UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

CANADIAN SOLAR INC.

Petitioner,

v.

MAXEON SOLAR PTE. LTD.,

Patent Owner

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

-and-

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

VIDEOCONFERENCE DEPOSITION OF

DOUGLAS S. RUBY, Ph.D.

Sacramento, California

Tuesday, June 24, 2025

STENOGRAPHICALLY REPORTED BY:

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

HANWHA v. MAXEON
IPR2024-01203
HANWHA 1071

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Canadian Solar Inc. v. Maxeon Solar PTE. Ltd., IPR2024-01040

Deposition testimony of DOUGLAS S. RUBY, Ph.D., taken on behalf of the Petitioner; all parties appearing remotely via Zoom videoconference; beginning at 8:33 a.m., Pacific Standard Time, on Tuesday, June 24, 2025, reported stenographically before Shannon Borge, Registered Professional Reporter and Certified 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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E X H I B I T S

EXHIBIT	DESCRIPTION	PAGE
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1001	Patent No.: US 8,222,516 B2 Date of Patent: 7/17/12	57
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SAN FRANCISCO, CALIFORNIA; TUESDAY, JUNE 24, 2025

9:06 a.m. PST

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DOUGLAS S. RUBY,

having been first duly sworn,

testified as follows:

EXAMINATION

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

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

A Nice to meet you.

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

A Douglas S. Ruby.

Q Where are you located today?

A Albuquerque, New Mexico.

Q Are you in your home office?

A Yes, I am.

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

A No reason.

Q Is there anyone in the room with you today?

A No one.

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

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

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

A No.

Q -- anything like that?

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

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

A Exactly.

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

A I did. I got them yesterday.

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

A Very good.

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

A No.
Q Just to go over a couple of things, please try to give verbal answers rather than just shaking your head "yes" or "no" so that we get a clear record; is that fair?
A You cut out for about ten seconds there. Could you repeat that, please.
Q Sure. Please give verbal answers rather than just shaking your head "yes" or "no" so we can get a clear record. Is that fair?
A That's very fair, yes.
Q And given that this is a remote deposition, we can -- we'll try not to talk over each other, but if anything breaks up or you don't hear me clearly, just let me know, and I'll rephrase or restate.
A Thank you.
Q If you don't understand a question, let me know, and I will try to clarify it.
A Okay.
Q But if you don't ask for clarification, I'll assume you understood. Is that fair?
A Okay. That's very understood. Yes. Well understood.
Q And if you need a break at any time, just ask and we'll finish up the question we're on and -- and

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take a break. Okay?
A Excellent. Very good.
Q Other than counsel, did you speak with anyone else in preparing for your deposition today?
A No.
Q Did you do anything to prepare for your deposition?
A Yes. I had two meetings with my counsel.
Q How long were those meetings?
A The one on Friday lasted about three hours, and the one yesterday lasted about two hours.
Q So about five hours in total meeting with counsel to prepare for your deposition?
A That's right.
Q Did you review any materials to prepare for your deposition?
A We did review the publications that were cited in my declaration.
Q Did you review your own declarations again?
A I reviewed portions of it, yes.
Q Did you review Dr. Banerjee's declarations?
A Not yesterday or -- or last week, no.
Q Did you review Dr. Banerjee's deposition?
A I reviewed parts of it probably several weeks ago.

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

A No, I did not.

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

A Yes, I have.

Q About how many matters?

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

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

A Yes.

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

A Yes, it is.

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

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

Q What was the technology at issue in the

Australian patent infringement matter?

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

Q What do you mean by "passivating surfaces"?

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

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

A There was a deposition on an aluminum oxide layer.

Q Did you testify at trial in that case?

A Yes, I did.

Q Were you deposed in that case?

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

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

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

A Oh, yes, definitely.

Q Did you testify at trial in that case?
A No. After my deposition, the case was settled.
Q How many times have you been deposed?
A There was one other time in a case long ago which, again, was settled after my deposition.
Q Was that case as an expert or as a fact witness?
A As an expert.
Q What was -- what were the issues in that case?
A I would have to look it up. It's been over a decade.
Q Okay. No problem. Do you understand you are here to testify today regarding declarations you've submitted in two IPR proceedings?
A Yes, I do.
Q And those are IPR proceedings 2024-01039 and -1040?
A Yes, that's correct.
Q The proceeding ending in No. -1039 is related to US Patent No. 8,222,516; is that right?
A Yes, it is.
Q And I'll just refer to that patent as the '516 patent. Does that work for you?
A Yes, it does.
Q Okay. And the -- the proceeding ending in IPR

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

A Yes, that's right.

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

A Very good.

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

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

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

A Yes, they are.

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

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

Q Around when were you retained for these IPR proceedings?

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

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

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

Q What is your hourly rate for these IPRs?

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

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

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

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

A Not whatsoever.

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

A Not at all.

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

You prepared one declaration corresponding to each proceeding; right?

A Yes, I did.

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

A There is quite a bit of overlap.

Q Okay. And generally based on my review, it

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

Is that generally correct?

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

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

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

Q Do you recall which declaration you prepared first?

A No. It had to do with deadlines.

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

A Maybe 10 to 15 hours for each one.

Q Did anyone assist you in preparing your declarations?

A Yeah. I was assisted by the law firm.

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

A No.

Q Did you do the first draft of your

declarations?

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

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

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

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

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

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

BY MS. BOLL:

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

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

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

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

Q Sure.

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

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

A The '516 patent, yes.

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

A Right.

Q -- is that right?

A Yes.

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

A Yes.

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

A Yes.

Q Are you aware of any errors in your

declaration?

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

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

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

A That's right.

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

A Page -- page 10?

Q Of the PDF and page 8 of the declaration.

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

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

opinions in this case?
A No other documents, no.
Q Aside from documents, what else have you considered in forming your opinions in this case?
A My generalized knowledge of semiconductor physics as it relates to solar cell design construction and performance.
Q Aside from the documents and your general knowledge, is there anything else you relied on in forming your opinions in this case?
A No.
Q How did you select which exhibits from the IPR proceeding to review?
A The law firm pointed out the particular documents that were of paramount importance, and I looked at those for the most part. And some of the others, I just reviewed in a more cursory manner.
Q Do you recall reviewing the Lemiti reference, which is titled "Physical properties of RT-LPCVD and LPCVD polysilicon thin films: application to emitter solar cell," which was Exhibit 1048 to the Petition?
A Where is that in the list?
Q It's not in the list, but it is within the -- the evidence in the proceeding -- or, the exhibits in the proceeding so I'm asking if -- if you reviewed that

one.

A Can you repeat the name again?

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

A I don't recall that one, no.

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

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

A That's right.

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

A That's right.

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

A That's right.

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

A Yes.

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

silicon dioxide in Claim 12; is that right?

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

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

A Give me the page number.

Q Oh, sure. It's page 100.

A Okay. What paragraph? Which paragraph?

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

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

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

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

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

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

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

A Right, "E."

Q "E" and "F"?

A Froitzheim and Kwark (Ground 4), yes.

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

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

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

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

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

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

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

Q And your --

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

motivated to combine Froitzheim and Kwark for any reason.

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

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

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

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

MR. PETERSON: Object to form.

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

Is that what you're questioning me about now,

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Claim 12 based on Froitzheim and Kwark combination?
BY MS. BOLL:
Q Yes. I'm asking whether you dispute that Froitzheim and Kwark includes a second metal contact with silver formed over a layer of silicon dioxide?
A Looks like my discussions on the Froitzheim Kwark combination deal mainly with the issue of a tunnel oxide and whether the combination would be -- would be something a POSITA would have a -- would believe -- would have a reasonable expectation of success.
So as -- as I said, again, because the independent claim was found to be un- -- unjustified, I didn't specifically consider Claim 12, which was a dependent claim.
Q And that's true for the combination of Froitzheim and Borden? You do not dispute that the limitations of Claim 12 are met for that combination?
MR. PETERSON: Object to form.
THE WITNESS: Again, because Claim 12 is a dependent claim, my having found fault with combining the two of them for other reasons in the independent claim, precluded the necessity of discussing whether it also was intolerable under Claim 12. Yes. So I didn't -- I didn't discuss the dependent claims because they were already irrelevant.

BY MS. BOLL:

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

A Apparently, it's true.

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

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

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

Q Yes.

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

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

A Definitely.

