

1 UNITED STATES PATENT AND TRADEMARK OFFICE
2 BEFORE THE PATENT TRIAL AND APPEAL BOARD

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5 HANWHA SOLUTIONS CORPORATION,

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7 Petitioner,

8

Case Nos.:

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v.

IPR 2024-01199,

10

IPR 2024-01203

11

MAXEON SOLAR PTE, LTD., U.S. Patent Nos.:

12

8,878,053,

13

Patent Owner

8,222,516

14

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17 Deposition of DOUGLAS S. RUBY, Ph.D.

18 Conducted In person

19 Thursday, July 31, 2025

9:29 a.m. EDT

Job No.: 592117

20 Pages 1 - 208

21 Reported by: Christine J. Roybal, RPR, CCR, CSR

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A P P E A R A N C E S

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I N D E X

-- WITNESS:

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E X H I B I T S

Hanwha 1001 U.S. Patent 8,222,516 (retained 12:16
by counsel)
Hanwha 1001 U.S. Patent 8,878,053 15:3
Hanwha 1004 European Patent Application, 170:18
Application No. 05105081.3
Hanwha 1005 Polysilicon Emitters for Silicon 176:4
Concentrator Solar Cells
Hanwha 1006 International Application Under the 182:14
Patent Cooperation Treaty, (WO 2009/094575 A2)
Hanwha 1007 U.S. Patent 6,998,288 B1 197:5
Hanwha 1008 China National Intellectual Property 185:4
Administration, Application No. 05105081.3
Hanwha 1012 U.S. Patent Application Publication 195:9
U.S. 2006/0157103A1, 7/20/06
Ruby 1071 Videotaped Deposition Transcript of 21:9
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Ruby 1072 Sandia Report Fundamental Understanding 109:11
and Developments of Low Cost High-Efficiency
Silicon Solar Cells
Ruby 1073 U.S. Patent Ruby, et al., 5,792,280 133:7

1 Ruby 1074 Simplified Processing for 23% Efficient 156:13
2 Silicon concentrator Solar Cells

3 Maxeon 2027 U.S. Patent Trademark Office 15:20
4 Declaration of Douglas Ruby, Ph.D., In Support
of Patent Owner's Response (retained by counsel)

5 Maxeon 2027 U.S. Patent Trademark Office 17:13
6 Declaration of Douglas Ruby, Ph.D., in Support
of Patent Owner's Response

7 Maxeon 2028 CV of Douglas Ruby, Ph.D. 18:4

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I N D E X

All Witnesses:	Page
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1 (On the record at 9:29 a.m.)

2 July 31, 2025

3 Dr. Douglas Ruby, Ph.D.

4 DOUGLAS S. RUBY, PH.D.,

5 was called as a witness and, having been first duly sworn,

6 was examined and testified as follows:

7 MR. SELWYN: Yes, for the petitioner, my name is

8 Mark Selwyn of WilmerHale. With me today is

9 Gilbert Smolenski, David Cavanaugh, and on the phone

10 Bobby Hampton.

11 MS. ZHAO: Jang Zhao for PV Law for Maxeon.

12 EXAMINATION

13 BY MR. SELWYN :

14 Q. Good morning, sir.

15 A. Good morning.

16 Q. Could you please state your full name for the
17 record?

18 A. Douglas Scott Ruby.

19 Q. Dr. Ruby, have you ever been known by any other
20 names?

21 A. No.

22 Q. By whom are you employed?

1 A. Self-employed.

2 Q. What is the name of your firm?

3 A. Douglas Ruby, Ph.D.

4 Q. What is your current business address?

5 A. Say again.

6 Q. What is your current business address.

7 A. Address, 9040 Wind Caves Way, Albuquerque.

8 Q. Do you understand you're under oath today?

9 A. I do understand.

10 Q. Do you understand that you must give complete
11 honest and responsive answers to my questions just as if you
12 were in a courtroom?

13 A. Yes, I do.

14 Q. Is there any reason you can't provide your best
15 testimony here today?

16 A. No reason.

17 Q. Have you ever been deposed before?

18 A. Yes.

19 Q. How many times, sir?

20 A. At least twice.

21 Q. What matters were those?

22 A. One was a few months ago, same patent, defending

1 against, I guess, litigation from Canadian Solar. And then
2 last week different clients involving Trina Solar.

3 Q. Who are the parties to the matter that you were
4 deposed in last week?

5 A. I was working for a firm hired by Trina Solar, and
6 they were in litigation with a firm -- I can't remember
7 right now who it was.

8 Q. Was that also an IPR?

9 A. It was an ITC case, International Trade
10 Commission.

11 Q. Thank you.

12 Have you ever testified at trial before?

13 A. Yes.

14 Q. How many times?

15 A. Once.

16 Q. What was that matter?

17 A. Sorry?

18 Q. What was that matter?

19 A. That matter was a patent infringement case where I
20 was hired by a firm defending Jinko Solar against
21 Hanwha Solar.

22 Q. Was that an ITC matter?

1 A. No. That was a patent infringement case in
2 Australia.

3 Q. And when did you testify?

4 A. September 2022.

5 Q. You are providing testimony for this matter
6 supporting Maxeon, the patent owner, and to inter partes
7 review proceedings; is that right?

8 A. Two, yes.

9 Q. You submitted two declarations supporting Maxeon's
10 patent owner responses, correct?

11 A. Two declarations. Oh, you mean one for each
12 patent? Yes, that's right.

13 Q. One of your declarations concerns U.S. Patent No.
14 8,222,516.

15 A. '516. Yes.

16 Q. Can we refer to that today as the '516 Patent?

17 A. Yes.

18 Q. And your other declaration concerns U.S. Patent
19 No. 8,878,053?

20 A. '053, correct.

21 Q. And can we refer to that as the '053 Patent today?

22 A. Yes, you may.

1 Q. Tell us what you did to prepare for today's
2 deposition.

3 A. I met with the law firm's representative here
4 yesterday.

5 Q. For how long?

6 A. Maybe four hours.

7 Q. Did you do anything else to prepare for today's
8 deposition?

9 A. Yes. I reread my declarations.

10 Q. In preparing for today's deposition, did you
11 review any documents that are not cited in your
12 declarations?

13 A. No.

14 Q. When did you first learn about the existence of
15 the IPR proceedings against the '516 and '053 Patents filed
16 by Hanwha Solutions?

17 A. Sometime early this year, maybe. I don't
18 remember. February, March.

19 Q. How did you learn?

20 A. Oh, I was contacted by an intermediary who
21 connects law firms with expert witnesses and I was
22 interviewed and accepted.

1 Q. Are you aware that Maxeon has sued
2 Hanwha Solutions and Hanwha Energy in district court?

3 A. Yes, I am.

4 Q. And when did you learn about the existence of the
5 district court case?

6 A. It would have been some time after February or
7 March of this year.

8 Q. How did you learn?

9 A. The law firm informed me.

10 Q. Other than the conversation that you have had with
11 Maxeon's lawyers, have you talked to anyone about the
12 lawsuit or about the IPR proceedings?

13 A. No.

14 Q. How did you come to be engaged in this matter?

15 A. Well, as I said, a intermediary firm whose job it
16 is to connect experts with law firms sought me out and
17 conducted a telephone interview and then forwarded my resume
18 to the law firm.

19 Q. Before you were retained were you told that
20 counsel was interested in you providing an opinion that
21 supported the validity of the '516 and the '053 patents?

22 A. Before I was retained?

1 Q. Yes.

2 A. Before I was retained I was told nothing.

3 Q. When you were retained were you told that counsel
4 was interested in you providing an opinion that supported
5 the validity of the '516 and '053 patents?

6 A. Yes.

7 Q. How many hours have you worked on this matter to
8 date?

9 A. To date?

10 Q. To date, yes.

11 A. I don't have that information available to me, but
12 maybe 20 hours.

13 Q. All right. I'm handing you U.S. Patent No.
14 8,222,516 as Exhibit 1001 from IPR 2024-1203. Do you have
15 that before you?

16 (Exhibit 1001 marked.)

17 A. Yes, I do.

18 Q. (BY MR. SELWYN) Were you aware of the '516 Patent
19 before you were retained for this matter?

20 A. No, I wasn't.

21 Q. Were you aware of the '053 Patent before you were
22 retained for this matter?

1 A. No, I wasn't.

2 Q. Were you aware of any patents in the same family
3 as the '516 or '053 patents before you were retained for
4 this matter?

5 A. What do you mean by "the same family"?

6 Q. Same patent family related to the '516 or '053
7 such as continuations.

8 A. No, I wasn't aware of any other patents related to
9 this.

10 Q. Do you see that the named vetter on the '516
11 Patent is Peter John Cousins?

12 A. Yes, I see that.

13 Q. Had you heard of Peter John Cousins before you
14 were retained for this matter?

15 A. I have heard his name mentioned.

16 Q. In what context?

17 A. As he was a researcher at SunPower Corporation.

18 Q. Had you heard anything else about
19 Peter John Cousins before you were retained for this matter?

20 A. No.

21 Q. Had you heard anything about the reputation of
22 Peter John Cousins before you were retained for this matter?

1 A. Well, I believe I had heard that he had a good
2 reputation.

3 Q. When did you first read the '516 Patent?

4 A. When the law firm gave it to me.

5 Q. And that was in the February/March 2025 time
6 frame; is that right?

7 A. Approximately.

8 Q. Did you read it in its entirety?

9 A. Yes, I did.

10 Q. And have you read it since you first read it?

11 A. I have read portions of it over again.

12 Q. How many times have you read it in its entirety?

13 A. In its entirety, probably once.

14 Q. Is there anything in the '516 Patent that you do
15 not understand?

16 A. No.

17 Q. How long did you spend reading the '516 Patent?

18 A. An hour.

19 Q. And to date, how much time have you spent reading
20 the '516 Patent, or is that an hour?

21 A. An hour-and-a-half.

22 Q. Thank you.

1 I'm now handing you U.S. Patent 8,878,053 as
2 Exhibit 1001 from IPR 2024-01199.

3 (Exhibit 1001 marked.)

4 Q. (BY MR. SELWYN) Do you have that before you?

5 A. Yes, I do.

6 Q. When did you first read the '053 Patent?

7 A. It would have been same time frame, probably in
8 the spring of this year.

9 Q. And how many times have you read the '053 Patent?

10 A. In its entirety, probably just once.

11 Q. And how much time have you spent to date reviewing
12 the '053 Patent?

13 A. Probably an hour-and-a-half.

14 Q. Is there anything in the '053 Patent that you do
15 not understand?

16 A. No.

17 Q. I'm going to hand you a copy of your declaration
18 with the '516 matter, which is Exhibit 2027. Do you have
19 that before you?

20 (Exhibit 2027 marked.)

21 A. Yes, I do.

22 Q. (BY MR. SELWYN) And this is the declaration you

1 submitted regarding the '516 Patent, correct?

2 A. Yes, it is.

3 Q. If you'd turn to, please sir, to Paragraph 1.

4 A. Okay.

5 Q. At the end of Paragraph 1 you say, "This
6 declaration sets forth the opinions that I have reached to
7 date regarding these matters." Do you see that?

8 A. Yes.

9 Q. Does this declaration provide your complete
10 opinion regarding the '516 Patent?

11 A. Yes, it does.

12 Q. Would you describe for us, please, the process by
13 which the declaration was prepared.

14 A. Well, I was asked to provide a background section
15 on the relevant technology in this matter, which I did. And
16 then the law firm drafted some sections on various matters
17 in dispute regarding the patent. And I reviewed those
18 drafts and edited them to make sure that all the statements
19 were true and correct. And the edits went back and forth a
20 few times with the law firm and then when we were all in
21 agreement I signed it.

22 Q. How many hours did you spend preparing this

1 declaration?

2 A. Ten, approximately.

3 Q. And approximately how much time did you spend
4 preparing your declaration regarding the '053 Patent?

5 A. Maybe another ten.

6 Q. When you say that you prepared the background
7 sections, looking at the table of contents, can you identify
8 the ones you're referring to?

9 A. Well, Section 6 entitled Background of the patent
10 and related technology, Sections A through G.

11 Q. Thank you. Let me now hand you, please,
12 Exhibit 2027 from IPR 2024-01199.

13 (Exhibit 2027 marked.)

14 Q. (BY MR. SELWYN) Which is your declaration
15 regarding the '053 Patent. Do you have that before you?

16 A. Yes, I do.

17 Q. Did you file the same process in preparing your
18 declaration for the '053 Patent as you described a moment
19 ago for the '516 Patent?

20 A. Yes, I did.

21 Q. Have you conducted any experiments in connection
22 with your work on these IPRs?

1 A. No.

2 Q. Let me now hand you Exhibit 2028 from
3 IPR 2024-1203.

4 (Exhibit 2028 marked.)

5 Q. (BY MR. SELWYN) Is this a copy of your CV, sir?

6 A. Yes.

7 Q. Is it accurate?

8 A. Yes, it is.

9 Q. Do you see on the first page in front of the
10 heading disclosure, it indicates that you were retained as
11 an expert for Jinko Solar opposite Hanwha?

12 A. Where do you see that?

13 Q. About two-thirds down the first page.

14 A. Disclosure. Dr. Ruby was retained as an expert
15 for Jinko Solar opposed to Hanwha. Yes.

16 Q. Can you describe what your work in that matter
17 involved.

18 A. Well, Jinko Solar had been sued by Hanwha for
19 patent infringement, and my work involved studying the
20 device structure that Jinko Solar fabricated for use in its
21 solar cells, and comparing that with the patent that was
22 owned by Hanwha, and discussing the differences which I saw

1 in the Jinko product and the Hanwha Patent.

2 Q. Did you study any Hanwha products as part of your
3 work in that matter?

4 A. No.

5 Q. Have you ever studied any Hanwha products?

6 A. No.

7 Q. Are you aware of any Hanwha products?

8 A. Not really.

9 Q. Do you know anything about the design of any
10 Hanwha products?

11 A. No.

12 Q. On Page 4 of your CV you have a client list; is
13 that right?

14 A. Page 4, list of clients. Yes.

15 Q. And your clients include SunPower Corporation.

16 A. Right.

17 Q. Is that the same SunPower that's listed as the
18 applicant to the '053 and '516 patents?

19 A. Yes, it is.

20 Q. When did you work for SunPower?

21 A. Well, over the course of several years, probably
22 between 2010 and 2015.

1 Q. And what was the nature of the work that you did
2 for them?

3 A. Well, I authored a short course, a three-day
4 course on the science and technology of photovoltaic cells,
5 and I presented that course at the SunPower factory location
6 in the Philippines.

7 Q. When was that?

8 A. As I said, sometime between 2010 and 2015.

9 Q. Did you do any other work for SunPower over that
10 period of time?

11 A. No.

12 Q. Approximately how many hours of time did you bill
13 SunPower for?

14 A. Well, it was a three-day course, I provided it
15 four times, so 12 days.

16 Q. And have you listed on your CV all the times
17 you've testified before a court?

18 A. I believe so. I believe there was only that one
19 time in Australia.

20 Q. Thank you.

21 Approximately how much did you charge SunPower for the
22 work that you performed for them?

1 A. I don't recall.

2 Q. Can you give us any estimate?

3 A. I don't recall.

4 Q. All right. Let me -- I will mark as our next
5 Exhibit 1071, which is a document bearing the title video
6 conference deposition of Douglas Ruby, Ph.D. for Case No.
7 IPR 2024-1039 and case No. IPR 2024-1040. Do you have that
8 before you?

9 (Exhibit 1071 marked.)

10 A. Yeah, I do.

11 Q. (BY MR. SELWYN) You gave a deposition on
12 June 24th in two IPRs that were filed by Canadian Solar,
13 correct?

14 A. Yes, that's right.

15 Q. Those IPRs also challenged the '516 and '053
16 patents, correct?

17 A. Yes, they did.

18 Q. And this is the transcript from your deposition of
19 those IPRs?

20 A. That's what you allege it to be, yes.

21 Q. And you testified truthfully in that deposition,
22 correct?

1 A. Yes.

2 Q. You had a chance to review your deposition
3 transcript and make corrections after the deposition,
4 correct?

5 A. No, I didn't. This is the first time I'm seeing
6 it.

7 Q. Okay. Do you stand by all the answers you gave in
8 response to the questions you were asked in that deposition?

9 A. Yes, I do.

10 Q. I ask you to put back in front of you your CV,
11 please.

12 A. Okay.

13 Q. And can you turn, please, to Page 7.

14 A. Yes.

15 Q. Do you see on Page 7 you have listed various
16 references?

17 A. Yes.

18 Q. One of the references is somebody named
19 Dick Swanson; is that right?

20 A. Yes, that's right.

21 Q. Is Dr. Swanson an experienced solar cell
22 scientist?

1 A. Yes, he is.

2 Q. Is he well known in the field?

3 A. Yes, he is.

4 Q. Do you consider Dr. Swanson's writing and
5 scholarship in the solar field to be well researched and
6 reliable?

7 A. Yes, I do.

8 Q. How long have you known Dr. Swanson?

9 A. Probably since about 1986.

10 Q. How did you come to know him?

11 A. Well, at the time, I was a member of the technical
12 staff at Sandia National Laboratories here in Albuquerque in
13 the Photovoltaic Cell Research Division. And at that time,
14 we provided funding and expertise to several contract
15 winners who received contracts through Sandia from the
16 Department of Energy. And one of them was to Dick Swanson
17 when he was a professor at Stanford University, performing
18 research in his lab on new solar cell designs. And we did a
19 lot of the measurement and testing of his solar cell
20 products.

21 Q. Is Dr. Swanson well known in the solar field?

22 A. Dr. Swanson is the father of the photovoltaic

1 industry.

2 Q. He's actually considered one of the pioneers; is
3 that fair?

4 A. Yes.

5 Q. Have you ever spoken with Dr. Swanson about these
6 IPRs or about the '516 or '053 Patent?

7 A. No, I have not.

8 Q. I~-- I apologize if I'm mispronouncing --
9 Ajeet Rohatgi.

10 A. Ajeet Rohatgi.

11 Q. Rohatgi. He's also a reference; is that right?

12 A. Yes.

13 Q. And who is he?

14 A. Well, when I worked with him he was professor of
15 electrical engineering at Georgia Tech.

16 Q. Is Dr. Rohatgi an experienced solar cell
17 scientist?

18 A. Yes.

19 Q. Is he well known in the field?

20 A. Yes, he is.

21 Q. And he founded a solar cell company?

22 A. Apparently so, yes. Suniva, Incorporated.

1 Q. Do you consider Dr. Rohatgi's writing and
2 scholarship in the solar field to be well researched and
3 reliable?

4 A. Yes, I do.

5 Q. For how long have you known him?

6 A. Probably also since the 1980s.

7 Q. Do you know Peter Borden?

8 A. Not really, no. I don't think so.

9 Q. Let me ask you a few other names, see if you know
10 them. Li Xudong, X-U-D-O-N-G?

11 A. No.

12 Q. How about Li Hai-ling, H-A-I-L-I-N-G?

13 A. No.

14 Q. Ju Ying, Y-I-N-G?

15 A. No.

16 Q. Song Shuang, S-H-U-A-N-G?

17 A. No.

18 Q. Hen Yang, Y-A-N-G.

19 A. No.

20 Q. Do you know Armin Froitzheim, F-R-O-I-T-Z-H-E-I-M?

21 A. No.

22 Q. Do you know Adolf Munzer, M-U-N-Z-E-R?

1 A. No.

2 Q. Do you know Jon Yewgan, J-O-N Y-E-W-G-A-N?

3 A. No.

4 Q. If you'll put back in front of you, please sir,
5 your declaration.

6 A. Which one?

7 Q. For the '516.

8 And if you turn, please sir, to Paragraph 3.

9 A. Yes.

10 Q. You list your qualifications, right?

11 A. Yes.

12 Q. And this includes a summary of your qualifications
13 and professional experience?

14 A. Yes.

15 Q. And in Paragraph 6 you discuss your university
16 degrees.

17 A. Yes.

18 Q. And I see you received a Bachelor of Science in
19 physics, a Master's Degree in semiconductor physics and your
20 Ph.D. is in semiconductor physics; is that right?

21 A. Yes, it is.

22 Q. Were your studies in semiconductor physics

1 relevant to solar cells?

2 A. Not directly, no.

3 Q. Were they, indirectly?

4 A. Well, they involved semiconductors, and solar
5 cells are made out of semiconductors.

6 Q. Does semiconductor physics include solar cells?

7 A. Yes.

8 Q. Are solar cells a type of semiconductor device?

9 A. Yes.

10 Q. And in your studies described in Paragraph 6 did
11 you take any classes on solar cells specifically?

12 A. Not specifically, no.

13 Q. Do principles applicable generally to
14 semiconductors often apply to solar cells?

15 A. Yes.

16 Q. Can you explain why?

17 A. As I said, solar cells are made using
18 semiconductors, so the principles of semiconductor physics
19 which apply to all semiconductor devices also apply to solar
20 cells.

21 Q. Is a transistor a semiconductor device?

22 A. Yes.

1 Q. Did you study transistors during your education
2 and schooling?

3 A. To some extent, yes.

4 Q. Can you describe how?

5 A. Well, they were discussed in courses that I took
6 on semiconductor device physics in general. And they were
7 one example of a semiconductor device.

8 Q. You worked at Sandia National Labs from 1985 to
9 2008; is that right?

10 A. Yes.

11 Q. How did you come to be hired by Sandia?

12 A. Well, I knew that they were one of the few
13 domestic research laboratories involved in photovoltaics
14 research, which is the area that I wanted to pursue my
15 career in. So I called them and sent in an application, was
16 interviewed and was hired.

17 Q. And would you describe for us what Sandia National
18 Laboratories is?

19 A. It is a federally funded research laboratory that
20 receives funds from U.S. Department of Energy to pursue
21 research in many areas. And up until recently, one of them
22 was photovoltaics.

1 Q. Has it ended?

2 A. My understanding is the budget for next year is
3 zero.

4 Q. Did Sandia do any work related to solar cells
5 while you were a member of its technical staff from 1985 to
6 2008?

7 A. Yes.

8 Q. At a high-level, what work did it do?

9 A. We pursued research to design and develop new
10 architectures for solar cells and new processes to achieve
11 those architectures in the hope of increasing the efficiency
12 and reducing the cost of photovoltaic technology.

