

1 UNITED STATES PATENT AND TRADEMARK OFFICE

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3
4 BEFORE THE PATENT TRIAL AND APPEAL BOARD

5
6 CANADIAN SOLAR INC.

7 Petitioner,

8 v.

9 MAXEON SOLAR PTE. LTD.,

10 Patent Owner

11
12 Case No. IPR2024-01039
13 U.S. Patent No. 8,222,516

14 -and-

15 Case No. IPR2024-01040
16 U.S. Patent No. 8,878,053

17 VIDEOCONFERENCE DEPOSITION OF

18 DOUGLAS S. RUBY, Ph.D.

19 Sacramento, California

20 Tuesday, June 24, 2025

21
22
23 STENOGRAPHICALLY REPORTED BY:

24 Shannon Borge, RPR, CSR No. 9436
25 Job No. 587650
Pages 1-138

1 Deposition testimony of DOUGLAS S. RUBY, Ph.D.,
2 taken on behalf of the Petitioner; all parties appearing
3 remotely via Zoom videoconference; beginning at
4 8:33 a.m., Pacific Standard Time, on Tuesday,
5 June 24, 2025, reported stenographically before Shannon
6 Borge, Registered Professional Reporter and Certified
7 Shorthand Reporter for the State of California.

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A P P E A R A N C E S

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I N D E X

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1006	Froitzheim reference	72
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1 SAN FRANCISCO, CALIFORNIA; TUESDAY, JUNE 24, 2025

2 9:06 a.m. PST

3 ---oOo---

4 DOUGLAS S. RUBY,

5 having been first duly sworn,

6 testified as follows:

7 EXAMINATION

8 BY BROOKE S. BOLL, Attorney at Law, counsel on behalf of
9 the Petitioner:

10 Q Good morning, Dr. Ruby. My name is Brooke
11 Boll. I am counsel for Canadian Solar, the petitioner
12 in these matters. It's nice to meet you.

13 A Nice to meet you.

14 Q Can you please state your full name for the
15 record.

16 A Douglas S. Ruby.

17 Q Where are you located today?

18 A Albuquerque, New Mexico.

19 Q Are you in your home office?

20 A Yes, I am.

21 Q Is there any reason you can't testify
22 truthfully today?

23 A No reason.

24 Q Is there anyone in the room with you today?

25 A No one.

1 Q Outside of this Zoom deposition, are you in
2 contact with anyone else?

3 A By "in contact," you mean like with the lawyers
4 who hired me?

5 Q Sure. Or like if you have like a chat window
6 open or email open or --

7 A No.

8 Q -- anything like that?

9 A No. Nothing else is open. I don't have my
10 phone in the room.

11 Q Okay. Is there any -- so there's nothing else
12 open on your screen other than this Zoom right now?

13 A Exactly.

14 Q Okay. And we sent you two binders. Did you
15 receive those?

16 A I did. I got them yesterday.

17 Q Okay. So those are paper copies of some of the
18 documents we'll be using today, and -- and feel free to
19 review those copies as necessary. I will also drop the
20 exhibits in the chat as well, if it's easier to use
21 electronic copies. Okay?

22 A Very good.

23 Q Besides the binders that we sent to you, did
24 you bring anything else with you to the deposition
25 today?

1 A No.

2 Q Just to go over a couple of things, please try
3 to give verbal answers rather than just shaking your
4 head "yes" or "no" so that we get a clear record; is
5 that fair?

6 A You cut out for about ten seconds there. Could
7 you repeat that, please.

8 Q Sure. Please give verbal answers rather than
9 just shaking your head "yes" or "no" so we can get a
10 clear record. Is that fair?

11 A That's very fair, yes.

12 Q And given that this is a remote deposition, we
13 can -- we'll try not to talk over each other, but if
14 anything breaks up or you don't hear me clearly, just
15 let me know, and I'll rephrase or restate.

16 A Thank you.

17 Q If you don't understand a question, let me
18 know, and I will try to clarify it.

19 A Okay.

20 Q But if you don't ask for clarification, I'll
21 assume you understood. Is that fair?

22 A Okay. That's very understood. Yes. Well
23 understood.

24 Q And if you need a break at any time, just ask
25 and we'll finish up the question we're on and -- and

1 take a break. Okay?

2 A Excellent. Very good.

3 Q Other than counsel, did you speak with anyone
4 else in preparing for your deposition today?

5 A No.

6 Q Did you do anything to prepare for your
7 deposition?

8 A Yes. I had two meetings with my counsel.

9 Q How long were those meetings?

10 A The one on Friday lasted about three hours, and
11 the one yesterday lasted about two hours.

12 Q So about five hours in total meeting with
13 counsel to prepare for your deposition?

14 A That's right.

15 Q Did you review any materials to prepare for
16 your deposition?

17 A We did review the publications that were cited
18 in my declaration.

19 Q Did you review your own declarations again?

20 A I reviewed portions of it, yes.

21 Q Did you review Dr. Banerjee's declarations?

22 A Not yesterday or -- or last week, no.

23 Q Did you review Dr. Banerjee's deposition?

24 A I reviewed parts of it probably several weeks
25 ago.

1 Q Okay. Aside from exhibits that are in the
2 record in this -- in these proceedings, did you review
3 any other materials to prepare for your deposition?

4 A No, I did not.

5 Q Have you served as an expert in litigation
6 matters before, Dr. Ruby?

7 A Yes, I have.

8 Q About how many matters?

9 A There were several, but I would say probably
10 the two that are most relevant, I believe, are I served
11 as an expert witness in an Australian lawsuit as a -- an
12 expert witness for patent infringement. That was in
13 2022. And before that as an expert for a class action
14 against BP Solar. That would have been maybe 2018 or
15 so.

16 Q Did -- you mentioned an Australian patent
17 infringement matter.

18 A Yes.

19 Q Is that the only patent case you've worked on
20 previously?

21 A Yes, it is.

22 Q So this is your first time serving as an expert
23 in an IPR proceeding?

24 A IPR, yes, I guess that's the case.

25 Q What was the technology at issue in the

1 Australian patent infringement matter?

2 A It had to do with passivating the surfaces of
3 silicon solar cells.

4 Q What do you mean by "passivating surfaces"?

5 A What I mean by that is processing the surface
6 in such a way that it would not be a location for the
7 recombination of free-charged carriers in the silicon
8 that were generated by light.

9 Q And what was the solution at issue in that case
10 in order to prevent the recombination?

11 A There was a deposition on an aluminum oxide
12 layer.

13 Q Did you testify at trial in that case?

14 A Yes, I did.

15 Q Were you deposed in that case?

16 A They have different ways of doing things in
17 Australia. I was involved in several meetings with
18 opposing expert witnesses, and we were expected to come
19 up with a joint report detailing areas of agreement and
20 disagreement.

21 Q Yeah, that does -- that does sound a little bit
22 different from how we do things here.

23 How about the class action, were you deposed in
24 that case?

25 A Oh, yes, definitely.

1 Q Did you testify at trial in that case?

2 A No. After my deposition, the case was settled.

3 Q How many times have you been deposed?

4 A There was one other time in a case long ago
5 which, again, was settled after my deposition.

6 Q Was that case as an expert or as a fact
7 witness?

8 A As an expert.

9 Q What was -- what were the issues in that case?

10 A I would have to look it up. It's been over a
11 decade.

12 Q Okay. No problem. Do you understand you are
13 here to testify today regarding declarations you've
14 submitted in two IPR proceedings?

15 A Yes, I do.

16 Q And those are IPR proceedings 2024-01039 and
17 -1040?

18 A Yes, that's correct.

19 Q The proceeding ending in No. -1039 is related
20 to US Patent No. 8,222,516; is that right?

21 A Yes, it is.

22 Q And I'll just refer to that patent as the '516
23 patent. Does that work for you?

24 A Yes, it does.

25 Q Okay. And the -- the proceeding ending in IPR

1 No. 1040 is regarding US Patent No. 8,878,053; is that
2 right?

3 A Yes, that's right.

4 Q And for ease of reference, I'll refer to that
5 as the '053 patent. Is that okay?

6 A Very good.

7 Q The '516 and '053 patents are related; right?

8 A I just lost contact for about ten seconds.
9 Whatever happened, do it again.

10 Q Okay. The '516 and the '053 patents are
11 related; is that right?

12 A Yes, they are.

13 Q How -- how did you become retained for this
14 matter?

15 A I was contacted by a law firm, I think PV Law
16 LLP.

17 Q Around when were you retained for these IPR
18 proceedings?

19 A I think it was in January. I think that's
20 right. I could look it up.

21 Q About how many hours have you spent working on
22 these IPR proceedings?

23 A I could look it up, but I would -- my estimate
24 is probably about 40 hours.

25 Q What is your hourly rate for these IPRs?

1 A Well, for doing standard research, it's 450 an
2 hour; for participating and preparing for depositions
3 like this, it's 475; and for testifying at trial, it
4 would be 500 per hour.

5 Q Are those rates in any way different from what
6 you charge in other matters?

7 A They are my contemporary rates that I charge
8 for current clients.

9 Q Was your compensation in any way dependent on
10 your testimony?

11 A Not whatsoever.

12 Q Is your compensation in any way dependent on
13 the outcome of the IPR proceedings?

14 A Not at all.

15 Q Okay. And we went over that there's two
16 different proceedings at issue today, the 1039 and the
17 1040.

18 You prepared one declaration corresponding to
19 each proceeding; right?

20 A Yes, I did.

21 Q Is it fair to say there's quite a bit of
22 overlap between your declarations in the two
23 proceedings?

24 A There is quite a bit of overlap.

25 Q Okay. And generally based on my review, it

1 looks like the opinions relating to the '053 patent are
2 sort of a subset of what you provided for the '516
3 patent.

4 Is that generally correct?

5 A I don't remember which is which precisely, but
6 I know that one encompassed slightly more material than
7 the other so the smaller one would be a subset.

8 Q Okay. In terms of sequence, did you prepare
9 the declarations together or one after another?

10 A I believe they were one after the other. It
11 was -- they were not at the same time.

12 Q Do you recall which declaration you prepared
13 first?

14 A No. It had to do with deadlines.

15 Q About how much time did you spend preparing the
16 declaration? So setting aside anything you've done
17 besides the IPR declarations.

18 A Maybe 10 to 15 hours for each one.

19 Q Did anyone assist you in preparing your
20 declarations?

21 A Yeah. I was assisted by the law firm.

22 Q Aside from counsel, did anyone else assist you
23 in preparing the declarations?

24 A No.

25 Q Did you do the first draft of your

1 declarations?

2 A I did submit background information, which they
3 edited and adopted into their format that was required.

4 Q And at a high level, not -- I'm not asking for
5 discussions you had with counsel, what -- what was your
6 process to form the opinions in your declarations?

7 A Well, I was asked to discuss certain factual
8 concepts and write down what I knew to be true about
9 them, and then those were further edited back and forth,
10 some were deleted, and the final copy was what we both
11 agreed upon.

12 Q Okay. And I'm going to send through the chat
13 Exhibit 2020 to the IPR proceeding ending in 1039. You
14 can turn to it in your binder as well.

15 (Exhibit Number 2020, 1039 IPR,
16 was previously marked for
17 identification.)

18 THE WITNESS: All right. Oh, let's see. Chat.

19 BY MS. BOLL:

20 Q I think you should be able to download it and
21 then open it on your computer.

22 A I will try. So download or -- let's see. File
23 name. Documents. Save. Okay. This is going to be
24 saved in documents. I'll save it in downloads, and then
25 I suppose you want me to open it.

1 Q Sure. And you have a hard copy of your
2 declaration in the binder as well, if that's easier for
3 you to reference.

4 A It's probably easier to look at it
5 electronically, to tell you the truth.

6 Q Sure.

7 A Let's see. Downloads. Ruby Declaration.
8 Okay. I have the document.

9 Q Okay. Dr. Ruby, this declaration, Exhibit 2020
10 in the 1039 IPR, provides your opinions regarding the
11 petition filed by Canadian Solar concerning the '516
12 patent; is that right?

13 A The '516 patent, yes.

14 Q Your signature appears at the end of this
15 document --

16 A Right.

17 Q -- is that right?

18 A Yes.

19 Q Did you review the entirety of this declaration
20 before signing it?

21 A Yes.

22 Q Does this declaration contain all of your
23 opinions in the '516 patent IPR?

24 A Yes.

25 Q Are you aware of any errors in your

1 declaration?

2 A I may have become aware of one yesterday.
3 There was a copy-and-paste error. If you ask me to find
4 it now, it might be difficult, but I -- and I'm not sure
5 if it was this one or the other declaration, but there
6 was a chart or a table essentially listing the claims in
7 the patent and one of the claims was slightly -- it may
8 have been the other -- the other patent. There was --
9 yeah. Not this one, no. Okay.

10 Q Okay. Well, I'll ask you again when we get to
11 the other declaration so you can clarify.

12 You have not provided any supplemental opinions
13 or corrections to this declaration; right?

14 A That's right.

15 Q If you turn to Section III, "Documents
16 Considered," which is on PDF page 10, declaration
17 page 8, other than the materials listed --

18 A Page -- page 10?

19 Q Of the PDF and page 8 of the declaration.

20 A Page 8 of the declaration. Let me find it.
21 Okay. I see page 9. Page 8, it starts with a list of
22 documents considered.

23 Q Yes. Other than the documents cited in your
24 declaration and listed in these bullets in paragraph 12,
25 have you considered any other materials in forming your

1 opinions in this case?

2 A No other documents, no.

3 Q Aside from documents, what else have you
4 considered in forming your opinions in this case?

5 A My generalized knowledge of semiconductor
6 physics as it relates to solar cell design construction
7 and performance.

8 Q Aside from the documents and your general
9 knowledge, is there anything else you relied on in
10 forming your opinions in this case?

11 A No.

12 Q How did you select which exhibits from the IPR
13 proceeding to review?

14 A The law firm pointed out the particular
15 documents that were of paramount importance, and I
16 looked at those for the most part. And some of the
17 others, I just reviewed in a more cursory manner.

18 Q Do you recall reviewing the Lemiti reference,
19 which is titled "Physical properties of RT-LPCVD and
20 LPCVD polysilicon thin films: application to emitter
21 solar cell," which was Exhibit 1048 to the Petition?

22 A Where is that in the list?

23 Q It's not in the list, but it is within the --
24 the evidence in the proceeding -- or, the exhibits in
25 the proceeding so I'm asking if -- if you reviewed that

1 one.

2 A Can you repeat the name again?

3 Q The first author is Lemiti, L-e-m-i-t-i.

4 A I don't recall that one, no.

5 Q And for the '516 patent, you haven't offered
6 any opinions on claim construction, is that right, in
7 this proceeding? Let me start. Let me try that again.

8 In this proceeding, you have not offered any
9 opinions on claim construction with regard to the claims
10 of the '516 patent. Is that fair?

11 A That's right.

12 Q You have not provided a proposed construction
13 of any claimed terms for this IPR proceeding; correct?

14 A That's right.

15 Q Is it your understanding that you're assessing
16 the '516 patent from the perspective of someone skilled
17 in the art in early 2008?

18 A That's right.

19 Q And you claim that you had the knowledge and
20 experience of a person of ordinary skill in the art as
21 of that time period; right?

22 A Yes.

23 Q In your declaration, you dispute that the
24 Froitzheim-Gan combination meets the limitations of a
25 second metal contact with silver formed over a layer of

1 silicon dioxide in Claim 12; is that right?

2 A Claim 12. Hang on. Let's see. Where would
3 that be in the declaration?

4 Q It's section -- let's see.

5 A Give me the page number.

6 Q Oh, sure. It's page 100.

7 A Okay. What paragraph? Which paragraph?

8 Q I think it's just this whole section is my
9 understanding.

10 A Oh, Section D. Okay. Is this -- "Second Metal
11 Contact." What was your question?

12 Q You dispute that the combination of Froitzheim
13 and Gan meets the limitations of Claim 12; right?

14 A I believe that's right. Yes, that's correct.

15 Q But you do not dispute that for the combination
16 of Froitzheim and Kwark; is that right?

17 A Well, let's see. In Section D, apparently it's
18 limited to -- Froitzheim-Gan does not include a second
19 metal content, Claim 12. In that section, it's refuting
20 the argument of a Froitzheim-Gan combination only.

