

**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 (US Patent No. 9,636,649)

Ref. 18768-0210IP7

VIDEOCONFERENCE DEPOSITION OF

DEBORAH D.L. CHUNG, Ph.D.

INDIVIDUALLY AND ON BEHALF OF

PATENT OWNER

JUNE 25, 2025

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9:04 a.m. to 2:29 p.m. EST

REPORTED BY:

Tamara L. Houston

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

Job Number J12853871

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REMOTE VIDEOCONFERENCE DEPOSITION OF DEBORAH D.L.
CHUNG, Ph.D., taken on behalf of the Petitioner,
commencing from 9:04 a.m. to 2:29 p.m. EST, Wednesday,
June 25, 2025, before Tamara L. Houston, CSR No. 7244,
CCRR, RPR.

THE SULLIVAN GROUP OF COURT REPORTERS

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THE SULLIVAN GROUP OF COURT REPORTERS

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DEBORAH CHUNG, Ph.D.

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

JUNE 25, 2025

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

EXHIBIT	DESCRIPTION	PAGE
Exhibit 1	LGES 1100; two pages with two handwritten drawings	119

(Exhibit marked electronically.)

**--000--
(Exhibit not attached)**

1 WEDNESDAY, JUNE 25, 2025, 9:04 A.M.

2 --o0o--

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

5 --o0o--

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

11 --o0o--

12 EXAMINATION BY MR. RIFFE:

13 Q. Good morning. Could you please state your
14 name for the record.

15 A. Deborah D.L. Chung.

16 Q. And could you please provide a business
17 address for the record.

18 A. Yes. Department of Mechanical and Aerospace
19 Engineering, University At Buffalo, the State University
20 of New York, Bell Hall, Room 211, Buffalo, New York,
21 14260.

22 Q. And how long have you been with the University
23 of Buffalo?

24 A. About 39 years.

25 Q. Could you please provide a home address for

1 the record as well?

2 A. 108 Rolling Meadow Lane, East Amherst,
3 New York, 14051.

4 Q. And how long have you been at that address?

5 A. Amherst with an A.

6 Q. And how long have you been at that address?

7 A. Over 40 years. No, no. That's not -- that
8 may be 35 years. I have to calculate it.

9 Q. Yeah. Just wanted to explain a little bit
10 because we're on this Zoom platform for the deposition
11 today.

12 I'll be asking a series of questions to you,
13 as I've been doing so far this morning. I would ask
14 that we try to -- you try to allow me to finish my
15 question before you begin answering so the court
16 reporter can take down our questions and answers
17 appropriately.

18 At times I may be introducing exhibits. And
19 in normal procedures, if we were sitting across from one
20 another, I'd be able to hand those to the court
21 reporter, and then she would then hand a copy of the
22 exhibit to you. But in this instance, I may need to
23 place a copy of the exhibit in the chat room or the chat
24 feature of the Zoom and then ask you to download it from
25 that chat room.

1 Are you familiar with that procedure on the
2 videoconference platforms?

3 A. Yes. I don't see the chat box here yet.

4 Q. Okay. If you -- if you do -- if you do bring
5 up the little ribbon bar at the bottom of the Zoom,
6 you'll see a chat box.

7 A. I see that. I see it now.

8 Q. And if you click on that, it will open the
9 side frame for you.

10 A. Okay. Got it.

11 MR. GLENN: Counsel, she has a -- she has a
12 paper copy, I believe, of every document on -- on file
13 in this proceeding.

14 MR. RIFFE: Okay. Okay.

15 MR. GLENN: So she may be -- she may do that
16 and use the paper document, if that's okay.

17 MR. RIFFE: That's fine. That's fine.

18 BY MR. RIFFE:

19 Q. Dr. Chung, given that you have paper copies of
20 the pleadings and the exhibits filed in this proceeding,
21 are those paper copies that you have with you, do they
22 have any markings of any kind whatsoever on them?

23 A. No.

24 Q. Those are all clean copies?

25 A. Yes.

1 Q. Okay. Do you have anything on your computer
2 that would allow you to conduct a conversation with
3 anyone during the deposition while you're testifying?

4 A. No.

5 Q. Such as a Skype feature or any other type of
6 messaging feature?

7 A. No.

8 Q. Do you have any files on your computer that
9 you can refer to today during your deposition?

10 A. Oh, yeah, definitely -- certainly files there.
11 I -- I don't intend to refer to any of them, but --

12 Q. Okay.

13 A. Yeah.

14 Q. All right. So outside of the paper copies
15 that you have with you present in the room, it sounds
16 like you do not have any other files that you plan to
17 review or refer to during the deposition today; is that
18 correct?

19 A. Yes.

20 Q. Okay. Have you been deposed before Dr. Chung?

21 A. Yes.

22 Q. How many times?

23 A. I really can't remember because it's been many
24 years. Could be five times.

25 Q. And what were those depositions related to, if

1 you recall?

2 A. Litigation, including those with the board and
3 also injury cases, trade secret case.

4 Q. When was the last time you were deposed?

5 A. Maybe around three years ago.

6 Q. And was that a patent case or trade secret
7 case?

8 A. Patent case.

9 Q. Do you recall what the patent case pertained
10 to?

11 A. I -- I can't remember very well. It has to do
12 with certain material. I can't remember.

13 Q. Have any of your prior cases for which you've
14 provided deposition testimony been related to technology
15 surrounding carbon nanotubes?

16 A. Prior what? I didn't hear that word.

17 Q. Your prior deposition testimony that you
18 provided, have they been related to carbon nanotube
19 technology?

20 A. I remember I think one case that has to do
21 with carbon, you know, but whether carbon nanotube is
22 specifically included, I cannot remember exactly.

23 Q. Do you recall the parties for whom you
24 provided deposition testimony previously related to
25 carbon?

1 A. It has to do with carbon battery electrode
2 between the Japanese company and a Chinese company.

3 Q. Sitting here today, you don't recall who those
4 Japanese or Chinese companies were?

5 A. I'm not positive about my memory.

6 Q. Okay.

7 A. More or less.

8 Q. Okay. Are any of those prior litigations for
9 which you provided deposition testimony identified in
10 your CV which is attached to your declaration that was
11 submitted as Exhibit 2006 in this proceeding?

12 A. I don't think my CV lists my expert witness
13 record.

14 Q. Do you know why you don't list your expert
15 witness record in your CV?

16 A. I've never done that. In the academic world,
17 you know, that expert witness work is kind of sideline.
18 It's not our main line academic work. So I've never --
19 I've never done that.

20 Q. Okay. Have you testified at trial before in
21 any of these prior cases?

22 A. Never.

23 Q. Only in deposition?

24 A. That's correct.

25 Q. And how many times have you been deposed in an

1 IPR or Inter Partes Review proceeding such as the one
2 we're talking about today?

3 A. Maybe two times.

4 Q. And do you recall who you were represented in
5 those IPR proceedings?

6 A. Oh, you mean the parties involved in the case,
7 huh?

8 Q. That's correct.

9 A. I really don't remember.

10 Q. Okay. Do you recall if you were on the side
11 of the petitioner or the patent owner in those prior IPR
12 proceedings?

13 A. I'm sorry. Can't remember. I just remember
14 the -- the firm's name. That's all I remember.

15 Q. Okay. And what -- what were those firms that
16 you recall?

17 A. That was Foley.

18 Q. In both IPR proceedings?

19 A. No. One of them. In one of them was --

20 Q. Who was the other firm?

21 A. The other -- I cannot remember. It actually
22 could be one or two. You know, I'm not positive that
23 it's two, but at least one.

24 Q. And what was the technology in play in those
25 IPR proceedings, if you recall?

1 A. Certain material, and I remember it's not
2 carbon.

3 Q. And certainly not carbon nanotubes; is that
4 correct?

5 A. Right.

6 Q. And did you testify live at the hearing in
7 either of those IPR proceedings in the past?

8 A. Yes.

9 Q. So you provided deposition testimony in the
10 IPRs as well as testifying live at the oral hearing; is
11 that correct?

12 A. Live at what?

13 Q. The oral hearing or oral argument before the
14 PTAB judges.

15 A. No, not before the judges. Just in the --

16 Q. Just the deposition? Okay. Let me just make
17 sure that's clear.

18 So in the prior IPR proceedings, Inter Partes
19 Review proceedings, you only provided deposition
20 testimony; is that correct?

21 A. That's right. And obviously the declaration.
22 Yes.

23 Q. Okay. Thank you.

24 I know you've been deposed before. It sounds
25 like maybe three years ago. Let's just go over some of

1 the ground rules again to make sure we have an
2 understanding between each other.

3 If you will, please provide verbal answers to
4 my questions, no head nods or shake of the head so that
5 Ms. Houston can properly record your testimony.

6 Is that okay?

7 A. Yes.

8 Q. And you understand that you've been given an
9 oath to tell the truth as if it will be as if you were
10 testifying in the court.

11 Do you understand that?

12 A. Yes.

13 Q. And you agree to do that today?

14 A. Yes.

15 Q. You're permitted to speak with your counsel
16 during the breaks but not about the substance of your
17 testimony.

18 Do you understand that?

19 A. Yes.

20 Q. And your attorney may make some limited
21 objections during today's deposition, but do you
22 understand that unless you're instructed and you choose
23 not to answer, that you're obligated to answer my
24 questions to the extent you're able to do so?

25 A. Yes.

1 Q. If you don't understand a question I ask, will
2 you, please, let me know --

3 A. Yes.

4 Q. -- as you've done already this morning?

5 And if you don't ask me to clarify a question
6 that I ask of you, is it fair for the judges to assume
7 that you understood my question when reviewing the
8 transcript of today's deposition?

9 A. Yes.

10 Q. Is there any reason you can't provide your
11 best, most accurate testimony today?

12 A. No.

13 Q. Are there any medical conditions that would
14 impact your ability to testify?

15 A. No.

16 Q. Was there anything else that would impact your
17 ability to testify that I should be aware of?

18 A. No.

19 Q. And if any of this changes during the
20 deposition, will you be sure to let us know?

21 A. Yes.

22 Q. As we discussed prior to the deposition
23 starting with your attorney, if there are any technical
24 issues with your connection or any of our connections,
25 we'll try and go off the record to address those.

1 Is that understood as well?

2 A. Yes.

3 Q. In any of the prior litigations or IPR
4 proceedings for which you've provided expert testimony,
5 do you recall if any parts of your expert declaration or
6 report were stricken by the Court for any reason?

7 A. No.

8 Q. Dr. Chung, what did you do to prepare for your
9 deposition today?

10 A. There were various documents, and I listed
11 them in my declaration. So I look -- look at those.

12 Q. And which particular documents are you
13 referring to that you listed in your declaration? And
14 in your declaration, specifically we're referring to
15 Exhibit 2006; is that correct?

16 A. Oh, yes, 2006. This is my declaration, yes.

17 Q. Okay. And you mentioned that there were
18 various documents that you listed in your declaration,
19 so you looked at those in preparation for your
20 deposition.

21 Can you let me know what those documents were?

22 A. Yes. They include the MRD-2007, 2008, 2009,
23 2010, 2011, 2012, and 2013.

24 In addition, I looked at the LGES 1004, 1001,
25 1008, 1007, 1003. I think that's about it.

1 Q. Okay. And just for the record, LGES 1004,
2 that is the Sun prior art reference. If we can refer to
3 that as the Sun reference today. Is that okay?

4 A. Okay.

5 Q. And that is U.S. Publication 2010/0197832; is
6 that correct?

7 A. Yes.

8 Q. And Exhibit 1001 is -- or LGES 1001, that is
9 the U.S. Patent Number 9,636,649 to Bosnyak, et al; is
10 that correct?

11 A. Yes.

12 Q. Is it okay with you if we shorthand that to
13 refer to that today as the '649 patent?

14 A. Yes.

15 Q. Okay. Exhibit LGES 1008 is the United States
16 patent application publication to Narayan, et al., U.S.
17 2003/0213939; is that correct?

18 A. Can you repeat that?

19 Q. Yes. LGES 1008 is United States patent
20 application publication to Narayan, et al., and that
21 publication number is U.S. 2003/0213939. Is that
22 correct?

23 A. Yes.

24 Q. And if we refer to the LGES 1008 today, can we
25 shorthand refer to that as Narayan? Is that okay?

1 A. Yes.

2 Q. Okay. Thank you. LGES 1007 that you refer
3 to, that is the Farrugia patent publication, U.S. Number
4 2010/0124713; is that correct?

5 A. Yes.

6 Q. And is it okay if we refer to that today in
7 shorthand as Farrugia reference?

8 A. Yes.

9 Q. Thank you.

10 And then finally you mentioned LGES 1003.
11 That was the declaration of Dr. Samuel Gido. Is that
12 correct?

13 A. Yes.

14 Q. Thank you.

15 Are there any other documents that you
16 reviewed other than the one that you just identified in
17 preparing for your deposition today?

18 A. There's also MRD-2005. Did I mention?

19 Q. I don't believe so.

20 A. Also MRD-2008, MRD-2009. I could have
21 mentioned that already.

22 Q. And 2008 and 2009 are listed on the exhibit
23 list on page 4 of your declaration, correct?

24 A. Correct.

25 Q. All right. And what again is MRD-2005?

1 A. 2000 -- okay. That's the deposition of Samuel
2 Gido on March 20th, 2025.

3 Q. Is that also listed as MRD-2011 in your
4 exhibit list on page 4 of your declaration?

5 A. Yes.

6 Q. Okay. Dr. Chung, why did you list Exhibit No.
7 MRD-2006, your declaration, in the exhibit list on page
8 4 of your declaration? Do you recall?

9 A. I guess it's just for the sake of
10 completeness.

11 Q. Okay. Thank you.

12 In preparation for your deposition today, did
13 you have an opportunity to meet with counsel for
14 Molecular Rebar Design to prepare for your testimony?

15 MR. GLENN: Objection to the extent that
16 question calls for attorney work product, that the
17 witness may answer "yes" or "no" if she did or did not.

18 THE WITNESS: Yeah, I've never had any
19 communication with Molecular Design, but certainly I
20 have had communication with counsel.

21 BY MR. RIFFE:

22 Q. Okay. And in preparation for your deposition
23 today, did you meet with counsel for MRD?

24 A. Yeah. I had Zoom meetings with counsel.

25 Q. Okay. And when did those take place?

1 A. Oh, yesterday.

2 Q. Okay. And was that with Mr. Glenn, who is
3 present today?

4 A. Yes. Also with Mr. Zinda.

5 Q. How do you spell Mr. Zinda's last name?

6 A. Z-I-N-D-A, with the same law firm.

7 Q. Okay. And approximately how long was your
8 meeting with Mr. Glenn and Mr. Zinda yesterday in
9 preparation for your deposition today?

10 A. Could be four hours or so.

11 Q. And during that preparation, did you review
12 the documents that you previously identified for me in
13 preparation for your deposition?

14 A. More or less. We did not review, you know,
15 everything that -- the main -- main documents that
16 directly pertain to the declaration we kind of went
17 through.

18 Q. Okay. Other than yesterday's Zoom meeting
19 with Mr. Glenn and Mr. Zinda, did you have any other
20 meetings with counsel for MRD in preparation for your
21 deposition today?

22 A. Well, I had meeting to cover the kind of the
23 general gist of deposition.

24 Q. And when did that take place?

25 A. That took place -- just looking at my

1 calendar. Okay. June 23rd.

2 (Court Reporter requested clarification.)

3 BY MR. RIFFE:

4 Q. Was that meeting on June 23rd also conducted
5 by videoconference?

6 A. Yes.

7 Q. And approximately how long did that meeting
8 last?

9 A. Probably around four hours.

10 Q. And during that meeting, did you discuss --

11 A. I'm sorry.

12 Q. No. Please, go ahead.

13 A. It was not four hours. Could be one to two
14 hours.

15 Q. Okay. And, again, that -- that meeting was to
16 discuss general topics related to depositions; is that
17 correct?

18 A. Yes.

19 MR. GLENN: Objection to the extent the
20 question calls for attorney work product, but I'll allow
21 the witness to answer "yes" or "no."

22 THE WITNESS: Yeah. The discussion amounts
23 to, you know --

24 MR. GLENN: Objection and instruct the witness
25 not to answer if it includes attorney work product or

1 attorney communication.

2 BY MR. RIFFE:

3 Q. Do you recall the question, Dr. Chung?

4 A. Could you repeat the question?

5 Q. Sure. The question was: The meeting on
6 June 23rd was to discuss, as I think you testified
7 previously, general topics related to depositions in
8 general, correct?

9 MR. GLENN: Same objection. But will allow
10 the witness to answer "yes" or "no."

11 THE WITNESS: Yeah. It includes some --

12 MR. GLENN: And instruct the witness not to --
13 not to testify to attorney work product or attorney
14 communication. She may confirm the general nature of
15 the meeting, however.

16 THE WITNESS: Yes, I confirm that it was
17 directed to prepare me so that I know what I'm supposed
18 to do in that deposition.

19 BY MR. RIFFE:

20 Q. Okay. Thank you.

21 Outside of your meeting with counsel -- and
22 let me back up.

23 When I refer to MRD today in shorthand
24 version, is that acceptable to you that we're referring
25 to the patent owner, Molecular Rebar Design, in this

1 proceeding?

2 A. Yes.

3 Q. Okay. Thank you. Just wanted to make sure
4 that's clear for both of us.

5 Outside of your meeting with counsel -- the
6 two meetings you had with counsel for MRD, did -- and
7 your review of the documents in preparation for today's
8 deposition, did you do anything else to prepare for your
9 deposition today?

10 MR. GLENN: Objection. Ambiguous.

11 THE WITNESS: To tell the truth, I prayed.

12 BY MR. RIFFE:

13 Q. Well, we'll try not to have to inject that
14 into today's deposition hopefully, but I appreciate
15 that.

16 Okay. Did you have any meetings with any MRD
17 employees in preparation for your deposition today?

18 A. No.

19 Q. And let me just be clear. Outside of the
20 meeting that you had yesterday with Mr. Zinda and
21 Mr. Glenn for approximately four hours, did you spend
22 any time outside of that four hours reviewing documents
23 in preparation for your deposition?

24 A. Yes.

25 MR. GLENN: Objection to the extent it calls

1 for attorney work product.

2 BY MR. RIFFE:

3 Q. And approximately how many hours did you spend
4 reviewing those documents in preparation for your
5 deposition outside of those four hours you spent with
6 counsel yesterday?

7 A. Couple of hours.

8 Q. Okay. And do you recall the focus of that
9 document review? Was that directly related to your
10 declaration or something else?

11 MR. GLENN: Same objection.

12 THE WITNESS: It was centered at the
13 declaration, yes.

14 BY MR. RIFFE:

15 Q. Do you know Mr. Clive Bosnyak of MRD?

16 A. No.

17 Q. Do you know Mr. Kurt Swogger of MRD?

18 A. No.

19 Q. And do you -- do you understand that they are
20 the named inventors of the '649 patent we'll be
21 discussing today?

22 A. Yes. I'm more familiar with the first name
23 than the second name.

24 Q. Okay. All right. Have you ever -- I assume
25 you've never met either Mr. Bosnyak or Mr. Swogger; is

1 that correct?

2 A. That's correct.

3 Q. And have you ever spoken to Mr. Bosnyak or
4 Mr. Swogger before?

5 MR. GLENN: Objection. Asked and answered.

6 THE WITNESS: No.

7 BY MR. RIFFE:

8 Q. Have you had any discussions with any employee
9 of MRD today?

10 MR. GLENN: Same objection.

11 BY MR. RIFFE:

12 Q. Strike that.

13 Have you had any other discussions with any
14 other employee of MRD --

15 MR. GLENN: Same objection.

16 MR. RIFFE: What's the objection, Counsel?

17 MR. GLENN: It's been -- that's the third time
18 it was asked.

19 MR. RIFFE: I'm not asking in the context of
20 the deposition, Counsel. I'm now asking --

21 MR. GLENN: I apologize. I'll withdraw the
22 objection.

23 MR. RIFFE: All right.

24 BY MR. RIFFE:

25 Q. Did you have any -- have you had any

1 discussions with any other employees of MRD prior to
2 today?