Q But you do not have an opinion as to whether the Froitzheim and Gan references teach each limitation of the claim; right?
A What do you mean by "teach each limitation of the claim"?
Q So maybe let's take a look at the claim, which I believe is in -- reprinted in a table beginning on --
A Yeah.
Q -- page 46.
A Yes, exactly.
Q You do not dispute that the Froitzheim and Gan references teach a solar cell having a front side facing the sun to collect solar radiation during normal operation and a backside opposite the front side; right?
A Actually, Gan doesn't teach anything about solar cells. It's all about making contact to a effused region --
Q Okay. But that --
A -- through a tunnel oxide.
Q That wasn't exactly my question.
A Well, what exactly is your question?
Q You do not dispute that the combination of Froitzheim and Gan discloses a solar cell having a front side facing the sun to collect solar radiation during normal operation and a backside opposite the front side;

right?

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

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

A Again, I believe Froitzheim patent makes that claim.

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

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

MS. BOLL: Oh, okay.

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

BY MS. BOLL:

Q Yes, I see that.

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

BY MS. BOLL:

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

A Yes.

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

A The Froitzheim patent does that, yes.

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

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

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

A That's right.

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

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

A That's right.

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

THE WITNESS: Claim 10?

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

THE WITNESS: Claim 12.

MR. PETERSON: Sorry.

BY MS. BOLL:

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

A Right.

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

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

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

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

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

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

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

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

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

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

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

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

(Court reporter requested clarification.)

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

BY MS. BOLL:

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

A That's right.

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

MR. PETERSON: Object to form.

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

BY MS. BOLL:

Q So you do not dispute that the combination of

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

A That's right.

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

A Yes, that's right.

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

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

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

A Of Froitzheim and Gan?

Q Correct.

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

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

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

but not Froitzheim and Kwark.

Q I believe that was for Claim 12.

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

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

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

A Right. I don't dispute.

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

A Right.

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

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

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

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

A Which patented invention?

Q The '516 patent.
A Did not achieve unexpected results? What do you mean by that?
Q You do not have any opinion that the '516 patent achieved unexpected results; is that right?
A What do you mean by "unexpected results"?
Q You do not dispute that the '516 patent did not achieve commercial success; is that right?
A Did not achieve commercial success?
Q Correct.
A I do not dispute that it did not achieve commercial success so I agree that it did achieve commercial success?
Q Is it your opinion that the '516 patent achieved commercial success?
MR. PETERSON: Object to form. Outside the scope of his declaration.
THE WITNESS: Not at the time of the patent.
BY MS. BOLL:
Q Are you familiar with something called "objective indicia of nonobviousness"?
A I don't even know what you said.
Q So fair to say you're not familiar with secondary considerations of obviousness or nonobviousness; is that right?

A I'm not familiar with that terminology.
Q So you don't have any opinions regarding such secondary considerations; is that fair?
A I don't -- I don't know what they are so it would be hard for me to have an opinion about it.
Q Okay. I'm going to upload into the chat your declaration in IPR proceeding ending in 1040, which is the '053 patent proceeding, and you can download that and open it on your computer or look at the paper copy, whatever is easier for you.
A Sorry. The '053 declaration?
Q Yes. I just put that into the chat.
(Exhibit Number 1001-053 was previously marked for identification.)
THE WITNESS: Okay. I've got it.
BY MS. BOLL:
Q You offered a declaration marked as Exhibit 2020 in the 1040 proceeding regarding the '053 patent; right?
A Yes, I did.
(Exhibit Number 2020, 1040 IPR, was previously marked for identification.)
Q This declaration provides your opinions

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

A That's correct.

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

A Yes, it is.

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

A Yes, I did.

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

A Yes, it does.

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

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

A I'm not aware of any, no.

Q Does this -- strike that.

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

A That's right.

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

A Of '053?

Q Let me know when you're there.
A Of '053?
Q Yes. We'll stick with the '053 for a few minutes.
A Okay. I am here.
Q This declaration provides a subset of what your opinions were in the '516 patent declaration. Is that fair?
A Yes. There are fewer cited references.
Q Generally, this declaration for the '053 patent provides arguments regarding the reasonable expectation of success and the motivation to combine for the combinations of Froitzheim and Gan and Froitzheim and Kwark; is that right?
A That's right.
Q In this IPR proceeding, you have not offered any opinions on claim construction with regard to the challenged claims of the '053 patent; right?
A Yes, I believe that's the case.
MR. PETERSON: Counsel, did you say he did not provide any?
MS. BOLL: Right.
THE WITNESS: Regarding claim construction; is that right?
MS. BOLL: That's right.

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

BY MS. BOLL:

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

A This is the '053 patent?

Q Yes.

A Page 49. In-situ. Okay.

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

A Yes, that looks to be the case.

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

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

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

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

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

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

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

A Say it again.

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

A Which combinations?

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

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

Q Yes.

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

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

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

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

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

A Right.

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

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

The combination of Froitzheim and Gan?

Q That's right.

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

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

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

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

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

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

A I guess that's the case, yes.

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

A That's right.

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

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

Q You reviewed the Hartiti reference; right?

A Not that I remember.

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

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

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

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

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

A No, I did not.

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

A That's right.

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

A I have no opinion about that.

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

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

(Recess.)

BY MS. BOLL:

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

A Yes.

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

A Yes.

Q Did you review the Sivoththaman reference,

which is the second bullet point on page 8?

A No.

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

A I have no opinion about that.

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

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

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

A No, I don't.

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

A No, I haven't.

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

A No, I have no reason to doubt it.

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

A No, not for Maxeon.

Q Have you ever worked for SunPower before?

A I did work for SunPower.
Q When was that work?
A Probably about 10 years ago. About 10 years ago.
Q What kind of work did you do for SunPower?
A One of the services I provide as a consultant to the photovoltaic industry is you present a three-day short course on solar cell science and technology, which I delivered to SunPower employees in the Philippines back 10, 12 years ago, something like that.
Q Is that the only work you have done for SunPower in the past?
A Yes.
Q Have you ever spoken to anyone at Maxeon?
A No.
Q Have you spoken to anyone at SunPower about these IPR proceedings?
A No.
Q Are you familiar with Richard Swanson?
A Yes, I know Dick Swanson.
Q Who is he?
A He's the founder of SunPower and a former professor of electrical engineering at Stanford University.
Q How do you know him?

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

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

A Yes, that's exactly right.

Q Roughly, what time frame was that work performed?

A 1980s and 1990s.

Q What is a concentrator solar cell?

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

Q How does that compare to a nonconcentrator solar cell?

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

Q Sure. We can start there.

A Costs?

Q Design and construction.

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

those for 1-Sun solar cells.

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

A Yes.

Q Is that --

A And high temperatures.

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

A Easier or more difficult measured how?

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

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

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

A (Inaudible.)

Q Sorry. I didn't hear your answer.

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

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

A More difficult in what way?

Q In terms of manufacturing.
A Depends how you measure difficulty. That's how I'll leave that answer.
Q Is it true that concentrator solar cells require lower contact resistance than non-concentrator solar cells?
A Yes, that's true.
(Clarification requested by Reporter.)
BY MS. BOLL:
Q Is it true that concentrator solar cells require much lower contact resistance than non-concentrator solar cells?
A My answer is yes, that's true.
Q Why is that?
A Because they must handle a much higher current and because -- because of the higher currents, the resistances need to be lower in order to have lower voltage drops or what you would call ohmic resistance in the cell. Less energy wasted in resistance.
Q A person of ordinary skill in the art, prior to 2008, would have knowledge of the differences between concentrator solar cells and 1-Sun solar cells; right?
A Well, I did.
Q And you were a person of ordinary skill in the art prior to 2008; right?

A Yes, I would consider myself to be so.
Q What are some ways that you can reduce contact resistance in a solar cell?
A By doping the contact region of the silicon very heavily; a high concentration of dopant atoms.
Q Was that known before 2008?
A Yes.
Q Are you aware of any other ways to reduce contact resistance in a solar cell?
A Correct choice of metals for making contact with.
Q Was that known before 2008?
A Yes.
Q Are you aware of any other ways to reduce contact resistance in a solar cell?
A No.
Q In a solar cell with an interfacial oxide, if you reduce the thickness of the interfacial oxide, will that lower the contact resistance?
A Yes.
Q Was that known prior to 2008?
A Yes.
Q If you increase the contact area, is that another way to reduce the contact resistance?
A Yeah. It reduces the specific contact

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

Q Understood. Was that known prior to 2008?

A Yes.

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

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

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

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

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

A Yes, it does.