13 Q. So Sandia was doing research and design for solar
14 cells between 1985 and 2008?

15 A. Well, certainly between 1985 and 2004. My
16 laboratory was closed by the DOE in 2000, and I managed to
17 continue doing research on my own until about 2004. And
18 after that, I believe solar cell research at Sandia was
19 suspended.

20 Q. Okay. But for a period of 19, 20 years or so,
21 Sandia was doing research and design of solar cells; is that
22 right?

1 A. Yes.

2 Q. And what was your contribution at a high-level to
3 that work?

4 A. Well, I developed processes to introduce new
5 materials and structures and solar cell architecture at the
6 atomic level in order to improve the performance and reduce
7 the cost.

8 Q. Did you do any manufacturing of solar cells as
9 part of your work?

10 A. No.

11 Q. Did you sell any solar cells as part of your work?

12 A. No.

13 Q. Okay. Are you proud of the research and design
14 work that you did on solar cells during that two-decade
15 period?

16 A. Yes.

17 Q. Was Sandia respected in the solar cell industry
18 during the time that you worked there?

19 A. I believe they were, yes.

20 Q. And did Sandia publish papers, articles, and the
21 like related to solar cell design between 1985 and 2008?

22 A. Yes, many.

1 Q. Do you consider the publications and articles by
2 Sandia during that period of time to be reliable?

3 A. Yes, I do.

4 Q. And you contributed to many of those articles,
5 right?

6 A. Yes, I did.

7 Q. How big was the team that you worked on at Sandia
8 working on solar cells?

9 A. There were several teams involved in different
10 aspects of photovoltaic technology. In the team devoted to
11 silicon solar cell device, design, and fabrication, at one
12 time there may have been ten or 2012 people involved. And
13 at other times, maybe seven people until the lab was finally
14 closed down.

15 Q. And how big was the budget for the work that you
16 and your team did?

17 A. I would say close to a million dollars per year.

18 Q. Can I ask you some questions about the work that
19 you did there?

20 A. Yeah, sure.

21 Q. During your time at Sandia did you ever face
22 design trade-offs when developing solar cells?

1 A. Yes.

2 Q. What types of design trade-offs did you face?

3 A. Well, for example, when I was designing a new
4 passivation layer for silicon solar cells I had to trade off
5 surface passivation against transmissivity of the layer.

6 Q. Did you ever face a trade-off between solar cell
7 efficiency on the one hand that reduced cost on the other?

8 A. I would say we always geared our designs for both
9 increased efficiency and reduced cost.

10 Q. Why?

11 A. Because they are both important.

12 Q. What was the passivation layer made of, of the
13 cell that you just described a moment ago?

14 A. Various compositions of silicon nitride.

15 Q. May I ask what compositions.

16 A. They had varying ratios of silicon and nitrogen.

17 Q. Did you ever face a design trade-off where a
18 feature added benefits to certain aspect of a cell but was
19 disadvantageous for other reasons?

20 A. Say that again.

21 Q. Sure. Did you ever face a trade-off where a
22 feature added benefits to some aspects of a cell, but was

1 disadvantageous for some other reason?

2 A. Well, it depends whose opinion you're referring
3 to. When I was involved in silicon nitride work there were
4 people who told me it could never be commercially acceptable
5 because it was a vacuumed process, and therefore, in their
6 mind, too costly. On the other hand, now, it is universally
7 accepted and everybody uses silicon nitride surface
8 passivation.

9 Q. So you turned out to be right?

10 A. I did.

11 Q. Was processing temperature ever a design trade-off
12 you faced?

13 A. There was a variable in our experiments.

14 Q. How so?

15 A. Well, deposition at different temperatures
16 resulted in different degrees of passivation and different
17 refractive indices.

18 Q. So did you ever change processing temperature
19 because it improved one aspect of a cell even if it had a
20 negative effect on another?

21 A. I don't believe it ever had a negative effect.

22 Q. During your time at Sandia did you work on solar

1 cells with a rear PN-junction?

2 A. No.

3 Q. During your time at Sandia did you work on solar
4 cells with tunnel oxide?

5 A. No.

6 Q. During your time at Sandia did you work on solar
7 cells with front-surface texturing?

8 A. Yes.

9 Q. What work did you do regarding solar cells with a
10 front-surface texturing?

11 A. Well, I was part of a group that worked on a
12 process to develop front-surface texturing in one of several
13 ways.

14 Q. Tell me about that, what you did.

15 A. Well, I personally worked on a technique known as
16 reactive ion etching, typically known by the acronym RIE, to
17 use a plasma process to texture the front surface of a solar
18 cell.

19 Q. Were there any other aspects of texturing that you
20 were working on?

21 A. There were others in my group who worked on wet
22 chemical etches for silicon texturing.

1 Q. Plasma removes material from the surface of the
2 cell, correct?

3 A. Yes, it does. Well, plasma etching does. Plasma
4 deposition adds material.

5 Q. Plasma etching removes material from the surface
6 of the cell, correct?

7 A. Yes.

8 Q. Did you or others at Sandia design and build a
9 solar cell having front-surface texturing?

10 A. Yes.

11 Q. And did you publish any papers describing a solar
12 cell with front-surface texturing?

13 A. Yes, I did.

14 Q. What papers did you publish?

15 A. Well, it should be listed in my CV under RIE
16 texture silicon solar cells or plasma textured.

17 Q. What was your motivation at the time for studying
18 front-surface texturing?

19 A. Well, at the time, solar cells made of silicon
20 were made using either monocrystalline silicon wafers or
21 multicrystalline silicon wafers, and for the case on
22 multicrystalline silicon, there was no cost-effective wet

1 chemical etch that could provide texturing. So I
2 investigated this plasma texturing process to develop a
3 texturing method for multicrystalline silicon solar cells.

4 Q. Were any of the front-surface texturing techniques
5 that you developed ever commercialized?

6 A. Well, I can't be certain.

7 Q. During your time at Sandia did you work on solar
8 cells with the anti-reflection coating?

9 A. Yes.

10 Q. What work did you do regarding solar cells with
11 the anti-reflection coating?

12 A. Well, silicon nitride, as I mentioned before
13 serves a dual purpose providing not only surface
14 passivation, but also acting as an anti-reflection coating.

15 Q. What partic- -- what particular aspects of
16 anti-reflection coating were you working on?

17 A. I was working on providing a silicon nitride layer
18 with the optimum refractive index to produce minimum
19 reflection.

20 Q. Did you work on methods of making anti-reflection
21 coating?

22 A. I worked on exploring the parameter space for

1 silicon nitride deposition in the plasma chamber, for the
2 purpose of providing both surface passivation and
3 anti-reflection coatings.

4 Q. Did you study the features that an ideal
5 anti-reflection coating should have?

6 A. Did you say "ideal"?

7 Q. Yes.

8 A. I knew about those features.

9 Q. How did you know about them?

10 A. I studied them in several of my classes, and they
11 were very well known.

12 Q. Your classes where?

13 A. University of Illinois.

14 Q. And while at Sandia did you ever design a solar
15 cell having the anti-reflection coating?

16 A. Yes.

17 Q. Would you describe that solar cell?

18 A. It was a solar cell having a front-end junction
19 with an RIE textured front surface and a silicon nitride
20 layer on top of that surface, providing both passivation and
21 anti-reflection.

22 Q. Did you or others at Sandia publish any papers or

1 articles describe that solar cell?

2 A. Yes.

3 Q. What articles? Are they listed in your CV?

4 A. Yeah, they are listed in my list of technical
5 publications.

6 Q. Do you remember any of the titles?

7 A. Want me to look it up?

8 Q. If it helps, sure.

9 A. Well, should I list all of them.

10 Q. Sure.

11 A. Okay.

12 Q. Are there a lot?

13 A. There are many.

14 Q. Why don't you give us some examples, then.

15 A. Well, there's one here, authors D.S. Ruby,
16 Wilbanks and Fleddermann, A Statistical Analysis of the
17 Effect of (PECVD) Deposition Parameters on Surface and Bulk
18 Retermination in Silicon Solar Cells, at the First World
19 Conference on Photovoltaic Energy Conversion, in Waikoloa,
20 Hawaii.

21 Q. How about another example?

22 A. Okay. Here is one by Ruby, Wilbanks, Fleddermann

1 and Rosenblum, Roncin and Narayanon, Optimization of Plasma
2 Deposition and Etching Processes for Commercial
3 Multicrystalline Silicon Solar Cells, Conference Record of
4 the 25th Photovoltaic Specialist Conference, Washington
5 D.C., May, 1996.

6 Q. Thank you. What did you believe at the time
7 anti-reflection coating could provide?

8 A. Well, it is well known that anti-reflection
9 coatings increase the amount of light that is transmitted
10 into the solar cell.

11 Q. How is that beneficial?

12 A. The increased amount of light that's absorbed then
13 generates a higher concentration of mobile carriers in the
14 silicon.

15 Q. Was anti-reflection coating a feature of many
16 solar cells at the time that you were working at Sandia?

17 A. Yes.

18 Q. Did you -- during your time at Sandia, did you
19 work on solar cells with metal contacts?

20 A. Yes.

21 Q. What work did you do regarding solar cells and
22 metal contacts while you were at Sandia?

1 A. All of the solar cells I made at Sandia used metal
2 contacts.

3 Q. Why?

4 A. Because that's the only way to extract the
5 electric current out of the solar cell.

6 Q. Were there particular aspects of metal contacts
7 that you studied while at Sandia?

8 A. Not really.

9 Q. Did you ever work on screen printing while at
10 Sandia?

11 A. No.

12 Q. Are you familiar with the phrase "firing through"?

13 A. Yes, I am.

14 Q. What does that mean?

15 A. That means depositing a metal paste on the surface
16 of a solar cell which may have an anti-reflection coating on
17 it, and then heating that solar cell to a relatively high
18 temperature so the metal paste is able to react with and
19 essentially remove the underlying film until it reaches the
20 surface of the silicon where it makes contact, electrical
21 contact with the silicon substrate.

22 Q. Were you aware of screen printing during your time

1 at Sandia?

2 A. Yes.

3 Q. And were you aware of firing through for screen
4 printing while at Sandia?

5 A. Yes.

6 Q. How did you become aware of screen printing?

7 A. Well, I worked with many solar cell manufacturers.
8 At that time, there were quite a few in the United States,
9 and that was the commercial method used by manufacturers
10 because it is very high throughput.

11 Q. How did you become aware of firing through for
12 screen printing?

13 A. By having discussions with those individuals at
14 the solar cell companies who were using it as a technique
15 for mass producing solar cells.

16 Q. And that was during your time at Sandia; is that
17 right?

18 A. Yes.

19 Q. Were you aware of solar cells with tunnel oxide
20 while you were at Sandia?

21 A. No.

22 Q. During your time at Sandia did you work on solar

1 cells with an N-type substrate?

2 A. Did I personally?

3 Q. Let's start there.

4 A. Well, as I mentioned, we measured some cells from
5 SunPower at Stanford previously, fabricated by Dick Swanson
6 and his company which used N-type substrates.

7 Q. So during your time at Sandia you were aware of
8 solar cells with an N-type substrate?

9 A. Yes.

10 Q. How did you become aware?

11 A. By working with SunPower.

12 Q. When was that?

13 A. Starting around 1986.

14 Q. Did you do any -- strike that.

15 Did you or your colleagues at Sandia do any work on
16 solar cells with an N-type substrate?

17 A. In my laboratory we did not fabricate any solar
18 cells on N-type substrates.

19 Q. How about other laboratories at Sandia?

20 A. I don't believe there were any.

21 Q. What work did you do with SunPower while at Sandia
22 involving solar cells with an N-type substrate?

1 A. Measurement, and to some extent modeling, computer
2 modeling of the performance of his N-type solar cells.

3 Q. Did that work involve commercialized solar cells?

4 A. I think at that stage it was primarily a research
5 project.

6 Q. Were there any publications that came out of that
7 work?

8 A. I'm sure there were.

9 Q. Did -- during your time at Sandia did you work on
10 solar cells with a P-type emitter?

11 A. P-type emitter, no.

12 Q. Do you know what a P-type emitter is?

13 A. Yes.

14 Q. What is it?

15 A. It is a region of the device which has high
16 concentration of acceptor ions, and therefore contributes
17 many free holes to conduction and the holes are positively
18 charged, which is why we call it P-type.

19 Q. When did you first become aware of solar cells
20 with a P-type emitter?

21 A. Can't tell you exactly when.

22 Q. During your time at Sandia?

1 A. Yes.

2 Q. How did you become aware?

3 A. Reading the publications of solar cell researchers
4 globally.

5 Q. Were solar cells with a P-type emitter well known
6 during your time at Sandia?

7 A. I would say they became more and more well known
8 over the course of time.

9 Q. Over the course of your time at Sandia?

10 A. Yes.

11 Q. During your time at Sandia, did you work on solar
12 cells with a Polysilicon Emitter?

13 A. Did I, personally?

14 Q. Let's start there.

15 A. No.

16 Q. Did any anyone else at Sandia?

17 A. Not that I know of.

18 Q. While you were at Sandia, were you aware of solar
19 cells with a Polysilicon Emitter?

20 A. I had heard that Professor Swanson and his
21 research group were doing research on Polysilicon Emitters.

22 Q. What is a Polysilicon Emitter?

1 A. It is an emitter region of a solar cell
2 characterized by its crystalline structure being many
3 microscopic crystals of silicon.

4 Q. During your time at Sandia were there published
5 articles regarding research on solar cells with a
6 Polysilicon Emitter?

7 A. From whom?

8 Q. From anyone.

9 A. There may have been articles by Dick Swanson and
10 his group.

11 Q. During your time at Sandia did you work on solar
12 cells with a trench cutting?

13 A. Not personally, but there were colleagues of mine
14 who I believe used laser trench cutting to isolate various
15 regions of a solar cell from one another.

16 Q. And did they publish any articles about that?

17 A. They would have, yeah.

18 Q. What benefits did that type of trench cutting
19 provide?

20 A. Well, if you were using a fabrication process that
21 involved dopants that wrapped around from the backside of a
22 cell to the front side, then you needed to provide some way

1 of preventing those regions from being electrically
2 contacted to one another.

3 Q. When did you first become aware of solar cells
4 with trench cutting?

5 A. Sometime when I was at Sandia.

6 Q. What is a dopant?

7 A. A dopant is a chemical additive introduced to
8 silicon at a high temperature such that it replaces some
9 silicon atoms buried.

10 Q. What is the purpose of adding in dopants?

11 A. The purpose is to provide in a certain region
12 either an excess of electrons or holes which are the absence
13 of free electrons.

14 Q. Were trench cuttings common features of many solar
15 cells at the time you were working at Sandia?

16 A. I believe they were common in some commercial
17 manufacturing lines.

18 Q. During the time -- strike that.

19 During your time at Sandia did you ever work on dopant
20 diffusion processes?

21 A. Yes.

22 Q. What is dopant diffusion?

1 A. Dopant diffusion is introducing these dopant
2 atoms, usually -- well, as -- by providing a dopant source,
3 and then sending that wafer through a high-temperature
4 furnace where those dopants were then able to diffuse into
5 the silicon and create a doped region.

6 Q. When did you first become aware of dopant
7 diffusion processes?

8 A. Way back during my studies at University of
9 Illinois.

10 Q. Why were you and others at Sandia studying dopant
11 diffusion?

12 A. Why?

13 Q. Yes.

14 A. Because the dopant diffusion profile is an
15 important parameter affecting the solar cell efficiency and
16 performance.

17 Q. Did you first learn that at the University of
18 Illinois?

19 A. Do you mean regarding solar cells?

20 Q. Regarding semiconductors.

21 A. Well, a dopant diffusion profile is important for
22 many semiconductor devices.

1 Q. Is that something you learned at the University of
2 Illinois?

3 A. Yes.

4 Q. Did you or your colleagues at Sandia, while you
5 were there, ever study the affect of time and temperature on
6 dopant diffusion?

7 A. Yes.

8 Q. Can you describe that, please?

9 A. Well, a physical law of diffusion involves several
10 parameters, two of which are time spent at an elevated
11 temperature.

12 Q. What did Sandia study about the affects of time
13 and temperature on dopant diffusion?

14 A. Sandia studied the dopant concentration profile,
15 in particular, a maximum concentration at the surface and
16 the depth of the diffused region into the silicon substrate.

17 Q. And that's work that occurred while you were at
18 Sandia?

19 A. Yes.

20 Q. Did you participate in it?

21 A. I was peripherally involved.

22 Q. Were Sandia scientists, during the time that you

1 were there, regularly adjusting the time and temperature
2 parameters of dopant diffusion processes in order to
3 optimize a given process for making a solar cell?

4 A. We developed a process that optimized those doping
5 profile parameters for optimum solar cell performance.

6 Q. What was that process?

7 A. That process was a diffusion process followed by
8 an in-situ oxidation.

9 Q. Did Sandia publish articles about that work?

10 A. Yes.

11 Q. During your time at Sandia did you ever work on
12 solar cells made with an in-situ diffusion process?

13 A. That's the one I just mentioned.

14 Q. What is an in-situ diffusion process?

15 A. It would be a process where you do, you can
16 conduct multiple operations without removing the wafers from
17 the furnace.

18 Q. When did you first become aware of the in-situ
19 diffusion processes?

20 A. Well, I don't know if I first became aware of it
21 then, but certainly during the proc- -- the experimentation,
22 it should be recorded here in my CV. Like, for example

1 here, 1994 Schubert, et al., A Simple Single Photo Mass
2 Process for Fabrication of High Efficiency Multicrystalline
3 Silicon Solar Cells, also presented at Waikoloa, Hawaii.

4 Q. What benefits did you and your colleagues at
5 Sandia believe an in-situ diffusion process would provide?

6 A. Well, in this case, it allowed us to adjust a
7 doping profile to provide the optimum surface concentration
8 and diffusion depth.

9 Q. Did in-situ diffusion also have the benefit of
10 decreasing fabrication costs?

11 A. It probably would.

12 Q. Why?

13 A. Because it was a process that combined the
14 benefits of two processes previously performed separately.

15 Q. What were those two processes?

16 A. One was a drive-in diffusions and the other was an
17 oxidation.

18 Q. During your time at Sandia did you work on solar
19 cells made with an atmospheric pressure chemical vapor
20 deposition?

21 A. Yes.

22 Q. Or APCVD process?

1 A. Yes.

2 Q. What work did you do?

3 A. I use APCVD for deposition of silicon oxide
4 layers.

5 Q. Okay. And what is APCVD?

6 A. It is a process, that atmospheric pressure whereby
7 certain sources are heated and evaporate, and therefore
8 deposit those materials on a substrate that's placed in
9 front of those sources.

10 Q. When did you first learn of APCVD?

11 A. Let's see. I think I wrote a paper on it. I
12 wrote a paper in 1992 Douglas Ruby and Jules Levine, Low
13 Temperature Emitter Passivation for Silicon Solar Cells,
14 presented at the European Photovoltaic Solar Conference in
15 Montreux, Switzerland in 1992.

16 Q. How does APCVD differ from other deposition
17 processes?

18 A. Well, it is atmospheric pressure, for one thing.

19 Q. Any other differences?

20 A. It results in a different molecular structure of
21 the deposited layer.

22 Q. Okay. When you were at Sandia, was Sandia using

1 APCVD for cells with metal contacts on front and rear sides?

2 A. Yes.

3 Q. Why?

4 A. It was a simple way to deposit a masking oxide.

5 Q. And did you or your colleagues publish about that?

6 A. Well, that paper I mentioned definitely mentions
7 using APCVD with -- what did you say, metal contacts?

8 Q. Yeah. On the front and rear sides.

9 A. Yes.

10 Q. During your time at Sandia did you do any work
11 involving transistors?

12 A. No.

13 Q. Were you aware, during your time at Sandia, of the
14 relevance of transistors to solar cells?

15 A. There were some -- there was some relevance, and
16 was aware of it.

17 Q. How did you become aware?

18 A. Reading scientific papers in scientific
19 periodicals and attending conferences such as those I
20 mentioned.

21 Q. While at Sandia or before, did you ever study
22 tunnel oxides for transistors?

1 A. Tunnel oxides for transistors, no.

2 Q. During your time at Sandia did you work on solar
3 cells with a front surface field?

4 A. Yes, front surface field.

5 Q. What is a front surface field?

6 A. Front surface field is an electric field at the
7 front surface of a solar cell, usually provided by the
8 deposition of a dielectric layer of some kind that has fixed
9 positive charges so that it creates an electric field that
10 would repel other positively charged and mobile carriers
11 such as holes in semiconductors.

12 Q. When did you first become aware of solar cells
13 with a front surface field?

14 A. Probably when I first started at Sandia.

15 Q. What work did you or your colleagues do while you
16 were at Sandia regarding solar cells with a front surface
17 field?

18 A. What work did we do?

19 Q. Yes.

20 A. Well, for example, the silicon nitride layers, I
21 optimized. One of their purposes was to provide a front
22 surface field.

1 Q. Did you design and build solar cells while at
2 Sandia having a front surface field?

3 A. Yes.

4 Q. And did you publish papers while at Sandia
5 describing a solar cell with a front surface field?

6 A. Yes.

7 Q. What benefits did you believe while at Sandia a
8 front surface field would provide to a solar cell?

9 A. Improved performance and efficiency.

10 Q. And did you publish any papers about that?

11 A. Yes, I did.

12 Q. Are they on your CV?

13 A. Yes, they are.

14 Q. Would you give us an example, if you could. Are
15 there many?

16 A. There were many.

17 Q. Just give us one example.

18 A. Okay. Here is one by Chen, Rohatgi, and myself,
19 1994, Silicon Surface and Bulk Defect Passivation by Low
20 Temperature PECVD Oxides and Nitrides, at the same world
21 conference on photovoltaic energy conversion in Waikoloa,
22 Hawaii.

1 Q. During your time at Sandia did you ever study J_0 .

2 A. Yes.

3 Q. What is J_0 ?

4 A. It is a symbol representing saturation current
5 density.

6 Q. When did you first become aware of J_0 ?

7 A. When I first started at Sandia?

8 Q. How did you become aware?

9 A. It is a parameter in the equation that defines
10 current flow in a PN-junction.

11 Q. Why were you studying J_0 while you were at Sandia?

12 A. Because it is an important parameter that
13 determines, among other things, solar cell efficiency.

14 Q. How does it do that?

15 A. It is a measure of the recombination that takes
16 place in a solar cell which is undesirable, because any
17 recombination detracts from the current voltage that can be
18 extracted from a solar cell.