3 A. No.

4 Q. Okay. And just to close this out, Dr. Chung,
5 have you ever been an employee of MRD?

6 A. No.

7 Q. Has MRD ever sponsored any of your research?

8 A. No.

9 Q. And outside of this IPR -- these IPR
10 proceedings, have you ever been paid by MRD for your
11 services?

12 A. No.

13 Q. Are you being paid by MRD currently for your
14 services with respect to these IPR proceedings?

15 MR. GLENN: Objection. Ambiguous.

16 THE WITNESS: I'm not directly paid by MRD.

17 BY MR. RIFFE:

18 Q. Okay. Are you paid by MRD's counsel for your
19 services with respect to these IPR proceedings?

20 A. Not directly either. There's -- there's a
21 company that refers experts, you know. That company
22 pays me.

23 Q. Okay. And what's that company's name?

24 A. Yes. Rubin -- Rubin An- something. The Rubin
25 An- --

1 Q. Could you spell that, to the best of your
2 ability?

3 A. Rubin is R-U-B-I-N, Rubin. And then "An-,"
4 A-N something.

5 Q. And what is your hourly rate that you are
6 charging for your services in these IPR proceedings?

7 A. 750.

8 Q. Do you know if this Rubin entity is adding any
9 additional rate to your hourly rate of \$750 in their
10 hourly charge to MRD?

11 A. Yes, they do.

12 Q. Do you know how much that is?

13 A. I don't know.

14 Q. Does your hourly rate of \$750 vary based on
15 whether you're providing testimony versus other types of
16 work?

17 A. No.

18 Q. It's a flat fee of \$750; is that correct?

19 A. Yes.

20 Q. Do you recall --

21 A. Rubin Anders.

22 Q. Rubin Anders, A-N-D-E-R-S; is that correct?

23 A. Yes.

24 Q. Okay. Thank you.

25 Do you recall how much you have billed to date

1 for this IPR proceeding related to the '649 patent?

2 A. About \$90,000.

3 Q. And do you recall how much in total --

4 A. I'm sorry. I should clarify that there are
5 five patents involved, you know. So there's not just
6 today's patent. And I deal with all five. That's why
7 it adds up.

8 Q. Sure. And that was going to be my next
9 question, so thank you for getting there.

10 So is it fair to say then that you have billed
11 approximately \$90,000 total for across all of the IPR
12 proceedings for which you've been retained on behalf of
13 MRD?

14 A. Yes.

15 Q. Thank you.

16 When were you first contacted to work on these
17 IPR proceedings on behalf of MRD?

18 A. I can't remember, but maybe half a year ago.
19 I really can't remember.

20 Q. And do you recall who contacted you first?

21 A. It was that company, Rubin Anders.

22 Q. Rubin Anders?

23 A. Yeah.

24 Q. And do you recall the reasons why you decided
25 to take on this work on behalf of MRD in these IPR

1 proceedings?

2 A. Well, I think it's something that my expertise
3 would help, be of value.

4 Q. And in the prior litigations and IPR
5 proceedings that we discussed earlier today, were you
6 retained for those proceedings through Rubin Anders as
7 well?

8 A. No.

9 Q. Were you retained directly for purposes of
10 those prior proceedings from either law firm or entity
11 involved?

12 A. I recall that it was also through these --
13 such companies that refer experts, but it's not this
14 particular company.

15 Q. Okay. So another third-party referral firm;
16 is that correct?

17 A. Exactly.

18 Q. And I know -- I may draw an objection from
19 counsel on this, but I'm trying to get a more specific
20 question here.

21 With respect to the preparation of your
22 declarations in this proceeding and/or the other
23 proceedings, did you have any discussions with any
24 employees of MRD for purposes of preparing your
25 declaration?

1 A. No.

2 Q. Is it fair to say then that for purposes of
3 preparing your declaration, those were prepared in
4 conjunction with your work with counsel for MRD?

5 A. Yes.

6 Q. Do you know if anyone at MRD reviewed your
7 draft declaration before it was filed in these
8 proceedings?

9 A. I don't know.

10 Q. Dr. Chung, I realize after having had the
11 opportunity to review your CV and some of your YouTube
12 videos, in fact, that you've published, that you have a
13 very accomplished career.

14 And so my colleagues who are on this call
15 today recognize you've had a very accomplished career
16 and even know your former colleague, Dr. Dresselhaus. I
17 did, however, want to explore a few additional things
18 regarding background with you, but I did want to make
19 note of that in the first instance, a very distinguished
20 career.

21 Now, in your declaration, which is, again,
22 MRD-2006, you note that you published 36 peer review
23 publications on carbon nanotube, carbon nanofiber,
24 carbon black and graphite nanoplate, correct?

25 A. Yes. Yes. Also carbon filament, which is the

1 original term for carbon nanofiber. Yes.

2 Q. Okay. And that was one of my questions as
3 well. You beat me to it again. So that's helpful.

4 And those 36 peer review publications appear
5 on page 9 of your declaration, correct, in paragraph 16?

6 A. Yes. I hope it adds up to 36. I suppose it
7 adds up to 36. Oh, yeah. Okay. All right.

8 Q. And then in your declaration at paragraph 17
9 on page 10, you specifically list several articles that
10 you say, quote, "pertain to the processing, structure,
11 properties, and applications of carbon nanotube and
12 related materials," end quote, correct?

13 A. Yes.

14 Q. And several of those are listed continuing on
15 over to page 13; is that right?

16 A. Yes.

17 Q. Are these references listed in your CV, and
18 specifically are those references listed in your CV
19 beginning at page 75 under the heading "Carbon" on page
20 75?

21 A. They should be. I'm sure they're listed in my
22 CV. But -- but they are to be listed in the Carbon, but
23 in this categorization in my CV might not be perfect,
24 but that's --

25 Q. Okay. And so there's no reason to believe

1 that any of these articles that you've listed in your
2 declaration would not be identified in your CV, correct?

3 A. That's right. Oh, yes. Oh, yes. Now I
4 remember. For the CV, it -- I have listed "Carbon" as
5 one category and "Cement-Matrix Composites" as another
6 category, "Polymer-Matrix Composites" as another
7 category. And these are the composites that can include
8 carbon, you know. And that's why the -- the listed
9 publications in my declaration I'm sure are not all in
10 the category of carbon of my CV.

11 Q. I see. And why did you choose to list out the
12 specific articles that begin on paragraph 17, page 10,
13 and extend over to page 13 in your declaration? Why did
14 you specify those particular articles in your
15 declaration?

16 MR. GLENN: Objection to the extent the
17 question calls for attorney work product.

18 THE WITNESS: I'm -- could you repeat, please?
19 BY MR. RIFFE:

20 Q. Sure. I want to understand why did you choose
21 to list the specific articles you chose to identify on
22 pages 10 through 13 in your declaration in paragraph 17.

23 MR. GLENN: Same objection.

24 THE WITNESS: Those publications pretty much
25 directly related to carbon filament, carbon nanotube,

1 carbon black. You know, those are really the most
2 relevant.

3 BY MR. RIFFE:

4 Q. Okay. Do any of the publications referenced
5 in paragraph 16 listed in paragraph 17 of your
6 declaration refer to or describe discrete carbon
7 nanotubes?

8 MR. GLENN: Objection. Ambiguous.

9 THE WITNESS: Could you repeat, please?

10 BY MR. RIFFE:

11 Q. Yes. Do any of the publications referenced in
12 paragraph 16 or listed in paragraph 17 of your
13 declaration refer to or describe discrete carbon
14 nanotubes?

15 MR. GLENN: Objection. Ambiguous.

16 THE WITNESS: I do not use such a term.

17 BY MR. RIFFE:

18 Q. What do you mean you do not use such a term?

19 A. That is, I don't have explicit mention of
20 discrete carbon nanotubes.

21 Q. And why is that?

22 A. Well, part of that because I often use the
23 term "carbon filaments." That's one of the reasons.
24 Another reason is I recognize that carbon nanotubes or
25 carbon filaments, whatever you call them, they -- they

1 come in an intertwined state, intertwined morphology.

2 That's the norm, you know; and with that norm, it's not
3 discrete.

4 Q. Have you -- have you used the phrase "discrete
5 carbon filament" before in your prior writing?

6 A. No.

7 Q. Why not?

8 A. Again, because the material comes in an
9 intertwined form, just not discrete.

10 Q. Are you aware of prior processes that
11 attempted to de-agglomerate or exfoliate these
12 agglomerated carbon filaments or nanotubes?

13 A. Well, because of this case, you know, I
14 certainly know that. But when I was writing these
15 papers, or publications, that -- I did not really -- I
16 was aware of the discrete nanotubes.

17 Q. Were you aware of exfoliated nanotubes or
18 nanofibers at the time of your writing? I apologize. I
19 misspoke.

20 Were you aware of exfoliated nanotubes or
21 carbon filaments when -- at the times of your prior
22 writings?

23 MR. GLENN: Objection. Ambiguous.

24 THE WITNESS: Actually, I -- I did publish on
25 exfoliated carbon filament. But it's not the same

1 meaning of the term "exfoliation" compared to what --
2 relevant to this particular case because I was
3 exfoliating one carbon filament, not -- not a whole
4 collection of carbon filaments, you know.

5 So I'm actually an expert in exfoliation of
6 carbon materials. And by that term, I mean exfoliating
7 a particular -- one particular filament, not a bunch of
8 them.

9 BY MR. RIFFE:

10 Q. And so in your publications with respect to
11 exfoliating carbon filament -- I just want to make sure
12 I'm understanding -- you were exfoliating a single
13 carbon filament at the time; is that correct?

14 A. Yes.

15 Q. And -- and it's your understanding that --
16 that single carbon filament could also be referred to as
17 a single carbon nanotube in today's terminology; is that
18 correct?

19 A. Yes.

20 MR. GLENN: Objection. Ambiguous.

21 THE WITNESS: I'm trying to remember. It's
22 been so long ago. The exfoliations that I did, I did it
23 on graphite, and I did it on carbon fiber. But I don't
24 think I did it on carbon filament. My recollection is
25 not perfect.

1 BY MR. RIFFE:

2 Q. Your -- to the best of your recollection, the
3 exfoliation you did was on carbon fiber; is that
4 correct?

5 A. Yes. Most of it was on graphite, actually.
6 But also on carbon fiber.

7 Q. So when you said earlier that you were
8 exfoliating a carbon -- a single carbon filament, is
9 that incorrect?

10 MR. GLENN: Objection. Mischaracterizes the
11 witness's testimony.

12 THE WITNESS: Yeah. My -- yeah, I think it's
13 incorrect because -- but based on my recollection at
14 this point, I did not do the exfoliations of a single
15 carbon filament.

16 BY MR. RIFFE:

17 Q. At the time of your prior articles on
18 exfoliation of graphite, were you familiar with the
19 concept of a single carbon filament or carbon nanofiber,
20 which is now referred to as carbon nanotube?

21 MR. GLENN: Objection. Ambiguous and
22 compound.

23 MR. RIFFE: And, Counsel, during these IPR
24 proceedings, my understanding -- and I've been very
25 careful in defending these -- not to use "vague and

1 ambiguous" as objections. I think they're called out as
2 improper in the trial practice guide.

3 So I'm not sure if you're trying to coach
4 Dr. Chung with those objections, but --

5 MR. GLENN: I'm simply --

6 MR. RIFFE: I'd ask that you adhere to the
7 trial practice guide or else we're going to have to get
8 in front of a judge this morning, which I despise to do,
9 but --

10 MR. GLENN: Understood. I'm actually trying
11 to do the opposite. I'll restrict my objection to form,
12 if that --

13 MR. RIFFE: I think that would be better.

14 MR. GLENN: Understood.

15 MR. RIFFE: Okay. Thank you.

16 THE WITNESS: Yeah. Just if you could
17 repeat --

18 BY MR. RIFFE:

19 Q. Sure. That's no problem.

20 So, Dr. Chung, I just want to unpack what
21 you've said in the last ten minutes.

22 Initially you said that you were exfoliating a
23 single carbon filament, but now you're saying that
24 you -- based on your recollection, you weren't doing
25 that. So I'm just trying to unpack what, if any,

1 familiarity you had with exfoliation of single carbon
2 nanofibers or single carbon filaments in the past.

3 MR. GLENN: Objection. Form.

4 THE WITNESS: I -- I did not do that. That is
5 the exfoliation of single carbon filament or single
6 carbon nanotube. And I doubt if anybody has done that.

7 However, I have done activation of the carbon
8 filament.

9 BY MR. RIFFE:

10 Q. And what do you mean by "activation of the
11 carbon filament"?

12 A. Just like activated carbon, you know. You
13 make it more porous. And just like activated carbon,
14 the porosity serves to get the junk so they can clarify
15 stuff.

16 (Court Reporter requested clarification.)

17 THE WITNESS: Activated carbon is well known
18 for its intended porosity, and the pores are where the
19 junk -- that is the impurities -- that you want to get
20 rid of. The junk will reside. That's why -- that's how
21 the activated carbon serves to purify fluid like air or
22 water.

23 So in a similar vein, I activated carbon
24 filament, and that -- that -- that was the very first
25 time that anybody did activation of carbon filament.

1 BY MR. RIFFE:

2 Q. And the carbon filament that you were
3 performing this activation of, was this an agglomerated
4 part of carbon filament, or were they discrete or
5 separated carbon filaments?

6 MR. GLENN: Objection. Form.

7 THE WITNESS: Not separated because the norm,
8 as I said, is the intertwined morphology.

9 BY MR. RIFFE:

10 Q. So the activation that you were performing was
11 on an intertwined morphology of the carbon filament; is
12 that correct?

13 A. Yes.

14 Q. Prior to your work in these Inter Partes
15 Review proceedings on behalf of MRD, had you heard of
16 the phrase, quote, "discrete carbon nanotubes," end
17 quote?

18 A. No.

19 Q. Had you heard of the phrase "exfoliated carbon
20 nanotubes"?

21 A. I might have heard of that, but I also
22 understood that it's not the exfoliations that the
23 original term "exfoliations" is supposed to mean, you
24 know. The original term of exfoliation of carbon
25 nanotube would mean doing exfoliation on a single

1 nanotube, you know.

2 And I realize that that original meaning of
3 exfoliation is not the meaning that pertains to the
4 present case.

5 Q. And what's the meaning of exfoliation that
6 pertains to the present case, in your opinion?

7 A. For the present case, there's no exfoliation
8 for -- you know, each carbon nanotube. It's just
9 untangling the collection of nanotubes so that they are
10 not so intertwined.

11 Q. And at that point you would disagree if
12 someone referred to those nonintertwined carbon
13 nanotubes as exfoliated; is that correct?

14 MR. GLENN: Objection. Form.

15 THE WITNESS: Could you clarify, please?

16 BY MR. RIFFE:

17 Q. Sure. At the point that the carbon nanotubes
18 are not intertwined, you would disagree with someone of
19 skill in the art that would refer to those nanotubes as
20 exfoliated; is that correct?

21 MR. GLENN: Objection. Form.

22 THE WITNESS: Well, it depends on what they
23 mean by exfoliation, you know. Understanding that they
24 don't mean the original meaning of exfoliation, then
25 it's okay, you know. So I have to search their hearts

1 to see what they mean by exfoliation.

2 BY MR. RIFFE:

3 Q. So if -- if someone in this industry referred
4 to exfoliated nanotubes as individually dispersed
5 nanotubes, would you agree with that reference?

6 MR. GLENN: Objection. Form.

7 THE WITNESS: Not exactly. Individually
8 disperse, that's more demanding than just untangling.

9 BY MR. RIFFE:

10 Q. So you would disagree with someone in the
11 industry that referred to individually dispersed --

12 MR. RIFFE: And I'm saying dispersed here,
13 Ms. Houston, with a P, as in Paul.

14 BY MR. RIFFE:

15 Q. You would disagree with someone in the
16 industry that referred to individually dispersed carbon
17 nanotubes as exfoliated, correct?

18 MR. GLENN: Objection. Mischaracterizes --

19 THE WITNESS: Oh, okay.

20 (Court Reporter requested clarification.)

21 MR. GLENN: Objection. Mischaracterizes the
22 witness's testimony.

23 THE WITNESS: Okay. This entanglement leads
24 to exfoliation, kind of pops up, you know, but that
25 doesn't mean that they become individually dispersed,

1 you know. That is, if it's individually dispersed, it
2 has to be exfoliated. But if it's exfoliated, it
3 doesn't have to be individually dispersed. So the two
4 scenarios are not identical.

5 MR. RIFFE: Okay. I'm going to strike that as
6 nonresponsive.

7 BY MR. RIFFE:

8 Q. My question is: If someone in the industry
9 refers to individually dispersed carbon nanotubes as
10 exfoliated, would you agree or disagree with that
11 person's definition?

12 A. I tend to agree with that. As I said already,
13 if it's individually dispersed, it -- it's exfoliated.

14 Q. Okay. Thank you.

15 Let's back up just a minute, Dr. Chung.
16 What -- what in general is a carbon nanotube? I've seen
17 many, many references to this, but I just wanted to see
18 what your understanding is.

19 A. Yes. A carbon nanotube is a form of carbon
20 nanofiber. And its structure is such that it consists
21 of one or more concentric cylinders. We call them
22 walls, you know.

23 And it could be -- one wall, we call it single
24 wall. Multiple walls, we call it multiwall nanotubes.
25 So basically a tube -- also is a tubular structure. So

1 that's -- there's a hollow channel in the middle along
2 the axis of the nanotube.

3 Q. And -- and I think I asked one of my
4 colleagues this. My simple mind of thinking here, is
5 that these carbon nanotubes are mono diameter; in other
6 words, they have a single diameter; is that correct?

7 MR. GLENN: Objection. Form.

8 THE WITNESS: Oh, no. Obviously between the
9 single wall and multiwall, there can be a really big
10 difference in the diameter. The more the number of
11 walls, the more is the diameter, and the number of walls
12 is a big barrier.

13 And so within the category of single wall,
14 then the diameter has less variation. But within the
15 category of multiwall nanotubes, then the variation in
16 the diameter is very large.

17 BY MR. RIFFE:

18 Q. And that's helpful and maybe my question
19 wasn't as good as I thought it was.

20 Take an instance where we have a single
21 single-walled nanotube, somehow we managed to
22 unagglomerate and we have a single single-wall nanotube.

23 Does that single nanotube have a consistent
24 diameter?

25 A. Yeah. For the single wall, the variation in

1 diameter is much smaller than that of the multiwall, but
2 it's still not -- not every single nanotube has exactly
3 the same diameter. It's not as exact as that.

4 Q. Understood. But if we take the instance of
5 this, if we're looking at one single nanotube, does that
6 nanotube have the same diameter across its length?

7 A. I see what you mean. For a single -- a
8 single-wall carbon nanotube along its length, ideally,
9 the diameter is constant.

10 Q. Okay.

11 A. But it might not be ideal because there can be
12 even functional groups sticking out, you know.

13 Q. Okay.

14 A. And even other defects like little nanoscale
15 indentation, you know. So in reality, it might not be
16 so constant.

17 Q. I see. Is it possible for a single
18 single-walled nanotube to break apart and then
19 reconfigure itself to another larger diameter
20 single-walled nanotube such that you had sort of -- you
21 ended up with a single-walled nanotube of a smaller
22 diameter connected to a single-walled nanotube of a
23 larger diameter?

24 A. Please clarify your question. Sounds
25 complicated.

1 Q. Okay. Maybe I'll just strike that just as
2 background. Okay.

3 We've -- we've said a lot of phraseology here
4 this morning, and I just want to make sure I'm clear
5 with you.

6 You say that a carbon nanotube is a type of
7 carbon nanofiber; is that correct?

8 A. Yes.

9 Q. Okay. And that carbon nanofiber was
10 originally known as carbon filament; is that correct?

11 A. Yes.

12 Q. So the progression has kind of been carbon
13 filaments were types of carbon nanofibers, and now
14 carbon nanofibers are now referred to as carbon
15 nanotubes in certain instances; is that correct?