21 Q And then the next two sections include your
22 opinions regarding Froitzheim and Kwark?

23 A Right, "E."

24 Q "E" and "F"?

25 A Froitzheim and Kwark (Ground 4), yes.

1 Q You do not dispute that the combination of
2 Froitzheim and Kwark meet the limitations for Claim 12;
3 right?

4 A It doesn't look like that's one of the sections
5 that's included. My understanding is Claim 12 is a
6 dependent claim and so it's dependent on a previous
7 claim, which I did find was unreasonable, and my
8 understanding wasn't necessary to refute the dependent
9 Claim 12.

10 Q But you did provide specific opinions on
11 Claim 12 for Froitzheim and Gan and you did not provide
12 any additional opinions on Froitzheim and Kwark. Is
13 that fair?

14 A I did provide it for Froitzheim-Gan combination
15 but apparently not for Froitzheim and Kwark.

16 Q And you did not provide any additional specific
17 opinions on Claim 12 for the combination of Froitzheim
18 and Borden; is that right?

19 A Apparently, that's correct. There were other
20 reasons why we disputed the motivation to combine
21 Froitzheim and Kwark and Froitzheim and Borden.

22 Well, let's see. Section G does say
23 Claims 9-12 are patentable under Froitzheim and Borden.

24 Q And your --

25 A Right. "E" and "F" say would not have been

1 motivated to combine Froitzheim and Kwark for any
2 reason.

3 Q So setting aside motivation to combine and
4 reasonable expectation of success arguments, I want to
5 focus on whether you dispute that the element of the
6 claim is literally met by the combination.

7 So you do not dispute that the limitations of
8 Claim 12 are met by the combination of Froitzheim and
9 Kwark or Froitzheim and Borden; right?

10 A Well, I didn't consider those combinations for
11 that particular claim. Probably as a -- for the reason
12 as I mentioned, that it's a dependent claim, and since
13 it was already -- since the independent claim was
14 already not found invalid. Therefore, it wasn't really
15 necessarily to look at the dependent claim. That was
16 my -- that was my understanding.

17 Q But you do not dispute that the limitations of
18 Claim 12 are met by the combination of Froitzheim and
19 Kwark or the combination of Froitzheim and Borden;
20 right?

21 MR. PETERSON: Object to form.

22 THE WITNESS: Well, let's see. Paragraph 215,
23 Froitzheim and Kwark, "Claims 9-12 are obvious based on
24 Froitzheim and Kwark."

25 Is that what you're questioning me about now,

1 Claim 12 based on Froitzheim and Kwark combination?

2 BY MS. BOLL:

3 Q Yes. I'm asking whether you dispute that
4 Froitzheim and Kwark includes a second metal contact
5 with silver formed over a layer of silicon dioxide?

6 A Looks like my discussions on the Froitzheim
7 Kwark combination deal mainly with the issue of a tunnel
8 oxide and whether the combination would be -- would be
9 something a POSITA would have a -- would believe --
10 would have a reasonable expectation of success.

11 So as -- as I said, again, because the
12 independent claim was found to be un- -- unjustified, I
13 didn't specifically consider Claim 12, which was a
14 dependent claim.

15 Q And that's true for the combination of
16 Froitzheim and Borden? You do not dispute that the
17 limitations of Claim 12 are met for that combination?

18 MR. PETERSON: Object to form.

19 THE WITNESS: Again, because Claim 12 is a
20 dependent claim, my having found fault with combining
21 the two of them for other reasons in the independent
22 claim, precluded the necessity of discussing whether it
23 also was intolerable under Claim 12. Yes. So I didn't
24 -- I didn't discuss the dependent claims because they
25 were already irrelevant.

1 BY MS. BOLL:

2 Q Okay. But you did specifically discuss
3 Claim 12 for Froitzheim and Gan but not Froitzheim and
4 Kwark or Froitzheim and Borden; right?

5 A Apparently, it's true.

6 Q Focusing back on your opinions regarding
7 Froitzheim with Gan, you do not have any opinion on --
8 strike that.

9 Focusing back on your opinion regarding
10 Froitzheim and Gan, you do not dispute that that
11 combination meets all of the elements of Claim 9 of the
12 '516 patent; right?

13 A Of Claim 9? That the Froitzheim-Gan
14 combination meets all the elements of Claim 9; is that
15 what you're asking?

16 Q Yes.

17 A Well, which was Claim 9? Let's see. Claim 9.
18 Yeah, I do dispute that, and I believe there's a whole
19 section explaining my reasoning for disputing that.

20 Q So as I understand your opinion, it is that a
21 person of ordinary skill in the art would not be
22 motivated to combine Froitzheim and Gan or would not
23 have a reasonable expectation of success in doing so;
24 right?

25 A Definitely.

1 Q But you do not have an opinion as to whether
2 the Froitzheim and Gan references teach each limitation
3 of the claim; right?

4 A What do you mean by "teach each limitation of
5 the claim"?

6 Q So maybe let's take a look at the claim, which
7 I believe is in -- reprinted in a table beginning on --

8 A Yeah.

9 Q -- page 46.

10 A Yes, exactly.

11 Q You do not dispute that the Froitzheim and Gan
12 references teach a solar cell having a front side facing
13 the sun to collect solar radiation during normal
14 operation and a backside opposite the front side; right?

15 A Actually, Gan doesn't teach anything about
16 solar cells. It's all about making contact to a effused
17 region --

18 Q Okay. But that --

19 A -- through a tunnel oxide.

20 Q That wasn't exactly my question.

21 A Well, what exactly is your question?

22 Q You do not dispute that the combination of
23 Froitzheim and Gan discloses a solar cell having a front
24 side facing the sun to collect solar radiation during
25 normal operation and a backside opposite the front side;

1 right?

2 A That's included in the Froitzheim patent, yes.

3 Q And you do not dispute that the combination of
4 Froitzheim and Gan discloses a substrate having a
5 textured front surface; right?

6 A Again, I believe Froitzheim patent makes that
7 claim.

8 Q And you do not dispute that the combination of
9 Froitzheim and Gan discloses an emitter layer formed
10 over a back surface of the substrate, the emitter layer
11 formed over a backside junction with the substrate;
12 right?

13 MR. PETERSON: Counsel, can I jump in here real
14 quick? I believe this is where the typo that we were --
15 he was talking about earlier was.

16 MS. BOLL: Oh, okay.

17 THE WITNESS: I'd say you'd have to look up
18 that patent, '516 patent, and look at the exact -- yeah,
19 not what's in the table but what's in the patent.

20 BY MS. BOLL:

21 Q Yes, I see that.

22 A A new layer formed SSS over a back surface
23 forming a backside junction. So what's in the table is
24 wrong.

25 BY MS. BOLL:

1 Q Okay. So let me re-ask my question, then, with
2 the corrected language.

3 A Yes.

4 Q You did not dispute that the combination of
5 Froitzheim and Gan meets the limitation of an emitter
6 layer formed over a back surface of the substrate, the
7 emitter layer forming a backside junction with the
8 substrate; right?

9 A The Froitzheim patent does that, yes.

10 Q Okay. And you do not dispute that the
11 combination of Froitzheim and Gan discloses an oxide
12 layer formed between the back surface of the substrate
13 and the emitter layer; right?

14 A The Gan reference and Gan thesis both discuss
15 forming an oxide layer between the back surface and the
16 emitter layer, yes.

17 Q You do not dispute that the combination of
18 Froitzheim and Gan discloses a first metal contact
19 making an electrical connection to the substrate on the
20 front side of the solar cell; is that right?

21 A That's right.

22 Q You do not dispute that the combination of
23 Froitzheim and Gan discloses a second metal contact
24 making an electrical connection to the emitter layer of
25 the backside of the solar cell, the first metal contact,

1 and the second metal contact being configured to allow
2 an external electrical circuit to be powered by the
3 solar cell; is that right?

4 A That's right.

5 MR. PETERSON: Object to form. I believe he
6 testified earlier that in Section D, Claim 10, is not
7 covered by Froitzheim and Gan.

8 THE WITNESS: Claim 10?

9 MR. PETERSON: I'm sorry. That's claim -- I'm
10 sorry. That's Claim 12.

11 THE WITNESS: Claim 12.

12 MR. PETERSON: Sorry.

13 BY MS. BOLL:

14 Q Okay. You do not dispute that the combination
15 of Froitzheim with Clark meets all of the limitations of
16 Claim 9; right?

17 A Right.

18 Q You do not dispute that the combination of
19 Froitzheim and Gan meets all of the limitations of Claim
20 9; right?

21 A Right. Taking pieces of one and taking pieces
22 of the other together cover what's discussed in Claim 9.

23 Q You do not dispute that the combination of
24 Froitzheim and Borden meets all of the limitations of
25 Claim 9; right?

1 A Actually, Borden talked about an oxide layer on
2 the front surface, not the back surface.

3 Q So you do dispute that the combination of
4 Froitzheim and Borden meets the limitation of an oxide
5 layer formed between the back surface of the substrate
6 and the emitter layer?

7 A Well, all of his discussion is regarding the
8 front surface.

9 Q Can you point me to where in your discussion of
10 Borden you -- you opined that a -- the combination of
11 Froitzheim and Borden does not disclose an oxide layer
12 formed between the back surface of the substrate and the
13 emitter layer?

14 A It may not be in my declaration. He talks
15 about an oxide layer, but all of his discussion is
16 referring to the front surface. Maybe he lives it
17 ambiguous so that it could be applied to the back
18 surface as well.

19 Q So in your declaration, you did not dispute
20 that the combination of Froitzheim and Borden discloses
21 an oxide layer formed between the back surface of the
22 substrate and the emitter layer; right?

23 A I suppose it could also be used on the back
24 surface, but that's -- that's not the example that he
25 uses in his patent.

1 Q So you agree that it's -- that Borden discloses
2 an oxide layer formed between the back surface of the
3 substrate and the emitter layer; right?

4 A He doesn't disclose it on the back surface.

5 (Court reporter requested clarification.)

6 THE WITNESS: He doesn't say which surface it
7 is. He doesn't discuss whether it's the front or the
8 back surface. All the diagrams show the front surface.

9 BY MS. BOLL:

10 Q In your declaration, which contains all of your
11 opinions in this proceeding, you did not dispute that
12 the combination of Froitzheim and Borden discloses an
13 oxide layer formed between the back surface of the
14 substrate and the emitter layer; is that right?

15 A That's right.

16 Q You do not dispute that the combinations of
17 Froitzheim and Gan meet all of the elements of Claim 10
18 of the '516 patent; right?

19 MR. PETERSON: Object to form.

20 THE WITNESS: Claim 10 regarding an
21 antireflective layer. No, the Froitzheim patent
22 includes an antireflective layer over the textured front
23 surface.

24 BY MS. BOLL:

25 Q So you do not dispute that the combination of

1 Froitzheim and Kwark meets the antireflection layer of
2 Claim 10; right?

3 A That's right.

4 Q And you do not dispute that the combination of
5 Froitzheim and Borden meets the limitations of Claim 10;
6 right?

7 A Yes, that's right.

8 Q Claim 11 recites, "The solar cell of Claim 9
9 wherein the substrate comprises an N-type silicon
10 substrate and the emitter layer comprises of P-type
11 doped polysilicon"; right?

12 A Yeah. That's the structure of the Froitzheim
13 patent.

14 Q So you do not dispute that the combination in
15 Froitzheim and Gan meets the elements of Claim 11 of the
16 '516 patent; right?

17 A Of Froitzheim and Gan?

18 Q Correct.

19 A That's right. The combination meets the
20 Claim 11.

21 Q You do not dispute that the combination of
22 Froitzheim and Kwark meets the limitations of Claim 11;
23 right?

24 A As I believe I mentioned earlier, I singled out
25 the combination of Froitzheim and Gan, I think it was,

1 but not Froitzheim and Kwark.

2 Q I believe that was for Claim 12.

3 A That was for Claim 12. Isn't that what we're
4 talking about now?

5 Q Sorry. Maybe I had misspoke. I'm talking now
6 about Claim 11.

7 You do not dispute that Froitzheim and Kwark
8 meets the limitations of Claim 11; right?

9 A Right. I don't dispute.

10 Q You do not dispute that the combination of
11 Froitzheim and Borden meets Claim 11; right?

12 A Right.

13 Q In your declaration regarding the '516 patent,
14 you do not offer any opinions regarding secondary
15 considerations; is that right?

16 A What do you mean by "secondary considerations"
17 and what do you mean by "opinions regarding secondary
18 considerations"?

19 Q Sure. So secondary considerations are one of
20 the factors for obviousness or not obviousness, but let
21 me ask something a little more specific.

22 You do not dispute Petitioner's arguments that
23 the patented invention did not achieve unexpected
24 results; right?

25 A Which patented invention?

1 Q The '516 patent.

2 A Did not achieve unexpected results? What do
3 you mean by that?

4 Q You do not have any opinion that the '516
5 patent achieved unexpected results; is that right?

6 A What do you mean by "unexpected results"?

7 Q You do not dispute that the '516 patent did not
8 achieve commercial success; is that right?

9 A Did not achieve commercial success?

10 Q Correct.

11 A I do not dispute that it did not achieve
12 commercial success so I agree that it did achieve
13 commercial success?

14 Q Is it your opinion that the '516 patent
15 achieved commercial success?

16 MR. PETERSON: Object to form. Outside the
17 scope of his declaration.

18 THE WITNESS: Not at the time of the patent.

19 BY MS. BOLL:

20 Q Are you familiar with something called
21 "objective indicia of nonobviousness"?

22 A I don't even know what you said.

23 Q So fair to say you're not familiar with
24 secondary considerations of obviousness or
25 nonobviousness; is that right?

1 A I'm not familiar with that terminology.

2 Q So you don't have any opinions regarding such
3 secondary considerations; is that fair?

4 A I don't -- I don't know what they are so it
5 would be hard for me to have an opinion about it.

6 Q Okay. I'm going to upload into the chat your
7 declaration in IPR proceeding ending in 1040, which is
8 the '053 patent proceeding, and you can download that
9 and open it on your computer or look at the paper copy,
10 whatever is easier for you.

11 A Sorry. The '053 declaration?

12 Q Yes. I just put that into the chat.

13 (Exhibit Number 1001-053 was
14 previously marked for
15 identification.)

16 THE WITNESS: Okay. I've got it.

17 BY MS. BOLL:

18 Q You offered a declaration marked as
19 Exhibit 2020 in the 1040 proceeding regarding the '053
20 patent; right?

21 A Yes, I did.

22 (Exhibit Number 2020, 1040 IPR,
23 was previously marked for
24 identification.)

25 Q This declaration provides your opinions

1 regarding Canadian Solar's petition on the '053 patent;
2 right?

3 A That's correct.

4 Q Is that your signature at the end of
5 Exhibit 2020 in the 1040 proceeding?

6 A Yes, it is.

7 Q Did you review the entirety of the declaration
8 before signing it?

9 A Yes, I did.

10 Q Does the declaration contain all of your
11 opinions in the '053 patent IPR?

12 A Yes, it does.

13 Q And we spoke about the copy-paste error in the
14 table of reprinting the claims in the 1039 declaration.

15 In the 1040 declaration, are you aware of any
16 errors?

17 A I'm not aware of any, no.

18 Q Does this -- strike that.

19 You haven't provided any corrections or
20 supplemental opinions to this declaration; is that
21 right?

22 A That's right.

23 Q If we look at the table of contents,
24 generally --

25 A Of '053?

1 Q Let me know when you're there.

2 A Of '053?

3 Q Yes. We'll stick with the '053 for a few
4 minutes.

5 A Okay. I am here.

6 Q This declaration provides a subset of what your
7 opinions were in the '516 patent declaration. Is that
8 fair?

9 A Yes. There are fewer cited references.

10 Q Generally, this declaration for the '053 patent
11 provides arguments regarding the reasonable expectation
12 of success and the motivation to combine for the
13 combinations of Froitzheim and Gan and Froitzheim and
14 Kwark; is that right?

15 A That's right.

16 Q In this IPR proceeding, you have not offered
17 any opinions on claim construction with regard to the
18 challenged claims of the '053 patent; right?

19 A Yes, I believe that's the case.

20 MR. PETERSON: Counsel, did you say he did not
21 provide any?

22 MS. BOLL: Right.

23 THE WITNESS: Regarding claim construction; is
24 that right?

25 MS. BOLL: That's right.

1 MR. PETERSON: I believe he did provide
2 something on in-situ; correct?

3 BY MS. BOLL:

4 Q If you turn to page 49, Dr. Ruby --

5 A This is the '053 patent?

6 Q Yes.

7 A Page 49. In-situ. Okay.

8 Q So for the construction of in-situ, you applied
9 Canadian Solar's definition for the purposes of your
10 analysis; is that right?

