

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

IPR2023-01383

U.S. Patent No. 8,404,508

CERTIFIED COPY

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INNOSCIENCE (ZHUHAI) TECHNOLOGY COMPANY, LTD. and  
INNOSCIENCE AMERICA, INC.,

Petitioners,

v.

EFFICIENT POWER CONVERSION CORPORATION,  
Patent Owner.

---

ORAL DEPOSITION OF JAMES RICHARD SHEALY, PH.D.

Thursday, May 23, 2024

Reported by:

OKEEMAH S. HENDERSON, RPR,  
CaseViewNet Realtime Reporter

Job No.: 137282

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12               Patent Owner.  
13

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17       Oral deposition of JAMES RICHARD SHEALY,  
18       PH.D., taken on behalf of the Petitioners,  
19       beginning at 9:35 a.m., on Thursday, May 23, 2024,  
20       at the Law offices of Finnegan, Henderson, Farabow,  
21       Garrett & Dunner, LLP, 1875 Explorer Street,  
22       Reston, Virginia, before Okeemah S. Henderson, RRP,  
23       CaseViewNet Realtime Reporter, and Notary Public of  
24       the Commonwealth of Virginia.  
25

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20 (Appearances continued on next page.)  
21  
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1 APPEARANCE OF COUNSEL (Continued):

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C O N T E N T S

| THE WITNESS                 | PAGE |
|-----------------------------|------|
| James Richard Shealy, Ph.D. |      |
| BY MR. ENGLAND              | 7    |
| BY MS. SPECHT               | 81   |

EXHIBITS

| Exhibit No.  | Description        | Marked |
|--------------|--------------------|--------|
| Exhibit 1040 | Four hand-drawings | 102    |

(The Exhibit is produced with the transcript.)

(Previously marked Exhibits are listed on the next page.)

1  
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EXHIBITS (Continued)

PREVIOUSLY MARKED EXHIBITS

| Exhibit No.     | Description                                | Introduced |
|-----------------|--------------------------------------------|------------|
| Exhibit 1001    | U.S. Patent Application 508                | 11         |
| Exhibit 1003    | Declaration of James Richard Shealy, Ph.D. | 11         |
| Exhibit Paper 1 | Petition for IPR 508 Patent                | 32         |
| Exhibit Paper 2 | Institution decision for 508 Patent        | 50         |
| Exhibit 1004    | Prior art reference of Yoshida             | 51         |
| Exhibit 1005    | Prior art reference of Beach               | 57         |
| Exhibit 1006    | Prior art reference of Sheppard            | 67         |
| Exhibit 1007    | Prior art reference of                     |            |
|                 | Hikita 347                                 | 70         |
| Exhibit 1008    | Prior art reference of                     |            |
|                 | Hikita 023                                 | 77         |

(The previously marked Exhibits were retained by  
Counsel.)

1 P R O C E E D I N G S

2 Whereupon,

3 JAMES RICHARD SHEALY, Ph.D.

4 was called as a witness, and having been first  
5 duly sworn, was examined and testified as  
6 follows:

7 MR. ENGLAND: We can do introductions.

8 My name is Jon England. I'm here with my

9 partner, at the firm Blank Rome, Walter Davis,

09:36 10 and we are representing Efficient Power

11 Conversion Corporation.

12 MS. SPECHT: Kara Specht, for petitioner

13 Innoscience, from Finnegan, and with me also from

14 Finnegan are Yi Yu, Lionel Lavenue and Caitlin

09:36 15 Coverstone.

16 EXAMINATION BY COUNSEL FOR EFFICIENT POWER

17 CONVERSION CORPORATION

18 BY MR. ENGLAND:

19 Q. How are you doing, Dr. Shealy?

09:36 20 A. Fine. Thank.

21 Q. So you understand that you're

22 here to testify in connection with your

23 declaration that was submitted in IPR Inter

24 Partes Review proceeding 2023-01383 and that

09:36 25 concerns U.S. patent 8,404,508; is that correct?

1 A. That's correct.

2 Q. Would you be okay if I called  
3 that U.S. Patent I just referred to the 508  
4 patent, just for ease of reference?

09:37 5 A. Yes.

6 Q. Could you please state your full  
7 name for the record.

8 A. James Richard Shealy.

9 Q. So I understand you testified  
09:37 10 before at least in depositions. So I'm going to  
11 do an abbreviated ground rules for this  
12 proceeding. So I'm going to ask you some  
13 questions today and you will provide your  
14 answers.

09:37 15 Hopefully we will not be able to speak  
16 over each other because the court reporter will  
17 be taking it down and it will make an easier  
18 record, and please provide audible answers where  
19 possible. However, if you decide that you would  
09:37 20 mark something down, you're permitted to do that  
21 as well.