19 Q. In your work at Sandia did you try to minimize J_0 ?

20 A. Yes.

21 Q. Why?

22 A. Because by minimizing J_0 you can maximize the

1 voltage produced by a solar cell.

2 Q. Did you publish anything about that while you were
3 at Sandia?

4 A. Yes, I did. Yes.

5 Q. And that would be on your CV?

6 A. Yes, it would.

7 Q. How did you measure J_0 during your work at Sandia?

8 A. We used a transient photoconductive decay method.

9 Q. Was that well known method to measure J_0 at the
10 time?

11 A. Yes.

12 Q. During your work at Sandia did you ever study P_c ?

13 A. By P_c I assume you mean specific contact
14 resistivity?

15 Q. Yes.

16 A. Yes.

17 Q. When did you become aware of P_c ?

18 A. During my time at Sandia.

19 Q. What work did you do at Sandia to study P_c ?

20 A. Can you repeat the question?

21 Q. What work did you do at Sandia regarding P_c ?

22 A. Well, at one point we were making concentrator

1 solar cells, and in that case, the contact resistivity
2 usually limits the performance of a cell, so we had to
3 measure and be aware of the resistance in order to optimize
4 the performance of the concentrator cells.

5 Q. In your work while at Sandia were you trying to
6 minimize P_c ?

7 A. Yes.

8 Q. Why?

9 A. To optimize the performance at high concentration.

10 Q. Did you publish anything regarding the work that
11 you did while at Sandia regarding P_c ?

12 A. I believe I did.

13 Q. That would be reflected on one or more of the
14 articles in your CV?

15 A. Yeah.

16 Q. How did you measure P_c while at Sandia?

17 A. From the electrical performance of the solar cell
18 at different solar intensity levels.

19 Q. Was that a well-known method at the time for
20 measuring P_c ?

21 A. Yes.

22 Q. Okay. So you started working at Sandia in 1985,

1 you left in 2008, right?

2 A. Yes.

3 Q. And over that period of time, that 23 or so years,
4 did the solar cell industry improve its fabrication process
5 and capabilities?

6 A. Yes.

7 Q. Just at a high-level, can you tell us how it
8 improved?

9 A. Well, for one thing they adopted silicon nitride
10 as an anti-reflection coating, resulting in improved surface
11 passivation at the front of the solar cell, boosting
12 performance significantly. There were many other
13 improvements.

14 Q. Like what?

15 A. The development of ALD or atomic layer deposition
16 of aluminum oxide, which, for the first time allowed the
17 passivation of P-type surfaces on solar cells.

18 Q. Did diffusion techniques improve between 1985 and
19 2008?

20 A. Yes.

21 Q. What was the nature of the improvements?

22 A. Well, to some extent because of our work showing

1 what the optimum diffusion profile needed to look like, it
2 became universally adopted by industry.

3 Q. Did techniques to form emitters improve between
4 1985 and 2008?

5 A. To improve emitters? In what way?

6 Q. In any way.

7 A. I'm sure they did.

8 Q. Can you give us some examples?

9 A. They probably improved the dopant profile.

10 Q. Any others?

11 A. Maybe they found ways to do it more cheaply.

12 Q. Were there improvements to the solar cell industry
13 between 1985 and 2008 related to forming external oxide
14 layers?

15 A. There were many methods developed to form external
16 oxide layers.

17 Q. Could you --

18 A. Some of which were improvements, I suppose.

19 Q. Could you describe for us how techniques for
20 forming external oxides improved from 1985 to 2008?

21 A. One example would be the plasma deposition of
22 silicon oxides.

1 Q. In what way did that improve?

2 A. Well, it avoids the use of a high-temperature
3 thermal oxidation.

4 Q. Were there improvements to forming tunnel oxide
5 layers from 1985 to 2008?

6 A. I'm not really aware of that particular
7 improvements.

8 Q. How much would you say Sandia was able to improve
9 solar cell efficiency between 1985 and 2008?

10 A. Well, we fabricated, I personally fabricated the
11 world's first 20 percent efficient solar cell on low-grade
12 silicon.

13 Q. Can you describe the structure of that solar cell?

14 A. It is described completely in one of these papers.
15 Let's see here. Basore, et al., Simplified High-efficiency
16 Silicon Cell Processing, published in Solar Energy Materials
17 and Solar Cells in 1994. And by D.S. Ruby, et al.,
18 Simplified Processing for 23 percent Efficient Silicon
19 Concentrated Solar Cells, presented at the 23rd IEEE
20 Photovoltaic Specialists Conference in 1993.

21 Q. Was quality control something that was important
22 to you in your work while at Sandia in designing solar

1 cells?

2 A. Yes, of course.

3 Q. Why?

4 A. For reproducibility.

5 Q. How does it relate to reproducibility?

6 A. Well, you need to start with the same conditions
7 in order to achieve the same results.

8 Q. Did quality control for solar fabrication improve
9 from 1985 to 2008?

10 A. Quality control, where?

11 Q. In the solar industry.

12 A. I can't speak for the entire solar industry.

13 Q. Let me ask you about Sandia, then; were you better
14 able to ensure consistent fabrication processes by the end
15 of your time at Sandia as compared with when you started?

16 A. When we started we designed the lab for exemplary
17 quality control from the very beginning.

18 Q. Did it improve over time?

19 A. We maintained it over time.

20 Q. All right. Can you put back in front of you your
21 declaration, please?

22 THE WITNESS: I'm going to need to take a break

1 pretty soon.

2 MR. SELWYN: Now is a good time.

3 (Off the record, 10:48 a.m. to 10:55 a.m.)

4 Q. (BY MR. SELWYN) Would you mind putting back in
5 front of you, your declarations for the '516 Patent,
6 Exhibit 2027.

7 A. Yes.

8 Q. Paragraph 7 explains your work as a consultant,
9 correct?

10 A. Yes, it does.

11 Q. Can you explain at a high-level how your work as a
12 consultant differs from what you were doing at Sandia?

13 A. Well, at Sandia, we were designing and developing
14 new solar cells in the hope that they would improve the
15 technology available; whereas as a consultant, I work with
16 manufacturers and other groups to improve the quality of
17 their products.

18 Q. In Paragraph 7 you say that you work with PV cell
19 manufacturers to improve their performance of their cell
20 designs and fabrication processes.

21 A. Yes.

22 Q. And at Sandia you were also working to improve

1 performance for solar cell design and fabrication processes,
2 right?

3 A. Yes.

4 Q. Was that a regular part of your work there?

5 A. Was it, at Sandia?

6 Q. Yes.

7 A. Yes.

8 Q. What do you mean by "performance"?

9 A. Efficiency.

10 Q. What criteria, in your experience, do PV cell
11 manufacturers use to measure and improve performance?

12 A. Efficiency, short circuit current, open circuit
13 voltage, and field factor.

14 Q. How, if at all, does performance of a solar cell
15 design differ from solar cell efficiency?

16 A. Efficiency is an overall measure of solar cell
17 performance.

18 Q. How did Sandia measure or improve performance of
19 solar cells during the time that you were there?

20 A. By measuring cell performance efficiency.

21 Q. And would you agree it is desirable to improve
22 solar cell efficiency?

1 A. Yes.

2 Q. Do PV cell manufacturers regularly ask you for
3 your advice on how to improve performance?

4 A. As a consultant they did, yes.

5 Q. Fair to say that improving performance is
6 important to the solar cell industry?

7 A. Yes, it is.

8 Q. Why is that?

9 A. Because you can get more electricity out of a
10 solar cell if it has a higher efficiency.

11 Q. And when you are working at Sandia you were also
12 trying to improve performance, correct?

13 A. Yes.

14 Q. You knew it was important, right?

15 A. Right.

16 Q. At a high-level, what steps do you typically take
17 to try to help a PV cell manufacturer improve its
18 performance?

19 A. Depends on the problems they are having.

20 Q. How so?

21 A. Well, they may be having a problem with
22 recombination; they may be having a problem with

1 anti-reflection coatings. As a consultant I would tailor my
2 advice to my clients based on the goals they wanted to
3 achieve.

4 Q. Do you typically propose alternative cell designs
5 or alternative fabrication processes to PV cell
6 manufacturers to help them improve performance?

7 A. Well, that would depend on how, how much they were
8 able to change their designs and procedures.

9 Q. Is one of the things that you have done as a
10 consultant is propose alternative cell designs and
11 fabrication processes to PV cell manufacturers to help them
12 improve performance?

13 A. In some cases, yes.

14 Q. How do you identify alternative cell designs in
15 fabrication processes?

16 A. Well, I would measure cell performance in certain
17 ways and compare those with experimental -- well, with
18 performance models, and use the differences to pinpoint
19 areas where the cell could use some improvement.

20 Q. And when you do what you've just described, how do
21 you determine whether an alternative would actually improve
22 performance?

1 A. I would use the computer modeling to determine
2 whether an improvement in a certain parameter, or change in
3 a certain parameter would result in an improvement to
4 performance.

5 Q. Why do you use computer modeling?

6 A. Because they use the semiconductor physics
7 equations to determine the performance of solar cells.

8 Q. I think you gave a moment ago as an example of a
9 potential problem recombination; is that right?

10 A. Recombination is a problem in solar cells.

11 Q. And in instances where that has been presented to
12 you as a problem, what are the types of things that you have
13 done to try to address it?

14 A. Well, depends where that recombination is taking
15 place. And an analysis of cell performance using the
16 computer models will help determine that. If you find a
17 recombination is taking place in the bulk of the material,
18 there are various methods you can use to try to reduce that
19 recombination in that region. If the recombination is
20 taking place at the surfaces or in the emitters, there are
21 other processes you can use to try to reduce that
22 recombination in those areas.

1 Q. When you were at Sandia were you aware of ways to
2 address problems of recombination?

3 A. Yes.

4 Q. What ways were you aware of at that time?

5 A. Well, we introduced atomic hydrogen to reduce bulk
6 recombination, and we used field effect layers to address
7 surface recombination.

8 Q. If recombination is at the PN-junction, what do
9 you do?

10 A. What you mean by "at the PN-junction"?

11 Q. According at the location of the PN-junction.

12 A. It may be because you have too high of a dope
13 intensity. So in that case you might reduce the dope
14 intensity.

15 Q. While you were at Sandia did you ever encounter
16 the problem of recombination at the PN-junction?

17 A. No. Because we optimize our diffusion profiles to
18 avoid that.

19 Q. In helping PV cell manufacturers to improve
20 performance, do you ever consider technologies from
21 semiconductor devices that are not solar cell?

22 A. Well, I personally didn't.

1 Q. How about in your work as a consultant?

2 A. I'm not aware if any of the procedures we used are
3 common in the transistor industry.

4 Q. While you were at Sandia did you ever look to
5 transistor technologies in seeking to improve cell design or
6 fabrication processes?

7 A. No.

8 Q. And how about as a consultant?

9 A. No.

10 Q. At a high-level, how do you determine whether the
11 improved PV cell performance is meaningful enough to
12 recommend a change to a manufacturer?

13 A. Well, I would say that if the, if there were any
14 increased costs involved with changing the process, how does
15 that compare to the increased cost of producing the cell?

16 Q. How do you weigh those two things?

17 A. Well, you knew what the cost -- you know what the
18 cost of electricity is, so an increase in efficiency has a
19 monetary value.

20 Q. Are there any performance metrics that you
21 consider?

22 A. What do you mean by that?

1 Q. Well, in determining whether improved cell
2 performance is meaningful enough to recommend a change, are
3 there any performance metrics that you would consider?

4 A. The question is very vague. I don't really
5 understand what you mean.

6 Q. Let me try another one: Is there a goal for
7 improved solar efficiency that you try to reach?

8 A. Generally speaking, an improvement of even
9 one-tenth of a percent in efficiency is worthwhile.

10 Q. Now, that sounds small. Why is one-tenth of
11 one percent a meaningful improvement?

12 A. Because when you're producing millions of solar
13 cells a year it adds up to a lot more electricity.

14 Q. Back to Paragraph 7 of your declaration, you
15 discuss, "working with PV cell manufacturers to reduce the
16 cost of their cell designs and fabrication processes,"
17 right?

18 A. Right.

19 Q. Why have PV cell manufacturers asked you to help
20 reduce the cost of their cell designs and fabrication
21 processes?

22 A. Why?

1 Q. Yes.

2 A. Have they asked me?

3 Q. Yes.

4 A. You would have to ask them.

5 Q. Okay. What is their motivation in trying to
6 reduce the cost of their cell designs and fabrication
7 processes?

8 A. Because they are competing with other
9 manufacturers who are also making solar cells, and
10 generally, the lower the cost of electricity you can produce
11 the more people will buy it.

12 Q. How common is it for your clients to ask you for
13 advice on how to reduce costs?

14 A. I would say it is not as common as asking me how
15 to improve performance.

16 Q. Would you still regard it as something that
17 happens relatively frequently, that is, cell manufacturer
18 will ask for advice on reducing costs?

19 A. No. I'm not a cost expert, I'm a physicist.

20 Q. Have you ever proposed alternative cost-effective
21 cell designs and processes to your clients?

22 A. Alternative cost-effective processes and designs,

1 yes.

2 Q. In what instances?

3 A. Well, for example, working for one of my clients,
4 I proposed use of a passivating layer and different dopant
5 concentrations that would result in improved performance
6 that potentially lower costs.

7 Q. How do you determine whether a reduction in cost
8 is meaningful enough to recommend a change?

9 A. Again, as I said previously, any change that I
10 recommend would be based on whether the change results in a
11 ratio of improved performance, to change in cost that is
12 greater than 1.

13 Q. And would you agree that for your PV cell
14 manufacturer clients reducing costs is often an important
15 call?

16 A. Well, it is an important call for them to maintain
17 competitiveness with their competing manufacturers.

18 Q. And one way to do that would be by reducing costs?

19 A. That would be one way to do it, assuming you could
20 maintain performance at the same time.

21 Q. In Paragraph 7 of your declaration you explain
22 that your work involves, "using numerical modeling to

1 pinpoint sources of loss mechanisms and to determine
2 technical requirements necessary for cost-effective PV cell
3 and module performance"; do you see that?

4 A. Yes.

5 Q. Can you explain what numerical modeling is?

6 A. For example, I would use a computer program that's
7 designed to predict the performance of solar cells based on
8 the values of various parameters. And using that, I could
9 determine which mechanisms were the main contributors to
10 loss in performance. Then I could suggest methods based on
11 my experience of procedures that might reduce those lost
12 mechanisms.

13 Q. And the computer program that you're referring to,
14 was that something that you've designed or is that an
15 off-the-shelf product?

16 A. It is actually free software.

17 Q. What is it called?

18 A. PC1D, written by one of my collaborators,
19 Paul Basore.

20 Q. So is that software that people like you can just
21 download for free?

22 A. Yes.

1 Q. How long has that existed?

2 A. Certainly since 1985. And now I believe there are
3 two- even three-dimensional models of that software.

4 Q. What I just read for you from Paragraph 7, you
5 refer to "sources of loss mechanisms." What are sources of
6 lost mechanisms?

7 A. Well, it would be essentially where the
8 recombination is taking place.

9 Q. So one source of loss would include recombination;
10 is that right?

11 A. Yes. Other sources could be ineffective
12 anti-reflection, ineffective back-surface reflection. There
13 are many, many reasons why you might be incurring losses.

14 Q. Is recombination one of the major sources of loss?

15 A. It is a major component.

16 Q. How, if at all, is modeling different from an
17 experiment testing a physical solar cell?

18 A. Well, modeling predicts what the behavior would be
19 given the values of the parameters you've chosen. Testing
20 or measurement would be actually determining what those,
21 what those various semiconductor properties are.

22 Q. Is modeling worthwhile to do even if you're not

1 testing a physical solar cell?

2 A. Yes. Modeling is always worthwhile to do.

3 Q. Have you ever conducted modeling on just a part of
4 a solar cell?

5 A. Well, generally you do modeling of an entire solar
6 cell but that includes studying the various parts that
7 comprise it.

8 Q. Have you ever modeled just an emitter?

9 A. You can look at a solar cell with varying emitter
10 parameters and see how that affects your overall
11 performance.

12 Q. Is that something you've done?

13 A. I can't recall.

14 Q. What data do you typically consider in your
15 models?

16 A. Well, as I said, we conduct measurements
17 beforehand to determine certain properties of the
18 semiconductor, such as conductance, reflectance,
19 resistivity, dopants, diffusion profile, rear surface
20 reflectance, and many others.

21 Q. Have you ever modeled J_0 or P_c ?

22 A. I would say I have modeled emitter -- let's see,

1 yeah, J_0 from, from the emitter.

2 Q. How did you go about doing that?

3 A. How did I model emitter saturation current
4 density?

5 Q. Exactly. How did you model emitter saturation
6 current density J_0 ?

7 A. That would be one of the parameters that you could
8 choose in the computer modeling program, and by varying it,
9 you can see what affect that had on the overall performance.

10 Q. Did the computer program that you use allow you to
11 do that as far back as 1985?

12 A. Yes.

13 Q. And have you ever modeled contact resistance R_c ?

14 A. Not personally, no.

15 Q. Does the software that you've described allow you
16 to model R_c ?

17 A. It would.

18 Q. And has it allowed you to do that since 1985.

19 A. Yes.

20 Q. At Sandia did you use numerical modeling to
21 pinpoint sources of lost mechanisms and to determine
22 technical requirements necessary for cost-effective PV cell

1 and module performance?

2 A. Yes.

3 Q. How, if at all, did your modeling work at Sandia
4 differ from what you do today?

5 A. Well, today, I don't do much modeling because all
6 the American manufacturers are out of business. So I
7 primarily work for law firms that are suing people over
8 device designs and patents.

9 Q. Got it. Okay, going back to Paragraph 7 of your
10 declaration, you state that your consulting work includes,
11 "providing PV module array and system performance
12 measurements in comparison with energy production model
13 predictions"; do you see that?

14 A. Yeah.

15 Q. So just a line on what some of the terms that
16 you're using mean. First, can you tell us, what is a PV
17 module?

18 A. PV module is a glass encapsulated package, usually
19 be with an aluminum frame in which many solar cells are
20 connected electrically in a series so that it provides a
21 definite amount of electrical output.

22 Q. What is an array?

1 A. An array would be a grouping of such PV modules
2 all connected in a series and in parallel to provide a
3 larger amount of electricity to the external world.

4 Q. And what is "a system" as you've used that word in
5 Paragraph 7?

6 A. A PV system would include a PV array connected to,
7 perhaps, an inverter which converts the direct current
8 output of the PV modules into alternating current that's
9 typically used in the electrical grid.

10 Q. Paragraph 7 you refer to "experiments," right?

11 A. Where?

12 Q. Maybe you're right.

13 In your work do you conduct experiments?

14 A. Which work?

15 Q. As a consultant.

16 A. Well, when I was hired by a company trying to
17 improve their cell performance I asked them to try a few
18 different variations of their process to see whether the
19 results could be improved based on my numerical modeling.

20 Q. What data to you typically consider in
21 experiments?

22 A. What data do I consider?

1 Q. Uh-huh.

2 A. Well, there's measured cell efficiency, there's
3 measured reflectance, there are current voltage
4 characteristics of the solar cell in the dark. That's data.

5 Q. When you were at Sandia, how did J_0 factor into
6 the analysis that you did in your experiments?

7 A. Well, J_0 was a measure of recombination which I
8 intended to minimize by varying, for example, the deposition
9 parameters of depositing silicon nitride.

10 Q. When you were at Sandia, how did P_c factor into
11 the analysis that you did in your experiments?

12 A. In those experiments not, not at all.

13 Q. While you were at Sandia did you ever measure J_0
14 using just an emitter.

15 A. Yes.

16 Q. What was the goal of that work?

17 A. The goal of that work was to, we simply identified
18 what the optimum parameters of the silicon nitride
19 deposition would be to produce a low J_0 emitter, and then
20 subsequently, we could incorporate that into a complete
21 solar cell.

22 Q. The device that you tested did not have a

1 PN-junction, correct?

2 A. It did have a PN-junction.

3 Q. Did you publish anything regarding the work that
4 you just described?

5 A. Yes.

6 Q. Is the --

7 A. Many of the previous papers which I mentioned
8 incorporate that method.

9 Q. While you were at Sandia did you provide PV module
10 array and system performance measurements in comparison with
11 energy production model predictions?

12 A. Yes.

13 Q. Okay. In Paragraph 8 of your declaration you
14 state that you initiated and directed a graduate student's
15 research program that resulted in several graduate student
16 theses projects in solar cell fabrication processing to
17 improve solar cell performance, right?

18 A. Yes.

19 Q. Would you describe the work that you did in that
20 regard.

21 A. Well, that was a program that I did jointly with
22 Professor Fleddermann at UNM, using his graduate students

1 and I think some PECVD equipment that he had there to
2 explore the parameter space and the deposition parameter
3 space so that we could achieve low G zeros in emitters.

4 Q. While at Sandia did you review thesis projects?

5 A. Review?

6 Q. Review.

7 A. Well, I directed his thesis project.

8 Q. And did that include reviewing thesis papers?

9 A. Well, we wrote a joint paper.

10 Q. Who is the "we"?

11 A. Well, I read it to you earlier, it was me,
12 Fleddermann, and Wilbanks.

13 Q. Got it, okay.

14 Did you review graduate student thesis papers?

15 A. The only papers that I reviewed were the ones that
16 I wrote with those graduate students as co-authors.

17 Q. Okay. So you were a co-author on theses papers of
18 graduate students?

19 A. Right.

20 Q. How many?

21 A. I think there were two.

22 Q. Can you find which ones those were?

1 A. Let's take a look. Well, there was certainly,
2 there's several with Ruby, Wilbanks, and Fleddermann and
3 possibly other authors. And there was an earlier one here,
4 Ruby, Fleddermann, and Roblevsky [phonetic].

5 Q. And were those papers also tendered by the
6 graduate student in the fulfillment of their thesis
7 requirement?

8 A. I assume they were listed among his achievements.

9 Q. So as the director for the graduate student
10 research program is it fair to say that you had a view as to
11 what would make a good thesis paper.

