p.m. to 1:45 p.m. EST

REPORTED BY:

Tamara L. Houston

CA CSR No. 7244, RPR, CCRR No. 140

Job Number J12853867

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REMOTE VIDEOCONFERENCE DEPOSITION OF DEBORAH D.L.
CHUNG, Ph.D., taken on behalf of the Petitioner,
commencing from 12:40 p.m. to 1:45 p.m. EST, Tuesday,
July 1, 2025, before Tamara L. Houston, CSR No. 7244,
CCRR, RPR.

THE SULLIVAN GROUP OF COURT REPORTERS

1 APPEARANCE OF COUNSEL:

2

3 On behalf of the Petitioner:

4 FISH & RICHARDSON
5 BY: HYUN JIN "HJ" IN, ATTORNEY
6 1000 MAINE AVENUE SW, SUITE 1000
7 WASHINGTON, D.C. 20024
8 (202) 783-5070
9 IN@FR.COM

10 FISH & RICHARDSON
11 BY: DANIEL JANG, ATTORNEY
12 BY: GRETCHEN DEVRIES
13 7 TIMES SQUARE, 20TH FLOOR
14 NEW YORK, NY 10036
15 (212) 765-5070
16 DJANG@FR.COM
17 DEVRIES@FR.COM

18 ON BEHALF OF THE PATENT OWNER AND WITNESS:

19 CABELLO HALL ZINDA, PLLC
20 BY: STEPHEN ZINDA, ESQ.
21 801 Travis Street
22 Suite 1610
23 Houston, Texas 77030
24 (832) 631-9994
25

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DEBORAH D.L. CHUNG, Ph.D.

LG ENERGY SOLUTION, LTD. vs. MOLECULAR REBAR DESIGN, LLC

JULY 1, 2025

Tamara L. Houston, CSR No. 7244, CRR No. 140, RPR

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NO EXHIBITS MARKED

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1 REMOTELY HELD AND REPORTED FROM THE STATE OF CALIFORNIA

2 TUESDAY, JULY 1, 2025, 12:40 P.M.

3 ---000---

4 COURT REPORTER: My name is Tamara Houston,
5 California Certified Shorthand Reporter Number 7244.

6 ---000---

7 Whereupon, DEBORAH D.L. CHUNG, PH.D., having
8 been called as a witness was duly sworn
9 to tell the truth, the whole truth,
10 and nothing but the truth testified
11 as follows:

12 --000--

13 EXAMINATION BY MR. IN:

14 Q. Okay. Good afternoon, Dr. Chung.
15 How are you?

16 A. Good.

17 Q. Welcome back.

18 We just went through the earlier deposition
19 for the '909 patent, so I will not repeat a lot of the
20 overlapping materials that we just covered; is that
21 okay?

22 A. Yes.

23 Q. Okay. So right now, you're here to offer your
24 testimony on U.S. Patent 8,682,924, also referred to as
25 the '924 patent; is that right?

1 A. Yes.

2 Q. And you've offered a sworn declaration for
3 this proceeding, and that is Exhibit No. 2006, correct?

4 A. Yes.

5 Q. Okay. If you could pull up 1001, the '924
6 patent, Dr. Chung.

7 A. Yes.

8 Q. Did you review this patent as part of your
9 preparation for this deposition as well as in preparing
10 for your declaration?

11 A. Yes.

12 Q. What is the '924 patent generally directed to?

13 MR. ZINDA: Objection -- objection. Form.

14 THE WITNESS: The title of this patent is,
15 "Lithium-ion batteries using discrete carbon nanotubes,
16 methods for production thereof and products obtained
17 therefrom."

18 BY MR. IN:

19 Q. Okay. So in your -- in your view, that is
20 what the '924 patent is about?

21 MR. ZINDA: Objection. Form.

22 THE WITNESS: Well, that's kind of the general
23 topic.

24 BY MR. IN:

25 Q. Okay. And with respect to the term "discrete

1 carbon nanotubes," I think we've been discussing that
2 for several depositions now and proceedings.

3 Is your view of the term "discrete carbon
4 nanotube" any different from the '924 patent as it has
5 been, for instance, the '909 patent?

6 MR. ZINDA: Objection. Form.

7 THE WITNESS: Yes, it's the same. Yes, and
8 you can refer to my declaration.

9 BY MR. IN:

10 Q. If I could direct you, Dr. Chung, in the '924
11 patent to Column 5, line 30.

12 A. Okay.

13 Q. So there, the '924 patent provides what they
14 call Example 2, and it is directed to "discrete carbon
15 nanotubes with lithium iron phosphate coated on the
16 surface of the tubes for a lithium-ion battery cathode
17 material."

