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

INERGY TECHNOLOGY,	)	
INC.,	)	
Petitioner	)	IPR2024-00093
	)	U.S. Patent No. 7,629,634
VS.	)	
	)	
FORCE MOS TECHNOLOGY	)	
CO., LTD,	)	
Patent Owner	)	

ORAL AND VIDEOTAPED DEPOSITION OF DAVID KUAN-YU LIU
AUGUST 22, 2024

ORAL AND VIDEOTAPED DEPOSITION OF DAVID KUAN-YU LIU,
produced as a witness at the instance of the Patent Owner
and duly sworn, was taken in the above styled and numbered
cause on Thursday, August 22, 2024, from 10:00 a.m. to
6:14 p.m., before Janalyn Elkins, CSR, in and for the
State of Texas, reported by computerized stenotype
machine, via Zoom, pursuant to the Federal Rules of Civil
Procedure and any provisions stated on the record herein.

A P P E A R A N C E S

FOR THE PETITIONER:

MIRCEA A. TIPESCU
BENESCH, FRIEDLANDER, COPLAN & ARNOFF, LLP
71 Wacker Drive, Suite 1600
Chicago, Illinois 60606
Tel: (216) 363-4500
mtipescu@beneschlaw.com

FOR THE PATENT OWNER:

MICHAEL D. SAUNDERS
DICKINSON WRIGHT, PLLC
607 W. 3rd Street, Suite 2500
Austin, Texas 78701
Tel: (512) 770-4200
msaunders@dickinsonwright.com

Also Present:

JOSEPH ACOSTA (Videographer)

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I N D E X

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1 REPORTER: Mr. Saunders, are you going to
2 want a rough draft?

3 MR. SAUNDERS: Yes, please.

4 THE REPORTER: I may butcher your name, but
5 Mr. Tipescu?

6 MR. TIPESCU: Tipescu.

7 THE REPORTER: Are you going to want a
8 copy?

9 MR. TIPESCU: Yes, please.

10 THE REPORTER: And are you going to want a
11 rough draft?

12 MR. TIPESCU: Yes, that's fine.

13 VIDEOGRAPHER: Today's date is August 22nd,
14 2024. We're on the record at 10:01 a.m. This is the
15 videotaped deposition of Dr. David Kuan-Yu Liu in the
16 matter of Inergy Technology, Inc. versus Force Mos
17 Technology Co. LTD filed in the United States Patent and
18 Trademark Office.

19 Counsel will now state their appearance and
20 affiliations for the record.

21 MR. SAUNDERS: Good morning, this is
22 Michael Saunders at Dickinson Wright on behalf of patent
23 owner.

24 MR. TIPESCU: Good morning. Mircea Tipescu
25 at the Benesch law firm on behalf of Petitioner.

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1 VIDEOGRAPHER: Will the court reporter
2 please swear in the witness and we may proceed.

3 DAVID KUAN-YU LIU,
4 having been duly sworn, testified as follows:

5 EXAMINATION

6 Q. (BY MR. SAUNDERS) Good morning, Dr. Liu, can
7 you state your full name for the record?

8 A. Good morning. My full name is David Kuan-Yu
9 Liu, L-I-U, is the last name.

10 Q. And you're appearing today remotely via Zoom;
11 is that correct?

12 A. Yes, that's correct.

13 Q. And where are you physically located right now?

14 A. I'm physically located in my home office in
15 Fremont, California.

16 Q. Is there anyone else in the room with you
17 today?

18 A. No, no one is with me and everyone have left
19 and I'm alone for the next two days.

20 Q. Okay. Let me know if someone joins you in the
21 room and we don't notice it.

22 A. Yes, I will. Most likely, if anything, will be
23 family members. But they know that I'm in a deposition
24 today and tomorrow so I don't think that will happen.

25 Q. Okay. Great. Thank you.

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1 You've been deposed before, correct?

2 A. Yes, I have.

3 Q. And you understand you're under oath today?

4 A. Yes, I do.

5 Q. And you understand that the court reporter will
6 need verbal answers to your questions rather than
7 nodding your head or gesturing?

8 A. Yes, I understand.

9 Q. And you understand that if you don't understand
10 any of my questions today, you can ask me to clarify it?

11 A. Yes, I do.

12 Q. And you understand you can ask for a break when
13 you need it?

14 A. Yes, I do. And most likely I will be asking --
15 I'll be asking for breaks, bio breaks, yes.

16 Q. Is there any reason why you can't provide
17 truthful and complete testimony today?

18 A. No, not at all.

19 Q. Okay. And you'll agree with me that you won't
20 communicate secretly with anyone while you're on the
21 record in this deposition?

22 A. Yes, I do agree with that.

23 Q. Okay. Do you have any papers with you right
24 now?

25 A. Yes, I do. I have the printed out -- I printed

1 out my declaration and also printed out the -- the '634
2 patent.

3 Q. And that declaration you're referring to; is
4 that the declaration that you submitted in IPR2024-00093
5 with exhibit label Exhibit 1003?

6 A. Yes, that's correct.

7 Q. And that's your declaration you submitted in
8 this IPR regarding the '634 patent?

9 A. Yes, that's correct.

10 Q. And you understand today if I refer to the '634
11 patent, I'm referring to Patent No. 7629634?

12 A. Yes, that's correct.

13 Q. And can you go to -- I guess I'll introduce in
14 your deposition first. But I'm going to ask you some
15 questions about the '634 patent. And while I'm waiting,
16 do you have access to the Exhibit Share platform for
17 Veritext?

18 A. I do believe so. I think I sign in as a guest,
19 a viewer, a guest. And right now, I believe it says the
20 folder is empty.

21 Q. All right. Well, you should now see the '634
22 patent, Exhibit 1001. You see that that's been
23 uploaded.

24 (Exhibit No. 1001 was marked.)

25 THE WITNESS: Let me refresh the screen to

1 see if it's there. Yes, I do see it now.

2 Q. (BY MR. SAUNDERS) Okay. And feel free to look
3 at your paper copy or the electronic copy when I'm
4 asking you about this or your declaration. And I'm
5 going to ask you --

6 A. I should mention -- I'm sorry. I should
7 mention that because the way I'm set up, I have my
8 eyes -- I have a larger screen so -- so when I'm looking
9 at the screen to see the exhibit, my eyes may not be
10 facing the camera and I hope that's okay with you, yeah.

11 Q. I understand. Thank you for letting me know.

12 So could you turn to Claim 1 of the '634
13 patent starting in Column 5 through Column 6?

14 A. I'm there.

15 Q. And do you see that the last element starting
16 at Column 6, line 11 says, (Reading:) A plurality of
17 source contact trenches formed on the top of said
18 interlayer oxide film extending downwardly through said
19 source layer to a portion of said base layer; wherein
20 the sidewalls of said trenches in said base layer are
21 covered by the lateral contact layer, wherein the bottom
22 base of said trenches in said base layer are covered by
23 the base contact layer.

24 Do you see that?

25 A. Yes, I do.

1 Q. Okay. Did you have an understanding of the
2 meaning of the phrase "lateral contact layer" when you
3 rendered your opinions in your declaration?

4 MR. TIPESCU: Objection, form.

5 THE WITNESS: Can you -- can you clarify
6 your question? I don't -- I don't know -- I don't know
7 the context of the question, please.

8 Q. (BY MR. SAUNDERS) Yeah. So you see that the
9 phrase "lateral contact layer" appears there in Claim 1
10 of the '634 patent?

11 A. Yes, I do.

12 Q. Okay. And in connection with your work on this
13 case, you compared the Claim 1 in the '634 patent
14 against various pieces of prior art; is that right?

15 A. Yes, that's correct.

16 Q. Did you have any particular claim construction
17 of lateral contact layer in mind when you rendered your
18 opinions in your declaration?

19 MR. TIPESCU: Objection, form.

20 THE WITNESS: I think my opinion is
21 rendered and put in my declaration. Is there a place
22 that you would like me to go to my declaration to -- in
23 order to answer your question?

24 Q. (BY MR. SAUNDERS) Well, I think part of the
25 problem I have here is I don't know if it's spelled out

1 in your declaration. But maybe we could start with --
2 sorry, one second. It's being slow. So why don't we go
3 to -- starting in paragraph 58 of your declaration.

4 A. Okay.

5 Q. And is this the beginning of a section
6 deposition entitled "Claim Construction"?

7 A. Yes, it appears so.

8 Q. Okay. And in paragraph 62, you have inclusion
9 as to your opinions regarding the meaning of the phrase
10 "the sidewalls of said trenches and said base layer".

11 Do you see that?

12 A. Yes, I do.

13 Q. And if you turn to the '634 patent, do you see
14 that that phrase appears as part of the longer phrase
15 "wherein the sidewalls of said trenches in said base
16 layer are covered by the lateral contact layer."

17 Do you see that?

18 A. Yes, I do.

19 Q. Okay. And turning back to paragraph 60, you
20 see a discussion with various quotes to the '634 patent
21 specification?

22 MR. TIPESCU: Objection, form.

23 THE WITNESS: Okay. I just read through
24 paragraph 60. Is there -- is there a question?

25 Q. (BY MR. SAUNDERS) Yes. So the question was

1 paragraph 60 has various quotes and citations to the
2 specification of the '634 patent, correct?

3 MR. TIPESCU: Objection, form.

4 THE WITNESS: There was some citation, and
5 I rely on some citation to support the opinion I'm
6 forming.

7 Q. (BY MR. SAUNDERS) And paragraph 60 has a
8 discussion of, among other things, lateral contact
9 layer, in the '634 patent, correct?

10 MR. TIPESCU: Objection, form.

11 THE WITNESS: Yes, I think lateral contact
12 layer is mentioned in paragraph 60.

13 Q. (BY MR. SAUNDERS) And so when you were
14 rendering these claim construction opinions in your
15 declaration, did you have an understanding of what the
16 phrase "lateral contact layer" meant?

17 MR. TIPESCU: Objection, form.

18 THE WITNESS: When I rendered opinion and
19 looking in the context of '634 in its totality, I do
20 have as a person of ordinary skill in the art, I do have
21 opinion as to the lateral contact layer.

22 Q. (BY MR. SAUNDERS) Okay. And what is that
23 opinion?

24 A. The opinion as I described in the -- in
25 paragraph 60 and in the context of Claim 1 limitation is

1 that the lateral contact layer is, as I mention right
2 here, the opinion I form is that the lateral contact
3 layer will cover the sidewall of said trenches and said
4 base layer. And the entire sidewall of said trenches is
5 said base layer.

6 Q. Do you have any other opinions as to what the
7 phrase "lateral contact layer" requires?

8 A. In addition -- in addition to support what I
9 just mentioned, in the context of Claim 1, limitation,
10 especially the phrase you just read. I form my opinion
11 that it would have to cover entire sidewall of the
12 trench in the base layer because limitation reads,
13 "wherein the sidewall of said trenches and said base
14 layer are covered by the lateral contact layer". And
15 then in parallel, in conjunction, you mention, "wherein
16 the bottom base of said trenches in said base layer are
17 covered by the base contact layer".

18 If you put the two sentence, they are
19 actually, I believe, the right term would be the
20 opposition of each other in terms of grammar and we know
21 that the bottom base of said trenches and said base
22 layer have to be completely contacted otherwise it
23 doesn't make sense. So therefore, in conjunction with
24 the previous sentence which says the said base layer are
25 covered by lateral contact layer, and putting these two

1 together, I have the opinion, along with the
2 specification of the '634 patent, I render the opinion
3 that the lateral contact layer has to cover, as I
4 mention here, the entire sidewall of said trenches and
5 said base layer.

6 Q. Okay. So it sounds like you told me your
7 opinion as to where the lateral contact layer has to be.
8 But do you have an opinion as to what the lateral
9 contact layer is?

10 MR. TIPESCU: Objection, form.

11 THE WITNESS: Which -- which aspect of the
12 lateral contact layer would you like to know?

13 Q. (BY MR. SAUNDERS) Well, I guess, let me start
14 asking some questions. Is the lateral contact layer a
15 part of the semiconductor that receives an ion
16 implantation?

17 MR. TIPESCU: Objection, form.

18 THE WITNESS: Again, given the claim
19 limitation of Claim 1, the lateral contact layer simply
20 is a layer of -- layer that cover the entire sidewall of
21 the trench in said base region.

22 Q. (BY MR. SAUNDERS) So what's your understanding
23 of the ordinary meaning of the phrase "layer" in the
24 field of semiconductors?

25 MR. TIPESCU: Objection, form.

1 THE WITNESS: Layer is used in many context
2 so you will have to perhaps narrow or parse it for me.

3 Q. (BY MR. SAUNDERS) You are familiar in some
4 context in the field of semiconductors that layer can
5 mean a particular physical layer of material that's
6 deposited together at the same time, correct?

7 MR. TIPESCU: Objection, form and
8 relevance.

9 THE WITNESS: That might be one way that
10 you describe a layer, but, again, I think the context
11 here is the lateral contact layer in the context of '634
12 patent.

13 Q. (BY MR. SAUNDERS) Okay. And in the context of
14 the '634 patent, the lateral contact layer is not a
15 particular layer of physical material that's all
16 deposited together at the same time; is that correct?

17 MR. TIPESCU: Objection, form.

18 THE WITNESS: I'm sorry. The question is
19 quite long. Can you break it down for me a little bit?
20 I'm sorry.

21 Q. (BY MR. SAUNDERS) Yeah. So we just talked
22 about one meaning of layer in the field of
23 semiconductors referring to, you know, a layer of
24 physical material that's deposited at the same time
25 together. Do you remember that?

1 MR. TIPESCU: Objection, form.

2 THE WITNESS: I remember that's one way you
3 describe it. But that might not be consistent -- that
4 might not be the context of '634 patent.

5 Q. (BY MR. SAUNDERS) Okay. And that's what I
6 wanted you to confirm. That's -- that's not what the
7 '634 patent is discussing when it uses the phrase
8 "lateral contact layer," correct?

9 MR. TIPESCU: Objection, form.

10 THE WITNESS: I don't -- I don't want to --
11 this is not a yes or no question. As I mentioned,
12 layer, when you talk about layer, layer has different --
13 different context and different context, you will have
14 different meaning. And I think '634 introduce a term
15 "lateral contact layer", and I believe to a person of
16 ordinary skill in the art in reviewing the specification
17 and claim limitation, I think my opinions are rendered
18 in the declaration and -- and I stand by my declaration.

19 Q. (BY MR. SAUNDERS) But where in your
20 declaration do you explain your understanding of the
21 meaning of the phrase "lateral contact layer"?

22 A. Give me a minute. I need to go back to my
23 declaration, please.

24 Q. Sure.

25 A. I need to look at -- excuse me. I believe in

1 paragraph 29 of my declaration, I refer to the
2 specification in the '634 patent and to help me describe
3 what the lateral contact layer is in the context of '634
4 patent.

5 Q. Okay. And in paragraph 29, you mention that
6 the lateral contact layer has "P*-type" doping; is that
7 correct?

8 A. In paragraph 29, I'm citing what the
9 specification said, and specification said clearly that
10 there -- there's a concentration requirement for a
11 different layers and these are relative requirement.
12 Now, I cite a P*-doping, P*-type. The P* is not a term
13 in the art. However, '634 patent bracketed as P* being
14 of doping concentration that is between P base layer and
15 the P+ source layer. So it's somewhere in between. And
16 there's a designation of P, P*, and P+.

17 Q. Okay. So you see in that last paragraph --
18 sorry, withdraw.

19 You see in the last sentence of paragraph
20 29 you say, (Reading:) "Doping concentration of P-* --
21 or P-asterisk is doped more heavily than P but less than
22 P+?

23 Do you see that?

24 MR. TIPESCU: Objection, form.

25 THE WITNESS: I cited there, again, P* is

1 not term of the art, and I cited there to describe what
2 '634 patent and consistent with my understanding. What
3 '634 patent is saying that the lateral contact layer has
4 a doping requirement, which is; it has to be less than
5 the base contact layer and it has to be greater than the
6 P base layer which is used to control the threshold
7 voltage of the vertical MOSFET.

8 So in the context of the '634 is bracketing
9 the relative doping concentration. But P* as a term,
10 there's no definitive doping associated with P*, it
11 simply is a relative term in the context of '634 that it
12 describes P* is between a base contact layer doping
13 concentration and a P base doping concentration.

14 Q. (BY MR. SAUNDERS) Can you just explain to me
15 what "doping concentration" means?

16 A. Again, this is very broad. Which part would
17 you like to know?

18 Q. Just in the sense that you use the phrase
19 "doping concentration" in paragraph 29 of your
20 declaration?

21 A. Semiconductor, generally, as I describe in my
22 declaration, has two type -- mainly two type of doping
23 or conductivity. Either N-type or P-type. So you
24 introduce impurity to facilitate these different type.
25 And the number of atoms or number of impurity per cubic

1 centimeter volume concentration, not aerial
2 concentration, but volume concentration is called a
3 doping concentration.

4 In semiconductor, there is the degree of
5 doping concentration are used to facilitate different --
6 different behavior on the -- on the device. So given
7 this P-type, then you will need to have -- you can
8 easily, if it's only one type of concentration, you just
9 say P-type, and '634 clearly sometimes just use P-type
10 region, P-type layer.

11 However, as I mentioned, due to different
12 concentration, if you want to demarcate, you want to
13 differentiate even within the same P-type, then you will
14 use different designation. This designation is very
15 akin to you going to a Starbucks. You want to order
16 tall, grande or venti. But if you go to, say, Peace
17 Coffee, you may have different set of nomenclature.

18 Similarly here, so people will use within
19 the context of a device they will use different
20 designation to help the audience or the reader or to
21 help to differentiate the difference in concentration.
22 In the context of '634, the inventor chose this term P*
23 simply to denote that that concentration is greater than
24 the base doping concentration, but less than the P+ or P
25 base layer concentration. So the designation they

1 choose to use is P+ and P, and in between, a P*. That's
2 a designation they -- they chose to use.

3 Again, as I mentioned, P* as itself has
4 no -- no definitive -- it's not a definitive term in the
5 art. So these are just relative to show the relative
6 concentration.

7 Q. Are the terms P and P+ terms used in the art
8 for doping concentrations?

9 MR. TIPESCU: Objection, form.

10 THE WITNESS: Just like P* or P+ or P,
11 sometimes even P- in cases in order to distinguish
12 it's -- it's -- they use P++. It's really -- you really
13 have to, within a given context, you really have to --
14 it's like a C level, you really have to calibrate it.
15 These terms are mainly -- only reason you need to have
16 these addition, for example, plus or plus plus or star
17 or minus is because within the same type of doping and,
18 say, P-type, of course, there's also N-type, within
19 P-type, you will have to distinguish one layer's doping
20 concentration relative to the other layer's doping
21 concentration.

22 So in the context, again, in context '634,
23 there's no magical definition of P*. Again, it's not a
24 term in the art. In the context '634 is simply using
25 this term to demarcate, look, I want this doping

1 concentration in order to optimize this device and to
2 serve its purpose of model contact layer, I would like
3 this doping concentration to be less than the P+ or P
4 base layer, and I'm going to call my P base layer P+
5 just to demarcate.

6 I could call it P++. I could call it P+++,
7 doesn't matter. But I just use that P+ to denote, look,
8 this guy's doping concentration is greater than the P*.
9 And then I have this P* and I also want to demarcate
10 against the P base layer so I also mention it in the
11 context that this P*-doping concentration is greater
12 than the P base layer. It's just a relative to denote,
13 to clarify the relative concentration, doping
14 concentration.

15 Q. (BY MR. SAUNDERS) You've read other articles
16 in the field of semiconductors that have used the terms
17 P, P+, and P- for identifying doping concentrations
18 before, correct?

19 MR. TIPESCU: Objection, form.

20 THE WITNESS: Can you repeat your question?
21 I don't know --

22 Q. (BY MR. SAUNDERS) Yeah.

23 A. Repeat your question, please.

24 Q. Yeah, in your understanding and review of
25 literature in the field of semiconductors, you've seen

1 the terminology P, P+ and P- used to refer to doping
2 concentrations before, correct?

3 MR. TIPESCU: Objection, form.

4 THE WITNESS: I think the better way to
5 answer is that any contacts, if you need to distinguish
6 or demarcate the different doping concentration --
7 relative doping concentration for the purpose of
8 clarity, people will use different designation. It
9 could be P+. It could be P++. It could be P-. It
10 could be P.

11 In the context where there is a benefit to
12 distinguish the relative concentration to clarify, then
13 there will be designation used. And the '634 patent,
14 you can see as well. Generically, if you don't need to
15 and they just say N-type, base layer, for example, in
16 the -- in the context '634, you mention N-type, P-type,
17 base layer.

18 Because in our case, I'm not -- I don't
19 need to -- I don't need to demarcate or differentiate,
20 yeah. I just want to show that a P-type, the base layer
21 is a P-type. But then when it needs to demarcate
22 relative concentration, then I'll have to add some
23 designation to it. So the designation is added only to
24 clarify the relative concentration.

25 MR. SAUNDERS: Okay. I'm going to object

1 as nonresponsive.

2 Q. (BY MR. SAUNDERS) I asked a relatively, you
3 know, narrow question. So make sure and try and keep my
4 question in mind.

5 In your review of literature in the field
6 of semiconductors before your work on Force Mos matters
7 you've seen authors in the field of semiconductors refer
8 to doping concentrations using the terms P, P+, and P-
9 before, correct?

10 MR. TIPESCU: Objection, form, relevance.

11 THE WITNESS: I believe I answered your
12 question. In my review in my field working in
13 semiconductor, when there is need to differentiate, I've
14 seen P, P-, P+, P++, P--, I've seen different
15 designation and I have to look at the context of
16 designation to -- it usually will have a context to
17 demarcate the relative concentration between different
18 regions or different -- in this case different layers to
19 demarcate to clarify the relative concentration for
20 implementing a device.

21 Q. (BY MR. SAUNDERS) And prior to your work on
22 matters relating to Force Mos, have you, in your
23 experience in the field of semiconductors, ever seen the
24 term P-asterisk or P* before?

25 MR. TIPESCU: Objection, form.

1 THE WITNESS: Sitting right here, I can't
2 recall. Again, I think these additional, I will call it
3 denotation or -- again is to designate different
4 relative concentration to help the audience get a
5 clarification on the relative concentration between
6 different area, different region or different layers.
7 But I have seen -- what I have seen is that these --
8 again, these different designation are -- are used,
9 again, to clarify the relative concentration.

10 Otherwise, if there's no need to clarify,
11 it will just be generic P-type, N-type, or something
12 like that. But in cases where the clarification is
13 needed, different author may choose different
14 designation as long as the context or relative
15 concentration is given.

16 Q. (BY MR. SAUNDERS) And prior to the '634
17 patent, it was known that there are various ways of
18 introducing dopants into semiconductor material for a
19 semiconductor, correct?

20 A. Excuse me.

21 MR. TIPESCU: Objection, form.

22 THE WITNESS: Can you repeat your question
23 again?

24 Q. (BY MR. SAUNDERS) Yes, prior to the '634
25 patent it was known in the field of semiconductors that

1 there are various ways of introducing dopants into
2 semiconductor material, correct?

3 MR. TIPESCU: Again, objection, form.

4 THE WITNESS: In my experience, there are
5 ways to introduce dopant into -- into a region of
6 semiconductor.

7 Q. (BY MR. SAUNDERS) And one of those ways is ion
8 implantation; is that correct?

9 MR. TIPESCU: Objection, form.

10 THE WITNESS: In my experience, implant
11 could be introduced depending on where in the process
12 sequence, implant could be introduced to a region or
13 next to a region. Doping could be introduced to a
14 region or into a region depending on the process
15 sequence before and after through ion implantation.

16 Q. (BY MR. SAUNDERS) And another way of doing --
17 sorry. Withdraw.

18 Another way to introducing dopants is to
19 introduce the dopants during a process of epitaxis where
20 you're growing silicon or other semiconductor material
21 and you're adding dopants during that process; is that
22 correct?