11 A Yes, that looks to be the case.

12 Q And the term "in-situ" appears in dependent
13 Claim 15; right?

14 A Dependent Claim -- dependent Claim 15. Let's
15 see. '053 patent. Dependent Claim 15. A method.
16 Effusion of dopants and an effusion with dopants in the
17 front surface are performed in-situ. Yes, they're both
18 in Claim 15.

19 Q You do not dispute that the combination of
20 Froitzheim and Gan and Froitzheim and Kwark meet the
21 limitations in Claim 15; right?

22 A Apparently, I did not dispute that. Again,
23 it's -- since it's a dependent claim, once I address the
24 independent Claim 9, discussion of the dependent claim
25 became irrelevant.

1 Q Okay. So other than stating that you're
2 applying Canadian Solar's definition of in-situ, you
3 don't otherwise discuss the concept of in-situ diffusion
4 in your declaration. Is that fair?

5 A I don't believe that I did. Yeah, I didn't --
6 I didn't discuss it.

7 Q You do not dispute that Petitioner's
8 combinations disclose all of the elements of the
9 challenged claims of the '053 patent; right?

10 A Say it again.

11 Q You do not dispute that Petitioner's
12 combinations disclose all of the elements of the
13 challenged claims of the '053 patent; right?

14 A Which combinations?

15 Q So we can take them one-by-one. So you do not
16 dispute that the combination of Froitzheim and Gan
17 discloses challenged Claims 9 through 11; right?

18 A Discloses. You mean they could combine --
19 could be combined to do what is described in Claims 9
20 through -- which one -- did you say 11?

21 Q Yes.

22 A Yeah, they could be combined to do what's
23 disclosed in Claims 9 through 11.

24 Q You do not dispute that the combination of
25 Froitzheim and Gan discloses Claims 14, 16 through 17,

1 and 19 through 20 of the '053 patent; right?

2 A Why don't you take that one at a time.

3 Q Sure. You do not dispute that the combination
4 of Froitzheim and Gan discloses Claim 14 of the '053
5 patent; right?

6 A Right.

7 Q You do not dispute that the combination of
8 Froitzheim and Gan discloses Claim 16 of the '053
9 patent; right?

10 A Froitzheim and Gan disclosing 16 (witness
11 mumbling while reading document to himself).

12 The combination of Froitzheim and Gan?

13 Q That's right.

14 A Yeah. That's -- if they were combined, that is
15 what they would accomplish.

16 Q You do not dispute that the combination of
17 Froitzheim and Gan discloses Claim 17 of the '053
18 patent; right?

19 A Effusing dopants. Backside junction. Open
20 layer. Effusing dopants. Yes, that's correct.

21 Q You do not dispute that the combination of
22 Froitzheim and Gan discloses Claims 19 and 20 of the
23 '053 patent; right?

24 A Puncturing the front surface and putting
25 antireflective layer. That's right.

1 Q Okay. So you do not dispute that the
2 combination of Froitzheim and Gan discloses all elements
3 of challenged Claims 9 through 11, 14, 16 to 17, and 19
4 to 20 of the '053 patent; right?

5 A I guess that's the case, yes.

6 Q And you do not dispute that the combination of
7 Froitzheim and Kwark discloses all elements of those
8 same challenged claims; right?

9 A That's right.

10 Q For Claims 11 through 13, 15, and 18, Canadian
11 Solar has proposed combinations involving one of Hartiti
12 or Sivoththaman; right?

13 A I don't understand. I do not -- I don't
14 remember those references so I -- I can't say whether
15 they're mentioned -- whether they accomplish what's
16 discussed in these claims.

17 Q You reviewed the Hartiti reference; right?

18 A Not that I remember.

19 Q If you turn to page 7, it lists your documents
20 considered.

21 A Okay. I mean, it's not one of the ones I spent
22 much, if any time, looking at.

23 Q Okay. And it -- it appears at the top of
24 page 8 in the first bullet. So you didn't provide any
25 opinions on the Hartiti reference. Is that fair?

1 A I didn't provide any opinions on it because I
2 didn't even read it.

3 Q How about the reference directly below that,
4 Sivoththaman? Did you review that reference?

5 A No, I did not.

6 Q So you do not have any opinions regarding that
7 reference?

8 A That's right.

9 Q So you do not dispute that a combination with
10 Hartiti would meet the elements of Claims 11 through
11 13 --

12 A I have no opinion about that.

13 And I need to take a break. It's time for me
14 to get a drink.

15 Q Okay. Sure. We can go off the record.

16 (Recess.)

17 BY MS. BOLL:

18 Q Dr. Ruby, if you turn back to your declaration
19 in the 1040 proceeding regarding the '053 patent --

20 A Yes.

21 Q -- before the -- before the break, we were
22 looking at the documents you considered in formulating
23 your opinions on pages 7 to 8 of your declaration.

24 A Yes.

25 Q Did you review the Sivoththaman reference,

1 which is the second bullet point on page 8?

2 A No.

3 Q So you do not have any opinions regarding
4 whether the combination of Sivoththaman with other
5 references would meet the elements of Claims 11 through
6 13, 15, and 18?

7 A I have no opinion about that.

8 Q Your declaration does not include any opinions
9 regarding secondary considerations relating to the '053
10 patent; right?

11 A Again, I'm not familiar with the term
12 "secondary considerations," so I don't know how to
13 answer your question.

14 Q Okay. Do you know Canadian Solar's expert
15 Dr. Sanjay Banerjee?

16 A No, I don't.

17 Q Have you ever reviewed Dr. Banerjee's work?

18 A No, I haven't.

19 Q Do you have any reason to doubt he is qualified
20 as an expert in solar technology?

21 A No, I have no reason to doubt it.

22 Q Prior to the engagement for these IPR
23 proceedings, have you ever worked for Maxeon before?

24 A No, not for Maxeon.

25 Q Have you ever worked for SunPower before?

1 A I did work for SunPower.

2 Q When was that work?

3 A Probably about 10 years ago. About 10 years
4 ago.

5 Q What kind of work did you do for SunPower?

6 A One of the services I provide as a consultant
7 to the photovoltaic industry is you present a three-day
8 short course on solar cell science and technology, which
9 I delivered to SunPower employees in the Philippines
10 back 10, 12 years ago, something like that.

11 Q Is that the only work you have done for
12 SunPower in the past?

13 A Yes.

14 Q Have you ever spoken to anyone at Maxeon?

15 A No.

16 Q Have you spoken to anyone at SunPower about
17 these IPR proceedings?

18 A No.

19 Q Are you familiar with Richard Swanson?

20 A Yes, I know Dick Swanson.

21 Q Who is he?

22 A He's the founder of SunPower and a former
23 professor of electrical engineering at Stanford
24 University.

25 Q How do you know him?

1 A I know him because when I worked at Sandia
2 National Laboratories, they had a contract with us to
3 design, develop, and produce solar cells, mainly
4 concentrator cells, of which we then tested for them.

5 Q When you say, "They had a contract with us," do
6 you mean SunPower had a contract with Sandia?

7 A Yes, that's exactly right.

8 Q Roughly, what time frame was that work
9 performed?

10 A 1980s and 1990s.

11 Q What is a concentrator solar cell?

12 A A concentrator solar cell is usually relatively
13 small in area and sits at the focal point of optical
14 concentrators which focus the sunlight down to the
15 activator area of the cell for conversion of that light
16 into electricity.

17 Q How does that compare to a nonconcentrator
18 solar cell?

19 A How does that compare in what respect? You
20 mean in design and construction?

21 Q Sure. We can start there.

22 A Costs?

23 Q Design and construction.

24 A Well, it needs to be designed and constructed
25 to handle very high current densities, much higher than

1 those for 1-Sun solar cells.

2 Q So a concentrator solar cell needs to be
3 designed and constructed to handle high current
4 densities?

5 A Yes.

6 Q Is that --

7 A And high temperatures.

8 Q Is it easier or more difficult to make a
9 concentrator solar cell compared to a 1-Sun cell?

10 A Easier or more difficult measured how?

11 Q In terms of -- let's start with cost.

12 A They're generally more expensive, but since
13 they replace many numbers of 1-Sun solar cells, the idea
14 was the overall cost of the system would be less.

15 Q So concentrator cells are more expensive sort
16 of on a per-cell basis compared to a 1-Sun cell. Is
17 that fair?

18 A (Inaudible.)

19 Q Sorry. I didn't hear your answer.

20 A Yes, they are more expensive than a 1-Sun cell
21 on a per-cell basis.

22 Q From sort of a technical point of view, are
23 concentrator solar cells more difficult to construct
24 than 1-Sun cells?

25 A More difficult in what way?

1 Q In terms of manufacturing.

2 A Depends how you measure difficulty. That's how
3 I'll leave that answer.

4 Q Is it true that concentrator solar cells
5 require lower contact resistance than non-concentrator
6 solar cells?

7 A Yes, that's true.

8 (Clarification requested by Reporter.)

9 BY MS. BOLL:

10 Q Is it true that concentrator solar cells
11 require much lower contact resistance than
12 non-concentrator solar cells?

13 A My answer is yes, that's true.

14 Q Why is that?

15 A Because they must handle a much higher current
16 and because -- because of the higher currents, the
17 resistances need to be lower in order to have lower
18 voltage drops or what you would call ohmic resistance in
19 the cell. Less energy wasted in resistance.

20 Q A person of ordinary skill in the art, prior to
21 2008, would have knowledge of the differences between
22 concentrator solar cells and 1-Sun solar cells; right?

23 A Well, I did.

24 Q And you were a person of ordinary skill in the
25 art prior to 2008; right?

1 A Yes, I would consider myself to be so.

2 Q What are some ways that you can reduce contact
3 resistance in a solar cell?

4 A By doping the contact region of the silicon
5 very heavily; a high concentration of dopant atoms.

6 Q Was that known before 2008?

7 A Yes.

8 Q Are you aware of any other ways to reduce
9 contact resistance in a solar cell?

10 A Correct choice of metals for making contact
11 with.

12 Q Was that known before 2008?

13 A Yes.

14 Q Are you aware of any other ways to reduce
15 contact resistance in a solar cell?

16 A No.

17 Q In a solar cell with an interfacial oxide, if
18 you reduce the thickness of the interfacial oxide, will
19 that lower the contact resistance?

20 A Yes.

21 Q Was that known prior to 2008?

22 A Yes.

23 Q If you increase the contact area, is that
24 another way to reduce the contact resistance?

25 A Yeah. It reduces the specific contact

1 resistivity, which is contact resistance per unit area.
2 So, yes, it reduces the contact resistance, but the --
3 the specific contact resistivity remains the same.

4 Q Understood. Was that known prior to 2008?

5 A Yes.

6 Q I reviewed your C.V., and you reported that you
7 designed and fabricated the world's first 20 percent
8 efficient silicon concentrator solar cell. Is that
9 right?

10 A I would say -- I would modify that and say on a
11 low-cost silicon substrate.

12 Q What do you mean by "a low-cost silicon
13 substrate"?

14 A A substrate made of crystalline silicon grown
15 by the Czochralski method. Low-cost silicon.

16 Q The Czochralski method generates
17 monocrystalline silicon; is that right?

18 A Yes, it does.

19 Q When did you fabricate that 20 percent
20 efficient concentrator cell on a low-cost substrate?

21 A Well, does it say it in my C.V.? I think it
22 was -- I'm going to have to look it up, but here's my
23 list of my publications right here. Let's see.

24 It looks like it was published -- let's see.
25 20 percent concentrator cell. It may have been part of

1 this conference paper delivered in 1993, "Simplified
2 Processing for 23%-Efficient Silicon Concentrator Solar
3 Cells," at a conference in 1993.

4 Q How did you go about designing that
5 concentrator solar cell?

6 A That's a long -- the question has a long
7 answer.

8 Q Sure.

9 A You have to choose the -- a substrate with the
10 correct resistivity, perform a diffusion of the proper
11 temperature and for the proper duration to achieve a low
12 heat emit- -- heat resistance in the emitter, use very
13 specialized metal contacts to form low-resistance
14 contacts to that emitter. It generally involves a lot
15 of high temperature anneals and some of them in what's
16 known as forming gas. The idea being to create a cell
17 with very low resistance and try to passivate as many
18 defects as possible on the surface and the bulk.

19 Q In selecting and designing the solar cell, did
20 you review published works in the field?

21 A I'm sure I did.

22 Q Did you limit your review to just published
23 works relating to concentrator solar cells?

24 MR. PETERSON: Object to form. Outside the
25 scope of his declaration.

1 THE WITNESS: Do I answer that question?

2 BY MS. BOLL:

3 Q Yes, unless your counsel instructs you not to
4 answer.

5 A Well, what was -- repeat the question then.

6 Q Sure. When you were reviewing published works
7 in the field, did you limit your review to just works
8 regarding concentrator solar cells?

9 A Probably not.

10 MR. PETERSON: Same objection.

11 BY MS. BOLL:

12 Q What was the efficiency of concentrator solar
13 cells that pre-dated your work in 1993?

14 A Well, on that low-cost substrate, my guess from
15 that statement you made is that it was less than
16 20 percent.

17 Q But you're not sure exactly how much less. Is
18 that fair?

19 A I'm not sure exactly how much less.

20 Q What is it that you can attribute to the
21 greater efficiency that you were able to achieve?

22 A We used the -- a fairly novel and effective
23 process for passivating the front surface of the cell
24 and providing an excellent antireflection coating at the
25 same time.

1 Q What was that process known as?

2 A Thermal oxidation of silicon.

3 Q Were similar techniques for passivating the
4 front surface ever applied to a 1-Sun solar cell?

5 A I believe they were but perhaps not in the same
6 way that we -- that we did it.

7 Q So you would agree that if you're developing a
8 1-Sun solar cell, it might be worthwhile to look at
9 publications regarding concentrator solar cells?

10 MR. PETERSON: Object to form.

11 THE WITNESS: Well, it would be advisable or
12 suggest -- you know, it would certainly be worth --
13 worth looking at, although not all of the methods for
14 creating solar cells -- concentrator cells are required
15 for producing 1-Sun cells. So some things would be of
16 use and many things would not.

17 BY MS. BOLL:

18 Q Do concentrator solar cells have more
19 requirements than 1-Sun solar cells?

20 A More specialized requirements, yes, especially
21 in regards to lower series resistance.

22 Q You worked at Sandia from about 1985 to January
23 2008; right?

24 A That's right.

25 Q Towards the end of your time there, so in sort

1 of the mid-2000's, what were you working on primarily?

2 A I was working on using plasma processing
3 techniques for texturing solar cells as well as
4 depositing passivating layers.

5 Q What are plasma processing techniques?

6 A Use of plasma chambers, which are essentially a
7 chamber that you can strike a plasma in.

8 Q What is that used for?

9 A As I said, we used it for both texturing of
10 silicon as well as depositing passivating layers.

11 Q What sorts of passivating layers were you
12 depositing?

13 A I was depositing primarily silicon nitrides and
14 silicon oxynitrides.

15 Q What is the difference between a silicon
16 oxynitride and a silicon oxide?

17 A Silicon oxynitride, by definition, contains
18 silicon oxygen and nitrogen, as well as hydrogen, if
19 deposited in a plasma chamber. A silicon oxide
20 generally just is composed of silicon and oxygen atoms.

21 Q In terms of the effect on a solar cell, what is
22 the difference between a silicon oxide and a silicon
23 oxynitride?

24 A Silicon nitrides, in general, have a higher
25 concentration of what are called "fixed positive

1 charges."

2 Q How does that impact the performance of a solar
3 cell?

4 A Well, if a layer containing high density of
5 fixed positive charges is deposited upon a surface of
6 silicon, those positive charges will repel positive
7 charges, which are in the silicon.

8 Q Do you have experience with forming chemical
9 oxides?

10 A No.

11 Q I believe you stated earlier that you had
12 experience with forming thermal oxides.

13 A Yes.

14 Q Is that right?

15 A Correct.

16 Q Prior to 2008, what sorts of methods did you
17 use to form thermal oxides?

18 A Thermal oxidation of silicon can be
19 accomplished in many ways; generally speaking, either a
20 wet or a dry oxidation. Dry oxidation involves exposing
21 the silicon to oxygen at a high temperature. Wet
22 oxidation involves exposing silicon to water vapor at
23 high temperature.