22 If you do not understand a question,  
23 please just ask for clarification, and I'll try  
24 to clarify the question for you; otherwise, I'm  
09:37 25 going to presume that you understand the

1 question. Then finally, if you need a break,  
2 please feel free to let me know.

3 I just ask that you finish any pending  
4 question, and otherwise I'm going to try to  
09:38 5 accommodate breaks every 45 minutes to an hour to  
6 move this proceeding along. Is that okay?

7 A. That's fine.

8 Q. Okay, Dr. Shealy. What did you  
9 do to get ready for your deposition today?

09:38 10 A. I had two remote sessions with  
11 the Finnegan attorneys, then two days of prep  
12 here in the office and of course I read -- I  
13 reviewed the materials in this binder, and I read  
14 the board's decision and the response of each  
09:38 15 party. And I think that covers it.

16 Q. Just so I understand, when you  
17 say this binder, is this a binder that was  
18 provided by counsel?

19 A. Yes. Its got all the exhibits  
09:39 20 for the 508 patent.

21 Q. So you reviewed the exhibits in  
22 the 508 patent, is what you're saying, and you  
23 reviewed -- you reviewed the exhibits found in  
24 the 508 patent to the best of your knowledge?

09:39 25 A. Yes.

1 Q. And you reviewed what I'm going  
2 to call the papers. So that would be the  
3 attorney drafted papers; the petition, the patent  
4 owner preliminary response, the surreply and the  
09:39 5 reply?

6 A. Yes.

7 Q. And then you said that you  
8 reviewed the institution decision as well?

9 A. Yes.

09:39 10 Q. In preparing for this deposition,  
11 did you review any documents not filed in this  
12 proceeding? So beyond --

13 A. No.

14 Q. Do you understand -- do you know  
09:39 15 whether patent -- sorry. Excuse me. Scratch  
16 that. You understand patent owner EPC and  
17 petitioner Innoscience are engaged in a dispute  
18 involving the 508 patent before the International  
19 Trade Commission?

09:40 20 A. Yes, I've heard of that. I  
21 haven't seen any materials of that proceeding.

22 Q. So besides for any materials  
23 filed in this proceeding, you've not seen any  
24 materials that were filed -- or that were  
09:40 25 involved in the ITC proceeding?

1 A. No.

2 MR. ENGLAND: I'm going to hand you a  
3 document that's been previously labeled Exhibit  
4 1001 in this proceeding. Do you recognize this  
09:41 5 document. Take a moment to look at it?

6 A. Yes.

7 Q. What do you recognize this  
8 document to be?

9 A. This is a copy of the 508 patent.

09:41 10 Q. Now, I'm going to hand you  
11 another document that's been previously marked as  
12 Exhibit 1003 for the proceeding. Would you  
13 prefer to use your version?

14 A. Well, if I got two, maybe I'll  
09:41 15 use them both.

16 Q. That may be beneficial. I'll be  
17 referencing multiple pages. Do you recognize  
18 this document?

19 A. Yes.

09:42 20 Q. What is this document?

21 A. This is my declaration that was  
22 submitted in this case.

23 Q. Would you prefer to call it this  
24 case or this proceeding?

09:42 25 A. Either one.

1 Q. Okay. I believe the last page of  
2 that -- sorry, the last page is page 148, that's  
3 your signature at the bottom?

4 A. Yes, it is.

09:42 5 Q. In paragraph 62 of your  
6 declaration, I'll give you a chance to flip to  
7 it, page 28 you describe a solution to -- that  
8 the 508 patent attempts to solve and that is by  
9 patterning and etching the gate material and the  
09:43 10 p-type GaN material using a single photomask; is  
11 that right?

12 A. Yes, that's the first sentence in  
13 paragraph 62.

14 Q. As your support for that you cite  
09:43 15 to paragraph -- the first paragraph in column 3  
16 of the 508 patent, that's column 3 in lines 1  
17 through 9 I believe you cite?

18 A. Okay. I have reviewed that.

19 Q. So in discussing the solution  
09:44 20 that the 508 patent was attempting to solve, you  
21 reference this paragraph, correct, in your  
22 declaration?

23 A. A portion of the paragraph, yes.

24 Q. Okay. And just for the record,  
09:44 25 what is an enhancement mode device?

1           A.     An enhancement mode device refers  
2     to a device that has a positive threshold voltage  
3     such that at zero volts applied to the gate  
4     source terminals there's no conduction in the  
09:44 5     drain circuit.

6           Q.     So another way to describe that  
7     is normally off; is that a fair characterization?

8           A.     Yes, it's referred to as normally  
9     off?

09:44 10          Q.     Is it also referred to nominally  
11     off?