23 MR. TIPESCU: Objection, form.

24 THE WITNESS: Again, in the epitaxial case,
25 I think the better way to -- to -- to describe it would

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1 be you can introduce different relative concentration
2 from another region with different concentration through
3 epitaxial growth.

4 Q. (BY MR. SAUNDERS) Okay. And did you have an
5 understanding as to whether the phrase "lateral contact
6 layer" in Claim 1 of the '634 patent requires a
7 particular way of introducing dopants?

8 A. Repeat your question again.

9 Q. Yeah. So in the context of Claim 1 of the '634
10 patent, does the phrase "lateral contact layer" require
11 a specific method of introducing dopants?

12 MR. TIPESCU: Objection, form.

13 THE WITNESS: Are you referring to in the
14 context of claim limitation or...

15 Q. (BY MR. SAUNDERS) Yes. Claim 1 of the '634
16 patent, the phrase "lateral contact layer"?

17 MR. TIPESCU: Objection, form.

18 THE WITNESS: Sorry, repeat your question
19 again.

20 Q. (BY MR. SAUNDERS) Yeah. So does the term
21 "lateral contact layer" in Claim 1 of the '634 patent
22 require a particular method of introducing dopants?

23 MR. TIPESCU: Again, objection, form.

24 THE WITNESS: The way I would answer is
25 that in looking at Claim 1, Claim 1 is an apparatus

1 structure. It does not describe the sequence of how the
2 lateral contact layer nor the process that the lateral
3 contact layer is -- is introduced. The only requirement
4 or limitation -- or one of the main limitation is said
5 trenches and said base layer are covered by the lateral
6 contact layer and the bottom base of said trenches and
7 said base layer are covered by the base contact layer.

8 There's no description of sequence, process
9 sequence, nor description of method of forming the
10 lateral contact layer.

11 Q. (BY MR. SAUNDERS) Prior to your work on Force
12 Mos matters, have you ever heard of the term "lateral
13 contact layer" before in connection with semiconductors?

14 MR. TIPESCU: Objection, form.

15 THE WITNESS: I heard of lateral, for
16 example, a vertical DMOS and lateral DMOS and I heard of
17 contact. And for example, making a contact to the
18 source. And also layer. But I -- sitting right here, I
19 don't recall these lateral contact layer. I don't
20 recall a lateral contact layer. I may or may not. I
21 don't recall sitting right here.

22 Q. (BY MR. SAUNDERS) Do you have an opinion as to
23 whether the phrase "lateral contact layer" has an
24 established ordinary meaning in the field of
25 semiconductors?

1 MR. TIPESCU: Objection, form and
2 relevance.

3 THE WITNESS: I'm sorry. It's kind of
4 open-ended. I'm not -- I'm not trying to -- I'm not --
5 I'm not getting what you -- the context of the question,
6 please.

7 Q. (BY MR. SAUNDERS) Yeah. So in connection with
8 claim construction, the board may attempt to determine
9 whether the phrase "lateral contact layer" has an
10 established ordinary meaning in the field, which has a
11 meaning to those of skill in the art in the field of
12 semiconductors.

13 And so what I'm asking you is, do you have
14 an opinion as to whether the phrase "lateral contact
15 layer" has an established ordinary meaning to those of
16 skill in the art in the field of semiconductors?

17 MR. TIPESCU: Objection, form.

18 THE WITNESS: I believe I answered the
19 question. I -- I -- I heard it -- I know the term
20 "lateral" like in a sense of vertical DMOS where the
21 current flow vertically and you have lateral DMOS where
22 the current flow horizontally and you have contact and
23 you have layers. So lateral contact layer. And in the
24 context described in context of '634. And I'm not sure
25 what other aspect you are asking in your question.

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1 Q. (BY MR. SAUNDERS) Yeah, so just looking at the
2 words "lateral contact layer" together, does that tell
3 you the meaning of the phrase in Claim 1 of the '634
4 patent based on your experience in the field of
5 semiconductors, or did you feel that you needed to turn
6 to the specification of the '634 patent to understand
7 the meaning of that phrase?

8 MR. TIPESCU: Objection, form, and -- and
9 relevance.

10 THE WITNESS: I think with any term in any
11 patent, you always refer to specification to get a
12 reference as to the context of the term that's being
13 introduced. Even -- even if the term may be familiar,
14 the inventor may be acting as their own source in
15 defining the term. So I will have to -- need you to
16 rephrase your question for me to answer clearly.

17 Q. (BY MR. SAUNDERS) Well, when you read Claim 1
18 of the '634 patent, you already knew what a MOSFET was,
19 right?

20 A. Yes, that's correct.

21 Q. And when you read Claim 1 of the '634 patent,
22 you already knew what a gate was, correct?

23 A. I knew a gate -- what a gate is. And then also
24 I have to look into the specification to understand in
25 the context is the -- is the gate is vertical, a

1 vertical gate, a trench gate.

2 Q. And when you first read --

3 A. I -- sorry.

4 Q. Go ahead and finish your answer.

5 A. Even though I understand what the gate is, I
6 have to refer to the context to know that the gate is a
7 vertical gate, is a trench gate.

8 Q. And when you first read Claim 1 of the '634
9 patent, did you have any understanding of what it meant
10 by a lateral contact layer?

11 A. I believe so. And I rendered opinion it's
12 the -- it's the layer that cover the entire -- the
13 entire sidewall of the trench in the base layer -- base
14 layer in the base region, excuse me. I'm sorry. I'm
15 really sorry.

16 Q. That's okay. Let me know if you need to take a
17 break.

18 A. I think I'm fine. Thank you.

19 Q. Okay. Would you agree with me in the context
20 of semiconductors and MOSFETs, the word "lateral" means
21 to the side?

22 MR. TIPESCU: Objection, form, relevance.

23 THE WITNESS: I don't know what to the side
24 means. I think lateral just means that -- lateral is --
25 I'm sorry, usually in the context to -- to describe

1 contracts were vertical. So, for example, as I
2 mentioned earlier, you have a lateral DMOS, which means
3 current flows horizontally, and you have a vertical DMOS
4 which means current flows vertically down the -- down
5 into the P+ -- N+ drain region in the case of structures
6 similar to '634.

7 Q. (BY MR. SAUNDERS) And what does the word
8 "contact" mean in the field of semiconductors?

9 MR. TIPESCU: Objection, form and
10 relevance.

11 THE WITNESS: You will have to bracket or
12 narrow your -- the scope of your question because
13 contact is a very -- very generic word, yeah.

14 Q. (BY MR. SAUNDERS) So you agree with me that
15 there are many different meanings of "contact" in the
16 field of semiconductors?

17 MR. TIPESCU: Objection, form and
18 relevance.

19 THE WITNESS: Again, I -- I cannot read
20 your mind, so you have to let me know exactly which
21 aspect of the contact that you are trying to referring
22 to.

23 Q. (BY MR. SAUNDERS) So one way of interpreting
24 contact is two things being in physical contact to each
25 other; is that correct?

1 MR. TIPESCU: Objection, form and
2 relevance.

3 THE WITNESS: I don't necessarily agree
4 with that because contact could be physical, could be
5 electrical. And you really need to -- to have a
6 context.

7 Q. (BY MR. SAUNDERS) Okay. So you mentioned
8 physical and electrical are different types of contacts.
9 What does electrical contact mean?

10 MR. TIPESCU: Objection, form and
11 relevance.

12 THE WITNESS: In the sense that electrical
13 contact is to facilitate -- either facilitate or is
14 relevant to the conduction of the electrical current.

15 Q. (BY MR. SAUNDERS) And are you also familiar
16 with the -- the use of the word "contact" to denote a
17 special part or structure for helping to create that
18 electrical contact between two different components or
19 structures?

20 MR. TIPESCU: Objection, form.

21 THE WITNESS: I'm sorry. Your question is
22 very -- very long. I'm having a little difficulty
23 parsing it. I'm really sorry.

24 Q. (BY MR. SAUNDERS) Well, let's give an example
25 here. So the '634 patent Claim 1 mentions a plurality

1 of source contact trenches, correct?

2 A. Let me try to find that in the -- in the --
3 yes.

4 Q. Okay. What does "contact" mean in that
5 context?

6 MR. TIPESCU: Objection, form and
7 relevance.

8 THE WITNESS: Excuse me. In that context,
9 one of the understanding of that context is to -- to
10 facilitate current conduction to the -- to the source.

11 Q. (BY MR. SAUNDERS) And does the word contact in
12 the phrase "lateral contact layer" have the same or a
13 different meaning?

14 MR. TIPESCU: Objection, form and
15 relevance.

16 THE WITNESS: I'm trying to understand your
17 question. Can you repeat the question again, please?

18 Q. (BY MR. SAUNDERS) Yeah. So you just gave your
19 understanding of the meaning of contact in the phrase "a
20 plurality of source contact trenches". And what I was
21 asking you is whether the words contact had the same or
22 a different meaning in the context of the phrase
23 "lateral contact layer"?

24 MR. TIPESCU: Objection, form and
25 relevance.

1 THE WITNESS: Look, I mention that it could
2 be physical. It could be electrical, okay. And it
3 could be both. So I don't understand the -- excuse me,
4 the -- the -- the context of the question. So the
5 lateral contact layer, I think in the context of '634,
6 it should be pretty clear it's -- it's a layer with a
7 relative doping concentration that covered the entire
8 sidewall of the trench in the base layer, base region.

9 Q. (BY MR. SAUNDERS) Relative doping
10 concentration with respect to what?

11 A. As -- as the '634 patent -- and -- also in the
12 limitation, subsequent limitation, is relative to the
13 base contact layer and the base region of the device.

14 Q. Can you turn to Figure 1 of the '634 patent and
15 let me know when you're there?

16 A. Okay. I'm there.

17 Q. You see Figure 1 is a depiction of prior art?

18 A. Yes, I do.

19 Q. And do you see the difference between Figure 1
20 and Figure 2G is that Figure 2G adds the structure 209
21 adjacent to the source contact trenches?

22 MR. TIPESCU: Objection, form.

23 THE WITNESS: Let me take a look at the --
24 hang on a second. Please repeat your question again.

25 Q. (BY MR. SAUNDERS) Yeah. So the difference

1 between Figure 1 and Figure 2G is that Figure 2G is
2 adding the structure 209, the lateral contact layer to
3 the sidewalls of the source contact trenches; is that
4 correct?

5 A. I think a better way to answer the question is
6 that the sidewall of the trench is always in the context
7 of whether it's 2G or Figure 1. The sidewall of the
8 trench is attempting to contact, you can say lateral --
9 laterally contact, the base region and vertically
10 contact the base layer which is designated P+.

11 Now, '634 patent says that unless you
12 somehow implement some kind of relative doping
13 concentration, otherwise if the trench source contact is
14 only contacting the P base region, if there's no
15 differentiation of doping concentration, then that
16 contact may not be ohmic contact. In such a case, then
17 you are susceptible to turning on of a bipolar
18 transistor, and you can call it avalanche, you can call
19 it punch-through. They are actually interrelated and
20 then you're going to have suffer in terms of your
21 breakdown voltage.

22 So I think in the context of your question,
23 a way -- better way to -- to pose that, to understand
24 would be that there's always trench source contact to
25 contact the sidewall. The question is modifying the

1 relative doping in that -- in where the sidewall
2 trench -- trench source contacting the sidewall, if you
3 can modify the relative doping, then perhaps you can
4 enhance your device performance.

5 MR. SAUNDERS: I think we've been on the
6 record for about an hour now. Is now an okay time for
7 your break, Dr. Liu?

8 THE WITNESS: Yes, please.

9 MR. SAUNDERS: All right. Let's go off the
10 record.

11 VIDEOGRAPHER: The time is 11:00 a.m.
12 We're off the record.

13 (Brief recess.)

14 VIDEOGRAPHER: The time is 11:12. We're
15 back on the record.

16 Q. (BY MR. SAUNDERS) Great. Dr. Liu, can you go
17 into Exhibit Share and see that there's been marked a
18 new Exhibit 2011.

19 (Exhibit No. 2011 was marked.)

20 THE WITNESS: So I think I might have to --
21 okay. It's pulling up right now.

22 Q. (BY MR. SAUNDERS) Let me know when you see it.

23 A. Okay. Okay. I have it up now.

24 Q. You see that -- what's been marked Force Mos
25 Exhibit 2011 is a "Claim Construction Order" entered in

1 Case No. 2:22-CV-00460 in the Eastern District of Texas?

2 A. I don't see Eastern District of Texas, but I
3 do -- yeah, yes.

4 Q. Okay. You see Eastern District of Texas at the
5 top?

6 A. Yeah.

7 Q. Okay. And then if you could do me a favor,
8 could you scroll to kind of see if you can see pages 49
9 and 50, bottom of 49 and top of 50?

10 A. All the way down. Okay.

11 Q. And do you see that -- and between pages 49 and
12 50, the court gives a construction of the term "lateral
13 contact layer" to mean, (Reading:) Requiring a region
14 of dopant in which is implanted into sidewalls of the
15 source contact trenches to have a dopant concentration
16 between P and P+ ("P* doping") for an N-channel MOSFET
17 or between N and N+ ("N* doping") in a P-channel MOSFET.

18 Do you see that?

19 A. Yes, I'm seeing this for the first time.

20 Q. Okay. You haven't seen this document before?

21 A. No, I have not.

22 Q. Do you agree or disagree with the Court's claim
23 construction of lateral contact layer here?

24 MR. TIPESCU: Objection, form and
25 relevance.

1 THE WITNESS: As you know, based on my
2 declaration, and I render my opinion, and my opinion is
3 in disagreement with the Court, the claim -- how the
4 Court construed the term. Regardless, I will -- I have
5 to -- it's the Court's claim construction, and I have to
6 follow it. But my declaration is very clear that my
7 opinion disagree with the Court's -- Court's opinion.

8 However, even with that, given that claim
9 construction, I don't think -- I don't believe my -- my
10 opinions are invalid -- I still believe the opinion I
11 render in my declaration are all valid.

12 Q. (BY MR. SAUNDERS) Okay. Can you identify to
13 me where the points of disagreement you have between
14 what you believe is the correct construction of lateral
15 contact layer and the Court's construction of lateral
16 contact layer here?

17 MR. TIPESCU: Objection, form and
18 relevance. And I'm going to continue to object to this
19 line of questioning, because this is not the PTAB's
20 construction. This is the Court's construction. The
21 witness has never seen this document before.

22 THE WITNESS: Sitting right here, I really
23 have to spend some time to digest it. I think my
24 claim -- the opinion I render for the lateral contact
25 layer -- excuse me. Has more to do -- I think this is

1 very clear that we just described already. And I think
2 I was not privileged to this information and sitting
3 right here I'm not going to try to -- try to parse it
4 out and -- I'm here to defend and to be deposed based on
5 my declaration, yeah.

6 Q. (BY MR. SAUNDERS) Can you turn back to Claim 1
7 of the '634 patent and particularly the lines 15 through
8 17 in Column 6?

9 A. Okay, I'm there.

10 Q. Can you see that the last words in Claim 1 is
11 the phrase "the base contact layer"?

12 A. Yes, I do.

13 Q. Do you have an understanding of the meaning of
14 the phrase "the base contact layer"?

15 A. Again, in the context of '634, which aspect of
16 the meaning are you looking for?

17 Q. The aspect is what does that term as it appears
18 in Claim 1 require?

19 MR. TIPESCU: Objection, form.

20 THE WITNESS: In the internal -- let me use
21 an internal vertical power MOSFET as an example. So the
22 base contact layer will be a high doping concentration
23 layer designated by -- in the -- if you want to go to
24 Figure 2G which you had earlier, it will be the P -- it
25 will be a P base, P region -- P-type region designated

1 by P+ to demarcate or distinguish this concentration
2 from the P*-doping and is labeled as P+ region at the
3 bottom of the source contact trench.

4 Q. (BY MR. SAUNDERS) So both the base contacted
5 layer and the lateral contact layer contact the source
6 contract trench; is that correct?

7 MR. TIPESCU: Objection, form.

8 THE WITNESS: The source contact trench,
9 the source in the -- in the vertical DMOS is actually
10 the N region -- source region at the top. And this
11 region needs to be connected to the P base region. And
12 so the N source, N-type source region denoted by N+ to
13 distinguish itself from the N- epitaxial layer. So this
14 N+ region needs to be contacted and also needs to be
15 contacted together with the -- excuse me, with the
16 P base region.

17 And the P base region, the way it contacts
18 it, as we show in the -- in both Figure 1 and Figure 2G,
19 it contacted along all the sides of the trench,
20 including the bottom and the two -- and the -- and the
21 sidewall of the trench. So in this -- yeah, that's
22 basically, yeah, the purpose of the source contact
23 trench.

24 Q. (BY MR. SAUNDERS) Okay. So one of the ways
25 the base contact layer is different than the lateral

1 contact layer in Claim 1 is that the base contact layer
2 is at the bottom of the source contact trenches and the
3 lateral contact layers on the sidewall of the source
4 contract trenches; is that correct?

5 MR. TIPESCU: Objection, form.

6 THE WITNESS: I don't necessarily agree
7 with that because the base -- when you -- there may be
8 an interface when you implement this so-called base
9 region and implement this base contact layer, the
10 interface may have -- interface is not abrupt interface.
11 It may have due to dopant diffusion. It's not an abrupt
12 interface. So it's hard to answer your question with a
13 yes.

14 Q. (BY MR. SAUNDERS) So it your understanding
15 that the base contact layer of Claim 1 of the '634
16 patent requires a different dopant concentration than
17 the lateral contact layer?

18 MR. TIPESCU: Objection, form.

19 THE WITNESS: You are -- you are now
20 talking about the optimization of the power, vertical
21 power MOSFET. And if you can repeat your question
22 again, I -- I can answer it better.

23 Q. (BY MR. SAUNDERS) Yeah. So in your
24 understanding of Claim 1 of the '634 patent, is it your
25 understanding that the term base contact layer requires

1 a different doping concentration than lateral contact
2 layer?

3 MR. TIPESCU: Objection, form and
4 relevance.

5 THE WITNESS: There is -- I'm sorry.
6 Repeat your question again. Because I think this is
7 very important in terms of device optimization. And in
8 this field of power devices, the -- all the parameters
9 you are trying -- you have -- you are trying to optimize
10 between the tradeoff between what we call the
11 ON Resistance in a way which is current conduction in
12 the on state versus the maximizing the breakdown voltage
13 during the off state.

14 And these -- these two optimization are
15 interrelated and sometimes it may be contradictory in
16 terms of how you want to go with different parameters.
17 So your question is that is it my understanding of what,
18 under what context between the doping? Because if
19 you're not worried about this optimization, you can make
20 up different doping, but it may not be an optimal
21 device. So you have to give me a context when you say
22 the doping concentration between base contact layer
23 versus the sidewall.

24 Q. (BY MR. SAUNDERS) Yes. I guess I'm just
25 asking about how one of skill in the art reading Claim 1

1 of the '634 patent in light of the specification, would
2 they understand those two different terms, "base contact
3 layer" and "lateral contact layer" as requiring --
4 having different doping concentrations?

5 MR. TIPESCU: Objection, form and
6 relevance.

7 THE WITNESS: So it turns out that in order
8 to optimize it without degrading the two aspects that I
9 mentioned or to even to find optimal sweet spot, it
10 turns out that there -- there -- the -- there is a
11 relative concentration between the base contact layer
12 and the doping concentration at the sidewall of the
13 trench in the base region. So one of the optimal points
14 is that the base contact layer will have a higher doping
15 compared to the doping profile at the sidewall of the
16 source contact trench.

17 Now, mind you, prior art 1 -- Figure 1
18 already satisfy this -- this condition, okay, in the
19 sense that the doping concentration, relative doping
20 concentration of the P based region, the sidewall makes
21 the sidewall of the trench of the P base region versus
22 the P -- versus the P-type base contact layer. So
23 there's already a relative doping concentration in the
24 prior art structure.

25 So according to the context of '634, this

1 issue apparently with the ohmic contact and the ohmic
2 contact causes premature breakdown, so therefore this --
3 there's this optimization. So...

4 Q. (BY MR. SAUNDERS) All right. Can you turn to
5 paragraph 66 of your declaration and let me know when
6 you're there?

7 A. I'm there.

8 Q. And this is part of your declaration where you
9 compare the Hirler reference against limitation 1[a] of
10 the '634 patent; is that correct?

11 A. I think this is where I describe Hirler's
12 implementation, that's correct.

13 Q. And one of the parts that you see that's in
14 limitation 1[b] in that heading b above paragraph 65 you
15 see it says, (Reading:) An epitaxial layer
16 corresponding to said drain region disposed on the top
17 of said silicon substrate.

18 Do you see that?

19 A. No, I don't. Can you -- can you repeat again?

20 Q. So just looking at heading there, b, and you
21 have inserted [2] on the third line down. Do you see it
22 mentions an epitaxial layer?

23 Do you see that?

24 A. Under No. 2?

25 Q. Yeah.

1 A. Okay. Yes.

2 Q. Okay. And then the second to last and last
3 lines on page 23 of your declaration in paragraph 66,
4 you say, (Reading:) The "n-drift zone 11" corresponds
5 with "an epitaxial layer corresponding with a drain
6 region."

7 Do you see that?

8 A. Yes.

9 Q. So that N- drip zone 11; that's the structure
10 in Hirler you're identifying as corresponding to the
11 epitaxial layer?

12 MR. TIPESCU: Objection, form.

13 THE WITNESS: I think I'm just mapping and
14 I think I mentioned that that's the drain region. And
15 one of the way that the lighter doping form on top of
16 the heavy doping is with epitaxial as we mentioned
17 earlier, yeah.

18 Q. (BY MR. SAUNDERS) And so we discussed what it
19 means to be an epitaxial layer earlier, correct?

20 MR. TIPESCU: Objection, form.

21 THE WITNESS: I think epitaxial layer was
22 mentioned earlier in the deposition.

23 Q. (BY MR. SAUNDERS) And is it your understanding
24 that epitaxial layer requires a layer created by the
25 process of epitaxis?

1 A. Repeat your question again.

2 Q. Yeah. Does the phrase "epitaxial layer" refer
3 to a layer of semiconductor material created by the
4 epitaxis process -- sorry. Let me withdraw. I think I
5 said it wrong that time.

6 Epitaxial layer refers to a layer created
7 by the process of epitaxy, correct?

8 MR. TIPESCU: Objection, form and -- and
9 relevance.

10 THE WITNESS: I think the -- it depends
11 really on the -- the context, context of -- I don't
12 know. It's -- it's -- I don't think that's a blanket
13 statement.

14 Q. (BY MR. SAUNDERS) Is there another meaning of
15 epitaxial layer that you have in mind?

16 MR. TIPESCU: Objection, form and
17 relevance.

18 THE WITNESS: Can you repeat your question
19 again?

20 Q. (BY MR. SAUNDERS) Yeah. So we're discussing
21 the meaning of the phrase "epitaxial layer". And I was
22 trying to understand if you had a different meaning in
23 your mind of the meaning of the phrase epitaxial layer
24 other than a layer created via the epitaxy process?

25 MR. TIPESCU: Objection, form and

1 relevance.

2 THE WITNESS: I think the better way to say
3 that. One way to create an epitaxial layer is through a
4 process called epitaxial growth. That's one way to
5 create epitaxial layer. But there may be other
6 connotation for epitaxial because the term just means
7 that a layer -- a layer on top of another layer with
8 distinct -- perhaps distinct doping concentration.

9 Or it doesn't even have to be distinct
10 doping concentration. It just means that a layer that's
11 disposed on top of another layer. And -- and to answer
12 your question, epitaxy -- epitaxy or epitaxial growth
13 could be one way for the formation of an epitaxial
14 layer.

15 Q. (BY MR. SAUNDERS) One second. I'm going to
16 just mark another exhibit. So I've uploaded what's been
17 previously marked as Exhibit 1006 which is the English
18 translation of the Hirler reference. And just let me
19 know when you see it.

20 (Exhibit No. 1006 was marked.)

21 THE WITNESS: Just as a logistic, every
22 time I download, I have to go -- I have to go to
23 register for my Veritext proceeding and then try to do
24 the share. Because every time an exhibit is downloaded,
25 somehow it -- it removed me from the link, yeah. So I

1 have to go back. Is that -- is that what is happening?
2 Is that how it's supposed to go?