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

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

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

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

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

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

Q Sure.

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

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

A I'm sure I did.

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

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

THE WITNESS: Do I answer that question?
BY MS. BOLL:
Q Yes, unless your counsel instructs you not to answer.
A Well, what was -- repeat the question then.
Q Sure. When you were reviewing published works in the field, did you limit your review to just works regarding concentrator solar cells?
A Probably not.
MR. PETERSON: Same objection.
BY MS. BOLL:
Q What was the efficiency of concentrator solar cells that pre-dated your work in 1993?
A Well, on that low-cost substrate, my guess from that statement you made is that it was less than 20 percent.
Q But you're not sure exactly how much less. Is that fair?
A I'm not sure exactly how much less.
Q What is it that you can attribute to the greater efficiency that you were able to achieve?
A We used the -- a fairly novel and effective process for passivating the front surface of the cell and providing an excellent antireflection coating at the same time.

Petitioner Canadian Solar Inc., Ex. 1081, p. 50
Canadian Solar Inc. v. Maxeon Solar PTE. Ltd., IPR2024-01040

Q What was that process known as?
A Thermal oxidation of silicon.
Q Were similar techniques for passivating the front surface ever applied to a 1-Sun solar cell?
A I believe they were but perhaps not in the same way that we -- that we did it.
Q So you would agree that if you're developing a 1-Sun solar cell, it might be worthwhile to look at publications regarding concentrator solar cells?
MR. PETERSON: Object to form.
THE WITNESS: Well, it would be advisable or suggest -- you know, it would certainly be worth -- worth looking at, although not all of the methods for creating solar cells -- concentrator cells are required for producing 1-Sun cells. So some things would be of use and many things would not.
BY MS. BOLL:
Q Do concentrator solar cells have more requirements than 1-Sun solar cells?
A More specialized requirements, yes, especially in regards to lower series resistance.
Q You worked at Sandia from about 1985 to January 2008; right?
A That's right.
Q Towards the end of your time there, so in sort

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

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

Q What are plasma processing techniques?

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

Q What is that used for?

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

Q What sorts of passivating layers were you depositing?

A I was depositing primarily silicon nitrides and silicon oxynitrides.

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

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

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

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

charges."

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

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

Q Do you have experience with forming chemical oxides?

A No.

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

A Yes.

Q Is that right?

A Correct.

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

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

Q Those techniques were known before 2008; right?

A Yes.

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

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

Q What is your educational background?

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

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

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

Q Did you ever do any work on bipolar transistors?

A No.

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

A Yeah, I did.

Q What was your thesis about?

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

compound semiconductor material.

Q Was your thesis related to solar cells?

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

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

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

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

A It was a "no result."

Q What does that mean?

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

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

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

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

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

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

Q How did those -- sorry. Go ahead.

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

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

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

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

MR. PETERSON: Object to form.

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

BY MS. BOLL:

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

A No. I had co-authors.

Q What did the co-authors contribute?

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

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

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

A Okay.

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

BY MS. BOLL:

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

A '516 patent, yes, I have that.

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

A Yes, it is.

Q Did you review this patent in forming your opinions?

A Yes, I did.

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

A The challenged claims? Which are those?

Q 9 through 12.
A Yes, especially 9.
Q 9 is the only challenged independent claim in this IPR; is that right?
A Well, yeah. Claim 1 is independent, but I guess that's not challenged.
Q That's right. I'll make that representation.
A Okay. So, yes, Claim 9 is challenged and is independent.
Q Is Claim 9 directed to a concentrator or a non-concentrator solar cell? Can you tell?
A Claim 9 in and of itself?
MR. PETERSON: Object to form.
THE WITNESS: Well, if you look at the rest of the patent, it certainly describes a 1-Sun solar cell. For example --
BY MS. BOLL:
Q The claims --
A Yeah.
Q Sorry. Go ahead.
A Yeah. FIG. 2, for example, in the '516 patent is that of a 1-Sun solar cell.
Q The claims do not specify a 1-Sun or a concentrator solar cell; right?
A No, they do not specify.

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

A They make no reference to cell efficiency.

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

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

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

A Say that again.

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

A They don't mention anything about its use.

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

A They don't mention anything about manufacturing.

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

Do you see that?

A Yes.
Q Could you just explain what's your understanding of what an oxide layer is?
A Well, in this context, it means a silicon dioxide layer, SiO2.
Q The claims do not specify any particular recipe or method to form the oxide layer; right?
A No, these claims do not.
Q The claims do not specify the material that the oxide layer should be formed from; right?
A The claims themselves do not specify where they should be formed from.
Q The claims do not specify the temperature at which the oxide layer should be formed; right?
A They do not mention temperature.
Q The claims do not specify the thickness of the oxide layer; right?
A The claim itself does not. In the specifications, there's plenty of references to thicknesses.
Q The claim itself does not specify a particular thickness of the oxide layer; right?
A That's right.
Q The claims do not specify the degree of tunneling that the oxide layer needs to achieve; right?

A The claim does not specify it.
MR. PETERSON: Objection.
THE WITNESS: Again, many of these are mentioned in the specifications of the patent.
BY MS. BOLL:
Q But the claim itself does not specify the degree of tunneling that the oxide layer must achieve; right?
MR. PETERSON: Objection. Lacks foundation.
THE WITNESS: The claim itself does not mention the degree of tunneling.
BY MS. BOLL:
Q If we can take a look now at the specification and turn to Column 2.
A Column 2 of what?
Q Of the specification of the '516 patent.
A Okay. Column 2 on what page?
Q It's on PDF page 10.
A Let's see.
Q If it's easier, I can maybe share my screen.
A No. I found it. Okay. I got it.
Q Okay. And if we look at the paragraph beginning around line 28, in the example of FIG. 1 -- do you see that?
A Yes.

Q You reviewed this specification; right?
A Yes.
Q This paragraph describes "A backside junction formed by a P-type doped polysilicon emitter, serving as a P-type diffusion region, and an N-type silicon substrate serving as an N-type diffusion region."
Do you see that?
A Yes, I do.
Q That's describing what is formed on the backside surface of the substrate; right?
A Yes, that's right.
Q Okay. And if we look at line -- starting at line 36, it states, "The front side surface of the substrate."
Do you see that?
A Yes.
Q And it goes on to describe what's formed on the front side surface of the substrate; is that right?
A Yes.
Q The front side surface, it says, "Includes N-type doped regions 105 and 106 formed in the substrate."
Do you see that?
A Yes.
Q So those are N-type doped regions formed in an

N-type substrate; is that right?
A That's right, yeah.
Q And the paragraph goes on to refer to this as "N-dot." Do you see that?
A Yeah, right.
Q This paragraph does not describe forming N-type doped regions on an N-type substrate as a junction; is that fair?
A If by -- what do you mean by "junction"?
Q This paragraph does not use the word "junction" to describe forming N-type doped regions on an N-type substrate; right?
A Let's see. It doesn't look like it uses the term junction to describe the front surface.
Q Okay. And I want to turn now back to the declaration in the 1039 proceeding, Exhibit 2020.
A Which patent -- which patent is that?
Q The '516 patent.
A '516 patent declaration. Okay.
Q And I want to go back to the table with the claims --
A Yeah.
Q -- which is on page 47.
A Right. And this is where there was a typographical error.

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

A Yes.

Q -- and the emitter layer --

A Yes.

Q -- limitation.

A Right.

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

A Yes, that's right.

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

A Yes.

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

A That's correct.

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

A Yes.

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

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

Q Claim 9 is a little bit different; right?

A Yes.
Q For Claim 9, you could have an N-type polysilicon emitter with a P-type silicon substrate; right?
A Yes. It doesn't mention doping types at all.
Q So for Claim 9, you could have an N-type emitter with a P-type substrate or a P-type emitter with an N-type substrate; right?
A Yes. And you could have an N-type emitter with a N-type substrate. It -- it doesn't mention types of emitters or substrates whatsoever so that's --
Q So for --
A -- that's left vague.
Q So for Claim 9, you could have an N-type silicon substrate and a P-type polysilicon emitter, same as Claim 1; right?
A Yes.
Q And another option would be to have a P-type silicon substrate and an N-type polysilicon emitter; right?
A True. True. Yeah.
Q So Claim 9 is broader than Claim 1?
A Yes. And as I said, you also left out when both emitter and substrate have the same poly connectivity type, both P and N. There are four

permutations.

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

A '053 patent. Okay.

Q Let me know when you have that --

A I've got it.