12          A.     No, nominally off doesn't mean  
13     anything to one skilled in the art.

14          Q.     So what would be a depletion mode  
09:45 15     device?

16          A.     A depletion mode device is a  
17     device that's typically with zero volts applied  
18     to the gate source terminals. The device would  
19     be on and you'd turn it off by forcing depletion  
09:45 20     of the 2D gas with a negative -- a voltage that's  
21     more negative than zero volts. So usually the  
22     threshold of a depletion mode device is a  
23     negative number.

24          Q.     So as I understand your  
09:45 25     testimony, the threshold for an enhancement mode

1 device is a positive number to turn it on?

2 A. Could be very close to zero too.

3 Q. I just meant generally a positive  
4 number, and then the threshold to turn off a  
09:46 5 depletion mode would be a negative voltage?

6 A. The threshold.

7 Q. It could range?

8 A. So the onset of conduction would  
9 occur as you exceed a negative threshold voltage.

09:46 10 Q. That would be for a depletion  
11 mode device?

12 A. Yes.

13 Q. Turning back to the first  
14 paragraph of the 508 patent which is column 3 at  
09:46 15 lines 1 through 9, you don't dispute that the 508  
16 patent characterizes the present invention as a  
17 device having a self-aligned structure of the  
18 gate material of the doped GaN or AlGaN material?

19 A. My understanding after reading  
09:47 20 this is that's the purported invention?

21 Q. Okay. So --

22 A. Everything else seems to be  
23 acknowledged that it exists in prior art.

24 Q. What exactly did you mean by that  
09:47 25 is purported invention, just the --

1 A. The self-aligned piece.

2 Q. Sorry. I was trying to ask --

3 A. I'm sorry. I'm sorry. I'll slow  
4 down.

09:47 5 Q. Is the purported invention the  
6 question I asked or are you saying it's the  
7 paragraph at COM 3, lines 1 through 9?

8 MS. SPECHT: Objection. Form.

9 A. My recollection reviewing this  
09:47 10 patent is that all of the other elements in the  
11 claims are in the prior art. That's why I said  
12 the purported invention is the bringing in the  
13 self-aligned piece to the gate.

14 BY MR. ENGLAND:

09:48 15 Q. So when you are talking about the  
16 purported invention, you're talking about the  
17 claims, not this paragraph; is that correct?

18 A. Well, I'm also talking about the  
19 abstract, it appears in the abstract. In fact,  
09:48 20 it's, kind of, the center piece of the abstract.

21 Q. The 508 patent describes  
22 self-alignment in the following manner, and this  
23 is at column 4, lines 7 to 10?

24 A. Okay.

09:48 25 Q. I'm sorry. I'll just repeat the

1 entire question for you. The 508 patent  
2 describes self-alignment in the following manner:  
3 [As read] "In accordance with the above-described  
4 method, gate metal 17 and the p-type GaN material  
09:48 5 15 are patterned and etched using a single  
6 photomask and are thus automatically  
7 self-aligned." Did I read that correctly?

8 A. Yes, you did.

9 Q. And do you agree with the 508  
09:49 10 patent's characterization automatically  
11 self-aligned?

12 A. I think one skilled in the art  
13 would just call it self-aligned. Automatically  
14 doesn't add any color to it at all; maybe to a  
09:49 15 layperson.

16 Q. So a self-aligned structure would  
17 be the result of etching multiple layers with a  
18 single photomask. Is that correct what you're  
19 saying?

09:49 20 A. Yes, if it's in a homogenous  
21 etch, yes.

22 Q. What do you mean by homogeneous  
23 etch?

24 A. Meaning that the etch rate is  
09:49 25 uniform about the entire structure you're

1 etching. In other words, it leads to symmetry  
2 when you perform the -- no local variations in  
3 etch when you do it.

4 Q. Okay. So are you saying you go  
09:50 5 out of your way to change parameters to not  
6 result in a self-aligned structure by using a  
7 single photomask?

8 MS. SPECHT: Objection. Form.  
9 Mischaracterization.

09:50 10 A. It just means you need to ensure  
11 the etch is homogeneous, whatever etch you're  
12 using, meaning it etches the same everywhere.

13 BY MR. ENGLAND:

14 Q. So would an example be making  
09:50 15 sure that -- this is hypothetical from my  
16 understanding -- making sure that the same amount  
17 of etching is provided on, for example, both  
18 sides of the material being etched?

19 A. Probably the easiest to  
09:50 20 understand would be if you use a liquid etch, you  
21 need -- the etchant that's diluting that solution  
22 needs to be uniform throughout so people use a  
23 stir bar in the bottom of a beaker. That would  
24 be an example of making it homogeneous.

09:50 25 Q. Okay. So then self-aligned

1 structures are patterned in etch using a single  
2 photomask, right?