3 MR. SAUNDERS: No. Not ideally. We can
4 try to work on that at the next break, hopefully.

5 THE WITNESS: Okay. No problem. Either
6 way. I'm just curious, yeah. It still works. I have
7 it now.

8 Q. (BY MR. SAUNDERS) Okay. So my question to you
9 is this. What is the basis for your conclusion that
10 Hirler's N- drift zone 11 is an epitaxial layer?

11 MR. TIPESCU: Objection, form.

12 THE WITNESS: Look -- if you look at my
13 declaration, I am comparing these two devices and I
14 mentioned to you the way these are formed in the
15 different many methods to form, and epitaxy is one of
16 them. And in my experience as a POSITA working in the
17 field, epitaxial, especially depending on the thickness,
18 given you have an N+ substrate, epitaxial is one of the
19 known way to form this type of structure.

20 Q. (BY MR. SAUNDERS) What are the other ways of
21 forming this type of structure?

22 A. It would be --

23 MR. TIPESCU: I'm sorry. Objection, form
24 on that.

25 THE WITNESS: I suppose there are many

1 other ways of form. But I, sitting right here, in my
2 declaration, for Hirler, I pointed out that drift zone
3 correspond to -- with an epitaxial layer. So a POSA at
4 time of invention would know that. It's very obvious,
5 it would have been obvious that epitaxial layer would be
6 epitaxial deposit -- growth and the N- region would have
7 been obvious to a POSA that epitax -- that region would
8 be an epitaxial layer.

9 In other words is that, there may be other
10 way. But the POSA would know that epitaxial growth to
11 implement region, that N- region 11 would be obvious to
12 a POSA.

13 Q. (BY MR. SAUNDERS) You don't recall anything in
14 Hirler stating that N- drift zone 11 was created via
15 epitaxy, correct?

16 MR. TIPESCU: Objection, form.

17 THE WITNESS: Sitting right here, I have to
18 go through it. Again, as I mentioned, we could go
19 through all -- we could go through all the reference --
20 other reference by Hirler and see. But again, my
21 declaration says clearly that the drift zone corresponds
22 with an epitaxial layer.

23 And a POSA at time of invention
24 irregardless that there might be many, many ways, there
25 might be other ways to form a drift region, but it would

1 be obvious to a POSA that epitaxial layer is one of the
2 common way to form that region 11.

3 Q. (BY MR. SAUNDERS) All right. Let's move on to
4 paragraph 73 of your declaration. Let me know when
5 you're there.

6 A. Would you like me to go through Hirler right
7 now to -- to -- to see --

8 Q. If you think you can identify somewhere in
9 Hirler that, you know, tells you that N- drift zone 11
10 was created via epitaxy, yes, please go through -- go
11 ahead and go through Hirler now.

12 A. Well, it's up to you. I mean, I don't -- I
13 don't necessarily need to go through it. I'm just --
14 again, my testimony is very clear. A POSA at the time
15 of invention, looking at Hirler's reference, looking at
16 the N- drift zone will find it obvious that epitaxial
17 growth would be one of the common ways to implement the
18 region 11.

19 Q. Okay. Understood.

20 Then if your answer is complete, let's go
21 ahead and go to paragraph 73.

22 A. I'm there.

23 Q. Can you see the second sentence, you say,
24 (Reading:) The POSITA would understand that the "body
25 amplification zone" or "body enhancement zone" disclosed

1 in Hirler is the "lateral contact layer" in the '634
2 Patent.

3 Do you see that?

4 A. Yes, I do.

5 Q. Okay. And so "body amplification zone"; you're
6 referring to -- to element 19 in Hirler; is that
7 correct?

8 A. Let me go to -- go back to the -- give me one
9 second to -- to find that. 19. That's correct.

10 Q. Okay. And I see how both the phrase "body
11 amplification zone" and "body enhancement zone" in that
12 sentence there. Now, I looked through Hirler and I
13 didn't see the phrase "body enhancement zone" anywhere
14 in that reference. Is that an accident or are you
15 just -- another way of referring to element 19, or
16 are -- is there some other structure that you're
17 referring to as body enhancement zone?

18 A. I don't -- I want to make sure I give you
19 the -- sitting right here, I believe it could be --
20 because this it's translated, so I think the -- it may
21 be the -- in the context. Again, we mention that you
22 need -- in order to -- for benefit that's known at the
23 time of the art -- '634 art, that it would be good if
24 the source contact can contact not -- can have a quick
25 contact, not only vertically to the bottom but also to

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1 the sidewall as well.

2 And so, therefore, again, it's a
3 distinction -- it's a demarcation of the doping
4 difference between the actual body region, which is
5 lower than the doping concentration that you added, you
6 added to amplify or to enhance the doping concentration
7 along the sidewall of the trench in the base region in
8 order to form a good contact.

9 So in that context, I believe this may be
10 the -- this term may come from, sitting right here, I
11 don't recall. But I think the meaning is the same.
12 It's just the doping -- again, the doping concentration,
13 relative doping concentration of that is -- excuse me,
14 enhanced or amplified from the actual doping
15 concentration of the body.

16 Q. You'd agree with me that in Hirler, the element
17 19 is implanted before the source contact trenches are
18 etched, correct?

19 A. Can you repeat your question again?

20 Q. Yeah. So in Hirler, the element 19 is
21 implanted before the source contact trenches are etched,
22 correct?

23 MR. TIPESCU: Objection, form.

24 THE WITNESS: Can you point me to a figure
25 in Hirler where an -- of a exemplary body or embodiment

1 of a process sequence. Because I think the one you
2 showed me right now, I may not have it.

3 Q. (BY MR. SAUNDERS) Yeah, so I think what
4 happened is the translated version does not include all
5 of the figures. But I did unload the German version as
6 well. You can see that it's been uploaded as
7 Exhibit 1005. So when you're able to look at that, let
8 me know.

9 (Exhibit No. 1005 was marked.)

10 THE WITNESS: What's your question again?

11 Q. (BY MR. SAUNDERS) Yeah. So you'd agree with
12 me that in Hirler, the element 19 is implanted before
13 the source contact trenches are etched, correct?

14 A. I don't necessarily agree with that, because
15 there are two things. Hirler, in one of its
16 embodiments, shows that the implant was done with the
17 source trench mask. So at that point, the trench itself
18 is defined by the mask. The trench and the mask -- in
19 fact, the -- the mask is the trench. So -- so that's
20 one -- one -- one aspect. The mask for the trench is
21 there, okay. So -- so the implant is implant into the
22 trench that's defined by the mask, okay. That's one.

23 And also, there's nowhere in Hirler,
24 especially if you look at the process sequence to oppose
25 that, if you look at the process sequence, there's

1 nowhere in Hirler that prohibits the implant to the
2 trench through the mask to be done before or after the
3 actual physical trench or actual etching of the silicon
4 is done. But the implant is implant into the trench, as
5 defined by the mask. The sidewall of the trench is
6 defined by the mask.

7 Q. Can you look at Figure 2C of Exhibit 1005?

8 A. Yes.

9 Q. Okay.

10 A. I'm there.

11 Q. And 2C is the figure showing the implantation
12 of element 19?

13 A. Into the trench mask, yes.

14 Q. Is the trench mask visible in Figure 2C?

15 A. Most definitely. It's -- it's defined by 16.
16 So let me -- let me answer your question in two ways.
17 Okay. Even under the -- the claim construction that
18 rendered by the Court, all it says that the implant has
19 to be introduced into the sidewall of the trench.
20 There's nowhere disclose the process sequence. So in
21 that -- under that context, in Hirler, the two aspects.
22 One, in 2C, the implant is done through the trench mask
23 so implant is into the trench as defined by the mask or
24 into the sidewall of the trench.

25 But regardless, as I mentioned, the claim

1 construction does not imply sequence. It imply implant
2 and implant process and imply the location of where the
3 doping needs to be. So if I look at 2D, Figure 2D and
4 Figure 2C, the POSA would know that Figure 2C and
5 Figure 2D, the implant sequence could be done at any --
6 any time. I could do the implant at 2D or I could do
7 the implant at 2C. Nonetheless, they are both implanted
8 into the sidewall of the trench.

9 Q. Turning to Hirler's Figure 2C, is element 12
10 the base layer?

11 MR. TIPESCU: Objection, form.

12 THE WITNESS: Let's take a look at Hirler
13 then. Excuse me. So Hirler says 12 is the body zone.
14 And so -- and I think I mentioned in my declaration and
15 I mapped it in my declaration the corresponding. So the
16 Hirler is mapped as the base layer.

17 Q. (BY MR. SAUNDERS) You map -- in paragraph 66,
18 you map Hirler's element 12 to the claim base layer,
19 correct?

20 A. Excuse me. That's correct.

21 Q. Okay. So turning back to Figure 2C in
22 Exhibit 1005, in Figure 2C of Hirler, there does not yet
23 exist sidewalls of source contact trenches in the base
24 layer, correct?

25 MR. TIPESCU: Objection, form.

1 THE WITNESS: I don't necessarily agree
2 with that characterization. I believe the sidewall of
3 the trench is defined by mask 16. Again, regardless
4 where the -- when in the process sequence the trench is
5 etched, even though I already explained that 2C and 2D,
6 the process sequence is not -- is not limiting, a POSA
7 would know -- would know that the P+ implant or the
8 implication region 19 could be introduced at -- at
9 either 2C or 2D.

10 But regardless, there's no sequence in
11 the -- in the current limitation of '634. All it has to
12 do is that the doping is introduced based on the claim
13 construction that I just saw from the Court that the --
14 this lateral contact layer in Hirler is designated as P+
15 to be in contrast with eventually P++.

16 Again, this is a relative terms. And that
17 implant is introduced along the sidewall to cover the
18 sidewall of the source trench. And so it only requires
19 one implant is the process based on the claim
20 construction rendered by the Court. Second is the
21 location. And clearly, Hirler satisfied both criteria.

22 Q. (BY MR. SAUNDERS) You'd agree with me that
23 figure 2D of Hirler shows that there's another etching
24 step after Figure 2C that completes the source contact
25 trenches?

1 A. I think the better way to characterize --

2 MR. TIPESCU: Objection, form. Sorry,
3 objection, form.

4 THE WITNESS: I think the better way to
5 characterize that the trench in the embodiment as
6 disclosed by Hirler, the trench and the sidewall --
7 sidewall are defined by mask 16. The location of the
8 sidewall of the trench and the trench itself are defined
9 by mask 16 in Figure 2C. And Figure 2D shows the
10 implementation of the trench in relationship to the --
11 corresponding to the narrow contact layer 19 with
12 respect to the trench.

13 So you satisfy the condition, one, is
14 introduced by implant and, two, location, which is the
15 doping is into the sidewall, which means it's butting
16 against the sidewall into the sidewall of the trench.

17 So 2D, I would say 2D is the results of the
18 embodiment. But within, 2D a POSA would find it very
19 clear that when you define the mass in 2B, you have to
20 look at 2B, when you define the mass in 2B and it comes
21 down to 2D, there's no sequence -- there's -- there may
22 be one sequence, but there's another sequence. And the
23 limitation, the claim construction rendered by the
24 Court, has no sequence to the formation to that -- to
25 that -- to that -- to that limitation.

1 So going from 2C to 2D fully satisfied --
2 I'm sorry. Going from 2B to 2D -- from 2B directly to
3 2D satisfy the claim construction. And 2C is one
4 embodiment and a POSA would know another embodiment
5 would have been implant at the 2D step and then implant
6 the -- the -- the lateral contact layer 19. There's no
7 sequence. And any -- either sequence to a POSA would
8 work just as well.

9 Q. (BY MR. SAUNDERS) Do you recall whether
10 there's anywhere in Hirler expressly disclosing an
11 embodiment where the body amplification zone is
12 implanted after the source contact trenches are fully
13 etched?

14 A. Again, effectively, if I look at to a POSA
15 looking at 2B and 2D effectively, you will -- you will
16 come to the conclusion that region 19, so-called the
17 mapping corresponding to lateral contact layer, a POSA
18 would know there are different sequence to get to 2D.
19 And I don't believe Hirler discouraged any other
20 implementation.

21 Q. Can you point me anywhere in the text of Hirler
22 of an express disclosure of a body amplification zone
23 being implanted after the source contact trench is fully
24 etched?

25 MR. TIPESCU: Objection, form.

1 THE WITNESS: Again, to a POSA, if I look
2 at going from 2B and directly to 2D with -- without
3 being contaminated or without being -- without seeing
4 one possible embodiment of process sequence disclosed by
5 Hirler, if I just look at 2B and 2D, effectively a POSA
6 would know that there are options in terms of sequence
7 to introduce region 19.

8 So effectively, a POSA looking at 2D and --
9 in conjunction with 2B would effectively know that
10 region 19 could be introduced after the trench, which
11 has been defined already with the sidewall, all defined
12 already by photoresist 16. But after the trench --
13 after the actual etching into the silicon has been
14 performed, a POSA would know that that is also an
15 embodiment option to implement the lateral contact
16 layer.

17 Q. (BY MR. SAUNDERS) Are you saying that that
18 option would be obvious or are you saying there's
19 somewhere in the text of Hirler itself that expressly
20 discloses that option?

21 MR. TIPESCU: Objection, form.

22 THE WITNESS: I think looking at 2D and
23 given that the claim construction does not imply any
24 sequence, I think it would have been -- a POSA would
25 definitely would have been obvious to try or obvious to

1 implement and it's not discouraged explicitly by --
2 there's no -- Hirler did not offer any reason to
3 discourage other process sequence. It's simply having
4 an option or to process sequence that introduces --
5 introduce an implant at the definition of the sidewall
6 of the trench.

7 Whereas, 2D, a POSA look at it, they will
8 find that it would just been -- just been as obvious to
9 try to implant the lateral contact layer not only at the
10 formation or definition of the trench sidewall, but also
11 at the -- after the implementation of the trench
12 sidewall.

13 Q. (BY MR. SAUNDERS) Does the term "zone" have a
14 different meaning from the term "layer" in the field of
15 semiconductors?

16 MR. TIPESCU: Objection, form, relevance.

17 THE WITNESS: Again, every term, context
18 matters. And I think my -- I rendered the opinion that
19 in the context of Hirler and corresponding to '634, in
20 that context, for example, I rendered opinion that the
21 N- drift zone is equal to the -- is corresponding to an
22 epitaxial layer corresponding with a drain region.

23 So I think that's -- in that context, they
24 correspond to each other. But again, I caution -- or I
25 hesitate to blanket saying that in every context, zone

1 is going to layer. You have to look at the context, and
2 in the context of showing that Hirler rendered '634
3 obvious in that context and in that corresponding
4 correlation. For example, I map the N- drift zone to
5 epitaxial layer corresponding to where the drain region.

6 Q. (BY MR. SAUNDERS) All right. Let's turn now
7 to some of your discussions about the Shiraishi
8 reference starting in paragraph 97 of your declaration.

9 A. Okay.

10 Q. And actually, let me upload the Shiraishi
11 reference while I get a chance. Just let me -- I'll let
12 you know when it's actually been uploaded.

13 A. Okay. Thank you.

14 THE WITNESS: Counsel, I just want to
15 mention that we're -- we're about almost another hour,
16 so if -- if --

17 MR. SAUNDERS: Let's go off the record.

18 THE WITNESS: If you indulge me, we can
19 take a break after your question or one question or
20 something, yeah. It's up to you.

21 MR. SAUNDERS: Yeah. Let's go off the
22 record.

23 THE WITNESS: Okay. Thank you.

24 VIDEOGRAPHER: The time is 12:05. We're
25 off the record.

1 (Brief recess.)

2 (Exhibit Nos. 1003 and 1009 were marked.)

3 VIDEOGRAPHER: The time is 12:27. We're
4 back on the record.

5 Q. (BY MR. SAUNDERS) Welcome back, Dr. Liu. I
6 think before the break, I was about to ask you some
7 questions about your opinions regarding the Shiraishi
8 reference starting in paragraph 97 of your report.

9 Do you see that?

10 A. Page 97 of my report. Paragraph 97, right?

11 Q. Yeah, starting with paragraph 97.

12 A. Okay.

13 Q. That starts the section of your report where
14 you compare Shiraishi to limitation 1[a] of the '634
15 patent; is that right?

16 A. Yeah.

17 Q. Do you see in limitation 1[a] there, it
18 mentions a body region?

19 A. Yes.

20 Q. And do you see it mentions a base layer
21 corresponding to said body region?

22 A. Are you referring to -- are you referring to
23 the claim limitation as in paragraph b right now?

24 Q. Yeah, the text that's in that limitation 1[a]
25 that's right above paragraph 97.

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1 A. Okay.

2 Q. So you see a base layer corresponding to said
3 body region there as well?

4 A. Right.

5 Q. Explain to me; what does the term "base layer"
6 mean?

7 MR. TIPESCU: Objection, form and
8 relevance.

9 THE WITNESS: I think the limitation is
10 clear. It says, (Reading:) A base layer corresponding
11 to said body region.

12 Q. (BY MR. SAUNDERS) But does base layer have a
13 meaning in the field of MOSFETs to you?

14 MR. TIPESCU: Objection, form and
15 relevance.

16 THE WITNESS: Repeat the question again?

17 Q. (BY MR. SAUNDERS) Yeah. In the field of
18 MOSFETs, does base layer have a particular meaning to
19 you?

20 MR. TIPESCU: Same objections.

21 THE WITNESS: It has to depend on the
22 context, and I think the context here is that the base
23 layer corresponding to said body region. And I'm not --
24 I'm not here to define or to define what base layer is.
25 Yeah.

1 Q. (BY MR. SAUNDERS) Did you have a particular
2 understanding of the phrase "base layer" in mind when
3 you rendered your opinions?

4 MR. TIPESCU: Objection, form.

5 THE WITNESS: I think the limitation says,
6 (Reading:) A base layer corresponding to said body
7 region disposed on the top of said epitaxial layer.

8 So that's -- that's the -- that's the
9 context of base layer.

10 Q. (BY MR. SAUNDERS) Okay. Let's talk about body
11 region then. Did you -- let me withdraw.

12 What does "body region" mean?

13 MR. TIPESCU: Objection, form and
14 relevance.

15 THE WITNESS: I don't -- is there a
16 particular point you want to refer in my report? I'm
17 not -- I'm not sure what the context of the question is.

18 Q. (BY MR. SAUNDERS) Well, I guess the context is
19 we're here in a portion of your report where you're
20 matching up Shiraishi to limitation 1[a] of the '634
21 patent. And limitation 1[a] mentions the phrase "body
22 region" and it mentions the phrase "base layer." And
23 I'm trying to understand what -- what was your
24 understanding of the meaning of those phrases when you
25 rendered your opinions that matched up disclosures in

1 Shiraishi to limitation 1[a] of the '634 patent?

2 MR. TIPESCU: Objection, form and
3 relevance.

4 THE WITNESS: Again, I -- what -- what --
5 let me go to the '634 patent and maybe that will help a
6 little bit.

7 Q. (BY MR. SAUNDERS) Okay.

8 A. So in the context of the '634, the body region,
9 if I -- it's simply -- it's very clear the context of
10 '634 is region 205.

11 THE REPORTER: Did you say region 205?

12 THE WITNESS: Yeah, 205.

13 Q. (BY MR. SAUNDERS) What is the body of a
14 MOSFET?

15 MR. TIPESCU: Objection, form and
16 relevance.

17 THE WITNESS: Again, there's -- there many
18 contexts. Is there any particular aspect you'd like to
19 discuss?

20 Q. (BY MR. SAUNDERS) Well, say, a student at the
21 university learning about MOSFETs is trying to
22 understand what the various parts of a MOSFET are and
23 they ask what is the body, what would you tell them?

24 MR. TIPESCU: Objection, form and
25 relevance.

1 THE WITNESS: Now, in the context of
2 '634 -- in the context of '634, again, I mention it's
3 the region 205, denoted region 205. And -- yeah.

4 Q. (BY MR. SAUNDERS) Does the term "body region"
5 in Claim 1 of the '634 patent have a different meaning
6 than the term "base layer"?

7 MR. TIPESCU: Objection, form and
8 relevance.

9 THE WITNESS: Can you point me where in my
10 declaration I -- I -- I -- this question is coming from?

11 Q. (BY MR. SAUNDERS) Well, I mean, this question
12 is generally about your understanding of limitation 1[a]
13 to understand how you applied it to the art. So I've
14 started pointing you to paragraph 97 through
15 paragraph 101, which is the portions of your declaration
16 that you apply limitation 1[a] to Shiraishi. And I'm
17 trying to understand your opinions. And part of that is
18 what your understanding of what limitation 1[a] means.

19 And limitation 1[a] mentions a body region
20 and limitation 1[a] mentions a base layer. And I want
21 to understand if you had an understanding that they were
22 the same thing or if those terms had different meanings?

23 MR. TIPESCU: Objection, form and
24 relevance.

25 THE WITNESS: The context of my declaration

1 is very clear. I'm trying to -- excuse me, I'm trying
2 to look at -- render opinion that the limitations
3 anticipated by teachings of Shiraishi and limitation
4 1 -- one of the limitations that a base layer
5 corresponding to said body region, and clearly in my
6 declaration, if you look at both the drawing before
7 the -- before the paragraph 96 as well as the drawing
8 shown again at my label in the -- in the underneath
9 paragraph 98. And I render my understanding of the body
10 region by -- by clearly label the body region.

11 Q. (BY MR. SAUNDERS) Let's turn to paragraph 100
12 of your declaration. Again, we're still in Shiraishi
13 versus limitation 1[a]. Let me know when you're at
14 paragraph 100?

15 A. Okay.

16 Q. And do you see it says there, (Reading:) The
17 POSITA would understand that the channel layer (13)
18 corresponds to a body region or base layer.

19 Do you see that?

20 A. Yes, I do see that.

21 Q. So why would a POSITA understand Shiraishi's
22 channel layer 13 as disclosing a body region or base
23 layer?

24 A. Let me go to -- let me pull up Shiraishi.

25 Okay. Can you repeat your question again?

1 I think it's on --

2 Q. Yes. Why would a POSITA understand Shiraishi's
3 channel layer 13 as disclosing a body region or base
4 layer?

5 A. I think it's pretty -- which aspect of that
6 sentence, I guess I'm not -- I'm not understanding the
7 question. Which part of the sentence is not clear? I
8 don't -- I don't quite understand. I'm sorry.

9 Q. Well, you have a statement that's a conclusion.
10 It's a conclusion that you say that -- you're saying
11 that channel layer 13 in Shiraishi corresponds to a body
12 region or base layer. And I'm asking what is the basis
13 for that opinion?

14 A. So the -- it's similar to -- to Shiraishi. The
15 base -- the channel layer, which is 13. And that layer
16 is corresponding to '634 patent. It's situated -- it's
17 a layer situated between the N+ source and the drift
18 region.

19 Q. So the basis of your opinion that Shiraishi
20 discloses a body region or base layer is because layer
21 13 is depicted as being between a source layer and a
22 drain region; is that right?

23 MR. TIPESCU: Objection, form.

24 THE WITNESS: I think at least that's one
25 of the -- the feature that correspond between Shiraishi

1 and '634 patent.

2 Q. (BY MR. SAUNDERS) Is there any other reason
3 why you believe a POSITA would understand that
4 Shiraishi's channel layer 13 corresponds to a body
5 region or base layer?

6 A. I think suffice to say that the answer I gave
7 that is -- if you look at the corresponding figure
8 between Shiraishi and the '634 patent and one saving
9 feature is that -- is what I just mentioned is between
10 the N+ source, the source region and the entrenched
11 region.

12 Q. What is a channel layer?

13 MR. TIPESCU: Objection, form and
14 relevance.

15 THE WITNESS: I don't know if I -- I
16 discuss it in my declaration. Can you point me to --
17 besides this context that I'm mapping the channel layer
18 of 13 to the base region or base layer, body region or
19 base layer.