16 A. In certain instances, yes. The carbon
17 nanotube is not the only type of carbon nanofiber, even
18 today.

19 Q. What are the other types of carbon nanofiber
20 besides carbon nanotubes?

21 A. Another type is also having the hollow tube in
22 the middle, but then instead of concentric cylinders of
23 carbon, it's got the carbon layers at an angle with
24 respect to the axis of the -- of the tube, and such that
25 the nanofiber is essentially a stack of ice cream cones.

1 It's like ice cream cones with the tip of each cone cut
2 off in the stack of this, okay, and that -- that is the
3 other type of carbon nanofiber.

4 Q. Does that have a specific name or label?

5 A. They call it fish bone morphology.

6 Q. Okay.

7 A. Ice cream cone, you know, like a fish bone.

8 Q. Okay. So they have a more sharper edge, if
9 you will, than the carbon nanotubes; is that correct?

10 MR. GLENN: Objection. Form.

11 THE WITNESS: Well, sharp edge sounds unclear
12 in meaning to me. But the thing is, you know, because
13 of the angle, the edge of the carbon layers would be
14 more exposed, yeah.

15 BY MR. RIFFE:

16 Q. Okay. That's helpful.

17 What are some applications of carbon
18 nanotubes?

19 A. Oh, there are numerous applications, both
20 mechanical and electrical, you know. Concerning the
21 mechanical side, the carbon nanotube within the tube is
22 very strong in terms of bolstering an elastic modulus.
23 And so it can be a very good reinforcement. Okay.
24 That's the mechanical side.

25 The electrical side is that it's electrically

1 conducted, and it is -- the aspect ratio can be
2 substantial because of the tiny diameter of the nanotube
3 that is compared to, say, short carbon fiber. Okay?

4 By "fiber," I mean the conventional micron
5 diameter fiber. Compared to short carbon fiber, the
6 carbon nanotube tends to have larger aspect ratio, and
7 the larger aspect ratio would enhance the chance of
8 developing percolation. That is forming a continuous
9 electrical network because of the touching of one
10 nanotube with another nanotube.

11 And having longer aspect ratio makes it more
12 likely to have these contact points, and these contact
13 points are essential for percolation. That is for the
14 entirety of the collection of nanotubes to provide a
15 continuous electrically conductive path.

16 And so conductivity is another big application
17 area of the nanotubes.

18 Q. Okay. That's very helpful. So you agree that
19 then, I think based on what you just told me, that these
20 carbon nanotubes are known for having a length that's
21 significantly larger than their diameter which leads
22 generally to them having a higher aspect ratio; is that
23 right?

24 A. Yes.

25 Q. And -- and based on what you've told me --

1 just make sure my understanding is correct -- this high
2 aspect ratio of the carbon nanotubes contribute their
3 ability to form percolating networks within a matrix
4 material; is that right?

5 A. Yes.

6 Q. And that's helpful -- in some instances
7 crucial -- for achieving high conductivity; is that
8 right?

9 A. Yes.

10 Q. What are the common types of carbon nanotubes
11 in terms of -- I want to make that a little more
12 precise. What are the common structures of carbon
13 nanotubes? I think we've talked about some of them, but
14 in your opinion, in your expertise, what are some of
15 those common structures?

16 A. Well, the main is pertaining to the diameter,
17 and that relates to the number of walls.

18 Another is the length. The length is limited;
19 you know, very far from infinity. And so the length,
20 the diameter, and its associated aspect ratio, those are
21 -- from the point of view of the geometry, that's
22 important characteristics.

23 But there are other characteristics such as
24 the surface chemistry which relates to the
25 functionalization, and that can -- the functionalization

1 provides the surface function loop to stick out from the
2 trunk of the nanotube, and that's allowing the nanotube
3 to interact with other species around and -- and the
4 functionalization can greatly affect the behavior of the
5 nanotube.

6 Q. In terms of the wall, carbon nanotubes are
7 either single wall or multiwall; is that correct?

8 A. Yes. Multiwall, including double wall, triple
9 wall, and so on, yes.

10 Q. Okay. And it seems to me like these
11 single-wall or multiwall nanotubes can have almost an
12 infinite number of geometrical configurations; in other
13 words, they can be anywhere from very -- very straight
14 carbon nanotubes, sort of wormy-looking carbon
15 nanotubes, if you will, or even could they be formed
16 into a doughnut shape in some instances?

17 A. I'm not sure what you mean by the doughnut
18 shape. You mean the collection of nanotubes making a
19 doughnut?

20 Q. I'm thinking of a single nanotube, if you
21 will. So we have a single-walled nanotube that could be
22 straight. It could be sort of wormy, if you will,
23 looking -- if you look at it under a microscope.

24 Could a single-walled nanotube be formed into
25 a doughnut; in other words, if you took the ends and

1 brought them around; is that a possibility?

2 A. Well, the nanotubes condense, right?

3 Q. Right.

4 A. And that's why, when you said "wormy," you
5 know, it's condensed. And you can -- but, you know, you
6 can bend it and have the two ends kind of almost meet or
7 meet, but I don't mean joining, you know, just kind of
8 closed like a doughnut. But I think the radius of
9 curvature obviously cannot be too tiny; you know, tiny
10 doughnut.

11 Q. Right. Right.

12 A. Too sharp a bend. So bendable, you know.
13 There's a limit to how sharp a bend you can have it.

14 Q. So it's true then that if you bend the carbon
15 nanotube too far, it will break; is that correct?

16 A. Yes.

17 Q. Under certain conditions. Okay.

18 Are single-walled nanotubes used in
19 applications instead of multiwalled nanotubes, and vice
20 versa, even?

21 A. Yeah. Because of the diameter difference, the
22 single-wall and multiwall nanotubes tend to be different
23 in their attractiveness for various applications.

24 Because of these tinier diameter of the
25 single-wall nanotube, it -- if you have a long enough

1 single-wall carbon nanotube, the aspect ratio can be
2 very large. That is, for the same length with the
3 carbon -- a single-wall carbon nanotube would have a
4 higher aspect ratio than a multiwall. Okay?

5 And the larger of the aspect ratio, the more
6 is the chance of developing a percolative network, you
7 know, electrically connected network through
8 percolation.

9 And that means you would need a lesser amount,
10 say by volume, of the nanotubes to achieve percolation.
11 And that saves money and efficient to having other
12 attractiveness such as the dispersion being not so
13 viscous.

14 MR. GLENN: Counsel, we've been going about
15 like an hour. I just don't know if you want a quick
16 break. I'm fine. Just check in with the witness just
17 for logistics purposes if you wanted a quick break
18 somewhere.

19 BY MR. RIFFE:

20 Q. Dr. Chung, would you like to take a break?

21 A. Okay. Maybe just five minutes then.

22 MR. RIFFE: Okay. That's fine. We'll come
23 back around 10:20.

24 (Recess: 10:15 a.m. to 10:25 a.m.)
25

1 BY MR. RIFFE:

2 Q. Dr. Chung, before the break, we were talking a
3 little bit about single-walled nanotubes and multiwalled
4 nanotubes and their application.

5 I next want to move to a different question.
6 Are there uses of carbon nanotubes on their own, or are
7 they always added in a mixture or dispersion with other
8 elements?

9 MR. GLENN: Objection. Form.

10 THE WITNESS: Both. Both on their own and as
11 part of the composite.

12 BY MR. RIFFE:

13 Q. Okay. What are some uses on their own that
14 carbon nanotubes have?

15 A. It is for both mechanical and electrical.
16 Because there are some situations where you want very
17 tiny -- very microscale kind of devices, and you want
18 reinforcement to be in a very tiny, tiny scale.

19 Now, composites can be big scale. But if you
20 deal with a single nanotube, it can be really tiny
21 scale, and in some micro devices, they might need that
22 tiny scale. Whether mechanical or electrical, that tiny
23 scale is beneficial for micro devices.

24 So it can be by itself or as a connection,
25 yes.

1 Q. And in that instance where you say that you
2 could have a single nanotube in a micro device for
3 mechanical or electrical benefits, is that a single
4 individual nanotube, or is it an agglomeration of
5 nanotubes that are used in that sort of micro device
6 application?

7 A. Like I said, if you want it to be a really,
8 really micro device, then having a big agglomerate would
9 not be suitable because you want it really, really tiny.
10 So it depends on how tiny you want it. If you want it
11 to be really, really tiny, you don't want a big
12 agglomerate.

13 Q. Are you familiar with micro devices that use
14 single carbon nanotubes in the past either for an
15 electrical or mechanical application?

16 A. In the first instance, one can make electrical
17 devices such as transistors. Okay. For a transistor,
18 you need different electronic components on the
19 different materials, the semi-conductive ones and
20 metallic ones.

21 And single carbon nanotube can be rendered
22 metallic or semi-conducting. So you can have an
23 assembly of carbon nanotubes, the metallic ones and
24 semi-conductive ones, and assemble that into a
25 transistor. That's kind of the research direction

1 that's very active right now.

2 Q. And how do they go about separating those
3 nanotubes to apply them in that single nanotube
4 application?

5 A. It's -- it's tedious work. It's never easy.
6 But there can be mechanical or electrical ways of doing
7 that. I'm not an expert in the details of how they do
8 it, but it can be done.

9 Q. Can you buy from a supplier -- strike that.
10 Can you specify from carbon nanotube suppliers
11 that you want individualized single carbon nanotubes?

12 A. I don't think so.

13 Q. Is it your understanding that any commercially
14 available carbon nanotubes would be shipped or present
15 in an agglomerated fashion?

16 A. Yeah. Intertwined fashion, yes.

17 Q. How are these carbon nanotubes generally
18 provided to a researcher or to another company? What
19 form do they take? Do they take a powder form, an
20 emulsion, or both?

21 A. Yeah, a solid form. You can call it powder.
22 A solid form is the most common. But in the form of a
23 dispersion, it's possible too. But most often it's in
24 the solid form.

25 Q. But when you say "most often it's in the solid

1 form," it's an agglomeration, or it's a powder of
2 collection of nanotubes?

3 A. I'm not sure what you mean by "powder."

4 Q. What do you mean when you say a solid form?

5 A. Not a solid liquid combination. It's just
6 solid.

7 Q. We look at it under a microscope, it's an
8 agglomeration of nanotubes in a solid form?

9 A. Yeah. But agglomeration would be a solid, you
10 know.

11 Q. Right. Right.

12 A. So solid is not limited to agglomerate.

13 Q. But would those -- would that starting solid
14 material have individualized nanotubes in it?

15 MR. GLENN: Objection. Form.

16 THE WITNESS: The -- it comes in intertwined
17 morphology, you know. If you want it not intertwined,
18 you have to --

19 BY MR. RIFFE:

20 Q. Process it?

21 A. -- process it yourself. I don't think you can
22 buy something that's already, you know, individualized.

23 Q. Have you or your research teams performed
24 research on the implementation of these individual
25 carbon nanotubes in micro devices as you described

1 earlier?

2 A. No. I haven't done that.

3 Q. But are you aware of industry participants
4 that use individualized carbon nanotubes in these micro
5 device implementation?

6 MR. GLENN: Objection. Form.

7 THE WITNESS: I'm aware of such work in
8 research, you know, in universities, but I'm not sure
9 this industrial kind of work on that.

10 BY MR. RIFFE:

11 Q. And the work that you're aware of in the
12 university setting, was your awareness before or after
13 you became involved in work on these Inter Partes Review
14 proceedings?

15 A. Before.

16 Q. How -- how much -- how much in the past were
17 you aware or -- at what point in the past did you become
18 aware of this work on the micro device implementation
19 that you described today?

20 A. Well, it starts with me where the carbon
21 nanotubes can be metallic or semi-conductive. That was
22 the big discovery of Professor Dresselhaus, my mentor.
23 And that is the -- that is the discovery which make
24 possible of what I just said about micro devices
25 involving metallic form of nanotube in semi-conductive

1 form.

2 So the start of the thinking, you might say,
3 is the discovery made by Professor Dresselhaus.

4 Q. And, again, those are -- those were single
5 individualized nanotubes at the time for use in those
6 micro devices as you described earlier; is that correct?

7 MR. GLENN: Objection. Form.

8 THE WITNESS: They don't have to be single.
9 Okay.

10 BY MR. RIFFE:

11 Q. Could they -- could they have been?

12 A. It depends on -- at the very beginning, I
13 should say, the discovery, that -- that is actually
14 theoretical. Okay? Depending on the detailed
15 structure, which is called the chirality of the
16 nanotube, it can end up metallic or semi-conductive, and
17 that can -- as a theoretical prediction, and then it was
18 verified experimentally.

19 But that -- that doesn't mean that you have to
20 deal with a single nanotube. You can have a collection,
21 which is all metallic or collection, which is all
22 semi-conductive.

23 Q. Okay. And I -- that's what I just wanted to
24 clarify because earlier I think in your testimony you
25 said that there are uses in these micro devices where a

1 single carbon nanotube could provide the structural or
2 electrical characteristic that you're looking for.

3 I just want to make sure that -- is it a
4 single carbon nanotube that can provide that or an
5 agglomeration of nanotubes? Which one were you
6 referring to?

7 A. As I said, it can be a single having, say,
8 semi-conductive behavior. It can be a collection such
9 that all of the units in that collection are
10 semi-conducted. You know, but if you have a collection,
11 with some nanotubes being metallic and some being
12 semi-conducted, then you have a mess.

13 Q. Do you agree that carbon nanotubes typically
14 have lengths ranging from nanometers to centimeters?

15 A. Oh, not that long. Even in a micrometer
16 range, it's considered to be long. A centimeter is a
17 few orders of nanotube, longer than a micrometer.

18 Q. So would it be more correct to say that the
19 lengths vary from nanometers to micrometers?

20 A. Yeah, that would be more realistic.

21 Q. And what diameter ranges does -- do carbon
22 nanotubes have? Are those generally in the nanometer
23 range?

24 A. Yes. Yes, but it -- it can -- by nanometer
25 range, I don't mean one nanometer range. It can be 10

1 nanometer, even larger. But, yeah, it is nanometer
2 scale, yeah.

3 Q. I earlier asked you if single-walled nanotubes
4 have certain applications instead of multiwall
5 nanotubes, and we kind of got into this next question,
6 but I just wanted to make sure that I have a full record
7 here.

8 Do agglomerated carbon nanotubes have
9 different uses than discrete carbon nanotubes? And if
10 so, what are some examples?

11 MR. GLENN: Objection. Form.

12 THE WITNESS: So, see, what you call
13 agglomerated, I suppose you mean interconnected from the
14 network. Okay? And that is widely used for composites
15 or whatever components that need high electrical
16 conductivity, because each individual nanotube cannot be
17 very long. That -- you want the conductivity to be over
18 a substantial distance, so you cannot achieve that with
19 a single nanotube. The single one is too short.

20 So you need multiple nanotubes, and you need
21 them to touch one another. That's what I mean by a
22 continuous electrically connected network.

23 And that form is very widely used. The
24 discrete form of the single individualized form is much
25 less used, and -- and the utilization could be in terms

1 of mechanical or electrical, but in a way that is more
2 microscopically directed. As a reinforcement or as an
3 electrically conductive path, it's for a microscopic
4 region, not over a big region.

5 BY MR. RIFFE:

6 Q. So are there applications, specific
7 applications or examples that you could provide where
8 that single individualized form is used? I know it's
9 used less than the -- the interconnected, but are -- are
10 there some specific examples that you're aware of where
11 those discrete forms are used?

12 MR. GLENN: Objection. Form.

13 THE WITNESS: I have not read papers that --
14 that deal with that. But I see the feasibility of using
15 that in those small situations, microscopic situations.
16 But I -- I haven't read papers that specifically talk
17 about that.

18 BY MR. RIFFE:

19 Q. That's fine.

20 So if nanotubes are being added to improve
21 electrical conductivity, like you said, the
22 interconnectivity, is it your view that those nanotubes
23 cannot be discrete?

24 MR. GLENN: Objection. Form. Objection.
25 Mischaracterizes the witness's testimony.

1 THE WITNESS: Yeah. As I said, for
2 percolation, there has to be contact between one
3 nanotube unit and another nanotube unit. And that
4 connectivity results in a continuous conductive path,
5 which is necessary.

6 And if you don't have this conductive network,
7 you would -- let's say you have just a single one, then
8 it's so short. You can still do it, but it's so short.
9 And so between point A and point B, you can still
10 connect electrically, but the distance between A and
11 B has to be very small.

12 BY MR. RIFFE:

13 Q. And that's -- that's more along the
14 microscopic scale that you were referencing earlier, I
15 take it; is that correct?

16 A. Yes.

17 Q. Okay. And just to make sure I've got a clear
18 record, you said for percolation there has to be contact
19 between one nanotube unit and the other nanotube unit,
20 and that connectivity results in the continuous
21 conductive path, which is necessary, correct?

22 A. Yes.

23 Q. And with individualized or discrete carbon
24 nanotubes, you just can't obtain that, maybe just for a
25 microscopic distance, if you will?

1 MR. GLENN: Objection. Form.

2 Mischaracterizes the witness's testimony.

3 BY MR. RIFFE:

4 Q. Is that right? Do you recall the question?

5 A. Can you clarify --

6 Q. I said with individualized or discrete carbon
7 nanotubes, you can't obtain that except for in that --
8 in that example you provided in that very short
9 microscopic distance; is that correct?

10 MR. GLENN: Same objections.

11 THE WITNESS: Yes. You want to electrically
12 connect point A and B using a single nanotube. Then the
13 distance between A and B has to be very small, yes.

14 BY MR. RIFFE:

15 Q. In your opinion, do discrete carbon nanotubes
16 have any advantages over agglomerated or carbon
17 nanotubes?

18 MR. GLENN: Objection. Form.

19 THE WITNESS: Yeah. If one doesn't want the
20 electrical conductivity, then one doesn't need the
21 percolated form. So under that situation, the discrete
22 form may be attractive for some other reasons.

23 BY MR. RIFFE:

24 Q. What reasons?

25 A. As I said, you might have a situation where

1 you want to interconnect between -- electrically connect
2 between point A and point B, and the point A and point
3 B are very close to each other. And so that's a
4 scenario where it's a very short distance, and the
5 single one would suffice.

6 Q. Are there any other reasons that you would
7 want to use those discrete individualized carbon
8 nanotubes other than this situation where you have this
9 very short distance to connect point A and B?

10 MR. GLENN: Objection. Form.

11 THE WITNESS: Yeah, you -- you can have -- I
12 mention about electrical conduction -- electrical
13 connection between A and B. They have to be very close
14 together.

15 But another application is not electrical but
16 mechanical. Okay? That is, you have an object, which
17 is -- which is the A and B inside the object, you know,
18 and A and B are very close -- and the distance is small
19 between A and B. Okay? Then you can consider having a
20 single one to provide the reinforcement, okay, over the
21 distance from A to B.

22 BY MR. RIFFE:

23 Q. What types of applications are you referring
24 to? Are you referring to semi-conductors? Are you
25 referring to other types of micro devices?

1 A. It's the general situation. For
2 semi-conductors, they don't care that much about
3 mechanical. It's mostly electrical. Okay? But for a
4 lot of other applications, such as battery electrodes,
5 they care about mechanical, not just electrical. So it
6 depends on the application whether they care about
7 mechanical or not.

8 Q. And it's your opinion that a single carbon
9 nanotube can provide reinforcement in those
10 applications?

11 MR. GLENN: Objection. Form. Objection.
12 Mischaracterizes the witness's testimony.

13 THE WITNESS: It can provided that the -- the
14 single nanotube is sufficiently bonded to that entity
15 that it's supposed to reinforce.