18 Do you see that?

19 A. Yes.

20 Q. And please feel free to take a minute, if
21 needed.

22 But at a high level, can you tell me what is
23 being made in Example 2?

24 MR. ZINDA: Objection. Form.

25 THE WITNESS: Well, I'm not sure what you mean

1 by "high level." This describes the steps of -- of the
2 process. And "high level," I'm not sure what that
3 means. You have to go through the details of the steps.
4 You cannot just --

5 BY MR. IN:

6 Q. Sure. Yeah. Let me re-ask.

7 What is -- what is being made in Example 2?

8 MR. ZINDA: Objection. Form.

9 THE WITNESS: It's making discrete carbon
10 nanotubes with the lithium iron phosphate coated on the
11 surface of the tubes.

12 BY MR. IN:

13 Q. And are these multiwall or single-wall carbon
14 nanotubes?

15 A. Multiwall.

16 Q. Okay. And are these carbon nanotubes
17 oxidized?

18 A. Yes.

19 Q. So as part of that process starting at around
20 line 42, it talks about -- or line 39, I should say, it
21 talks about adding things like iron acetate, lithium
22 acetate, and ammonium phosphate.

23 Do you see that?

24 A. Yes.

25 Q. Why are those materials being added?

1 MR. ZINDA: Objection. Form.

2 THE WITNESS: The iron acetate is a precursor
3 to make the iron part of the resulting salt. The
4 lithium acetate is the precursor to enable having
5 lithium in the resulting salt, and the ammonium
6 phosphate is a precursor that enables the final product
7 to have phosphorus in the resulting salt.

8 BY MR. IN:

9 Q. Would it be accurate to characterize those
10 components as LFP precursors?

11 MR. ZINDA: Objection. Form.

12 THE WITNESS: Could you define LSP [sic]?

13 BY MR. IN:

14 Q. So "LFP" is "lithium iron phosphate."

15 And so based on your understanding of why
16 those three materials we just talked about are being
17 added, would a POSITA view those materials collectively
18 as LFP or lithium iron phosphate precursors?

19 A. Yes, those are precursors that, upon a
20 reaction, would form the lithium iron phosphate.

21 Q. And why are they called precursors?

22 A. Precursors are not the final reaction product.
23 It's the reactant, and you convert the precursor to a
24 certain reaction or certain process to make the product
25 you want.

1 Q. Okay. And in case of Example 2 then, what is
2 the process that is being performed with those
3 precursors?

4 MR. ZINDA: Objection. Form.

5 THE WITNESS: Well, it's clearly stated in
6 Example 2. First of all, iron acetate is dissolved in
7 the ionized water and that is -- that constitutes one of
8 the precursors.

9 And -- but then this is added to the carbon
10 nanotube mixture with that nanotube in the diethylene
11 glycol, that carbon nanotube mixture; and this iron
12 acetate as dissolved in water is added to that mixture
13 that consists of the carbon nanotube and the diethylene
14 glycol. And after that, you heat it under nitrogen,
15 stir, and sonicate.

16 (Court reporter requested clarification.)

17 THE WITNESS: Under nitrogen, yeah, stir and
18 sonicate. And then after an hour at 140 degrees C, a
19 solution of a lithium acetate and ammonium phosphate in
20 deionized water is added. Okay?

21 So in other words, the three precursor
22 chemicals are not added at the same time. The iron
23 acetate is there first. And after that, they add the
24 other two; that is, the lithium acetate and the ammonium
25 phosphate.

1 And then after that, then they raise the
2 temperature to about 185 degrees C for 30 minutes and --
3 over 30 minutes -- raise the temperature over
4 30 minutes. And then held at 185 C for four hours.

5 That's the main steps. There are others after
6 that, but these are the main steps.

7 BY MR. IN:

8 Q. Okay. Thank you.

9 And what is the purpose of that raising
10 temperature step that you just talked about?

11 A. Oh, the temperature is raised to 185 degrees C
12 over a period of 30 minutes. That's generally a
13 procedure that's common; that is, you don't raise a
14 temperature instantaneously from room temperature to
15 185 degrees, instantaneously raise the temperature.
16 That's not usual practice, you know. And they are just
17 very careful about describing the details.

18 Q. Sure.

19 And what is the contribution of that raised
20 temperature to the formation of the final product that
21 they are trying to make?

22 A. Could you rephrase that, please?

23 Q. Yeah.

24 What does raising the temperature do to the
25 precursors such that the final product is made in this

1 example?

2 MR. ZINDA: Objection. Form.

3 THE WITNESS: You need to have a reaction so
4 that the precursors react together to form the final
5 product. And an elevated temperature helps the
6 reaction, and --

7 BY MR. IN:

8 Q. And then what -- I'm sorry.

9 A. That's why they use 185 degree C.

10 Q. And is that final product an LFP particle?

11 MR. ZINDA: Objection. Form.

12 THE WITNESS: I don't think it's a single
13 particle. It gives you the reaction product, which is
14 the solid, but I wouldn't say that that solid is one
15 particle.

16 BY MR. IN:

17 Q. And that certainly wasn't what I was referring
18 to. But those individual precursors, after the high
19 temperature step, become LF -- LFP, correct?