Q -- in front of you.

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

A That's correct.

Q You reviewed this patent?

A Yes, I did.

Q And you reviewed the claims of the patent?

A I did.

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

A They are related.

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

A The specifications are similar.

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

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

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

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

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

A Right.

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

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

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

A Yes.

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

Those are the first three limitations. Do you

see that?
A Yes, I do.
Q You don't dispute that the prior art discloses those limitations; right?
A No. It's a fairly common way of getting dopants into a layer.
Q And so Claim 9 describes, first, forming the polysilicon layer and then diffusing the dopant into the polysilicon layer; right?
A Yes.
Q And the claim then describes that a backside junction is formed when the dopant is diffused into the polysilicon layer; right?
A Yes, that's right.
Q Okay. And if you turn to Claim 16 --
A Yes.
Q -- the first three limitations are -- are similar; right? It's "forming an oxide layer over a back-surface of the silicon substrate, forming a layer of polysilicon over the oxide layer, and then diffusing dopants into the layer of polysilicon to form a backside junction with the silicon substrate"; right?
A Yeah. The -- I don't know what you call them. The claims regarding forming an oxide layer are not present in Claim 9, but they are present in Claim 16.

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

A Yes.

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

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

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

A Yes.

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

A If the polysilicon forms a back-surface field?

Q Yes.

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

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

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

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

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

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

MR. PETERSON: Counsel --

BY MS. BOLL:

Q Have you relied on --

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

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

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

BY MS. BOLL:

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

A A back-surface field is a type of backside

junction.

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

A Yes.

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

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

Q Independent. Right.

Are the claims directed to -- strike that.

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

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

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

A No.

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

A Yeah.

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

A The claims do not require a particular contact

resistivity.

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

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

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

A The claims do not mention anything about manufacturing.

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

A Froitzheim reference. Okay.

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

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

(Exhibit Number 1006 was previously marked for identification.)

(Recess.)

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

BY MS. BOLL:

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

the proceedings.

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

A Yes, I did.

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

A No.

Q Froitzheim describes an operable solar cell; right?

A Right.

Q What type of solar cell does Froitzheim disclose?

A A backside junction solar cell.

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

A Yes, rear and back are used interchangeably.

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

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

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

A Yes.

Q -- it states, "Preferably Czochralski grown silicon is used."
A Okay. Yep.
Q And Czochralski grown silicon is not a crystalline silicon; right?
A Yes, it is.
Q Froitzheim teaches methods of driving in dopants at the rear side of the substrate; right?
A Yes.
Q At that rear side, Froitzheim forms a diffused emitter; right?
A Yes.
Q As opposed to a polysilicon emitter as described in the claims of the '516 and '053 patents; right?
A Yes, that's right.
Q What is a diffused emitter?
A It's an emitter where the dopant for the emitter region is obtained by diffusion of a dopant source into the substrate.
Q How is that different from a polysilicon emitter?
A A polysilicon emitter is some -- is a layer which is deposited on top of the crystalline substrate rather than something that's diffused into it.

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

A Yes. Preferably between 1000 and 1100.

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

A That is the extreme limit of his temperature range.

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

A Yes, just barely.

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

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

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

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

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

A Yes, at the lower end of Froitzheim.

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

A Where?
Q 925 degrees is in the range of -- in Froitzheim?
A It's in the range between 900 and 1200, true.
Q Froitzheim also discloses driving in dopants at a temperature of 950 degrees; right?
A Well, he gives a range. I don't know if he's got any data points in between.
Q Driving in dopants at a temperature from 900 to 1000 degrees Celsius would be consistent with what's disclosed in Froitzheim; right?
A Between 900 and 1000, yes.
Q Froitzheim's disclosed temperature range is the range for diffusing dopants into monocrystalline silicon; right?
A It's at the lower end of the range for diffusion.
Q In general, though, just at a higher level, the disclosed temperature range in Froitzheim is for the purpose of diffusing dopants into the Czochralski silicon; right?
A Yes. It can be diffused within that range.
Q So the preferable range of 1000 to 1100 degrees is what's preferable for diffusing dopants into a monocrystalline silicon substrate; right?

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

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

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

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

A It doesn't mention polysilicon at all.

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

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

THE WITNESS: He doesn't mention polysilicon.

BY MS. BOLL:

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

A Yes.

Q -- in both of the proceedings.

(Exhibit Number 1008 was previously marked for

identification.)

BY MS. BOLL:

Q Do you have that in front of you?

A Yes, I do.

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

A I did.

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

A No, I don't know him.

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

Do you see that?

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

Q Do you know Ron Sinton?

A Yes, I do.

Q How do you know him?

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

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

A Ron Sinton was an exceptional person in the art.
Q So his work would be well-respected in the industry by -- around this time?
A Definitely.
MR. PETERSON: Object to form.
BY MS. BOLL:
Q And Richard Swanson, is that the same Richard Swanson we discussed earlier?
A Yes.
Q And he was the founder of SunPower?
A Yes.
Q He was -- Richard Swanson was also a person of ordinary skill in the art in 1984; right?
A At least.
Q His work would be well-respected by those in the industry in 1984 and thereafter?
A Yes.
MR. PETERSON: Object to form.
BY MS. BOLL:
Q SunPower -- strike that.
Maxeon is a spin-off of SunPower; right?
A As I understand it, that's correct.
Q Okay. And if we look at Kwark, Kwark's findings are not specific to concentrator or

non-concentrator solar cells; is that fair?

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

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

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

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

A Yes.

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

A Right.

Q Do you see that?

A Yes.

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

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

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

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

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

A Which paragraph?

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

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

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

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

A I believe that's the case, yes.

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

A I believe that's the case, yes.

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

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

diffused silicon surface.

Q And that diffused emitter, according to Kwark, is associated with the highest measured J0,e; right?

A Yeah.

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

A Right.

Q The "No Chemox" sample, both of them, have a lower J0,e than the diffused emitter aluminum contact sample; right?

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

Q So according to Kwark, a polysilicon emitter has a better J0,e as compared to a diffused emitter; is that fair?

A The addition of poly without the Chemox does not greatly impact J0,e, as would be expected since heavily doped poly acts essentially as an extension of the monocrystalline emitter. Yes, it reduces it, but not much.

Q And can you just explain what is J0,e as compared to J0?

A It's the emitter component of the -- let's see. J0 is the -- let's see -- emitter. It's the recombination current. So it's a matter of recombination occurring in the emitter region.

Q J0,e is the amount of recombination occurring in the emitter region; right?
A Yes. Yes.
Q And it's advantageous for that amount of recombination to be lower; right?
A Right. For solar cell purposes, correct.
Q Okay. Fig. 4 of Kwark shows two lines corresponding to "With Chemox"?
A Yes.
Q One is a prediffused emitter and one is an outdiffused emitter.
Do you see that?
A Yes.
Q The "With Chemox" samples have lower recombination than the diffused emitter of the...
(Clarification requested by Reporter.)
THE WITNESS: The diffused emitter of the -- yeah, it did cut out.
MS. BOLL: Okay. I -- my -- my speaker said, "PC disconnected." Can you hear me?
THE WITNESS: I can now.
MS. BOLL: Okay. Let me start again.
BY MS. BOLL:
Q Fig. 4 of Kwark shows two lines that correspond to "With Chemox"; right?

A Yes.
Q One is a prediffuser polysilicon emitter and one is an outdiffused polysilicon emitter; right?
A Okay.
Q The "With Chemox" emitters have a lower recombination than the diffused emitter aluminum contact sample; right?
A Yes.
Q And the "With Chemox" samples have lower recombination than the "No Chemox" samples at the measured temperatures; right?
A Yes, that's right.
Q Even at 1000 degrees Celsius anneal temperature, the "With Chemox" samples have a lower recombination than the "No Chemox" samples; right?
A But not by much. Oh, 900, did you say?
Q Sorry. Let me start again.
Even at 1000 degrees Celsius anneal temperature, the "With Chemox" samples have a lower recombination than the "No Chemox" samples; right?
A A small amount, yes, that's correct.
Q At 1000 degrees anneal temperature, the "With Chemox" samples have a lower recombination than the aluminum contact diffused emitter; right?
A Yes.

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

A Yes.

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

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

Q Okay. So Kwark did not specifically measure the J0,e at 950 but, rather, drew lines between a measurement of 900 and a measurement at 1000. Is that fair?

A That's what it looks like to me.