24 Q Those techniques were known before 2008; right?

25 A Yes.

1 Q In terms of your work experience, have you
2 worked only on solar cells or have you worked on other
3 semiconductor devices?

4 A My professional work exclusively at -- starting
5 the time I began work at Sandia, exclusively on solar
6 cells.

7 Q What is your educational background?

8 A Well, I got a Bachelor of Science degree from
9 MIT in 1978. Went to graduate school at the University
10 of Illinois where I got a master's and Ph.D. degrees in
11 semiconductor physics, 1980 and '85, respectively.

12 Q During your education, did you work with
13 semiconductor devices other than solar cells?

14 A Yes. I worked with not so much devices as
15 materials. Semiconductor materials, in particular.
16 Compound semiconductor materials.

17 Q Did you ever do any work on bipolar
18 transistors?

19 A No.

20 Q Did you write a thesis for your Ph.D.?

21 A Yeah, I did.

22 Q What was your thesis about?

23 A It was about trying to reduce or eliminate --
24 eliminate the defects that are present during the
25 epitaxial growth of gallium arsenide, which is a

1 compound semiconductor material.

2 Q Was your thesis related to solar cells?

3 A No. It was related to semiconductor materials
4 and semiconductor science.

5 Q Are the teachings of semiconductor materials
6 and semiconductor science more generally applicable to
7 the solar cell context?

8 A Yes, they are very applicable to solar cells
9 because a very thorough understanding of semiconductor
10 science is required to make efficient solar cells, which
11 are themselves made out of a semiconductor material.

12 Q Was your thesis successful in eliminating the
13 defects during the epitaxial growth you described?

14 A It was a "no result."

15 Q What does that mean?

16 A It means the things that we tried didn't make a
17 difference, and that has -- that's not necessarily a
18 failure. You can gain information from that.

19 Q Did your thesis ever get published in another
20 form like a paper?

21 A Well, there were other papers which were
22 published, maybe related to. Let's see.

23 Q Let me know if you prefer an electronic copy of
24 your C.V. and I can put it into the chat.

25 A I'm going to say -- I mean, there were other

1 papers that were published relating to -- relating to
2 the work I did on my thesis, yes.

3 Q How did those -- sorry. Go ahead.

4 A Essentially, in the time frame of 1981 through
5 1985.

6 Q How did those published papers differ from the
7 contents of the thesis?

8 A Published papers generally were a subset of
9 what was in the thesis. They were concise and to the
10 point, and they made specific argument about something
11 we were trying to accomplish.

12 Q So it's fair to say that the published papers
13 are more of a -- conclusions and key takeaways, as
14 opposed to every single result along the way. Is that
15 fair?

16 MR. PETERSON: Object to form.

17 THE WITNESS: It's -- it's a -- it's a subset
18 of information that was in the thesis, which makes a
19 short and cogent argument.

20 BY MS. BOLL:

21 Q Were you the only author on the papers that
22 related to your thesis?

23 A No. I had co-authors.

24 Q What did the co-authors contribute?

25 A Well, in the case of my thesis advisor, he

1 contributed quite a bit of understanding of the
2 processes that were going on. Some other people may
3 have contributed certain measurements that I needed to
4 have taken that, you know, they had built equipment for.
5 So complementary, you know, capabilities that were --
6 that I need -- that needed to make a complete argument.

7 Q Okay. I want to shift gears a little bit, and
8 I'm going to put the '516 patent into the chat.

9 A Okay.

10 (Exhibit Number 1001-516 was
11 previously marked for
12 identification.)

13 BY MS. BOLL:

14 Q And I believe you also have a printed copy as
15 well if that's easier for you to reference.

16 A '516 patent, yes, I have that.

17 Q This is the '516 patent that is addressed in
18 your declaration in the 1039 IPR; right?

19 A Yes, it is.

20 Q Did you review this patent in forming your
21 opinions?

22 A Yes, I did.

23 Q Did you review the challenged claims of the
24 '516 patent?

25 A The challenged claims? Which are those?

1 Q 9 through 12.

2 A Yes, especially 9.

3 Q 9 is the only challenged independent claim in
4 this IPR; is that right?

5 A Well, yeah. Claim 1 is independent, but I
6 guess that's not challenged.

7 Q That's right. I'll make that representation.

8 A Okay. So, yes, Claim 9 is challenged and is
9 independent.

10 Q Is Claim 9 directed to a concentrator or a
11 non-concentrator solar cell? Can you tell?

12 A Claim 9 in and of itself?

13 MR. PETERSON: Object to form.

14 THE WITNESS: Well, if you look at the rest of
15 the patent, it certainly describes a 1-Sun solar cell.
16 For example --

17 BY MS. BOLL:

18 Q The claims --

19 A Yeah.

20 Q Sorry. Go ahead.

21 A Yeah. FIG. 2, for example, in the '516 patent
22 is that of a 1-Sun solar cell.

23 Q The claims do not specify a 1-Sun or a
24 concentrator solar cell; right?

25 A No, they do not specify.

1 Q And if we look at Claims 9 through 12 in
2 particular, Claims 9 through 12 do not specify the
3 required efficiency of the solar cell; right?

4 A They make no reference to cell efficiency.

5 Q Claims 9 through 12 do not specify the contact
6 resistivity of the claimed solar cell; right?

7 A They do not -- they do not require a contact
8 resistivity of any particular value.

9 Q Claims 9 through 12 do not require the solar
10 cell to be capable of being used for a commercial
11 product; right?

12 A Say that again.

13 Q Claims 9 through 12 do not require the solar
14 cell to be capable of being used for a commercial
15 product; right?

16 A They don't mention anything about its use.

17 Q Claims 9 through 12 do not require the solar
18 cell to be capable of being manufactured at scale; is
19 that right?

20 A They don't mention anything about
21 manufacturing.

22 Q Claim 9, the third limitation, recites "An
23 oxide layer formed between the back surface of the
24 substrate and the emitter layer."

25 Do you see that?

1 A Yes.

2 Q Could you just explain what's your
3 understanding of what an oxide layer is?

4 A Well, in this context, it means a silicon
5 dioxide layer, SiO₂.

6 Q The claims do not specify any particular recipe
7 or method to form the oxide layer; right?

8 A No, these claims do not.

9 Q The claims do not specify the material that the
10 oxide layer should be formed from; right?

11 A The claims themselves do not specify where they
12 should be formed from.

13 Q The claims do not specify the temperature at
14 which the oxide layer should be formed; right?

15 A They do not mention temperature.

16 Q The claims do not specify the thickness of the
17 oxide layer; right?

18 A The claim itself does not. In the
19 specifications, there's plenty of references to
20 thicknesses.

21 Q The claim itself does not specify a particular
22 thickness of the oxide layer; right?

23 A That's right.

24 Q The claims do not specify the degree of
25 tunneling that the oxide layer needs to achieve; right?

1 A The claim does not specify it.

2 MR. PETERSON: Objection.

3 THE WITNESS: Again, many of these are
4 mentioned in the specifications of the patent.

5 BY MS. BOLL:

6 Q But the claim itself does not specify the
7 degree of tunneling that the oxide layer must achieve;
8 right?

9 MR. PETERSON: Objection. Lacks foundation.

10 THE WITNESS: The claim itself does not mention
11 the degree of tunneling.

12 BY MS. BOLL:

13 Q If we can take a look now at the specification
14 and turn to Column 2.

15 A Column 2 of what?

16 Q Of the specification of the '516 patent.

17 A Okay. Column 2 on what page?

18 Q It's on PDF page 10.

19 A Let's see.

20 Q If it's easier, I can maybe share my screen.

21 A No. I found it. Okay. I got it.

22 Q Okay. And if we look at the paragraph
23 beginning around line 28, in the example of FIG. 1 -- do
24 you see that?

25 A Yes.

1 Q You reviewed this specification; right?

2 A Yes.

3 Q This paragraph describes "A backside junction
4 formed by a P-type doped polysilicon emitter, serving as
5 a P-type diffusion region, and an N-type silicon
6 substrate serving as an N-type diffusion region."

7 Do you see that?

8 A Yes, I do.

9 Q That's describing what is formed on the
10 backside surface of the substrate; right?

11 A Yes, that's right.

12 Q Okay. And if we look at line -- starting at
13 line 36, it states, "The front side surface of the
14 substrate."

15 Do you see that?

16 A Yes.

17 Q And it goes on to describe what's formed on the
18 front side surface of the substrate; is that right?

19 A Yes.

20 Q The front side surface, it says, "Includes
21 N-type doped regions 105 and 106 formed in the
22 substrate."

23 Do you see that?

24 A Yes.

25 Q So those are N-type doped regions formed in an

1 N-type substrate; is that right?

2 A That's right, yeah.

3 Q And the paragraph goes on to refer to this as
4 "N-dot." Do you see that?

5 A Yeah, right.

6 Q This paragraph does not describe forming N-type
7 doped regions on an N-type substrate as a junction; is
8 that fair?

9 A If by -- what do you mean by "junction"?

10 Q This paragraph does not use the word "junction"
11 to describe forming N-type doped regions on an N-type
12 substrate; right?

13 A Let's see. It doesn't look like it uses the
14 term junction to describe the front surface.

15 Q Okay. And I want to turn now back to the
16 declaration in the 1039 proceeding, Exhibit 2020.

17 A Which patent -- which patent is that?

18 Q The '516 patent.

19 A '516 patent declaration. Okay.

20 Q And I want to go back to the table with the
21 claims --

22 A Yeah.

23 Q -- which is on page 47.

24 A Right. And this is where there was a
25 typographical error.

1 Q Yes. So this table reprints Claim 1 of the
2 '516 patent on the left and then Claim 9 on the right
3 with a typo --

4 A Yes.

5 Q -- and the emitter layer --

6 A Yes.

7 Q -- limitation.

8 A Right.

9 Q Okay. And for Claim 1, you've added some color
10 coding to track N-type versus P-type substrates and
11 emitters; right?

12 A Yes, that's right.

13 Q Claim 1 requires a P-type polysilicon emitter;
14 right?

15 A Yes.

16 Q And Claim 1 requires an N-type silicon
17 substrate; right?

18 A That's correct.

19 Q That's what you show here in this table?

20 A Yes.

21 Q So a solar cell with an N-type polysilicon
22 emitter and a P-type substrate would not satisfy
23 Claim 1; is that fair?

24 A That's right. Not Claim 1, no.

25 Q Claim 9 is a little bit different; right?

1 A Yes.

2 Q For Claim 9, you could have an N-type
3 polysilicon emitter with a P-type silicon substrate;
4 right?

5 A Yes. It doesn't mention doping types at all.

6 Q So for Claim 9, you could have an N-type
7 emitter with a P-type substrate or a P-type emitter with
8 an N-type substrate; right?

9 A Yes. And you could have an N-type emitter with
10 a N-type substrate. It -- it doesn't mention types of
11 emitters or substrates whatsoever so that's --

12 Q So for --

13 A -- that's left vague.

14 Q So for Claim 9, you could have an N-type
15 silicon substrate and a P-type polysilicon emitter, same
16 as Claim 1; right?

17 A Yes.

18 Q And another option would be to have a P-type
19 silicon substrate and an N-type polysilicon emitter;
20 right?

21 A True. True. Yeah.

22 Q So Claim 9 is broader than Claim 1?

23 A Yes. And as I said, you also left out when
24 both emitter and substrate have the same poly
25 connectivity type, both P and N. There are four

1 permutations.

2 Q Let's take a look at the '053 patent now. I
3 will drop it into the chat.

4 A '053 patent. Okay.

5 Q Let me know when you have that --

6 A I've got it.

7 Q -- in front of you.

8 This is the '053 patent that's addressed in
9 your declaration in the 1040 IPR; right?

10 A That's correct.

11 Q You reviewed this patent?

12 A Yes, I did.

13 Q And you reviewed the claims of the patent?

14 A I did.

15 Q This patent is related to the '516 patent. I
16 think we discussed that earlier; right?

17 A They are related.

18 Q Based on your review, do the patents contain
19 essentially the same specifications?

20 A The specifications are similar.

21 Q At a high level, what is the '053 patent
22 directed to compared to the '516 patent?

23 A It looks like the difference is primarily how
24 the dopants are diffused into the deposited polysilicon
25 layer.

1 Q Are you looking at the claims or what is it
2 that you're looking at?

3 A That would be the claims, yes. The claims of
4 the '053 patent, specifically Claims 9 and 16.

5 Q Claims 9 and 16, I'll represent to you, are the
6 two independent claims that are challenged in the '053
7 patent proceedings.

8 A Right.

9 Q Okay. The '053 patent has method claims,
10 right, while this '516 has device claims?

11 A Right. That's why it talks about how the
12 dopants are diffused into the layer, the method by which
13 they're diffused.

14 Q And for this proceeding, you've assessed the
15 '053 patent and its claims from the perspective of
16 someone skilled in the art in early 2008; right?

17 A Yes.

18 Q Let's take a look at Claim 9. It recites, "A
19 method of fabricating a solar cell comprising, forming a
20 layer of polysilicon over a back-surface of a silicon
21 substrate, forming a first dopant source layer over a
22 layer of polysilicon, and diffusing dopants from the
23 first dopant source layer to the layer of polysilicon to
24 form a backside junction with the silicon substrate."

25 Those are the first three limitations. Do you

1 see that?

2 A Yes, I do.

3 Q You don't dispute that the prior art discloses
4 those limitations; right?

5 A No. It's a fairly common way of getting
6 dopants into a layer.

7 Q And so Claim 9 describes, first, forming the
8 polysilicon layer and then diffusing the dopant into the
9 polysilicon layer; right?

10 A Yes.

11 Q And the claim then describes that a backside
12 junction is formed when the dopant is diffused into the
13 polysilicon layer; right?

14 A Yes, that's right.

15 Q Okay. And if you turn to Claim 16 --

16 A Yes.

17 Q -- the first three limitations are -- are
18 similar; right? It's "forming an oxide layer over a
19 back-surface of the silicon substrate, forming a layer
20 of polysilicon over the oxide layer, and then diffusing
21 dopants into the layer of polysilicon to form a backside
22 junction with the silicon substrate"; right?

23 A Yeah. The -- I don't know what you call them.
24 The claims regarding forming an oxide layer are not
25 present in Claim 9, but they are present in Claim 16.

1 Q In Claim 16, it also describes first forming a
2 polysilicon layer and then diffusing dopants into that
3 polysilicon layer; right?

4 A Yes.

5 Q And the backside junction in Claim 16 is formed
6 when the dopant is diffused into the polysilicon layer;
7 right?

8 A They're saying a backside junction is formed
9 when the dopants are diffused. There are other meanings
10 to the word "junction."

11 Q In your view, the backside junction can be
12 formed at the interface of any two semiconductor
13 materials; right?

14 A Yes.

15 Q So if the polysilicon forms a back-surface
16 field with the substrate, that's also considered a
17 backside junction in your view?

18 A If the polysilicon forms a back-surface field?

19 Q Yes.

20 A That would mean it's of the same dopant type as
21 the substrate and, yes, that's considered a -- that
22 could be considered a backside junction.

23 Q So, in your view, if polysilicon forms a
24 back-surface field with the substrate, that would
25 constitute a backside junction?

1 A Polysilicon forms a heterojunction with
2 crystalline silicon regardless of whether an electric
3 field is formed or not. The materials are different.
4 That's what heterojunction means.

5 Q Okay. So in your view, it's -- strike that.

6 So it's your view that if polysilicon forms a
7 back-surface field with the substrate, that constitutes
8 a backside junction; right?

9 A That's one version of a backside junction, yes.

10 MR. PETERSON: Counsel --

11 BY MS. BOLL:

12 Q Have you relied on --

13 MR. PETERSON: Counsel, are we deposing him
14 based on his claim construction declaration or based on
15 the IPR?

16 MS. BOLL: Based on the IPR. We just looked at
17 his declaration and the different claims in the table.

18 MR. PETERSON: I understand you looked at the
19 claims, but this seems much more relevant to his claim
20 construction declaration than the IPR.

21 BY MS. BOLL:

22 Q Dr. Ruby, in forming your opinions in the IPR
23 proceeding, have you relied on your understanding that a
24 back-surface field is a type of backside junction?

25 A A back-surface field is a type of backside

1 junction.