12 A. I was not the director of the program.
13 Professor Fleddermann was the director of the program.

14 Q. You helped initiate the program?

15 A. Yes.

16 Q. Can you tell us just at a high-level, what are the
17 qualities that make a good thesis paper in your view?

18 A. Doing something of value that's never been done
19 before.

20 Q. Should a thesis follow the scientific method?

21 A. Yes.

22 Q. Should a thesis identify and describe an issue?

1 A. Yes.

2 Q. Should a thesis propose a hypothesis?

3 A. Yes.

4 Q. Should a thesis consider relevant prior work on an
5 issue?

6 A. Right.

7 Q. Should a thesis test the hypothesis with
8 theoretical principles?

9 A. Well, it should test the hypothesis with
10 experimental results.

11 Q. Would a good thesis identify any issues or
12 problems with the study and propose other areas for study?

13 A. Yes.

14 Q. In Paragraph 8 of your declaration you explain
15 that you served as a subarea Chairman of 2000 IEEE PV
16 Specialist Conference on Silicon Cell Processing?

17 A. Yes.

18 Q. Tell us a little bit about what that role
19 entailed, if you would.

20 A. Well, it involved reviewing and organizing the
21 review of several proposed papers that were invited -- not
22 invited, but were submitted for presentation at this

1 specialists conference, and then organize the, essentially
2 the voting on which papers should be accepted and which are
3 rejected.

4 Q. Are you a member of the IEEE?

5 A. No.

6 Q. Would you agree that the IEEE is a well-known and
7 distinguished professional organization?

8 A. Yes.

9 Q. It is the world's largest professional
10 organization of engineers; is that right?

11 A. I don't know.

12 Q. Does the IEEE publish papers?

13 A. Yes.

14 Q. Have you published for the IEEE?

15 A. Yes.

16 Q. How many times have you published through the
17 IEEE?

18 A. Many.

19 Q. How does one get a paper published by the IEEE?

20 A. Well, it could be presented at a conference, in
21 which case it has to be approved by this session chairman
22 and his session reviewers; or it can be submitted as a

1 scientific research paper, in which case, it has to be
2 approved by peer reviewers.

3 Q. Are the IEEE papers that you've done all
4 peer-reviewed?

5 A. The ones that were submitted to conference were, I
6 guess you would say peer-reviewed by my colleagues at
7 Sandia.

8 Q. The papers that IEEE publishes are generally
9 peer-reviewed, correct?

10 A. Yes, 100 percent.

11 Q. They are all peer-reviewed, correct?

12 A. Yes.

13 Q. And just so we're clear on our terms here; what is
14 peer review?

15 A. Peer review would be a review by other experts in
16 the field who have knowledge of the subject matter and who
17 are seen as distinguished members whose opinions can be
18 valued and believed in.

19 Q. Have you ever done a peer review of a paper
20 published by IEEE?

21 A. Yes.

22 Q. Have you relied upon IEEE papers as part of your

1 own research work?

2 A. Yes.

3 Q. Is the IEEE typically considered to be a reputable
4 source?

5 A. Yes.

6 Q. Are IEEE publications regularly relied on in the
7 PV industry?

8 A. Yes, they are.

9 Q. All right. Could you turn, please, to the
10 background of the '516 Patent and related technology section
11 in your declaration that starts on Page 14.

12 While you're getting there, if we could go off the
13 record for one second.

14 (Off the record, 11:29 a.m. to 11:34 a.m.)

15 Q. (BY MR. SELWYN) All right, Dr. Ruby, would you
16 put in front of you the section of your declaration
17 entitled, "Background of '516 Patent and Related
18 Technology," which begins on Page 14.

19 A. Yes.

20 Q. And starting at Paragraph 23, you have a section
21 entitled "Theory of converting solar energy into
22 electricity," correct?

1 A. Yes.

2 Q. I think you told us earlier that you did the first
3 draft of that entire section; is that right?

4 A. Yes.

5 Q. And Paragraphs 23 through 27, describe general
6 background information about the function of solar cells,
7 right?

8 A. Yes.

9 Q. And would you agree that what you describe in
10 Paragraphs 23 through 27 is prior art to the '516 and '053
11 patents?

12 A. Yes.

13 Q. When was the theory that you described in
14 Paragraphs 23 through 27 developed?

15 A. I can't say exactly, but quite early. Maybe,
16 maybe in the 1950s.

17 Q. You'd agree that the theory of converting solar
18 energy into electricity that you describe from Paragraphs 23
19 through 27 isn't the claimed invention of the '516 or '053
20 patents, correct?

21 A. Right.

22 Q. And you'd agree that a person of ordinary skill in

1 the art in the '516 and '053 patents would have known the
2 principles that you describe from Paragraphs 23 through 27
3 by February 2008, correct?

4 A. Yes.

5 Q. Now, Paragraph 25 you have a graphic, right?

6 A. Twenty-five.

7 Q. Page 16.

8 A. Oh, yes.

9 Q. Is that a graphic that you prepared?

10 A. Yes.

11 Q. Sir, if you'd please turn to Paragraph 28.

12 A. Yes.

13 Q. Paragraph 28 is below the section heading,
14 "Doping," is that right?

15 A. Yes.

16 Q. And the doping principle that you describe in
17 Paragraph 28 are prior art to the '516 and '053 patents,
18 correct?

19 A. Yes.

20 Q. When were the doping principles that you describe
21 in Paragraph 28 developed?

22 A. 1950s.

1 Q. The doping principles you describe in Paragraph 28
2 are not the invention claimed by the '516 or '053 patents,
3 correct?

4 A. That's right.

5 Q. A person of ordinary skill in the art would have
6 -- strike that.

7 A person of ordinary skill in the art of the '516 and
8 '053 patents would have known how to dope silicon by 2008,
9 correct?

10 A. Yes.

11 Q. Sir, if you'd turn, please, to Paragraph 29, which
12 is in a section entitled "Annealing"?

13 A. Yes.

14 Q. The annealing process that you describe in
15 Paragraph 29 is the also prior art to the '053 and '516
16 Patents, correct?

17 A. Yes.

18 Q. The annealing process you describe in Paragraph 29
19 is not the invention claimed in the '053 or '516 patents,
20 correct?

21 A. That's right.

22 Q. And you'd agree that a person of ordinary skill in

1 the art in the '053 and '516 patents would have known how to
2 anneal by 2008, correct?

3 A. Yes.

4 Q. And if you turn, please, to Paragraph 30, which is
5 the start of the section entitled, "Solar cell structure."
6 Do you see in Paragraph 30 you provide a diagram of a
7 generic solar cell?

8 A. Yes.

9 Q. And the generic solar cell that you depict in
10 Paragraph 30 was prior art to the '053 and '516 patents,
11 correct?

12 A. Yes.

13 Q. The generic solar cell that you show in
14 Paragraph 30 existed by 2008, correct?

15 A. Yes.

16 Q. A generic prior art solar cell as of 2008 had an
17 emitter region, correct?

18 A. Yes.

19 Q. A generic solar -- strike that.

20 A generic prior art solar cell as of 2008 had a
21 silicon substrate basic cell, correct?

22 A. Yes.

1 Q. And a generic prior art solar cell as of 2008 had
2 an N++ NP++ region, correct?

3 A. Certain types of solar cells did.

4 Q. N++ and P++ regions are highly doped regions on
5 the front and rear of the cell, correct?

6 A. In that diagram, yes.

7 Q. Is the N++ region a front surface field?

8 A. It is a selectively doped emitter region.

9 Q. And as shown in Paragraph 30, the figure in
10 Paragraph 30 is the N++ region a front surface field?

11 A. It provides some small electric field. It is what
12 is known as a high-low junction, and it does provide some
13 degree of field effect passivation.

14 Q. Is the P++ region a back surface field?

15 A. Yes.

16 Q. A generic prior art solar cell as of 2008 had a
17 front and rear metal -- strike that.

18 A generic prior art solar sell as of 2008 had front
19 and rear metal contacts, correct?

20 A. Yes. Well, bifacially contacted cells did. There
21 were some cells at that point that had all of their metal
22 contacts on the rear sides. They were known as back contact

1 solar cells.

2 Q. A generic prior art cell as of 2008 had a
3 PN-junction, correct?

4 A. Yes.

5 Q. The junction shown in the figure in Paragraph 30
6 is where the P-type layer and the N-type layer meet,
7 correct?

8 A. Yes.

9 Q. The features shown on the generic prior art solar
10 cell in Paragraph 30 would have been known by 2008, correct?

11 A. I'm sorry, can you say that again?

12 Q. Sure. The features that are shown on the generic
13 prior art solar cell in Figure 30 of your declaration were
14 known by 2008, correct?

15 A. Yes.

16 Q. And, sir, if you'd turn, please, to Paragraph 31,
17 which is the start of a subsection entitled "Junctions." Do
18 you see that?

19 A. Yes.

20 Q. And in Paragraphs 31 through 45 you describe
21 technological principles for junctions, right?

22 A. Yes.

1 Q. And what you described in Paragraphs 31 through 45
2 is prior art to the '516 and '053 patents, correct?

3 A. Yes.

4 Q. What you described in Paragraphs 31 through 45 is
5 not the invention claimed by the '516 or '053 patents,
6 correct?

7 A. That's right.

8 Q. And you'd agree that by 2008, a person of ordinary
9 skill in the art of '516 and '053 patents would have known
10 of homojunctions, correct?

11 A. Homojunctions, yes.

12 Q. And by 2008, a person of ordinary skill in the art
13 in the '516 and '053 patents would have known of
14 heterojunctions, correct?

15 A. Yes, that's right.

16 Q. In your declarations for the '516 and '053 patents
17 you didn't offer any construction of the word "junction,"
18 right?

19 A. Not that I recall.

20 Q. In your declarations for the '516 and '053 patents
21 you didn't suggest any of the prior art that the petitioner
22 relies on that fails to disclose a junction, correct?

1 A. Petitioner relies on, fails to disclose a
2 junction. Prior art that petitioner relies on, such as
3 what?

4 Q. Such as Weisheim [phonetic], Borden, or Li.

5 A. Oh, no. They do not fail to disclose a junction.

6 Q. They do disclose a junction?

7 A. They do disclose a junction.

8 Q. If polysilicon forms a back surface field with a
9 substrate, that's also considered to be a backside junction,
10 correct?

11 A. Say it again.

12 Q. Sure. If polysilicon forms a back surface field
13 with the substrate, that's also considered a backside
14 junction, correct?

15 A. Yes.

16 Q. Now, in Paragraph 46, you describe an emitter,
17 right?

18 A. Yes.

19 Q. And you state that both in a semiconductor device
20 the emitter is usually defined as the region which is doped
21 to have the opposite majority carrier polarity compared to
22 the substrate, right?

1 A. Yes.

2 Q. What do you mean there by "semiconductor device"?

3 A. Solar cells and transistors.

4 Q. A person of ordinary care skill in the art of the
5 '516 and '053 patents as of 2008 would have understood a
6 solar cell to be a type of semiconductor device, correct?

7 A. Yes.

8 Q. And what do you mean in that sentence by "usually
9 defined"?

10 A. Well, most of the experts in the field would think
11 of an emitter as the region of the device doped to have the
12 opposite polarity compared to a substrate.

13 Q. And the POSITA in the '516/'053 patents would
14 understand the word "emitter" that way; is that right?

15 A. Well, those particular patents use the word
16 "emitter" in a more general sense.

17 Q. You state that the emitter is, "The region which
18 is doped to have the opposite majority carrier polarity
19 compared to the substrate." Correct?

20 A. I say that it is usually defined that way.

21 Q. Would you agree that the emitter is the region
22 that forms the PN-junction with the substrate?

1 A. Not always.

2 Q. If the substrate is N-type, emitter would usually
3 be defined as the P-type region, correct?

4 A. Usually.

5 Q. And if the substrate is P-type, the emitter would
6 usually be defined as the N-type region, correct?

7 A. Usually, but not always.

8 Q. Now, in the last sentence of Paragraph 46 you
9 state, "However, as in Claim 9 of the '516 patents the
10 emitter can be a polysilicon layer on the backside of the
11 substrate," correct?

12 A. Yes.

13 Q. And in that paragraph you just cite the patent
14 claim as support for that statement, correct?

15 A. Yes.

16 Q. What is polysilicon?

17 A. Polysilicon is a material composed of silicon
18 atoms which consists of many small single crystalline
19 silicon grains all smashed together.

20 Q. In your declarations regarding the '516 and '053
21 IPRs you don't suggest that the Board should construe
22 emitter, correct?

1 A. That the Board should construe emitter. What do
2 you mean by that?

3 Q. Sure. You don't suggest that the Board should
4 interpret the word "emitter," correct?

5 A. Interpret in what way?

6 Q. Well, are you familiar with the concept of claim
7 construction?

8 A. Vaguely.

9 Q. What is your understanding of the claim
10 construction process?

11 A. If a term is used in -- it defines what a term
12 means in that particular legal situation.

13 Q. And in your declarations for the '516 and '053
14 patents you don't suggest that the Board should go through
15 the claim construction process to construe "emitter,"
16 correct?

17 A. Well, unless I have laid it out somewhere else in
18 my declaration, no.

19 Q. In your declarations regarding the '516 and '053
20 IPRs, you don't suggest that Froitzheim, Borden Li, or Gan
21 fail to disclose an emitter, correct.

22 A. They do not fail to disclose an emitter.

1 Q. They do disclose an emitter, correct?

2 A. That's right.

3 Q. Now, turning back, if you would --

4 A. I don't know if they use that terminology for it.

5 Q. But they do disclose it, right?

6 A. I believe so.

7 Q. Turning back to the generic prior art solar cell
8 graphic in Paragraph 30. Let me ask a little bit of
9 something else.

10 Okay, let's skip ahead to Paragraph 51. Do you see
11 the section entitled "Solar cell efficiency"?

12 A. Yes.

13 Q. And that section, Paragraphs 51 through 59 is all
14 about solar cell efficiency, correct?

15 A. Yes.

16 Q. And what you describe in Paragraphs 51 through 59
17 is prior art to the '516 and '053 patents, correct?

18 A. Right.

19 Q. And in that section you describe both the
20 overarching goal of the solar cell industry and how it is
21 achieved, correct?

22 A. Yes.

1 Q. What you describe in Paragraph 51 as the
2 overarching goal of the solar cell industry was the same as
3 of 2008, correct?

4 A. Yes.

5 Q. And you'd agree that a person of ordinary skill in
6 the art in the '516 and '053 patents as of 2008 would have
7 known that the overarching -- overarching goal of the solar
8 cell industry was to increase the efficiency of the solar
9 cell, which is the ratio of electrical power output at the
10 max power point to the photo power incident and the incoming
11 summary, correct?

12 A. Yes.

13 Q. You also write in Paragraph 51 that the solar cell
14 industries' overarching goal of increasing solar cell
15 efficiency, "is achieved by maximizing light absorption,
16 reducing photo carrier recombination to increase current
17 voltage, and maintaining low electrical resistance within
18 the cell." Correct?

19 A. Yes.

20 Q. And a person of ordinary skill in the art of the
21 '516/'053 patents as of 2008 would have known that, correct?

22 A. Yes.

1 Q. Paragraphs 52 through 58 of your declaration
2 describe recombination and passivation principles that a
3 person of ordinary skill in the art of the '516 and '053
4 patents would have known as of 2008, correct?

5 A. Yes.

6 Q. And in Paragraph 53, you describe a measurement
7 known as saturation current density or J_0 , correct?

8 A. Yes.

9 Q. And that's the same J_0 that's discussed in the Gan
10 reference, right?

11 A. Yes.

12 Q. By 2008, a person of ordinary skill in the art in
13 the '516 and '053 patents would have known about J_0 ,
14 correct?

15 A. Yes.

16 Q. And by 2013, a person of ordinary skill in the art
17 in the '516 and '053 patents would have known that, "the
18 goal of effective solar cell design is to minimize
19 recombination by maximizing carrier lifetimes and diffusion
20 lengths, thereby keeping J_0 low," correct?

21 A. That's right.

22 Q. And in Paragraph 54, Dr. Ruby, you discuss

1 recombination due to surface defects and impurities, right?

2 A. Yes.

3 Q. And you would agree that by 2008 a person of
4 ordinary skill in the art in the '053 and '516 patents would
5 have known recombination occurred due to surface defects,
6 right?

7 A. Yes.

8 Q. And by 2008, a person of ordinary skill in the art
9 would have known that, "effective solar cell design
10 implements the invention and inclusion of critical features
11 to reduce the amount of recombination occurring at surfaces,
12 which is known as surface passivation"?

13 A. That's right.

14 Q. In Paragraphs 54 through 57 you discuss surfaces,
15 right?

16 A. Yes.

17 Q. And does that discussion of surfaces include a
18 solar cell's internal surfaces?

19 A. What do you mean by "internal surfaces"?

20 Q. Well, are you familiar with the internal surfaces
21 of a solar cell versus the external surfaces?

22 A. Well, there's the surface of the substrate, there

1 is a surface of any deposited layers you put on the
2 substrate.

3 Q. Would internal surfaces be the interfaces between
4 layers?

5 A. Yes.

6 Q. Okay. So with that understanding, does your
7 discussion of surfaces in Paragraphs 54 through 57 include a
8 solar cell's internal surfaces?

9 A. Yes, I believe so.

10 Q. And by 2008 a person of ordinary skill in the art
11 would have known that effective solar cell design implements
12 the invention and inclusion of critical features to reduce
13 the amount of recombination occurring at internal surfaces
14 of the solar cell --

15 A. Yes.

16 Q. -- as well as external surfaces, correct?

17 A. Primarily at the interface between the silicon
18 surface and any deposited layers.

19 Q. Turning to the subsection entitled, "Resistance,"
20 Paragraph 60.

21 A. Yes.

22 Q. Is that subsection you discuss serious resistance

1 in solar cells, right?

2 A. Yes.

3 Q. And by 2008 a person of ordinary skill in the art
4 of the '516 and '053 patents would have known if the
5 principles that are described in Paragraphs 60 through 67,
6 correct?

7 A. Yes.

8 Q. And the principles that are described between
9 Paragraph 60 and 67 are not the invention claimed by the
10 '053 and '516 patents, correct?

11 A. Right.

12 Q. Would you look, sir, to Paragraph 62.

13 A. Okay.

14 Q. Do you see in Paragraph 62 you discuss an example
15 trade-off commonly occurring in solar cell design?

16 A. Yes.

17 Q. Could you explain for us that trade-off, please?

18 A. Well, in the case of a solar cell that has front
19 metal contacts, those metal contacts usually are not
20 transparent, and therefore they reduce the amount of light
21 that manages to -- that can be absorbed by the silicon;
22 therefore, you would like to reduce that amount of metal

1 shading, but you can only reduce it so far, because if you
2 reduce it too much, then you incur excessive series
3 resistance, which is another loss mechanism.

4 Q. Would a person of ordinary skill in the art of the
5 '516 and '053 patents have been familiar with the trade-off
6 that you just described as of 2008?

7 A. Yes, right.

8 Q. In Paragraph 63 and 64 you discuss Pc, correct?

9 A. Yes.

10 Q. In Paragraph 63 you explain how Pc is commonly
11 measured, correct?

12 A. Right.

13 Q. And you'd agree that by 2008 a person of ordinary
14 skill in the art of the '516 and '053 patents would have
15 known how to measure Pc as you described in Paragraph 63?

16 A. Yes.

17 Q. Do the measurements you mention in Paragraph 63
18 need to be completed on a full solar cell?

19 A. No.

20 Q. Why not?

21 A. Because they are the measurements to see what the
22 electrical resistance is between metal contacts, and those

1 metal contacts don't need to be on a completed solar cell,
2 they can be on a test structure.

3 Q. Would you agree that as of 2008, a person of
4 ordinary skill in the art would have known that you could
5 study Pc for solar cells by testing only a part of a fully
6 built-out cell?

7 A. Yes.

8 Q. And that person of ordinary skill in the art would
9 know that the results would still be useful to consider how
10 the contact would perform in a full solar cell?

11 A. Yes.

12 Q. By 2008, was measuring Pc by testing only a part
13 of a fully built-out solar cell a common practice?

14 A. Yes.

15 Q. And is the Pc that you discuss in Paragraph 63 the
16 same Pc that's discussed in the Gan reference?

17 A. Yes.

18 Q. Which of the methods, if any, that you describe in
19 Paragraph 63 did the Gan reference use?

20 A. I believe they used this transmission-line method.

21 Q. And then turning from Paragraph 64. By 2008,
22 would a person of ordinary skill in the art of the '516 and

1 '053 patents have known that a high Pc results in excessive
2 loss of power and lower efficiency?

3 A. Yes.

4 Q. In the last sentence of Paragraph 64 you describe,
5 "several trade-offs and careful optimization." Do you see
6 that?

7 A. Yes.

8 Q. Can you explain what trade-offs and optimization
9 you're referring to there?

10 A. Well, I believe this follows from the previous
11 sentence, which says that contact resistance is only one
12 component of total series resistance, and that all those
13 components need to be optimized simultaneously, along with
14 allowing maximum light collection. And those various
15 components needed to be optimized simultaneously to achieve
16 the best result.

17 Q. By 2008, would a person of ordinary skill in the
18 art of the '516 and '053 patents have known that minimizing
19 Pc involved the types of trade-offs and careful optimization
20 that you describe in Paragraph 64?

21 A. Yes.

22 Q. Can you turn, please, to the section entitled

1 tunnel oxides which starts at Paragraph 77.

2 A. Paragraph 77.

3 Q. Yes.

4 A. Okay.

5 Q. What you describe in the section entitled "tunnel
6 oxides" from Paragraph 77 through 84 is prior art to the
7 '516 and '053 patents, correct?

8 A. Yes.

9 Q. And by 2008, a person of ordinary skill in the art
10 of the '516 and '053 patents would have known of what you
11 describe in Paragraph 77 through 84, correct?

12 A. Yes.

13 Q. By 2008 a person of ordinary skill in the art of
14 the '516 and '053 patents would have known that, "tunnel
15 oxides are high quality silicon dioxide layers that are
16 extremely thin about, 1.5 nanometers just about 3 atomic
17 monolayers that cover the entire backside surface of the
18 substrate," correct?

19 A. Yes.

20 Q. Do you see the discussion starting at Paragraph 80
21 that describes U.S. Patents Publication No. 2022/0142500 to
22 Foglietti?