Q In your experience, would the J0,e at 950 be somewhere between the value associated with a 900 degree anneal and the value associated with 1000 degree anneal?

MR. PETERSON: Object to form.

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

BY MS. BOLL:

Q But, regardless, the J0,e at 950 for the Chemox

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

A I believe it would be so.

Q What is an "outdiffused emitter"?

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

Q Okay. How does Kwark define an outdiffused emitter?

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

Q That one is "C."

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

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

What is an outdiffused emitter C according to

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Kwark?

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

Q What is prediffused emitter B according to Kwark?

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

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

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

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

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

substrate.

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

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

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

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

A Which patent?

Q '516. Take a look at page 83.

A 83.

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

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

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

A 83. I'm there.

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

A Yes, that's right.

Q Did you generate this figure? Strike that.

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

A No, I did not.

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

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

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

A Approximately so.

Q You didn't conduct an actual experiment to confirm that the level of J0,e would be observed over 1000 degrees; right?

A I did not conduct any experiments.

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

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

Q But you can't say for certain the temperature

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

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

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

You can't say for certain that the J0,e would continue to increase linearly as you've depicted; right?

A Not precisely linearly.

MR. PETERSON: Object to form.

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

BY MS. BOLL:

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

A Not that I see.

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

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

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

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

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

Q No problem. Let me start again.

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

A Yes.

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

MR. PETERSON: Object to form.

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

BY MS. BOLL:

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

MR. PETERSON: Object to form.

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

temperature.
BY MS. BOLL:
Q And 900 degrees Celsius is one of the anneal temperatures that's disclosed in Froitzheim; right?
A It is.
Q Take a look at paragraph 205 of your declaration, which is on --
A Which declaration?
Q Sorry. Let's -- let's go to the '053 declaration. Thanks for clarifying.
A '053. What page?
Q 98.
A What paragraph?
Q Paragraph 205.
A Okay.
Q Your opinion is that a person of ordinary skill in the art would not want to combine Froitzheim and Kwark because "A Chemox layer simply does not have the special properties of a tunnel oxide"; is that right?
A That's what I stated.
Q What is your basis for that statement?
A Well, in my experience, a chemical oxide layer is formed, more or less, at room temperature using aqueous solutions and reacting with a silicon surface. They form a -- an oxide layer which cannot be

well-defined.

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

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

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

Q Yeah.

A Where tunneling could be present, yes.

Q So it's possible --

A It's possible.

Q Sorry. Let me finish my question.

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

A It's possible.

MR. PETERSON: Object to form.

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

BY MS. BOLL:

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

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

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

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

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

MR. PETERSON: Object to form.

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

BY MS. BOLL:

Q So if --

A Unknown.
Q So if someone generates a thin Chemox layer, it's possible to get tunneling; right?
MR. PETERSON: Object to form.
THE WITNESS: It depends on how thick it is.
(Clarification requested by the Reporter.)
MR. PETERSON: Object to form.
Dr. -- Dr. Ruby, you need to leave me enough time to object.
THE WITNESS: Okay.
BY MS. BOLL:
Q You would agree, though, that methods of forming a chemical oxide were known prior to 2008; right?
A I would assume they were known, yes. I don't --
Q And Kwark -- Kwark used RCA clean; right?
A Kwark used the RCA clean, yes.
Q What other methods were available prior to 2008 for forming a chemical oxide?
A I don't know.
Q You would agree that methods of forming a thermal oxide were known prior to 2008; right?
A Thermal oxides, yes. Methods were not.
Q Were those methods difficult for those skilled

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in the art to perform prior to 2008?

MR. PETERSON: Object to form.

THE WITNESS: Methods for what?

BY MS. BOLL:

Q Generating thermal oxides.

A No.

MR. PETERSON: Same objection.

BY MS. BOLL:

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

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

Q Is LPCVD one of those methods?

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

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

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

Q Understood. You reviewed the Gan paper in forming your opinions; right?
A Yes.
Q I'm going to put that into the chat now. This is Exhibit 1007 in both of the proceedings.
A Okay.
(Exhibit Number 1007 was previously marked for identification.)
BY MS. BOLL:
Q Let me know when you have that open.
A I have it.
Q Do you know Dr. Gan?
A No.
Q The second author of the Gan paper is R.M. Swanson.
Do you see that?
A Yes.
Q Is that the Richard Swanson we have been discussing a couple times today?
A I presume so.
Q He was a person of ordinary skill in 1990 when the Gan Thesis -- sorry. Strike that.
Dr. Swanson was a person of ordinary skill in 1990 when the Gan paper was published; right?

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A Yes.

MR. PETERSON: Object to form.

BY MS. BOLL:

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

A Yes.

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

A Show me where.

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

A Yes.

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

A Yes, I do.

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

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

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

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

Do you see that?

A Yes.

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

A Yes.

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

A Yes.

Q Do you see that?

A Right.

Q What is "drive-in"?

A It's what other people refer to as an anneal. Essentially, you're raising the material to a high temperature and allowing the dopant that's in the dopant source layer to diffuse into, in this case, I think both the polysilicon layer as well as probably going into the crystalline silicon beneath it.

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

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

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

A Where does he say that?

Q Page 247.
A Where? "Results and Discussions"?
Q If you take a look at the table --
A Which table?
Q On -- sorry -- page 248.
A Okay.
Q Do you -- do you agree that Gan discloses that the second-step anneal at 900 degrees Celsius for four hours is optimal?
MR. PETERSON: Object to form.
THE WITNESS: Well, I don't know if it's optimal, but it shows that for the temperatures and times in this table, he has the lowest value for J0,e for the 900 degree drive-in.
BY MS. BOLL:
Q Can you turn to your declaration in the '516 patent proceeding --
A Yes.
Q -- at page 67.
A 67. Okay. Where?
Q Paragraph 141.
A Okay.
Q In the second sentence of that, you state, "This is Gan's second-step anneal, and it's optimal when performed at 900 degrees Celsius for four hours."

Do you see that?
A Yes, I do.
Q Is that your opinion?
A Well, that's my opinion given the data that he showed. It was the best result which he got for the various conditions he tried.
Q So Gan's best result was achieved using a second-step anneal of 900 degrees Celsius for four hours; right?
A Yes, that's right.
MR. PETERSON: Objection. Asked and answered.
THE WITNESS: Whose turn is it?
MR. PETERSON: You can go, but you've got to give me time to object, Dr. Ruby.
THE WITNESS: Okay. Do you want me to answer?
MR. PETERSON: Yes. Go ahead.
THE WITNESS: He got the best result when he did the drive-in diffusion at 900 degrees for four hours.
BY MS. BOLL:
Q You also reviewed the Gan Thesis in forming your opinions; right?
A I did. Excerpts of it, really.
Q You did not review the full thesis?
A Not in its entirety, no.

Q Do you recall which sections you reviewed?
A No. I reviewed excerpts regarding -- essentially regarding his difficulty in obtaining reproducible oxide thicknesses.
Q Did you select the excerpts you reviewed or were they selected by counsel?
MR. PETERSON: Objection to the extent it calls for privilege. I don't want him answering what counsel suggested.
MS. BOLL: Okay. Can he answer yes, like whether he selected it or whether counsel selected it?
MR. PETERSON: As long as that's as far as you go.
MS. BOLL: Yeah, that's -- okay. So let me re-ask. And just -- just stick to answering the question directly, Dr. Ruby. I'm not trying to get into anything privileged.
BY MS. BOLL:
Q Did you select the excerpts of the Gan Thesis that you reviewed or were they selected by counsel?
A They were selected by counsel.
Q The Gan Thesis acknowledges that thin oxide growth may be improved by performing the oxidation at lower temperatures such that the oxide rate can be controlled more precisely; right?

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

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

MR. PETERSON: Object --

THE WITNESS: Lower temperatures result in slower growth rates.

(Clarification requested by Reporter.)

MR. PETERSON: Object to form.

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

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

BY MS. BOLL:

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

A Yes.

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

A Speculations, yes.

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

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

what could have happened had he done things differently.

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

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

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

A '516 declaration, paragraph --

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

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

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

Do you see that?

A Yes.

Q Is that your opinion?

A Well, they were certainly unproven speculation.

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

A Yes.

MR. PETERSON: Object to form.

BY MS. BOLL:

Q That paper was presented at the IEEE?

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

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

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

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

A Yes. Yes.

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

A I'm not aware of any.

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

A No.