16 BY MR. RIFFE:

17 Q. And in the context of battery electrodes where
18 you say they're -- they care about mechanical
19 properties, how does a single carbon nanotube provide
20 such mechanical properties in those applications?

21 A. In a battery electrode, particularly a lithium
22 ion battery, it involves intercalation during charging
23 and de-intercalation during discharge. And in
24 intercalation you have expansion because you're putting
25 something in. In de-intercalation, you have

1 contraction.

2 And so you have dimensional change. And you
3 have many cycles of charge, discharge, charge, discharge
4 and so many cycles of expansion and contraction. And
5 that can lead to fatigue, you know. And that can lead
6 to mechanical degradation of the electrode, even
7 fracture of the active particles.

8 And when the active particles are fractured,
9 you lose both electrical and mechanical performance.
10 Electrical performance goes back because you have a
11 crack there within a particle, an actual particle. You
12 have a crack within it, and so it's almost like a little
13 open circuit within it, so it would make the electrical
14 connectivity much worse, the electrical cracking that --
15 but the mechanical also that -- and you have a crack
16 there.

17 But a battery electrode doesn't need high
18 strength, but it cannot be too flimsy. So when the
19 particles are cracked, it can be kind of flimsy.

20 Q. Why do the nanotubes have to be discrete to
21 prevent these fractures that you just described?

22 MR. GLENN: Objection. Form.

23 THE WITNESS: Okay. These particles are not
24 very big, and you want to make the particles have a
25 lower tendency to crack. Okay. And so you need kind of

1 a mechanical bridge to cut -- to go across that particle
2 to kind of constrain the particle in case it wants to
3 crack.

4 And so for that constraining, for that one
5 particle, you don't need a long length of the nanotube.

6 So even one could suffice provided that, as I
7 said, that that one nanotube is sufficiently bonded to
8 that particle.

9 If you have multiple nanotubes, it's possible;
10 but then it -- they -- but what I mean is that it's not
11 required. Okay?

12 BY MR. RIFFE:

13 Q. You would agree with me that in these -- in
14 these applications in the electrodes you've been
15 discussing this morning, discrete carbon nanotubes are
16 not required to provide that structural characteristic,
17 correct?

18 MR. GLENN: Objection. Form.

19 THE WITNESS: You want at least one nanotube
20 to do this reinforcement between A and B, you know,
21 within the particle. Okay. And you want to make sure
22 that at least one is doing that, and so -- and if you
23 have a bunch of that, not all of that may be physically
24 connected or bonded to that particle, the active
25 particle. Okay?

1 It has to be bonded to it. If you have an
2 agglomerate and only the outer -- outer -- outermost
3 unit of the nanotube is bonded to this particle, and the
4 rest is not bonded, then the rest is not participating
5 in the reinforcement. Any nanotube can participate in
6 the reinforcement only if it's sufficiently bonded to
7 that entity that is being reinforced.

8 So if you have a bundle, you might be wasting
9 a large part of your bundle because a large part of the
10 bundle might not be sufficiently bonded to the entity
11 that you want to reinforce.

12 BY MR. RIFFE:

13 Q. You would agree with me, however, that you
14 could use nondiscrete carbon nanotubes. It just may not
15 be as efficient if you -- if you were to use a two or
16 three, if you will, bundled nanotubes versus a single
17 discrete individualized nanotube, correct?

18 MR. GLENN: Objection. Form.

19 THE WITNESS: Could you rephrase, please?

20 BY MR. RIFFE:

21 Q. Sure. You could certainly use a bundled set
22 of nanotubes in this application, in the electrode
23 application. It just may not be as efficient as using a
24 single individualized nanotube as you've testified to
25 earlier; is that correct?

1 A. There are other complications of using a
2 bundle as opposed to a single because within the bundle
3 you have empty space, right, between the adjacent units
4 of the nanotube in the bundle. You have some empty
5 space there.

6 And -- and other things can get into the empty
7 space -- empty space like impurities from the
8 environment. Even the binder itself can get -- get in.
9 And it just complicates matter.

10 And in addition, when you have a bundle,
11 the -- the single carbon nanotube that happens to be
12 touching that entity to be reinforced is mechanically
13 constrained on the other side by the rest of the bundle,
14 you know. It's like baggage. The rest of the bundle is
15 like a baggage for this single nanotube that is touching
16 the entity to be reinforced.

17 So it's got that baggage at its back that
18 would make a single nanotube not -- not so free in doing
19 what it wants to do. So there can be various
20 complications if one has a bundle.

21 Q. Dr. Chung, could you please explain to me how
22 you prepared your declaration?

23 MR. GLENN: Objection to the extent the
24 question calls for attorney work product.

25 THE WITNESS: Well, I reviewed those various

1 documents, as I mentioned to the board, and I look --
2 looked at the various concepts inside in the context of
3 how I understand the subject is. I looked at those --
4 whether I agree with or not agree with some of the
5 concepts presented by various documents, I try to
6 formulate some -- some reasons.

7 Now, if I don't agree, I say why I don't agree
8 so a lot of thinking -- a lot of thinking is involved in
9 association with reviewing all those documents. And
10 obviously I also have discussion with the counsel, and
11 the counsel helps me in -- in putting my thoughts in a
12 format which -- which is required for the declaration.

13 BY MR. RIFFE:

14 Q. Did you write the first draft of the
15 declaration, or did your counsel provide you with the
16 first draft?

17 MR. GLENN: Objection. Calls for attorney
18 work product. We would instruct the witness not to
19 answer.

20 (Witness instructed not to answer the
21 question.)

22 BY MR. RIFFE:

23 Q. Are you going to follow the instruction not to
24 answer?

25 A. Well, it's a joint effort.

1 Q. But did you write portions of the declaration
2 and then the attorneys wrote other portions?

3 MR. GLENN: Same objection. Instruct the
4 witness not to answer.

5 (Witness instructed not to answer the
6 question.)

7 BY MR. RIFFE:

8 Q. Are you going to follow the instruction not to
9 answer?

10 A. Yes.

11 MR. RIFFE: Counsel, you're not going to allow
12 her to answer whether she wrote portions of the
13 declaration or the attorneys wrote other portions; is
14 that your standing objection?

15 MR. GLENN: It is.

16 BY MR. RIFFE:

17 Q. How much time in total did you spend drafting
18 your declaration, Dr. Chung?

19 A. A lot.

20 Q. Do you recall how many hours?

21 A. It's a lot of hours. I told you how many --
22 how many dollars. Now you can divide by hourly rate and
23 you know how many hours I spent pretty much.

24 Q. Right. So you spent 120 hours in total across
25 the five IPRs, correct? You spent about -- you charged

1 about \$90,000 at \$750 an hour. That comes to about
2 120 hours if my calculator is correct.

3 Does that sound correct?

4 MR. GLENN: Objection. Form.

5 THE WITNESS: I don't -- I don't have my -- I
6 can use my calculator if you want me to check your math.

7 Yeah, your math is right. 120 hours, and then
8 you divide by five, right, because there are five
9 patents. So that would be 24 hours. Something like
10 that.

11 BY MR. RIFFE:

12 Q. You didn't spend 24 hours drafting this
13 declaration, MRD-2006, correct?

14 MR. GLENN: Objection. Form.

15 THE WITNESS: If drafting means actually --
16 and I'll preface it, writing things, it's -- it's -- I
17 consider declaration preparation, which is not just
18 drafting. It's a lot of thinking involved.

19 BY MR. RIFFE:

20 Q. So is it fair to say that in total in
21 reviewing documents, discussions with counsel for MRD
22 and then drafting portions of your declaration, you
23 spent approximately 24 hours on this IPR proceeding; is
24 that correct?

25 MR. GLENN: Objection. Form.

1 THE WITNESS: More or less, roughly.

2 BY MR. RIFFE:

3 Q. Let me ask you this question: Did you
4 actually type any portion of your declaration into a
5 word processing software feature? Or did you rely on
6 counsel to do the drafting?

7 MR. GLENN: Objection. Form.

8 THE WITNESS: I might have done part of that,
9 and I might have also verbally told the counsel. I
10 think I've done both.

11 BY MR. RIFFE:

12 Q. Did anyone help you form your opinions set
13 forth in your declaration?

14 MR. GLENN: Objection. Form.

15 THE WITNESS: No other person. I discuss with
16 counsel to a degree, but no -- the thoughts come from me
17 alone.

18 BY MR. RIFFE:

19 Q. Are you aware of any errors in your
20 declaration that you'd like to make note of on the
21 record and correct at this time?

22 A. There might be a little bit of really
23 nonessential errors that anybody can see it's not -- not
24 really... so there's nothing really important enough to
25 really go through.

1 Q. Maybe -- maybe that's your opinion, but I
2 might disagree with you on that.

3 Did you note any errors that you
4 specifically -- let me strike that.

5 Are there any errors in your declaration that
6 you would like to note on the record at this time?

7 A. I've noticed a couple, but I did not jot them
8 down. So I'm not sure if I can get those couple so
9 quickly.

10 Q. Do you understand what the nature of those
11 errors were? Were they typographical errors or
12 substantive errors?

13 A. It's not substantive. It's just like missing
14 a word or messing up with one word or something like
15 that.

16 Q. Well, if we -- as part of the review of your
17 declaration, if you -- if you come across that error,
18 will you please let me know about that?

19 A. Sure.

20 Q. Okay. Thank you.

21 If you will, turn to page 67 of your
22 declaration, and let me know when you're there.

23 A. Yes, I'm there.

24 Q. Is that your signature on page 67 of the
25 declaration?

1 A. Yes.

2 Q. Did you insert your signature, or did Counsel?

3 A. I did.

4 Q. And did you sign the declaration on
5 March 31st, 2025?

6 A. Yes.

7 Q. Are you aware of any changes that were made to
8 your declaration after you signed it on March 31st,
9 2025?

10 A. No.

11 Q. Turn to Section 3 of your declaration. It
12 begins on page 13.

13 A. Yes.

14 Q. And this is a legal standard. In paragraph 19
15 on page 13 you state: "I am not an attorney. For
16 purposes of this declaration, I have been informed about
17 certain aspects of the law that are relevant to my
18 opinions, as set forth below."

19 Do you see that?

20 A. Yes.

21 Q. And then you go on to discuss patentability on
22 page 14, prior art on page 19, inherency on page 20,
23 person of ordinary skill in the art on page 20, and then
24 claim construction on page 22. And that section ends on
25 page 23, correct?

1 A. Yes.

2 Q. Okay. What's your understanding of the
3 difference between whether prior art anticipates or
4 renders obvious a claim?

5 A. Okay. Excuse me, I have to look.

6 Q. Sure.

7 A. "For a patent claim to be anticipated by the
8 prior art, each and every element or requirement of the
9 claim must be found expressly or inherently in a single
10 prior art reference.

11 "Anticipation requires that the single prior
12 art reference must disclose the elements of the claim
13 arranged or combined in the same way as in the claim.

14 "A claimed invention is obvious if the
15 differences between the claimed invention and the prior
16 art are such that the claimed invention as a whole would
17 have been obvious before the effective filing date of
18 the claimed invention to a person having ordinary skill
19 in the art.

20 "Obviousness requires consideration of the
21 following underlying factual inquiries:"

22 One: "Determining the scope and content of
23 the prior art."

24 Two: "Ascertaining the differences between
25 the claimed invention and the prior art."

1 Three: "Resolving the level of ordinary skill
2 in the art."

3 Four: "Violating objective evidence or
4 secondary considerations of nonobviousness such as
5 experimental results, commercial success, long felt but
6 unresolved need, failure of others, industry praise and
7 unexpected results."

8 "A reference must be analogous art to the
9 claimed invention in order to be properly considered for
10 use in an obviousness inquiry."

11 "A reference is analogous art to the claimed
12 invention if:"

13 Number one: "The reference is from the same
14 field of endeavor as the claimed invention, even if it
15 addresses a different problem."

16 Or, number two: "The reference is reasonably
17 pertinent to the problem faced by the inventor even if
18 it is not in the same field of endeavor as the claimed
19 invention."

20 "Whether a reference is reasonably pertinent
21 depends on how the problem faced by the inventor is
22 reflected, either explicitly or implicitly, in this
23 specification."

24 Q. And you were reading from photographs 22 to 27
25 of your declaration in that answer, correct?

1 A. Yes.

2 Q. Outside of what you just read, do you have an
3 understanding of the difference between what is
4 anticipation of a claim versus what is obviousness of a
5 claim?

6 MR. GLENN: Objection. Calls for a legal
7 conclusion.

8 THE WITNESS: I'm not understanding your
9 question very well.

10 BY MR. RIFFE:

11 Q. Outside of the paragraph that you just read,
12 do you have any other understanding of the differences
13 between anticipation and obviousness of a claimed
14 invention?

15 MR. GLENN: Same objection.

16 THE WITNESS: Well, I -- I could read more
17 because what I read is not everything.

18 BY MR. RIFFE:

19 Q. Okay.

20 A. I could read more if you want.

21 Q. I'm not going to ask you to read into the
22 record your declaration for certain. Okay.

23 Is it your understanding that each of the
24 asserted grounds of unpatentability set forth in the
25 petition filed in this IPR against the '649 patent are

1 based on the obviousness of the challenged claims?

2 A. Obviousness is -- is -- yes.

3 Q. Okay. Turn to page 20 of your declaration.

4 A. Yes.

5 Q. And will you explain why you included a
6 section on inherency here?

7 A. It is good to --

8 (Videoconferencing interruption; Mr. Glenn
9 dropped from Zoom.)

10 MR. RIFFE: Let's go off the record for a
11 moment.

12 (Short pause in the proceedings.)

13 BY MR. RIFFE:

14 Q. At page 20 of your declaration, Dr. Chung, you
15 included paragraphs 37 and 38 on the concepts of
16 inherency. And I just wanted to note why you included
17 this section on inherency here.

18 MR. GLENN: Objection to the extent the
19 question calls for attorney work product.

20 THE WITNESS: If a prior art reference does
21 not expressly set forth a particular claim element, the
22 prior art may still disclose that element if it is
23 inherent in its disclosure.

24 BY MR. RIFFE:

25 Q. Are you aware if Petitioner has relied on

1 inherency in the petition in this IPR proceeding?

2 MR. GLENN: Objection to the extent it calls
3 for a legal conclusion.

4 You may answer, Dr. Chung, to the extent that
5 you know.

6 THE WITNESS: I -- I believe that this -- this
7 is relevant to the case.

8 BY MR. RIFFE:

9 Q. And what's that based on?

10 MR. GLENN: Objection to the extent it calls
11 for attorney work product.

12 THE WITNESS: I haven't studied it in -- in
13 the angle of inherency.

14 BY MR. RIFFE:

15 Q. Then why do you believe it's relevant to the
16 case if you haven't studied it?

17 MR. GLENN: Same objection.

18 THE WITNESS: As I said, if a prior art
19 reference does not expressly set forth a particular
20 claimed element, the prior art may still disclose that
21 element if it is inherent in its disclosure.

22 BY MR. RIFFE:

23 Q. Do you have any opinions set forth in your
24 declaration, which is MRD-2006, with respect to whether
25 a claim element is inherently disclosed in any of the

1 prior art references?

2 MR. GLENN: Object. Object. Calls for a
3 legal conclusion.

4 THE WITNESS: Could you please repeat?

5 BY MR. RIFFE:

6 Q. Sure. Do you have any opinions set forth in
7 your declaration, which is MRD-2006, with respect to
8 whether a claim element is inherently disclosed, or not,
9 in any of the prior art references?

10 MR. GLENN: Objection. Form. Objection.
11 Calls for a legal conclusion.

12 THE WITNESS: In the declaration, other than
13 this particular page, page 20, I did not use the
14 inherent -- the discussion. But that doesn't imply that
15 the inherency is irrelevant. I did not express --
16 explicitly address the inherency scenario -- inherency
17 situation. I did not address that expressly.

18 BY MR. RIFFE:

19 Q. Okay. And that's what I wanted to just close
20 out is that in your declaration you have not provided an
21 opinion with respect to inherency of the challenged
22 claims in view of the prior art, correct?

23 MR. GLENN: Objection. Form. Objection.
24 Calls for a legal conclusion.

25 THE WITNESS: Yeah. As I said before, I did

1 not address the inherency explicitly.

2 BY MR. RIFFE:

3 Q. Okay. And in your declaration, you have not
4 provided an opinion with respect to inherency, right?

5 MR. GLENN: Objection. Form. Objection.
6 Calls for a legal conclusion.

7 THE WITNESS: Yeah. I offered a lot of
8 opinions. And some of the opinions may be relevant to
9 this inherency issue, so I wouldn't say that everything
10 I mentioned in my declaration is irrelevant in the angle
11 of inherency.

12 BY MR. RIFFE:

13 Q. Let's turn to Section 6 of your declaration
14 that begins on page 25. And it's under the heading,
15 "Claim Construction."

16 A. Yes.

17 Q. And do you recall writing any of the claim
18 construction section that begins on page 25 and extends
19 over to the top of page 28 in your declaration?

20 MR. GLENN: Objection to the extent it calls
21 for attorney work product.

22 THE WITNESS: I certainly provided a lot of
23 thoughts to -- to the counsel in -- in formulating what
24 has been written in the declaration. I counterinterviewed it
25 a lot.

1 BY MR. RIFFE:

2 Q. But my question was: Did you write any of the
3 paragraphs 54 through 58?

4 MR. GLENN: Objection. Form. Objection to
5 the extent it calls for attorney work product.

6 THE WITNESS: Well, this is a product of a lot
7 of back-and-forth communication between myself and
8 the -- and the counsel. And...

9 BY MR. RIFFE:

10 Q. Let me try this, make it a little more crystal
11 clear, maybe.

12 Did you type any portion of paragraphs 54
13 through 58 in your declaration?

14 MR. GLENN: Objection. Form.

15 THE WITNESS: I -- I did not assemble the
16 pieces of information through typing.

17 BY MR. RIFFE:

18 Q. Can you explain to me how you came up with the
19 plain and ordinary meaning of the term "discrete carbon
20 nanotubes" set forth in paragraph 54 of your
21 declaration?

22 MR. GLENN: Objection to the extent it calls
23 for attorney work product.

24 THE WITNESS: Yes. It is the plain and
25 ordinary meaning of discrete carbon nanotubes; that is,

1 I call the nanotubes separate and distinct from other
2 nanotubes not attached to other nanotubes.

3 BY MR. RIFFE:

4 Q. I'm sorry.

5 A. Yeah, and the face of the patent teaches this.

6 Q. Okay. Let me go back to my original question.

7 How did you come up with what you just read
8 from paragraph 54, which was the first sentence, your
9 proposed definition of discrete carbon nanotubes? How
10 did you come up with what a POSITA would understand a
11 plain and ordinary meaning of that phrase would be?

12 MR. GLENN: Objection. Form. Objection to
13 the extent it calls for attorney work product.

14 THE WITNESS: Yeah. As I said, number one, it
15 is the plain and ordinary meaning of discrete carbon
16 nanotubes.

17 Number two, the face of the patent teaches
18 this.

19 BY MR. RIFFE:

20 Q. Dr. Chung, with all due respect, my question
21 is: How did you come up with this plain and ordinary
22 meaning? You're just reading from your declaration.
23 I'm asking you: How did you come up with this meaning?

24 MR. GLENN: Same objections.

25 THE WITNESS: Yeah. I came up with this by

1 looking and reviewing the various documents, even the
2 dictionary.

3 BY MR. RIFFE:

4 Q. And what documents are you referring to?

5 A. The dictionary is Webster. Okay? And as I
6 said, the specification teaches that an embodiment of
7 the invention is a method for obtaining individually
8 dispersed carbon nanotubes. So it's looking at all
9 these specific kinds of information.

10 Q. Okay. Thank you.

11 In that second sentence that you just read,
12 you say, "The face of the patent teaches this," and I
13 know you have a copy, but for our court reporter, I
14 dropped that into the chat, a copy of Exhibit 1001.