20 Q. (BY MR. SAUNDERS) Well, in paragraph 100 of
21 your declaration, you cite to Shiraishi at paragraph 72
22 and you quote the language that the P- type --
23 (Reading:) Semiconductor region 13 may serve as a
24 channel layer for the respective power MISFETs.

25 And so what does it mean when Shiraishi

1 says that region 13 may serve as a channel layer?

2 MR. TIPESCU: Objection, form.

3 THE WITNESS: Again, this is consistent
4 channel layer, consistent again is the -- between the
5 source region 206 and the N region 202. So the -- so
6 that if you consider the N region 202 -- so that region
7 of Shiraishi corresponds to the 205 with the -- with
8 the '634.

9 Q. (BY MR. SAUNDERS) What is the channel of a
10 MOSFET?

11 MR. TIPESCU: Objection, form.

12 THE WITNESS: One description would be the
13 channel MOSFET is the -- the region between the drain --
14 region between the source, which is 206, and the drain,
15 which is 202.

16 Q. (BY MR. SAUNDERS) Anything else that makes
17 a -- withdraw.

18 Anything else that defines the channel of a
19 MOSFET?

20 MR. TIPESCU: Objection, form and
21 relevance.

22 THE WITNESS: Again, the channel is just
23 the region between the source and the drain. And, of
24 course, yeah, it's between the source and the drain.
25 That's -- you can say it's -- because being a MOSFET, so

1 you have metal oxide silicon so -- so that the channel
2 which is the region in the silicon that's between the
3 source and the drain.

4 Q. (BY MR. SAUNDERS) So paragraph 100, you say,
5 (Reading:) The POSITA would understand that the channel
6 layer (13) corresponds to a body region or base layer.

7 Is it your position that Shiraishi's
8 channel layer 13 satisfies both the body region and base
9 layer limitations of Claim 1 of the '634 patent?

10 A. Repeat your question again?

11 Q. Yeah. Is it your opinion that Shiraishi's
12 channel layer 13 satisfies both the body region
13 limitation and the base layer limitation of Claim 1 of
14 the '634 patent?

15 MR. TIPESCU: Objection, form.

16 THE WITNESS: Are you referring to
17 limitation of Claim 1 where -- I think the statement is
18 simply to reflect that the base layer corresponds here
19 to said body region. So -- so I'm just simply saying
20 that channel layer corresponds to a body region that
21 giving that body region corresponds to base layer. So
22 all base layer. That's where the statement comes from.

23 Q. (BY MR. SAUNDERS) Okay. So let's look at that
24 language there that's in limitation 1[a], for example,
25 right above paragraph 97 of your report. Do you see

1 that it says, "a body region."

2 Do you see that text?

3 A. I mean, the first line?

4 Q. Yeah, at the end of the first line going on the
5 second line there.

6 A. Okay.

7 Q. You see it says, "a body region"?

8 A. Right.

9 Q. The structure you're identifying in Shiraishi
10 as satisfying a body region is Shiraishi's layer 13,
11 correct?

12 MR. TIPESCU: Objection, form.

13 THE WITNESS: I think my statement is that,
14 yeah, they need a channel layer corresponding to body
15 region or base layer.

16 Q. (BY MR. SAUNDERS) And so going down in that
17 having -- that has the text of limitation 1[b] you also
18 see that it says "a base layer", and then it continues
19 on.

20 Do you see that?

21 A. Yes, I do.

22 Q. Okay. So is the structure you're identifying
23 in Shiraishi as satisfying a base layer also layer 13 in
24 Shiraishi?

25 MR. TIPESCU: Objection, form.

1 THE WITNESS: Yes, my statement is very
2 clear in the paragraph 100. The channel layer
3 corresponds to -- corresponds to a body region or base
4 layer.

5 Q. (BY MR. SAUNDERS) Now, I want you to look at
6 the annotated Figure 8 of Shiraishi you have after
7 paragraph 98 at your report. Let me know when you're
8 there.

9 A. Yes, I'm there.

10 Q. And do you see that in that annotation, you say
11 "Body Region (13 and 14)."

12 Do you see that?

13 A. I do see it.

14 Q. Can you explain to me why in some portions of
15 your declaration, you're identifying Shiraishi's layer
16 13 as being the body region, and in other portions,
17 you're identifying Shiraishi's layer 13 and layer 14 as
18 corresponding to the body region?

19 MR. TIPESCU: Objection, form.

20 THE WITNESS: Excuse me. I think this
21 is -- the reason is that I want to demarcate the extent
22 of this body region.

23 Q. (BY MR. SAUNDERS) So you're mapping the
24 claimed body region to both layers 13 and layers 14 of
25 Shiraishi; is that correct?

1 MR. TIPESCU: Objection, form.

2 THE WITNESS: I disagree with that. I
3 think -- I think the -- as I mentioned, the layer 13
4 correspond to the body region. Just like if you look at
5 '634, the 205. And so that layer 13 correlate --
6 correspond to 205. And I think the designation just to
7 show that, no, the body region extent is really between
8 the source and the -- and the epi or N drain region.

9 So I'm trying to use that to say if you
10 look at a figure -- you've got to see that the extent is
11 going to from the -- is really between the -- let me
12 see -- is really between 15 -- but region 13 is really
13 the extent between the -- the N source and the -- and
14 the N region, epitaxial region.

15 Q. (BY MR. SAUNDERS) Okay. Do you agree with me
16 Figure 8 of Shiraishi also shows layer 14 as being
17 between the N source and the epitaxial layer?

18 A. I agree that there's another layer implanted to
19 cover the entire sidewall of the trench in the base
20 layer and to serve as lateral contact there. And I
21 agree that there's that -- there's that layer there
22 within the -- within the body region, just as the
23 lateral contact layer 209 of '634 patent is within
24 the 205 P base layer.

25 Q. You -- so -- let me withdraw.

1 So is it your opinion that both layers 13
2 and 14 of Shiraishi combined correspond to the claimed
3 base layer?

4 MR. TIPESCU: Objection, form.

5 THE WITNESS: I don't -- that's not what I
6 said. Again, my declaration is very clear. Layer 13
7 corresponds -- the layer 13, the whole extent of it, the
8 whole extent going between the source region to the
9 N- -- to the N- region to the N region is the layer 13.
10 And that is the body region or the -- yeah, that's the
11 body region or the base layer.

12 Q. (BY MR. SAUNDERS) So is it your opinion that
13 part of region 13 includes region 14 in Shiraishi?

14 A. Repeat your question again?

15 Q. Yeah, I'm just trying to understand how you're
16 mapping, you know, both limitations in 13 and 14 to --
17 in Shiraishi to the claim. And I'm trying to
18 understand, you know, why you're saying in some parts
19 that, you know, layer 13 corresponds to base layer, but,
20 you know, you also see layer 14 in this Figure 8 here.

21 And so what I'm trying to understand is;
22 are you opining that layer 13 in Shiraishi includes
23 layer 14 of Shiraishi?

24 MR. TIPESCU: Objection. Hold on.
25 Objection, form. And I don't think there's a question

1 pending in -- in there, but...

2 Q. (BY MR. SAUNDERS) Well, let me -- well, let me
3 re-ask it.

4 Is it your opinion that layer 13 in
5 Shiraishi includes layer 14 of Shiraishi?

6 A. I don't think that's the right way to -- to
7 look at it. I think the right way to look at it is you
8 have layer 13, which clearly, according to my
9 declaration, I mapped to the base layer or the body
10 region, just like 205 in the context of '634 patent.
11 And then you have this other layer just like in '634,
12 you have this other layer that is within this body
13 region.

14 That is -- so to the extent that when I use
15 13, 14 to -- to -- in the figure, I think it's really
16 meant to say that I don't want to confuse that to think
17 that the body region -- I think it's to denote the
18 extent of the body region is really just like the 205,
19 region 205 in '634, is between the source region and the
20 N region.

21 So layer 13 corresponds to body region is
22 between the source region on top and the body region --
23 sorry, the drain region, which include the N- and N+
24 region on the bottom. So that's the extent of saying 13
25 and 14. 13 and 14 to show the extent of the distance.

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1 And to the extent that region 14 is contained inside
2 region 13 and that's similar to '634 where the lateral
3 contact layer region is contained within the P -- within
4 the 205 P base layer. So it's completely -- it's
5 analogous.

6 Q. Okay. So let's turn back to paragraph 100 of
7 your report and that sentence that says, (Reading:) The
8 POSITA would understand that the channel layer (13)
9 corresponds to a body region or base layer.

10 Do you see that sentence?

11 A. Yes, I do.

12 Q. Okay. When you're -- when you state that
13 sentence, are you including layer 14 as part of what
14 you're saying corresponds to the body region or base
15 layer?

16 MR. TIPESCU: Objection, form.

17 THE WITNESS: Look, again, it's analogous
18 to a P+ layer in 205 that has, within it that has the
19 lateral contact layer 209. So to the extent that 205
20 extends from N+ 206 down to N 202 what I'm saying here
21 analogously is that layer 13, the extent of layer 13,
22 within that layer 13 there may be another layer just
23 like -- analogous to 209 layer -- lateral contact layer.
24 There may be another layer in there. But the extent --
25 the full extent of layer 13 is the body region or the

1 base layer.

2 Q. (BY MR. SAUNDERS) And does the full extent of
3 region 13 include region 14?

4 MR. TIPESCU: Objection, form.

5 THE WITNESS: Again, I think the region 13
6 is very clear. Sorry, based on the process formation.
7 So the region 13, again, analogously just correspond to
8 region 205 of '634 patent.

9 Q. (BY MR. SAUNDERS) So looking at the annotated
10 version of Shiraishi Figure 8 at the bottom of
11 paragraph 98 of your report, you'd agree with me that
12 source region 15 is located on top of layer 14 of
13 Shiraishi, correct?

14 A. I think if we're talking about the -- if we're
15 talking about the layer 13, it says the subject is being
16 layer 13, discussing layer 13, again, analogously basing
17 on the way you are phrasing the question will be, yes,
18 region 206 in '634 patent, the N+ region '634 is on top
19 of the 205, the base layer.

20 So I think that in -- if we're talking
21 about the region 13, I would agree that the N+ region,
22 which is 15, is actually on top of layer 13.

23 MR. SAUNDERS: I object as nonresponsive.

24 Q. (BY MR. SAUNDERS) Right now, I'm asking a very
25 simple question. I wasn't asking about layer 13. I

1 wasn't asking about the '634 patent. I just want you to
2 literally look at that Figure 8 of Shiraishi and tell me
3 that the layer that is labeled 15 is immediately above
4 the layer that is labeled 14 in Figure 8 of Shiraishi;
5 is that correct?

6 MR. TIPESCU: Objection, form.

7 THE WITNESS: The reason I'm answering this
8 question, I'm not being unresponsive, is that in the
9 context of my declaration, I'm drawing analogy, I'm
10 mapping everything. So in order to answer your
11 question, then analogously in '634 patent, 206 is also
12 on top of the lateral contact layer. So in that case,
13 since I'm mapping the layer 14 as the lateral contact
14 layer, in that context and in comparison analogous to
15 '634, yes, just like '634, the N+ layer is on top of the
16 lateral contact layer.

17 MR. SAUNDERS: All right. I'll object as
18 nonresponsive again. I'll ask the question a different
19 way.

20 Q. (BY MR. SAUNDERS) If Force Mos submits expert
21 testimony interpreting Figure 8 of Shiraishi as showing
22 layer 15 on top of layer 14, would you have a reason for
23 disagreeing with that interpretation of Shiraishi's
24 Figure 8?

25 MR. TIPESCU: Objection, form.

1 THE WITNESS: I just want everything to
2 have its proper context, okay. In the context where the
3 figure -- sorry, the region 14 is mapped as lateral
4 contact layer as shown in the figure that I show here,
5 Figure 8, in that context the N+ -- the source region is
6 on top of the lateral contact layer which is region 14.
7 And just like in '634 analogously, because I'm
8 mapping -- in the context of my declaration I'm mapping,
9 it's mapping to 206 N+ region on top of 209 the lateral
10 contact layer.

11 MR. SAUNDERS: Okay. I'll object as
12 nonresponsive again and move on.

13 Q. (BY MR. SAUNDERS) If Force Mos submits expert
14 testimony interpreting Figure 8 of Shiraishi as
15 depicting layer 14 as being on top of layer 13, would
16 you have any basis for disagreeing with that testimony?

17 MR. TIPESCU: Objection, form.

18 THE WITNESS: Again, I have to have the
19 context on top. All I want to say is that layer 14 is
20 within layer 13 and serving as the lateral contact layer
21 just like mapping to '634, that layer 209 is within
22 layer 205.

23 Q. (BY MR. SAUNDERS) All right. When you look at
24 Figure 8 of Shiraishi, would you agree with me that the
25 bottom of the source contact trenches are below the

1 bottom of layer 14?

2 A. Say that again?

3 Q. Yeah, looking at Figure 8 of Shiraishi, would
4 you agree with me that bottom of the source contact
5 trenches are below the bottom of layer 14?

6 A. When I'm looking at the figure, I don't know
7 if -- how accurate the figure is. But I do know that
8 based on the process flow in looking at Figure 8 that
9 the base contact layer, which will be 20, will be --
10 will be butted in a way that I will -- I will say that
11 the layer 14 will be covering the entire sidewall of the
12 trench in the base layer up to the base contact layer.

13 Q. What is the basis for your opinion that
14 Shiraishi's layer 14 will cover the entire sidewalls of
15 the source contact trenches in the base layer?

16 A. Repeat your question again?

17 Q. Yeah, what is the basis for your opinion that
18 layer 14 of Shiraishi covers the entire sidewalls of the
19 source contact trenches in the base layer?

20 MR. TIPESCU: Objection, form.

21 THE WITNESS: If you look at the process
22 flow in Figure 8, just like the -- the '634, when you
23 introduce the layer 20, the P+ base layer, layer 14 will
24 be between -- between the dopant from the layer 20 and
25 to the -- well, to the extent of the base layer

1 that's -- that's -- that's -- to the extent of the
2 trench that's within the base layer to the top.

3 Q. (BY MR. SAUNDERS) Are you saying that it would
4 be obvious for a POSA to implement Shiraishi such that
5 layer 14 covered the entire sidewalls in the base layer,
6 or are you saying that there is an express disclosure in
7 Shiraishi of the layer 14 covering the entire sidewalls
8 of the source contact trenches in the base layer?

9 MR. TIPESCU: Objection, form.

10 THE WITNESS: Can you repeat your question?
11 That's really a long -- long-winded question. I'm not
12 sure at this time of the day I can -- I can parse it.
13 Can you repeat it?

14 Q. (BY MR. SAUNDERS) Yeah. So regard -- are you
15 saying it would be obvious for layer 14 to cover the
16 entire sidewalls of the source contact trenches in the
17 base layer or are you saying there's an express
18 disclosure of that somewhere in Shiraishi?

19 MR. TIPESCU: Objection.

20 THE WITNESS: The context -- go ahead.

21 MR. TIPESCU: Objection, form.

22 THE WITNESS: In the context of my
23 declaration where I'm opining that Claim 1 is
24 anticipated by Shiraishi, and looking at Figure 8 where
25 the implant sequence is done, you have the 13 base

1 layer -- base layer 13, and then after that, you
2 introduce correspondingly the lateral contact layer and
3 then you implant layer 20, which is the -- what we call
4 the source contact region, it's clear that the sidewall
5 of the trench in the base region using this process flow
6 in light of the opinion I'm opining that Shiraishi
7 anticipates '634, you can see that region 14 will be
8 covering the entire sidewall of the trench in the base
9 layer.

10 Q. (BY MR. SAUNDERS) Okay. If Force Mos offers
11 expert testimony that Figure 8 of Shiraishi depicts the
12 source contact trenches having portions of their
13 sidewalls that are beneath layer 14 and therefore layer
14 14 does not cover the entire sidewalls, what basis would
15 you have for disagreeing with such opinion?

16 MR. TIPESCU: Objection, form.

17 THE WITNESS: I don't -- I'm sorry, but you
18 are doing a hypothetical case. I'm simply supporting in
19 my declaration my opinion that looking at Figure 8 and
20 I'm offering the opinion that Shiraishi anticipates
21 '634, claim -- at least claim limitation 1 and 2. I'm
22 offering the opinion that looking at Figure 8 and in
23 contrasting with -- an analogous to '634 patent, that
24 the layer 14 is between the source region and the -- and
25 the -- and the subsequent layer 20.

1 And I'm opining that under that scenario
2 because the implant is done with the -- with the layer
3 20 introduced at Figure 8. So that the P region 14 will
4 be butting against the doping from region 20.
5 Therefore, that region 14 covers entire sidewall of the
6 trench in the base layer.

7 Q. (BY MR. SAUNDERS) So you understand Figure 8
8 of Shiraishi as depicting a portion of element 20 as
9 going around the corner of the bottom of the trench and
10 covering parts of the sidewall of the trench; is that
11 correct?

12 MR. TIPESCU: Objection, form.

13 THE WITNESS: Can you repeat your question
14 again?

15 Q. (BY MR. SAUNDERS) Yeah. Do you interpret
16 Figure 8 of Shiraishi as depicting element 20 as
17 covering not just the bottom of the source contact
18 trenches, but also going around the bottom corners to
19 cover parts of the sidewalls of those trenches?

20 A. I don't know the -- I'm not -- I'm not
21 understanding your question. So can you repeat again?
22 I'm sorry.

23 Q. So yeah. Looking at Figure 8 of Shiraishi, to
24 me, it looks like the bottom of the source contact
25 trenches are below the bottom of layer 14 and that

1 there's something on the sidewalls between those two
2 layers. Do you have an opinion as to what that is?

3 MR. TIPESCU: Objection, form.

4 THE WITNESS: Excuse me. I believe in
5 paragraph 108, I discuss this.

6 Q. (BY MR. SAUNDERS) Okay. You want to point me
7 where in that paragraph you discuss it?

8 A. Yeah. Paragraph 108, (Reading:) Element 1[h]
9 is disclosed in Shiraishi, in which the bottom of the
10 contract trench is covered by a semiconductor region
11 (20).

12 Which is the implant, (Reading:) In such a
13 way to -- as to cover the respective bottom of the
14 contact grooves 17.

15 Q. Is it your opinion that that statement means
16 that region 20 of Shiraishi cannot cover any portion of
17 the sidewalls of the source contact trenches?

18 A. Repeat your question again. I don't quite...

19 Q. Yeah. I'm asking you whether Figure 8 of
20 Shiraishi depicts any portion of region 20 of the
21 covering parts of the sidewall as the source contact
22 trenches and you pointed me to paragraph 108. And I'm
23 trying to understand what paragraph 108 had relevance to
24 that question.

25 So is there something that you're pointing

1 to in paragraph 108 that indicates to you that element
2 20 in Figure 8 of Shiraishi is not touching the
3 sidewalls of the source contact trenches?

4 MR. TIPESCU: Objection, form.

5 THE WITNESS: I think you're -- okay. So
6 we're talking about Figure 8, okay. And I'm saying that
7 layer -- dopant 20 is implanted with respect to the
8 layer 13 and layer 14 and with the -- with the trench.
9 And I'm saying that based on what I'm writing here 108
10 is that that layer 20 would, due to the implant, due to
11 the -- the -- the implant going in would actually cover
12 all the corners of the groove 17.

13 And therefore, it would -- it would
14 facilitate layer 14, the lateral contact layer to
15 contact the entire -- to contact the sidewall of the
16 trench in the base layer.

17 Q. (BY MR. SAUNDERS) So would that region 20 go
18 around the bottom corners or only go along the bottom
19 and stop at the corners of the source contact trenches?

20 MR. TIPESCU: Objection, form.

21 THE WITNESS: It would really -- excuse me.
22 It depends on the implant used. It's conceivable that
23 it would go around and -- and -- and butt against the
24 layer 14, the lateral contact layer.

25 Q. (BY MR. SAUNDERS) And is -- is that what you

1 see depicted in Figure 8 of Shiraishi?

2 MR. TIPESCU: Objection, form.

3 THE WITNESS: Look, I think my opinion is
4 rendered that it covers limitation of Claim 1 wherein
5 the sidewall of said trench and said base layer are
6 covered by the lateral contact there and I map layer 14
7 to be the lateral contact layer and layer 20 to be
8 the -- the source contact layer.

9 Q. (BY MR. SAUNDERS) Do you have any opinion as
10 to the relative thicknesses of layer 13 and 14 in
11 Shiraishi?

12 A. Let me refer to -- I don't want to look at a
13 drawing. Let me refer to the -- to a specification
14 of -- of Shiraishi.

15 Q. Okay.

16 A. Bear with me a second because I need to flip
17 back and forth with the figures. I'm sorry about this.

18 Q. That's okay.

19 A. Okay. I think I -- I glanced through the
20 patent. Thank you for affording the time to look at it.
21 So I think I'm ready to answer your question. Can you
22 repeat your question again?

23 Q. Yeah. Did you have any opinions as to the
24 thicknesses of layer 13 and 14 of Shiraishi?

25 A. I think -- excuse me. Relatively speaking, I'm

1 not -- you know, there's no way to -- to ascertain
2 from -- from what's depicted in the picture because
3 there's no scale. The only reference, according to the
4 specification of Shiraishi, is that the -- so if you
5 look at paragraph 72, it gives you some idea. And,
6 again, I'm not here to speculate. So I think if you
7 look at the -- we know that group 7 is about 10 micron
8 and then it says that the layer 13 is not less than
9 10 percent of that.

10 So if hypothetically, so the layer 13 is
11 around 10 percent of layer 14 and then you go from
12 there. So I think your question -- what's your question
13 again?

14 Q. Yeah. Do you have any opinions about the
15 relative thicknesses of layer 13 and 14 of Shiraishi?

16 A. Again, it's not the -- explained -- in the --
17 it's not clearly described. There are design
18 optimization to choose these parameters. 20 is -- I'm
19 sorry. Go ahead, please.

20 MR. SAUNDERS: That was all I had. Would
21 now be a good time for a lunch break?

22 MR. TIPESCU: Dr. Liu, would you like --

23 THE WITNESS: I'm fine. Yeah, it's fine.
24 Yeah --

25 MR. SAUNDERS: Let's go off the record.

1 VIDEOPHOTOGRAPHER: The time is 1:42. We're off
2 the record.

3 (Brief recess.)

4 VIDEOPHOTOGRAPHER: The time is 2:31. We're
5 back on the record.

6 Q. (BY MR. SAUNDERS) All right. Good afternoon,
7 Dr. Liu.

8 A. Good afternoon.

9 Q. I'd like to talk now about some of your
10 opinions about a proposed combination of the Kobayashi
11 reference with the Shiraishi reference starting at
12 paragraph 164 of your report. So let me know when
13 you're there.

14 A. Which -- which paragraph again? I'm sorry.

15 Q. Yeah, so it's page 71, starting at
16 paragraph 164.

17 A. 164. Okay.

18 Q. So paragraphs 164 through 170 provide your
19 opinion why you believe it would be obvious to combine
20 and modify Kobayashi with the Shiraishi reference and
21 the knowledge of a POSITA to render obvious the claims
22 of the '634 patent; is that correct?

23 A. Yes, that's correct.

24 Q. Okay. And in paragraph 168, let me know when
25 you're there.

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1 A. I'm there.

2 Q. Do you see the sentence that says, (Reading:)
3 The POSITA would be motivated to try these doping
4 concentration profiles, as opposed to the doping dosing
5 as disclosed in Kobayashi, to achieve an
6 anti-punch-through result.

7 Do you see that?

8 A. Yes, I do.

9 Q. So what is punch-through?

10 A. I believe I actually render description of that
11 in my declaration so, is there any specific thing you
12 want to know about punch-through? I mean, in what
13 context?

14 Q. Well, I guess the context that you're opining
15 that it provides a motivation to combine Kobayashi and
16 Shiraishi?

17 A. Okay. If you refer to my declaration paragraph
18 35.

19 Q. Okay.

20 A. Where at the start, punch-through. Okay.
21 Before that, I don't like to give long-winded answer,
22 but in this case, I think it would be good to set a
23 context, if you don't mind.