2 Q And have you relied on that understanding in
3 forming your opinions in the IPR?

4 A Yes.

5 Q The challenged claims in the '053 patent IPR
6 are Claims 9 through 20; right?

7 A Right, and the two dependent Claims 9 and 16.
8 Independent.

9 Q Independent. Right.

10 Are the claims directed to -- strike that.

11 Do the claims specify whether they're directed
12 to a method of making a concentrator cell or a 1-Sun
13 cell?

14 A No, they don't. The claims themselves do not.

15 Q The claims of the '053 patent do not specify
16 the required efficiency of the solar cell resulting from
17 the method; right?

18 A No.

19 Q The claims of the '053 patent do not specify
20 the required efficiency of the solar cell; right?

21 A Yeah.

22 Q The claims of the '053 patent do not specify
23 the required contact resistivity of the solar cell
24 resulting from the methods; right?

25 A The claims do not require a particular contact

1 resistivity.

2 Q The claims do not require the solar cell that
3 results from the method to be capable of being used for
4 commercial products; right?

5 A The claims make no mention of the use of the
6 solar cell.

7 Q The claims do not require the solar cell that
8 results from the method to be capable of being
9 manufactured at scale. Is that fair?

10 A The claims do not mention anything about
11 manufacturing.

12 Q I'm uploading to the chat Exhibit 1006, which
13 is the Froitzheim time reference.

14 A Froitzheim reference. Okay.

15 MR. PETERSON: Counsel, we've been going for
16 about an hour. Could we take a break?

17 MS. BOLL: Oh, sure. We can go off the record.

18 (Exhibit Number 1006 was
19 previously marked for
20 identification.)

21 (Recess.)

22 MS. BOLL: We'll go back on the record.

23 BY MS. BOLL:

24 Q Dr. Ruby, before the break, I dropped the
25 Froitzheim reference, which is Exhibit 1006, in both of

1 the proceedings.

2 You reviewed the Froitzheim reference in
3 forming your opinions; correct?

4 A Yes, I did.

5 Q Are you familiar with the inventors Armin
6 Froitzheim or Adolf M nzer?

7 A No.

8 Q Froitzheim describes an operable solar cell;
9 right?

10 A Right.

11 Q What type of solar cell does Froitzheim
12 disclose?

13 A A backside junction solar cell.

14 Q Froitzheim uses the term "rear junction solar
15 cell." Is that right?

16 A Yes, rear and back are used interchangeably.

17 Q The substrate of Froitzheim uses the
18 Czochralski grown silicon; right?

19 A It just says "N-type bulk doping." It doesn't
20 say how the -- how the crystal is grown, not that I --
21 well, I don't know. I'd have to do a search for
22 Czochralski.

23 Q If you turn to paragraph 24 of Froitzheim,
24 which is on page 4 of the PDF --

25 A Yes.

1 Q -- it states, "Preferably Czochralski grown
2 silicon is used."

3 A Okay. Yep.

4 Q And Czochralski grown silicon is not a
5 crystalline silicon; right?

6 A Yes, it is.

7 Q Froitzheim teaches methods of driving in
8 dopants at the rear side of the substrate; right?

9 A Yes.

10 Q At that rear side, Froitzheim forms a diffused
11 emitter; right?

12 A Yes.

13 Q As opposed to a polysilicon emitter as
14 described in the claims of the '516 and '053 patents;
15 right?

16 A Yes, that's right.

17 Q What is a diffused emitter?

18 A It's an emitter where the dopant for the
19 emitter region is obtained by diffusion of a dopant
20 source into the substrate.

21 Q How is that different from a polysilicon
22 emitter?

23 A A polysilicon emitter is some -- is a layer
24 which is deposited on top of the crystalline substrate
25 rather than something that's diffused into it.

1 Q Froitzheim's methods include treating the wafer
2 in an atmosphere containing oxygen at a temperature of
3 900 to 1200 degrees Celsius; right?

4 A Yes. Preferably between 1000 and 1100.

5 Q Froitzheim's disclosures include using a
6 temperature of 900 degrees for driving in the dopants;
7 right?

8 A That is the extreme limit of his temperature
9 range.

10 Q The 900 degree temperature overlaps with the
11 900 degree anneal temperature taught by Gan; right?

12 A Yes, just barely.

13 Q The 900 degree temperature also overlaps with
14 the 900 degree anneal temperature taught in Kwark;
15 right?

16 A Let me take a look at Kwark. Yes. Kwark, in
17 fact, actually has data down to 850 degrees C.

18 Q Kwark also teaches an anneal temperature of
19 900 degrees; right?

20 A That's one of the data points he uses.

21 Q And that overlaps with the 900 degree
22 temperature at the lower end of Froitzheim; right?

23 A Yes, at the lower end of Froitzheim.

24 Q Froitzheim also discloses driving in the
25 dopants at a temperature of 925 degrees Celsius; right?

1 A Where?

2 Q 925 degrees is in the range of -- in
3 Froitzheim?

4 A It's in the range between 900 and 1200, true.

5 Q Froitzheim also discloses driving in dopants at
6 a temperature of 950 degrees; right?

7 A Well, he gives a range. I don't know if he's
8 got any data points in between.

9 Q Driving in dopants at a temperature from 900 to
10 1000 degrees Celsius would be consistent with what's
11 disclosed in Froitzheim; right?

12 A Between 900 and 1000, yes.

13 Q Froitzheim's disclosed temperature range is the
14 range for diffusing dopants into monocrystalline
15 silicon; right?

16 A It's at the lower end of the range for
17 diffusion.

18 Q In general, though, just at a higher level, the
19 disclosed temperature range in Froitzheim is for the
20 purpose of diffusing dopants into the Czochralski
21 silicon; right?

22 A Yes. It can be diffused within that range.

23 Q So the preferable range of 1000 to 1100 degrees
24 is what's preferable for diffusing dopants into a
25 monocrystalline silicon substrate; right?

1 A Not necessarily, but it's preferable for the
2 purpose for which Froitzheim was trying to accomplish
3 it, which was to create this rear junction solar cell.

4 Q So it's preferable for accomplishing a diffused
5 emitter; right?

6 A That temperature range, between -- whatever it
7 was -- 1000 to 1100 is preferable for a diffused emitter
8 for a back-surface solar cell.

9 Q Froitzheim is silent as to what temperatures
10 would be preferable for diffusing dopants into
11 polysilicon; right?

12 A It doesn't mention polysilicon at all.

13 Q So Froitzheim is silent as to what temperatures
14 would be preferable for diffusing dopants into
15 polysilicon; right?

16 MR. PETERSON: Objection. Asked and -- asked
17 and answered.

18 THE WITNESS: He doesn't mention polysilicon.

19 BY MS. BOLL:

20 Q Okay. I'm dropping into the chat the Kwark
21 reference, which is Exhibit 1008 --

22 A Yes.

23 Q -- in both of the proceedings.

24 (Exhibit Number 1008 was
25 previously marked for

1 identification.)

2 BY MS. BOLL:

3 Q Do you have that in front of you?

4 A Yes, I do.

5 Q You reviewed the Kwark paper in forming your
6 opinions; right?

7 A I did.

8 Q Do you know -- I don't know if it's Dr. or
9 Mr. Kwark?

10 A No, I don't know him.

11 Q The other two authors on this reference are Ron
12 Sinton and Richard Swanson.

13 Do you see that?

14 A Let me go up to page 1 and I'll find out. It's
15 an awful lot of proceedings. Ron Sinton, Richard
16 Swanson, yes.

17 Q Do you know Ron Sinton?

18 A Yes, I do.

19 Q How do you know him?

20 A I know him from the time that -- when I was at
21 Sandia and he was at both Stanford University and at
22 SunPower from our interactions in measuring and
23 developing concentrator silicon solar cells.

24 Q Was Ron Sinton a person of ordinary skill in
25 the art in 1984 when this paper was published?

1 A Ron Sinton was an exceptional person in the
2 art.

3 Q So his work would be well-respected in the
4 industry by -- around this time?

5 A Definitely.

6 MR. PETERSON: Object to form.

7 BY MS. BOLL:

8 Q And Richard Swanson, is that the same Richard
9 Swanson we discussed earlier?

10 A Yes.

11 Q And he was the founder of SunPower?

12 A Yes.

13 Q He was -- Richard Swanson was also a person of
14 ordinary skill in the art in 1984; right?

15 A At least.

16 Q His work would be well-respected by those in
17 the industry in 1984 and thereafter?

18 A Yes.

19 MR. PETERSON: Object to form.

20 BY MS. BOLL:

21 Q SunPower -- strike that.

22 Maxeon is a spin-off of SunPower; right?

23 A As I understand it, that's correct.

24 Q Okay. And if we look at Kwark, Kwark's
25 findings are not specific to concentrator or

1 non-concentrator solar cells; is that fair?

2 A It looks to me like Kwark is, again, working on
3 a test structure that would have applicability for all
4 kinds of electronic devices, including even transistors,
5 I believe.

6 Q You're familiar with Fig. 4 of Kwark; right?

7 A Yeah, I'm familiar with all the figures.

8 Q Can you turn, please, to Fig. 4, which is at
9 the top of page 15.

10 A Yes.

11 Q At the top of the figure, the -- the top line
12 is labeled "aluminum contact"?

13 A Right.

14 Q Do you see that?

15 A Yes.

16 Q What's your understanding of what the aluminum
17 contact line represents?

18 A That's a worst-case scenario as far as emitter
19 recombination is concerned where you have the maximum
20 amount of recombination physically possible at
21 the surface.

22 Q The aluminum contact sample is a sample with a
23 diffused emitter; right?

24 A Well, I would have to look into it. Aluminum
25 contact? Where is that referred to in the text?

1 Q I believe it is in the left-hand column on
2 page 743. I'm trying to find it and I'll share my
3 screen.

4 A Which paragraph?

5 Q The first full paragraph, "In order to
6 establish." I think it's in here.

7 A "In order to establish unambiguous results,
8 polysilicon films insitu in an RF heated cold wall APCVD
9 reactor."

10 I don't see where he mentions aluminum contact
11 at all. If you do, please direct me to it. Wait. "The
12 value for emitter B with a conventional aluminum contact
13 is shown for reference." Okay. "Emitter B which had a
14 Gaussian surface concentration." So, yeah, these were
15 diffused emitters.

16 Q So the aluminum contact one in Fig. 4
17 corresponds to a diffused emitter; is that right?

18 A I believe that's the case, yes.

19 Q Okay. So the aluminum contact one does not
20 have a polysilicon emitter and does not have a Chemox
21 layer; is that right?

22 A I believe that's the case, yes.

23 Q Is the aluminum contact sample similar to the
24 insubstrate diffuse emitter of Froitzheim?

25 A Yes, it is similar. It's a metal contact on a

1 diffused silicon surface.

2 Q And that diffused emitter, according to Kwark,
3 is associated with the highest measured $J_{0,e}$; right?

4 A Yeah.

5 Q The next two lines down labeled "No Chemox," do
6 you see those ones?

7 A Right.

8 Q The "No Chemox" sample, both of them, have a
9 lower $J_{0,e}$ than the diffused emitter aluminum contact
10 sample; right?

11 A Yeah. They're lower to some extent, right.

12 Q So according to Kwark, a polysilicon emitter
13 has a better $J_{0,e}$ as compared to a diffused emitter; is
14 that fair?

15 A The addition of poly without the Chemox does
16 not greatly impact $J_{0,e}$, as would be expected since
17 heavily doped poly acts essentially as an extension of
18 the monocrystalline emitter. Yes, it reduces it, but
19 not much.

20 Q And can you just explain what is $J_{0,e}$ as
21 compared to J_0 ?

22 A It's the emitter component of the -- let's see.
23 J_0 is the -- let's see -- emitter. It's the
24 recombination current. So it's a matter of
25 recombination occurring in the emitter region.

1 Q J0,e is the amount of recombination occurring
2 in the emitter region; right?

3 A Yes. Yes.

4 Q And it's advantageous for that amount of
5 recombination to be lower; right?

6 A Right. For solar cell purposes, correct.

7 Q Okay. Fig. 4 of Kwark shows two lines
8 corresponding to "With Chemox"?

9 A Yes.

10 Q One is a prediffused emitter and one is an
11 outdiffused emitter.

12 Do you see that?

13 A Yes.

14 Q The "With Chemox" samples have lower
15 recombination than the diffused emitter of the...

16 (Clarification requested by Reporter.)

17 THE WITNESS: The diffused emitter of the --
18 yeah, it did cut out.

19 MS. BOLL: Okay. I -- my -- my speaker said,
20 "PC disconnected." Can you hear me?

21 THE WITNESS: I can now.

22 MS. BOLL: Okay. Let me start again.

23 BY MS. BOLL:

24 Q Fig. 4 of Kwark shows two lines that correspond
25 to "With Chemox"; right?

1 A Yes.

2 Q One is a prediffuser polysilicon emitter and
3 one is an outdiffused polysilicon emitter; right?

4 A Okay.

5 Q The "With Chemox" emitters have a lower
6 recombination than the diffused emitter aluminum contact
7 sample; right?

8 A Yes.

9 Q And the "With Chemox" samples have lower
10 recombination than the "No Chemox" samples at the
11 measured temperatures; right?

12 A Yes, that's right.

13 Q Even at 1000 degrees Celsius anneal
14 temperature, the "With Chemox" samples have a lower
15 recombination than the "No Chemox" samples; right?

16 A But not by much. Oh, 900, did you say?

17 Q Sorry. Let me start again.

18 Even at 1000 degrees Celsius anneal
19 temperature, the "With Chemox" samples have a lower
20 recombination than the "No Chemox" samples; right?

21 A A small amount, yes, that's correct.

22 Q At 1000 degrees anneal temperature, the "With
23 Chemox" samples have a lower recombination than the
24 aluminum contact diffused emitter; right?

25 A Yes.

1 Q At 900 degrees Celsius, the "With Chemox"
2 samples have a lower recombination than the "No Chemox"
3 samples; right?

4 A Yes.

5 Q At 950 degrees, the "With Chemox" samples have
6 a lower recombination than the "No Chemox" samples;
7 right?

8 A He doesn't actually show data points at 950.
9 Those are just lines he drew between existing data
10 points.

11 Q Okay. So Kwark did not specifically measure
12 the J_0 at 950 but, rather, drew lines between a
13 measurement of 900 and a measurement at 1000. Is that
14 fair?

15 A That's what it looks like to me.

16 Q In your experience, would the J_0 at 950 be
17 somewhere between the value associated with a 900 degree
18 anneal and the value associated with 1000 degree anneal?

19 MR. PETERSON: Object to form.

20 THE WITNESS: It would be -- it would be
21 somewhere in between, but it's not exactly clear where.
22 It's not necessarily a straight line. It might be a
23 curved line.

24 BY MS. BOLL:

25 Q But, regardless, the J_0 at 950 for the Chemox

1 sample would be less than the "No Chemox" sample; is
2 that fair?

3 A I believe it would be so.

4 Q What is an "outdiffused emitter"?

5 A He's defining these terms. They're not
6 generally accepted.

7 Q Okay. How does Kwark define an outdiffused
8 emitter?

9 A I'm trying to find out. What label does he
10 give that? "B"?

11 Q That one is "C."

12 A "C." Okay. Emitter C relies solely on
13 outdiffusion from the doped poly to form the base
14 emitter junction. Whereas, Emitter B had a Gaussian
15 surface concentration. How he got that, I don't know.
16 He's not really clear that -- what these things -- how
17 he got them. Emitter, which had a Gaussian surface
18 emitter diffused prior to poly deposition. Okay. So
19 Emitter B was diffused prior to the poly deposition and
20 Emitter C relied on outdiffusion from doped poly. Okay.
21 So that's the difference.

22 Q Okay. And just so we can get a sort of clearer
23 record, what is an outdiffused emitter C versus an
24 outdiffused -- strike that.

25 What is an outdiffused emitter C according to

1 Kwark?

2 A Well, it sounds like he deposits or otherwise
3 dopes polysilicon films on a silicon substrate and then
4 uses the doping in the polysilicon to diffuse into the
5 crystalline substrate.

6 Q What is prediffused emitter B according to
7 Kwark?

8 A It sounds like a method where he did an emitter
9 diffusion directly into the crystalline substrate and
10 then deposited the polysilicon on top of it so they
11 result in different doping profiles in the silicon
12 substrate and the polycrystalline silicon layer.

13 Q Other than the different doping profiles, are
14 there other differences between the prediffused emitter
15 B and the outdiffused emitter C?

16 A Well, he doesn't mention any other differences.
17 He's just saying there are different methods by which
18 dopant was diffused into the semiconductor substrate and
19 resulting in different doping profiles. I don't know
20 what other difference is -- results from that.