1 A. Yes, I do.

2 Q. And you explain in Paragraph 80 that although
3 Foglietti relates to bipolar transistors, the tunneling
4 mechanism it describes, also applies to solar cells. Do you
5 see that?

6 A. Yeah, I do.

7 Q. Can you explain why that's so?

8 A. Because the tunneling mechanism is a property of
9 semiconductor devices. And bipolar transistors and solar
10 cells are semiconductor devices. So those properties would
11 apply to both types of devices.

12 Q. By 2008, a person of ordinary skill in the art of
13 the '516 and '053 patents would have known how to add a
14 tunnel oxide to a transistor, correct?

15 A. Yes.

16 Q. And by 2008, a person of ordinary skill in the art
17 of the '516 and '053 patents would have known how to add a
18 tunnel oxide to a solar cell, correct?

19 A. I presume so, yes.

20 Q. Your declaration doesn't cite or identify any
21 articles from before 2008 that suggest that tunnel oxides
22 are incompatible with solar cells, correct?

1 A. They are not incompatible, no.

2 Q. They are compatible, correct?

3 A. They are compatible.

4 Q. And that was known by 2008, correct?

5 A. Yes.

6 Q. In Paragraph 85 of your declaration you describe a
7 solar cell having, "a layer of polysilicon, heavily doped
8 with N-type dopants is formed on the tunnel oxide."

9 Correct?

10 A. Yes.

11 Q. That was a structure that was known by 2008,
12 correct?

13 A. I would say it was not widely known.

14 Q. But it was known, correct?

15 A. Yes.

16 Q. By 2008, it was known that, "the combination of a
17 tunnel oxide and doped polycrystalline silicon layer
18 provides excellent passivation and carrier re- -- carrier
19 selectivity on the N-type substrate." Correct?

20 A. Where do you see that?

21 Q. Paragraph 85.

22 A. Repeat the question, please.

1 Q. Of course. By 2008, it was known that the
2 combination of a tunnel oxide and doped polycrystalline
3 silicon layer provides excellent passivation and carrier
4 selectivity on the N-type substrate, correct?

5 A. It was not widely known.

6 Q. But it was known, correct?

7 A. It was known by some.

8 Q. In fact, Gan teaches that, right?

9 A. That's what he was working to prove.

10 Q. I have marked as Exhibit 1072.

11 (Exhibit 1072 marked.)

12 Q. (BY MR. SELWYN) A document entitled "Sandia
13 Report Fundamental Understanding and Developments of Low
14 Cost High-efficiency Silicon Solar Cells." Do you have that
15 before you?

16 A. Yes.

17 Q. Do you recognize that?

18 A. I recognize the authors.

19 Q. Do you recognize the document?

20 A. I don't remember the document, but I can see
21 that's what it is.

22 Q. Who are the authors?

1 A. Rohatgi, Narasimha, Moschner, Ebong, Kamra,
2 Krygowski, Doshi, Ristow, and Yelundur.

3 Q. A. Rohatgi is the individual listed on your CV's
4 references?

5 A. Yes.

6 Q. And I think you told me before that you hold him
7 in high regard?

8 A. Yes.

9 Q. These are all individuals with whom you worked
10 with at Sandia?

11 A. They were individuals at Georgia Tech, with whom
12 we had a research contract.

13 Q. Can you turn to the very last page which says
14 "distribution"?

15 A. Yes.

16 Q. And look at the bottom right-hand corner.

17 A. Yes.

18 Q. Do you see there is a reference "0752 Doug Ruby
19 6219."

20 A. Yes.

21 Q. That's you, right?

22 A. Right.

1 Q. You said this was a paper that was distributed to
2 you?

3 A. Yes.

4 Q. What was your role on the project?

5 A. Well, I was probably a technical monitor for some
6 of it.

7 Q. If you could look please, sir, to Page 4-9.

8 A. Yes.

9 Q. Do you see that this indicates that you were the
10 source of the data provided for this -- strike that.

11 Do you see that this page indicates that you were a
12 source for the data included in this graph?

13 A. Yes, I was a source for the data.

14 Q. So it appears that this report relies, at least to
15 some extent, on your data, right?

16 A. On measurements.

17 Q. How was this report prepared?

18 A. Well, the authors would have written it and I
19 probably provided some review, maybe some minor editing.
20 But it was essentially -- it was the result of the authors.

21 Q. Could you turn, please, to the abstract, which is
22 on Page 5 of the exhibit.

1 A. My abstract. Roman numeral 5, or...

2 Q. That's a good question.

3 A. I see a table of contents.

4 Q. It is not in a commonplace vernacular, in my
5 experience, but it seems to be on Page 5 of the document
6 under the list of authors.

7 A. Okay.

8 Q. Do you see the abstract describes, "the overall
9 objectives of the program"?

10 A. Yeah.

11 Q. And do you see the overall objectives include
12 developing processes and designs that increase performance
13 and lower costs?

14 A. Well, it says, "can improve yield, throughput, and
15 performance and design on promising low cost materials."
16 That's what I see.

17 Q. Turn with me to Page 1-2. If you look about
18 halfway down the page there is a sentence that reads, "the
19 stack also lowers the emitter saturation current density J_0)
20 of 40 and 90" --

21 A. Ohms per square.

22 Q. -- "ohms per square," thank you, "emitters by a

1 factor of 3 in 10 respectively, compared to no passivation."

2 A. I see that.

3 Q. Do you understand that sentence?

4 A. Well, I need to look at the context in which it is
5 used.

6 Q. Please.

7 A. So the stack lowers the emitter saturation current
8 density compared to no passivation. Yes, I see that and I
9 understand.

10 Q. How, if at all, does the J_0 -- strike that.

11 The J_0 that's described in that sentence that I just
12 read for you is the same J_0 discussed in your declaration
13 and the same J_0 in Gan, right?

14 A. This J_0 is $J_0 E$, which means that component of the
15 saturation current density, which is due exclusively to the
16 emitter region of the solar cell. It is referred to here at
17 $J_0 E$.

18 Q. Can you turn the page, please, to the section
19 entitled "introduction."

20 A. Yes.

21 Q. Do you see that the paragraph on Page 1-3
22 discusses the importance of reducing costs for both the

1 solar cell module and individual solar cells?

2 A. Yes.

3 Q. Do you agree that at the time of this paper it was
4 important to create processes that can significantly reduce
5 the cell processing time and number of processing steps?

6 A. Yes.

7 Q. And can you look, please, at the second paragraph
8 on Page 1-4.

9 A. Okay.

10 Q. Do you see that the first sentence in the
11 paragraph says, "most manufacturers, in an attempt to reduce
12 manufacturing costs use a minimal number of low cost
13 processing steps"?

14 A. Yes.

15 Q. And you'd agree that that was true as of 2008,
16 correct?

17 A. Yes.

18 Q. And it is still true, right?

19 A. Right. But your definition of a low-cost
20 processing step may differ from someone else's.

21 Q. Okay. Let's skip ahead. Can you turn to
22 Page 1-19.

1 A. Okay.

2 Q. Below that heading, 1.6, the first sentence
3 states, "Silicon solar cell fabrication involves processing
4 of emitter back surface fields that electric passivation and
5 anti-reflection coatings, and front and back contact
6 formation." Do you see that?

7 A. Yeah, I do.

8 Q. And you'd agree that all those features were well
9 known by 2008, correct?

10 A. Yes, they were.

11 Q. Now skip ahead to Section -- strike that.

12 Turn next to Chapter 2, Page 2-1.

13 A. Okay.

14 Q. And do you see the title of Chapter 2 is,
15 "Fabrication and characterization of gridded back cells,
16 GBC"?

17 A. Yes.

18 Q. What is a gridded back cell?

19 A. Well, I would assume it is a back contact cell
20 with a grid on the back, or a cell with a metal contact on
21 the back comprised of grids.

22 Q. Can you look at the first paragraph on Page 2-2.

1 A. Yes.

2 Q. The first paragraph uses the phrase,
3 "Screen-printed solar cells," do you see that?

4 A. Where?

5 Q. First sentence.

6 A. Yes.

7 Q. What is a screen-printed solar cell?

8 A. It is a solar cell where the metal contact regions
9 are produced on the cell surface using screen printing
10 techniques.

11 Q. And screen printing was a method of forming a
12 metal contact using a paste?

13 A. Yes.

14 Q. Screen printing was known by 2008, correct?

15 A. Yes.

16 Q. And by 2008, screen printing was a common way to
17 form metal contacts, correct?

18 A. In industry, yes.

19 Q. And, high-level, can you describe the steps of a
20 typical screen printing process?

21 A. Well, a screen is placed over the solar cell and a
22 metal paste is pushed through the screen to only lie on top

1 of areas of the cell defined by the pattern in the screen.
2 Then that paste is dried in an oven at what I would call low
3 temperature to remove the components that make it viscous to
4 solidify, dry it out. And then it goes through a higher
5 temperature step where the grid lines are, go through a
6 chemical reaction such that they ultimately come into
7 contact with the silicon surface and make an electrical
8 contact with it.

9 Q. What does "firing through" mean in the context of
10 screen printing?

11 A. Firing through means if there is a dielectric
12 layer on the surface of the silicon cell, the process of
13 heating the paste up to the elevated temperature promotes a
14 chemical reaction with the dielectric layer, such that the
15 dielectric layer is dissolved in those regions where they
16 are in contact with the paste, and this allows the metal
17 paste to transfer or to go through whatever layer is on the
18 surface and make contact with the underlying silicon
19 substrate.

20 Q. So the purpose of firing through is so the metal
21 reaches the substrate or the emitter?

22 A. Yes.

1 Q. And that allows the metal to extract energy?

2 A. It allows the metal to conduct current from the
3 silicon.

4 Q. What would a cross-sectional view of the solar
5 cell look like after the firing-through process?

6 A. Well, in the region under the grid line the metal
7 would be in direct contact with the silicon. In regions
8 adjacent to that with no metal present, the previous
9 dielectric layer would remain intact.

10 Q. After firing through does the metal completely
11 etch through the anti-reflection or passivation coating?

12 A. Yes.

13 Q. The first paragraph on Page 2-2 of the Sandia
14 report, Exhibit 1072, explains that, "In order for these
15 devices to be highly efficient two important requirements
16 must be met." Do you see that?

17 A. Yes.

18 Q. And it says the first is that the contact
19 resistance P_c at the rear SP electrode must be low, right?

20 A. Yes.

21 Q. Can you explain how, if at all, the contact
22 resistance, that is P_c , differ from the P_c discussed in your

1 declarations and Gan, or is it the same?

2 A. I believe it is the same.

3 Q. Now, could you turn, please, to the second
4 paragraph on Page 2-4 which starts Section 2.1.1

5 "quantitative assessment of Pc for rear conductor paste."

6 A. Yes.

7 Q. The conductor paste that is discussed here is the
8 paste used in screen printing to form the metal contacts,
9 right?

10 A. Yes.

11 Q. And do you see that the second paragraph on 2-4
12 discusses, "A pure, a one paste" --

13 A. Aluminum paste.

14 Q. Okay. Let me start again, thank you.

15 The second paragraph on 2-4 discusses a pure aluminum
16 paste and the second was --

17 A. Silver paste.

18 Q. Mixed with a small fraction of aluminum additive?

19 A. Yes.

20 Q. That means for the resulting first paste, the
21 resulting metal contact would be aluminum, right?

22 A. Yes.

1 Q. And for the second paste the resulting contact
2 with be silver with a small fraction of aluminum?

3 A. Yes.

4 Q. And silver pastes were known by 2008, correct?

5 A. Yes.

6 Q. Silver contacts made from screen printing were
7 known by 2008, correct?

8 A. Yes.

9 Q. Why was silver used?

10 A. It has a lower resistivity.

11 Q. Could you turn, please, now to Page 6-2, which
12 starts at Chapter 6, entitled "Development of front surface
13 field aluminum back junction, n⁺-n-p⁺ screen printed cell on
14 dendritic web silicon." D-E-N-D-R-I-T-I-C.

15 A. Which paragraph?

16 Q. Page 6-2, first paragraph.

17 A. Okay.

18 Q. Do you see that the first sentence on Page 26 says
19 that The chapter discusses, "A new silicon solar cell
20 structure that is fabricated in which the PN-junction is
21 formed by alloying aluminum with N-type silicon and where
22 the PN-junction is located at the back (non-illuminated)

1 surface of the cell"?

2 A. Yes, I see that.

3 Q. Can you describe that solar cell structure?

4 A. Give me a moment, please.

5 So this describes a structure in which the, the
6 silicon is N-type and a P-type emitter in this case is
7 formed on the backside of the cell simply by alloying the
8 silicon with aluminum.

9 Q. Was this silver cell structure commercially sold
10 as of the time of this report?

11 A. I don't know.

12 Q. Then it says in the third sentence on Page 6-2,
13 "The most striking feature of the cell" --

14 A. Wait a minute. Third sentence.

15 Q. I'm sorry. Three lines from the bottom.

16 A. Three lines from the bottom of the page?

17 Q. Yes.

18 A. Okay.

19 Q. Three lines from the bottom of Page 6-2, which is
20 the third sentence under 6.1.

21 A. Right.

22 Q. Do you see it says, "The most striking feature of

1 this cell is the aluminum alloy PN-junction on the back,
2 non-illuminated side"?

3 A. Yes.

4 Q. So this is describing that the PN-junction was on
5 the side away from the sun, correct?

6 A. Right.

7 Q. And the emitter was on the rear side, correct?

8 A. Yes.

9 Q. It says the cell also had, "A phosphorus doped
10 layer."

11 A. Where? Last sentence?

12 Q. Last sentence carrying over to Page 6-3.

13 A. Go ahead.

14 Q. It says that the cell also had a phosphorus --

15 A. It doesn't say that. It just starts, "A
16 phosphorus doped layer..."

17 Q. Fair enough. Let me just read the sentence, then.
18 Do you see the sentence reading, "A phosphorus-doped layer
19 which gives rise to a strong electric yield for effectively
20 passivating a front surface leading to an N+ NP+ structure."

21 A. Yes.

22 Q. The substrate of the solar cell was N-type,

1 correct?

2 A. I believe so, yes.

3 Q. And the emitter of the solar cell was P-type?

4 A. Yes.

5 Q. And according to the first full sentence on 6-3,
6 the cell had a silicon nitride anti-reflective coating?

7 A. Yes.

8 Q. And silicon nitride is also referred to as SiN.

9 A. Right.

10 Q. And "AR" means anti-reflection?

11 A. Yes.

12 Q. And according to that first full sentence on 6-3
13 the cell also had a solderable silver contacts as a grid on
14 the front?

15 A. Yes.

16 Q. And that refers to the front side contacts?

17 A. Yes.

18 Q. And also, according to the first full sentence on
19 6-3, the cell also had, "Two stripes over the aluminum
20 silicon eutectic metal on the back."

21 A. Yes.

22 Q. And that refers to the backside contacts?

1 A. Well, the stripes are the solderable of the
2 backside contacts.

3 Q. Can you look at the second paragraph on Page 6-3,
4 please.

5 A. Yes.

6 Q. You see that it discusses, "A comparison of a
7 conventional silicon cell with a dendritic" --

8 A. Dendritic web.

9 Q. Thank you. "dendritic web silicon PhosTop cell."

10 A. Yes.

11 Q. And the comparison is discussed in the second
12 paragraph on 6-3 and in Table 6-1, right?

13 A. Apparently so.

14 Q. And according to Table 6-1, the conventional cell
15 had a P-type boron-doped substrate?

16 A. Yes.

17 Q. And the junction (dopants) of the conventional
18 cell were phosphorus and boron?

19 A. Yes.

20 Q. And that would indicate that the emitter of the
21 conventional cell was N-type phosphorus-doped, correct?

22 A. Yes.

1 Q. According to Table 6-1 the junction location for
2 its conventional cell is on the front, correct?

3 A. Right.

4 Q. And that means that the conventional cell's
5 emitter would have been on the front of the cell, correct?

6 A. Yes.

7 Q. Can you look again at the second paragraph on
8 Page 6-3?

9 A. Okay.

10 Q. Do you see where it explains, "There are several
11 potential advantages of the PhosTop cell over the
12 conventional cell"?

13 A. I see where it says that.

14 Q. And it says one advantage described is that,
15 "Moving the PN-junction" --

16 A. Wait a minute. Where is, where are you reading?

17 Q. Do you see the sentence, two sentences up in the
18 first full paragraph on 6-3 that begins, "moving the
19 PN-junction"?

20 A. Now I see it.

21 Q. Great. So it says, "Moving the PN-junction from
22 the front of the cell to the back opens the possibility of

1 making the front diffuse layer thinner without fear of
2 shunting." Correct?

3 A. Yes.

4 Q. And there, it is describing one of the advantages
5 of the PhosTop cell over the conventional cell?

6 A. Right.

7 Q. What is shunting?

8 A. Apparently, that's what they believe.

9 Q. What is it? What is shunting?

10 A. Shunting would be unintentional conductive path
11 from the front contact to the back contact.

12 Q. Do you see the last sentence on that paragraph
13 says, "The prospect of enhancing a blue response of the cell
14 in this way was recognized previously as fabricating cells
15 with a P* PN* structure using the 100-micrometer thick
16 wafers sawn from a 3-grain ingot."

17 A. I see where it says that.

18 Q. What is "blue response of the cell"?

19 A. The blue response is the portion of the spectral
20 response of a cell in the blue region of the spectrum,
21 essentially the short wavelength response.

22 Q. And why would enhancing the blue response of the

1 cell be an advantage?

2 A. You can increase the short circuit current that
3 way.

4 Q. Do you see that the last paragraph on Page 6-3
5 begins, "A second advantage of the PhosTop cell is the
6 existence of a strong front surface field"?

7 A. Yes.

8 Q. Why would a strong front surface field be
9 considered an advantage?

10 A. Well, it would reduce front surface recombination.

11 Q. And the last paragraph on Page 6-3 explains this
12 decreased recombination, correct?

13 A. Yes.

14 Q. Would you please turn to Page 6-5.

15 A. Yes.

16 Q. Do you see the sentence that begins on the bottom
17 of Page 6-5 reading, "The dendritic web silicon PhosTop cell
18 holds a third potential advantage over the conventional cell
19 in its high lifetime for minority characters [sic] in the
20 base."

21 A. I see where it says that.

22 Q. What does "high lifetime for minority characters

1 in the base" mean?

2 A. It means less space recombination.

3 Q. Why is that a potential advantage?

4 A. Because reducing recombination in all regions
5 results in higher voltages and currents.

6 Q. If you turn, please, to Page 6-6.

7 A. Yes.

8 Q. Do you see the second -- strike that.

9 Do you see that the first full sentence on Page 6-6
10 reads: "The choice of N-type is also important because
11 minority carrier holds carry a positive charge."

12 A. Yeah.

13 Q. And that's referring to the importance of the
14 substrate being N-type, correct?

15 A. Right.

16 Q. Why are minority carrier holds that carry a
17 positive charge important?

18 A. Well, minority carrier holds -- minority carriers,
19 regardless of their charge are important because the
20 minority carriers which are generated in a solar cell are
21 the carriers which have to be transferred across the
22 PN-junction to result in the delivery of current to an

1 external circuit.

2 MS. ZHAO: Counsel, before you continue, we've
3 been going for about an hour.

4 MR. SELWYN: Yeah, I probably have five more
5 minutes on this document.

6 THE WITNESS: Five minutes is fine.

7 MR. SELWYN: That okay?

8 MS. ZHAO: Yeah.

9 MR. SELWYN: That would be a natural breaking
10 point.

11 THE WITNESS: Good.

12 Q. (BY MR. SELWYN) All right, the second paragraph
13 on Page 6-6 begins, "A final advantage of the PhosTop cell
14 is that there is no light-induced degradation since it is an
15 N-type base." Do you see that?

16 A. Yes, I do.

17 Q. What does "no light-induced degradation" mean?

18 A. Well, the P-type substrates that were normally
19 produced using boron as a dopant have a fundamental flaw,
20 which is that when light is absorbed in the substrate, after
21 a while it creates boron-oxygen complexes which are
22 recombination sites, and therefore, result in degradation of

1 device performance.

2 Q. Why is that an advantage?

3 A. Well, it is an advantage to avoid that because any
4 recombination that can be avoided benefits the performance
5 of the solar cell.

6 Q. Do you see in the middle of the Page 6-6 there is
7 a reference to V_{OC} ?

8 A. V_{OC} , yes.

9 Q. What is that?

10 A. Open circuit voltage.

11 Q. What is open circuit voltage?

12 A. That's the voltage a solar cell would produce at
13 zero delivered current.

14 Q. Would you agree that a person of ordinary skill in
15 the art in '516 and '053 patents would have known about open
16 circuit voltage as of 2008?

17 A. Yes.

18 Q. And a person of -- strike that.

19 Would a person of ordinary skill in the art of the
20 '516 and '053 patents have known the equation for open
21 circuit voltage as of 2008?

22 A. Which equation?

1 Q. I will come back to that.

2 Can you look at the section starting on Page 6-6
3 entitled "6.2 experimental results."

4 A. Yes.

5 Q. And according to the first sentence of that
6 section, Sandia fabricated PhosTop the cell that we've been
7 discussing, right?

8 A. No, Sandia did not fabricate it.

9 Q. Where did the PhosTop cell come from?

10 A. I don't know.

11 Q. Okay.

12 MR. SELWYN: I said five minutes, we'll keep to
13 it.

14 (Off the record, 12:38 p.m to 1:18 p.m.)

15 Q. (BY MR. SELWYN) Can you put back in front of you,
16 sir, the Sandia report marked as Exhibit 1072 that we were
17 talking about before.

18 A. Uh-huh. Yeah, what page?

19 Q. Turn, please, to Page 6-6.

20 A. Okay, I'm there.

21 Q. And if you will recall I asked you before about
22 the subscript OC open circuit voltage?

1 A. Yes.

2 Q. For context would you explain again what open
3 circuit voltage is.

4 A. This is voltage generated by a solar cell when it
5 is open and circuited.

6 Q. And open circuit voltage was known by the date of
7 the Sandia report, correct?

8 A. Yes.

9 Q. And open circuit voltage was known to a person of
10 ordinary skill in the art of '516 and '053 patents by 2008,
11 correct?