15 And, Dr. Chung, feel free to refer to your
16 copy of Exhibit 1001, which again is the '649 patent.

17 And I would like for you to describe for me
18 how the face of the patent, the '649 patent, teaches
19 that a POSITA would understand that a plain and ordinary
20 meaning of discrete carbon nanotubes are carbon
21 nanotubes that are separate and distinct from other
22 nanotubes; not attached to other nanotubes?

23 MR. GLENN: Objection. Form.

24 THE WITNESS: Okay. In Column 3 --

25

1 BY MR. RIFFE:

2 Q. I apologize to interrupt, Dr. Chung. I'm
3 talking about -- let me make sure we're discussing the
4 same thing.

5 When you said the face of the patent teaches
6 this, were you referring to the front page of U.S.
7 patent 9,636,649? Or what were you referring to as the
8 face of the patent?

9 A. I'm referring to the -- how the patent shows
10 itself.

11 Q. I don't understand that.

12 A. The face is not limited to the first page.
13 Okay? The face is how the patent faces to the reader.

14 Q. Well, that's not what you said in your
15 declaration. You said the face of the patent teaches
16 this. You didn't say the patent teaches this. You said
17 the face of the patent teaches this.

18 Under my understanding of face -- and I think
19 most people in my industry -- the face of the patent is
20 the first page.

21 Is that not what you were referring to when
22 you said, "the face of the patent teaches this"?

23 MR. GLENN: Objection to form.

24 THE WITNESS: Yeah, that's not my
25 understanding of the word "face."

1 BY MR. RIFFE:

2 Q. Your understanding of the word "face" is not
3 only the front page of the patent but all subsequent
4 pages of the patent?

5 A. Yes.

6 Q. So when you say someone's face of a person,
7 you include their entire body? I'm just trying to make
8 sure I understand what you're talking about.

9 MR. GLENN: Objection to form. Objection.
10 Mischaracterizes the witness's testimony.

11 THE WITNESS: I don't think the analogy is
12 very appropriate because the face and the body of the
13 person are really -- they are both facing to the people
14 that see, you know. So like the body -- the hand is
15 page 1. The body is page 2. Both page 1 and page 2 can
16 be seen by people.

17 BY MR. RIFFE:

18 Q. But when you're talking about the face of the
19 patent, when I'm looking at a patent in paper form, I
20 only see the first page. I don't see all of the
21 subsequent pages. But under your construction of face
22 of the patent, that includes the subsequent pages,
23 correct?

24 A. Yes.

25 Q. Did you come up with this phrase, "face of the

1 patent," Dr. Chung, or did counsel?

2 MR. GLENN: Objection to the extent it calls
3 for attorney work product.

4 THE WITNESS: I did not come up with this
5 phrase, "the face."

6 BY MR. RIFFE:

7 Q. Counsel for MRD came up with it?

8 A. I never considered that to be a very
9 significant word. I didn't look at that as a
10 significant word.

11 Q. Okay. All right. So just to be clear, the
12 face of the patent that you referred to in page 25,
13 paragraph 54, includes the entirety of the patent,
14 correct?

15 A. Yes.

16 Q. Okay. Thank you.

17 Now, at the bottom of paragraph 54, you state
18 that, "The specification also teaches that the carbon
19 nanotube fibers are exfoliated, which a POSITA would
20 understand that exfoliation refers to the untangling of
21 carbon nanotubes from one another allowing the CNTs to
22 be separated from one another to become discrete."

23 That's what you wrote, correct?

24 A. Yes.

25 Q. Now, earlier when I asked if you agreed with

1 the phrase "exfoliated meaning individually dispersed
2 nanotubes," you agreed with me on that.

3 Do you recall that?

4 MR. GLENN: Objection. Mischaracterizes the
5 witness's testimony.

6 THE WITNESS: I did not agree to that. I said
7 that the two are not the same thing. Exfoliation refers
8 to untangling, but untangling doesn't mean no touching.
9 Okay? And so discreteness means no touching. And,
10 therefore, you need exfoliation in order to have
11 discreteness. But exfol- -- this -- in other words, in
12 order to be discrete, it has to be exfoliated. But to
13 be exfoliated doesn't imply that it's discrete.

14 BY MR. RIFFE:

15 Q. So if someone in the industry -- and I believe
16 this might have been my question. If someone in the
17 industry refers to exfoliated as individually dispersed
18 nanotubes, would you agree with them or not?

19 MR. GLENN: Objection. Form.

20 THE WITNESS: I would say that that's a sloppy
21 kind of definition.

22 BY MR. RIFFE:

23 Q. Why -- why would you say "sloppy"?

24 A. As I said, exfoliation means untangling,
25 doesn't mean no touching. And discrete means no

1 touching. And so the two cannot be equated.

2 Q. So what do you mean by "no touching"? When
3 you say discrete necessarily means no touching, what do
4 you mean by that?

5 A. As I mentioned before, discrete carbon
6 nanotubes are carbon nanotubes that are separate and
7 distinct from other nanotubes not attached to other
8 nanotubes. So not attached is what I mean by not
9 touching.

10 Q. So is attached equivalent to not touching in
11 your parlance?

12 A. That is. Touching means contact, okay? And
13 you have a point of one nanotube touching a point of
14 another nanotube. And there is scientific origin for
15 that contact. Could be due to the -- the bent nature of
16 the nanotubes, which is geometry, so that it has to
17 touch in there because it's not straight. Okay. And
18 also can be due to some forces, like Van der Waals
19 forces.

20 MR. GLENN: You should probably go ahead and
21 spell that for the reporter.

22 THE WITNESS: Yeah, V-A-N D-E-R W-A-A-L-S.
23 Van der Waals forces, and those forces can be
24 particularly strong if you have functional groups
25 sticking out from the trunk of the nanotubes. So -- so

1 that's what I mean by touching or attaching.

2 BY MR. RIFFE:

3 Q. So let me break this down because in your
4 definition or what -- strike that.

5 In your construction of what the plain and
6 ordinary meaning of discrete carbon nanotubes said --
7 and I'm looking at the top of page -- paragraph 54. You
8 say there are, "carbon nanotubes that are separate and
9 distinct from other nanotubes; not attached to other
10 nanotubes."

11 There you don't use "touching." You don't say
12 not touching to other nanotubes. You say "attached."

13 Is there a difference, in your opinion,
14 between touching and attached in the context of carbon
15 nanotubes?

16 MR. GLENN: Objection to form.

17 THE WITNESS: Attachment has to involve
18 touching. And what I mean by that is really contact.
19 Okay. Physical contact between one nanotube and another
20 nanotube. Okay. The physical origin of that physical
21 contact is another matter, as I mentioned before, the
22 Van der Waals forces or whatnot. Okay?

23 But the point is you have contact, physical
24 contact, between a certain point of one nanotube and a
25 certain point of another nanotube. And that's the

1 meaning of the word "attach" here.

2 BY MR. RIFFE:

3 Q. You say, "The point is you have contact,
4 physical contact, between a certain point of one
5 nanotube and a certain point of another nanotube, and
6 that's the meaning of the word 'attach' here."

7 Okay. What is touching then?

8 A. Touching is contact. Okay. That is the
9 physical contact means touching.

10 Q. That's what you just told me attaching means.

11 A. Yeah.

12 Q. So does touching and attaching mean the same
13 thing in your opinion?

14 MR. GLENN: Objection to form.

15 THE WITNESS: Touching is a little less
16 precise than -- than attaching because touching may --
17 may -- may be a very loose type of touching. But
18 attaching is a little more precise.

19 But it's -- you know, it's a matter of -- of
20 the physical interaction. There is physical interaction
21 involved whether it's touching or physical contact or
22 attachment.

23 BY MR. RIFFE:

24 Q. Where is the line between touching and
25 attachment? And then I'll give you an example, but I

1 want to hear from you first.

2 MR. GLENN: Objection to form.

3 THE WITNESS: Okay. Touching might have more
4 reversibility than attaching. That is you touch and not
5 touch. And it's reversible; touch and not touch. But
6 the attaching might not have that high a degree of
7 reversibility.

8 BY MR. RIFFE:

9 Q. So if I touch my colleague, Dr. In, on the
10 shoulder, but then I proceed to give him a hug and I
11 don't let go, is that touching an attachment, in your
12 opinion, as an analogy?

13 MR. GLENN: Objection to form.

14 THE WITNESS: I -- I understand your analogy,
15 but I don't think it's a very appropriate analogy.

16 BY MR. RIFFE:

17 Q. Let me put it in the context of carbon
18 nanotubes then.

19 We have these little -- I call them worms. I
20 know that's probably not technically precise. That's
21 what they look like to me under a -- you know, we have
22 these carbon nanotubes, and they crisscross and they
23 touch at a point, but there aren't Van der Waals forces
24 that attach to themselves.

25 Is that the difference, in your opinion,

1 between touching and attachments --

2 MR. GLENN: Objection to form.

3 BY MR. RIFFE:

4 Q. -- in the context of carbon nanotubes.

5 MR. GLENN: Same objection.

6 THE WITNESS: No. Really, the ultimate
7 objective is whether that contact point is an electrical
8 contact. Okay. That -- that is really what's relevant
9 to the context of this whole -- whole discussion here.
10 It's -- it's whether that physical contact is an
11 electrical contact or not. Okay? And you can call it
12 attaching; you can call it contact. You can also call
13 it touch. But the acid test is whether it's a -- it's
14 an electrical contact or not.

15 BY MR. RIFFE:

16 Q. And how does one determine between two carbon
17 nanotubes if that touch/attachment is an electrical
18 contact or not?

19 A. For instance, if there is a little bit of
20 junk, okay, in the -- and that junk is -- let's say is
21 insulating junk, okay? There's a little thin film of
22 junk that's insulating between the -- the nanotube A and
23 nanotube B at contact point. Then that contact would
24 not be an electrical contact.

25 Q. What type of junk, for example, would that

1 include --

2 A. Say --

3 Q. -- based on your experience.

4 A. Yes. Say a polymer or resin, which is
5 typically not conductive.

6 Q. Are carbon nanotubes ever wrapped in a polymer
7 resin that would prevent them from being electrically
8 conducted?

9 MR. GLENN: Objection to form.

10 THE WITNESS: Yeah. The wrapping of a single
11 carbon nanotube by a polymer molecule, that -- that's
12 known to exist, and the -- the wrapping -- the wrapping
13 doesn't mean covering the surface of the nanotube
14 hundred percent, you know. It's just like a ribbon
15 wrapping around. And so possibly surface area of the
16 nanotube is still kind of exposed.

17 BY MR. RIFFE:

18 Q. And if that -- I'm sorry. I didn't mean to
19 cut you off?

20 A. Yeah, that's -- that's all I mean. You can
21 have this wrapping, but that wrapping might not cover
22 the entirety of the surface.

23 Q. So if I had a single carbon nanotube that --
24 just based on your most recent example, that was wrapped
25 or insulated along a portion of its length and then a

1 portion of its length was not insulated or wrapped and
2 it was contacting another carbon nanotube at the
3 insulated half, if you will, and contacting another
4 carbon nanotube at its noninsulated half, that single
5 carbon nanotube, based on your -- your opinion, could be
6 both discrete and nondiscrete; is that correct? Because
7 a portion of the carbon nanotube has electrical contact,
8 and a portion of the carbon nanotube does not have
9 electrical contact --

10 MR. GLENN: Objection to form. Objection.
11 Mischaracterizes the witness's testimony.

12 THE WITNESS: Yeah, I don't think your logic
13 is right, because as long as a nanotube is in contact --
14 I mean electrical contact with another nanotube, that
15 nanotube is not discrete even though part of the
16 nanotube might -- might be insulated and another part
17 not insulated. As long as a part of it is making a
18 contact, particularly an electrical contact, with
19 another nanotube, then that makes this particular
20 nanotube not discrete.

21 BY MR. RIFFE:

22 Q. I see. That's helpful. Thank you.

23 So you would agree with me, then, that based
24 on what we just discussed, nonconducting filaments --
25 nonconducting nanotubes, if you will, or filament, those

1 can never be attached to each other, correct?

2 MR. GLENN: Objection. Mischaracterizes the
3 witness's testimony.

4 THE WITNESS: Yeah, I -- I -- my testimony in
5 this whole thing deals with carbon nanotube, okay, which
6 is conductive, and you're trying to branch it off to a
7 nonconductive nanotube. I don't think that's really
8 relevant.

9 BY MR. RIFFE:

10 Q. Well, I guess I assume, then, that if -- if a
11 carbon nanotube is surrounded by an insulator or has
12 this sort of junk, if you will, on its surface somewhere
13 that prevents it from it making electrical contact, then
14 that carbon nanotube is discrete, in your opinion,
15 because it can -- it cannot make electrical contact in
16 that instance, correct?

17 MR. GLENN: Objection. Objection. Form.

18 THE WITNESS: From a plain and ordinary
19 meaning of discrete carbon nanotube, it doesn't require
20 electrical contact. But from a point of view of our
21 understanding of the relevant science for this
22 particular patent, we understand that the impact of
23 whether it's discrete or not discrete -- or not discrete
24 on the electrical behavior relates to whether that
25 touching or attaching or contact is an electrical

1 contact or not. Okay?

2 In that context, that's what's relevant;
3 whether there's an electrical contact or not in
4 impacting the electrical conductivity. But for the
5 plain and ordinary meaning of "discrete," it doesn't
6 require the electrical contact to be present.

7 BY MR. RIFFE:

8 Q. That seems contradictory in and of itself.

9 I mean, how does one of skill in the art
10 determine if a carbon nanotube is discrete or not if
11 you're saying electrical conductivity doesn't matter?

12 I mean, it has to matter, doesn't it?

13 MR. GLENN: Objection to form. Objection.
14 Mischaracterizes the witness's testimony.

15 THE WITNESS: I never said electrical
16 conductivity doesn't matter. In fact, I said the
17 opposite.

18 In the context of this patent, electrical
19 conductivity matters greatly because a lot of the prior
20 art, maybe vast majority, all of it, use carbon nanotube
21 for the purpose of electrical conductivity enhancement.
22 Okay. So I never said that electrical conductivity is
23 not important.

24 BY MR. RIFFE:

25 Q. Okay. And what -- what's your basis for this

1 electrical conductivity concept that you -- you're
2 discussing this morning with respect to discrete carbon
3 nanotubes?

4 MR. GLENN: Objection to form.

5 THE WITNESS: Could you clarify?

6 BY MR. RIFFE:

7 Q. Well, I'll strike the question. With respect
8 to this patent, the '649 patent, where does the patent
9 talk about electrical conductivity in the context of
10 discrete carbon nanotubes?

11 MR. GLENN: Objection to form.

12 THE WITNESS: In -- in this particular patent,
13 the discreteness is not specifically or in a singular
14 manner directed at electrical conductivity. But the
15 prior art that I've cited, they all point to the
16 importance of percolation in forming a continuous
17 conductive network so as to achieve good conductivity.
18 Okay? And that is the distinction.

19 If you have a discrete carbon nanotube, you
20 cannot have percolation. You cannot have that
21 continuous electrically conducted network. But that
22 network is precisely what the prior art is trying to
23 exploit in order to achieve high conductivity.

24 So the contrast between the '649 patent and
25 the prior art is really clear.

1 MR. GLENN: Counsel, we've been going for
2 about another hour. So let's --

3 MR. RIFFE: We can take a break here. That's
4 fine.

5 (Recess: 11:47 a.m. to 12:01 p.m.)

6 BY MR. RIFFE:

7 Q. Dr. Chung, welcome back.

8 Did you have any discussions with counsel
9 regarding the substance of your testimony during the
10 break?

11 A. No.

12 Q. Okay. So going back to our discussion of
13 discrete, and I guess I'm harkening back to -- it's an
14 earlier discussion where you introduced the concept of,
15 for lack of a better word, junk that might be between
16 the carbon nanotube and something else. So in your
17 view, discrete means not touching, but not touching
18 other nanotubes only.

19 In other words, the carbon nanotube can touch
20 anything and still be discrete, but it just can't touch
21 another nanotube; is that correct?

22 MR. GLENN: Objection. Form. Objection.
23 Mischaracterizes the witness's testimony.

24 THE WITNESS: Yeah. For instance, the carbon
25 nanotube can touch a lithium-ion active particle in the

1 battery, electrode. That touching is a good one. But
2 that touching does not mean that the nanotube is not
3 discrete with respect to the carbon nanotube itself.
4 It -- it -- it is still discrete even though it touches
5 that ion active particle.

6 BY MR. RIFFE:

7 Q. Okay. And so long as -- so long as one carbon
8 nanotube is separate and distinct from other nanotubes;
9 in other words, not attached to other nanotubes.

10 That's your -- that's your construction of
11 what discrete carbon nanotubes means, right?

12 A. Yes.

13 Q. Okay. Now, you also mentioned you relied on
14 the Webster dictionary, and I think you cite to that at
15 the bottom of page 25 in paragraph 55, and that's
16 MRD-2012, 4. And you have a parenthetical there that
17 says, "define discrete to mean separate and distinct,
18 not attached to others; unrelated."

19 And that, to me, you're relying primarily on
20 the Webster dictionary for that plain and ordinary
21 meaning, correct?

22 MR. GLENN: Objection. Form. Objection.
23 Mischaracterizes the witness's testimony.

24 THE WITNESS: I wouldn't say primarily because
25 it's all these different sources of information put

1 together, as I mentioned, from the patent and so forth.
2 And the dictionary meaning is consistent with the
3 meaning we obtained from other sources. So it's just
4 consistency rather than saying it's primarily coming
5 from the dictionary.

6 BY MR. RIFFE:

7 Q. Other than the dictionary meaning that it's
8 not touching, what other source other than the
9 dictionary did you rely upon to say that discrete means
10 not touching?

11 A. Okay.

12 MR. GLENN: Objection. Form. Objection.
13 Mischaracterizes the witness's testimony.

14 THE WITNESS: The specification teaches that
15 an "embodiment of the invention is a method for
16 obtaining individually dispersed carbon nanotubes." And
17 "The background discusses hampered utilization of CNTs
18 because of the 'inability to reliably produce
19 individualized carbon nanotubes.'"

20 Also, "The methodology of the specification
21 uses the fact that carbon nanotube fibers can have
22 oxidation species comprising of carboxylic acid or
23 derivative carbonyl containing species and are
24 essentially discrete individual fibers."

25 And there are more -- more examples of such

1 information that points to this concept of discreteness.

2 BY MR. RIFFE:

3 Q. But none of what you just read, Dr. Chung,
4 respectfully, says anything about touching, correct?

5 MR. GLENN: Objection. Form. Objection.
6 Mischaracterizes the witness's testimony.

7 THE WITNESS: Well, individualized carbon
8 nanotubes -- they're individualized. That's consistent
9 with the lack of touching, and also it mentions discrete
10 individual fibers. And also the specification goes on
11 to describe mixtures of master batches where the
12 individually dispersed nanotubes are distributed,
13 whether uniformly or nonuniformly.

14 And, also, the specification teaches that the
15 carbon nanotube fibers are exfoliated. A POSITA would
16 understand that exfoliation refers to the untangling of
17 carbon nanotubes from one another, allowing the
18 nanotubes to be separated from one another to become
19 discrete.

20 BY MR. RIFFE:

21 Q. Individualized -- I think what you said, you
22 said consistent -- individualized consistent with the
23 lack of touching.

24 So you're drawing an analogy between
25 individualized and not touching; is that correct?

1 MR. GLENN: Objection. Form.

2 THE WITNESS: Individualized is the
3 prerequisite for being discrete, just like exfoliation
4 is a prerequisite for being discrete.

5 BY MR. RIFFE:

6 Q. Does something come after individualized
7 before it can then -- the carbon nanotube can become
8 discrete just like you testified as the intermediary
9 step between exfoliating before it can become discrete?

10 MR. GLENN: Objection. Form.

11 THE WITNESS: Yeah, could you clarify, please?

12 BY MR. RIFFE:

13 Q. You said, "individualized is the prerequisite
14 for being discrete."

15 If an individual -- individualize is a
16 prerequisite, is there some intervening step that has to
17 take place before the carbon nanotube can become
18 discrete?