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

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

Q You said you don't know Dr. Gan personally; right?
A No, I don't.
Q At the time of his thesis, you don't know whether he was a person of ordinary skill in the art or not; right?
A At the time of his thesis? He -- whether he was ordinarily skilled in what art? The art of solar cells?
Q So if you take a look at your declaration, page 10 --
A Which declaration?
Q The '516. You can stick with that one.
A Okay. Page 10.
Q It says you were asked to apply the level -- the skill level of a person of ordinary skill in the art that is proposed in the petition, which is someone with an advanced degree involving various disciplines and at least two years of experience designing, developing, or researching in the field.
A Right.
Q So applying that definition, you don't know whether Gan was a person of ordinary skill at the time of his thesis; right?
MR. PETERSON: Object to form.

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

BY MS. BOLL:

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

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

Q But you don't know one way or another whether Gan had been working for at least three years at the time he performed all of his research for his thesis; right?

MR. PETERSON: Object to form.

THE WITNESS: I don't know -- I don't know for certain.

MS. BOLL: It's a good time to break for lunch if that works for you all. Could we go off the record?

THE WITNESS: That would be fine with me.

MS. BOLL: Okay.

(Recess.)

BY MS. BOLL:

Q Dr. Ruby, we took a few breaks today. Did you speak with counsel on any of those breaks?

A Yeah, I called Jeremy and asked him how he thought I was doing.

Q What did he say?

A He said he thought I was doing well.

Q Okay. Did you speak about anything else with counsel?

A No.

Q Aside from your call with Mr. Peterson, did you speak to anyone else on our breaks?

A No, I did not.

Q Okay. I want to return to the Gan paper, which is Exhibit 1007. If you could turn to page 249, the paragraph above "Conclusions."

A Yes.

Q Gan reports on the difference between a polysilicon emitter with an interfacial oxide and a diffused emitter; right?

A Well, he reports on the results of a polysilicon emitter with an interfacial oxide.

Q In this paragraph, it states, first, most of J0 are below 5 times 10 to the -14 A/cm squared, which is about one order magnitude lower than that of diffused

emitters.

Do you see that?

A Yes.

Q So according to Gan, a diffused emitter has a j naught about one order of magnitude higher --

A Yes.

Q -- than a polysilicon emitter; right?

A Well, the polysilicon emitter is with his tunnel oxide in between.

Q That's right. So according to Gan, a diffused emitter has a j naught of about one order of magnitude higher than a polysilicon emitter with a tunnel oxide?

A Yes.

MR. PETERSON: Object to form.

THE WITNESS: Yes. His J0s are less than what you generally get with diffused emitters.

BY MS. BOLL:

Q And Gan reports that it's about "one order of magnitude lower"; right?

A That's what he says.

Q He also reports a lower Rc; is that right?

A He says that most of the contact resistivities are lower than 5 times 10 to the minus 5 ohm square centimeters.

(Clarification requested by Reporter.)

THE WITNESS: He says that most of the contact resistivities are lower than 5 times 10 to the minus 5 ohm square centimeters.

BY MS. BOLL:

Q And "contact resistivity" is Rc; right?

A Yes.

Q That contact resistivity of lower than 5 times 10 to the minus 5 ohm per centimeter square reflects the contact resistivity of polysilicon emitters with a tunnel oxide; right?

A Those are the resistivities he measured for his polysilicon emitters on top of a tunnel oxide.

Q I'm going to drop into the chat the Borden reference --

A Okay.

Q -- Exhibit 1009.

A Okay.

(Exhibit Number 1009 was previously marked for identification.)

BY MR. B LL:

Q Let me know when you have that open.

A All right. Borden. That's Gan. Oh, there's more. Borden. Okay. Downloads. The rain is coming down very hard.

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Q Do you have Borden open now?
A I do.
Q You reviewed the Borden patent publication in forming your opinions on the '516 patent; right?
A Yes, I did.
Q Are you familiar with the named inventor Peter Borden?
A Am I familiar with Peter Borden, the author?
Q Yeah.
A No.
Q If you take a look at the abstract at the bottom of page 1 --
A Yes.
Q -- the first sentence is "The present invention relates to improved HIT-type or polysilicon emitter solar cells."
Do you see that?
A Yes, I see that.
Q So Borden discusses, in part, HIT solar cells; right?
A Yes.
Q What is a HIT solar cell?
A It's a heterojunction solar cell which uses amorphous silicon as the emitter of the solar cell.
Q HIT cells, that H-I-T stands for

"heterojunction intrinsic thin layer cells"; right?

A Exactly.

Q What is a heterojunction?

A A heterojunction is the joining of two dissimilar materials.

Q That's different from a homojunction; right?

A Right. Homojunction is the joining of two materials with the same crystal structure and chemical makeup.

Q In terms of their properties, how is a heterojunction different from a homojunction?

A The amorphous silicon has a higher bandgap than crystalline silicon, so there's a huge -- there's a large bandgap discontinuity at the heterojunction. This leaves strong electric fields being generated at the junction.

Q Any other differences in properties between a heterojunction and a homojunction?

A Aside from the bandgap discontinuity, well, there's different -- different absorption coefficients in the heterojunction -- in the amorphous material, so it absorbs different -- different wavelengths of light, either more or less strongly.

Q If you form an emitter, it's either a heterojunction or a homojunction. Is that fair?

A Yes, an emitter can be formed either as a heterojunction or a homojunction.
Q But not both and not neither. Is that fair?
MR. PETERSON: Object to form.
THE WITNESS: Did you say something?
MR. PETERSON: I said object to form.
THE WITNESS: It's really noisy here right now. Say the question again.
BY MS. BOLL:
Q Sure. You stated that an emitter can be formed either as a heterojunction or a homojunction?
A Yes.
Q So if you form an emitter, it needs to be one or the other as opposed to both or neither. Is that fair?
A Well, you can't -- yes, it's either one or the other. Yes.
Q How is a HIT solar cell different from a polysilicon emitter solar cell?
A Well, polysilicon has the same bandgap as crystalline silicon so you don't get the benefit of the bandgap discontinuity, and it won't perform as well in general.
Q If we turn to paragraph 16 of Borden, which is on page 4.

A Paragraph 16, yes.
Q It states, "The present inventors recognized that thin tunnel oxide layers can be used in solar cells?"
Do you see that?
A Recognize that tunnel oxides can be used between --
Q In solar cells.
A Well -- oh, first sentence. Yes. Right.
Q Okay. And then it goes on to state, as I think you had recognized, "The present inventors further recognize that tunnel oxides can be used between a heavily doped or insulating layer of polysilicon and a crystalline silicon substrate forming a polysilicon emitter solar cell."
Do you see that?
A Yes, I do.
Q So the inventors did disclose an embodiment in Borden forming a polysilicon emitter solar cell with a tunnel oxide?
A Yes, they do, but then it goes on to say in the same paragraph that such cells do not provide the benefit of a higher cell voltage that would be accrued using the amorphous silicon.
Q So you agree that polysilicon solar cells do

not provide the heterojunction and its benefit of a higher cell voltage due to the higher bandgap of amorphous silicon; right?

A Right. The polysilicon cells do not provide that.

Q In fact, in your declaration, you argued that Borden distinguishes polysilicon emitter solar cells from HIT cells because polysilicon emitter solar cells do not provide the heterojunction; right?

A What part of my declaration are you referring to?

Q You could take a look at paragraph 233 --

A Which -- which one?

Q The '516.

A '516. Paragraph --

Q 233. It's on pages 110 to 111.

A 233. I'm going to close my window shade here and turn on the light because I can't hear over the thunderstorm.

Q Okay. No problem.

A All right. Where do you want me to look?

Q In your declaration at Paragraph 233, your '516 patent declaration.

A Yes.

Q Okay. And it goes on to page 111.

A Right.

Q Your opinion is that Borden distinguishes polysilicon emitter solar cells from HIT cells because polysilicon emitter solar cells do not provide a heterojunction; right?

A Yes.

Q So your opinion is that polysilicon emitter solar cells do not provide a heterojunction?

A Well, they do not provide -- they -- they are a heterojunction, but they don't provide the bandgap discontinuity. It's a different type of heterojunction.

Q So you disagree with Borden's statement that polysilicon emitter solar cells do not provide a heterojunction?

A We're going into semantics now. They don't provide the type of heterojunction that he is referring to, meaning one with a bandgap discontinuity. In general, heterojunction can mean more than just one type of discontinuity. For example, polysilicon cells provide a heterojunction between crystalline and polycrystalline silicon. That is a heterojunction, but it's not the one that Borden's talking about here.