20 MR. ZINDA: Objection. Form.

21 THE WITNESS: Yes. And it -- the -- after the
22 reaction is complete so that all of the precursors have
23 been converted to the final product, which is the
24 lithium iron phosphate, then that's what you have.

25

1 BY MR. IN:

2 Q. And what is the relationship in the final
3 product between lithium iron phosphate and the carbon
4 nanotubes?

5 MR. ZINDA: Objection. Form.

6 THE WITNESS: Okay. This pertains to the step
7 involving the iron acetate being introduced before
8 introducing the lithium acetate and the ammonium
9 phosphate.

10 In the step with the iron acetate introduced,
11 then you form some iron deposit on the carbon nanotube
12 surface and that provides the spots for a subsequent
13 growth of the lithium iron phosphate when the other two
14 precursors are added.

15 BY MR. IN:

16 Q. Okay. And so for this deposition of the iron
17 on the surface of the carbon nanotube, is it necessary
18 that the nanotubes be oxidized?

19 MR. ZINDA: Objection. Form.

20 THE WITNESS: The -- in this particular
21 procedure, the nanotube is first dispersed in diethylene
22 glycol through sonication. And this is the very first
23 step before any of those precursors are added.

24 And this dispersion of the nanotubes in the
25 diethylene glycol is expected to be helped by having the

1 carbon nanotubes oxidized.

2 BY MR. IN:

3 Q. And then once the remaining constituents --
4 namely, the lithium acetate and the ammonium phosphate
5 -- are added and then the temperature is raised, then
6 does that result in the formation of LFP on the surface
7 of the nanotube?

8 MR. ZINDA: Objection. Form.

9 THE WITNESS: Yeah, the lithium iron phosphate
10 would coat on the surface of the tubes.

11 BY MR. IN:

12 Q. Okay. And is it accurate to say that the use
13 of oxidized carbon nanotubes as opposed to unoxidized
14 carbon nanotubes facilitates the attachment of LFP to
15 the carbon nanotube surface?

16 MR. ZINDA: Objection. Form.

17 THE WITNESS: That is not for sure, because
18 what's for sure is that the oxidation of the nanotube
19 helps the dispersion of the nanotubes in the diethylene
20 glycol. And then once you raise the temperature,
21 especially to 185 degrees C, the heating can cause the
22 removal of some of the functional groups produced
23 through the oxidation of the carbon nanotubes.

24 So whether the functional groups produced by
25 the oxidation of the nanotubes helps the formation of

1 the lithium iron phosphate on the nanotube, that's
2 unclear. That's not taught. That's not clear.

3 BY MR. IN:

4 Q. Okay. But would it be fair to say that the
5 presence of oxidized functional groups, at least, does
6 not hinder that attachment of LFP to the nanotube
7 surface?

8 MR. ZINDA: Objection. Form.

9 THE WITNESS: Well, without any teaching of
10 that, I wouldn't come to that conclusion for sure.

11 BY MR. IN:

12 Q. Well, based on your review of Example 2, are
13 you able to make any rational conclusions regarding the
14 effect of oxidation in creating LFP that is attached to
15 carbon nanotubes?

16 MR. ZINDA: Objection. Form.

17 THE WITNESS: No. By reading this patent, it
18 appears that the deposition of iron on the surface of
19 the nanotube plays a bigger role than the functional
20 groups on the nanotube in -- in the growth of the
21 lithium iron phosphate on the nanotube.

22 BY MR. IN:

23 Q. Okay. If we looked at that -- the temperature
24 raising step that occurs at 185 degrees Celsius, is that
25 a common temperature that is used for these types of

1 processes?

2 MR. ZINDA: Objection. Form.

3 THE WITNESS: The temperature required depends
4 on the precise chemicals. You know, you are not limited
5 to a particular chemical. I saw -- it's a precursor
6 that would give you the product you want. But it's --
7 the choice of chemical is not unique, and the
8 temperature required depends on the exact choice of the
9 precursor chemicals.

10 But this ballpark kind of temperature seems
11 reasonable to me.

12 BY MR. IN:

13 Q. Okay. Could a lower temperature be used?

14 MR. ZINDA: Objection. Form.

15 THE WITNESS: Yeah. I hate to speculate.

16 All I want to say is that the temperature
17 requirement varies depending on exactly the situation.

18 BY MR. IN:

19 Q. Is there a situation you know of where a lower
20 temperature could be used?

21 MR. ZINDA: Objection. Form.

22 THE WITNESS: I -- I hate to speculate that.

23 BY MR. IN:

24 Q. Yeah, I'm not -- I'm not asking you to
25 speculate, Dr. Chung. I'm just asking if you know, as

1 you sit here today, of a particular set of circumstances
2 and materials that would allow formation of these active
3 particles at a lower temperature.

4 MR. ZINDA: Objection. Form.

5 THE WITNESS: Yeah. It -- you have to look at
6 the overall process. There are two heating steps here.
7 The first heating step is 140 degree C, and that
8 involves the iron acetate. Not the other two
9 precursors.