21 Q Are you familiar, in your experience, with
22 these two different methods of doping the substrate?

23 A Well, in my experience -- well, I never did any
24 polysilicon deposition. So in my experience, I always
25 did an emitter diffusion directly into the silicon

1 substrate.

2 Q Is there any reason you would want to do a
3 prediffusion over an outdiffusion process?

4 A After he talks about the diffusion method --
5 oh, let's see. Prediffused emitter. Recombination in
6 the bulk of the emitter. This is adding a component.
7 Outdiffusion from a heavily doped poly.

8 All I can say is they result in different
9 diffusion profiles, and apparently that results in
10 different amounts of recombination.

11 Q Okay. Please take a look back at your
12 declaration, Exhibit 2020, in the 1039 proceeding.

13 A Which patent?

14 Q '516. Take a look at page 83.

15 A 83.

16 Q Which is PDF page 85, if that's helpful.

17 A I don't know the difference between what you're
18 talking about. I mean, they have page numbers at the
19 bottom.

20 Q Yeah. The page number at the bottom is 83.

21 A 83. I'm there.

22 Q And at the top of the page, there's an
23 annotated figure of Kwark; right?

24 A Yes, that's right.

25 Q Did you generate this figure? Strike that.

1 Did you generate the annotations on Fig. 4 at
2 the top of page 83?

3 A No, I did not.

4 Q Do you agree with the annotations at the top of
5 page 83 of your declaration?

6 A Yeah, I agree that if you continued to anneal
7 at higher temperatures, those lines would extend more or
8 less the way they are drawn there in red.

9 Q And this annotation provides what you believe
10 the recombination would be at an anneal temperature
11 greater than 1000 degrees Celsius; right?

12 A Approximately so.

13 Q You didn't conduct an actual experiment to
14 confirm that the level of J_0 would be observed over
15 1000 degrees; right?

16 A I did not conduct any experiments.

17 Q You did not perform any specific calculation to
18 arrive at the annotated red lines?

19 A No, I did not, but similarly to what you have
20 alleged, that the results for recombination at 950 would
21 be somewhere between those of 900 and 1000, I agree that
22 results above 1000 would probably fall somewhere close
23 to the red lines, which is known as an extrapolation of
24 results.

25 Q But you can't say for certain the temperature

1 would continue to increase linearly as you depicted in
2 Fig. 4; right?

3 A Well, the temperature would not increase
4 linearly and perhaps neither would the recombination.
5 They would simply continue to increase.

6 Q You're right. That was a bad question.

7 You can't say for certain that the J_0 would
8 continue to increase linearly as you've depicted; right?

9 A Not precisely linearly.

10 MR. PETERSON: Object to form.

11 THE WITNESS: But I do agree that they would
12 definitely tend to increase. Extrapolation is a method
13 used in science all the time and it's very justifiable.

14 BY MS. BOLL:

15 Q Kwark does not report any data at anneal
16 temperature of 1100 degrees Celsius; right?

17 A Not that I see.

18 Q Kwark does not report any data at an anneal
19 temperature of 1050 degrees Celsius; right?

20 A I don't see data points at those temperatures.
21 It seems like he goes up to 1000 degrees, which is the
22 maximum extent of his temperature range that he
23 investigated.

24 Q Your opinion is that a person of ordinary skill
25 in the art would understand from Kwark that a chemical

1 oxide layer works better when it's subject to low
2 temperature anneals at 900 Celsius or below; right?

3 A I'm sorry. I was distracted. Say that again.

4 Q No problem. Let me start again.

5 Your opinion is that a person of ordinary skill
6 in the art would understand from Kwark that the chemical
7 oxide layer works better when subject to low temperature
8 anneals at 900 degree Celsius or below; right?

9 A Yes.

10 Q So your opinion is that a person of ordinary
11 skill in the art would understand a Chemox layer will
12 work at 900 degrees Celsius; right?

13 MR. PETERSON: Object to form.

14 THE WITNESS: Well, I would say that this is
15 data that shows it has worked. It's not data that shows
16 that it always will work.

17 BY MS. BOLL:

18 Q So a person of ordinary skill in the art
19 reading Kwark would understand that Kwark successfully
20 showed lower recombination at 900 degrees Celsius with
21 use of a Chemox layer; is that fair?

22 MR. PETERSON: Object to form.

23 THE WITNESS: Yeah. He -- he has data
24 indicating that during his experiment he obtained lower
25 recombination at a 900 degree polysilicon anneal

1 temperature.

2 BY MS. BOLL:

3 Q And 900 degrees Celsius is one of the anneal
4 temperatures that's disclosed in Froitzheim; right?

5 A It is.

6 Q Take a look at paragraph 205 of your
7 declaration, which is on --

8 A Which declaration?

9 Q Sorry. Let's -- let's go to the '053
10 declaration. Thanks for clarifying.

11 A '053. What page?

12 Q 98.

13 A What paragraph?

14 Q Paragraph 205.

15 A Okay.

16 Q Your opinion is that a person of ordinary skill
17 in the art would not want to combine Froitzheim and
18 Kwark because "A Chemox layer simply does not have the
19 special properties of a tunnel oxide"; is that right?

20 A That's what I stated.

21 Q What is your basis for that statement?

22 A Well, in my experience, a chemical oxide layer
23 is formed, more or less, at room temperature using
24 aqueous solutions and reacting with a silicon surface.
25 They form a -- an oxide layer which cannot be

1 well-defined.

2 It -- it -- it has random chemical properties
3 and thicknesses. And it's not reproducible and it may
4 have impurities. It's not thought of as being a
5 particularly high quality oxide layer.

6 Q Is it your opinion that you do not get
7 tunneling through a Chemox layer generated using RCA
8 clean?

9 A You may get it once or twice. I mean, it's --
10 it's not reproducible. You know, it depends on, you
11 know, how -- how you splash the wafer around in the --
12 you know, in the HF. Or, I mean, it's not consistent.
13 It has impurities. You may get a particular instance
14 where you have -- where -- did you say tunneling?

15 Q Yeah.

16 A Where tunneling could be present, yes.

17 Q So it's possible --

18 A It's possible.

19 Q Sorry. Let me finish my question.

20 So it is possible to get tunneling through a
21 Chemox layer that's generated using RCA clean?

22 A It's possible.

23 MR. PETERSON: Object to form.

24 THE WITNESS: It's possible, but not
25 reproducible, and you may or may not get it.

1 BY MS. BOLL:

2 Q You don't cite any references that discuss
3 tunneling properties of chemical oxides in your
4 declaration; right?

5 A No, I don't cite them. Although, I mean, in my
6 research for this, reading the -- the Gan Thesis, he
7 talks himself about how the Chemox layer is unreliable,
8 irreproducible, and generally not of much value.

9 Q The Gan Thesis does not report on whether
10 Chemox layers have tunneling properties; right?

11 A I don't remember specifically what -- you know,
12 what the properties of Chemox are, other than to say
13 they are not reliable.

14 Q But it is possible for a Chemox layer to get
15 tunneling; right?

16 MR. PETERSON: Object to form.

17 THE WITNESS: I would say it may be possible.
18 Actually, the Kwark reference does not talk about
19 tunneling. It talks about recombination so that's a
20 different thing. I don't know if you can get tunneling
21 through a Chemox layer. It depends on how thick it is.
22 The thickness is uncontrolled. If it's too thick, you
23 won't get tunneling.

24 BY MS. BOLL:

25 Q So if --

1 A Unknown.

2 Q So if someone generates a thin Chemox layer,
3 it's possible to get tunneling; right?

4 MR. PETERSON: Object to form.

5 THE WITNESS: It depends on how thick it is.

6 (Clarification requested by the Reporter.)

7 MR. PETERSON: Object to form.

8 Dr. -- Dr. Ruby, you need to leave me enough
9 time to object.

10 THE WITNESS: Okay.

11 BY MS. BOLL:

12 Q You would agree, though, that methods of
13 forming a chemical oxide were known prior to 2008;
14 right?

15 A I would assume they were known, yes. I
16 don't --

17 Q And Kwark -- Kwark used RCA clean; right?

18 A Kwark used the RCA clean, yes.

19 Q What other methods were available prior to 2008
20 for forming a chemical oxide?

21 A I don't know.

22 Q You would agree that methods of forming a
23 thermal oxide were known prior to 2008; right?

24 A Thermal oxides, yes. Methods were not.

25 Q Were those methods difficult for those skilled

1 in the art to perform prior to 2008?

2 MR. PETERSON: Object to form.

3 THE WITNESS: Methods for what?

4 BY MS. BOLL:

5 Q Generating thermal oxides.

6 A No.

7 MR. PETERSON: Same objection.

8 BY MS. BOLL:

9 Q What were some of the known techniques for
10 generating thermal oxides prior to 2008?

11 A I already mentioned them. There's a wet
12 oxidation and a dry oxidation. There may be other
13 methods possibly. Then they wouldn't be called thermal
14 oxidations. They would be oxidations of another type,
15 but there are other methods.

16 Q Is LPCVD one of those methods?

17 A Right. That's low pressure chemical vapor
18 deposition. You could deposit an oxide. I wouldn't
19 call that a thermal oxidation. It's a deposited oxide.

20 Q Okay. And atmospher- -- is that atmospheric
21 pressure chemical vapor deposition? Is that something
22 different?

23 A Yes. That's deposition of a -- an oxide layer
24 at atmospheric pressure, but it's not a thermal
25 oxidation of the silicon.

1 Q Understood. You reviewed the Gan paper in
2 forming your opinions; right?

3 A Yes.

4 Q I'm going to put that into the chat now. This
5 is Exhibit 1007 in both of the proceedings.

6 A Okay.

7 (Exhibit Number 1007 was
8 previously marked for
9 identification.)

10 BY MS. BOLL:

11 Q Let me know when you have that open.

12 A I have it.

13 Q Do you know Dr. Gan?

14 A No.

15 Q The second author of the Gan paper is R.M.
16 Swanson.

17 Do you see that?

18 A Yes.

19 Q Is that the Richard Swanson we have been
20 discussing a couple times today?

21 A I presume so.

22 Q He was a person of ordinary skill in 1990 when
23 the Gan Thesis -- sorry. Strike that.

24 Dr. Swanson was a person of ordinary skill in
25 1990 when the Gan paper was published; right?

1 A Yes.

2 MR. PETERSON: Object to form.

3 BY MS. BOLL:

4 Q The Gan paper reports on concentrator solar
5 cells; right?

6 A Yes.

7 Q The Gan paper also states that its work is
8 quite useful for silicon solar cells, meaning 1-Sun
9 cells; right?

10 A Show me where.

11 Q If you take a look at page 249, on the
12 right-hand column --

13 A Yes.

14 Q -- towards -- the first sentence of the first
15 full paragraph, "The data shown in Fig. 6 are quite
16 useful for silicon cells," do you see that?

17 A Yes, I do.

18 Q Do you understand that to mean that the data is
19 useful in the non-concentrator solar cell context?

20 A I understand that he was writing this paper and
21 doing this research for the purposes of making
22 context-to-concentrator silicon solar cells, and I
23 believe that -- those are the ones that he's referring
24 to there.

25 Q If you take a look at page 246 of Gan, there's

1 a list of 12 steps on the left-hand side.

2 Do you see that?

3 A Yes.

4 Q If you take a look at Step No. 10 --

5 A Yes.

6 Q -- it says, "Drive-in; 900 to 1000 degrees C."

7 A Yes.

8 Q Do you see that?

9 A Right.

10 Q What is "drive-in"?

11 A It's what other people refer to as an anneal.

12 Essentially, you're raising the material to a high
13 temperature and allowing the dopant that's in the dopant
14 source layer to diffuse into, in this case, I think both
15 the polysilicon layer as well as probably going into the
16 crystalline silicon beneath it.

17 Q So Gan discloses doping at 900 to 1000 degrees
18 Celsius; right?

19 A Yes, that's right. Well, it denotes driving in
20 at temperatures between 900 and 1000, the drive-in
21 diffusion.

22 Q Okay. Gan discloses that "the second-step
23 anneal is optimal when performed at 900 degrees Celsius
24 for four hours"; right?

25 A Where does he say that?

1 Q Page 247.

2 A Where? "Results and Discussions"?

3 Q If you take a look at the table --

4 A Which table?

5 Q On -- sorry -- page 248.

6 A Okay.

7 Q Do you -- do you agree that Gan discloses that
8 the second-step anneal at 900 degrees Celsius for four
9 hours is optimal?

10 MR. PETERSON: Object to form.

11 THE WITNESS: Well, I don't know if it's
12 optimal, but it shows that for the temperatures and
13 times in this table, he has the lowest value for J0,e
14 for the 900 degree drive-in.

15 BY MS. BOLL:

16 Q Can you turn to your declaration in the '516
17 patent proceeding --

18 A Yes.

19 Q -- at page 67.

20 A 67. Okay. Where?

21 Q Paragraph 141.

22 A Okay.

23 Q In the second sentence of that, you state,
24 "This is Gan's second-step anneal, and it's optimal when
25 performed at 900 degrees Celsius for four hours."

1 Do you see that?

2 A Yes, I do.

3 Q Is that your opinion?

4 A Well, that's my opinion given the data that he
5 showed. It was the best result which he got for the
6 various conditions he tried.

7 Q So Gan's best result was achieved using a
8 second-step anneal of 900 degrees Celsius for four
9 hours; right?

10 A Yes, that's right.

11 MR. PETERSON: Objection. Asked and answered.

12 THE WITNESS: Whose turn is it?

13 MR. PETERSON: You can go, but you've got to
14 give me time to object, Dr. Ruby.

15 THE WITNESS: Okay. Do you want me to answer?

16 MR. PETERSON: Yes. Go ahead.

17 THE WITNESS: He got the best result when he
18 did the drive-in diffusion at 900 degrees for four
19 hours.

20 BY MS. BOLL:

21 Q You also reviewed the Gan Thesis in forming
22 your opinions; right?

23 A I did. Excerpts of it, really.

24 Q You did not review the full thesis?

25 A Not in its entirety, no.

1 Q Do you recall which sections you reviewed?

2 A No. I reviewed excerpts regarding --
3 essentially regarding his difficulty in obtaining
4 reproducible oxide thicknesses.

5 Q Did you select the excerpts you reviewed or
6 were they selected by counsel?

7 MR. PETERSON: Objection to the extent it calls
8 for privilege. I don't want him answering what counsel
9 suggested.

10 MS. BOLL: Okay. Can he answer yes, like
11 whether he selected it or whether counsel selected it?

12 MR. PETERSON: As long as that's as far as you
13 go.

14 MS. BOLL: Yeah, that's -- okay. So let me
15 re-ask. And just -- just stick to answering the
16 question directly, Dr. Ruby. I'm not trying to get into
17 anything privileged.

18 BY MS. BOLL:

19 Q Did you select the excerpts of the Gan Thesis
20 that you reviewed or were they selected by counsel?

21 A They were selected by counsel.

22 Q The Gan Thesis acknowledges that thin oxide
23 growth may be improved by performing the oxidation at
24 lower temperatures such that the oxide rate can be
25 controlled more precisely; right?

1 A That was his speculation. I don't believe he
2 actually did that and proved it.

3 Q You would agree that it was known prior to 2008
4 that lowering the temperature at which an oxide is
5 formed will slow the growth of the oxide layer; right?

6 MR. PETERSON: Object --

7 THE WITNESS: Lower temperatures result in
8 slower growth rates.

9 (Clarification requested by Reporter.)

10 MR. PETERSON: Object to form.

11 And, Dr. Ruby, you've got to give me time.

12 THE WITNESS: Okay. Lower temperatures result
13 in slower growth rates.

14 BY MS. BOLL:

15 Q So it was known prior to 2008 that lowering the
16 temperature at which an oxide is formed will slow the
17 growth of that oxide; right?

18 A Yes.

19 Q The Gan Thesis reflects some musings of the
20 author; is that right?

21 A Speculations, yes.

22 Q The Gan Thesis reflects just theories and
23 unproven speculation; right?

24 A I wouldn't say "just." I mean, he presents
25 results of experiments and then he also speculates about

1 what could have happened had he done things differently.

2 Q A POSITA would recognize Gan Thesis's musings
3 as admittedly just theories and unproven speculation;
4 right?

5 A Well, if he said something like should or would
6 or could, then you have to take him at face value and
7 assume he means if he had done this, that might have
8 happened.