24 Q. Sure.

25 A. The whole area of power MOSFET is really

1 involving the trade-off between, as I mentioned earlier
2 today, in the on state, the current drive capability or
3 minimizing the ON Resistance. Now, minimizing the ON
4 Resistance comes in different form. It comes in you
5 want to make sure your -- your doping profile is correct
6 so you can get a maximum current or also a threshold is
7 controllable, so your gauge at dry current is high.

8 In the off-state, you want to make sure
9 that when I design in the doping profile, I want to
10 maximize the breakdown voltage. And all of these have
11 to be done in a given area; that's why it's always per
12 area that you get the minimum ON Resistance or the
13 maximum dry current with the breakdown voltage of
14 current you want to achieve, okay.

15 So the punch-through as 35 -- in
16 paragraph 35 shows, you have a punch-through essentially
17 just means that you have NPN or in the case of N channel
18 vertical power MOSFET as my declaration shows that, you
19 have NPN. And the reason you want to the P+ source and
20 the N+ source to be connected together, contacted
21 together is that you want to prevent the -- any minority
22 current that flows and causes the voltage drop which, in
23 turn, turns on the bipolar transistor.

24 So that would be one form of punch-through.
25 And that is very similar to the fact that if the doping

1 profile is -- is not designed well enough that you could
2 have N+ reaching from the source and N- reaching
3 essentially communicating.

4 So -- so the way I describe paragraph 35
5 would be a punch-through essentially is that you no
6 longer have NPN that can block the voltage, but in fact,
7 the NPN is actually conducting current when you don't
8 want it to. And that will compromise your breakdown
9 voltage requirement of the device.

10 Q. Do you have an opinion as to whether the
11 Kobayashi reference has a problem with punch-through?

12 A. I am not sure what you're asking. I'm sorry.

13 Q. Well, you're opining that a person of skill in
14 the art would be motivated to take Shiraishi's
15 punch-through stopper layer and add that to the
16 structure of Kobayashi, correct?

17 A. I believe that's what I wrote is that the -- it
18 (Reading:) would be motivated to combine the distinct
19 lateral contact layers of Shiraishi with P doping
20 concentration that is greater than the P- doping
21 concentration of the underlying base layer but less than
22 the P-type concentration of the base contact layer with
23 the disclosure of Kobayashi to optimize the MOSFET and
24 prevent punch-through.

25 MR. TIPESCU: And I'm sorry, I was on mute,

1 Michael, before I didn't realize. But I wanted to
2 object to form on that question. But -- my apologies.

3 Q. (BY MR. SAUNDERS) And Dr. Liu, you identify in
4 paragraph 168 the problem of punch-through as a
5 motivation to combine Shiraishi with Kobayashi, correct?

6 A. I disagree with that characterization. Maybe
7 perhaps the proper characterization is that the -- in
8 this field, Shiraishi proposed a method that -- to
9 improve the punch-through while can still maintain the
10 threshold voltage. According to Shiraishi, Shiraishi
11 says that I can actually, with this punch-through layer
12 if engineering correctly, I can actually prevent
13 punch-through without compromising the threshold
14 voltage. And this is the same problem that '634 is
15 talking about.

16 So in that sense, a person skilled in the
17 art will look to -- ways to improve the device
18 performance. Any additional benefit you can gain,
19 including the prevention of punch-through to maximize a
20 breakdown voltage, it will be obvious to try. I mean,
21 I -- sitting right here, I don't want to -- I don't want
22 to -- if you can point out to me where in Kobayashi, I
23 don't recall right now where Kobayashi mentions
24 punch-through as a problem, I will be happy to -- to --
25 to look at it.

1 But regardless, a person practice the art,
2 person of ordinary skill in the art will always look to
3 to -- express teaching or -- or look for motivation to
4 try a method that can, as I mentioned, this
5 optimization, a method to optimize this boundary
6 condition to get your optimal breakdown voltage as well
7 as optimal dry current or lowest ON Resistance.

8 So that's the name of the game. And you
9 just keep on -- you're constantly trying to improve
10 that. And to the extent that Shiraishi proposed a
11 method to improve the punch-through, therefore allow you
12 to achieve your avalanche breakdown requirement. I
13 think it is obvious to try for a person of ordinary
14 skill in the art. So...

15 Q. Okay. I mean, I have introduced the Kobayashi
16 reference, Exhibit 1008, if you want to look.

17 (Exhibit No. 1008 was marked.)

18 Q. (BY MR. SAUNDERS) But I think my question is,
19 have you offered an opinion that there is a
20 punch-through problem in the Kobayashi reference?

21 MR. TIPESCU: Objection, form.

22 THE WITNESS: As I mentioned, this
23 device -- every power devices could be subject to high
24 ON Resistance, could be subject to punch-through. It's
25 always how you design it, and you always look for ways

1 to hopefully optimize both the ON Resistance, meaning
2 that make it as slow as possible, optimize your dry
3 current and optimize the breakdown voltage. You always
4 look for a way to do this. It's not -- it's not -- I
5 think it's wrong to say that, oh, certain device don't
6 have this problem.

7 It's all a different degree and how you
8 want to incrementally optimize your device and --
9 without sacrificing any of the parameters. The name of
10 the game is optimizing your power MOS and that includes
11 make it as robust as possible against punch-through,
12 make it conductive as possible to have lowest
13 ON Resistance for giving specific area. So that's the
14 name of the game.

15 Q. Have you heard of "Zener breakdown" before in
16 the field of MOSFETs?

17 A. I have heard the term and I know the term, but
18 it's not relevant to this -- to this -- to the '634
19 patent to this declaration.

20 Q. Have you heard of the term "avalanche
21 breakdown" in the context of MOSFETs?

22 MR. TIPESCU: Objection, form.

23 THE WITNESS: Can you repeat the question?
24 I'm not sure what you're asking.

25 Q. (BY MR. SAUNDERS) Yeah, have you heard the

1 phrase "avalanche breakdown" in the context of MOSFETs?

2 MR. TIPESCU: Objection, form.

3 THE WITNESS: Let me go to my -- so in my
4 declaration paragraph 43, I describe avalanche
5 breakdown. Now, when you mention avalanche breakdown,
6 you have to put it in the context. Avalanche breakdown,
7 similar to what you mentioned earlier, which is out of
8 the scope of this declaration, Zener breakdown. These
9 things occur between a junction of opposite dope. So I
10 mention between the P-N junction. Okay. Under reverse
11 bias.

12 Avalanche breakdown simply means, as I
13 describe here, when the electric field, which is due to
14 the voltage you apply across the reverse bias junction,
15 when the electric field reach certain peak or certain
16 limit number where the physics of impact ionization
17 occur and become uncontrolled and this is avalanche
18 breakdown.

19 Now, as I mentioned, this happen in a
20 reverse bias P-N junction. To the extent that a MOSFET
21 has the P-N junction, a MOSFET operate especially in the
22 context '634, you have a P -- you have reverse bias P-N
23 junction during the off-state for vertical power MOSFET.
24 Therefore, in that context, avalanche breakdown occurs
25 in a MOSFET. But avalanche breakdown is the phenomenon

1 that occurs strictly in the P-N junction. And to the
2 extent P-N junction exists in the power MOSFET, then
3 that's -- that's the -- the relevance.

4 Q. (BY MR. SAUNDERS) So you'd agree with me that
5 different designs of MOSFETs would experience different
6 types of breakdown under different conditions, correct?

7 A. Repeat your question again?

8 Q. Different designs of MOSFETs would experience
9 different types of breakdown under different conditions,
10 correct?

11 MR. TIPESCU: Object -- objection, form.

12 THE WITNESS: I don't understand the
13 question. But I think the -- the statement I will make
14 is that, again, in light of context of this declaration,
15 you're trying to optimize such that you can achieve
16 highest breakdown voltage. And you don't want the
17 breakdown voltage to be undermined by other means of
18 breakdown. I think that's -- that's the -- that's --
19 another way of saying that; you want to live to 120
20 years and you don't want -- you don't want any other
21 things, you know, reckless driving or reckless drinking
22 to undermine your lifespan.

23 In a similar way, you have a breakdown
24 criteria and you just want to optimize it such that no
25 other phenomenon in a well-designed device will

1 undermine your breakdown voltage, and to the extent that
2 that a poorly designed -- if someone just reckless
3 design and other breakdown happens, that -- we have no
4 -- we have no -- I have no comments on that.

5 But suffice to say, according to my
6 declaration, the name of the game is a trade off that
7 you want to optimize one without compromising the other
8 as much as possible. And Shiraishi definitely says that
9 I want to optimize my breakdown that could be limited by
10 punch-through without sacrificing the threshold voltage,
11 which is aligned with the goal of '634, aligned with the
12 goal of Kobayashi.

13 Q. (BY MR. SAUNDERS) You'd agree with me that
14 there are designs of MOSFETs where Zener breakdown is
15 more of a problem than punch-through, correct?

16 MR. TIPESCU: Objection, form.

17 THE WITNESS: I don't understand your
18 context of Zener breakdown. Nowhere in my declaration
19 and nowhere I don't believe sitting right here, I don't
20 recall Zener breakdown is ever mentioned in any of the
21 reference or in '634 patent. I'm here to opine on
22 the -- on the -- on the scope of '634 patent along with
23 its prior art, where the name of the game is optimizing
24 the breakdown voltage, especially avalanche breakdown
25 voltage, without getting compromised by, for example,

1 due to poorly contacted source contact that cause
2 premature punch-through breakdown voltage, or, in the
3 case of Shiraishi, same thing.

4 So the context is always optimizing in that
5 context without sacrificing the threshold voltage.

6 Q. (BY MR. SAUNDERS) When you say "breakdown
7 voltage, what kind of breakdown are you referring to?

8 A. Repeat your question, again, please.

9 Q. Yeah, you mentioned breakdown voltage in your
10 prior answer. Which kind of breakdown were you
11 referring to the breakdown voltage of?

12 MR. TIPESCU: Objection, form.

13 THE WITNESS: There's a -- there's a --
14 when you have a device, there's a design criteria. I
15 want my device in the off-state, due to maybe an
16 automobile operation, whatever -- whatever application,
17 it's going to have to sustain certain kind of breakdown
18 voltage without conducting, and that's called the
19 off-state blocking. So I -- when the device is off, I
20 want to make sure that it can sustain the -- the voltage
21 that's going to be exerted on the device, okay. So I
22 want to make sure I -- I have that. I can achieve that.

23 And during the on-state, as I mentioned
24 already, you want to achieve the maximum amount the
25 current conduction or lowest amount of ON Resistance.

1 So now, given that, then I tweak, I design and I do
2 experiment, I try different things, and I find out what
3 my voltage is, breakdown voltage is. And I look into
4 the literature, I look at the -- at the teaching.

5 Now, assuming if I have achieved the dry
6 current but I don't have -- I have not achieved the
7 breakdown voltage, somehow my breakdown voltage is
8 premature -- prematurely breaking down, my device is
9 prematurely breaking down, then I will look to -- to
10 other technique, try other technique, perhaps my
11 breakdown voltage, instead of limited by avalanche
12 breakdown, is limited by punch-through breakdown, and I
13 will -- I will try, for example, the method in Shiraishi
14 to improve the punch-through voltage to enhance my
15 breakdown so that maybe I can achieve a better breakdown
16 voltage.

17 Maybe that breakdown could be -- could be
18 due to a different mechanism. But I don't -- I want my
19 breakdown voltage not to be undermined by any other
20 breakdown phenomenon. And those phenomenon -- two of
21 those phenomenon were mentioned, the avalanche --
22 avalanche is between the P-N junction UG, that's the
23 highest you can get. And then you don't want it to be
24 undercut by poorly designed -- whether it's due to the
25 source contact not being ohmic, as the '634 allegedly

1 trying to solve, or similarly solve by Shiraishi, by
2 preventing the punch-through and to achieve the maximum
3 breakdown voltage that may come in the form of avalanche
4 breakdown, all while without compromising the threshold
5 voltage.

6 So Shiraishi achieved that and -- as well
7 as exact same goal, Shiraishi mentioned in the earlier
8 paragraph, Shiraishi achieved the improvement of the
9 punch-through which is -- which was manifested in '634
10 as poorly contacted source. Shiraishi achieved that.
11 In addition, Shiraishi also achieved the stated goal of
12 '634, which is not compromising the ON Resistance, not
13 compromising the threshold voltage.

14 Q. (BY MR. SAUNDERS) You'd agree with me that if
15 a MOSFET design experienced Zener breakdown at a lower
16 voltage than punch-through breakdown, that improving its
17 anti-punch-through capabilities wouldn't be beneficial,
18 correct?

19 A. I don't -- I don't agree with what you just
20 said because first of all, Zener breakdown, while I
21 understand the physics and everything of Zener
22 breakdown, I do not -- I do not see the relevance in the
23 context of my declaration. If you can point out to my
24 declaration where I mention Zener breakdown voltage,
25 I'll be happy to -- to look at it and then try to -- try

1 to adjust or -- or -- or think through. But Zener
2 breakdown also has its context, which is beyond the
3 scope -- beyond the scope of this declaration. So I
4 don't know why we are bringing out Zener breakdown
5 voltage.

6 Q. Well, I guess the question is, you opine that a
7 POSITA would be motivated to combine Shiraishi with
8 Kobayashi to address punch-through. And my question is,
9 did you consider whether Zener breakdown was more of a
10 gating problem than punch-through in the design of
11 Kobayashi?

12 MR. TIPESCU: Objection, form.

13 THE WITNESS: Again, I don't know why Zener
14 breakdown -- why it mentions Zener breakdown and I don't
15 understand your context. If you can clarify your
16 context of Zener breakdown, I'll be happy to entertain.
17 I know Zener breakdown well, and I do not see how Zener
18 breakdown is -- is -- is even in the context of a
19 vertical power MOSFET.

20 Q. (BY MR. SAUNDERS) You don't believe that Zener
21 breakdown occurs in vertical power MOSFETs as in the
22 design of Kobayashi?

23 MR. TIPESCU: Objection, form.

24 THE WITNESS: Again, you're asking a
25 hypothetical question. I can make any device. It's

1 possible that any device, I can -- a poorly designed
2 device can have any type of breakdown voltage as I
3 mentioned earlier, including as your concept of a -- of
4 a so-called Zener.

5 First of all, I don't even know if your
6 understanding of Zener breakdown voltage is consistent
7 with that of a person of ordinary skill in the art. And
8 I don't mean this in any -- any derogatory way or
9 condescending way. It's just that all of a sudden we're
10 talking about Zener without the context and I believe
11 that we need to -- we need to -- I don't know if we need
12 to, but I believe that in this -- in the vertical power
13 MOSFET that we're dealing with, in the context of '634,
14 in the context of my declaration, I don't believe Zener
15 that breakdown phenomenon, Zener breakdown phenomenon
16 is -- is being considered in the context '634.

17 I know Zener breakdown occurs in
18 semiconductor and I know Zener breakdown -- Zener
19 breakdown voltage, but I just fail -- you will have to
20 provide me the context of how it fits in -- in my
21 declaration.

22 Q. (BY MR. SAUNDERS) Okay. When you opined that
23 a POSITA would be motivated to combine Shiraishi with
24 Kobayashi to achieve an anti-punch-through result, you
25 didn't think Zener breakdown was relevant. Is that

1 fair?

2 MR. TIPESCU: Objection, form.

3 THE WITNESS: I -- I will disagree. I
4 think looking at the context of '634 and knowing how --
5 how a MOSFET work and how you are trying to design to
6 achieve your optimum breakdown voltage, and I think
7 Zener breakdown voltage would be a very, very poorly
8 designed case. So I don't think -- I don't think in the
9 context '634, I don't think in the context of a -- of a
10 well designed or -- in the context of, say, combining
11 Kobayashi with Shiraishi in the context '634 where
12 you're trying to optimize the power MOSFET.

13 I think Zener breakdown is something
14 that -- that I would think that is not something that
15 should happen, and it's not something that even -- I
16 will hope that we will design our device so that you
17 will never -- you will not really be considered Zener to
18 be a limiting factor, yeah.

19 Because if we're talking about Zener
20 breakdown, that means the breakdown voltage is going to
21 be much lower than what we're trying to optimize. So
22 it's -- I just -- you have to provide me a better
23 context, because '634 does not talk about Zener
24 breakdown. My declaration doesn't talk about Zener
25 breakdown and I do not see why we brought up Zener

1 breakdown, because it's not -- it's not relevant to --
2 to the -- to the scope of this optimizing the vertical
3 power MOSFET.

4 Q. (BY MR. SAUNDERS) All right. Let's go to this
5 annotated figure you have on top of page 74 of your
6 declaration, it's kind of after paragraph 169.

7 A. Okay.

8 Q. And is that figure kind of explaining visually
9 how you are opining a person of skill in the art would
10 be motivated to modify Kobayashi in light of Shiraishi?

11 A. So I mention in my -- in my paragraph 139 [sic]
12 (Reading:) Accordingly, the combination of Kobayashi
13 and Shiraishi render obvious the Claims 1 through 9,
14 illustrated below in a hypothetical diagram based on
15 Kobayashi's Figure 5A with the addition of the lateral
16 contact layer according to disclosure of Shiraishi.

17 Q. So in Figure 5A of Kobayashi, the channel forms
18 adjacent to the gate oxides in a vertical direction; is
19 that correct?

20 A. I will say that probably -- the way I will say
21 it is that the current flows through from the N+ source.
22 The N+ region 10 down to be collected by region -- going
23 through -- down to collected by region -- well, N+
24 region 1 and through the trench gate that's form.

25 Q. So in the combination of Kobayashi and

1 Shiraishi depicted in that figure at the top of page 74
2 of your declaration, the punch-through stopper layer is
3 present in the channel region of that MOSFET, correct?

4 A. In this implementation, that layer is across
5 and as shown is to the -- to the -- to the -- I'm sorry,
6 getting to the gate of the -- getting to the trench
7 gate.

8 Q. Okay. And so at least part of the channel
9 region would have that punch-through stopper layer in
10 it, right?

11 MR. TIPESCU: Objection, form.

12 THE WITNESS: Again, I explain it very
13 clearly that the -- that layer in the current teaching
14 of Shiraishi does not change the threshold voltage of
15 the transistor.

16 MR. SAUNDERS: I'm going to object as
17 nonresponsive.

18 Q. (BY MR. SAUNDERS) I think you're going about
19 two or three steps ahead of me right now. So I just
20 want us to focus very narrowly on a specific question.

21 The -- the combination you're showing at
22 the top of page 74 of your declaration, it's showing the
23 punch-through stopper layer Shiraishi include -- being
24 present in at least part of the channel region of the
25 MOSFET, correct?

1 A. I will say in that embodiment, how is your
2 term -- how do you -- how do you describe it again,
3 please.

4 Q. I was saying, in the figure that we're talking
5 about at the top of page 74 of your report, the
6 punch-through stopper layer is present in at least part
7 of the channel region?

8 MR. TIPESCU: Objection, form.

9 THE WITNESS: I think the drawing is
10 showing that it's there. But, you know, electrically
11 speaking, as far as punch-through is concerned, again, I
12 don't want to jump -- jump ahead. I'm saying, yes, it's
13 drawn to be across and that is just a hypothetical
14 diagram showing that. Again, the impact, electrical
15 impact is something that -- that is not -- the
16 electrical impact is something that actually helped
17 achieve the desired goal in accordance with '634 patent
18 and in accordance with Shiraishi and in accordance with
19 Kobayashi.

20 Q. (BY MR. SAUNDERS) And in the proposed
21 combination of Kobayashi and Shiraishi that's depicted
22 at the top of page 74 of your declaration, that
23 punch-through stopper layer is created by the additional
24 P-type dopants added to that blue region in the P-type
25 base layer of Kobayashi, correct?

1 MR. TIPESCU: Objection, form.

2 THE WITNESS: I think I would -- I would
3 like to go back to Shiraishi to show you exactly --
4 exactly how it is done. Okay. So repeat your question
5 again?

6 Q. (BY MR. SAUNDERS) Yeah. So in the proposed
7 combination of Kobayashi and Shiraishi that's on the top
8 of page 74 of your declaration, that blue punch-through
9 stopper layer would be created by the addition of more
10 P-type dopants to the base layer of Kobayashi in the
11 blue region of that figure, correct?

12 MR. TIPESCU: Objection, form.

13 THE WITNESS: So according to the
14 Shiraishi, it's that you first implant, in one
15 embodiment, your first implant. And then one dose to
16 form layer 13 and then you do another implantation to
17 form region 14. And there's a difference in terms of
18 the dose. So...

19 Q. (BY MR. SAUNDERS) So as a result, the
20 punch-through layer has a higher dose than the layer
21 underneath it, correct?

22 A. That's correct in the sense that it's additive
23 so that P layer 14 will have initial dose, and however
24 that translate to the concentration and then the
25 subsequent dose, and then that translate to another

1 concentration, yeah. Yes.

2 Q. You'd agree with me that one of the problems
3 that Kobayashi is trying to address is the problem of
4 increased threshold voltage, correct?

5 A. Are you -- I'm not sure -- Kobayashi, can you
6 point me to -- refresh my memory, point me to Kobayashi
7 where -- where that --

8 Q. Sure. It should be available to you as an
9 exhibit. And if you want to turn to Column 3, around
10 lines 52 through 55.

11 A. Kobayashi -- which one is it? I don't -- I
12 don't see it on my --

13 Q. It should be available as exhibit -- let me
14 double-check. I'm pretty sure I already marked it.

15 MR. TIPESCU: It's Exhibit 108 [sic].

16 THE WITNESS: Yes, I just -- I just saw it.
17 Thank you.

18 Okay. Which line again?

19 Q. (BY MR. SAUNDERS) Column 2 -- or sorry, Column
20 3, lines 52 through 55 in Kobayashi.

21 A. Column 3, the Kobayashi you sent me is an -- is
22 an application.

23 Q. You know what, I'm sorry. Let me...

24 A. That's a different one -- different Kobayashi,
25 I believe.

1 Q. Let me. I may have mixed up the two --

2 MR. TIPESCU: And Michael, while you're
3 doing that, I'll just -- Dr. Liu, you've disappeared off
4 the screen.

5 THE WITNESS: Oh, yeah, because I'm trying
6 to -- I'm using the -- my bigger display because my eyes
7 are not as good with my laptop. So I have to remove
8 the -- move the laptop display so I can see the -- see
9 the full screen on my display screen. I'm sorry about
10 that.

11 MR. TIPESCU: Oh, no. That's okay.

12 THE WITNESS: No one wants to see my face
13 anyway. I'm not a movie star. So...

14 So are you reloading the Kobayashi?

15 MR. SAUNDERS: Yeah, I'm sorry. Can we
16 just go off the record for like five minutes?

17 MR. TIPESCU: Sure.

18 VIDEOGRAPHER: The time is 3:12. We're off
19 the record.

20 (Brief recess.)

21 VIDEOGRAPHER: The time is 3:21. We're
22 back on the record.

23 Q. (BY MR. SAUNDERS) Okay. Dr. Liu, I think
24 before the break, I was asking you some questions about
25 Kobayashi. Luckily I double-checked, so Exhibit 1008 is

1 correct. I was just reading from the patent when I
2 should have been reading from Exhibit 1008.

3 So let me direct you to paragraph --
4 paragraph No. 14 of Kobayashi. Let me know when you're
5 there.

6 A. I have 14. I have 14 now.

7 Q. And so you agree with me that one of the
8 problems that Kobayashi is trying to address is the
9 problem of increased threshold voltage; is that correct?

10 A. I think yeah, I think we -- we discussed this
11 earlier in terms of how the P contact layer, when it
12 forms and the extent of it, and I think in this context,
13 yeah, Kobayashi is saying that the -- I think if the
14 wording correctly is that threshold voltage is increased
15 in certain -- certain cases where you have this P+
16 contact layer implant, yeah.

17 Q. And Kobayashi specifically identifies the
18 problems of impurity concentration in the channel region
19 as contributing to increased threshold voltage, correct?