10 And after that, after you have introduced the
11 other two precursors -- namely, the lithium acetate and
12 ammonium phosphate -- then you have another heating
13 step, which is 185 degree C. So you have to look at the
14 totality, not just singling out one step.

15 BY MR. IN:

16 Q. I understand that, Dr. Chung. But I'm asking
17 you -- asking you specifically about that second step,
18 which is undertaken after lithium acetate and ammonium
19 phosphate is added. I'm just trying to know if you've
20 seen, in your long, illustrious career, an instance of
21 using a lower temperature to form those active
22 particles.

23 MR. ZINDA: Objection. Form.

24 THE WITNESS: Yeah, my testimony is detailed
25 in my declaration. That's what I -- I have come to

1 understanding based on the various exudates that I rely
2 on. So I don't want to rely on something else in this
3 testimony.

4 BY MR. IN:

5 Q. So -- so what are you relying on, then,
6 Dr. Chung, in this testimony?

7 A. I -- I am -- my testimony is in detail
8 described in my declaration. And what I rely on in this
9 declaration is all of the documents that I cited in this
10 declaration.

11 Q. Okay. And I assume you've reviewed all of
12 those references that you cited in your declaration?

13 A. Essentially.

14 Q. And based on that understanding, you're not
15 able to tell me whether a lower temperature than 185
16 degree Celsius has been used to form active particles
17 from precursors; is that right?

18 MR. ZINDA: Objection. Form.

19 THE WITNESS: Could you repeat, please?

20 BY MR. IN:

21 Q. So based on your understanding of the
22 references that you've cited in your declaration, you
23 are not able to tell me whether a temperature lower than
24 under 105 degrees Celsius -- 185 degrees Celsius can be
25 used to form active particles from lithium precursors;

1 is that right?

2 MR. ZINDA: Objection. Form.

3 THE WITNESS: What I'm saying is that based on
4 my study of those -- those documents that I cited, in
5 relation to the arguments that I make in my declaration,
6 I haven't come across a temperature different from this
7 and, also, the same chemicals. Okay. Same two-step
8 heating process and same chemicals. I haven't come
9 across that.

10 BY MR. IN:

11 Q. Are you aware of a scientific or technical
12 reasons why a lower temperature than 105 [sic] degrees
13 Celsius may not be used for formation of active
14 particles?

15 MR. ZINDA: Objection. Form.

16 THE WITNESS: It is not just a matter of
17 temperature; it's a matter of time. Here is 185 degrees
18 C for four hours for the second heating, and for the
19 first heating is 140 degrees C for one hour. Okay? So
20 it's not just a matter of temperature. It's time also.

21 BY MR. IN:

22 Q. Sure. I realize that, Dr. Chung, but I'm
23 asking about the temperature aspect right now, and you
24 can assume whatever you need to for the time aspect.

25 But at least for the temperature aspect,

1 you're not aware of a reason why a lower temperature
2 cannot be used; is that right?

3 MR. ZINDA: Objection. Form.

4 THE WITNESS: In general, to carry out a
5 certain chemical reaction, if you lower the temperature,
6 chances are you need to have a longer time because the
7 reaction rate increases with increasing temperature.

8 So if you lower the temperature, the reaction
9 rate decreases and, therefore, you would need to give it
10 more time. That concept is well known.

11 BY MR. IN:

12 Q. And would the converse be true for higher
13 temperatures, such that at a higher temperature, you
14 could perhaps get by with less than four hours to form
15 the active particles?

16 MR. ZINDA: Objection. Form.

17 THE WITNESS: Yes, in fairness, for a certain
18 reaction, in general, when you raise the temperature of
19 the reaction, chances are that would hasten the
20 reaction; that is, make the reaction rate greater so
21 that you would need less time.

22 However, there's always a limit to how much
23 you can raise and how much you can decrease, because as
24 you -- if the temperature is too low, then just a
25 reaction might not occur or might occur. Such a tiny,

1 tiny rate that it's not meaningful. And if you raise
2 the temperature too high, you might have some side
3 reactions that give you contamination or other products
4 that you don't want.

5 So there's obviously a window of the
6 temperature that is feasible. And within that window,
7 the higher is the temperature, the faster the reaction,
8 and the shorter is the required time to complete the
9 reaction.

10 BY MR. IN:

11 Q. And based on the declaration that you've
12 provided and the various references that you have cited
13 therein, are you aware of any lower or upper limits in
14 temperature for this process?

15 MR. ZINDA: Objection. Form.

16 THE WITNESS: I have not formed an opinion on
17 that particular point.

18 BY MR. IN:

19 Q. If you could call up the Gan reference,
20 Dr. Chung. That was LGES 1021.

21 A. I have that.

22 Q. And if I could also, at the same time, point
23 you to paragraph 201 of your declaration. That's on
24 page 116.

25 A. Okay.

1 Q. So starting on paragraph 201, I believe you
2 are talking about the Cheng-Gan combination. And then
3 if we go down to, like, paragraph 208, you provide your
4 understanding of Gan's objectives, which I believe form
5 your basis for determining that Gan's nanotubes are not
6 discrete.