Q In your declaration, you don't clarify this portion of Borden to explain this sentence; right?

A What I'm doing is simply copying what he wrote

in his paper.

Q Okay. And you don't say that you disagree with it or that you need to clarify what -- what he meant by "polysilicon emitter solar cells do not provide a heterojunction"?

A Well, what I'm saying is he, himself, realizes that a polysilicon emitter cell does not provide the benefit that the heterojunction using amorphous silicon would have provided. I'm agreeing with him. He, himself, is pointing it out.

Q So when Borden says, "Polysilicon emitter solar cells do not provide a heterojunction" --

A Yes.

Q -- you disagree?

A No. I agree. They don't provide the kind of heterojunction that he would like to -- to see, which is a heterojunction using amorphous silicon.

Q Okay. If we take a look at Borden paragraph 8 -- let me know when you're there.

A Borden paragraph 8. Okay. I'm there.

Q This talks about, towards the middle of the paragraph, some benefits of the invention; right?

A Right.

Q It says, "Moreover, the tunnel oxide prevents epitaxial growth of amorphous silicon."

Do you see that?
A Yes, I see it.
Q What is epitaxial growth?
A Epitaxial growth is crystalline growth, a continuation of the crystal structure of the substrate.
Q Is epitaxial growth -- strike that.
What is amorphous silicon?
A Amorphous silicon is a glassy form of silicon where the distances between adjacent atoms and their orientation is random and not structured the way it is in crystalline silicon.
Q Polysilicon has crystallated [sic] structures; right?
A Polycrystalline is a type of crystalline silicon where there are many individual crystalline grains or -- yes, grains, but they -- they're very small, and they have random orientation relative to adjacent grains.
Q Amorphous silicon does not have crystalline structures in it; right?
A That's correct.
Q Polysilicon has a different bandgap than amorphous silicon as well; right?
A That's correct.
Q What is the relative difference in the bandgap

between those materials?

A Crystalline or polycrystalline silicon, I believe, has a bandgap of about 1.1 electron volts. Whereas, amorphous silicon is more like 1.8 electron volts, which is significantly larger.

Q Aside from the bandgap and the crystalline structure, are there other differences between amorphous silicon and polysilicon?

A I believe the resistivity is different.

Q Anything else?

A There may be other differences. I don't have them all at my fingertips.

Q Okay. But that's all you recall just sitting here today?

A Yes.

Q If we turn to the end of paragraph 8, which goes on to this -- the next page of Borden --

A Yes.

Q -- it's -- it describes another advantage of -- of the tunnel oxide, which is that, "It may be used in conjunction with a point contact structure to further increase efficiency."

Do you see that?

A Yes.

Q What does that sentence mean?

A Well, that way you could limit the area of contact to the underlying substrate.
Q And that will increase efficiency of the solar cell?
A Not necessarily, but some point contact solar cells, if they're made correctly, can have higher efficiency.
Q The words "amorphous silicon" do not appear in this sentence; right?
A Not in that sentence.
Q So Borden does not limit the advantage of the point contact structure to just an embodiment with amorphous silicon; right?
A Well, repeat the question.
Q Borden does not limit the described advantage of the point contact structure to just an embodiment with amorphous silicon; right?
A Apparently not.
Q So the advantage of the point contact structure is not specifically limited to the application of amorphous silicon; right?
A Say it again.
Q So the advantage of the point contact structure of Borden is not specifically limited to amorphous silicon applications; right?

A Apparently, yes, that's what he's suggesting.
Q Take a look at paragraph 18 of Borden, which is on page 5.
A Okay.
Q This paragraph describes --
A Yes.
Q -- a dielectric layer.
Do you see that?
A A thin dielectric layer. A tunnel oxide is provided. Okay.
Q Is a tunnel oxide a type of dielectric layer?
A Yes, it's a type of dielectric layer.
Q It describes that the thin dielectric layer 228 (e.g. tunnel oxide) can be formed using conventional methods such as rapid thermal oxidation, furnace oxidation, or the Chemox process.
Do you see that?
A Yes.
Q What is the rapid thermal oxidation method?
A Well, it's exactly what it describes. You oxidize something rapidly. So it's a very short duration excursion to a high temperature.
Q Do you agree that it was conventional to use rapid thermal oxidation prior to 2008?
A I don't know if it was conventional, but it

certainly has been used during solar cell processing.

MR. PETERSON: Object to form.

BY MS. BOLL:

Q So it was at least known to those skilled in the art prior to 2008?

A Yes. It was generally widely known.

Q Is rapid thermal oxidation a difficult process?

A I don't know what you mean by "difficult."

Q In terms of sort of the capabilities of a person of ordinary skill in the art in 2008.

A It's no more difficult than the furnace oxidation.

Q Before 2008, what was the relative cost of rapid thermal oxidation compared to other methods?

A I'm not familiar with the costs.

Q What is furnace oxidation?

A Putting silicon wafers into a tube furnace, providing a source of oxygen, and elevating the temperature.

Q Was furnace oxidation known to those with skill in the art prior to 2008?

A Yes.

Q Would you agree with Borden that it was a conventional method prior to 2008?

A Yes.

Q Are you familiar with the costs of furnace oxidation?
A Not really.
Q The third method Borden references is the "Chemox process (formation in an ozonated H2O2 bath.)"
Do you see that?
A Yes.
Q What is that process?
A Well, I'm not totally familiar with it, but it sounds like you put the silicon wafer in hydrogen peroxide that has had ozone, which is O3 dissolved in it.
Q Would that have been known to those skilled in the art prior to 2008?
A I didn't know about it, but I didn't spend a lot of time working with chemical oxides because of their generally accepted view that they were unreliable.
Q Borden did not report that chemical oxides were unreliable; right?
A No, he did not report it.
Q Borden instead described Chemox formation as conventional; right?
A That's how he described it.
Q Paragraph 24 of Borden, which is on page 6 to page 7, describes "Plasma enhanced chemical vapor

deposition."

Do you see that?

A It's in paragraph 24?

Q Yeah.

A Oh, it carries over to the next page. Amorphous silicon is formed. For example, by PE-CVD. Okay.

Q You're familiar with PE-CVD; right?

A Yes.

Q That was well-known in the literature prior to 2008?

A Yes.

Q So those skilled in the art could reliably generate oxide layers using PE-CVD prior to 2008?

A In this -- in this sentence, he's talking about depositing amorphous silicon layers using PE-CVD.

Q I see.

A Not -- not oxide layers.

Q Okay. So in this embodiment -- that's right -- it says in the beginning of paragraph 24, a rapid thermal oxide process is used to form a thin tunnel oxide; right?

A That's what he's suggesting, yes.

Q So those skilled in the art can reliably generate a thin thermal oxide --

A I would say --
Q -- prior to 2008 using this rapid thermal oxide process?
MR. PETERSON: Object to form.
THE WITNESS: Apparently, it was available. I don't know how reliable it was or how conventional it was or how well-known it was.
BY MS. BOLL:
Q But Borden at least reports that rapid thermal oxidation could be used to form a thin tunnel oxide prior to 2008?
A Yes, that's what he reports.
Q Okay. I'd like to turn now to the Foglietti reference, and I'm sending that one through the chat now. Let me know when you have it open.
A Okay. Foglietti. Okay. I have it open.
(Exhibit Number 1014 was previously marked for identification.)
Q You reviewed Foglietti in forming your opinions in both the IPRs; right?
A Yes.
Q Are you familiar with the named inventors, Foglietti and Carl Willis?
A No.

Q "Foglietti disclosed a method of forming an interfacial oxide with good control which maintains its integrity during subsequent processing"; is that right?

A Where does he say that?

Q I'm in Paragraph 10, which is the first page after the figures.

A It looks like Paragraph 10 is before summary of the invention. I don't see the line you're talking about.

Q It says, "Therefore, there is a need in the art for a method of forming an interfacial oxide with good control which maintains its integrity during subsequent processing."

A Well, yeah, there remains a need, yes.

Q And that's the goal the invention was designed to solve; right?

A Apparently, yes.

Q And if we look at the next paragraph, it states, "The present invention." Do you see that?

A Yes.

Q And it states, "The present invention relates generally to the formation of a tightly controllable interfacial oxide in conjunction with a bipolar transistor, wherein the interfacial oxide maintains exemplary integrity during thermal processing."