12 A. Yes.

13 Q. The equation for open circuit voltage was also
14 known by 1999, correct?

15 A. Which equation.

16 Q. An equation for determining open circuit voltage.

17 A. An equation?

18 Q. Yes.

19 A. There probably are more than one, but I know of at
20 least one.

21 Q. That was known by 1999, correct?

22 A. Yes.

1 Q. And a person of ordinary skill in the art of the
2 '516 and '053 patents would know of an equation for open
3 circuit voltage by 2008, correct?

4 A. Yes.

5 Q. Let me hand you as our next exhibit U.S. Patent
6 5,792,280 which is Exhibit 1073.

7 (Exhibit 1073 marked.)

8 Q. (BY MR. SELWYN) Dr. Ruby, do you recognize U.S.
9 Patent No. 5,792,280. It is one of your patents.

10 A. Yes.

11 Q. And does this patent relate to work that you did
12 at Sandia?

13 A. Yes, it does.

14 Q. Can you explain how?

15 A. Well, this was a method for fabricating solar
16 cells that we invented at Sandia.

17 Q. Will you please turn to the paragraph starting at
18 Column 2, Line 50.

19 A. Okay.

20 Q. Do you see that the paragraph discusses current
21 concentrator cells?

22 A. Yes.

1 Q. And then in the second sentence it states,
2 "Silicon is chosen as a compromise between cost and
3 conversion efficiency."

4 A. Yes.

5 Q. Can you explain what you meant by that?

6 A. Well, I think what was meant by that is that
7 silicon is chosen as a material from which to make solar
8 cells, for one reason, because it is widely available, which
9 keeps the cost low. But it has certain material parameters
10 known, one of which is known as a Band Gap, which is not
11 ideal for converting terrestrial sunlight to the maximum
12 amount of electricity; for example, gallium arsenide has a
13 Band Gap that more closely matches the optimum for solar
14 cell efficiencies using the terrestrial solar spectrum.

15 Q. And in what way, as of 1998 was silicon a
16 compromise between cost and conversion efficiency?

17 A. As I mentioned, silicon is cheaper than gallium
18 arsenide, but doesn't perform as well as gallium arsenide.
19 So that was the trade-off that was made.

20 Q. In solar cell design, in your experience, is there
21 frequently a compromise between cost and conversion
22 efficiency?

1 A. It depends on the potential use of the product;
2 for example for space satellites where cost is less of a
3 constraint, gallium arsenide is the material of choice for
4 solar cells. On earth where there are other forms of
5 electricity to compete with, cost becomes an important
6 factor.

7 Q. The next sentence in that same paragraph,
8 Column 2, Line 53 reads, "A number of expedience known to
9 those skilled in the art are utilized to obtain this level
10 of conversion efficiency, including the use of
11 anti-reflection coatings, texturization of the surface to
12 reduce the reflectance of above Band Gap photons." Do you
13 see that.

14 A. Yes.

15 Q. Was that sentence still accurate as of
16 February 2008?

17 A. Yes.

18 Q. Would you turn, please, sir, to the first
19 paragraph in Column 3. Do you see that this paragraph
20 explains that, "There is room for improvement in the
21 processing of high-efficiency concentrator cells"?

22 A. Yes.

1 Q. And then one issue identified with, "The current
2 process streams," is that the designs, "included multiple
3 dopant diffusions, many photolithography steps, and up to
4 six high-temperature furnace steps."

5 A. Yes.

6 Q. What is a photolithography step?

7 A. Photolithography is a process whereby a
8 light-sensitive substance is applied to the surface of a
9 semiconductor and then light is shined on this semiconductor
10 with the substance through a photo mask which illuminates
11 certain portions, but keeps others in the dark. Then this
12 photosensitive substance in the presence of light becomes
13 more or less resistive to various chemical treatments, and
14 so you're able to use it to, for example, selectively etch
15 off underlying silicon regions in areas where the
16 photoresist, which is normally what is used to spin onto the
17 surface of the wafer has been illuminated and patterned by
18 the photo mask.

19 Q. And then in the next sentence your patent
20 explains, "Such complexity leads naturally to an expensive
21 process with low product yield." Do you see that?

22 A. Yes, I do.

1 Q. Would you agree that a person of ordinary skill in
2 the art of the '053 and '516 patents as of 2008 would have
3 known that process complexity leads to an expensive process
4 with a low product yield?

5 A. It leads to a more expensive product with a lower
6 product yield.

7 Q. And the patent explains that the process needs to
8 be simplified to reduce costs, right?

9 A. Right.

10 Q. Can you turn now to the section entitled "summary"
11 which starts at Column 3, Line 30.

12 A. Yes.

13 Q. And that's a summary of your patent's invention;
14 is that right?

15 A. Yes.

16 Q. The last sentence in the summary says this is
17 process is applied here to a, capital P-E-S-C-type design,
18 but can be applied to other solar cell designs producing
19 significant reduction in the cost of the finished device?

20 A. Right.

21 Q. What is a PS -- PESC-type design?

22 A. PESC. It is an acronym standing for passivated

1 emitter solar cell, a diagram of which is included in my
2 declaration.

3 Q. And before 2008 were there PESC-type designs that
4 did not include features that concentrate sunlight such
5 as --

6 A. Say that again.

7 Q. Sure. Before 2008, were there PESC-type designs
8 that did not include features that concentrate sunlight?

9 A. Yes.

10 Q. What did you mean by the process, "can be applied
11 to most solar cell designs"?

12 A. Well, I guess this was a process simplification,
13 and so any solar cell design that used the aforementioned
14 process could be simplified in the way described in this
15 patent.

16 Q. Did you mean that a person of ordinary skill in
17 the art would have understood that the invention could have
18 been implemented in most solar cell designs?

19 A. Yeah. In other solar cell designs that used the
20 processes described here that were amenable to process
21 simplification.

22 Q. And your patent, the '280 Patent, doesn't include

1 figures or descriptions showing the invention applied to,
2 "most solar cell designs," right?

3 A. No, I imagine it includes figures that pertain to
4 a particular design when considered here.

5 Q. So when you were referring to most solar cell
6 designs you were referring to things that were not shown in
7 your patent, correct?

8 A. Right. Other designs not shown here in the
9 patent.

10 Q. Now, can you turn to the description beginning
11 here on Column 3, Line 60.

12 A. Sixty. Yes.

13 Q. The first sentence, which starts at Column 6, Line
14 -- sorry, Column 3 -- start that over.

15 The first sentence under "description" beginning at
16 Line 63.

17 A. Yes.

18 Q. Discloses user either a P and N-type substrate,
19 correct?

20 A. Either a P-type or N-type silicon wafer.

21 Q. So if the substrate were N-type, the emitter would
22 be P-type, correct?

1 A. If the substrate were N-type, the emitter would be
2 P-type.

3 Q. And by 2008, a person of ordinary skill in the art
4 of the '516 and '053 patents knew about N-type substrates
5 and P-type emitters, right?

6 MS. ZHAO: Objection; form.

7 A. They knew about solar cells with -- say the
8 question again.

9 Q. (BY MR. SELWYN) Sure. Let me ask a new question.

10 By 2008, a person of ordinary skill in the art of the
11 '516 and '053 patents knew about N-type substrates, right?

12 A. Yes.

13 Q. And by 2008, a person of ordinary skill in the art
14 of the '516 and '053 patents knew about P-type emitters,
15 right?

16 A. P-type emitters, yes.

17 Q. Now, sir, if you turn to the next column,
18 Column 4, beginning at Line 8.

19 A. Yes.

20 Q. Do you see that the paragraph explains Figures 2A,
21 B, and C illustrate the steps which take place to form a
22 junction and an oxide passivation layer on a silicon wafer?

1 A. Yes.

2 Q. Would you agree that by 2008 a person of ordinary
3 skill in the art of the '516 and '053 patents would have
4 known how to form a junction in an oxide passivation layer
5 on a silicon wafer as described in that paragraph?

6 A. Yes.

7 Q. The junction referred to in Column 4, Line 9 is
8 formed when the silicon wafer is doped with dopant atoms of
9 the opposite conductivity type to those originally in the
10 doped silicon wafer, correct?

11 A. Say that again.

12 Q. Sure. The junction that's referenced in Column 4
13 Line 9, is formed when the silicon wafer is doped with
14 dopant atoms of the opposite conductivity type to those
15 originally in the doped silicon wafer, correct?

16 A. Yes.

17 Q. And this paragraph says that a dopant source
18 material, "Comprises dopant atoms of the opposite
19 conductivity type" --

20 A. Can you show me which sentence that is?

21 Q. Sure.

22 A. I think I found it. You're reading starting from

1 the middle of the sentence. Well, in Figure 2A the initial
2 process atmosphere has been replaced by a gaseous dopant
3 source material which comprises dopant atoms of opposite
4 conductivity type, compared to those originally existing in
5 the doped silicon wafer.

6 Q. Let me start over. I want to refer you to
7 Column 4, Paragraph Lines 8 through 24.

8 A. Okay, that entire paragraph.

9 Q. And that paragraph talks about a dopant source
10 material that is, "Comprised of dopant atoms of the opposite
11 conductivity type to those originally existing in the doped
12 silicon wafer."

13 A. Yes.

14 Q. That's about forming the emitter, correct?

15 A. Yes.

16 Q. The emitter is formed when the silicon wafer is
17 doped with the doping atoms of the opposite conductivity
18 type than those originally in the doped silicon wafer,
19 right?

20 MS. ZHAO: Objection; form.

21 A. That is how the term "emitter" is used in this
22 paragraph.

1 Q. (BY MR. SELWYN) Do you see the second to last
2 sentence in parentheses, which says, note that it is also
3 possible to -- strike that.

4 Do you see the second to last sentence in Column 4?
5 Strike that.

6 Let me refer you to Column 4, Lines 19 through 24.

7 A. Okay.

8 Q. Do you see it reads, "Note, that it is also
9 possible to directly deposit prior to placing the wafer, 11,
10 into the high-temperature furnace, 10, the layer 16, using
11 suitable physical deposition means"?

12 A. Yes.

13 Q. And then the following sentence after that
14 explains that suitable deposition means include spin-on
15 techniques, CVD deposition of a doped silicon glass, and ion
16 implementation techniques, right?

17 A. Yes.

18 Q. Would you agree that a POSITA in the '516 and '053
19 Patents would have understood by 2008 that suitable means to
20 form an emitter include, "Spin-on techniques, CVD deposition
21 of doped silicon glass, and ion implementation techniques"?

22 A. Yes.

1 Q. What is a spin-on technique?

2 A. Well, you would take chemical compound, which is a
3 viscous liquid and apply it to the surface of a spinning
4 wafer so that once it deposits on it, it fans out over the
5 entire area. And depending on the spin speed and the
6 viscosity of the liquid you get a layer of a given
7 thickness, predetermined thickness.

8 Q. What is CVD deposition of a doped silicon glass?

9 A. For example, you could use atmospheric pressure or
10 plasma-enhanced chemical vapor deposition of a doped silicon
11 dioxide glass.

12 Q. If a dopant is boron, this refers to borosilicate
13 glass?

14 A. Yes.

15 Q. And that's also called BSG?

16 A. Yes, it is.

17 Q. That's boron-doped silicon dioxide?

18 A. Yes, boron containing silicon dioxide.

19 Q. And by 2008, a person of ordinary skill in the art
20 of the '516 and '053 patents would have known how to dope
21 using borosilicate glass, right?

22 A. Yes.

1 Q. If the dopant is phosphorus, this would refer to
2 phosphosilicate glass?

3 A. Yes.

4 Q. And that's also called PSG, right?

5 A. Yes.

6 Q. Phosphorus-doped silicon dioxide?

7 A. Phosphorus containing silicon dioxide.

8 Q. By 2008, a person of ordinary skill in the art of
9 the '516 and '053 patents would have known how to dope using
10 phos --

11 A. Phosphosilicate glass, yes.

12 Q. Thank you. Now, sir, could you please look at the
13 paragraph beginning Line 25 of Column 4. Do you see it
14 begins, "A large number of possible gaseous dopant source
15 materials exist"?

16 A. Yes.

17 Q. And the paragraph explains that, "The dopant
18 chosen to form the PN-junction is phosphorus for the
19 applicant's experimental work"?

20 A. Yes.

21 Q. And the gaseous dopant source material, thus was
22 chosen to comprise a mixture of POCL₃ and O₂?

1 A. Yes.

2 Q. So this discloses POCl diffusion?

3 A. Yes.

4 Q. And by 2008 a person of ordinary skill in the art
5 of the '516 and '053 patents would have known how to perform
6 POCl diffusion?

7 A. Yes.

8 Q. Now, if you would, sir, please turn to Column 5,
9 paragraph beginning Line 36.

10 A. Okay.

11 Q. Do you see that this discusses several reasons why
12 the process described in your patents, "is so important in
13 developing an overall process for manufacturing
14 cost-effective, high-efficiency solar cells"?

15 A. Yes.

16 Q. And your patent explains, "The most obvious is
17 that the fewer discrete operations required, the lower will
18 be the cost of final product."

19 A. Yes.

20 Q. And this explains it was obvious that if you
21 decrease the number of discrete operations, the cost of the
22 solar cell would be lower, right?

1 A. Right.

2 Q. Then the patent also explained, "This is
3 particularly true for multiple furnace operations which
4 require care and handling wafers being processed time for
5 thermal cycling." Do you see that?

6 A. Yes, I do.

7 Q. Could you explain why it was particularly true for
8 multiple furnace operations?

9 A. Well, when you introduce a silicon wafer to a
10 high-temperature operation there's always a chance that you
11 might inadvertently contaminate the wafer carriers holding
12 the wafers, and at high temperatures, those contaminants can
13 be driven into the silicon, thereby creating recombination
14 centers and reducing cell efficiency.

15 Q. And the next sentence says that the patents
16 achieved this because --

17 A. Which line, which column?

18 Q. Sure, sure. We're still in Column 5, Line 42.

19 A. Okay.

20 Q. So Column 5, Line 42, your patent explains that,
21 "All three steps of the current process take place in a
22 single furnace, set at a single temperature."

1 A. Yes.

2 Q. The furnace steps will be, "The steps performed in
3 one loading of the wafer into the furnace," right?

4 A. Yes.

5 Q. The steps will be performed using a single loading
6 of the substrate in a furnace, right?

7 A. Yes.

8 Q. And the patent explains that this is a
9 simplification that greatly reduces both processing time and
10 the set-up cost for the processing line?

11 A. Yes.

12 Q. Sir, could you turn to Column 6, the paragraph
13 beginning at Line 34. Do you see that this paragraph
14 discusses how Figures 4A, B, C, D illustrate the process
15 flow for fabrication of a PESC-type textured surface solar
16 cell?

17 A. Yes.

18 Q. The patent says, beginning on Line 57, "The choice
19 of this specific design, the particular processes"" --

20 A. Wait, Line 57?

21 Q. Sorry, my eyesight. Let me direct your attention,
22 sir, to Column 6, Line 37.

1 A. Thirty-seven. Okay.

2 Q. Do you see it reads, "The choice of the specific
3 designs, the particular process steps indicated, and the
4 order of said steps is not intended to limit the scope of
5 the present invention, as many variations will be clear to a
6 person having ordinary skill in the art." What did you mean
7 by that?

8 A. Yes. Well, this gives a single example of a way
9 in which this patent can be used. And there may be other
10 variations that can be used based on, I suppose, the claims
11 of this patent.

12 Q. If you would turn to the next paragraph beginning
13 at Line 46 of Column 6.

14 A. Yes.

15 Q. Do you see the second sentence says, "Begin with a
16 P-type (N-type) single crystalline Silicon Wafer 40 having a
17 front surface and a back surface"?

18 A. Yes.

19 Q. So that discloses beginning with either a P- or
20 N-type substrate, correct?

21 A. Yes.

22 Q. If the substrate were N-type, again, the emitter

1 would be P-type, right?

2 A. Right.

3 Q. And turning to the next paragraph, beginning at
4 Line 49 of Column 6, this describes the step of deposit
5 silicon oxide layer 41 on the front surface of wafer 40
6 using a low temperature process, correct?

7 A. Right.

8 Q. What is the purpose of that step?

9 A. Well, without having read the whole thing, I
10 presume that's a masking oxide.

11 Q. Do you see a few lines lower where it begins, "The
12 inventors' demonstration used a CVD process"?

13 A. Which line? There it is.

14 Q. Line 51. Do you see beginning Column 6, Line 51
15 it reads, "The inventors' demonstration used a CVD process
16 operating at 400 Celsius but other low temperature
17 processes are possible (EG vacuum evaporation)."

18 A. Yes.

19 Q. So here you're explaining that a CVD process
20 operating at 400 Celsius is a demonstration, but a person
21 of ordinary skill in the art would have known alternative
22 deposition techniques could have worked such as vacuum

1 evaporation?

2 A. Yes.

3 Q. And is that because a low temperature deposition
4 process was known by the date of your patent?

5 A. I assume other low temp- -- low temperature
6 deposition processes were known.

7 Q. What low temperature deposition processes were
8 known by August 1998?

9 A. Deposition of what? Depositing a silicon oxide
10 layer?

11 Q. Yes.

12 A. Maybe there was a spin-on process. I mean, it
13 could be probably -- several low-temperature silicon oxide
14 layer deposition processes have used low temperature.

15 Q. I then direct your attention to the paragraph
16 beginning at Line 55 at Column 6.

17 A. Uh-huh.

18 Q. Do you see it begins, "Form a layer 42 comprising
19 aluminum on the bottom surface of wafer 40."

20 A. Yes.

21 Q. And again, this paragraph explains the
22 demonstrations technique, but it also says other techniques,

1 materials, thicknesses may be used?

2 A. Yes.

3 Q. And the paragraph doesn't explain what these other
4 techniques, materials, and thicknesses may be used would be,
5 right?

6 A. It doesn't explain.

7 Q. That's because you knew that a person of ordinary
8 skill in the art would have understood that there would be
9 other ways to form a layer comprising of aluminum, right?

10 A. Yes.

11 Q. And if you'd look to the next paragraph, Column 6,
12 Line 59.

13 A. Uh-huh.

14 Q. That describes anneal wafer 40 at 800 Celsius and
15 oxygen atmosphere, right?

16 A. Yes.

17 Q. And it says this step, "Has the combined effect of
18 alloying the layer 42 of the silicon on the back surface of
19 wafer 40 and of densifying the silicon oxide layer 41,"
20 right?

21 A. Yes.

22 Q. And you also discuss annealing in the technology

1 background section of your declaration in the IPR
2 proceedings, right?

3 A. Yes.

4 Q. In the annealing discussed -- strike that.

5 Is the annealing that you describe in your
6 declarations the same process as described in your patent,
7 the 280 Patent?

8 A. Annealing is a term that's used by different
9 authors for different reasons, or -- so it is somewhat
10 author-dependent. In this case, I'm using the term
11 "annealing" in the sense of not driving in a diffusion, but
12 simply heating up sufficiently so that atoms can rearrange.

13 Q. And you agree that by 2008 a person of ordinary
14 skill in the art of the '516 and '053 patents would have
15 known now to anneal a wafer, right?

16 A. Yes. But again, different authors consider
17 annealing to mean different things sometimes.

18 Q. Could you turn to Claim 1 of the '280 Patent.
19 There is a column, it is Line 44.

20 A. Okay.

21 Q. And do you see that Column 8, Lines 44 through 48
22 describe, "A method for fabricating a junction between a

1 Silicon Wafer doped with a first-dopant species having a
2 first electrical conductivity type and a silicon layer doped
3 with a second dopant species having a second electrical
4 conductivity type"?

5 A. Yes.

6 Q. And would you agree that by 2008, a person of
7 ordinary skill in the art of '516 and '053 Patents would
8 have known how to fabricate a junction between a Silicon
9 Wafer doped with a first-dopant species, having a first
10 electrical conductivity type and a second layer -- second
11 dopant species having a second electrical conductivity type
12 as you explain in your patent?

13 A. Yes.

14 Q. Claim 1 doesn't use the word "concentrator,"
15 right?

16 A. No, not in that paragraph.

17 Q. Just to be clear, Claim 1 does not use the word
18 "concentrator," correct?

19 A. Well, I have to read the rest of Claim 1, then.

20 Q. Sure.

21 A. No, it doesn't use the word "concentrator."

22 Q. Claim 2 claims a silicon concentrate solar cell,

1 right?

2 A. Yes.

3 Q. Going back to Claim 1, Claim Element 1A recites,
4 "Heating said Silicon Wafer at high temperature in a
5 furnace." Do you see that?

6 A. Yes.

7 Q. Would you agree that by 2008, a person of ordinary
8 skill in the art would have known how to heat a Silicon
9 Wafer at high temperature in a furnace?

10 A. Oh, yes.

11 Q. And Claim Element 1B of your '208 Patent recites,
12 "Forming a dopant silicon oxide layer on a top surface of
13 said Silicon Wafer," right?

14 A. Yes.

15 Q. By 2008, a person of ordinary skill in the art of
16 the '516 and '053 patents would have known how to form a
17 dopant silicon oxide layer on a top surface of a Silicon
18 Wafer, correct?

19 A. Yes.

20 Q. And Claim Element 1D recites, "Diffusing said
21 second dopant species into the top surface of said Silicon
22 Wafer to form said silicon layer doped with said second

1 dopant species," right?

2 A. That's what it says.

3 Q. And would you agree that by 2008, a person of
4 ordinary skill in the art of the '516 and '053 Patents would
5 have known how to diffuse a dopant species into the top
6 surface of a Silicon Wafer to form a silicon layer doped
7 with a dopant species?

8 A. Yes.

9 Q. Dr. Ruby, let me hand you what I have marked as
10 Exhibit 1074, which is a paper entitled, Simplified
11 Processing for 23 percent Efficient Silicon Concentrator
12 Solar Cells.

13 (Exhibit 1074 marked.)

14 A. Yes.

15 Q. (BY MR. SELWYN) Do you recognize this document?

16 A. Yes.

17 Q. You are one of the authors of this paper, right?

18 A. That's right.

19 Q. Would you briefly describe your role in writing
20 this paper?

21 A. I was the first author on this paper. I wrote it
22 in its entirety. The others provided data, experimental

1 results and advice.