7 Does that ring a bell, Dr. Chung?

8 MR. ZINDA: Objection. Form.

9 THE WITNESS: It rings a bell.

10 BY MR. IN:

11 Q. Okay. So let me take it a little more
12 specifically in paragraph 208. There, you provide one,
13 two, three -- three objectives of the nanotubes in Gan,
14 and the third one you provide there says, "It provides a
15 conductive bridge between CNTs to reduce the electrical
16 contact resistance there between."

17 Do you see that?

18 A. Yes.

19 Q. What is meant by "conductive bridge"?

20 MR. ZINDA: Objection. Form.

21 THE WITNESS: A conductive bridge between CNTs
22 refer to electrical current being able to flow from one
23 nanotube to the adjacent nanotube through that bridge.

24 BY MR. IN:

25 Q. And what is the significance of electrical

1 contact resistance with respect to that electrical
2 bridge?

3 A. Okay.

4 MR. ZINDA: Form.

5 THE WITNESS: The electrical contact
6 resistance refers to the electrical resistance of --
7 of -- between point A and B. A being nanotube A;
8 B being nanotube B, you know. A point in nanotube A to
9 a point in nanotube B, and the resistance between the A
10 point and the B point, that -- that is the contact
11 resistance.

12 BY MR. IN:

13 Q. So would it be accurate to say, Dr. Chung,
14 that in order to increase conductivity between
15 components, it is important to reduce contact resistance
16 between those components?

17 MR. ZINDA: Objection. Form.

18 THE WITNESS: What do you mean by conductivity
19 in your -- in your statement?

20 BY MR. IN:

21 Q. Electrical conductivity.

22 A. Yes. Of what?

23 Q. Electrical conductivity between components via
24 a conductive bridge?

25 MR. ZINDA: Objection. Form.

1 THE WITNESS: Yeah. We don't -- electrical
2 conductivity describes the conductivity attribute of a
3 volume of material. Okay. Say copper, a volume of
4 copper. What is the conductivity of this chunk of
5 copper? Okay. That's how one describes -- understands
6 conductivity to mean.

7 But now when you talk about conductivity
8 between A and B, that -- that's not volume. That
9 doesn't jibe with how people understand the word
10 "conductivity" to mean.

11 However, resistance would be okay. That is
12 the resistance between point A and point B. That would
13 be okay to consider.

14 BY MR. IN:

15 Q. So is the objective of providing a conductive
16 bridge between two particles the same as, say, trying to
17 reduce the resistance between those two particles?

18 MR. ZINDA: Objection. Form.

19 THE WITNESS: In having a conductive bridge
20 between two particles, you would make the resistance
21 between the two particles lower. Now, whether that
22 reduction in the resistance is enough to satisfy your
23 conduction application, that is another question.

24 BY MR. IN:

25 Q. In that example just now of trying to reduce

1 resistance between two particles through the electrical
2 bridge between them, is it important also to try to
3 reduce the electrical contact resistance that may be
4 present in that system?

5 MR. ZINDA: Objection. Form.

6 THE WITNESS: I don't quite understand your
7 distinction between resistance and electrical contact
8 resistance.

9 BY MR. IN:

10 Q. Yeah. I was just referring to your
11 declaration from paragraph 208 where you said Gan uses
12 carbon nanotubes to provide a conductive bridge between
13 CNTs, and then you also go on to say "to reduce the
14 electrical contact resistance there between."

15 So I'm trying to see if there is a difference
16 here between just conductivity and contact resistance.

17 MR. ZINDA: Objection. Form.

18 THE WITNESS: Electrical contact resistance is
19 the resistance across that contact. The contact is
20 between A and B.

21 The resistance between A and B, that is the
22 electrical contact resistance. But the term
23 "conductivity" is not very suitable for describing
24 this -- the quality of this electrical contact.

25

1 BY MR. IN:

2 Q. And so what is more suitable, then, for
3 describing the quality of this electrical contact?

4 MR. ZINDA: Objection. Form.

5 THE WITNESS: As I said, it's the resistance.

6 BY MR. IN:

7 Q. You mean contact resistance?

8 A. Yes.

9 Q. What about the resistance through the body of
10 the nanotube itself? Is that important?

11 MR. ZINDA: Objection. Form.

12 THE WITNESS: What do you mean by "body"?
13 Because we are talking about the surface of -- of
14 nanotube A --

15 BY MR. IN:

16 Q. Sorry. I don't know if it was me, but
17 something -- something froze the last 20 seconds. It
18 may be me. Give me a second here.

19 MR. IN: Can we just go quickly off the
20 record?

21 (Discussion off the record.)