19 MR. GLENN: Objection. Form.

20 THE WITNESS: The term "individualized" means
21 that the nanotubes cut into individuals, but that
22 doesn't mean that these individuals are not touching one
23 another at all. The same thing for exfoliations. It
24 doesn't imply that the nanotubes are not touching at
25 all.

1 And so it takes effort, yes, to make it truly
2 discrete. And that is more what this patent '649
3 provides.

4 BY MR. RIFFE:

5 Q. So when you're saying -- when you point to the
6 patent at Column 536 through 39 -- and you mentioned
7 this earlier in your testimony -- you say, "they are
8 essentially discrete individual fibers."

9 A. I'm sorry. Where are you reading from?

10 Q. In the paragraph 54 of your declaration, about
11 middle of the page, it says, "The methodology of the
12 specification uses the fact that 'carbon nanotube fibers
13 can have oxidation species comprising of carboxylic acid
14 or derivative carbonyl containing species and are
15 essentially discrete individual fibers.'"

16 Do you see that?

17 A. Yes.

18 Q. Are you drawing a distinction there, then, at
19 this point between individual and discrete fibers?

20 A. Okay. Let me take a look. Okay.

21 What you are reading is from -- from that
22 patent, '649, Column 5, line 36 to 39. About the
23 actual -- let me see.

24 Yeah, I thought the actual process used to
25 achieve discrete carbon nanotubes is better to look at

1 the examples rather than this generalized statement in
2 Column 5.

3 Q. You -- you -- I'm just reading what you cited
4 in your declaration, and you pointed to -- when I asked
5 you what other support outside of Webster's dictionary
6 do you have for discrete carbon nanotubes not being
7 attached to other nanotubes, and you pointed
8 specifically me to this statement of discrete individual
9 fibers at Column 5.

10 So what support do you have outside of
11 Webster's dictionary that "discrete" means not attached
12 to other nanotubes?

13 MR. GLENN: Objection. Mischaracterizes the
14 witness's testimony.

15 BY MR. RIFFE:

16 Q. Do you understand my question, Dr. Chung?

17 A. Yes.

18 As I mentioned -- excuse me.

19 Yeah, the specification of '649 mentions about
20 individually dispersed nanotubes that are distributed
21 and also mentions about exfoliated nanotube fibers and
22 the untangling, which is necessary for the discreteness.

23 So putting all these things together, all
24 these specific information together, it paints a picture
25 which is discreteness in the sense of not attached to

1 other nanotubes, and this understanding is consistent
2 with what Webster dictionary says.

3 In addition, this understanding is consistent
4 with the Petitioner's expert, Dr. Zhu's testimony. And
5 he testified in relation to the meaning of discrete
6 carbon nanotubes in the co-pending IPRs challenging
7 together CNT related patents of the patent owner, and he
8 mentioned that the discreteness would involve the
9 nanotubes being fully isolated from each other in order
10 to be discrete.

11 And so it's various information, including
12 Dr. Zhu's testimony which points at the discreteness,
13 meaning no attachment, fully isolated.

14 Q. Let me try to make it very simple.

15 You would agree with me that the phrase "not
16 attached" is -- only appears in Webster's dictionary,
17 correct?

18 MR. GLENN: Objection. Form.

19 THE WITNESS: The word is in the Webster
20 dictionary, but the meaning behind this word is very
21 well supported by all these other pieces of information,
22 including Dr. Zhu's testimony.

23 BY MR. RIFFE:

24 Q. Dr. Chung, your counsel can ask you other
25 questions during his redirect, but I'm asking you a very

1 specific question.

2 The phrase "not attached" only appears in
3 Webster's dictionary, Exhibit MRD-2012 -- MRD-2012,
4 correct?

5 MR. GLENN: Objection. Form.

6 THE WITNESS: Yes. The term "attached,"
7 indeed, is expressly mentioned only in the -- in that
8 dictionary. But what we are after is not just one
9 particular word but the meaning embodied in that word.
10 I think the meaning --

11 BY MR. RIFFE:

12 Q. That's not my question. I'm going to strike
13 your answer as nonresponsive.

14 Dr. Chung, I'm asking you this very specific
15 question, and I want you to answer my question. Your
16 counsel can redirect you at his will later on, but I
17 want an answer to my question.

18 Do you understand me?

19 A. Yes.

20 Q. Okay. My question is: The phrase that
21 appears in your definition of discrete that is, quote,
22 not attached, end quote, that phrase only appears in
23 Webster's dictionary, which is MRD-2012, correct?

24 MR. GLENN: Objection to form.

25 THE WITNESS: I would say the word "attached,"

1 not the phrase associated with the attached, but the
2 word "attached," indeed, comes from the Webster
3 dictionary.

4 BY MR. RIFFE:

5 Q. Look at the top of your declaration, page 26,
6 where you cite to Webster's dictionary, and you have a
7 quotation there defining discrete, correct?

8 A. Yes.

9 Q. It says -- it says, "Defining discrete to mean
10 'separate and distinct; not attached to others;
11 unrelated.'"

12 Did I read that correctly?

13 A. Yes.

14 Q. The phrase "not attached" appears in that
15 definition of discrete from Webster's dictionary,
16 correct?

17 A. Yes.

18 Q. The phrase "not attached," the only support
19 you have cited to for that phrase, quote, "not
20 attached," end quote, is Webster's dictionary, correct?

21 MR. GLENN: Objection to form. Objection.
22 Mischaracterize's the witness's testimony.

23 THE WITNESS: Could you rephrase, please?

24 BY MR. RIFFE:

25 Q. Yes.

1 The phrase, quote, "Not attached," end quote,
2 only appears in Webster's dictionary, correct?

3 MR. GLENN: Objection to form.

4 THE WITNESS: Within the realm of exhibits
5 that I cited, the term "not attached" is explicit.
6 Perhaps only in the dictionary, but --

7 BY MR. RIFFE:

8 Q. Okay. Dr. Chung, does the phrase "not
9 touching" appear in any of the exhibits that you rely
10 upon for what you believe a person of ordinary skill in
11 the art would understand discrete carbon nanotubes to
12 mean?

13 A. The term "not touching" is -- is a term that I
14 tried to use during this discussion just to make it, you
15 know, easy to understand. Okay. A better term is
16 physical contact, you know. So I don't want to make the
17 "touching" word a very important word because I just use
18 it just like you say touching another person, you know.
19 I just use that word to -- to -- to explain things --

20 Q. Okay.

21 A. -- in an easy fashion. I don't mean to make
22 it a technical term.

23 Q. Does physical contact equal attachment or
24 attached?

25 MR. GLENN: Objection to form.

1 THE WITNESS: Yeah. Physical contact, yeah,
2 A; physically contacting, B. So that which would be in
3 the same -- same -- same -- same concept as attachment.

4 BY MR. RIFFE:

5 Q. So physical contact, the way you're using that
6 phrase, is it the same degree of contact that we
7 discussed earlier today between the phrases "touching"
8 and "attachment"?

9 MR. GLENN: Objection. Form.

10 THE WITNESS: I -- could you rephrase, please?

11 BY MR. RIFFE:

12 Q. I'm trying to -- I'm trying to understand what
13 the difference is between physical contact and touching
14 now.

15 Or are you saying they are the same?

16 MR. GLENN: Objection to form.

17 THE WITNESS: Yeah. When A, physically
18 touch -- physical contact, B, A has to touch B.

19 BY MR. RIFFE:

20 Q. Okay. So physically contacting is the same as
21 touching in the discussion that we've had here today; is
22 that correct?

23 A. That's -- yes.

24 Q. Okay. So going back to our earlier
25 discussion, there is a degree of physical contact or

1 touch before you get to attachment; is that correct?

2 MR. GLENN: Objection. Form. Objection.

3 Mischaracterizes the witness's testimony.

4 THE WITNESS: In the context of the present
5 definition of the word "discrete carbon nanotubes" or
6 the word "discrete," the term "attachment" doesn't
7 reflect the degree of -- of the -- of the contact that
8 is -- it doesn't reflect that. It's just plain and
9 ordinary meaning. Okay. It doesn't imply that the
10 attachment, as mentioned in this definition, is
11 different from physical contact. Whether it's a higher
12 degree or a lower degree, it doesn't imply that.

13 BY MR. RIFFE:

14 Q. So if a carbon nanotube, in your opinion, is
15 physically contacting another carbon nanotube, is it
16 attached to that carbon nanotube?

17 A. In the context --

18 Q. Please go ahead.

19 A. Yes, in the context of this -- this technology
20 being discussed, yes.

21 Q. And so physical contact, touching, attached,
22 all the same thing to you with respect to carbon
23 nanotubes; is that correct?

24 MR. GLENN: Objection. Form.

25 THE WITNESS: Yes. But I have to make it

1 clear that A physically contacting B doesn't mean having
2 something in between, you know.

3 BY MR. RIFFE:

4 Q. So if A and B are contacting one another but
5 there's something in between them, they are not
6 attached; is that correct?

7 MR. GLENN: Objection. Form.

8 THE WITNESS: Right, in this context.

9 BY MR. RIFFE:

10 Q. In this context.

11 A. In this context, the A is a carbon nanotube.
12 B is another carbon nanotube, okay? So when A touches
13 B, indeed, there is no intervening junk, or whatever you
14 call it, between the A and the B.

15 Q. Okay. And those are attached pursuant to your
16 definition of discrete, correct?

17 MR. GLENN: Objection to form.

18 THE WITNESS: Yes, that's what I said.

19 BY MR. RIFFE:

20 Q. Okay. And then if there's a carbon nanotube A
21 and a carbon nanotube B but there's intervening junk and
22 that junk could be an insulator or, you know,
23 nonconductive material, then those are not discrete; is
24 that correct?

25 MR. GLENN: Objection to form.

1 THE WITNESS: As I tried to explain before,
2 in -- in the plain and ordinary meaning of discreteness,
3 it doesn't specify whether that contact is -- the
4 electrical contact or not an electrical contact, in that
5 plain and ordinary meaning, it doesn't specify that.

6 But when we look at this -- this definition in
7 the context of this very patent and associated prior
8 art, then we realize that this attachment pertains to
9 having an electrical contact between one nanotube and
10 the other nanotube without having an insulator in
11 between. Okay? In the context of this -- this patent,
12 we realize that the attachment has to involve an
13 electrical contact. But in the ordinary and plain
14 meaning of the term "discrete," it doesn't narrow it
15 down.

16 BY MR. RIFFE:

17 Q. But, Dr. Chung, when the PTAB judges are
18 trying to determine if the prior art references render
19 obvious this claim limitation of discrete carbon
20 nanotubes and they're faced with your proposed
21 definition of what discrete carbon nanotubes are, how do
22 they then discern whether two carbon nanotubes are
23 attached to each other?

24 Because you're saying on the one hand, plain
25 and ordinary meaning doesn't require you to look at the

1 electrical conductivity; but then you go to say, well,
2 in the context of this patent, it actually does require
3 to determine. Whether two carbon nanotubes are
4 attached, you have to look at their electrical
5 conductivity.

6 But the board judges need to have a clear
7 delineation between what you mean by this phrase not
8 attached, and that's what I'm trying to get at. With
9 all due respect, it seems like you're talking out of
10 both sides of your mouth, but I'm trying to get a clear
11 record for the judges so that they can make a
12 determination.

13 So does your -- what a POSITA would understand
14 "not attached" to mean, the question is: Does that
15 require electrical conductivity or not between the two
16 carbon nanotubes?

17 MR. GLENN: Objection to form. Objection.
18 Mischaracterizes the witness's testimony.

19 THE WITNESS: Okay. Let me explain. In order
20 for nanotube A and nanotube B to be in electrical
21 contact, they have to be extremely close to one another
22 at the -- at that particular point. I don't mean junk
23 now. I just mean not exactly contacting, just a tiny
24 bit, say, 10 angstroms, you know, a tiny bit, a tiny
25 little microscopic gap at the point of so-called

1 touching. Okay?

2 And if that is the case, it's not an
3 electrical contact just because of that tiny microscopic
4 gap there. Okay.

5 So that -- that's what I mean. If there's
6 this tiny microscopic gap, then it's not an electrical
7 contact, and that's not attachment because there's this
8 tiny microscopic gap.

9 BY MR. RIFFE:

10 Q. What range of microscopic gaps can you have
11 before you have attachment and you don't have
12 attachment?

13 MR. GLENN: Objection. Form.

14 (Court Reporter requested clarification.)

15 THE WITNESS: Yeah. The question is, is the
16 size of that gap. Okay. If the size of that gap is
17 more than, let's say, 10 angstroms, then there's no
18 electrical contact.

19 And 10 angstroms is a very small size, by the
20 way. Very small size. Very small distance.

21 BY MR. RIFFE:

22 Q. Where does an electrical contact begin, at
23 what distance between two carbon nanotubes?

24 A. It's not a clear-cut delineation because the
25 electron wave function doesn't work like that. It's

1 just a wave function. It's a probability distribution
2 from the electron wave, so -- but the ballpark is what I
3 said.

4 Q. Okay. So the ballpark is 10 angstroms, and
5 at -- if there are two carbon nanotubes at that 10
6 angstrom ballpark, those would not be attached; and,
7 therefore, those would be discrete carbon nanotubes, in
8 your opinion; is that correct?

9 MR. GLENN: Objection to form.

10 THE WITNESS: In the plain and ordinary
11 definition, one would not read it as deeply as what I
12 said, the plain and ordinary definition. Okay. But if
13 at one point, one wants to dig deep into what's meant by
14 the electrical contact, then what I mentioned about
15 that -- the size of the little gap matters.

16 BY MR. RIFFE:

17 Q. If -- if I'm designing a microcircuit of some
18 type and I'm looking at the '649 patent, for example,
19 and I'm trying to avoid -- I'm doing my darnedest to
20 avoid infringing Mr. Swogger's patent, and I'm trying to
21 get -- make sure I don't have discrete carbon nanotubes
22 in my device, where is the line?

23 If I'm designing my device to have a 10
24 angstrom gap between my carbon nanotubes, am I
25 infringing -- do I have discrete carbon nanotubes or do

1 I not? I mean, part of the patent process is allowing
2 people still in the art to try to avoid patents.

3 So where is the line that you draw based on
4 your expertise for doing that?

5 MR. GLENN: Objection. Form.

6 THE WITNESS: I really need to explain a
7 little better, okay, because the matter is not just
8 electrical. It's mechanical as well, as I mentioned
9 earlier. Okay?

10 BY MR. RIFFE:

11 Q. Okay.

12 A. This matter of electrical contact only
13 pertains to the electrical side, but there's the other
14 side, which is mechanical; and for that purpose, the
15 electrical contact is -- is not pertinent. Okay. And
16 that's why I kept saying, in the plain and ordinary
17 definition, one should not limit it to the attachment
18 being an electrical contact because we are not limited
19 to the electrical side. There's also the mechanical
20 side, which is totally different.

21 Q. Okay. So given that totality of
22 electrical/mechanical and I'm trying to design a new
23 circuit to not infringe on Mr. Swogger's patent, how do
24 I know that my nanotubes are not going to be attached to
25 each other based on your definition of discrete carbon

1 nanotubes? Your definition says they are separate and
2 distinct; they are not attached.

3 Where is the line that I can design up to to
4 ensure that my nanotubes are not attached to one
5 another?

6 MR. GLENN: Objection. Form. Objection to
7 the extent it calls for a legal conclusion.

8 THE WITNESS: In general, to show
9 discreteness, the best way is microscopy. And you
10 actually look at -- under the microscope to see if they
11 are discrete or not, to see if there is this physical
12 contact between the nanotubes or not.

13 BY MR. RIFFE:

14 Q. Okay. Based -- your definition that you set
15 forth here of discrete, that applies to the -- all of
16 the IPRs in context in this particular set of IPRs; is
17 that correct?

18 In other words, you apply the same definition
19 of discrete in this IPR as the other four; is that
20 correct?

21 MR. GLENN: Objection to form.

22 THE WITNESS: Yes. Pretty much. Although
23 the -- the language is not the same among the different
24 patents.

25 ///

1 (Whereupon Exhibit 1101 was marked for
2 identification.)

3 BY MR. RIFFE:

4 Q. Okay. So let's -- let me introduce an
5 exhibit -- it will be labeled exhibit -- I'm going to
6 put this one in the chat because, based on your most
7 recent testimony about microscopy -- I've got a little
8 schematic. It's not microscopy. You'll see that once
9 we get to it, but I wanted to talk to you a little bit
10 about this one. So let me put this in the chat. I'll
11 send that.

12 Let me know once you're able to get that,
13 Dr. Chung.

14 MR. RIFFE: And, James, if you'll let me know
15 as well as, Tamara, if you've got it.

16 THE WITNESS: So I have to go to the chat?

17 BY MR. RIFFE:

18 Q. Yes, ma'am. You open that up, you should see
19 it down there, Exhibit 1100.

20 A. No, it goes to -- I click it, and it goes to
21 my documents in my computer. It wants to stay there
22 when I click it.

23 Q. It might -- you may have to save it, and then
24 you can open it from there. Sometimes this chat feature
25 makes you do that, unfortunately.

1 MR. GLENN: Mine did the same thing.

2 MR. RIFFE: Yeah, I think it's a part of the
3 Zoom feature.

4 THE WITNESS: Okay. So I --

5 MR. RIFFE: If you could save it to your
6 desktop maybe and then you could erase it after this.

7 THE WITNESS: Okay.

8 MR. GLENN: To make sure that I'm looking at
9 the right document, Mr. Riffe, it's two pages including
10 two handwritten drawings, one on each page?

11 MR. RIFFE: Yes, two pages marked LGES 1100 at
12 the bottom right.

13 MR. GLENN: Okay. Was this an exhibit to
14 anything else, or is that just a number you --

15 MR. RIFFE: It's a new number.

16 MR. GLENN: Got it. Okay. I just wanted to
17 make sure.

18 THE WITNESS: By clicking 1100, I see only one
19 drawing. Am I supposed to see two drawings?

20 MR. GLENN: Yeah, two pages.

21 MR. RIFFE: If you scroll in the PDF.

22 And, Tamara, just to be clear. I do want to
23 mark this as Exhibit 1.

24 (Exhibit 1 was marked for
25 identification.)

1 THE WITNESS: I see it.

2 BY MR. RIFFE:

3 Q. Do you see it now? Okay. The best of
4 intentions here.

5 So two-page document before you marked LGES
6 1100 bottom right corner.

7 Do you see that?

8 A. Yes.

9 Q. Okay. So are the nanotubes -- I'm looking at
10 page 1 of LGES 1100, which is now marked also as Exhibit
11 1 to your deposition.

12 Are the nanotubes depicted in this drawing on
13 page 1 of Exhibit 1100 -- are those discrete carbon
14 nanotubes?

15 MR. GLENN: Objection to form.

16 THE WITNESS: Yes, those are discrete.

17 BY MR. RIFFE:

18 Q. Why?

19 A. Because they are not physically in contact.
20 They are separate.

21 Q. Would you need to know how many angstroms
22 apart the two carbon nanotubes depicted in -- on page 1
23 of Exhibit 1100 are in order to confirm that they are
24 discrete carbon nanotubes?

25 MR. GLENN: Objection to form.

1 THE WITNESS: Well, as I said, that the
2 quality of the electrical contact only pertains to
3 electrical applications or applications that require the
4 electrical contact. But, in general, you have
5 mechanical as well as electrical performance
6 requirements; and the quality of the electrical contact
7 in general would not be of prime importance.

8 So in the general case -- well, if I look at
9 this picture and there's no scale -- right now, there's
10 no scale, right? If there's no scale, then I would
11 interpret this as being discrete.