2 Q. At a high-level what is this paper about?

3 A. It is about using a somewhat simplified process
4 using only a single furnace step, such as described in this
5 patent that we've been discussing, to fabricate silicon
6 concentrator cells, approaching 23 percent on float-zone
7 silicon, and for the first time, an efficiency of 20 percent
8 on solar grade Czochralski silicon.

9 Q. Exhibit 1074 is an example of one of your papers
10 published by the IEEE, right?

11 A. Yes.

12 Q. It indicates it was published in January of 1993;
13 is that right?

14 A. Yes, I believe so. It says 1993, something that
15 says 1/93, and that may be the date.

16 Q. On the first page of Exhibit 1074, which is
17 Page 172 of the paper. It discusses fabrication of, "Front
18 and back point contact cells, the interdigitated back
19 contact cell, and several variations of passivated emitter
20 solar cells," correct?

21 A. Those are given as examples of other types of
22 silicon concentrator cells with efficiencies greater than

1 22 percent.

2 Q. And the paper explains that you developed a
3 simplified processing schedule, right?

4 A. Yes.

5 Q. And that processing schedule refers to the
6 fabrication of silicon concentrator solar cells, correct?

7 A. Yes. That fabrication schedule describes, is
8 described by the simplified three photo less process.

9 Q. Table 1 describes a concentrator cell processing
10 sequence?

11 A. Yes, that's right.

12 Q. The second line the table reads, "Deposit APCVD
13 oxide on wafer fronts (400 Celsius)," correct?

14 A. Yes, that's right.

15 Q. That's the same APCVD we discussed earlier in
16 connection with your work at Sandia, right?

17 A. Yes.

18 Q. You were using APCVD to deposit an oxide on the
19 front surface of the wafer?

20 A. Yes.

21 Q. The seventh line in the table reads, "Deposit
22 APCVD oxide on wafer backs, (400 Celsius)." Do you see

1 that?

2 A. Yes, I see it.

3 Q. And you were using APCVD to deposit an oxide on
4 the rear surface of the wafer, correct?

5 A. Yes, that's right.

6 Q. The solar cell made using this process sequence
7 had front and rear contacts, correct?

8 A. Yes, it did.

9 Q. The solar cell made using this process sequence is
10 shown in Figure 1, right?

11 A. Yes, it is.

12 Q. The grid line is the front metal contact, correct?

13 A. That's right.

14 Q. And the portion labeled "back contact" is the back
15 metal contact?

16 A. It is.

17 Q. Would you agree that by 2008, a person of ordinary
18 skill in the art of the '516 and '053 Patents would have
19 known how perform APCVD?

20 A. Yes.

21 Q. Put back in front of you your declaration for the
22 '516 Patent.

1 A. All right.

2 Q. And would you turn to Page 12, Section 4,
3 "assumptions."

4 A. Assumptions.

5 Q. In Paragraph 13, you explain that you assumed the
6 date of the inventions of the claims of the '516 Patent was
7 February 20th, 2008, correct?

8 A. Yes.

9 Q. The assumed date of the inventions is the same for
10 the '516 and the '053 Patents, correct?

11 A. I'm not sure. They have -- the different patents
12 have different filing dates on them. But I think one is a
13 continuation of the other, so I guess the earlier date
14 applies to both.

15 Q. You would agree that inventions disclosed before
16 February 20th, 2008 are prior art to the '516 and '053
17 Patents, correct?

18 A. Yes.

19 Q. Could you describe in your own words the invention
20 claimed in the '516 Patent?

21 A. '516 Patent describes solar cell structure, which
22 has -- I think the claims make it quite general. I think if

1 you look at Claim 9 in particular, it generalizes it to be
2 something other than just a cell of N-type substrate. It
3 says it is a cell on -- with having a textured front
4 surface, an emitter formed over the back surface, an oxide
5 layer between the back surface and the emitter, and metal
6 contacts on the front and back.

7 Q. And can you describe in your own words the
8 invention claimed by the '053 Patent?

9 A. The '053 Patent, it offers specific and then more
10 generalized versions that it claims ownership of, I think in
11 its most general sense such as described in Claim 16. It is
12 a solar cell with an oxide layer on the back surface, a
13 polysilicon layer over the oxide layer. Dopants diffused
14 into the polysilicon. Dopants diffused into the front
15 surface, and then metal contacts on the front and back.

16 Q. What, in your view, makes the '053 Patent novel as
17 compared with the prior art?

18 A. Well, the use of '053, okay, forming a polysilicon
19 layer over an oxide layer on the back surface, and then
20 diffusing dopants into that.

21 Q. And what, in your view, makes the '516 Patent
22 novel as compared with the prior art?

1 A. It is describes, more or less, the same structure
2 where you have an oxide layer on the back, and over that, on
3 top of that, you have what they call an emitter layer
4 formed, which is another deposited silicon layer.

5 Q. What makes what you just described novel as
6 compared with the prior art?

7 A. Well, none of the prior art used a deposited
8 silicon layer on top of an oxide layer as an emitter.

9 Q. Could you turn, now, back to your declaration,
10 Paragraph 14.

11 A. Paragraph 14. Okay.

12 Q. In Paragraph 14 you explain that you were asked to
13 apply the skill level of a person of ordinary skill in the
14 art, POSITA, that is proposed in the petition, correct?

15 A. Yes.

16 Q. And you agree with the definition set forth in
17 Hanwha's IPR petition of a person of ordinary skill in the
18 art as of the claim priority date of the '516 and '053
19 Patents, correct?

20 A. Yes.

21 Q. Your declaration doesn't dispute that Dr. Holman
22 was a person of ordinary skill in the art with respect to

1 the '053 and '516 Patents as of 2008, correct?

2 A. It doesn't dispute that he was a POSITA.

3 Q. Turning to Paragraphs 16, 17 of your '516
4 Declaration, that's where you describe your understanding of
5 claim construction standards?

6 A. Paragraph 16 and 17?

7 Q. Yes.

8 A. What is your question?

9 Q. In Paragraph 16 and 17 of your declaration you set
10 forth the understanding you have of claimed construction,
11 correct?

12 A. Yes.

13 Q. In your declarations you do not offer any claimed
14 construction opinions of your own, correct?

15 A. I don't see any.

16 Q. Your declaration doesn't suggest that the petition
17 anywhere used or applied an incorrect claimed construction
18 in analyzing the prior art, correct?

19 A. Can you read that -- can you ask that question
20 again, please?

21 Q. Sure. Your declaration for the '516 Patent and
22 your declaration for the '053 Patent don't suggest that

1 Hanwha's petitions anywhere used or applied an incorrect
2 claim construction in analyzing any prior art, right?

3 A. I don't make that distinction. I'm only looking
4 at one of the declarations. I will get both. You're asking
5 about both.

6 Q. I can ask them separately if it is easier for you
7 and to try and save time.

8 A. '053 claim construction. Where would that be?
9 Somewhere on page -- claim construction, I think the
10 paragraphs are identical. So nowhere in those paragraphs do
11 I dispute Hanwha's defining a term.

12 Q. Your declarations don't suggest that the petitions
13 anywhere used or applied an incorrect claim construction
14 when analyzing any prior art, correct?

15 A. Right.

16 Q. Sticking with your declarations for the '516
17 Patents.

18 A. Yes.

19 Q. If you can turn, please, to Paragraphs 18 through
20 20.

21 A. Okay.

22 Q. In Paragraphs 18 through 20 you describe your

1 understanding of the standards for obviousness; is that
2 right?

3 A. Yes.

4 Q. What is your understanding of the standard
5 required to demonstrate a motivation to combine references?

6 A. Say that again.

7 Q. What is your understanding of the standard that
8 the law requires to demonstrate a motivation to combine
9 references?

10 A. I'm really not familiar with the legal
11 terminology. But motivation to combine in my mind means
12 that if there is an idea in one prior art reference that
13 could be reasonably combined with an idea from another prior
14 art reference, that those two could be combined. And if the
15 resulting sum, or similar to what the patent at issue here,
16 then that could negate the validity of the patent.

17 Q. Do you have an understanding of the legal standard
18 required to demonstrate a motivation to combine references?

19 A. I'm not that familiar with legal standards, no.

20 Q. Do you have an understanding of the legal standard
21 required to demonstrate reasonable expectation of success?

22 A. Well, I know what reasonable expectation of

1 success means in plain English.

2 Q. What is your understanding of the plain English
3 meaning of "reasonable expectation of success"?

4 A. It means that the probability of success is close
5 to 100 percent.

6 Q. Do you have an understanding of the legal standard
7 required to demonstrate reasonable expectation of success?

8 A. Yeah, I'm not that familiar with legal standards.

9 Q. Have you heard of the "term secondary
10 considerations of non-obviousness"?

11 A. I don't know what that means right now.

12 Q. Have you heard of "objective indicia of
13 non-obviousness"?

14 A. No.

15 Q. Your declarations don't identify any books, papers
16 or articles that praise the '053 or '516 Patents, correct?

17 A. Praise?

18 Q. Praise, speak highly of, commend.

19 A. Say that again, the question?

20 Q. Your declarations don't identify any books,
21 papers, or articles that praise or commend the '516 or '053
22 Patents, correct?

1 A. I don't think so.

2 Q. Your declarations don't discuss any solar cell
3 that practiced the '053 or '516 or Patents, correct?

4 A. Well, let's see, my declarations. They do mention
5 solar cell publicized by Feldmann which use a similar
6 design.

7 Q. What are you referring to?

8 A. Look up Feldmann, see where it is.

9 Q. How do you spell it?

10 A. F-E-L-D-M-A-N-N. Paragraph 74.

11 Q. Do you understand Ground 1 of Hanwha's petition
12 and for the '516 Patent is that Claims 1 through 4 and 6
13 through 12 are invalid as obvious for Froitzheim and Gan,
14 correct?

15 A. That's what they claim.

16 Q. And your declaration for the '516 Patent doesn't
17 dispute that the combination of Froitzheim and Gan discloses
18 all of the elements of Claims 1 through 4 and 6 through 11,
19 correct?

20 A. Well, my declaration states that the combination
21 of Froitzheim and Gan is not obvious, and would not be a
22 motivation to combine because it does not leave a POSITA

1 with a reasonable expectation of success.

2 Q. Right. But you don't dispute that Froitzheim and
3 Gan together disclose all of the elements of Claims 1
4 through 4 and 6 through 11, right?

5 A. One through 4 and 6 through 11, on which patent?

6 Q. The '516.

7 A. Maybe you better break that down. You're asking
8 too much in one question.

9 Q. Sure. Your objection to Hanwha's proposed
10 combination of Froitzheim and Gan is that you say there is a
11 lack of motivation to combine, right?

12 A. That's one of the reasons.

13 Q. You don't dispute, though, that Froitzheim and Gan
14 together disclose the limitations of Claims 1 through 4 and
15 6 through 12, correct?

16 A. Oh, the '516 Patent?

17 Q. Yes?

18 A. One through 4 and 6 through 12?

19 Q. Six through 11.

20 A. Six through 11. So you want me to read all those
21 claims now?

22 Q. If that helps you answer, sure.

1 A. Well, I want to answer accurately. Froitzheim and
2 Gan?

3 Q. Froitzheim and Gan. All I'm asking you is your
4 declarations don't dispute that all the elements of those
5 claims are disclosed by the combination of Froitzheim and
6 Gan. I understand you dispute the motivations to combine
7 the two, but I'm trying to understand, I don't think you
8 dispute that all of the elements of those claims are
9 disclosed by those two references in your declarations.

10 A. This includes Claim 9?

11 Q. No, 1 through 4. Yes, it does include Claim 9.
12 Sorry.

13 A. Well, if you were to combine Froitzheim and Gan,
14 which I don't think anybody would be motivated to do, then
15 it would include those claims of the '516 Patent. Does that
16 answer your question.

17 Q. I think so. So just so we're clear, your
18 declaration for the '516 Patent does not dispute that the
19 combination of Froitzheim and Gan discloses each of the
20 elements of Claims 1 through 4 and 6 through 11, correct?

21 A. I believe I just said that.

22 Q. Thank you.

1 Your declaration for the '516 Patent also does not
2 dispute that the combination of Froitzheim, Gan, and Sheets
3 discloses Claim 5 of the '516 Patent, correct?

4 A. Well, Sheets -- I don't think Sheets discusses a
5 trench on a single solar cell. He's discussing trenches
6 between different solar cells. So I don't think it includes
7 Claim 5.

8 Q. Okay. But your declaration for the '516 Patent
9 doesn't dispute that the combination of Froitzheim, Gan, and
10 Sheets discloses each of the elements of Claim 5, correct?

11 A. Well, I think I just said that it doesn't include
12 Claim 5.

13 Q. And you make that point in your declaration?

14 A. I believe I do.

15 Q. Okay. Let me hand you Exhibit 1004. Do you
16 recognize that as the Froitzheim reference?

17 A. Yes.

18 (Exhibit 1004 marked.)

19 Q. (BY MR. SELWYN) You viewed the Froitzheim
20 reference as part of your work in this matter?

21 A. I did.

22 Q. Approximately how much time did you spend reading

1 the Froitzheim reference?

2 A. Probably an hour.

3 Q. Did you review Froitzheim's entire disclosure
4 before you signed your declaration for the '516 IPR?

5 A. I believe I did.

6 Q. Let's look at Paragraph 1 of the Froitzheim.

7 A. Paragraph 1.

8 Q. Do you see that it reads --

9 A. Wait a minute.

10 Q. Top of the page.

11 A. Double -- 0001?

12 Q. Yes. I'm sorry.

13 A. Okay.

14 Q. Do you see it reads, "The present invention
15 relates to a solar cell and to a method of manufacturing a
16 solar cell"?

17 A. Yes, I see that.

18 Q. Froitzheim discloses solar cells, right?

19 A. He's discussing a solar cell and a method to
20 manufacturing it.

21 Q. Let's look at Paragraph 9, please, of Froitzheim.

22 A. Yes.

1 Q. Do you see that in Paragraph 9 he writes, "It is
2 an object of the present invention to provide a new type of
3 silicon solar cell that improves stability and good
4 efficiency that shows" -- I'll try it again. Paragraph 9 of
5 Froitzheim states that it is an object of the present
6 invention to provide a new type of silicon solar cell that
7 shows improved stability and good efficiency, right?

8 A. That's what it says.

9 Q. And he explains that a goal of his invention is to
10 teach a silicon solar cell that has improved stability,
11 right?

12 A. Yes.

13 Q. And good efficiency?

14 A. Right.

15 Q. You would agree that solar cells can be connected
16 together into a string of solar cells?

17 A. Yes.

18 Q. And a solar module includes multiple solar cells?

19 A. Yes, it does.

20 Q. A solar module can include multiple strings of
21 solar cells, correct?

22 A. Yes.

1 Q. And a solar array is multiple solar modules
2 connected together, right?

3 A. That's right.

4 Q. And a solar array includes solar cells, correct?

5 A. Yes.

6 Q. Could you turn, please, to Figure 3 of Froitzheim.
7 On the front.

8 A. Figure 3, on the front?

9 Q. It should also be somewhere inside.

10 Figure 3 on Froitzheim depicts a cross-section of a
11 solar cell, right?

12 A. Yes, it does.

13 Q. And it depicts metal contacts on the front of the
14 solar cell?

15 A. It does.

16 Q. The front contacts in Froitzheim's solar cell were
17 screen printed, correct?

18 A. It could be screen printed.

19 Q. If you look at Paragraph 28 of Froitzheim. Does
20 that confirm that the front contacts in Froitzheim's solar
21 cell were screen printed?

22 A. Yes.

1 Q. Figure 3 of Froitzheim depicts metal contacts on
2 the back of the solar cell, correct?

3 A. It does.

4 Q. And the back contacts in Froitzheim's solar cell
5 were also screen printed, right?

6 A. Where is that described?

7 Q. Paragraph 48.

8 A. Yes.

9 Q. Metal contacts in solar cells are used to connect
10 a solar cell to a circuit, right?

11 A. Yes, they are.

12 Q. And metal contacts in solar cells may be used to
13 connect solar cells together?

14 A. Yes, they are.

15 Q. Metal contacts in solar cells may be used to
16 connect solar cells in strings of multiple solar cells,
17 correct?

18 A. Yes.

19 Q. Metal contacts in solar cells may be used to
20 connect solar cells together to form a solar module, right?

21 A. That's correct.

22 Q. And Froitzheim's metal contacts in the solar cell

1 that's shown in Figure 3 may be used to connect multiple
2 solar cells together, correct?

3 A. Say that one again.

4 Q. Of course. Froitzheim's metal contacts in the
5 solar cell shown in Figure 3 may be used to connect multiple
6 solar cells together, correct?

7 A. Yes.

8 Q. Froitzheim's metal contacts in the disclosed solar
9 cells may be used to connect multiple solar cells together,
10 correct?

11 A. Yes.

12 Q. And Froitzheim's metal contacts in its disclosed
13 solar cells may be us used to connect multiple solar cells
14 together to form a solar module, correct?

15 A. Yes.

16 Q. Froitzheim's metal contacts in its disclosed solar
17 cells may be used to connect multiple solar cells together
18 to form multiple solar modules, too, correct?

19 A. Yeah. That's part of connecting modules together.

20 Q. And Froitzheim's metal contacts in its disclosed
21 solar cells may be used to connect multiple solar cells
22 together to form multiple solar modules that are arranged in

1 an array, correct?

2 A. Yes.

3 Q. Let me show you Exhibit 1005.

4 (Exhibit 1005 marked.)

5 Q. (BY MR. SELWYN) Do you recognize that as a Gan
6 reference?

7 A. Yes.

8 Q. Did you review Gan in its entirety before signing
9 your declaration?

10 A. Yes.

11 Q. And Gan was an IEEE article, correct? Is an IEEE
12 article?

13 A. Yes.

14 Q. Gan was peer reviewed by the IEEE before it was
15 published, right?

16 A. Well, depending on if this was a conference
17 article or part of a scientific journal. Where did it come
18 from?

19 Q. Well, either way, it would have been
20 peer-reviewed, right?

21 A. Well, it would have been peer-reviewed, but not
22 necessarily by the IEEE.

1 Q. Gan's title is polysilicon Emitters for Silicon
2 Concentrator Solar Cells, correct?

3 A. That's what it is entitled, yes.

4 Q. And Gan teaches a structure for solar cells,
5 right?

6 A. Well, Gan's work involved trying to develop a
7 particular type of metal contact to the silicon substrate
8 involving an intervening oxide layer.

9 Q. Are you familiar with the concept of "analogous
10 art"?

11 A. You'd have to describe that to me.

12 Q. Do you have an understanding of the legal standard
13 for analogous art?

14 A. No.

15 Q. Referring back to Froitzheim for a moment.

16 A. Yes.

17 Q. Do you agree that Froitzheim shows a solar cell
18 having a front side facing the sun, right?

19 A. Yes.

20 Q. And you'd agree that Froitzheim shows the front
21 side collecting solar radiation during normal operation?

22 A. Yes.

1 Q. You'd agree Froitzheim teaches a backside opposite
2 the front side?

3 A. Yes.

4 Q. And you'd agree that the solar cell that has
5 Froitzheim's structure would generate electricity, right?

6 A. If he did everything right, yes.

7 Q. You'd agree that Froitzheim teaches a substrate
8 having a textured front surface, right?

9 A. Well, it is not showing in Figure 3. Where are
10 his other figures? None of his figures show a textured
11 front surface.

12 Q. You'd agree that Froitzheim teaches an emitter
13 layer forming a backside junction with the substrate,
14 correct?

15 A. Yes.

16 Q. Would you turn, please, to Paragraph 116 of your
17 declaration. I'm sorry, turn to Paragraph 113 of your '516
18 declaration.

19 A. Paragraph which?

20 Q. It's 113 of the '516.

21 A. Okay. What would you like to know about
22 Paragraph 113?

1 Q. In Paragraph 113 you discuss Gan and the Gan
2 thesis, right?

3 A. Yes.

4 Q. And you state that Gan's, "Interfacial oxide layer
5 is formed between a crystalline silicon substrate and a
6 polysilicon layer applied over the rear surface of the
7 substrate." Right?

8 A. That's exactly what it says.

9 Q. And the polysilicon layer you're referring to is
10 the emitter, right?

11 A. I believe he may refer to it as an emitter, yes.

12 Q. And by "rear surface of the substrate" you're
13 referring to the side facing away from the sun, correct?

14 A. That's right.

15 Q. The substrate and the polysilicon layer would form
16 a PN-junction, correct?

17 A. It depends on the doping used in the polysilicon
18 layer and the substrate.

19 Q. You'd agree that Gan teaches a rear PN-junction,
20 correct?

21 A. I think I need to take a look at the Gan paper
22 again. Can't find it right now. Here it is.

1 Q. If it helps you can also refer to Paragraph 118 in
2 the declaration.

3 A. 118 in my declaration.

4 Q. You're free to look at Gan, too.

5 A. It might be more succinct here. That's
6 Paragraph 118. That's not from Gan. Let's see,
7 Paragraph 113? Okay. Well, okay. Where does it say the
8 substrate conductivity type is in Gan's paper? I can't seem
9 to find that at the moment.

10 Q. Let me ask a new question, then we'll take a
11 break.

12 You'd agree that Gan discloses an interfacial oxide,
13 correct?

14 A. Yes.

15 Q. And interfacial means the oxide layer between --
16 strike that.

17 "Interfacial" means the oxide layer would be between
18 the substrate and the emitter layer, correct?

19 A. Yes.

20 Q. And Gan teaches an oxide layer formed between the
21 back surface of the substrate and the emitter layer,
22 correct?

1 A. Yes.

2 MR. SELWYN: Why don't we take a break.

3 (Note: Off the record, 2:36 p.m. to 2:45 p.m.)

4 Q. (BY MR. SELWYN) Dr. Ruby, can you please turn in
5 your declaration for the '516 Patent to the section entitled
6 "Gan thesis" beginning in Paragraph 131.

7 A. Okay. Okay.

8 Q. Before signing your declarations regarding the
9 '516 and '053 Patents did you review all of the Gan thesis?

10 A. Not all of it.

11 Q. Which sections of the Gan thesis did you review
12 before signing your declarations?

13 A. I can't tell you right now exactly which sections
14 I reviewed.

15 Q. How did you decide which sections in the Gan
16 thesis to review before signing your declaration?

17 A. I think the law team directed me to certain
18 sections that were more relevant to this case.

19 Q. How many sections of the Gan thesis did they
20 direct you to?

21 A. Well, I can see here that it directs me in
22 Paragraph 136 to a section about oxide breakup. So I don't

1 know exactly how many sections. I would say the relevant
2 sections.