22 BY MR. IN:

23 Q. Sorry. Just earlier, just now, Dr. Chung, you
24 were asking me what do I mean by the body of the
25 nanotube, and I was simply referring to the conductive

1 path that is provided by the nanotube itself as opposed
2 to, you know, contact resistance that may be present
3 when the nanotube comes into contact with something
4 else.

5 Does that make sense?

6 A. Yeah. Yeah. You talk about two different
7 things. The contact -- the electrical contact
8 resistance between two nanotubes is between the surface
9 of one nanotube and the surface of the other nanotube.

10 So the interior of either nanotube is not in
11 the picture because that electrical contact resistance
12 is the resistance between the surface of one nanotube
13 and the surface of the other nanotubes.

14 So what -- the body inside the nanotube is
15 something else, which is not a part of this electrical
16 contact resistance concept. But then you're talking
17 about percolation. That -- that obviously is important,
18 but that's another -- another thing for a percolative
19 network. The resistance of that network depends not
20 only on the contact of electrical resistance of each
21 contact between one nanotube and the other, not only
22 that, it also depends on the conductivity of the
23 nanotubes in that network.

24 Q. So is it accurate to say that to improve
25 conductivity, you have to, one, reduce contact

1 resistance associated with the nanotubes; and, two, also
2 make sure that the nanotubes themselves are conductive?
3 Is that right?

4 MR. ZINDA: Objection. Form.

5 THE WITNESS: Yeah. The conductivity within
6 the nanotubes and the contact electrical resistance
7 between the nanotubes, those obviously enter into the
8 consideration of the conductivity of the overall
9 percolative network.

10 But in addition, it's the number of these
11 contact points, nanotube -- nanotube contact points.
12 The numbers of these also matters.

13 BY MR. IN:

14 Q. And is the contact electrical resistance
15 between nanotubes and the active particles also
16 important?

17 MR. ZINDA: Objection. Form.

18 THE WITNESS: Since we are -- let's say we
19 want to have this active particle, having the electrical
20 conduit so that the electrons can, you know, reach from
21 there to -- to the current collector or from the current
22 collector to the nanotube, you know, in and of, and you
23 need the carbon nanotube, let's say, to -- to provide
24 that conduit, then the nanotube must be in electrical
25 contact with the -- with the active particle.

1 However, the nanotubes might not be just by
2 themselves. They might be within a binder, like the
3 PVDF. It becomes a conductive binder, and the
4 conductive binder can help establish that conduit.
5 Okay?

6 So there are kind of two entity that can help
7 that conduit. One is the nanotubes by themselves, if
8 present; the other is the binder which has the nanotube
9 in case the binder has the nanotubes.

10 So if you are relying on the latter -- that
11 is, relying on the binder having nanotubes inside the
12 binder -- then in that case, the carbon nanotube inside
13 the binder would not be able to directly touch the
14 active particles. Yet, the binder is rendered more
15 conductive due to the presence of the nanotube inside,
16 so the binder still helps provide that electrical
17 conduit.

18 BY MR. IN:

19 Q. So are you saying, Dr. Chung, that at the
20 interface between that binder and that active particle,
21 there's no carbon nanotube there?

22 MR. ZINDA: Objection. Form.

23 THE WITNESS: Can you say that again?

24 BY MR. IN:

25 Q. Yeah.

1 So you were talking about this supposedly
2 conductive binder just now, and so if that conductive
3 binder is in contact with a nanotube -- sorry, if that
4 conductive binder is in contact with an active particle,
5 is it your view that current can flow through that
6 interface between the binder and the active particle
7 even in the absence of a carbon nanotube or other
8 conductive materials at that interface?

9 MR. ZINDA: Objection. Form.

10 THE WITNESS: That's right. Because that
11 binder lump itself is conducted. The nanotubes don't
12 have to stick out of that lump because that lump within
13 the lump is conducted.

14 BY MR. IN:

15 Q. And what gives that conductivity to that lump?

16 MR. ZINDA: Objection. Form.

17 THE WITNESS: It's the presence of carbon
18 nanotube.

19 BY MR. IN:

20 Q. Is current able to flow through the parts of
21 the binder that do not have carbon nanotubes?

22 MR. ZINDA: Objection. Form.

23 THE WITNESS: If it is correctly formed,
24 conductive binder, then the totality of that binder lump
25 should be conductive. If a part of that lump is

1 conductive and part of that lump is nonconductive, then
2 it is a bad lump. It is a bad conductive binder. And
3 I'm talking about a good one, not a bad one.

4 BY MR. IN:

5 Q. So in the -- in the case of this good
6 conductive binder, if you look at the external surface
7 of that binder, is it conductive?

8 MR. ZINDA: Objection. Form.

9 THE WITNESS: Yes, it is conductive because
10 this lump is conductive.

11 BY MR. IN:

12 Q. And it is conductive because of the presence
13 of carbon nanotubes; is that right?

14 A. Yes.

15 MR. ZINDA: Objection. Form.

16 THE WITNESS: Yes. Obviously it have to be
17 under the condition that the nanotubes form a
18 percolative conductive network, and that would render
19 that lump to be a conductor.