9 Q Can you take a look at paragraph 157 of your
10 declaration of the '516 patent.

11 A '516 declaration, paragraph --

12 Q 157, and it's on pages 74 to 75.

13 A 157. Okay. Okay. I'm there.

14 Q If you -- if you take a look at the portion of
15 the paragraph on page 75, it says, "Stepping back,
16 however, a POSITA would recognize Gan Thesis's musings
17 as admittedly just theories and unproven speculation."

18 Do you see that?

19 A Yes.

20 Q Is that your opinion?

21 A Well, they were certainly unproven speculation.

22 Q The Gan paper, Exhibit 1007, is a polished work
23 that Dr. Swanson signed onto as an author; right?

24 A Yes.

25 MR. PETERSON: Object to form.

1 BY MS. BOLL:

2 Q That paper was presented at the IEEE?

3 A Let's see what it says. Well, you know, the
4 copy I have doesn't say where it was published. Where
5 is it in the -- let's see.

6 Q I think it's the most recent one in the chat,
7 if you want to look at the electronic version, or it
8 should be in your binder.

9 A Most recent version. Let's see. So Gan.
10 Okay. Let me open it up. Okay. Gan. All right.
11 A-ha. Yes. It was a conference paper given at the 21st
12 IEEE PVSC. Okay.

13 Q So the Gan paper was presented at the IEEE
14 Photovoltaic Specialists Conference in 1990?

15 A Yes. Yes.

16 Q The Gan paper has been cited by other papers;
17 right?

18 A I'm not aware of any.

19 Q Okay. So you didn't look into whether the Gan
20 paper was cited in any other papers or patents?

21 A No.

22 Q Has the Gan Thesis been cited in any papers or
23 patents?

24 A I don't know. I didn't look into the citations
25 of these references.

1 Q You said you don't know Dr. Gan personally;
2 right?

3 A No, I don't.

4 Q At the time of his thesis, you don't know
5 whether he was a person of ordinary skill in the art or
6 not; right?

7 A At the time of his thesis? He -- whether he
8 was ordinarily skilled in what art? The art of solar
9 cells?

10 Q So if you take a look at your declaration,
11 page 10 --

12 A Which declaration?

13 Q The '516. You can stick with that one.

14 A Okay. Page 10.

15 Q It says you were asked to apply the level --
16 the skill level of a person of ordinary skill in the art
17 that is proposed in the petition, which is someone with
18 an advanced degree involving various disciplines and at
19 least two years of experience designing, developing, or
20 researching in the field.

21 A Right.

22 Q So applying that definition, you don't know
23 whether Gan was a person of ordinary skill at the time
24 of his thesis; right?

25 MR. PETERSON: Object to form.

1 THE WITNESS: Thesis and his paper, it looks to
2 me like he -- he was a person of ordinary skill in the
3 art.

4 BY MS. BOLL:

5 Q Can you point me to where in your declaration
6 you provide your opinion that Gan was a person of
7 ordinary skill in the art at the time of his thesis?

8 A Well, he certainly -- I mean, he was working
9 his Ph.D. thesis. So, I mean, he had a bachelor's
10 degree, and generally speaking, it takes several years
11 before you get to the point where you can write a Ph.D.
12 thesis. And I think one of the definitions was
13 bachelor's degree plus three years working in the field.

14 Q But you don't know one way or another whether
15 Gan had been working for at least three years at the
16 time he performed all of his research for his thesis;
17 right?

18 MR. PETERSON: Object to form.

19 THE WITNESS: I don't know -- I don't know for
20 certain.

21 MS. BOLL: It's a good time to break for lunch
22 if that works for you all. Could we go off the record?

23 THE WITNESS: That would be fine with me.

24 MS. BOLL: Okay.

25 (Recess.)

1 BY MS. BOLL:

2 Q Dr. Ruby, we took a few breaks today. Did you
3 speak with counsel on any of those breaks?

4 A Yeah, I called Jeremy and asked him how he
5 thought I was doing.

6 Q What did he say?

7 A He said he thought I was doing well.

8 Q Okay. Did you speak about anything else with
9 counsel?

10 A No.

11 Q Aside from your call with Mr. Peterson, did you
12 speak to anyone else on our breaks?

13 A No, I did not.

14 Q Okay. I want to return to the Gan paper, which
15 is Exhibit 1007. If you could turn to page 249, the
16 paragraph above "Conclusions."

17 A Yes.

18 Q Gan reports on the difference between a
19 polysilicon emitter with an interfacial oxide and a
20 diffused emitter; right?

21 A Well, he reports on the results of a
22 polysilicon emitter with an interfacial oxide.

23 Q In this paragraph, it states, first, most of J0
24 are below 5 times 10 to the -14 A/cm squared, which is
25 about one order magnitude lower than that of diffused

1 emitters.

2 Do you see that?

3 A Yes.

4 Q So according to Gan, a diffused emitter has a
5 j naught about one order of magnitude higher --

6 A Yes.

7 Q -- than a polysilicon emitter; right?

8 A Well, the polysilicon emitter is with his
9 tunnel oxide in between.

10 Q That's right. So according to Gan, a diffused
11 emitter has a j naught of about one order of magnitude
12 higher than a polysilicon emitter with a tunnel oxide?

13 A Yes.

14 MR. PETERSON: Object to form.

15 THE WITNESS: Yes. His J0s are less than what
16 you generally get with diffused emitters.

17 BY MS. BOLL:

18 Q And Gan reports that it's about "one order of
19 magnitude lower"; right?

20 A That's what he says.

21 Q He also reports a lower Rc; is that right?

22 A He says that most of the contact resistivities
23 are lower than 5 times 10 to the minus 5 ohm square
24 centimeters.

25 (Clarification requested by Reporter.)

1 THE WITNESS: He says that most of the contact
2 resistivities are lower than 5 times 10 to the minus 5
3 ohm square centimeters.

4 BY MS. BOLL:

5 Q And "contact resistivity" is R_c ; right?

6	A	Yes.
---	---	------

7 Q That contact resistivity of lower than 5 times
8 10 to the minus 5 ohm per centimeter square reflects the
9 contact resistivity of polysilicon emitters with a
10 tunnel oxide; right?

11 A Those are the resistivities he measured for his
12 polysilicon emitters on top of a tunnel oxide.

13 Q I'm going to drop into the chat the Borden
14 reference --

15	A	Okay.
----	---	-------

16 Q -- Exhibit 1009.

17	A Okay.
----	---------

18 (Exhibit Number 1009 was
19 previously marked for
20 identification.)

21 BY MR. B LL:

22 | Q Let me know when you have that open.

23 A All right. Borden. That's Gan. Oh, there's
24 more. Borden. Okay. Downloads. The rain is coming
25 down very hard.

1 Q Do you have Borden open now?

2 A I do.

3 Q You reviewed the Borden patent publication in
4 forming your opinions on the '516 patent; right?

5 A Yes, I did.

6 Q Are you familiar with the named inventor Peter
7 Borden?

8 A Am I familiar with Peter Borden, the author?

9 Q Yeah.

10 A No.

11 Q If you take a look at the abstract at the
12 bottom of page 1 --

13 A Yes.

14 Q -- the first sentence is "The present invention
15 relates to improved HIT-type or polysilicon emitter
16 solar cells."

17 Do you see that?

18 A Yes, I see that.

19 Q So Borden discusses, in part, HIT solar cells;
20 right?

21 A Yes.

22 Q What is a HIT solar cell?

23 A It's a heterojunction solar cell which uses
24 amorphous silicon as the emitter of the solar cell.

25 Q HIT cells, that H-I-T stands for

1 "heterojunction intrinsic thin layer cells"; right?

2 A Exactly.

3 Q What is a heterojunction?

4 A A heterojunction is the joining of two
5 dissimilar materials.

6 Q That's different from a homojunction; right?

7 A Right. Homojunction is the joining of two
8 materials with the same crystal structure and chemical
9 makeup.

10 Q In terms of their properties, how is a
11 heterojunction different from a homojunction?

12 A The amorphous silicon has a higher bandgap than
13 crystalline silicon, so there's a huge -- there's a
14 large bandgap discontinuity at the heterojunction. This
15 leaves strong electric fields being generated at the
16 junction.

17 Q Any other differences in properties between a
18 heterojunction and a homojunction?

19 A Aside from the bandgap discontinuity, well,
20 there's different -- different absorption coefficients
21 in the heterojunction -- in the amorphous material, so
22 it absorbs different -- different wavelengths of light,
23 either more or less strongly.

24 Q If you form an emitter, it's either a
25 heterojunction or a homojunction. Is that fair?

1 A Yes, an emitter can be formed either as a
2 heterojunction or a homojunction.

3 Q But not both and not neither. Is that fair?

4 MR. PETERSON: Object to form.

5 THE WITNESS: Did you say something?

6 MR. PETERSON: I said object to form.

7 THE WITNESS: It's really noisy here right now.
8 Say the question again.

9 BY MS. BOLL:

10 Q Sure. You stated that an emitter can be formed
11 either as a heterojunction or a homojunction?

12 A Yes.

13 Q So if you form an emitter, it needs to be one
14 or the other as opposed to both or neither. Is that
15 fair?

16 A Well, you can't -- yes, it's either one or the
17 other. Yes.

18 Q How is a HIT solar cell different from a
19 polysilicon emitter solar cell?

20 A Well, polysilicon has the same bandgap as
21 crystalline silicon so you don't get the benefit of the
22 bandgap discontinuity, and it won't perform as well in
23 general.

24 Q If we turn to paragraph 16 of Borden, which is
25 on page 4.

1 A Paragraph 16, yes.

2 Q It states, "The present inventors recognized
3 that thin tunnel oxide layers can be used in solar
4 cells?"

5 Do you see that?

6 A Recognize that tunnel oxides can be used
7 between --

8 Q In solar cells.

9 A Well -- oh, first sentence. Yes. Right.

10 Q Okay. And then it goes on to state, as I think
11 you had recognized, "The present inventors further
12 recognize that tunnel oxides can be used between a
13 heavily doped or insulating layer of polysilicon and a
14 crystalline silicon substrate forming a polysilicon
15 emitter solar cell."

16 Do you see that?

17 A Yes, I do.

18 Q So the inventors did disclose an embodiment in
19 Borden forming a polysilicon emitter solar cell with a
20 tunnel oxide?

21 A Yes, they do, but then it goes on to say in the
22 same paragraph that such cells do not provide the
23 benefit of a higher cell voltage that would be accrued
24 using the amorphous silicon.

25 Q So you agree that polysilicon solar cells do

1 not provide the heterojunction and its benefit of a
2 higher cell voltage due to the higher bandgap of
3 amorphous silicon; right?

4 A Right. The polysilicon cells do not provide
5 that.

6 Q In fact, in your declaration, you argued that
7 Borden distinguishes polysilicon emitter solar cells
8 from HIT cells because polysilicon emitter solar cells
9 do not provide the heterojunction; right?

10 A What part of my declaration are you referring
11 to?

12 Q You could take a look at paragraph 233 --

13 A Which -- which one?

14 Q The '516.

15 A '516. Paragraph --

16 Q 233. It's on pages 110 to 111.

17 A 233. I'm going to close my window shade here
18 and turn on the light because I can't hear over the
19 thunderstorm.

20 Q Okay. No problem.

21 A All right. Where do you want me to look?

22 Q In your declaration at Paragraph 233, your '516
23 patent declaration.

24 A Yes.

25 Q Okay. And it goes on to page 111.

1 A Right.

2 Q Your opinion is that Borden distinguishes
3 polysilicon emitter solar cells from HIT cells because
4 polysilicon emitter solar cells do not provide a
5 heterojunction; right?

6 A Yes.

7 Q So your opinion is that polysilicon emitter
8 solar cells do not provide a heterojunction?

9 A Well, they do not provide -- they -- they are a
10 heterojunction, but they don't provide the bandgap
11 discontinuity. It's a different type of heterojunction.

12 Q So you disagree with Borden's statement that
13 polysilicon emitter solar cells do not provide a
14 heterojunction?

15 A We're going into semantics now. They don't
16 provide the type of heterojunction that he is referring
17 to, meaning one with a bandgap discontinuity. In
18 general, heterojunction can mean more than just one type
19 of discontinuity. For example, polysilicon cells
20 provide a heterojunction between crystalline and
21 polycrystalline silicon. That is a heterojunction, but
22 it's not the one that Borden's talking about here.

23 Q In your declaration, you don't clarify this
24 portion of Borden to explain this sentence; right?

25 A What I'm doing is simply copying what he wrote

1 in his paper.

2 Q Okay. And you don't say that you disagree with
3 it or that you need to clarify what -- what he meant by
4 "polysilicon emitter solar cells do not provide a
5 heterojunction"?

6 A Well, what I'm saying is he, himself, realizes
7 that a polysilicon emitter cell does not provide the
8 benefit that the heterojunction using amorphous silicon
9 would have provided. I'm agreeing with him. He,
10 himself, is pointing it out.

11 Q So when Borden says, "Polysilicon emitter solar
12 cells do not provide a heterojunction" --

13 A Yes.

14 Q -- you disagree?

15 A No. I agree. They don't provide the kind of
16 heterojunction that he would like to -- to see, which is
17 a heterojunction using amorphous silicon.

18 Q Okay. If we take a look at Borden
19 paragraph 8 -- let me know when you're there.

20 A Borden paragraph 8. Okay. I'm there.

21 Q This talks about, towards the middle of the
22 paragraph, some benefits of the invention; right?

23 A Right.

24 Q It says, "Moreover, the tunnel oxide prevents
25 epitaxial growth of amorphous silicon."

1 Do you see that?

2 A Yes, I see it.

3 Q What is epitaxial growth?

4 A Epitaxial growth is crystalline growth, a
5 continuation of the crystal structure of the substrate.

6 Q Is epitaxial growth -- strike that.

7 What is amorphous silicon?

8 A Amorphous silicon is a glassy form of silicon
9 where the distances between adjacent atoms and their
10 orientation is random and not structured the way it is
11 in crystalline silicon.

12 Q Polysilicon has crystallated [sic] structures;
13 right?

14 A Polycrystalline is a type of crystalline
15 silicon where there are many individual crystalline
16 grains or -- yes, grains, but they -- they're very
17 small, and they have random orientation relative to
18 adjacent grains.

19 Q Amorphous silicon does not have crystalline
20 structures in it; right?

21 A That's correct.

22 Q Polysilicon has a different bandgap than
23 amorphous silicon as well; right?

24 A That's correct.

25 Q What is the relative difference in the bandgap

1 between those materials?

2 A Crystalline or polycrystalline silicon, I
3 believe, has a bandgap of about 1.1 electron volts.
4 Whereas, amorphous silicon is more like 1.8 electron
5 volts, which is significantly larger.

6 Q Aside from the bandgap and the crystalline
7 structure, are there other differences between amorphous
8 silicon and polysilicon?

9 A I believe the resistivity is different.

10 Q Anything else?

11 A There may be other differences. I don't have
12 them all at my fingertips.

13 Q Okay. But that's all you recall just sitting
14 here today?

15 A Yes.

16 Q If we turn to the end of paragraph 8, which
17 goes on to this -- the next page of Borden --

18 A Yes.

19 Q -- it's -- it describes another advantage of --
20 of the tunnel oxide, which is that, "It may be used in
21 conjunction with a point contact structure to further
22 increase efficiency."

23 Do you see that?

24 A Yes.

25 Q What does that sentence mean?

1 A Well, that way you could limit the area of
2 contact to the underlying substrate.

3 Q And that will increase efficiency of the solar
4 cell?

5 A Not necessarily, but some point contact solar
6 cells, if they're made correctly, can have higher
7 efficiency.

8 Q The words "amorphous silicon" do not appear in
9 this sentence; right?

10 A Not in that sentence.

11 Q So Borden does not limit the advantage of the
12 point contact structure to just an embodiment with
13 amorphous silicon; right?

14 A Well, repeat the question.

15 Q Borden does not limit the described advantage
16 of the point contact structure to just an embodiment
17 with amorphous silicon; right?

18 A Apparently not.

19 Q So the advantage of the point contact structure
20 is not specifically limited to the application of
21 amorphous silicon; right?

22 A Say it again.

23 Q So the advantage of the point contact structure
24 of Borden is not specifically limited to amorphous
25 silicon applications; right?