3 Q. All of the portions of the Gan thesis that you
4 reviewed before signing your declaration were provided to
5 you by counsel, correct?

6 A. Right.

7 Q. And are the sections of the Gan thesis that you
8 reviewed before signing your declaration, those that are
9 cited in your declarations.

10 A. Yes.

11 Q. Are there any sections of the Gan thesis that you
12 reviewed that you did not cite in your declarations?

13 A. No.

14 (Exhibit 1006 marked.)

15 Q. (BY MR. SELWYN) Let me hand you 1006. Do you
16 recognize Exhibit --

17 A. Exhibit 1006?

18 Q. Yes. Let me ask a new question: Do you recognize
19 Exhibit 1006 as the Borden '575 prior art reference?

20 A. Yes, I do.

21 Q. Did you review Borden '575 before signing your
22 declaration?

1 A. I did.

2 Q. Did you review Borden '575s entire disclosure
3 before signing your declarations?

4 A. Most of it.

5 Q. What portions of it did you not review?

6 A. Well, it was short enough that I probably would
7 have read the whole thing. I tell you what portions I did
8 review were the claims and the diagrams.

9 Q. Are you certain you reviewed anything in the
10 Borden '575 reference other than the claims and the
11 diagrams?

12 A. I may have read some of the specifications.

13 Q. Are you sure you did?

14 A. Am I sure I did?

15 Q. Yes.

16 A. Yes.

17 Q. Which portions of the specification of Borden 575
18 reference did you review before signing your declaration?

19 A. A brief description of the drawings, the detailed
20 descriptions, summary, the background, and the claims and
21 the figures. So all of it.

22 Q. Can you turn, please, to Paragraph 002 of

1 Borden '575.

2 A. Yes.

3 Q. Paragraph 2 of Borden's '575 states that, "The
4 present invention relates to forming contacts in a
5 semiconductor device, and more particularly, to methods and
6 apparatuses for providing a buried insulator isolation for
7 polysilicon emitter solar cell contacts." Right?

8 A. Yes, that's what it says.

9 Q. And you would agree, Borden '575 discloses a
10 polysilicon emitter for a solar cell, correct?

11 A. Yes, it does.

12 Q. Borden '575 relates to solar cells, correct?

13 A. Yes, it does.

14 Q. Borden '575 shows the silicon substrate, right?

15 A. In which figure?

16 Q. Any of them.

17 A. The figures really don't show a substrate.

18 Q. Well, the reference discloses a silicon substrate,
19 right?

20 A. The reference? What is the reference?

21 Q. The Borden '575.

22 A. Well, he talks about having a substrate, yes.

1 Q. You can put that aside.

2 A. Yes.

3 Q. Let me now show you Exhibit Hanwha 1008.

4 (Exhibit 1008 marked.)

5 Q. (BY MR. SELWYN) Do you recognize Exhibit 1008 to
6 be the Li prior art reference?

7 A. Yes.

8 Q. And you reviewed Li before signing your
9 declaration?

10 A. I did.

11 Q. Did you review the entire disclosure of Li before
12 signing your declarations?

13 A. In its entirety.

14 Q. Li discloses a structure for a solar cell, right?

15 A. You are correct.

16 Q. And Li teaches a substrate, right?

17 A. Li describes a substrate used in his solar cell.

18 Q. Li teaches an emitter, right?

19 A. He does.

20 Q. And Li teaches the emitter is a P-type, right?

21 A. Yes.

22 Q. You can put that aside, too.

1 Would you turn to Paragraph 194 of your declaration.

2 A. Which declaration?

3 Q. The '516 declaration.

4 A. 194?

5 Q. Yes.

6 A. Okay. What page is that on?

7 Q. It is on Page 106.

8 A. Okay.

9 Q. In Paragraph 194 you refer to "edge isolation"?

10 A. Yes, I do.

11 Q. What is edge isolation?

12 A. Edge isolation is the means by which the front
13 doped layer is electrically isolated from the rear doped
14 layer.

15 Q. What is an electrical short?

16 A. Electrical short would be an extremely low
17 resistance electrical pathway.

18 Q. Can a solar cell short circuit?

19 A. Of course.

20 Q. What causes a solar cell to short circuit?

21 A. Well, you can put a wire from the front to the
22 back. That would be one way of measuring the short circuit

1 current.

2 Q. A string of solar cells is multiple solar cells
3 connected in a series, right?

4 A. Series connection of solar cells.

5 Q. Multiple strings of solar cells can be connected
6 in a parallel configuration, correct?

7 A. That's true.

8 Q. And multiple strengths of solar cells can be
9 connected in a series, correct?

10 A. They could be.

11 Q. Solar cells are connected together to increase the
12 amount of power that can be generated, right?

13 A. Yes. Where the solar cells are connected together
14 the power generated by each cell is added to those of all
15 the others.

16 Q. Solar cells are designed to be connected to other
17 solar cells, right?

18 A. Yes, they are.

19 Q. And there are multiple types of solar cells,
20 right?

21 A. Yes.

22 Q. One type of solar cell is a full-sized solar cell,

1 correct?

2 A. Full-sized?

3 Q. Full sized.

4 A. Well, if by that you mean occupying a full area of
5 a Silicon Wafer, then, yes.

6 Q. Another type of solar cell is a half-cut solar
7 cell, correct?

8 A. I assume you mean by that a solar cell made on a
9 wafer that's been cut in half.

10 Q. A short circuit is a potential problem for solar
11 cells that are in a string of multiple solar cells, correct?

12 A. If a single solar cell is short-circuited in a
13 string it would reduce the output of the string.

14 Q. A short circuit is a potential problem for
15 full-sized solar cells that are in a string of multiple
16 solar cells, correct?

17 A. Yes.

18 Q. And a short circuit is a potential problem for
19 half-cut solar cells that are in a string of multiple solar
20 cells, correct?

21 A. Yes.

22 Q. So a short-circuit is at potential problem for

1 various types of solar cells that are in a string of
2 multiple solar cells, correct?

3 A. Yes.

4 Q. And a solar module can include multiple strings of
5 solar cells?

6 A. Yes, they could.

7 Q. A short-circuit is a potential problem for a solar
8 module of full-size solar cells, correct?

9 A. Yes.

10 Q. And a short-circuit is a potential problem for a
11 solar module with half-cut solar cells, correct?

12 A. Yes. When you say "a short-circuit" you mean a
13 single short-circuited cell or a short-circuit of the
14 module?

15 Q. Either.

16 A. Well, it is a problem for both, yes. One a lot
17 more than the other.

18 Q. A solar array is multiple solar modules connected
19 together, correct?

20 A. Yes.

21 Q. And A short-circuit is a problem for solar cells
22 that are on a solar array, correct?

1 A. A short-circuit of what, an individual module?

2 Q. Yes.

3 A. That would be a problem for the array.

4 Q. Edge isolation is a category of techniques to
5 prevent a solar cell from short-circuiting, correct?

6 A. It is usually considered a technique for reducing
7 a probability of a shunt between front and back contacts
8 rather than a short-circuit. But edge isolation could
9 prevent both.

10 Q. When was the first time you learned about edge
11 isolation?

12 A. When I first started at Sandia.

13 Q. Did you publish any articles while at Sandia that
14 mention or describe edge isolation?

15 A. I don't believe so.

16 Q. How did you learn about edge isolation while at
17 Sandia?

18 A. Reading the papers of scientific articles that
19 others had published.

20 Q. Would you agree that a person of ordinary skill in
21 the art of the '516 and '053 Patents would have known about
22 edge isolation as of 2008?

1 A. Oh, yes.

2 Q. And would you agree that by 2008, a person of
3 ordinary skill in the art of the '516 and '053 Patents would
4 have known how to avoid short -- short-circuits?

5 A. Yes.

6 Q. Would you agree that by 2008, a person of ordinary
7 skill in the art would have known that trenches were one
8 technique to prevent short-circuits?

9 A. It is one technique, yes.

10 Q. And a trench is an edge isolation technique,
11 correct?

12 A. Yes, it is an example of an edge isolation
13 technique.

14 Q. Trench cutting is a trench that's cut out of the
15 cell surface, correct?

16 A. It's a trench that's dug into and around the
17 periphery of the cell surface.

18 Q. Trench cutting is a groove that's cut out of the
19 cell surface?

20 A. It is a groove. I would -- the way I would say it
21 is cut into a cell surface.

22 Q. When did you first learn about trenches or grooves

1 cut into the cell surface?

2 A. When? Probably early at my time at Sandia. There
3 were others who published papers using that technique.

4 Q. So trenches were known in the art before 2008,
5 correct?

6 A. Oh, yes.

7 Q. And a person of ordinary skill of in the art of
8 the '516 and '053 Patents would have known about trenches as
9 of 2008, correct?

10 A. I believe so, yes.

11 Q. One -- strike that.

12 There are a number of different ways to create a
13 trench in a solar cell, correct?

14 A. Yes.

15 Q. And one technique to create a trench is plasma
16 etching?

17 A. That's not a method that I ever heard about.
18 Usually, a trench is cut either by a dicing saw or a laser.
19 Plasma etching is typically not used to create trenches, but
20 it could be; for example, reactive ion etching is plasma
21 etching. You could use it to create a trench, I suppose.

22 Q. Plasma etching is a trenching technique that a

1 person of ordinary skill in the art of the '516 and '053
2 Patents would have known as of 2008, correct?

3 A. I believe so.

4 Q. Laser machining is another technique to create a
5 trench that a person of ordinary skill in the art of the
6 '053 and '516 Patents would have known as of 2008, correct?

7 A. Yes.

8 Q. What techniques, other than plasma etching and
9 laser machining existed as of 2008 to create trenches?

10 A. Well, as I just mentioned, dicing saw cutting.

11 Q. When did you first learn about dicing saws as a
12 technique to trench a solar cell?

13 A. When? Well, early in my days at Sandia I read
14 papers from the University of New South Wales in Australia
15 where they typically used dicing saws to isolate their solar
16 cells.

17 Q. You would agree that the '516 and '053 Patents
18 don't disclose any new technique to create a trench,
19 correct?

20 A. No.

21 Q. You agree, right?

22 A. I agree.

1 Q. And you'd agree that by 2008 a person of ordinary
2 skill in the art of the '516 and '053 Patents would have
3 been capable of adding a trench to a solar cell, correct?

4 A. It was well known. Different ways to do it.

5 Q. What is plasma etching?

6 A. Plasma etching involves putting your substrate
7 into a low pressure device in which you would introduce
8 reactive gases, which have the property that they chemically
9 react with the silicon, vaporizing it, and then having it
10 removed from the enclosure by a vacuum pump.

11 Q. A person of ordinary skill in the art of the '516
12 and '053 Patents would have known about plasma etching as of
13 2008, correct?

14 A. I believe so.

15 Q. What does the resulting structure look like on a
16 solar cell that was plasma-etched to prevent shorts?

17 A. To prevent shorts? Well, to prevent shorts, or
18 for isolation purposes, the wafers were generally stacked
19 like coins, one against another, so that the plasma really
20 only interacted with the edges of the wafers and removed,
21 etched away the silicon at the edges of the wafers, so that
22 the faces were left intact, the edges were removed, and

1 there was no way that leakage of dopants from one side or
2 the other could wrap around the edge.

3 Q. As of 2008, could plasma etching be used to make a
4 trench in a solar cell?

5 A. Probably so. Again, I'm not familiar with using
6 plasma etching to make a trench. It would have been one of
7 the lesser used methods, but I suppose it is possible.

8 Q. Let me hand you Hanwha Exhibit 1012.

9 (Exhibit 1012 marked.)

10 Q. (BY MR. SELWYN) Do you recognize that as the
11 Sheets prior art reference?

12 A. Yes, I do.

13 Q. You read the Sheets prior art reference before
14 signing your declaration?

15 A. Yes, I did.

16 Q. Did you read it in its entirety?

17 A. I tried to.

18 Q. Were you successful?

19 A. It is not well-written, so it was very difficult
20 to do so.

21 Q. Did you read the reference in its entirety?

22 A. I read most of it.

1 Q. If you look at Paragraph 2 of Sheets, the
2 invention.

3 A. What page?

4 Q. It is the one at the top.

5 A. Okay. 0002.

6 Q. 0002. Do you see that it states, "This invention
7 relates to optoelectronic devices, and more particularly, to
8 mass manufacturer of optoelectronic devices such as solar
9 cells"?

10 A. That's what it says.

11 Q. It states that it is directed to manufacturing
12 solar cells, right?

13 A. Apparently so.

14 Q. And it discloses that it is directed to solar
15 cells, correct?

16 A. One out of many optoelectronic devices that that
17 is directed to.

18 Q. Sheets discloses a trench, right?

19 A. Yes, he discloses trenches.

20 Q. And he discloses techniques such as laser
21 machining to form trenches, correct?

22 A. Yes.

1 Q. And he discloses that laser machining is one
2 example of a technique to form a trench, correct?

3 A. Yes.

4 Q. Let me hand you, Dr. Ruby, Hanwha 1.

5 (Exhibit 1007 marked.)

6 Q. (BY MR. SELWYN) Do you recognize Hanwha
7 Exhibit 1007 as the Smith prior art reference?

8 A. Yes, I do.

9 Q. Did you review Smith before signing your
10 declaration?

11 A. I did.

12 Q. And did you review it in its entirety?

13 A. I did.

14 Q. If you turn, please, sir, to the first column of
15 Smith. Do you see where it says "field of the invention"?

16 A. First column of which page? Here.

17 Q. Column 1 --

18 A. Okay.

19 Q. -- line 16?

20 A. Line 16, field of the invention.

21 Q. And under field of the invention Smith states that
22 the present invention relates generally to solar cells, and

1 more particularly, but not exclusively, to methods and
2 apparatus for fabricating solar cells?

3 A. Yes, I see that.

4 Q. So Smith discloses methods for fabricating solar
5 cells, right?

6 A. I agree.

7 Q. And if you look, please, sir, at around Line 36 of
8 Column 1, do you see that Smith states, "Just like in most
9 manufacturing processes, each step employed in the
10 manufacture of solar cells has an associated cost."

11 A. I do see that.

12 Q. Do you agree with that?

13 A. Yes, I do agree with that.

14 Q. And then the next sentence says, "Thus, techniques
15 for simplifying the fabrication of solar cells are generally
16 desirable." Do you see that?

17 A. I see that.

18 Q. Do you agree with that sentence?

19 A. Yes, I do.

20 Q. Smith teaches that each step in manufacturing a
21 solar cell has an associated cost, correct?

22 A. That's what he states.

1 Q. And he also teaches that simplifying the
2 fabrication of solar cells is generally desirable, right?

3 A. Yes.

4 (Off the record, 3:13 p.m. to 3:20 p.m.)

5 Q. (BY MR. SELWYN) Dr. Ruby, just a few more
6 questions if I might.

7 A. Sure.

8 Q. Was there anything that limited or constrained the
9 amount of time that you could spend on this matter?

10 A. No.

11 MR. SELWYN: I pass the witness.

12 EXAMINATION

13 BY MS. ZHAO :

14 Q. Dr. Ruby, just a few questions. Can we turn to
15 your '516 Declaration, Paragraph 59.

16 A. Fifty-nine?

17 Q. Yes. In Paragraph 59 you mention a TOPCon one sun
18 cell, correct?

19 A. Yes, I do.

20 Q. You also mention literature in 2023. Do you see
21 that?

22 A. Yes, I do.

1 Q. It says literature describing TOPCon cells?

2 MR. SELWYN: Objection; form.

3 A. I believe it is, yes.

4 Q. (BY MS. ZHAO) In or before 2008, were TOPCon one
5 sun cells known to a person of ordinary skill in the art?

6 MR. SELWYN: Objection; form.

7 A. In 2008?

8 Q. (BY MS. ZHAO) Yes.

9 A. No, it was not generally known.

10 Q. You were also asked whether by 2008 a person of
11 ordinary skill in the art would have known how to add a
12 tunnel oxide to a solar cell. Do you remember?

13 A. Do I remember being asked that?

14 Q. Yes.

15 A. Being asked what?

16 Q. Whether a person of ordinary skill in the art
17 would have known how to add a tunnel oxide to a solar cell.

18 A. Not generally, no.

19 Q. You don't remember being asked that?

20 A. Oh yeah, I was asked that, but it is -- it was a
21 novel concept that was not generally known, discussed, or
22 published. In fact, it was this Feldmann's publication in

1 2013 where it became more generally known.

2 Q. Can you turn to Paragraph 85 of your '516
3 Declaration.

4 A. Eighty-five?

5 Q. Yes. Earlier you were asked about the first
6 sentence. Do you see that?

7 A. Yes.

8 Q. Let me just read the sentence for the record. It
9 states that in a TOPCon structure a layer of polysilicon,
10 heavily doped with N-type dopants forms on the tunnel oxide.
11 Is it okay if I call that the TOPCon structure?

12 A. Yes.

13 Q. You were asked if the TOPCon structure was known
14 in 2008. Do you remember?

15 MR. SELWYN: Objection.

16 A. I guess I don't remember it being asked like that.

17 Q. (BY MS. ZHAO) Can I ask you, was the TOPCon
18 structure known in 2008?

19 MR. SELWYN: Objection.

20 A. I would say it was not generally known, but there
21 may have -- there were certainly people -- there were
22 certainly research groups that were investigating the TOPCon

1 structure.

2 Q. (BY MS. ZHAO) In or before 2008, are you aware of
3 anyone successfully creating the TOPCon structure in a solar
4 cell?

5 MR. SELWYN: Objection.

6 A. Successfully creating the TOPCon structure? No,
7 I'm not aware of anyone before 2008.

8 Q. (BY MS. ZHAO) In or before 2008, are you aware of
9 any solar cells in the market that included the TOPCon
10 structure?

11 MR. SELWYN: Objection.

12 A. No, I'm not aware of any cells in the marketplace
13 using the TOPCon structure.

14 MS. ZHAO: Pass the witness.

15 EXAMINATION

16 BY MR. SELWYN:

17 Q. Just a couple more questions, Dr. Ruby.

18 A. Yes.

19 Q. If you can turn back in your '516 Declaration to
20 Paragraph 74.

21 A. Page 42. Okay.

22 Q. Maxeon's counsel just a moment ago referred you to

1 Paragraph 74.

2 A. She referred me to a different paragraph.

3 MS. ZHAO: Fifty-nine.

4 Q. (BY MR. SELWYN) Turn, please, to Paragraph 59 in
5 your declaration.

6 A. Fifty-nine. Yes.

7 Q. Paragraph 59 in your declarations was one of the
8 paragraphs that was drafted by counsel, not you, correct?

9 A. I think I may have drafted that paragraph because
10 I remember finding this figure.

11 Q. Where did you find the figure?

12 A. It was a figure by MacDonald, in one of his
13 videos, in one of his slides in his UNSW seminar.

14 Q. So you're sure that you drafted Paragraph 59?

15 A. I'm not sure.

16 Q. Can you turn to Paragraph 85.

17 A. But I agree with everything in that paragraph.

18 Eighty-five, yes.

19 Q. Paragraph 85 is one of the paragraphs that was
20 drafted by counsel and not you, correct?

21 A. I disagree with that. It looks like something I
22 would have drafted.

1 Q. Are you sure?

2 A. Yes. It uses terminology that I would ordinarily
3 use. Yes, I drafted that paragraph and I stand by what it
4 says.

5 MR. SELWYN: Nothing further.

6 MS. ZHAO: Nothing further here either.

7 (Deposition concluded at 3:28 p.m.)

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PAGE	LINE	CORRECTION	REASON FOR CHANGE
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I, DOUGLAS S. RUBY, PH.D., do hereby certify that I have read the foregoing pages of my testimony as transcribed and that the same is a true and correct transcript of the testimony given by me in this deposition on July 31, 2025, except for the changes made.

Date signed

DOUGLAS S. RUBY, PH.D.

1 UNITED STATES PATENT AND TRADEMARK OFFICE

2 BEFORE THE PATENT TRIAL AND APPEAL BOARD

3 _____
4
5 HANWHA SOLUTIONS CORPORATION,

6
7 Petitioner,

8 Case Nos.:

9 v.

IPR 2024-01199,

10 IPR 2024-01203

11 MAXEON SOLAR PTE, LTD., U.S. Patent Nos.:

12 8,878,053,

13 Patent Owner

8,222,516
14 _____
15

16 CERTIFICATE OF DEPOSITION

17 I, CHRISTINE J. ROYBAL, CCR, RPR, CSR,
18 DO HEREBY CERTIFY that on July 31, 2025, the Deposition of
DOUGLAS S. RUBY, PH.D. was taken before me at the request
19 of, and sealed original thereof retained by:

20 MARK SELWYN, ESQUIRE
21 WILMER CUTLER PICKERING HALE AND DORR, LLP
2600 El Camino Real, Suite 400
22 Palo Alto, California 94306
(650) 858-6031

1

2

I FURTHER CERTIFY that copies of this Certificate have been mailed or delivered to all Counsel, and parties to the proceedings not represented by counsel, appearing at the taking of the deposition.

4

5

I FURTHER CERTIFY that examination of this transcript and signature of the witness REQUESTED by the witness and all parties present. On _____, a letter was mailed or delivered to ATTORNEY regarding obtaining signature of the witness, and any corrections, if any, were appended to the original and each copy of the Deposition.

7

8

I FURTHER CERTIFY that the recoverable cost of the original and one copy of the deposition, including exhibits, to MARK SELWYN, ESQ. is \$_____.

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1 I FURTHER CERTIFY that I did administer the oath
2 to the witness herein prior to the taking of this
3 Deposition; that I did thereafter report in stenographic
4 shorthand the questions and answers set forth herein, and
5 the foregoing is a true and correct transcript of the
6 proceeding had upon the taking of this Deposition to the
7 best of my ability.

8
9 I FURTHER CERTIFY that I am neither employed by
10 nor related to nor contracted with (unless excepted by the
11 rules) any of the parties or attorneys in this case, and
12 that I have no interest whatsoever in the final disposition
13 of this case in any court.

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CHRISTINE J. ROYBAL, CCR, RPR, CSR,
CCR No. 50
License Expires: 12/31/25

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