20 BY MR. IN:

21 Q. If a carbon nanotube is being used to form an
22 electrical bridge between two points, does that carbon
23 nanotube need to be in physical contact with either of
24 those two points?

25 MR. ZINDA: Objection. Form.

1 THE WITNESS: Okay. Let me make sure I
2 understand it.

3 You mean you have a single carbon nanotube,
4 not with any polymer resin; just a single nanotube
5 between two -- two objects. The objects could be the
6 active material particle. That's what you mean; is that
7 right?

8 BY MR. IN:

9 Q. Well, let's start with that, then.

10 A. Okay. So if there's a single carbon nanotube
11 and you want to improve the electrical connectivity
12 between these two objects, then the nanotube needs to be
13 touching each of those two objects.

14 Q. And how would that answer change, if at all,
15 in the presence of resin?

16 A. It would change because if the carbon nanotube
17 is incorporated in resin to form a composite material
18 and -- so because of that carbon nanotube incorporation,
19 that composite is conductive.

20 And if you put this composite in between A and
21 B, because of the conductivity of this composite, the
22 presence of this composite between A and B will enhance
23 the electrical connectivity between A and B. But,
24 again, the common nanotube inside this lump or inside
25 this composite doesn't have to stick out of the

1 composite.

2 Q. So is it your view in that instance that the
3 contact resistance between the nanotube and the active
4 particle is irrelevant?

5 MR. ZINDA: Objection. Form.

6 THE WITNESS: Are you referring to the carbon
7 nanotube inside the resin?

8 BY MR. IN:

9 Q. Yes.

10 A. And -- and the contact resistance -- I'm a
11 little confused here. Maybe you can rephrase it.

12 Q. So it is your view that with this resin
13 nanotube lump, assuming that this is a good conductive
14 lump, as you've referred to earlier, when there is
15 electrical contact between the active particle and the
16 good lump, that conductivity has nothing to do with
17 whether or not there is any physical contact between the
18 active particle and the nanotubes themselves?

19 MR. ZINDA: Objection. Form.

20 THE WITNESS: Any physical contact between the
21 nanotube and the active particle; is that what you said?

22 BY MR. IN:

23 Q. Yes. That's right.

24 A. Okay. All of the nanotubes inside the lump,
25 okay, they -- they just don't stick out. Okay. They

1 are -- they are trapped inside the lump. And so what's
2 touching the active particle is the lump. Not any --

3 Q. You keep saying the lump, Dr. Chung. But as I
4 understand it, based on your example here, the lump has
5 two materials, right? Let's say PVDF and carbon
6 nanotubes. That's it.

7 If you take an SEM or TEM or whatever and look
8 at the interface between this good lump and the active
9 particle, which additive is touching the active
10 particle?

11 MR. ZINDA: Objection. Form.

12 THE WITNESS: It doesn't work out quite like
13 this. The -- this conductive lump is a material on its
14 own. Okay? And this material happens to be a
15 conductive binder, and it happens to be a polymer matrix
16 composite with carbon nanotube inside of it.

17 Okay. And the -- and because this lump is
18 conducted, it is able to make electrical contact with,
19 say, the active particle or whatever object it is
20 touching. Okay?

21 It is the conductivity of this overall lump or
22 overall composite that enables the lump to function so
23 that it can act as a conduction medium. And this
24 conduction medium is touching the active particle.

25 So it's this conduction medium, which is the

1 lump, that is the entity that is doing the touching.

2 The carbon nanotube inside is a modifier. It modifies
3 the lump so that the lump becomes conducted.

4 BY MR. IN:

5 Q. So it is your view then, Dr. Chung, that in
6 this lump, the PVDF and the carbon nanotube become
7 indistinguishable, that it just becomes one homogenous
8 material?

9 MR. ZINDA: Objection. Form.

10 THE WITNESS: Obviously they're not one -- one
11 phase. It's not one phase. Okay? It's two phases, at
12 least: The PVDF of resin is one, and the nanotube is
13 the other. A composite material involves more than one
14 phase. And it doesn't mean that there's no distinction
15 between the two phases inside the composite. They are
16 still different phases, but they make up the composite
17 material.

18 BY MR. IN:

19 Q. Okay. Understood. Understood.

20 Then which phase is in direct contact with the
21 active particle?

22 MR. ZINDA: Objection. Form.

23 THE WITNESS: It -- again, it -- it is not --
24 that is, if the carbon nanotube indeed is distributed
25 throughout the lump. Then you don't have a surface

1 region of the lump that is devoid of the nanotube.

2 Okay? Then this lump would have no problem in providing
3 the electrical connectivity between A and B. Okay.

4 That's what I mean by a good lump, a good
5 conductive binder.

6 But if it's a bad one, so that the very
7 surface region of that lump is devoid of nanotube, then
8 this would be a bad lump.