1 A Apparently, yes, that's what he's suggesting.

2 Q Take a look at paragraph 18 of Borden, which is
3 on page 5.

4 A Okay.

5 Q This paragraph describes --

6 A Yes.

7 Q -- a dielectric layer.

8 Do you see that?

9 A A thin dielectric layer. A tunnel oxide is
10 provided. Okay.

11 Q Is a tunnel oxide a type of dielectric layer?

12 A Yes, it's a type of dielectric layer.

13 Q It describes that the thin dielectric layer 228
14 (e.g. tunnel oxide) can be formed using conventional
15 methods such as rapid thermal oxidation, furnace
16 oxidation, or the Chemox process.

17 Do you see that?

18 A Yes.

19 Q What is the rapid thermal oxidation method?

20 A Well, it's exactly what it describes. You
21 oxidize something rapidly. So it's a very short
22 duration excursion to a high temperature.

23 Q Do you agree that it was conventional to use
24 rapid thermal oxidation prior to 2008?

25 A I don't know if it was conventional, but it

1 certainly has been used during solar cell processing.

2 MR. PETERSON: Object to form.

3 BY MS. BOLL:

4 Q So it was at least known to those skilled in
5 the art prior to 2008?

6 A Yes. It was generally widely known.

7 Q Is rapid thermal oxidation a difficult process?

8 A I don't know what you mean by "difficult."

9 Q In terms of sort of the capabilities of a
10 person of ordinary skill in the art in 2008.

11 A It's no more difficult than the furnace
12 oxidation.

13 Q Before 2008, what was the relative cost of
14 rapid thermal oxidation compared to other methods?

15 A I'm not familiar with the costs.

16 Q What is furnace oxidation?

17 A Putting silicon wafers into a tube furnace,
18 providing a source of oxygen, and elevating the
19 temperature.

20 Q Was furnace oxidation known to those with skill
21 in the art prior to 2008?

22 A Yes.

23 Q Would you agree with Borden that it was a
24 conventional method prior to 2008?

25 A Yes.

1 Q Are you familiar with the costs of furnace
2 oxidation?

3 A Not really.

4 Q The third method Borden references is the
5 "Chemox process (formation in an ozonated H2O2 bath.)"

6 Do you see that?

7 A Yes.

8 Q What is that process?

9 A Well, I'm not totally familiar with it, but it
10 sounds like you put the silicon wafer in hydrogen
11 peroxide that has had ozone, which is O3 dissolved in
12 it.

13 Q Would that have been known to those skilled in
14 the art prior to 2008?

15 A I didn't know about it, but I didn't spend a
16 lot of time working with chemical oxides because of
17 their generally accepted view that they were unreliable.

18 Q Borden did not report that chemical oxides were
19 unreliable; right?

20 A No, he did not report it.

21 Q Borden instead described Chemox formation as
22 conventional; right?

23 A That's how he described it.

24 Q Paragraph 24 of Borden, which is on page 6 to
25 page 7, describes "Plasma enhanced chemical vapor

1 deposition."

2 Do you see that?

3 A It's in paragraph 24?

4 Q Yeah.

5 A Oh, it carries over to the next page.

6 Amorphous silicon is formed. For example, by PE-CVD.

7 Okay.

8 Q You're familiar with PE-CVD; right?

9 A Yes.

10 Q That was well-known in the literature prior to
11 2008?

12 A Yes.

13 Q So those skilled in the art could reliably
14 generate oxide layers using PE-CVD prior to 2008?

15 A In this -- in this sentence, he's talking about
16 depositing amorphous silicon layers using PE-CVD.

17 Q I see.

18 A Not -- not oxide layers.

19 Q Okay. So in this embodiment -- that's right --
20 it says in the beginning of paragraph 24, a rapid
21 thermal oxide process is used to form a thin tunnel
22 oxide; right?

23 A That's what he's suggesting, yes.

24 Q So those skilled in the art can reliably
25 generate a thin thermal oxide --

1 A I would say --

2 Q -- prior to 2008 using this rapid thermal oxide
3 process?

4 MR. PETERSON: Object to form.

5 THE WITNESS: Apparently, it was available. I
6 don't know how reliable it was or how conventional it
7 was or how well-known it was.

8 BY MS. BOLL:

9 Q But Borden at least reports that rapid thermal
10 oxidation could be used to form a thin tunnel oxide
11 prior to 2008?

12 A Yes, that's what he reports.

13 Q Okay. I'd like to turn now to the Foglietti
14 reference, and I'm sending that one through the chat
15 now. Let me know when you have it open.

16 A Okay. Foglietti. Okay. I have it open.

17 (Exhibit Number 1014 was
18 previously marked for
19 identification.)

20 Q You reviewed Foglietti in forming your opinions
21 in both the IPRs; right?

22 A Yes.

23 Q Are you familiar with the named inventors,
24 Foglietti and Carl Willis?

25 A No.

1 Q "Foglietti disclosed a method of forming an
2 interfacial oxide with good control which maintains its
3 integrity during subsequent processing"; is that right?

4 A Where does he say that?

5 Q I'm in Paragraph 10, which is the first page
6 after the figures.

7 A It looks like Paragraph 10 is before summary of
8 the invention. I don't see the line you're talking
9 about.

10 Q It says, "Therefore, there is a need in the art
11 for a method of forming an interfacial oxide with good
12 control which maintains its integrity during subsequent
13 processing."

14 A Well, yeah, there remains a need, yes.

15 Q And that's the goal the invention was designed
16 to solve; right?

17 A Apparently, yes.

18 Q And if we look at the next paragraph, it
19 states, "The present invention." Do you see that?

20 A Yes.

21 Q And it states, "The present invention relates
22 generally to the formation of a tightly controllable
23 interfacial oxide in conjunction with a bipolar
24 transistor, wherein the interfacial oxide maintains
25 exemplary integrity during thermal processing."

1 Do you see that?

2 A Yeah, I do.

3 Q And this Foglietti reference is dated in -- is
4 published in October 2002; right?

5 A 2000 what?

6 Q '2.

7 A Okay.

8 Q So as of 2002, it was possible to form a
9 tightly controlled interfacial oxide; is that right?

10 MR. PETERSON: Object to form.

11 THE WITNESS: Well, that's what he claims, yes.

12 BY MS. BOLL:

13 Q And in 2002, it was possible to form an
14 interfacial oxide that would maintain exemplary
15 integrity during subsequent thermal processing?

16 MR. PETERSON: Object to form.

17 THE WITNESS: That's what he's claiming, yes.

18 BY MS. BOLL:

19 Q Foglietti relates to bipolar transistors;
20 right?

21 A That's what he claims, yes.

22 Q And although Foglietti relates to bipolar
23 transistors, the tunneling mechanism that he applies
24 also applies to solar cells; is that right?

25 A Well, tunneling would apply to any

1 semiconductor device.

2 Q So the tunneling mechanism of bipolar
3 transistors is applicable to solar cells. Is that fair?

4 A It would be.

5 Q Why do you say that?

6 A Well, tunneling is a process which occurs when
7 the oxide layer is thin enough that majority carriers
8 can go through it and the minority characters are
9 blocked. And that's the case regardless of what kind of
10 a device it is.

11 Q So is it fair, then, to apply the teachings of
12 Foglietti to the solar cell context?

13 A It should be.

14 Q So would you agree that a person of ordinary
15 skill in the art would look to bipolar transistor
16 references as relevant to designing a solar cell?

17 A It could be relevant.

18 Q Would you agree that bipolar transistor
19 conditions have to be even more tightly controlled than
20 those for a 1-Sun solar cell?

21 MR. PETERSON: Object to form.

22 THE WITNESS: I wouldn't necessarily agree with
23 that.

24 BY MS. BOLL:

25 Q If we can take a look back at your declaration

1 in the '516 proceeding -- I'm sorry -- in the '053
2 proceeding, so the 1040 case number.

3 A Yes. Which page?

4 Q Page 45. This is the table of the claims.

5 A Okay.

6 Q In this table, you've reprinted Claim 1,
7 Claim 9, and Claim 16; right?

8 A Yes, I have.

9 Q Those are the three independent claims of the
10 '053 patent?

11 A That's right.

12 Q And here you've added color coding to track the
13 N-type versus the P-type substrate and dopant; right?

14 A Yes.

15 Q Claim 1 requires an N-type silicon substrate;
16 right?

17 A Yes.

18 Q Claim 1 also requires a P-type dopant; right?

19 A Yes.

20 Q And that's what you've illustrated here for
21 Claim 1 in the table; right?

22 A Right.

23 Q So a solar cell -- a method of making a solar
24 cell with a P-type substrate and an N-type dopant would
25 not fall within the scope of Claim 1; right?

1 A That's true.

2 Q For Claim 9, though, you could have an N-type
3 dopant with a P-type substrate; right?

4 A Yes, that's true.

5 Q Or you could have a P-type dopant and an N-type
6 silicon substrate as with Claim 1; right?

7 A Right. Claim 9 is -- doesn't mention the
8 polarity of the dopant or the substrate.

9 Q So Claim 9 is broader than Claim 1?

10 A That's true.

11 Q And the language in Claim 16 is also a little
12 bit different from Claim 1; right?

13 A Yes, it is.

14 Q For Claim 16, you could have an N-type dopant
15 and a P-type silicon substrate; right?

16 A Yes. It doesn't mention the polarities of the
17 dopant to form the emitter or the substrate.

18 Q So for Claim 16, you could also have, as with
19 Claim 1, a P-type dopant and an N-type substrate?

20 A You could.

21 Q So Claim 16 is also broader than Claim 1;
22 right?

23 A Yes, it is.

24 Q Have you communicated, aside from your call
25 with counsel, with anyone during today's deposition?

1 A No.

2 Q Since the time we went on the record this
3 morning, did you look at any materials other than what's
4 in the binders and what I've dropped into the chat?

5 A No.

6 MS. BOLL: I have nothing further.

7 MR. PETERSON: Okay. I have a few further
8 questions.

9 EXAMINATION

10 by JEREMY PETERSON, Attorney at Law, Counsel on behalf
11 of the Patent Owner:

12 Q Dr. Ruby, could you turn to Froitzheim for me,
13 please.

14 A Yes, I have it.

15 Q Okay. Can you turn to paragraph 42, please.

16 A Yes, I have it.

17 Q Okay. So paragraph 42 gives a range that the
18 dopant can be driven in at; is that correct?

19 A You cut out there for ten seconds. Say it
20 again.

21 Q Paragraph 42 provides a range that the dopant
22 can be driven in at; correct?

23 A That's right.

24 Q Do you know why there is a preferable range
25 given?

1 MS. BOLL: Object to form.

2 THE WITNESS: I can speculate about why.

3 BY MR. PETERSON:

4 Q Let me -- let me strike that first.

5 It also gives a preferable range that the
6 dopant can be driven in at; correct?

7 A Yes, it does.

8 Q Okay. And do you know why there is a
9 preferable range?

10 A I would say that that temperature range is
11 preferable because driving in a dopant in that
12 temperature range results in a diffusion profile, a
13 doping concentration, and a surface concentration that
14 is optimum for making a solar cell emitter.

15 So, for example, if you were to go outside that
16 temperature range, for example, down to the 900 degree
17 temperature, you would not get enough dopant driven into
18 substrate to form a low-resistance emitter. The sheet
19 resistivity would simply be too high, and the contact
20 resistance would simply be too high to make an efficient
21 solar cell at a temperature of 900 degrees centigrade.

22 Q So I believe that you said that Gan and Kwark
23 both discussed j naught values at 900 degrees; is that
24 correct?

25 A Yep, that's right.

1 Q So making the combination between Froitzheim
2 and Gan and Froitzheim and Kwark would involve some
3 trade-offs, would it not?

4 A I --

5 MS. BOLL: Object to form.

6 THE WITNESS: As far as performing a
7 combination where you use the diffusion temperatures
8 preferred by Froitzheim, those would produce
9 recombination parameters that are nonoptimal as shown by
10 both Gan and Kwark.

11 BY MR. PETERSON:

12 Q I believe that you testified earlier that Gan
13 showed that it was getting inconsistent oxide layers;
14 correct?

15 A Certainly in --

16 MS. BOLL: Object to form.

17 THE WITNESS: Certainly in his thesis, he
18 showed that even if he did the same process over and
19 over again, he wound up with different results being
20 that the oxide thickness was not reproducible.

21 BY MR. PETERSON:

22 Q And how does the oxide thickness affect the
23 j naught values reported by Gan?

24 A Well, if -- how does the oxide thickness what
25 now?

1 Q Affect the j naught values reported by Gan.

2 A Well, if the oxide is too thin, then J0's too
3 high. On the other hand, if the oxide's too thick, then
4 the resistivity's too high.

5 Q So would you consider Froitzheim and Gan to be
6 compatible given their differences in optimal
7 temperatures?

8 A I would say no, and that's because Gan shows
9 that in order to get low enough J0s to make an
10 improvement in the recombination, you need to use a
11 low-driving temperature of 900 degrees, which I believe
12 in the case of the Froitzheim solar cell would not
13 provide sufficient doping for the rear service emitter
14 to obtain required low resistances.

15 Q Would your answer be the same for Froitzheim
16 and Kwark?

17 A Yes. Kwark and Gan just both show the same
18 thing.

19 Q So, in your opinion, would a person of ordinary
20 skill in the art, back in 2008, have combined Froitzheim
21 and Gan?

22 A I don't believe so, and that's because
23 Froitzheim -- Gan and Kwark both show you need to keep
24 the temperature to 900 degrees at a maximum. Whereas,
25 Froitzheim was saying 900 degrees was a minimum, and --

1 and you would not be getting optimum parameters for
2 making solar cells at that temperature. Whatever
3 advantage you would gain by reducing recombination would
4 be lost because of the high resistance of the
5 non-optimized emitter.

6 Q Is your answer the same for Froitzheim and
7 Kwark?

8 A Yes, it is.

9 MR. PETERSON: I don't have any further
10 questions.

11 FURTHER EXAMINATION

12 by BROOKE S. B LL, Attorney at Law, Counsel for
13 Petitioner:

14 Q Just a couple of questions, Dr. Ruby.

15 Froitzheim does not state what temperatures are
16 preferred for doping polysilicon; right?

17 A Well, I believe he does. Paragraph 42 says
18 that he prefers a temperature between 1000 and 1100 to
19 both generate the oxide layer and to drive in the
20 dopant.

21 Q But that's for a diffused emitter, right, not a
22 polysilicon emitter?

23 A That's true, but what I would say to that is
24 the diffusion properties of crystalline and
25 polycrystalline silicon are the same.

1 Q But Froitzheim is silent as to the temperature
2 that would be preferable for a polysilicon emitter;
3 right?

4 A Froitzheim doesn't mention polysilicon
5 whatsoever.

6 Q Counsel also asked you about the Gan Thesis;
7 right?

8 A Yes.

9 Q That was a thesis done by, at the time, a
10 graduate student; right?

11 A Yes.

12 Q And, generally, a Ph.D. thesis reports on all
13 experimentation, whether it was successful or not;
14 right?

15 A It should.

16 MS. BOLL: Nothing further.

17 MR. PETERSON: Okay. I don't have anything
18 further.

19 (Whereupon, proceedings were adjourned.)

20 ---oOo---

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CERTIFICATE OF CERTIFIED SHORTHAND REPORTER

STATE OF CALIFORNIA)
) ss.
COUNTY OF SACRAMENTO)

I, SHANNON BERGE, RPR, CSR No. 9436, Certified
Shorthand Reporter, do hereby certify:

That DOUGLAS S. RUBY, Ph.D., the witness whose
deposition is hereinbefore set forth, was duly sworn by
me before the commencement of such deposition and that
such deposition was taken before me and is a true record
of the testimony given by such witness.

I further certify that the adverse party, MAXEON
SOLAR PTE. LTD Solar, was represented by counsel at the
deposition.

I further certify that the deposition of DOUGLAS S.
RUBY, Ph.D., occurred remotely, on June 24, 2025,
commencing at 8:33 a.m., to 1:08 p.m.

I further certify that I am not related to any of
the parties to this action by blood or marriage, I am
not employed by or an attorney to any of the parties to
this action, and that I am in no way interested,
financially or otherwise, in the outcome of this matter.

1 I further certify that I am not a party to any
2 stipulation, if made, that would waive my duties
3 mandated by the Court Reporters Board of California.

4 In witness whereof, I have hereunto subscribed
5 my name.

6 Dated: Wednesday, June 25, 2025

7

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Shannon Borge

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Shannon Borge, RPR, CSR
Certificate No. 9436

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