20 MR. TIPESCU: Objection, form.

21 THE WITNESS: I think the better wording
22 would be that in Kobayashi's embodiment as it is, and of
23 course, that context is how he optimize everything and
24 in the context and he's saying in that -- in his
25 structure, the impurity in the concentration -- impurity

1 concentration in the channel -- in a channel region is
2 increased by lateral or horizontal diffusion. So he's
3 saying that in his design, based on his process --
4 processing method, you know, temperature and all this
5 stuff, after implant in his structure, that horizontal
6 diffusion may occur, which will increase the channel
7 doping and which will result in threshold voltage being
8 increased. Yes, in that context.

9 Q. (BY MR. SAUNDERS) So turning back to your
10 declaration in that figure that's on the top of page 74,
11 let me know when you're there.

12 A. I'm there.

13 Q. What is the basis for your opinion that
14 Shiraishi would be combined with Kobayashi such that the
15 punch-through stopper layer would cover the entire
16 sidewalls in the base layer?

17 A. Repeat your question again?

18 Q. Well, I guess, let me -- let me back up and
19 make first a simple question.

20 Do you have an opinion as to whether it
21 would be obvious to combine Shiraishi with Kobayashi
22 such that Shiraishi's punch-through stopper layer would
23 cover the entire sidewalls of Kobayashi's source contact
24 trenches in the base layer?

25 A. I think we -- we went over Shiraishi and went

1 over how the implant is formed and -- as well as how
2 the -- in the hypothetical combining case that P+
3 implant will be formed. And, again, combining the two,
4 combining the two, it's -- it's -- the answer would be
5 yes, it's obvious that the layer, the P-type lateral
6 contact layer will be between the P+ source contact
7 layer and the N+ source will be sandwiched between,
8 therefore will be covering the entire sidewall of the
9 trench in the base layer.

10 Q. And your basis for that opinion is because you
11 believe that Shiraishi discloses its punch-through
12 stopper layer covering the entire sidewalls of its
13 source contact trenches in the base layer; is that
14 correct?

15 MR. TIPESCU: Objection, form.

16 THE WITNESS: My paragraph 167 says,
17 (Reading:) Shiraishi expressly teaches a lateral
18 contact layer along the entire sidewalls of the contact
19 trench in the base layer that serves as "a punch-through
20 stopper layer". And I -- and there's citation
21 paragraph 73, 80, 84, and 85.

22 Q. (BY MR. SAUNDERS) Okay. Are there any other
23 reasons why you believe it would be obvious to combine
24 Shiraishi with Kobayashi such that the punch-through
25 stopper layer covered the entire sidewalls of the source

1 trenches in Kobayashi's base layer?

2 MR. TIPESCU: Objection, form.

3 THE WITNESS: Repeat your question. It's
4 getting late in the day. So can you repeat your
5 question? It's long-winded.

6 Q. (BY MR. SAUNDERS) Yeah, so -- I'm just asking
7 about your reasons why you think a POSITA would be
8 motivated to combine these two references to cover the
9 entire sidewalls in the -- of the source contact
10 trenches in the base layer. And so far, you've pointed
11 me to paragraph 167. And I was just wondering if
12 there's anything else that you have an opinion as a
13 basis for why a POSITA would be motivated to combine the
14 references in that way?

15 A. So in my paragraph 167, we know that Shiraishi,
16 (Reading:) Expressly teaches lateral contact layer
17 along the entire sidewall of the contact trench in the
18 base contact, in the base layer and that serves as a
19 punch-through stopper layer.

20 And we also know that in implementing that
21 for Shiraishi, Shiraishi specifically said that it did
22 not -- there's a way to do it such that the threshold
23 voltage or the ON Resistance is not compromised.
24 Shiraishi expressly said that, and that aligns in the
25 context of Kobayashi trying to, one, make sure that the

1 base -- make sure the source contact layer contact the
2 base, including the bottom of the base, contact the base
3 in a well manner, provide good contact. And if -- if
4 Kobayashi were to use Al diffusion as a way described by
5 Kobayashi, then the threshold voltage will be high.

6 And yet Shiraishi's method could help
7 without compromising the threshold voltage. Therefore,
8 you will be -- it's obvious to try and combine the
9 teaching of Shiraishi that does not compromise the
10 threshold voltage, yet allow you to improve or allow you
11 to not have your breakdown voltage degraded by
12 punch-through voltage, which is the exact -- which is
13 the same problem that Kobayashi solved and Kobayashi
14 also does not want to degrade the threshold voltage.
15 Therefore, it's obvious to combine these two together.

16 Q. Does the punch-through stopper layer have to be
17 so thick as to cover the entire sidewalls of the source
18 contact trench in the base layer to achieve the
19 anti-punch-through result?

20 MR. TIPESCU: Objection, form.

21 THE WITNESS: You're asking a hypothetical
22 question. Now, there are -- if you combine a
23 hypothetical question, there are different boundary
24 conditions, of course. And I also don't know what you
25 mean by "has to be so thick", because the thickness of

1 the entire sidewall of the trench when the base region,
2 that's also subject to device design optimization. I
3 think the key issue is that as long as, one, it enhance
4 the device not to be gated by punch-through breakdown
5 voltage.

6 And, two, the threshold voltage is not
7 compromised by introducing -- introduction of this
8 punch-through layer. So to answer your question, I
9 think -- I don't know what thickness you have in mind,
10 but I think that covering the entire sidewall of the
11 trench in the base layer to facilitate improving the
12 punch-through without degrading professional voltage is
13 expressly taught by Shiraishi.

14 Q. (BY MR. SAUNDERS) Turning back to that figure
15 that's on top of page 74 of your report, you'd agree
16 with me if you made that punch-through stopper layer
17 that's in blue thinner, then it would not cover the
18 entire sidewalls of the source contact trench in the
19 base layer, correct?

20 A. You're asking a hypothetical question, which is
21 not something I opine. I opine that, again, going back
22 to paragraph 167, (Reading:) Shiraishi expressly teach
23 a lateral contact layer along the entire sidewall of the
24 contact trench in the base layer that serves as a
25 "punch-through stopper layer". Okay.

1 So to the extent I don't -- I don't --
2 you're asking a hypothetical question, but that
3 hypothetical question may -- may have -- may have other
4 issue or things which is hypothetical, I did not -- I
5 did not opine on it and I don't want to be sitting here
6 trying to opine on all the different trade off,
7 different aspect.

8 But suffice to say, that my Figure 8
9 modified figure hypothetical -- hypothetical Figure 8 is
10 inconsistent -- in consistency with what is being taught
11 by Shiraishi and also being consistent with what
12 Kobayashi is trying to address.

13 Q. You'd agree with me if you made that
14 punch-through stopper layer thicker in that figure
15 that's at the top of page 74 of your report, then that
16 would increase the amount of dopant impurities in the
17 channel region, correct?

18 MR. TIPESCU: Objection, form.

19 THE WITNESS: The goal in Kobayashi as well
20 as in '634 as well as in the Shiraishi, the goal is not
21 to compromise the threshold voltage. To the extent
22 whether doping increase -- but the doping increase, we
23 talk about earlier, you have all these relative doping
24 concentration to the extent if doping increase
25 by certain degree, by how much -- but the ultimate

1 problem we're trying to solve is not the holding the
2 doping concentration to be constant.

3 We're hold -- we're trying to solve is that
4 we're going to improve the punch-through characteristic
5 without compromising the threshold voltage. To that
6 extent, that's the ultimate performance metric and
7 that's the achieved goal. And to that extent, Shiraishi
8 teaches it and Kobayashi -- combined with Kobayashi,
9 that express goal could be achieved with the
10 hypothetical combined structure that is shown on -- in
11 the -- on page 74.

12 Q. (BY MR. SAUNDERS) If Force Mos introduces
13 expert testimony opining that the punch-through stopper
14 layer of Shiraishi could address punch-through without
15 being so thick as to cover the entire sidewalls in the
16 base layer of Kobayashi, would you have a basis for
17 disagreeing with that?

18 MR. TIPESCU: Objection, form.

19 THE WITNESS: Again, it's a hypothetical
20 question. And I think there are many parameters to --
21 to consider. I think you just -- you are -- you are --
22 you are simply bringing up one facet without having the
23 total context of the picture. Okay. And -- and if I
24 were to look at '634, the express goal of '634 with the
25 ohmic -- having ohmic contact, and if not covering the

1 entire sidewall, you're going to have a region that's
2 not ohmic contact, and granted, you might have this
3 punch-through implant in there, but then because you
4 don't have adequate ohmic contact, you may introduce new
5 problem.

6 So this thing -- all these things have to
7 be taken into consideration. So you cannot just throw a
8 hypothetical one sided and one facet and expect that
9 this will address what -- will actually be adequate to
10 address all the different facet of the problem in its
11 totality.

12 Q. (BY MR. SAUNDERS) And if Force Mos introduced
13 expert testimony opining that a POSITA would be
14 motivated to implement Shiraishi's punch-through stopper
15 layer as thin as possible to avoid adding unnecessary
16 impurities in the channel region, thereby increasing
17 threshold voltage, would you have a basis for
18 disagreeing with such opinion?

19 MR. TIPESCU: Objection, form and
20 relevance.

21 THE WITNESS: My declaration if we go back,
22 clearly I provide a context that the -- in Shiraishi's
23 implementation where a punch-through layer covered the
24 entire sidewall of the trench in the base layer and that
25 punch-through layer serves the purpose to increase the

1 overall breakdown voltage behavior of the device without
2 compromising the threshold, that is my declaration --
3 that is my opinion that this is a -- this combination
4 meets the requirement of Claim 1. Any other opinion
5 does not change my opinion.

6 My opinion still holds that the fact that
7 Shiraishi teaches a punch-through layer that covers
8 entire sidewall of the trench and the base layer and in
9 combination with Kobayashi's structure, does not
10 increase threshold and achieve a purpose of eliminating
11 premature punch-through based on voltage, and that --
12 that's my opinion. I stand by it.

13 And regardless, other implementation that
14 might come along, whether the hypothetical or however,
15 it does not change my opinion, and it does not change
16 the validity of my -- of my conclusion.

17 Q. (BY MR. SAUNDERS) In your combination of
18 Kobayashi and Shiraishi that's the top of page 74 of
19 your report, you selected the embodiment in Figure 5A of
20 Kobayashi to select -- to combine with Shiraishi,
21 correct?

22 MR. TIPESCU: Object to form.

23 THE WITNESS: I'm simply showing that in
24 the embodiment as taught by Kobayashi and it's
25 illustrated in Figure 5 and to combine that, it will be

1 obvious to a POSA to try and combine Shiraishi with the
2 implementation in Figure 5A to achieve the structure
3 that's shown on page 74 and to -- and to obtain -- to
4 reach the purpose -- purported goals that meets the
5 requirement for both '634 and meets the requirement of
6 what Kobayashi is trying to solve and what Shiraishi is
7 trying to address.

8 Q. (BY MR. SAUNDERS) Figure 10 of Kobayashi
9 depicts a different embodiment than Figure 5A of
10 Kobayashi, correct?

11 A. I have to -- sorry, let me -- let me refresh my
12 memory on Figure 10. Okay. So what's your question?

13 Q. So Figure 10 of Kobayashi depicts a different
14 embodiment than Figure 5A, correct?

15 A. I think that to be fair, the spirit of Figure 5
16 and Figure 10 are the same. I think that Figure 10
17 simply introduced what's so-called a silicided layer and
18 that's to promote many, many -- that has different
19 impact, but it doesn't change the conclusion or change
20 the essential aspect of the doping profile as related to
21 Kobayashi in both implementation 5 and embodiment 5 and
22 embodiment 10, and you will not impact the combination
23 or the conclusion opinion of combining Kobayashi with
24 Shiraishi, with teachings of Shiraishi to achieve the
25 stated goals.

1 Q. And what is your understanding of the purpose
2 of the silicide that's present in the embodiment of
3 Kobayashi's Figure 10?

4 A. First of all, let me -- let me answer this
5 question. I don't believe I refer to Figure 10. And to
6 the extent that I don't believe that the -- the exercise
7 is trying to use the doping concentration to optimize
8 the breakdown voltage without suffering the
9 punch-through and also not to degrade the threshold
10 voltage. The addition -- additional teaching in
11 Figure 10 will assist silicided layer. There are
12 purpose to that and which is -- which is not in the
13 scope of this teaching.

14 Suffice it to say that the purpose of that,
15 if I were to try to look at Figure 10, as I mentioned,
16 the extent is to use the doping profile to
17 strategically, to optimally place the doping profile as
18 in the teaching of '634 as in the teaching of Kobayashi
19 or as in teaching of Shiraishi. The teaching is to use,
20 to place doping profile correctly and without to achieve
21 the stated purpose.

22 Now, that knob of using doping
23 concentration to achieve the stated purpose is not going
24 to be affected by having a silicide layer. Silicide
25 layer may serve other purpose, but it's not going to

1 change -- ultimate -- ultimately, it's not going to
2 change the conclusion or the use of the doping
3 concentration to enhance your breakdown voltage without
4 compromising the threshold voltage.

5 Q. Did you articulate an opinion for why you
6 believe a person of skill in the art would be motivated
7 to select the embodiment of Kobayashi's Figure 5A as
8 opposed to the embodiment of Kobayashi's Figure 10 for
9 selection?

10 MR. TIPESCU: Objection, form.

11 THE WITNESS: Again, as I testified just
12 now, whether -- whether you use -- whether you have a
13 silicided layer or not, the silicide layer has other
14 purpose, other function. But Figure 10 and also the
15 teaching of Kobayashi has no indication that simply with
16 the introduction of silicided -- silicide in the -- in
17 the -- along the sidewall of the trench in the base
18 region that you will have to alter the doping to
19 accommodate that node.

20 So to that extent, the conclusion and the
21 motivation to combine, to strategically use the teaching
22 of the anti-punch-through layer in Shiraishi to combine
23 with the teaching of Kobayashi to trying to achieve good
24 source contact without increase the threshold voltage,
25 that purpose is achieved, regardless whether the

1 silicide is introduced or not.

2 I think the purpose, again, as I mentioned,
3 is to use the doping concentration or use the doping
4 to -- that's the same as the -- the -- the method in
5 '634, to use doping concentration, to use -- to use them
6 in a strategic way such that you can enhance or prevent
7 the early onset of punch-through. Whether that's due to
8 ohmic contact-induced punch-through or whether that's
9 due to the profile tailoring that induced punch-through,
10 which are very much related and really are one
11 different -- different side of one coin.

12 Without increasing the threshold voltage,
13 and that stated purpose is achieved with the
14 implementation that's shown. And whether I show
15 silicide or not, it's not going to change the conclusion
16 of the use of the teaching of Kobayashi -- Shiraishi to
17 combine and to combine as an obvious combination to
18 combine with Kobayashi to obtain the desired goal.

19 Q. (BY MR. SAUNDERS) Can you turn to paragraph 71
20 of Kobayashi and let me know when you're there?

21 A. Okay.

22 Q. Paragraph 71 of Kobayashi discloses that the
23 silicide 15 improves source contact resistance at the
24 sidewalls of the source contact in Kobayashi, correct?

25 A. Okay. What's the -- I see the statement that

1 says, (Reading:) Therefore, as -- as compared with the
2 first embodiment, an increase source contact resistance
3 at the side wall of the contact holes could be
4 suppressed by the silicide.

5 Is that what you're saying?

6 Q. Yeah, so you see that there, right?

7 A. Yes, I do.

8 Q. And increase in source contact resistance at
9 the sidewall of the source contact trenches can result
10 in breakdown, correct?

11 MR. TIPESCU: Objection, form.

12 THE WITNESS: Everything has to be taken in
13 its own totality in the context in totality, yes.

14 Q. (BY MR. SAUNDERS) Okay. But everything else
15 being equal, an increase in source contact resistance at
16 the sidewall of the source contact trench can increase
17 breakdown, correct?

18 A. Repeat your question again.

19 Q. Yeah. Everything else being equal, an increase
20 in source contact resistance at the sidewall of a source
21 contact trench can cause an ecrease in breakdown?

22 A. I'm sorry. I -- repeat your question, please.

23 Q. Yeah. So an increase in source contact
24 resistance at the sidewall of a source contact trench
25 can result in increased breakdown?

1 MR. TIPESCU: Objection, form.

2 THE WITNESS: I disagree with your
3 question.

4 Q. (BY MR. SAUNDERS) Okay. Why is that?

5 A. I just disagree with your question.

6 Q. Okay. Can you explain why you disagree?

7 A. Repeat your question again.

8 Q. Yeah. So everything else being equal, an
9 increase in source contact resistance at the sidewall of
10 a source contact trench can result in increased
11 breakdown?

12 MR. TIPESCU: Again, objection to form.

13 THE WITNESS: I just disagree with that
14 statement, and that statement is not true.

15 Q. (BY MR. SAUNDERS) Do you see any relationship
16 between source contact resistance at the sidewalls of a
17 source contact trench and breakdown?

18 A. Yes, I do.

19 Q. And what -- what relationship do you see there?

20 A. Increased source resistance will decrease the
21 breakdown voltage.

22 Q. Okay. I think I used wrong terminology. I
23 said increase breakdown. But I meant made breakdown
24 worse. So I guess you corrected me.

25 So increase in source contact resistance at

1 the sidewall of the source contact trench can decrease
2 breakdown voltage; is that correct?

3 A. Even in that statement, you've got to take
4 into -- into its totality, okay. Let me -- allow me to
5 answer the question. In the second embodiment,
6 introduction of silicide is not free. I don't want to
7 go into the context of process silicitation process, but
8 suffice to say that it will introduce other issue and
9 you have to evaluate that in its totality. So simply to
10 say that, oh, now, if I introduce silicide, I would
11 reduce source contact resistance.

12 No, it's not that simple. Because
13 introducing silicide -- I just realized that somehow it
14 suppressed by the suicide, not silicide. But in any
15 case, introducing the silicide will have additional
16 process that -- which will introduce additional problems
17 because dopant tend to move with the introduction of
18 temperature cycle. So there -- there's going to be a
19 host of different issues.

20 So suffice to say that we have to compare
21 apple to apple. Now, Shiraishi, already, my opinion
22 doesn't change. Shiraishi already introduced a method
23 to improve the punch-through voltage in the context of
24 the structure without silicide and that could be applied
25 to the context of Kobayashi embodiment 1 without the

1 silicide.

2 So this is -- this is -- this is direction
3 very similar to combine and you expect the particular
4 results. You don't want to combine something that, with
5 the silicide, for example, you might introduce different
6 temperature cycle and the silicide known to suck dopant,
7 all that -- all that stuff; I don't want to get into
8 that, because that's a whole different -- beyond the
9 scope. But suffice to say that what I'm doing is -- is
10 within the scope of obviousness in the sense that I
11 have -- supposed to have reasonable expectation of
12 success and reasonable expectation of the outcome.

13 And that's why I combine the Shiraishi with
14 the layer that I know could help prevent punch-through
15 and enhance the punch-through breakdown voltage, make it
16 higher, not lower, okay. And I can do so without
17 increasing the threshold voltage. And this is exactly
18 the stated goal also of Kobayashi and stated goal of
19 '634 in the sense that these have to do -- this
20 punch-through voltage could come -- punch-through
21 phenomenon could come in different form, whether it's
22 punch-through due to the doping profile or punch-through
23 due to doping profile on the sidewall.

24 It's apple to apple. I'm not introducing
25 another variable with silicide that could convolute the

1 outcome. I'm -- I'm simply combining things that I know
2 will have expected outcome.

3 Q. All right. Let's go to another topic. And can
4 you go to paragraph 90 of your report or, sorry, your
5 declaration?

6 MR. TIPESCU: And, Michael, it's Mircea,
7 before we move on to another topic, I don't know how
8 long we've been going or if Dr. Liu -- Liu needs a
9 break.

10 MR. SAUNDERS: I'm fine going off the
11 record if you want a break, Dr. Liu.

12 THE WITNESS: It might be a good time to
13 take a break since we're changing subjects, yeah.

14 MR. TIPESCU: Okay. Let's go off the
15 record.

16 VIDEOGRAPHER: The time is 3:58. We're off
17 the record.

18 (Brief recess.)

19 VIDEOGRAPHER: The time is 4:08, we're back
20 on the record.

21 Q. (BY MR. SAUNDERS) All right. Dr. Liu, I was
22 going to ask you some questions about paragraph 90 of
23 your declaration. Let me know when you're there.

24 A. Paragraph 90, you said?

25 Q. Yeah.

1 A. Okay. I'm there.

2 Q. And this is part of your section on motivation
3 to combine Hirler and Kobayashi to disclose the
4 limitations of Claims 3 through 5 and 7 through 9; is
5 that right?

6 A. Referring to paragraph 88, right, when I said,
7 (Reading:) A POSITA would have been motivated to
8 combine the barrier metal layer of Kobayashi with the
9 MOSFET of Hirler to arrive at the subject matter of
10 Claim 3 through 5 and 7 through 9.

11 Q. Yeah.

12 A. Okay.

13 Q. So Paragraph 90 is part of your explanation of
14 this motivation, correct?

15 A. Right. Yes, that's correct.

16 Q. Okay. And in paragraph 90, you mention
17 "fluorine from the deposition process of W."

18 Do you see that?

19 A. Yes, I do.

20 Q. Okay. And that refers to tungsten; is that
21 correct?

22 A. W is the symbol for tungsten, that's correct.

23 Q. Okay. And so in semiconductor manufacturing,
24 if you deposit tungsten with a chemical vapor deposition
25 process that tungsten is bound to fluorine during that

1 process and can -- that fluorine can contaminate the
2 semiconductor material; is that correct?

3 A. That's one. I mean, I mean, that's just an
4 exemplary reason that -- why Ti and Ti nitride are used
5 as the adhesion layer for tungsten access, yes, that's
6 correct.

7 Q. Now, Hirler teaches that its contact plugs can
8 be made of tungsten or polycrystalline silicon, correct?

9 A. I would like to get to -- I would like to go to
10 Hirler to -- to address that.

11 Q. Sure. If you could look at --

12 A. Do you have a citation?

13 Q. Yeah, you can look at paragraph 23.

14 A. All right. Okay.

15 Q. Okay. And do you offer opinions in your
16 declaration as to why a person of skill in the art would
17 be motivated to -- to select Hirler's tungsten
18 embodiment as opposed to its polycrystalline silicon
19 embodiment in the combination with Kobayashi?

20 MR. TIPESCU: Objection, form.

21 THE WITNESS: The reason to select tungsten
22 over polycrystalline silicon; for one thing a resistance
23 is a concern, the resistivity of tungsten is much, much
24 smaller compared to resistivity of polycrystalline
25 silicon. So -- and, again, the name of the game is

1 getting the most dry current out of it, and, you know,
2 resisting any path of the current is not desirable.

3 Q. (BY MR. SAUNDERS) The purpose of the contact
4 stoppers in Hirler is to short Hirler's body to the
5 source, correct?

6 A. Give me one second. I want to understand
7 the -- the issues with that, the context. Excuse me.
8 I'm sorry, I'm coughing here. I'm not -- I'm trying to
9 look at Hirler. I'm sorry, I'm having a problem
10 correlating the figures, so hang on a second.

11 Q. The figures might be in the German version,
12 Exhibit 1005?

13 A. Okay. Go ahead with your question, please.

14 Q. Yeah. So the purpose of the conductive stopper
15 in Hirler is to short the body to the source, correct?

16 A. It's a source contact. In that context, that's
17 correct.

18 Q. But -- I guess, let me withdraw.

19 Paragraph 22 of Hirler also teaches that
20 the source contact trenches can be filled with aluminum,
21 correct?

22 A. That's correct.

23 Q. Aluminum has a higher conductivity than
24 tungsten, right?

25 A. Again, I don't know the relative comparison.

1 Again, you have to take everything in its totality.
2 Aluminum tend to cause what we call spiking, especially
3 with these high voltage devices, you're going to have
4 current flow and everything. So -- so it's fair to say
5 that as CMOS technology progresses, eventually the
6 contact is used -- you prefer to use a contact at the
7 time of the invention is with tungsten and tungsten with
8 a liner to replace the aluminum. Because aluminum,
9 although it may have good conductivity or low
10 resistivity, the fact is that it tends to spike.