9 BY MR. IN:

10 Q. Okay. And this conductivity that you speak of
11 now, Dr. Chung, comes from direct contact; is that
12 right?

13 MR. ZINDA: Objection.

14 BY MR. IN:

15 Q. Also having a gap?

16 MR. ZINDA: Objection. Form.

17 THE WITNESS: The -- that conductive lump
18 obviously has to be in contact with the active particle
19 or whatever you're trying to connect.

20 BY MR. IN:

21 Q. Okay. So -- so the conductive part of the
22 lump has to be in direct contact with the conductive
23 part of the active particle; is that fair?

24 MR. ZINDA: Objection. Form.

25 THE WITNESS: Yeah, I don't like to say

1 there's a conductive part of a lump and a nonconductive
2 part of a lump. Because if the lump is a good one, the
3 totality of this lump should be conducted.

4 BY MR. IN:

5 Q. Just earlier, though, Dr. Chung, you said that
6 there would be a CNT phase within the lump as well as a
7 PVDF phase. If we look specifically at just the PVDF
8 phase, is that conductive by itself?

9 MR. ZINDA: Objection. Form.

10 THE WITNESS: If you have an individual PVDF
11 lump without carbon nanotube at all --

12 BY MR. IN:

13 Q. That was not my question, Dr. Chung.

14 We were -- earlier, we agreed that within this
15 good lump, there would be discernible phases of carbon
16 nanotubes and PVDF.

17 Do you recall that?

18 MR. ZINDA: Objection. Form.

19 THE WITNESS: Could you repeat that?

20 BY MR. IN:

21 Q. Yeah.

22 Do you recall our conversation earlier where
23 you were saying that within the good lump, there would
24 be phases -- there would be a CNT phase and a PVDF phase
25 within that lump, that good lump.

1 Do you recall that discussion?

2 A. Yes.

3 MR. ZINDA: Objection. Form.

4 BY MR. IN:

5 Q. Okay. And my question now to you is: Just
6 looking within the PVDF phase of that good lump, is that
7 phase conductive?

8 MR. ZINDA: Objection. Form.

9 THE WITNESS: If you consider a very small
10 part of that good lump and very microscopically in the
11 nanoscale, over in that little region of nanoscale, then
12 you would be just looking at the PVDF without the carbon
13 nanotube. But that's not the picture we are trying to
14 depict here. It's not -- I'm not talking about a
15 nanoscale, nano-size type of lump. It's a microscopic
16 size, you know.

17 BY MR. IN:

18 Q. Understood. Yeah.

19 A. Yes, it's a microscopic size that we're
20 talking about and -- and so we should not just consider
21 a tiny nanoscale region inside the good lump that has no
22 nanotube because it's not -- it's not relevant to the
23 discussion here because our discussion is -- it's not in
24 that scale because our lumps are not that tiny.

25 MR. IN: Okay. Thank you very much,

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1 Dr. Chung. No more questions at this time.

2 I pass the witness.

3 MR. ZINDA: Just give me one minute. We can
4 stay on the record.

5 I have no questions for the witness.

6 MR. IN: Nothing further for the Petitioner,
7 either.

8 COURT REPORTER: Mr. Zinda, would you like a
9 transcript?

10 MR. ZINDA: No, thank you.

11 (Whereupon the proceedings concluded at
12 1:45 p.m.)

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ERRATA SHEET

NAME OF CASE: LG ENERGY v. MOLECULAR REBAR DESIGN
DATE OF DEPOSITION: JULY 1, 2025
NAME OF WITNESS: DEBORAH CHUNG, Ph.D.

Reason Codes:

- 1: To clarify the record.
- 2: To conform to the facts.
- 3: To correct transcription error.

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DECLARATION UNDER PENALTY OF PERJURY

I, DEBORAH CHUNG, Ph.D., do hereby certify under penalty of perjury that I have read the foregoing transcript of my deposition taken on July 1, 2025; that I have made such corrections as appear noted on the Deposition Errata Page(s), attached hereto, signed by me; that my testimony as contained herein, as corrected, is true and correct.

This Declaration is executed this _____ day of _____, 20____, at _____, California.

DEBORAH CHUNG, Ph.D.

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**I, Tamara Houston, RPR, CCRR, CSR No. 7244, a
Certified Shorthand Reporter in the State of California,
duly empowered to administer oaths, do hereby certify:**

That said deposition was taken down by me in shorthand at the time and place therein named, and thereafter reduced to typewriting by computer-aided transcription under my direction;

That the dismantling, unsealing, or unbinding of the original transcript will render the reporter's certification null and void.

I further certify that I am not interested in the event of the action.

In witness whereof, I have hereunto subscribed my
name.

Dated: 8th of July, 2025.

Zamara L. Houston

TAMARA L. HOUSTON
CSR 7244, RPR, CCRR 140

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