12 BY MR. RIFFE:

13 Q. If there were a scale, hypothetically, that
14 showed that those two -- the closest point between those
15 two carbon nanotubes was 10 angstroms as measured by a
16 microscope, would those two carbon nanotubes be discrete
17 in accordance with your definition of discrete carbon
18 nanotubes?

19 MR. GLENN: Objection. Form.

20 THE WITNESS: Did you say it's more --

21 BY MR. RIFFE:

22 Q. I'm sorry. Let me repeat the question for
23 you.

24 If there were a scale that showed that the two
25 closest points between the two carbon nanotubes shown on

1 page 1 of Exhibit 1100, as measured by the microscope
2 where it's 10 angstroms, would these two carbon
3 nanotubes depicted here be discrete in accordance with
4 your definition of discrete carbon nanotubes?

5 MR. GLENN: Objection. Form.

6 THE WITNESS: The -- even if it's -- see, when
7 you come to that small a distance, then there could be
8 electrical interaction between the two, but the
9 mechanical interaction might be absent.

10 BY MR. RIFFE:

11 Q. How would a person of skill in the art know
12 that?

13 A. Because the electrical side pertains to the
14 electrons, and the electrons are in form of waves, and
15 they have probability distribution being somewhere.

16 But the mechanical side is -- is not centered
17 around the electrons moving around. So it's just a
18 different situation.

19 And in other words, the force felt by one
20 nanotube doesn't transmit to the other nanotubes because
21 of that gap. Okay? And so in -- in the plain and
22 ordinary meaning, which should encompass both the
23 electrical and mechanical side, I would not narrow down
24 my definition in terms of that distance.

25 Q. So if -- excuse me.

1 What you're saying now is if there was a
2 10-angstrom gap between these two carbon nanotubes, you
3 would say that these carbon nanotubes are discrete; is
4 that correct?

5 Or would you need to do more experimentation
6 to figure that out?

7 A. In accordance with -- if -- with the meaning
8 of this definition, these would be discrete. However,
9 this -- because of the closeness of -- of the -- of this
10 A and B, then in spite of the fact that they are
11 discrete, there could be electrical effect of that.
12 Okay.

13 Q. And the --

14 A. But the electrical effect is something else.
15 That is -- it's still discrete even though there might
16 be an electrical effect due to the proximity.

17 Q. If there was an electrical effect due to the
18 proximity, these two carbon nanotubes would be
19 electrically attached to one another, correct?

20 MR. GLENN: Objection. Form.

21 THE WITNESS: Could you -- could you repeat,
22 please?

23 BY MR. RIFFE:

24 Q. Sure.

25 Again, in the contexts of this 10-angstrom

1 distance, which is what you told me earlier, if there
2 is -- an electrical effect due to that proximity, then
3 these two exemplary carbon nanotubes would be
4 electrically attached to one another, correct?

5 MR. GLENN: Objection to form.

6 THE WITNESS: Electrically attached. That's
7 another term that you are introducing. Okay. I never
8 use that term.

9 BY MR. RIFFE:

10 Q. If there's electrical effect between these two
11 carbon nanotubes at the 10-angstroms distance, are they
12 attached to one another, either electrically or
13 mechanically?

14 A. The 10-angstroms distance is -- as I said, is
15 a very ballpark figure. Actually, even at 10 angstroms,
16 the electron waves doesn't get through to a high degree.
17 Okay? And -- and -- and so even though they are maybe
18 10 angstroms apart, the quality of the electrical
19 contact is lousy.

20 Q. If the distance between these two carbon
21 nanotubes was 2 angstroms but there's still a distance
22 between them, would they still be discrete carbon
23 nanotubes, in your opinion, as shown here on page 1 of
24 Exhibit 1100?

25 MR. GLENN: Objection to form.

1 THE WITNESS: I think obviously the smaller
2 the gap, the more the electrons can go -- go across from
3 one -- from A to B. And the better is the electrical
4 contact quality.

5 But in reality, it's very, very difficult to
6 measure the distance, whether 2 angstroms or 10
7 angstroms. You can imagine what magnification -- how
8 many times of magnification it would need to be able to
9 see that gap of 2 angstroms or 10 angstroms. It's just
10 almost impossible to -- to do this -- to actually
11 measure that.

12 So the assumption that we can put a scale mark
13 and then here it's 12 angstroms, here it's 10 angstroms,
14 that is way too simplistic because that is too far from
15 reality of what microscopy in this field can provide in
16 a reliable fashion.

17 So the discussion is more and more towards
18 something which is -- is far from reality.

19 BY MR. RIFFE:

20 Q. So to satisfy your definition of discrete
21 carbon nanotube as nanotubes that are not attached to
22 other nanotubes, is it your opinion that one in the
23 skill of the art would need to look at the electrical
24 and mechanical properties between the two carbon
25 nanotubes or not?

1 MR. GLENN: Objection to form.

2 THE WITNESS: As I said, microscopy is the
3 best technique to do that because we are talking about
4 kind of a geometric kind of characteristic. And how
5 this geometric characteristic affects the electrical
6 behavior or the mechanical behavior, that's a different
7 deal.

8 BY MR. RIFFE:

9 Q. So when you say microscopy is the best
10 technique, are you then just suggesting to see whether
11 or not the carbon nanotubes have space between them as
12 shown in Exhibit 1100 on page 1?

13 A. Yes.

14 Q. Okay. Look at page 2 of Exhibit 1100.

15 A. Yes.

16 Q. Are those two carbon nanotubes depicted on
17 page 2 of Exhibit 1100 discrete carbon nanotubes in
18 accordance with your definition of discrete carbon
19 nanotubes?

20 MR. GLENN: Objection to form.

21 THE WITNESS: Yes. This drawing is
22 two-dimensional. There's a third dimension that's not
23 shown, you know. If you just look at a two-dimensional
24 view, it looks like that they are in physical contact.
25 But if one looks at the third dimension as well, they

1 might not be.

2 BY MR. RIFFE:

3 Q. So in other words, just to be clear -- again,
4 I agree with you that this is a two-dimensional
5 depiction. If you look at it in 3-D or a
6 three-dimensional depiction, there may be spacing and
7 very significant spacing between the carbon nanotubes,
8 correct?

9 A. Yes.

10 Q. I'm sorry. Did you say "yes"?

11 A. Yes.

12 Q. Thank you.

13 We're going to refer back now to your
14 declaration, Dr. Chung.

15 MR. GLENN: Counsel, are we going to keep this
16 exhibit available, or are you done with that?

17 MR. RIFFE: I should be done with that for
18 now.

19 BY MR. RIFFE:

20 Q. Okay. I'm going to turn our attention now,
21 Dr. Chung, to paragraph 84 on page 38 of your
22 declaration.

23 A. 84. Okay.

24 Q. And at paragraph 84 -- and I want to refer to
25 Figure 7, which you've reproduced at the top of page 38.

1 Do you see that also? It's Figure 7B and C.

2 A. Yes.

3 Q. Okay. With reference to that figure, what are
4 the black arrows in Figure 7P -- B pointing to?

5 A. Okay. Let me look. That's -- okay. For --
6 there's 7B. The white arrows indicate some of the
7 exfoliated --

8 (Court Reporter requested clarification.)

9 A. We just -- zirconium phosphate nanoplatelets,
10 and the black arrows are individually dispersed and
11 straight single-wall nanotubes.

12 Q. And in order to determine what those black
13 arrows were pointing to, you relied upon, as you just
14 did, paragraph 25 of the Sun reference, correct?

15 A. Right. Yeah. Paragraph 25 of the Sun
16 reference describes what Sun means for those microscope
17 photos.

18 Q. Okay. Looking at Figure 7B, would you be able
19 to determine if the black arrows are pointing to
20 individually dispersed single-wall nanotubes without the
21 help of Sun's description in paragraph 25? Just
22 looking -- if you were just solely looking at
23 paragraph -- at Figure 7B?

24 MR. GLENN: Objection to form.

25 THE WITNESS: Yeah, these microscope pictures

1 are really, at least in the reproduction -- in the
2 reproduction that we have available in front of us,
3 these images are really too low in quality to -- to give
4 justice as to what this truly conveys. So it's really
5 hard to say just by looking at the picture.

6 And, therefore, basing just on what we look to
7 find in the picture, I would go for what Sun actually
8 described as what he sees because I can tell that he's
9 not lying.

10 BY MR. RIFFE:

11 Q. If you were reviewing a journal manuscript,
12 for example, for publication, would you agree that this
13 quality of figure would not be acceptable to support a
14 conclusion that Sun draws in paragraph 25, just by
15 looking at Figure 5B -- I mean 7B?

16 MR. GLENN: Objection. Form.

17 THE WITNESS: I think for patents and for
18 journal papers, they are different in the quality of the
19 reproduction of the images. For patents, the quality of
20 reproduction tends to be low. Okay?

21 And so I agree, you know, for a journal
22 publication, one would require really high quality
23 microscope images to support what the author means.

24 But there's kind of technical difficulty in
25 the patent arena in that regard.

1 BY MR. RIFFE:

2 Q. Okay. Okay. Let's next turn to paragraph 85
3 and the accompanying figures below that, or included in
4 that paragraph Figure 6A and 6B from Sun, and that's on
5 page 39 of your declaration.

6 Do you see that?

7 A. Yes.

8 Q. In Figure 6A, what are the arrows pointing to?

9 A. In Figure 6A, the arrows indicate exfoliated
10 zirconium phosphate nanoplatelets.

11 Q. And how do you know what those figures in
12 Figure 6A are pointing to?

13 A. Again, the quality of the images is just too
14 low to really allow us to see clearly. And so we just
15 have to assume that Sun is not lying when he states what
16 is in that figure.

17 Q. And Sun indicates those arrows are indicating
18 the exfoliated zirconium, ZrP nanoplatelets in paragraph
19 22; is that correct?

20 A. Yes.

21 Q. I have a similar question.

22 Just by looking at Figure 6A, would you agree
23 with me that without the help of Sun's description in
24 paragraph 22 that you really wouldn't be able to
25 determine what those arrows in Figure 6A are pointing

1 to?

2 A. At least not for sure.

3 Q. Okay. And that's because, again, the quality
4 and the resolution of the figures is not great to draw
5 those conclusions; is that correct?

6 A. Right.

7 Q. Let's go to paragraph 87 of your declaration.
8 That starts at the bottom of page 39, the same page we
9 were on.

10 And here in paragraph 87, you conclude that
11 Sun failed to achieve discrete multiwall nanotubes based
12 on Sun's word choice in his description, but you didn't
13 base your conclusions on an analysis of the images of
14 Figure 6A and 6B that we just looked at, correct?

15 MR. GLENN: Objection. Form. Objection.
16 Mischaracterizes the witness's testimony.

17 THE WITNESS: Could you clarify, please?

18 BY MR. RIFFE:

19 Q. Sure.

20 In paragraph 87, you say, "In fact, Sun
21 expressly concedes that he was unable to achieve fully
22 exfoliated multiwall CNTs." And then you cite to
23 paragraph 69 of Sun.

24 And then you go on to say, "Rather than
25 stating that the experiment 'shows' that the multiwall

1 CNTs have fully been dispersed down to the individual
2 level," you say "Sun's experiment merely suggests that
3 they could be dispersed."

4 Do you see that?

5 A. Yes.

6 Q. And so your conclusion there that Sun fails to
7 achieve multiwall CNTs -- I'm sorry.

8 Your conclusion that Sun fails to achieve
9 discrete multiwall CNTs, you base that on Sun's
10 description, not an analysis that you did of Figure 6A
11 and 6B, correct?

12 MR. GLENN: Objection to form. Objection.
13 Mischaracterizes the witness's testimony.

14 THE WITNESS: Even though the images in Sun's
15 patent are low in quality, you can tell very clearly
16 that for -- for 6 -- Figure 6B, which is for the
17 multiwall nanotubes, the arrows indicate exfoliated
18 nanoplatelets. No arrow for the nanotubes.

19 You know, the paragraph 23 of Sun just
20 mentions arrows indicating exfoliated nanoplatelets.
21 Doesn't mention any arrow for the nanotubes. Okay. So
22 it is not just a matter of ignoring -- not analyzing the
23 images. It's the absence of arrows for the nanotubes,
24 and that absence is important.

25

1 BY MR. RIFFE:

2 Q. And why is it important?

3 A. Because it indicates that Sun is not trying to
4 show the presence of exfoliated multiwall nanotubes.

5 Q. Well, isn't it correct that Sun just merely
6 used arrows to indicate the nanoplatelets, correct?

7 A. No.

8 Q. Did you have an opportunity to ask Mr. Sun or
9 Dr. Sun why he excluded any arrows pertaining to the
10 multiwall CNTs?

11 A. I did not ask, but it's very clear from his
12 specification, because in relation to Figure 7, which
13 pertains to the single wall, then he has two arrows,
14 white arrows indicating the exfoliated nanoplatelets,
15 and black arrows are individually dispersed in straight
16 single-wall nanotubes. Okay?

17 So the contrast between what he describes for
18 Figure 7 and what he describes for Figure 6, that's very
19 clear.

20 In the case of single-wall nanotube, which is
21 Figure 7, he clearly puts arrows indicating that these
22 are the individually dispersed single-wall nanotubes;
23 but for Figure 7, he simply doesn't put any arrow for
24 the multiwall nanotubes. And only arrows for the
25 exfoliated nanoplatelets.

1 And it's not only -- looking at these two
2 paragraphs of Sun, it's also supported by -- by the
3 other parts of the specification. And it's clear from
4 these other parts, as I discuss in detail in my -- in my
5 declaration, that Sun is very clear-cut about his
6 success for the single-wall case but shies away from
7 being clear about the success, in fact, of the multiwall
8 case.

9 If you look at the entirety of Sun's patent,
10 the fact that he succeeds for the single-wall case and
11 not succeeds in the multiwall case is very clear.

12 Q. And that's your testimony even though Sun says
13 that both multiwall nanotubes and the nanoplatelets can
14 be fully dispersed down to individual level in epoxy
15 matrices. That's your testimony, correct?

16 MR. GLENN: Objection. Enforcement.

17 THE WITNESS: Sun, in his specification,
18 discusses the single-wall and multiwall nanotubes often
19 in a generalized fashion without distinguishing in his
20 language, in the specifications. He does this
21 generalization and just call it nanotubes, and he
22 provides ranges of various parameters without
23 differentiating what portion of those ranges refer to
24 single wall or multiwall.

25 And so you are kind of referring to one of

1 those generalized statements in Sun's specification, but
2 one needs to go into details of the specification in
3 order to recognize his different results between the
4 single wall and multiwall.

5 He conducted separate experiments for his
6 single-wall and nano [sic] wall cases, and he presented
7 those results for the two cases separately. One needs
8 to look at those results in detail rather than banking
9 on one generalized statement in the specs.

10 BY MR. RIFFE:

11 Q. Dr. Chung, you said that I was referring to
12 one of those generalized statements, but I beg to
13 differ. I'm looking at paragraph 87 of your declaration
14 where you cite specifically to paragraph 69.

15 And so Sun specifically says that both
16 multiwall nanotubes and nanoplatelets can be fully
17 dispersed down to individual level in epoxy matrices.
18 He comes right out and says that, dual dispersion,
19 correct?

20 MR. GLENN: Objection to form.

21 THE WITNESS: Are you looking at my paragraph
22 89?

23 BY MR. RIFFE:

24 Q. Correct. 87. 87.

25 A. Paragraph 87. So what -- what did you read

1 from there?

2 Q. I -- my original question to you says that Sun
3 says, "Both MWNTs," which are multiwall nanotubes, "and
4 nanoplatelets can be fully dispersed down to individual
5 level in epoxy matrices," correct?

6 MR. GLENN: Objection. Form. Objection.
7 Mischaracterizes the testimony.

8 THE WITNESS: Where are you reading? I don't
9 see that from my paragraph 87.

10 BY MR. RIFFE:

11 Q. In paragraph 87 at the bottom of page 39,
12 you're citing to Sun, and he says, "Both MWNTs and
13 nanoplatelets can be fully dispersed down to individual
14 levels in epoxy matrices."

15 A. Okay.

16 MR. GLENN: Objection -- objection to form.
17 Objection. Mischaracterizes the testimony.

18 THE WITNESS: Okay. I see what you're reading
19 now.

20 Yes. That excerpt, it says, "The TEM images
21 shown here clearly suggests -- suggests [as read] that
22 through the aqueous dispersion, organic redispersion
23 approach, both multiwall nanotubes and nanoplatelets can
24 be -- can be [as read] fully dispersed down to
25 individual levels in epoxy matrices."

1 So he is suggesting that it can be. He did
2 not show that. He did, indeed, achieved that. But in
3 the single-wall case, he was very clear in saying that
4 he has achieved it.

5 BY MR. RIFFE:

6 Q. Okay. So you're relying upon the terms
7 "suggestion" and "can be" to conclude that Mr. Sun did
8 not suggest to a person of ordinary skill in the art
9 that he achieved multiwall carbon nanotubes in a
10 discrete form; is that correct?

11 MR. GLENN: Objection.

12 THE WITNESS: I am not relying only on this.
13 Not only on this. I told you in detail about the Figure
14 6 and Figure 7 in contrast about the arrows, you know.
15 So it's not only this -- this -- this sentence with the
16 word "suggest" and the word "can be." But this --
17 this -- this sentence with the word "suggest" and "can
18 be" corroborates with what I mentioned earlier as
19 conveyed by the Figures 6 and 7 and the associated
20 arrows.

21 BY MR. RIFFE:

22 Q. And you agree with me that other than your
23 conjecture, I might say, you don't know the real reason
24 why Mr. Sun did or did not include arrows in Figures 6A
25 and 6B with respect to the multiwall nanotubes, correct?

1 MR. GLENN: Objection to form.

2 THE WITNESS: Again, if you look at the
3 entirety of this document, this patent, it's very clear
4 that he is succeeding in single-wall case and is not
5 bashful at all in telling that; but in relation to the
6 multiwall, it has the opposite. He didn't put the
7 arrows and didn't put the sentence down to the same to
8 ensure that he has succeeded in the multiwall case.

9 So if you look in the entirety of this
10 document, it's very clear. You don't have to talk to
11 Dr. Sun.

12 BY MR. RIFFE:

13 Q. Okay. Let's turn to paragraph 115 of your
14 declaration.

15 A. 115.

16 MR. RIFFE: Yes. Start on page 51, and it
17 proceeds over to page 52.

18 MR. GLENN: It's 1:10 on the East Coast. Do
19 we want to break for lunch? I don't want to break your
20 flow, Mr. Riffe.

21 MR. RIFFE: That's fine. We can break for
22 lunch.

23 Do you want to do a quick one, like 30 minutes
24 or something?

25 MR. GLENN: It's up to you. I don't know how

1 long you have to go or intend to go today.

2 MR. RIFFE: Yeah, I've got a little bit more
3 to do so --

4 MR. GLENN: Understood.

5 MR. RIFFE: It's up to Dr. Chung. If she
6 wants a full hour, then we'll take a full hour. If she
7 wants to do a quick one, that's fine too.

8 THE WITNESS: How about 45 minutes?

9 MR. RIFFE: I was going to say we can split
10 the baby. We'll split the difference, I should say, and
11 do that. All right. 45 minutes. That puts us at
12 one -- just say 1:50 -- 12:50 on the Central time?

13 MR. GLENN: Works for me.

14 (Recess: 1:09 p.m. to 1:55 p.m.)

15 BY MR. RIFFE:

16 Q. Dr. Chung, welcome back from lunch.

17 Did you have any conversations with counsel
18 pertaining to the substance of your testimony during the
19 break?

20 A. No.

21 Q. Great. Thanks.

22 Did you recall in your declaration -- and
23 you're welcome to refer to paragraph 88, if you need to,
24 of your declaration.

25 In your declaration, you refer to Sun's

1 Figure 1 as a conceptual scheme. I think it's the
2 language you used, and you concluded that it pertains
3 only to single-walled nanotubes as opposed to both
4 single-wall and multiwall nanotubes. And it appears to
5 me that you base that conclusion on -- solely on Sun's
6 experimental results and not on Sun's general
7 descriptions of carbon nanotubes; is that correct?