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Do you see that?
A Yeah, I do.
Q And this Foglietti reference is dated in -- is published in October 2002; right?
A 2000 what?
Q '2.
A Okay.
Q So as of 2002, it was possible to form a tightly controlled interfacial oxide; is that right?
MR. PETERSON: Object to form.
THE WITNESS: Well, that's what he claims, yes.
BY MS. BOLL:
Q And in 2002, it was possible to form an interfacial oxide that would maintain exemplary integrity during subsequent thermal processing?
MR. PETERSON: Object to form.
THE WITNESS: That's what he's claiming, yes.
BY MS. BOLL:
Q Foglietti relates to bipolar transistors; right?
A That's what he claims, yes.
Q And although Foglietti relates to bipolar transistors, the tunneling mechanism that he applies also applies to solar cells; is that right?
A Well, tunneling would apply to any

semiconductor device.

Q So the tunneling mechanism of bipolar transistors is applicable to solar cells. Is that fair?

A It would be.

Q Why do you say that?

A Well, tunneling is a process which occurs when the oxide layer is thin enough that majority carriers can go through it and the minority characters are blocked. And that's the case regardless of what kind of a device it is.

Q So is it fair, then, to apply the teachings of Foglietti to the solar cell context?

A It should be.

Q So would you agree that a person of ordinary skill in the art would look to bipolar transistor references as relevant to designing a solar cell?

A It could be relevant.

Q Would you agree that bipolar transistor conditions have to be even more tightly controlled than those for a 1-Sun solar cell?

MR. PETERSON: Object to form.

THE WITNESS: I wouldn't necessarily agree with that.

BY MS. BOLL:

Q If we can take a look back at your declaration

in the '516 proceeding -- I'm sorry -- in the '053 proceeding, so the 1040 case number.

A Yes. Which page?

Q Page 45. This is the table of the claims.

A Okay.

Q In this table, you've reprinted Claim 1, Claim 9, and Claim 16; right?

A Yes, I have.

Q Those are the three independent claims of the '053 patent?

A That's right.

Q And here you've added color coding to track the N-type versus the P-type substrate and dopant; right?

A Yes.

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

A Yes.

Q Claim 1 also requires a P-type dopant; right?

A Yes.

Q And that's what you've illustrated here for Claim 1 in the table; right?

A Right.

Q So a solar cell -- a method of making a solar cell with a P-type substrate and an N-type dopant would not fall within the scope of Claim 1; right?

A That's true.
Q For Claim 9, though, you could have an N-type dopant with a P-type substrate; right?
A Yes, that's true.
Q Or you could have a P-type dopant and an N-type silicon substrate as with Claim 1; right?
A Right. Claim 9 is -- doesn't mention the polarity of the dopant or the substrate.
Q So Claim 9 is broader than Claim 1?
A That's true.
Q And the language in Claim 16 is also a little bit different from Claim 1; right?
A Yes, it is.
Q For Claim 16, you could have an N-type dopant and a P-type silicon substrate; right?
A Yes. It doesn't mention the polarities of the dopant to form the emitter or the substrate.
Q So for Claim 16, you could also have, as with Claim 1, a P-type dopant and an N-type substrate?
A You could.
Q So Claim 16 is also broader than Claim 1; right?
A Yes, it is.
Q Have you communicated, aside from your call with counsel, with anyone during today's deposition?

A No.
Q Since the time we went on the record this morning, did you look at any materials other than what's in the binders and what I've dropped into the chat?
A No.
MS. BOLL: I have nothing further.
MR. PETERSON: Okay. I have a few further questions.

EXAMINATION

by JEREMY PETERSON, Attorney at Law, Counsel on behalf of the Patent Owner:
Q Dr. Ruby, could you turn to Froitzheim for me, please.
A Yes, I have it.
Q Okay. Can you turn to paragraph 42, please.
A Yes, I have it.
Q Okay. So paragraph 42 gives a range that the dopant can be driven in at; is that correct?
A You cut out there for ten seconds. Say it again.
Q Paragraph 42 provides a range that the dopant can be driven in at; correct?
A That's right.
Q Do you know why there is a preferable range given?

MS. BOLL: Object to form.

THE WITNESS: I can speculate about why.

BY MR. PETERSON:

Q Let me -- let me strike that first.

It also gives a preferable range that the dopant can be driven in at; correct?

A Yes, it does.

Q Okay. And do you know why there is a preferable range?

A I would say that that temperature range is preferable because driving in a dopant in that temperature range results in a diffusion profile, a doping concentration, and a surface concentration that is optimum for making a solar cell emitter.

So, for example, if you were to go outside that temperature range, for example, down to the 900 degree temperature, you would not get enough dopant driven into substrate to form a low-resistance emitter. The sheet resistivity would simply be too high, and the contact resistance would simply be too high to make an efficient solar cell at a temperature of 900 degrees centigrade.

Q So I believe that you said that Gan and Kwark both discussed j naught values at 900 degrees; is that correct?

A Yep, that's right.

Q So making the combination between Froitzheim and Gan and Froitzheim and Kwark would involve some trade-offs, would it not?

A I --

MS. BOLL: Object to form.

THE WITNESS: As far as performing a combination where you use the diffusion temperatures preferred by Froitzheim, those would produce recombination parameters that are nonoptimal as shown by both Gan and Kwark.

BY MR. PETERSON:

Q I believe that you testified earlier that Gan showed that it was getting inconsistent oxide layers; correct?

A Certainly in --

MS. BOLL: Object to form.

THE WITNESS: Certainly in his thesis, he showed that even if he did the same process over and over again, he wound up with different results being that the oxide thickness was not reproducible.

BY MR. PETERSON:

Q And how does the oxide thickness affect the j naught values reported by Gan?

A Well, if -- how does the oxide thickness what now?

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Q Affect the j naught values reported by Gan.
A Well, if the oxide is too thin, then J0's too high. On the other hand, if the oxide's too thick, then the resistivity's too high.
Q So would you consider Froitzheim and Gan to be compatible given their differences in optimal temperatures?
A I would say no, and that's because Gan shows that in order to get low enough J0s to make an improvement in the recombination, you need to use a low-driving temperature of 900 degrees, which I believe in the case of the Froitzheim solar cell would not provide sufficient doping for the rear service emitter to obtain required low resistances.
Q Would your answer be the same for Froitzheim and Kwark?
A Yes. Kwark and Gan just both show the same thing.
Q So, in your opinion, would a person of ordinary skill in the art, back in 2008, have combined Froitzheim and Gan?
A I don't believe so, and that's because Froitzheim -- Gan and Kwark both show you need to keep the temperature to 900 degrees at a maximum. Whereas, Froitzheim was saying 900 degrees was a minimum, and --

and you would not be getting optimum parameters for making solar cells at that temperature. Whatever advantage you would gain by reducing recombination would be lost because of the high resistance of the non-optimized emitter.

Q Is your answer the same for Froitzheim and Kwark?

A Yes, it is.

MR. PETERSON: I don't have any further questions.

FURTHER EXAMINATION

by BROOKE S. B LL, Attorney at Law, Counsel for Petitioner:

Q Just a couple of questions, Dr. Ruby.

Froitzheim does not state what temperatures are preferred for doping polysilicon; right?

A Well, I believe he does. Paragraph 42 says that he prefers a temperature between 1000 and 1100 to both generate the oxide layer and to drive in the dopant.

Q But that's for a diffused emitter, right, not a polysilicon emitter?

A That's true, but what I would say to that is the diffusion properties of crystalline and polycrystalline silicon are the same.

Q But Froitzheim is silent as to the temperature that would be preferable for a polysilicon emitter; right?

A Froitzheim doesn't mention polysilicon whatsoever.

Q Counsel also asked you about the Gan Thesis; right?

A Yes.

Q That was a thesis done by, at the time, a graduate student; right?

A Yes.

Q And, generally, a Ph.D. thesis reports on all experimentation, whether it was successful or not; right?

A It should.

MS. BOLL: Nothing further.

MR. PETERSON: Okay. I don't have anything further.

(Whereupon, proceedings were adjourned.)

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CERTIFICATE OF CERTIFIED SHORTHAND REPORTER

STATE OF CALIFORNIA)
) ss.
COUNTY OF SACRAMENTO)

I, SHANNON BORGE, 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.

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I further certify that I am not a party to any stipulation, if made, that would waive my duties mandated by the Court Reporters Board of California.

In witness whereof, I have hereunto subscribed my name.

Dated: Wednesday, June 25, 2025

Shannon Borge

Shannon Borge, RPR, CSR
Certificate No. 9436

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