11 So that's why, you know, you see the
12 literature, aluminum will always be adding some silicon
13 in there and adding some copper in there, because
14 aluminum tend to spike through the junction and cause
15 undesirable shorting and device failure.

16 And this is especially critical in light of
17 the -- these high voltage devices that are used to
18 conduct current under the high voltage. So aluminum is,
19 I will say, is the older generation, and it's at the
20 time of invention, definitely migrating to the use of
21 tungsten with liner.

22 Q. Do you mention somewhere in your declaration
23 that issue of aluminum spiking?

24 A. I -- I don't specifically, per se. But I think
25 effectively in figure -- in paragraph 91, I actually

1 list some of the key feature of using tungsten as the
2 barrier metal to fill contact. And this is definitely
3 applied to in contrast or aluminum. And at the time the
4 technology, during -- at the time of invention, we were
5 definitely -- the art definitely migrating to the use of
6 tungsten plug with liner as a choice of metallization as
7 a choice of so-called stopper.

8 Stopper is really just -- just a plug,
9 plugging the trench so that subsequent metal layer can
10 connect it, yeah.

11 Q. And do you mention somewhere in your
12 declaration the improved conductivity of aluminum over
13 polycrystalline stoppers? Sorry, let me withdraw.

14 Do you mention somewhere in your
15 declaration the improved conductivity of tungsten over
16 polycrystalline stoppers?

17 A. I don't know. I don't know if I effectively
18 say the same thing. But the fact of the matter is that
19 at the time of the invention and the metallization of
20 choice is definitely as taught by Kobayashi, the use of
21 tungsten with Ti or Ti nitride liner. And that's the
22 trend of technology. And that's -- that is -- it has --
23 it offers benefit compared to polysilicon, compared to
24 aluminum, and these are just the -- where the technology
25 at the time would be -- would be migrating.

1 And so given that the constant with Ti, Ti
2 nitrite liner offer superior results, definitely a
3 POSITA, in light of looking at Hirler and looking at
4 Kobayashi would definitely try to use tungsten with
5 liner as a stopper and to use that combination.

6 Q. In paragraph 91 of your declaration when you
7 discuss benefits of tungsten plugs, you mention
8 producing a planar top surface; is that correct?

9 A. That's correct.

10 Q. You can also produce a planar top surface using
11 chemical mechanical planarization techniques, correct?

12 A. I'm trying to see how I should -- I should
13 answer the question. I -- I think regardless of what
14 other technique you want to use, that doesn't change the
15 fact that one of the saving feature of the use of
16 tungsten is to be able to conformally fill the trench
17 and also conformally to -- due to the fact that it's
18 very conformal in filling the trench. So there is --
19 it's easier to planarize such conformal layer through
20 many methods.

21 It doesn't have to be CNP. Of course it
22 maybe can use it. It can be just a straight edge back.
23 You may have other fancy or even other method to -- to
24 planarize it. It doesn't change the fact if you want an
25 advantage of tungsten as a plug is that it's conformal

1 profiling, it's conformal deposition, especially with
2 high aspirational. You don't want to get into a
3 bread-loafing where even with CNP you have localized
4 area that has thick protrusions in our kind of CNP it's
5 undesirable because the difference in other issue due to
6 stress and everything.

7 So just slowing down CNP could be used to
8 planarize does not change the fact that you still want
9 have a more planar surface to begin your CNP or to begin
10 with before you perform CNP, it doesn't change the fact
11 that there's advantage to have a conformal and more
12 planarized surface before any of your technique to
13 planarize the top surface.

14 Q. Is polycrystalline silicon -- sorry. Withdraw.

15 Is polycrystalline silicon also able to
16 conformally fill contact holes with a high aspect ratio?

17 A. I'm trying to figure out how to answer the
18 question. Because, again, you cannot just take -- take
19 a line in the -- in the specification and then -- and
20 then trying to -- trying to apply it without looking at
21 the totality. Okay. The -- the issue with polysilicon,
22 which I -- I don't know if I really need to digress
23 into. But suffice to say, into this other problem.

24 For example, polysilicon is just like
25 silicon layer, it has to dope with one type of doping or

1 the other type of doping. Okay. And so then you going
2 to have a -- have a case where if I dope the polysilicon
3 with N-type, then I cannot contact the N+ source, no
4 problem. But then when it comes to P type, then you
5 have a P-N junction, and you're going to have to do some
6 other things to make sure that P-N junction is not --
7 it's -- it's the only junction rather than the
8 rectifying junction.

9 So there -- there are a lot of other issue.
10 To say that, you know, I can use this and I can use that
11 is easy. But -- but you have to evaluate in its
12 totality. And a POSA along with looking at the
13 combination of Kobayashi and Hirler, it's just -- of
14 course there -- you can try to do it. But you have to
15 find one that gives you predictable results and give you
16 the desirable result and then have a chance to succeed.

17 And therefore, it's obvious to combine
18 Kobayashi with Hirler and because the tungsten or
19 titanium, Ti nitride would remove or leave a lot of the
20 constraint. The other implementation may have. You can
21 fill out aluminum, you can fill out polysilicon. But
22 the -- the motivation to combine and the one with the
23 chance to succeed and the predictable result is tungsten
24 with titanium, Ti nitride.

25 Q. So in paragraph 91 of your report when you say,

1 (Reading:) The CVD tungsten process is able to
2 conformally fill contact holes with a high aspect ratio
3 and produce a planar top surface.

4 Those are benefits of CVD tungsten over
5 aluminum, not benefits over polycrystalline, correct?

6 A. You have to remember; the contact is the
7 contact resistance. I'm using this to contact. So
8 other performance metric matters as well, so I think in
9 the scale of progression, in looking at things, right, I
10 just mentioned polysilicon has its own, for lack of
11 better word, baggage that it carries, and it's not --
12 the other challenge that introduce that you're going to
13 have to -- have to address. I just mentioned that
14 polysilicon, are you going to -- is it going to be doped
15 N-type polysilicon or P-type polysilicon? Because
16 either way, you're using polysilicon to contact the N-P
17 junction, and you have three -- you know, you have
18 different -- different -- different doping concentration
19 therefore there's a work function difference and in some
20 cases in one case it's going to be an ohmic contact,
21 that's fine.

22 In the other case, there's going to be
23 rectifying contact, and that's not going to be okay. So
24 you're going to have to do other things to address it,
25 and doing the other things to address it, you're going

1 to introduce other issue and then the motivation to
2 combine or the usage may not become obvious.

3 So the case where I have Kobayashi, I have
4 Shiraishi -- no, sorry, Hirler, I have Hirler, and in
5 order to going from these two to come up with a better
6 contact structure, better choice, then it makes sense
7 to -- to combine the teaching of Hirler in terms of the
8 doping concentration with the contact structure of
9 Kobayashi.

10 MR. SAUNDERS: I'll object as
11 nonresponsive.

12 Q. (BY MR. SAUNDERS) I was asking a really simple
13 question; I think you kind of leapt ahead. When you're
14 talking about the benefits of tungsten process being
15 able to conformally fill contact holes with a high
16 aspect ratio and produce a planar top surface, you're
17 not opining that polycrystalline silicon stoppers are
18 able to satisfy those specific properties. You just
19 have other problems with polycrystalline stoppers. Is
20 that fair?

21 A. I think that the way -- I don't know why I'm
22 not responsive. But I think the way to answer the
23 question is that in looking at the situation, in looking
24 at the -- the stated goal, and in looking at the
25 property or performance results from having a tungsten

1 with Ti nitrite plug, it will be obvious to a POSA that
2 to combine Hirler with the -- with the barrier metal of
3 Kobayashi to obtain the best performance and predictive
4 of performance.

5 Q. Maybe -- maybe I'll ask the question this way.
6 If I want to know where in your declaration you offer an
7 opinion that a person of skill in the art would be
8 motivated to select tungsten plugs instead of the
9 polycrystalline stoppers of Hirler, where is that in
10 your declaration?

11 A. Can you repeat the question again?

12 MR. TIPESCU: Objection, form.

13 Q. (BY MR. SAUNDERS) Yeah. If I wanted to find
14 in your declaration an opinion that one of skill in the
15 art would be motivated to implement Hirler using
16 tungsten plugs instead of polycrystalline stoppers,
17 where would I find that in your declaration?

18 MR. TIPESCU: Objection, form.

19 THE WITNESS: The fact that effectively I
20 opine that a person of ordinary skill in the art would
21 be obvious -- it would be obvious to try for that person
22 to combine the structure, MOSFET structure of Hirler
23 with the Kobayashi bare metal layer, I think that
24 effectively says that that is the one that yield
25 predictable results and yield good performance metrics

1 so that a POSA would be motivated to try.

2 I think effectively, I'm saying that
3 effectively because I am, in my declaration, offer an
4 opinion it is obvious to try to -- obvious to combine
5 due to all the benefit that we know from a tungsten plug
6 and all the negative impact that would have happened
7 without using a tungsten plug and the bare metal. So I
8 think effectively I'm saying that this is the -- the way
9 to go. And this is the way that will yield predictable
10 results.

11 So I think effectively, I offer the opinion
12 whether somebody wants to insist on using aluminum or
13 using polysilicon. But I'm offering an opinion as a
14 person skilled in the art that it will be
15 straightforward, it will be obvious to combine Hirler
16 with Kobayashi back end, and I -- in my opinion is not
17 going to be affected by the fact that, you know, certain
18 other metallization may offer one-sided property and
19 then all this other stuff. It doesn't change my
20 opinion.

21 Q. (BY MR. SAUNDERS) All right. Let's go on
22 to -- can you turn to Hirler at paragraph 7?

23 A. Turn to Hirler reference you mean?

24 Q. Yeah, the Exhibit 1006, paragraph 7.

25 A. I'm there.

1 Q. And you agree that one of the objects of Hirler
2 is to avoid "precisely defining the depth of the body
3 contact zone"; is that correct?

4 A. From paragraph 7?

5 Q. Yeah.

6 MR TIPESCU: Objection, form.

7 THE WITNESS: Repeat your question again?
8 I don't understand your question.

9 Q. (BY MR. SAUNDERS) Well, let's say -- start
10 with this. This is the section of Hirler that talks
11 about objects of the invention, correct?

12 A. It's under the title "Object", that's correct.

13 Q. Okay. And it mentions in paragraph 7 "without
14 precisely defining the depth of the body contact zone."

15 Do you see that?

16 A. Okay.

17 Q. Okay. So would you agree with me that one of
18 the objects of the Hirler invention is avoiding
19 precisely defining the depth of the body contact zone?

20 MR. TIPESCU: Objection, form.

21 THE WITNESS: I -- I don't understand. I
22 don't -- I don't -- I don't understand the question,
23 please.

24 Q. (BY MR. SAUNDERS) Let's move on.

25 The body contact zone is element 17 at the

1 bottom of the source contact trenches in Hirler,
2 correct?

3 MR. TIPESCU: Objection, form. I'm sorry,
4 Michael, are you looking at -- are you looking at a
5 specific figure, or are we -- I couldn't hear the entire
6 question. I'm sorry.

7 MR. SAUNDERS: I mean, it's throughout
8 Hirler.

9 Q. (BY MR. SAUNDERS) But, when -- I guess, let me
10 ask the question this way.

11 In paragraph 7 of Hirler, when it's
12 referring to the body contacted zone, do you understand
13 that that's referring to element 17 in Hirler's figures?

14 A. That's correct.

15 Q. And that's found at the bottom of the source
16 contact trenches, correct?

17 MR. TIPESCU: Objection, form.

18 THE WITNESS: I guess we can point to a
19 particular figure, maybe.

20 Q. (BY MR. SAUNDERS) Well, so 2E, element 17 is
21 at the bottom of the source contact trench, correct?

22 A. That's correct.

23 Q. And in 1D, element 17 is also bottom of the
24 source contact trench, correct?

25 A. That's correct.

1 Q. And so the depth of the body contact zone in
2 Hirler is determined by the depth of the source contact
3 trench, correct?

4 A. Sorry. It must be getting late. I don't quite
5 follow your question. I'm sorry.

6 Q. Well, let me ask this way. So going back to
7 paragraph 7 of Hirler, why do you understand that Hirler
8 wants to avoid precisely defining the depth of the body
9 contact zone?

10 MR. TIPESCU: Objection, form.

11 THE WITNESS: Can you repeat your question?
12 I'm...

13 Q. (BY MR. SAUNDERS) Yeah. So turning to
14 paragraph 7 in Hirler, why do you think that Hirler
15 wants to avoid precisely defining the depth of the body
16 contact zone?

17 MR. TIPESCU: Objection, form.

18 THE WITNESS: I -- give me a second.

19 MR. TIPESCU: Michael, it's Mircea, could I
20 ask the court reporter to read back that question. I
21 want to make sure I know what I'm looking at.

22 (Requested question was read.)

23 MR. TIPESCU: Thank you.

24 THE WITNESS: So in the context of Hirler,
25 just like '634 and just like Kobayashi, you have this P+

1 layer. And I think in the context of precisely defining
2 the depth, it really means that you have -- you have
3 different requirement, not only you want the bottom to
4 be sufficiently dope, you also want the sidewall to have
5 certain type doping so that you can have -- you can
6 achieve the desirable breakdown voltage that you wanted.

7 And simply having an implant 17 it's not
8 going to satisfy that requirement. So the introduction
9 of another implant which is the body amplification zone
10 and which is corresponding to lateral contact layer
11 would help remove the constraint of having to put this
12 layer 17 at the -- at the other location that you want
13 to place.

14 So I think it's in this context that, of
15 course, Hirler does not specify, but it's in this
16 context that you -- you are doing this body
17 amplification layer.

18 Q. (BY MR. SAUNDERS) If Force Mos introduces
19 expert testimony opining that Hirler is concerned with
20 the difficulty of precisely etching a source contact
21 trench -- trench to a specific depth, would you disagree
22 with that?

23 MR. TIPESCU: Objection, form and
24 relevance.

25 THE WITNESS: Again, you're asking

1 hypothetical question. I -- again, it doesn't change my
2 opinion that you want, whether through additional method
3 to introduce doping, you want the sidewall of the trench
4 to be covered with a body amplification layer. So you
5 basically sort of divide and conquer. I am going to
6 have this P 17, the highest doping region at the bottom,
7 but, because as you said, the trench and location,
8 whatnot, I am also going to have another implant now
9 surround the sidewall, the trench. It doesn't change my
10 opinion. This -- this is hypothetical. I don't know
11 what Force Mos is going to introduce.

12 But, again, this -- this doesn't change the
13 opinion that you have lateral contact layer with a
14 different doping compared to the bottom source base --
15 source contact and then together, they achieve to make
16 the breakdown voltage being optimized.

17 Q. (BY MR. SAUNDERS) Can you turn to Kobayashi
18 paragraph -- actually, let's turn to Kobayashi, the
19 abstract.

20 THE WITNESS: Counsel, before you begin
21 your question, can -- can I take a quick bio break?

22 MR. SAUNDERS: Yeah, let's go off the
23 record.

24 THE WITNESS: Thank you.

25 VIDEOGRAPHER: The time is 4:49. We're off

1 the record.

2 (Brief recess.)

3 VIDEOGRAPHER: The time is 4:55. We're
4 back on the record.

5 Q. (BY MR. SAUNDERS) I think before the break,
6 Dr. Liu, I was pointing to the abstract of Kobayashi.

7 Do you see that?

8 A. Yes, I do.

9 Q. And I want to point you to kind of sort of the
10 language that appears between the numbers 19 and the
11 numbers 14 in the abstract. Can let me know when you
12 see that language?

13 A. Yes, I do.

14 Q. Can you see Kobayashi's abstracts mentions,
15 (Reading:) The contact is formed to a depth different
16 to a peak depth which is a position having a maximum
17 impurity-concentration in a depth direction of the base
18 layer.

19 Do you see that?

20 A. Yes, I do.

21 Q. That's referring to making sure that the source
22 contact trench is a specific depth in Kobayashi,
23 correct?

24 MR. TIPESCU: Objection, form.

25 THE WITNESS: It's just simply saying that

1 the depth of the trench is not hitting the maximum
2 impurity concentration of the -- of the P+ of the base
3 contact layer. So to the extent it applies to any --
4 any trench depth.

5 Q. (BY MR. SAUNDERS) Okay. But you just have to
6 make sure that the depth is not the depth that is at the
7 maximum impurity concentration, correct?

8 MR. TIPESCU: Objection, form.

9 THE WITNESS: Now, the -- again, it depends
10 on the process sequence. This -- this does not mean
11 that necessarily mean that you have to control your
12 trench depth. It just means that relative position
13 between the -- when the -- when the implant is formed
14 versus when a trench is formed, that tis -- that the
15 depth of the trench is not at the peak concentration of
16 the base -- of the contact source layer.

17 Q. (BY MR. SAUNDERS) Do you offer an opinion in
18 your declaration why when combining Hirler and
19 Kobayashi, a person of skill in the art would be
20 motivated to use Hirler's body amplification zone
21 instead of Kobayashi's silicide embodiment to address
22 the problem of source contact resistance?

23 MR. TIPESCU: Objection, form.

24 THE WITNESS: Repeat your question again.

25 Q. (BY MR. SAUNDERS) In your declaration, do you

1 offer an opinion explaining why a person of skill in the
2 art would be motivated to select Hirler's body
3 amplification zone as opposed to Kobayashi's silicide
4 for addressing the problem of source contact resistance
5 at the sidewalls when a POSA was combining Kobayashi and
6 Hirler?

7 MR. TIPESCU: Objection, form and
8 relevance.

9 THE WITNESS: My declaration is not trying
10 to opine what may be or may not be the best
11 implementation to address source contact resistance. My
12 declaration is -- which -- which -- for one thing,
13 which -- which ground are you referring to, for example?
14 Can you let me know?

15 Q. (BY MR. SAUNDERS) Yeah. I mean, I think
16 there's only one ground where you have the combination
17 of Hirler with Kobayashi, which is the ground that we've
18 been talking about where your motivation to combine is
19 starting in paragraph 88.

20 A. Excuse me. Yeah, so for the sake of being able
21 to answer your question complete, can you -- can you
22 just repeat your question again? I'm really sorry, it's
23 getting late, I know. It's getting late. But I just
24 want to know.

25 Q. Yeah. So with respect to your ground involving

1 the -- the proposed combination of Hirler and Kobayashi,
2 in your declaration, do you have an opinion explaining
3 why a person of skill in the art would be motivated to
4 use Hirler's body amplification zone as opposed to
5 Kobayashi's silicide to address the problem of source
6 contact resistance at the sidewalls?

7 MR. TIPESCU: Objection, form and
8 relevance.

9 THE WITNESS: I use -- which -- I guess --
10 I guess which claim are you referring to? I'm -- I'm a
11 little bit confused now.

12 Q. (BY MR. SAUNDERS) Well, you understand that
13 Claims 3 through 5 and 7 through 9 have all of the
14 limitations of Claim 1 as part of them, correct?

15 A. Can you clarify your question, please? I don't
16 understand. I don't get it.

17 Q. Let me say it this way. You are aware that
18 Claim 1 of the '634 patent is the only independent claim
19 in that patent, correct?

20 A. I think that's correct.

21 Q. And do you understand as matter of law that a
22 dependent claim has all of the limitations of the claims
23 that it depends from. Do you understand that?

24 A. Yes, I do.

25 Q. Okay. And so you understand that when you're

1 combining Hirler and Kobayashi, the -- although you're
2 focusing on Claims 3 through 5 and 7 through 9, Claim 1
3 is still relevant to that motivation to combined
4 inquiry.

5 Do you understand that?

6 A. Yes, I do.

7 Q. Okay. And with so that explanation given, is
8 there somewhere in your declaration where you offer an
9 explanation for why a person of skill in the art
10 combining Hirler with Kobayashi would be motivated to
11 select Hirler's body amplification zones as opposed to
12 Kobayashi's silicide to address the problem of source
13 contact resistance at the sidewalls?

14 MR. TIPESCU: Objection, form.

15 THE WITNESS: I -- my declaration and
16 opinion I offer, is that combining -- combining Hirler
17 and Kobayashi would render '634 patent obvious and to
18 the -- to the extent I'm comparing, again, apple to
19 apple, okay. There is -- in '634 with the Claim 5
20 through 7 and 3 through 5, 7 through 9 with the -- with
21 the -- with the back end, given that even if in Claim 1,
22 I'm comparing that '634 use a lateral contact layer to
23 reduce the source contact resistance and my opinion is
24 that this technique, this limitation is rendered obvious
25 by combining Hirler's body amplification zone with

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1 Kobayashi's implementation.

2 That's my declaration. That's my opinion.
3 I'm not trying to necessarily opine on what's the best
4 implementation, what may be the implementation, or
5 whether it's best or not, whether it may be our
6 implementation. I'm simply saying that this
7 implementation in Hirler combined with this
8 implementation that is taught by Kobayashi render '634
9 limitation obvious.

10 Q. (BY MR. SAUNDERS) Okay. Let's go on to some
11 of your opinions where you have Shiraishi as a primary
12 reference and you combine that with Kobayashi. And that
13 starts on page 53 of your declaration in paragraph 125.
14 Let me know when you're there.

15 A. You said paragraph 125?

16 Q. Yeah, that's the section where it starts.

17 A. Okay.

18 Q. And so this section you're giving the reasons
19 why you believe a POSA would be motivated to combine
20 Shiraishi with Kobayashi in the manner recited in Claims
21 3 through 9 of the '634 patent, correct?

22 A. Yes, that's correct.

23 Q. And in paragraph 128, you address the
24 motivation to use metal contact plugs; is that correct?

25 A. Yes.

1 Q. Which -- why don't you pull up Shiraishi and go
2 to Figure 11. Let me know when you're there.

3 A. Because I'm coughing I'm drinking a lot of
4 liquid, and because I'm drinking a lot of liquid, I need
5 to go to the restroom.

6 Figure 11 you said?

7 Q. Yeah, Figure 11 of Shiraishi.

8 A. I'm there.

9 Q. Is this the embodiment of Shiraishi that you
10 are opining a POSA would be motivated to combine with
11 Kobayashi for this ground where Shiraishi is the primary
12 reference?

13 MR. TIPESCU: Objection, form.

14 THE WITNESS: Can you say it again. I --
15 I'm having a hard time --

16 Q. (BY MR. SAUNDERS) So focus on your opinions
17 where Shiraishi is the primary reference and you're
18 combining it with Kobayashi. And what I want to know is
19 which embodiment of Shiraishi are you opining would be
20 obvious to combine with Kobayashi? And I pointed you to
21 Figure 11 and I asked is that the embodiment?

22 MR. TIPESCU: Objection, form.

23 THE WITNESS: Give me a second. I think a
24 better figure will be Figure 9. I use Figure 9 to
25 show --

1 Q. (BY MR. SAUNDERS) Figure 9 is --

2 A. The embodiment, determination embodiment, yeah.

3 Q. Figure 9 is showing cross section in Shiraishi,
4 right?

5 A. Yeah, sorry. So I use Figure 9 to -- to offer
6 my opinion.

7 Q. And so Figure 11 is showing a top view of a
8 MOSFET in Shiraishi, right?

9 A. It's -- it's not easy to translate sitting here
10 the -- translate the top view with a side view because
11 I'm not sure if the numbers are -- are lining up.

12 Q. Well, I mean you've seen the number of MOSFET
13 topologies from the top view before, right?

14 MR. TIPESCU: Objection, form.

15 THE WITNESS: Yes, I have. But from top
16 view, it's hard to depict all the layers, different
17 layers, right, so...

18 Q. (BY MR. SAUNDERS) Okay. I understand. But it
19 looks like Figure 11 in Shiraishi is a top view,
20 correct?

21 MR. TIPESCU: Objection, form.

22 THE WITNESS: As I said, I'm having a hard
23 time correlating. The top view does not show all the
24 underlying layer features, so it's hard to correlate.
25 For example, you see the GP and it doesn't show all the

1 trenches -- of the gate trenches so it's hard to -- hard
2 to -- the layers involved that mask all the other
3 layers, so it's hard to -- to get an idea.