8 MR. GLENN: Objection to form. Objection.
9 Mischaracterizes the witness's testimony.

10 THE WITNESS: First of all, about the
11 conceptual scheme term, I recall that it's not my term
12 but Sun's term.

13 BY MR. RIFFE:

14 Q. Okay. I apologize if I misspoke.

15 A. Yeah. His paragraph 14, he calls it a
16 conceptual scheme.

17 Q. Okay.

18 A. Yeah.

19 Q. And your conclusions regarding Figure 1
20 pertaining only to single-wall nanotubes, that's based
21 on your review of Sun's experimental results and not on
22 Sun's general description of carbon nanotubes generally;
23 is that correct?

24 MR. GLENN: Objection to form.

25 THE WITNESS: No, it -- as I mentioned before

1 lunch, the conclusion that Sun succeeded with single
2 wall and not succeeded in multiwall is based on looking
3 at the entirety of his patent, not just looking at some
4 experimental results.

5 And -- and so in addition, it is unexpected
6 that a certain scheme would be so generally applicable
7 regardless of the diameter aspect ratio, length of the
8 carbon nanotube, you know. The difference between
9 single wall and multiwall in terms of the diameter can
10 be very large.

11 The aspect ratio, also difference can be very
12 large. And so it's kind of odd that one would expect
13 that this scheme to be applicable to carbon nanotubes of
14 whatever type. You know, because one knows that the --
15 the behavior of the nanotube differs greatly depending
16 on the structure, the structure -- including the
17 difference between single wall and nano -- single wall
18 and multiwall.

19 BY MR. RIFFE:

20 Q. Sun, himself, nowhere limits Figure 1 to only
21 single-wall nanotubes though, correct?

22 A. In his description, he generalizes, yeah. But
23 one has to look at the entirety and one sees that when
24 it comes to interpreting his own experimental results,
25 which are separate between single wall and multiwall, he

1 does concede that in single wall case, he succeeded,
2 according to the scheme of Figure 1, but he did not
3 succeed in case of multiwall, according to the same
4 scheme in Figure 1.

5 Q. And that's based on your interpreting of Sun's
6 experimental results, correct, to draw that conclusion
7 that Figure 1 only applies to single-wall nanotubes,
8 correct?

9 MR. GLENN: Objection to form.

10 THE WITNESS: It's not only his experimental
11 results. It's also his words in his specifications, as
12 I mentioned before lunch. In a single-wall case, he was
13 very clear-cut in the success; but in the multiwall
14 case, no.

15 BY MR. RIFFE:

16 Q. And that specification portion you're pointing
17 to are the experimental results section of the
18 specification, correct?

19 MR. GLENN: Objection to form.

20 THE WITNESS: I'm not sure what you mean by
21 experimental result section.

22 BY MR. RIFFE:

23 Q. When you talk about the experiments that you
24 rely upon in concluding that Figure 1 -- so let me take
25 it back.

1 In paragraph 75 of your declaration, you make
2 the comment that, "While Sun describes his conceptual
3 scheme as applicable to CNTs generally, Sun's actual
4 experimental results show that they clearly only apply
5 to SW CNTs and not MW CNTs."

6 Do you see that?

7 A. Yes.

8 Q. And so those are the experimental results I'm
9 referring to. That's what you referred to in paragraph
10 75 of your declaration.

11 A. Yes.

12 Q. So what were those experimental results you
13 were referring to in paragraph 75?

14 A. Those are the Sun's result. He conducted
15 experiments in his example one, and the experiment is
16 separate between single wall and multiwall. And he
17 presented the results separately for the single wall and
18 multiwall.

19 And in addition to providing the images in
20 Figure 6A and 7, he provides discussion of what those
21 images mean. So all that information is included in the
22 conclusion concerning his success in single wall and
23 lack of success for multiwall.

24 Q. Okay. And then with respect to my specific
25 question then, when you say that in paragraph 88 that we

1 just looked at, that a POSITA would understand Sun's
2 conceptual scheme in Figure 1 as teaching applicable to
3 single-wall CNTs but not applicable to multiwall CNTs,
4 you base that ultimately -- and I'm asking you solely
5 upon your reading of how Sun presents his experimental
6 results, correct?

7 MR. GLENN: Objection to form and objection
8 that it mischaracterizes the witness's testimony.

9 THE WITNESS: I don't mean -- I don't know
10 what you mean by how he presented it.

11 BY MR. RIFFE:

12 Q. The experimental result that you read in Sun
13 formed the basis for your conclusion that Sun's
14 conceptual scheme of Figure 1 only applies to
15 single-wall nanotubes, correct?

16 MR. GLENN: Objection. Form.

17 THE WITNESS: Yeah, and his experimental
18 results are presented by him along with his discussion
19 of the meaning of his results.

20 BY MR. RIFFE:

21 Q. Okay. And you read paragraph 38 of the Sun
22 reference, correct, as part of your analysis?

23 A. Yes.

24 Q. And your conclusion with respect to the
25 applicability of Figure 1 to only single-wall nanotubes

1 but not multiwall nanotubes, you consider that to be
2 true, even though of the discussion in Sun, paragraph
3 38, that carbon nanotubes comprise both single-wall and
4 multiwall nanotubes, correct?

5 MR. GLENN: Objection to form.

6 THE WITNESS: Yeah. This is an instance of
7 how he generalized in his -- quite a number of his
8 sentences generalized to nanotubes of any type; single
9 wall, multiwall, whatever.

10 But one needs to look at the entirety of
11 the -- of the document to see that, in fact, the
12 behavior is different. His results are different
13 between single wall and multiwall, even though he had
14 sentences that generalize as if single wall and
15 multiwall are all behaving the same.

16 BY MR. RIFFE:

17 Q. Let's turn to the next, paragraph 96 of your
18 declaration.

19 A. Yes.

20 Q. I'll get there as well.

21 Now, in your declaration at paragraph 96, you
22 refer to differences in structure and behavior of
23 nanotubes that can be attributed to aspect ratio,
24 correct?

25 A. Yes.

1 Q. And looking back at paragraph 94 of your
2 declaration, you refer to aspect ratios of 50 compared
3 to 51; that is, aspect ratios that are one integer
4 apart, correct?

5 A. Yes.

6 Q. You would agree that a 1 integer difference in
7 aspect ratio would not have a measurable impact on the
8 structure and behavior of the nanotubes, right?

9 MR. GLENN: Objection to form.

10 THE WITNESS: I didn't say that.

11 BY MR. RIFFE:

12 Q. I'm asking you.

13 Do you agree that a 1 integer difference would
14 have no measurable immaterial impact on the structure
15 and behavior of nanotubes?

16 MR. GLENN: Objection to form.

17 THE WITNESS: I would not say that in a
18 general fashion. It depends. Now, if you are -- aspect
19 ratio is 10,000 versus 10,001, it's not a big
20 difference. But the difference between 10 and 11 could
21 be a substantial difference.

22 BY MR. RIFFE:

23 Q. And why is that?

24 A. Well, because it's like the percentage
25 difference, you know. Between 10 and 11, the percentage

1 difference is much bigger than 10,000 versus 10,001 in
2 terms of the percentage difference.

3 Q. I understand it's percentage difference, but
4 what material impact would it have on the structure and
5 behavior of the nanotube between a 10 and 11 aspect
6 ratio?

7 A. Well, a difference is -- can be quite a few.
8 And I list it as being seven of these differences in
9 paragraph 96. Okay? Obviously the bigger the
10 difference in aspect ratio, the more is the difference.
11 Okay?

12 But it's still a difference. It's just a
13 matter of how different. Obviously, the bigger is the
14 difference in aspect ratio, the bigger would be the
15 difference in the resulting structure and properties.

16 Q. So if two carbon nanotubes -- one had an
17 aspect ratio of 10 and another had an aspect ratio of
18 11, how would that increase the number of bends, if you
19 will, which is one of -- I think that's your first
20 difference in structure and behavior that you listed in
21 paragraph 96.

22 MR. GLENN: Objection to form.

23 THE WITNESS: Yes. The larger -- now, let's
24 say that we have diameter kind of fixed, okay, just --
25 as I said here in paragraph 96. If we consider the

1 diameter is fixed, just for the sake of our discussion,
2 then a larger aspect ratio would mean a longer nanotube.
3 Okay. And when it's longer, there would be more
4 tendency for it to bend, so more chance of bending and
5 therefore, the number of bends would tend to increase.
6 Okay?

7 BY MR. RIFFE:

8 Q. How large would that larger aspect ratio need
9 to be to be a discernible difference in a number of
10 bends between the two nanotubes? It certainly must be
11 greater than a difference of one, correct?

12 MR. GLENN: Objection to form.

13 THE WITNESS: No, the number of bends is -- is
14 kind of -- you know, it's -- you can have a sharp bend
15 or a gentle -- a not sharp bend, you know. That is, the
16 radius of curvature of the bend is a variable in
17 describing the nature of the bend.

18 So -- so even if -- compare aspect ratio of 10
19 and aspect ratio of 11, you can call it waviness or
20 whatever, you know, that would be more tendency for
21 waviness for the larger aspect ratio.

22 BY MR. RIFFE:

23 Q. So according to your testimony and your
24 expertise, if a carbon nanotube had an aspect ratio of
25 10 versus a carbon nanotube with an aspect ratio of 11,

1 the carbon nanotube with the aspect ratio of 11 would
2 tend to have more waviness, if you will, based on how
3 you just testified; is that correct?

4 MR. GLENN: Objection to form.

5 THE WITNESS: Yeah. They would tend to have
6 more waviness, yes.

7 BY MR. RIFFE:

8 Q. And how would that be discernible or
9 measurable?

10 A. Oh, can be discerned by microscopy.

11 Q. Would an aspect ratio difference of 1 between
12 two carbon nanotubes necessarily result in structural or
13 behavioral differences?

14 MR. GLENN: Objection to form.

15 THE WITNESS: Necessarily increases the
16 tendency of bending or tendency of entanglement. It
17 necessarily increases the tendency.

18 BY MR. RIFFE:

19 Q. You would agree with me about -- that
20 differences of aspect ratios of greater than an integer
21 of 1, for example, would have a greater increase -- a
22 greater tendency to increase the number of entanglements
23 or the tendency to bend as opposed to an integer
24 difference, correct?

25 MR. GLENN: Objection to form.

1 THE WITNESS: Yeah. Could you clarify?

2 BY MR. RIFFE:

3 Q. Yeah.

4 You would agree with me that as the aspect
5 ratio differences increase, you have more of a tendency
6 to see structural or behavioral differences, correct?

7 A. Yes.

8 Q. Okay. Now, if you were investigating the
9 effect of aspect ratio on material properties across a
10 range of aspect ratios, would you prepare samples for
11 every single integer value of those aspect ratios across
12 the entirety of the range?

13 MR. GLENN: Objection. Form.

14 THE WITNESS: The different aspect ratios over
15 that range give different structure, different
16 properties. And these effects might not be so simple, a
17 linear relationship, you know. It might not be so
18 simple. You can just extrapolate from one aspect ratio
19 to another. And it's not so simple as I list it. It's
20 not just a matter of the tendency to bend but the number
21 of contact points among the CNTs and the likelihood of
22 reaching percolation and so on.

23 You know, so the effect of the aspect ratio is
24 not as simple -- simply related. It's not a simple
25 function like a linear function. It's not like that.

1 Okay? And so one really needs to explore each
2 individual aspect ratio, assuming linearity.

3 BY MR. RIFFE:

4 Q. Okay. So if you had a range of aspect ratios
5 that span 50, let's say, in a particular sample, based
6 on your testimony just now, you would prepare a sample
7 for every single integer value of aspect ratio across
8 that entire range of 50; is that correct?

9 MR. GLENN: Objection. Form. And
10 mischaracterizes the witness's testimony.

11 THE WITNESS: Could you rephrase, please?

12 BY MR. RIFFE:

13 Q. Sure.

14 If you had a range of aspect ratios that span
15 50, 50 different aspect ratios in a particular sample,
16 based on your most recent testimony, it's your opinion
17 that you would need to prepare a sample for every single
18 one of those to determine the effect it would have on a
19 particular structure or behavioral characteristic of the
20 carbon nanotube; is that correct?

21 MR. GLENN: Objection to form and
22 mischaracterizes the witness's testimony.

23 THE WITNESS: The experiment in this regard is
24 actually complicated. The reason is when you will buy a
25 sample of carbon nanotube, they might give you an

1 average aspect ratio or a range of aspect ratio.

2 And if you want to be very sure -- I want this
3 particular value of the aspect ratio -- well, you have
4 to sort it out and you buy that, and it's a mix of
5 various aspect ratios, and it's terrible work. Very
6 tedious. You have to look microscopically and to see
7 which piece of that nanotube has the particular aspect
8 ratio you want.

9 So it's very complicated. I mean, very
10 tedious. Not just because of the large number of aspect
11 ratios, but because it's difficult to get a sample of
12 CNT that is all off that particular aspect ratio.

13 BY MR. RIFFE:

14 Q. Okay.

15 A. So it's very tedious.

16 Q. That was one question I had is can you -- can
17 you obtain a sample of -- of nanotubes, carbon
18 nanotubes, that have a specified single or small -- very
19 small range of aspect ratios? It sounds like that's not
20 possible, at least today?

21 A. Yeah. It's --

22 MR. GLENN: Objection to form.

23 THE WITNESS: It's very hard.

24 BY MR. RIFFE:

25 Q. Okay. And when you get that bundle of

1 nanotubes and you want to determine certain of the
2 nanotubes that have certain aspect ratios, it sounds
3 like you use microscopy to go in and select particular
4 nanotubes from those bundles and then extract those for
5 whatever experimental purpose you have; is that correct?

6 A. Yes.

7 Q. Okay. So it sounds like -- would you agree
8 that in order to test a particular property, like the
9 number of bends, you could do so at several different
10 values of the aspect ratio that are distributed across
11 the range of values of aspect ratio, for example, that
12 you may receive in this bundle that you obtained; is
13 that correct?

14 MR. GLENN: Objection to form.

15 THE WITNESS: Do you mind rephrasing?

16 BY MR. RIFFE:

17 Q. Sure.

18 Would you agree that in order to test the
19 particular property, like the number of bends in a
20 carbon nanotube, you can do so at several different
21 values of the aspect ratio distributed across a range of
22 values?

23 A. Again, it sounds simple, like what you said;
24 but in reality, it's complicated, tedious because the
25 nanotubes that you buy, a sample of that, it's not all

1 the same diameter. There's a range of diameter or they
2 give you an average diameter. Okay?

3 So to do this experiment in a really
4 controlled fashion, you -- you should have the diameter
5 fixed and just vary the aspect ratio. But that would be
6 even more tedious than what I described a moment ago.

7 Q. So you would agree with me, then, though, that
8 if you're looking at the effect of aspect ratio on any
9 of these seven delineated structural features or
10 behavioral features of carbon nanotubes, it's going to
11 be almost impossible to evaluate every single different
12 aspect ratio for that particular sample; is that
13 correct?

14 MR. GLENN: Objection to form.
15 Mischaracterizes the witness' testimony.

16 THE WITNESS: Well, "that particular sample,"
17 I'm not sure what you mean.

18 BY MR. RIFFE:

19 Q. If you obtain a sample of carbon nanotubes --

20 A. Okay.

21 Q. -- and you're trying to determine the effect
22 of the varying aspect ratios of those carbon nanotubes
23 in that sample, it would be almost impossible to analyze
24 that on an aspect-ratio-by-aspect-ratio basis, correct?

25 MR. GLENN: Objection to form.

1 THE WITNESS: It's very tedious. Yeah. I
2 wouldn't say impossible, but it's very tedious.

3 BY MR. RIFFE:

4 Q. Wouldn't it be better to obtain -- look at
5 samples of that set and then determine what effect
6 aspect ratio has on a particular characteristic?

7 A. What do you mean by "samples of that set"?

8 Q. So if you obtain a bundle of carbon nanotubes
9 and there's a mixture of aspect ratios in that set, that
10 sample set, you would agree with me that it may be
11 better to take samples of carbon nanotubes and then plot
12 the effect of the aspect ratio on that particular
13 feature for which you're trying to determine from that
14 set of carbon nanotubes?

15 MR. GLENN: Objection. Form.

16 THE WITNESS: I am not clear. You mean
17 samples? Just randomly selected samples from that
18 bundle?

19 BY MR. RIFFE:

20 Q. Yes, to see what effect the aspect ratio may
21 have on the structural or behavioral characteristics of
22 the carbon nanotubes.

23 A. But if these samples are randomly obtained
24 from that -- that bundle, I don't see how you can
25 investigate the effect of the aspect ratio.

1 Q. Okay. All right. Okay.

2 Let's next -- let's turn our attention next to
3 the Farrugia reference, Dr. Chung. And that is Exhibit
4 LGES 1007.

5 And in particular, I'd like to turn your
6 attention to example one of Farrugia, which is -- begins
7 as a full paragraph, 89 in the Farrugia reference. And
8 let me know when you're there.

9 A. Yes.

10 Q. Dr. Chung, it says in the first sentence
11 that -- actually, in the second sentence, that 5 grams
12 of multiwalled CNTs are used as a starting material,
13 correct?

14 A. Yes.

15 Q. And example one is describing a three-step
16 purification process for multiwall carbon nanotubes; is
17 that right?

18 A. I think so. Yes. Three paragraphs for the
19 three sets. Yes. Yes.

20 Q. Okay. And based on your experience, is it
21 reasonable to understand that this procedure that refers
22 to nanotubes by weight is using a powder of nanotubes as
23 the starting material?

24 MR. GLENN: Objection to form.

25 THE WITNESS: Yeah. It -- you can call it

1 powder; but, you know, powder sounds like particles, but
2 actually it's lumps. Lumps.

3 BY MR. RIFFE:

4 Q. Lumps of nanotubes?

5 A. Yes.

6 Q. Okay. Okay. So the nanotubes in this
7 starting -- we'll call them lumps. I think you like
8 that term better.

9 The nanotubes starting with these lumps in
10 Farrugia's example one -- let me strike that.

11 And in these lumps of nanotubes, the nanotubes
12 are touching one another; is that right?

13 MR. GLENN: Objection to form.

14 THE WITNESS: Yes. They are lumps, yes. So
15 they -- they have to touch at least with degree, yes.

16 BY MR. RIFFE:

17 Q. Sorry for the delay.

18 MR. RIFFE: Can we go off the record for just
19 a moment?

20 (Recess: 2:25 p.m. to 2:28 p.m.)

21 MR. RIFFE: All right. I think that concludes
22 my line of questioning for now, so I'll pass the
23 witness.

24 MR. GLENN: We have no -- we have no
25 questions.

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1 MR. RIFFE: All right. Guess we can go off
2 the record.

3 COURT REPORTER: May I get requests on the
4 record for transcripts?

5 MR. GLENN: Yes, ma'am.

6 We would like a full transcript. I'd also
7 like a dirty as quickly as possible, if I could.

8 MR. RIFFE: Same for us, Tamara.

9 (Proceedings concluded at 2:29 p.m.)

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1	ERRATA SHEET		
2	NAME OF CASE: LG ENERGY SOLUTION, LTD. V. MOLECULAR		
3	REBAR DESIGN, LLC		
4	DATE OF DEPOSITION: JUNE 25, 2025		
5	NAME OF WITNESS: DEBORAH CHUNG, Ph.D.		
6	Reason Codes:		
7	1:	To clarify the record.	
8	2:	To conform to the facts.	
9	3:	To correct transcription error.	
10	Page	Line	Reason
11	From	to	
12	Page	Line	Reason
13	From	to	
14	Page	Line	Reason
15	From	to	
16	Page	Line	Reason
17	From	to	
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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 June 25, 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;

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

Dated: 8th of July, 2025.

TAMARA L. HOUSTON
CSR 7244, RPR, CCRR 140

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