4 Q. (BY MR. SAUNDERS) You see at the bottom of
5 paragraph 77 in Shiraishi, it mentions that Figure 11
6 exhibits a case of the respective gate electrodes being
7 formed in a "stripe-like pattern"?

8 MR. TIPESCU: Hold on. Dr. Liu.

9 Michael, I didn't hear your question. What
10 column and line?

11 MR. SAUNDERS: Oh, let me -- here. Let me
12 make sure my volume is turned all the way up.

13 MR. TIPESCU: Very good. I just think you
14 went kind of fast.

15 MR. SAUNDERS: Okay. Actually, let me turn
16 to a different place that's better. Let's see.

17 Q. (BY MR. SAUNDERS) Yeah, let's go to
18 paragraph 77. Let me know when you're there, Dr. Liu.

19 A. I'm there.

20 Q. You see the very last portion of that paragraph
21 it says, (Reading:) Figure 11 exhibits a case of the
22 respective gate electrodes 10 being formed in a
23 stripe-like pattern.

24 Do you see that?

25 A. Yes, I do.

1 Q. Do you have any opinion about whether the
2 cross-section of Figure 9 is consistent or inconsistent
3 with a stripe-like pattern?

4 MR. TIPESCU: Objection, form.

5 THE WITNESS: Look, Figure 9 is a
6 cross-section, okay, and if I look at the gate
7 electrodes, number 9 or number 10, okay, electrodes
8 number 10, that's a cross-section. And we don't know
9 when it goes through to the picture, does it go straight
10 line as a stripe or does it go into a square. That's
11 what I'm saying that it's very difficult to look at a
12 cross-section.

13 In cross-section, I can see all the
14 feature, and I believe the cross-section I'm using the
15 cross-section to show where the Claim 3 to 9 are
16 combined rendered. So between Shiraishi and Kobayashi.
17 And I think it's the top view in a sense it doesn't
18 change opinion. It's just top view, because we don't
19 know how the 10 in Figure -- Figure 9 either goes
20 straight or they form -- form a -- form a square, form a
21 circle or form whatnot. We don't know how -- how it
22 goes into the picture, goes to the paper or go into the
23 screen in this case.

24 Q. (BY MR. SAUNDERS) You'd agree with me that if
25 Figure 9 was implemented with the gate electrodes and a

1 stripe like pattern, then the source contact trenches
2 would form long continuous trenches of metal; is that
3 correct?

4 MR. TIPESCU: Objection, form.

5 THE WITNESS: Look, I think the way to
6 answer that is going -- looking from Figure 9 to
7 Figure 10 you have a top metal layer, okay. The source
8 metal layer. And that's aluminum, silicon, copper, or
9 aluminum. And so the top view, Figure 10 actually
10 covers a lot of the underlying layer with regard to the
11 contact of the gate trench and also how the source
12 contact.

13 And I'm not going to speculate or trying to
14 work on a layout. I'm simply looking on a cross-section
15 and I'm opining. So I don't understand the question.
16 I'm sorry.

17 Q. (BY MR. SAUNDERS) Let me ask this question.
18 In your declaration, did you offer any opinion opining
19 that one of the skill in the art would select a
20 particular gate layout for the combination of Shiraishi
21 with Kobayashi?

22 MR. TIPESCU: Objection, form.

23 THE WITNESS: If you see -- if you see --
24 if you can point me to where I actually opine on the
25 layout of -- of the gate source contact with the gate

1 trenches.

2 Q. (BY MR. SAUNDERS) I didn't see it. And that's
3 why I wanted to double-check with you whether I was
4 correct that it's not there or whether you believed it
5 was there. So are you able to point me somewhere that
6 you have that opinion?

7 MR. TIPESCU: Objection, form.

8 THE WITNESS: All we -- all we know is that
9 on top of this device, there's going to be a source
10 contact there and there's going to be a gate contact
11 layer. And how it intricately connect them to down
12 below the metal layer, it depends on the cell layout, it
13 depends on how the -- the -- how the routing goes.

14 So simply looking at Figure 10 and looking
15 at Figure 11, suffice to say that Figure 9 with the
16 cross-section is much more indicative all the different
17 layers and which is the opinion I offer -- I'm trying to
18 offer that it makes sense given the Figure 9 to -- to --
19 to combine that with Kobayashi to come up with the
20 tungsten plaque with the titanium and the Ti nitride
21 layer.

22 Q. (BY MR. SAUNDERS) Do you have an opinion about
23 the meaning of the term "contact metal plugs" in Claim 3
24 of the '634 patent?

25 MR. TIPESCU: Objection, relevance.

1 THE WITNESS: Which claim again? I'm
2 sorry.

3 Q. (BY MR. SAUNDERS) Claim 3 of the '634 patent?

4 MR. TIPESCU: Same objection.

5 THE WITNESS: What's the question? I'm
6 sorry. I'm really sorry.

7 Q. (BY MR. SAUNDERS) Yeah. Let me ask it this
8 way. What is your understanding of the meaning of the
9 phrase "contact metal plugs"?

10 MR. TIPESCU: Objection, form.

11 THE WITNESS: In the sequence of forming
12 metallization you typically will have, for example, I'm
13 using the example I say in the -- in the microprocessor
14 technology. After you finish all the silicon and the
15 doping and the sourcing chain, you typically will have a
16 contact layer to act as the interface between the metal
17 above it and the silicon in between. So we call that
18 the contact layer. And because the shape of it, we call
19 it a plug because as shown in Figure 9, I'm looking at
20 Figure 9, it's really just an opening and you fill it
21 up.

22 So you plug it. You fill it. And
23 typically, contact metal plug, in this context,
24 typically refers to tungsten with titanium, Ti nitrate
25 liner at the time of the '634 invention.

1 Of course, prior to that, you may have
2 other implementation. But at least at the time of the
3 '634, the industry has widely adopted the use of the
4 tungsten plug along with titanium, tie nitrate liner as
5 a barrier.

6 And to that extent, Figure 10 and Figure 11
7 are really not very relevant because there's a top view.
8 It doesn't denote, regardless of what layer you have, it
9 doesn't denote what plug, process, whatnot. You cannot
10 see that from -- from that resolution with the top view.

11 Q. (BY MR. SAUNDERS) All right.

12 MR. SAUNDERS: Can we go off the record for
13 a little bit. I'm going to just check my notes and see
14 how much more I have.

15 VIDEOGRAPHER: The time is 5:28. We're off
16 the record.

17 (Brief recess.)

18 VIDEOGRAPHER: Time is 5:44. We're back on
19 the record.

20 Q. (BY MR. SAUNDERS) Good afternoon, Dr. Liu.
21 During any of the breaks today, did you discuss the
22 substance of your testimony with anyone?

23 A. No, like I said, I'm alone here and I have a
24 couple of phone call with my attorney basically just --
25 just saying are you okay. How are you holding up. He's

1 knowing that I'm -- I was getting over COVID, yeah.

2 Q. All right.

3 MR. SAUNDERS: Well, thank you, Dr. Liu.
4 I'll pass the witness. I have no further questions at
5 the time.

6 MR. TIPESCU: All right. Thank you,
7 Michael. So -- so I -- let's go off the record for just
8 five or ten minutes. I do think I have just one or --
9 just a couple of questions on redirect. But let me --
10 let me talk to Dr. Liu and then we'll be -- we'll be
11 back on in -- in -- let's say ten minutes, Michael. Is
12 that okay.

13 VIDEOGRAPHER: The time is 5:45. We're off
14 the record.

15 (Brief recess.)

16 VIDEOGRAPHER: The time is 5:58. We're
17 back on the record. I believe you're muted.

18 EXAMINATION

19 Q. (BY MR. TIPESCU) All right. Good afternoon,
20 Dr. Liu.

21 A. Good afternoon, counsel.

22 Q. Just a few questions on -- on redirect for you.

23 Earlier today, you were asked about the
24 Hirler reference and specifically about the epitaxial
25 layer that's recited in limitation 1[a]. Do you recall

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1 that?

2 A. Yes, I do.

3 Q. And -- and, in fact, that limitation in --
4 in 1 -- in that Claim 1 is an epitaxial layer
5 corresponding with the drain region; is that correct?

6 A. That's correct. The element 2 of 1[a], yeah.

7 Q. So can you turn to your declaration, at
8 page 23, paragraph 66. This is, I believe, the
9 paragraph you're being asked about previously. Do you
10 recall that?

11 A. Yes, I do.

12 Q. Okay. And before I -- I ask you about the
13 opinions in this paragraph, earlier you were asked if
14 there are different ways to form an epitaxial layer, I
15 believe. Do you recall that?

16 A. Yes, I do.

17 Q. Okay. And I believe you said one way to form
18 an epitaxial layer is by epitaxy. Is -- is -- do you
19 recall that?

20 A. Yes. Epitaxial growth.

21 Q. Okay. And I -- I believe Mr. Saunders asked
22 you whether it would have been obvious in -- in -- in
23 view of Hirler to form an epitaxial layer via epitaxy.
24 Do you recall that?

25 MR. SAUNDERS: Objection, form, leading.

1 THE WITNESS: I believe he was saying that
2 would it be -- I seem to recall sitting right here
3 hearing this from you the first time. I believe he --
4 the question was would it have been obvious as a -- to
5 me as a person of ordinary skill in the art to form an
6 epitaxial layer. Something to that effect, yeah.

7 Q. (BY MR. TIPESCU) Okay. Now setting
8 obviousness aside for a minute with regards to the
9 epitaxial layer, let me turn here near paragraph 66. At
10 the bottom of the paragraph, starting with number 2 in
11 parenthesis, you say, (Reading:) The "n-drift zone 11,"
12 corresponds with "an epitaxial layer corresponding with
13 a drain region."

14 Do you see that?

15 A. Yes, I do.

16 Q. Okay. Is it your opinion that Hirler discloses
17 an epitaxial layer corresponding with the drain region?

18 MR. SAUNDERS: Objection, form, leading.

19 THE WITNESS: It is my opinion, I think I
20 rendered this under the scope of anticipation. And
21 when -- when -- when I was addressing the question of
22 obvious, I was -- answering counsel's question. But the
23 fact anticipation, my conclusion of the -- it is
24 disclosed by Hirler, actually start with paragraph 66.
25 It says "the starting point is n+ substrate 10." So now

1 you start with N+ substrate 10. And keep in mind, this
2 N+ is highly doped, okay.

3 Now, you're going to have an N- doping,
4 much lighter doping on top of this layer. The way to
5 form that is to epitaxy, because if you have a lighter
6 dope, say, substrate, it's easy to implant heavier ion
7 to compensate and make into N+, higher doping. But it
8 will be very hard to implant something that's heavy with
9 the same type of doping into something very light unless
10 you do it by epitaxy.

11 So the fact it says the starting point is
12 the n+ substrate, so the substrate is given already.
13 And now you want to have a layer that's lightly dope on
14 top of that with the same type of doping, meaning that
15 it's going to be N and it's going to have to be
16 epitaxial growing another layer, epitaxial layer on top
17 of the N+ substrate.

18 Otherwise it's going to be very difficult
19 somehow to neutralize the N+ through an implant and then
20 make it into N-. It's just not -- not feasible. So
21 this is why I offer the opinion that based on Hirler's
22 disclosure, the starting point is an N+ substrate and
23 then you have -- excuse me. N+ substrate of silicon and
24 then you have N- drip zone. It is disclosing an N- drip
25 zone of epitaxial layer on top of N+ substrate.

1 Q. (BY MR. TIPESCU) Thank you, Dr. Liu, but I'm
2 afraid you're going to have to repeat a lot of that
3 because Mr. Saunders had an objection to my question and
4 I want to make sure we -- the record is clear, so I'm
5 going to have to re-ask the question and hopefully avoid
6 any objections from Mr. Saunders. So let me rephrase my
7 question and you can answer accordingly as you see fit
8 in response to that question.

9 What is the basis for your opinion that the
10 N-drift zone 11 corresponds with an epitaxial layer
11 corresponding with the drain region as stated in
12 paragraph 66 of your declaration?

13 MR. SAUNDERS: Objection, leading.

14 Q. (BY MR. TIPESCU) Okay. Let me -- I'll
15 rephrase the question again.

16 Is it your -- let me take you to your
17 declaration paragraph 66. Do you see where it states,
18 quote, and I'm reading from the declaration, (Reading:)
19 The "n-drift zone 11," corresponds with "an epitaxial
20 layer corresponding with the drain region."

21 Do you see that?

22 A. Yes, I do.

23 Q. Is that your opinion today?

24 A. It is.

25 Q. What is the basis for your opinion?

1 A. Again, in paragraph 66, Hirler discloses and I
2 cite it, the starting point is an N+ substrate 10 of
3 silicon. So you have an N+ substrate, N+ very heavily
4 dope N+ substrate to facilitate as a drain -- for the
5 drain contact.

6 Now, you're going to have an N- drift
7 region much like a dope. And the way to do that is
8 through epitaxial. You cannot do an implant. The
9 implant can actually make -- if you want to implant it's
10 possible to implant going from N- substrate and adding
11 extra dopant to make it N+ on top of that N-. But it's
12 going to be -- it's not going to be possible to implant,
13 to make an implant substrate on the bottom and then a
14 layer with actually lighter doping layer on top just to
15 implant, because you cannot suck out implant.

16 So the only way -- the way to do it is
17 through epitaxial and this is how I form my opinion of
18 Hirler, anticipate this claim limitation, which I cited
19 that the, (Reading:) "N- drift zone 11 correspond with
20 an "epitaxial layer corresponding with a drain region".

21 MR. TIPESCU: Thank you, Dr. Liu. That's
22 all the questions I had.

23 THE WITNESS: Thank you.

24 FURTHER EXAMINATION

25 Q. (BY MR. SAUNDERS) I have a few questions on

1 recross.

2 Dr. Liu, you did not explain an opinion
3 that an N- layer could not be put on top of an N+ layer
4 without epitaxy in your declaration, correct?

5 MR. TIPESCU: Objection, form.

6 THE WITNESS: I think effectively, I said
7 that by saying that the N- drift zone corresponding with
8 an epitaxial layer corresponding with a drain region,
9 and I think this morning, the question was somehow was
10 it obvious, and I was trying to answer the question in
11 the context how you -- how you address it. But I think
12 effectively, I'm saying that the N- drip zone 11
13 correspond with an -- with an epitaxial layer
14 corresponding with the drain region.

15 Q. (BY MR. SAUNDERS) Would adding P-type dopants
16 to an existing N+ doped region of silicon reduce the
17 concentration -- effective concentration of N-type
18 doping in that region?

19 A. Well, the question you asked is -- is -- is on
20 the surface, you could use a different type of doping to
21 neutralize. But that is not the right way to do -- keep
22 in mind that this is a drift region. This already is
23 going to be somewhat having a high resistance. So now
24 if you counter dope, what happened when you counter dope
25 is that mobility, which is -- which is contribution to

1 the -- to the current mobility degrades significantly as
2 a function of doping regardless is compensated or
3 whatever. As long as you introduce dopant one type and
4 you introduce this dopant another type, the total doping
5 concentration effected together with the greater
6 mobility significantly, therefore it's not done because
7 the mobility will be degraded significantly such that
8 your ON Resistance will be totally degraded.

9 Q. You didn't express an opinion in your
10 declaration that explained that the N- region could not
11 be created by counter doping the N+ substrate with
12 P-type dopant; is that correct?

13 MR. TIPESCU: Objection, form.

14 THE WITNESS: I think effectively, again,
15 if you look at my conclusion given the beginning of
16 paragraph 66, (Reading:) The starting point is an N+
17 substrate of 10 of silicon, and then my conclusion that
18 the N+ substrate 10 of silicon correspond with the
19 silicon substrate and the N- drift region 11 correspond
20 with epitaxial layer corresponding with the drain
21 region. I think effectively what I'm saying is that the
22 epitaxial layer is disclosed in the Hirler -- Hirler
23 prior art.

24 Q. (BY MR. SAUNDERS) In theory, you could
25 introduce dopants into the backside of a substrate prior

1 to backside metallization, correct?

2 MR. TIPESCU: Objection, form.

3 THE WITNESS: Again, Hirler discloses, and
4 this is the Hirler quote in -- in -- which I cited in
5 paragraph 18. Hirler disclosed that the starting point
6 is an N+ substrate, okay. That's the starting point.
7 So the -- so the -- so that's the starting point.

8 Q. (BY MR. SAUNDERS) Sorry, one -- all right.
9 What are you referring to in Hirler saying that this N+
10 substrate is the starting point?

11 A. It's paragraph 18 as cited in my -- in my -- in
12 this paragraph 16 -- 18 in Hirler is cited in my
13 paragraph 66.

14 Q. Okay. So Hirler says the starting point is an
15 N+ substrate 10 of silicon and N- drift zone 11, P-body
16 zone areas 12 as well as an N+ source zone areas 13; is
17 that correct?

18 A. That's correct.

19 Q. Okay. So Hirler doesn't say how it got to that
20 point of having an N+ substrate 10 and an N- drift zone
21 11, correct?

22 A. I disagree with that because effectively,
23 especially in the context of you saying that implanting
24 the bottom, whatnot. I think Hirler is saying that,
25 look, I have an N+ substrate, okay, starting N+

1 substrate 10 and on top, I have epitaxial layer of a
2 drip zone 11. And then on top of that, now you can use
3 implant to introduce N+ source zone layer 13, because
4 you can always add in the same type doping but you
5 cannot subtract.

6 Q. All right. Sitting here today, could you point
7 to anything in Hirler expressly disclosing not using a
8 backside doping process to create the arrangement of an
9 N+ substrate 10 and N- drip zone 11?

10 MR. TIPESCU: Objection, form.

11 THE WITNESS: Again, I'm referring to
12 Hirler. So the starting point is N+ substrate 10 of
13 silicon. Then you have N- drip zone 11 of epitaxial
14 layer on top of it and you have a P-body zone area 12
15 and as well as N+ source zone area 13.

16 Q. (BY MR. SAUNDERS) Sitting here today, can you
17 point to any express disclosure in Hirler that the
18 arrangement of an N+ substrate 10 and N- drift zone 11
19 is not created by counter doping the N+ substrate using
20 positive dopants, P-type dopants?

21 MR. TIPESCU: Objection, form.

22 THE WITNESS: Effectively, again, it's
23 disclosed because the purpose of the N- drip zone 11 is
24 to facilitate the conduction of current in a vertical
25 power DMOS, and to that extent, the name of the game as

1 we gone over many times this morning, is you have to
2 have a low ON Resistance, excuse me.

3 So effectively, it's saying that to achieve
4 the lower ON Resistance you cannot be compensated. So
5 it corresponds to an epitaxial layer. Again, it's in
6 the context of the starting point as an N+ substrate 10
7 of silicon and that you have other stuff on top of it.

8 Q. (BY MR. SAUNDERS) Okay. That explanation you
9 just gave, you weren't identifying any particular
10 portion of Hirler; is that correct?

11 MR. TIPESCU: Objection, form.

12 THE WITNESS: I'm not identifying
13 effectively taking into the context that's what is
14 disclosed, that this is source of N- drip zone and this
15 is for facilitate conduction occurring. So in that
16 context, effectively saying that it's an epitaxial layer
17 in light of the paragraph 66, what I just cited in light
18 of Hirler paragraph 18 that the starting point is an N+
19 substrate 10 of silicon.

20 MR. SAUNDERS: All right. I have no
21 further questions. I'll pass the witness.

22 MR. TIPESCU: No other -- no further
23 questions here either.

24 VIDEOGRAPHER: Time is 6:14. We're off the
25 record.

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MR. TIPESCU: And I just want to reserve
signature.

(Deposition concluded.)

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ERRATA PAGE

WITNESS NAME: DAVID KUAN-YU LIU DATE: 08/22/2024

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[illegible]

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ACKNOWLEDGMENT OF DEPONENT

I, DAVID KUAN-YU LIU, do hereby certify that I have read the foregoing pages and that the same is a correct transcription of the answers given by me to the questions therein propounded, except for the corrections or changes in form or substance, if any, noted on the attached errata page.

DAVID KUAN-YU LIU DATE

THE STATE OF TEXAS)
)
COUNTY OF _____)

Before me, , on this day personally appeared DAVID KUAN-YU LIU, known to me (or proved to me under oath or through (description of identity card or other document) to be the person whose name is subscribed to the foregoing instrument and acknowledged to me that they executed the same for the purposes and consideration therein expressed.

Given under my hand and seal of office this ____ day of , .

NOTARY PUBLIC IN AND FOR
THE STATE OF

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REPORTER'S CERTIFICATION
DEPOSITION OF DAVID KUAN-YU LIU
TAKEN AUGUST 22, 2024

I, Janalyn Elkins, Certified Shorthand
Reporter in and for the State of Texas, hereby certify
to the following:

That the witness, DAVID KUAN-YU LIU, was duly
sworn by the officer and that the transcript of the oral
deposition is a true record of the testimony given by
the witness;

That the original deposition was delivered to
MICHAEL D. SAUNDERS;

That a copy of this certificate was served on
all parties and/or the witness shown herein on
_____.

I further certify that pursuant to FRCP No.
30(f)(i) that the signature of the deponent was
requested by the deponent or a party before the
completion of the deposition and that the signature is
to be returned within 30 days from date of receipt of
the transcript. If returned, the attached Changes and
Signature Page contains any changes and the reasons
therefor.

I further certify that I am neither counsel
for, related to, nor employed by any of the parties in
the action in which this proceeding was taken, and

1 further that I am not financially or otherwise
2 interested in the outcome of the action.

3 Certified to by me this 10th day of September
4 2024.

5 

6 JANALYN ELKINS

7 Texas CSR 3631

Expiration Date 1/31/2025

8 Veritext Legal Solutions

300 Throckmorton Street, Suite 1600

9 Fort Worth, Texas 76102

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1 Mircea Tipescu

2 mtipescu@beneschlaw.com

3 September 10, 2024

4 RE: Inergy Technology Inc v. Force Mos Technology Co LTD
5 8/22/2024, Dr. David Kuan-Yu Liu (#6868809)

6 The above-referenced transcript is available for
7 review.

8 Within the applicable timeframe, the witness should
9 read the testimony to verify its accuracy. If there are
10 any changes, the witness should note those with the
11 reason, on the attached Errata Sheet.

12 The witness should sign the Acknowledgment of
13 Deponent and Errata and return to the deposing attorney.
14 Copies should be sent to all counsel, and to Veritext at
15 errata-tx@veritext.com.

16 Return completed errata within 30 days from
17 receipt of testimony.

18 If the witness fails to do so within the time
19 allotted, the transcript may be used as if signed.

20
21
22 Yours,

23 Veritext Legal Solutions
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25

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[breakdown - chose]

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Federal Rules of Civil Procedure

Rule 30

(e) Review By the Witness; Changes.

(1) Review; Statement of Changes. On request by the deponent or a party before the deposition is completed, the deponent must be allowed 30 days after being notified by the officer that the transcript or recording is available in which:

(A) to review the transcript or recording; and

(B) if there are changes in form or substance, to sign a statement listing the changes and the reasons for making them.

(2) Changes Indicated in the Officer's Certificate. The officer must note in the certificate prescribed by Rule 30(f)(1) whether a review was requested and, if so, must attach any changes the deponent makes during the 30-day period.

DISCLAIMER: THE FOREGOING FEDERAL PROCEDURE RULES ARE PROVIDED FOR INFORMATIONAL PURPOSES ONLY.

THE ABOVE RULES ARE CURRENT AS OF APRIL 1, 2019. PLEASE REFER TO THE APPLICABLE FEDERAL RULES OF CIVIL PROCEDURE FOR UP-TO-DATE INFORMATION.

VERITEXT LEGAL SOLUTIONS

COMPANY CERTIFICATE AND DISCLOSURE STATEMENT

Veritext Legal Solutions represents that the foregoing transcript is a true, correct and complete transcript of the colloquies, questions and answers as submitted by the court reporter. Veritext Legal Solutions further represents that the attached exhibits, if any, are true, correct and complete documents as submitted by the court reporter and/or attorneys in relation to this deposition and that the documents were processed in accordance with our litigation support and production standards.

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