3 A. Yes, they are.

4 Q. If you sought to make the same  
09:51 5 structure as a self-aligned gate -- sorry.

6 Scratch that. If you sought to make the same  
7 structure between a self-aligned process, so  
8 using one photomask and using two photomasks,  
9 would the resulting structure be the same?

09:51 10 A. It could be.

11 Q. Can you please elaborate on that?

12 A. Well, the self-aligned, as the  
13 name implies, aligns two layers with respect to  
14 each other if you decide and you do it with one  
09:51 15 photomask. You can do it with two photomasks  
16 with a high-resolution lithography tool and end  
17 up with the same thing.

18 Q. I'd like parse that. First, you  
19 said two layers; do you have to self-align two  
09:52 20 layers or can you self-align two features?

21 MS. SPECHT: Objection. Form.

22 A. There's layers and features of  
23 the etched layers when you're done.

24 BY MR. ENGLAND:

09:52 25 Q. You spoke about photolithography

1 but before I touch on that topic, the 508 patent  
2 discusses both photoresist and photomasks. Can  
3 you explain the difference between the two?

4 MS. SPECHT: Objection. Foundation.

09:53 5 A. When you buy photoresist it comes  
6 in a jar, so there's a jar of photoresist. To  
7 make a mask out of photoresist you have to either  
8 spray it or spend it on the surface, cure it,  
9 prepare it for the photo process, and then it is  
09:53 10 illuminated with a mask aligner to project a  
11 pattern on that.

12 It's developed and now you have a mask  
13 that has a pattern on it which -- what did you  
14 call it again, a photomask?

09:53 15 Q. Yeah.

16 A. It becomes a photomask after that  
17 sequence of events.

18 Q. When you use the term photomask,  
19 you're talking about the pattern photoresist --  
09:53 20 by pattern, I mean the cured photoresist that has  
21 been patterned by I believe you called it the  
22 aligned?

23 A. Mask aligner.

24 Q. Mask aligner and that is then  
09:54 25 used to etch?

1           A.     It has -- it's patterned in a  
2 mask aligner. The mask aligner there's various  
3 types, but it exposes the resist in some areas  
4 and some areas are not exposed; maybe the easiest  
09:54 5 to imagine is light coming down.

6           So after that exposure, the resist has  
7 to be developed and that's put into a -- so after  
8 the exposure, it's still just a film on the  
9 semiconductor wafer and then when it's developed,  
09:54 10 the region that's exposed is removed or the  
11 region that wasn't exposed is removed, that's  
12 what's known as positive and negative  
13 photoresist, and then it's usually cured, that's  
14 to make it robust for subsequent processing, and  
09:55 15 then once it's cured, then you would call it a  
16 photomask. None of those intermediate steps are  
17 discussed, kind of, assume you know they're going  
18 on.

19           Q.     Okay. So you mentioned  
09:55 20 photolithography. Is what you just described  
21 photolithography; those process steps?

22           A.     One form.

23           Q.     Okay. One form and is there a  
24 difference between photolithography and  
09:55 25 photolithographic processes?

1           A.     I think they're often used  
2 interchangeably, I would say.

3           Q.     Okay. So from my understanding,  
4 photolithography is the process that begins that  
09:56 5 as you said spinning on or depositing the  
6 photoresist onto the layer to be etched; is that  
7 correct?

8           A.     Yes.

9           Q.     And it proceeds through  
09:56 10 patterning that photo resisting and curing that  
11 photoresist and developing that photoresist to  
12 essentially result in the what you're calling the  
13 photomask pattern or the pattern photomask?

14          A.     That's better.

09:56 15          Q.     And then that photomask remains  
16 on the layer to be etched during the etching  
17 process?

18          A.     Yes.

19          Q.     Or at least during the first  
09:56 20 etching process if you're going to etch multiple  
21 layers as described in claim 4.

22               MS. SPECHT: Objection. Form.

23           BY MR. ENGLAND:

24          Q.     Can you give me an answer?

09:56 25          A.     Give me a question on that and

1 I'll --

2 Q. Back to that, the photomask  
3 remains on the layer to be etched during the  
4 etching process, correct?

09:57 5 A. That's correct.

6 Q. And then or it could optionally  
7 be -- if you're etching more than one layer, it  
8 could remain on the top layer during both etching  
9 processes?

09:57 10 MS. SPECHT: Objection. Foundation.

11 A. Both etching processes, what do  
12 you mean by that?

13 BY MR. ENGLAND:

14 Q. If you would turn to claim 4 of  
09:57 15 the 508 patent. Right above line 35 it recites,  
16 [As read] "Etching away the gate contact layer  
17 outside the gate region" -- sorry. The next  
18 line. [As read] "Etching away the doped GaN  
19 layer and the doped InAlGaN aluminum nitride  
09:57 20 layer" --

21 THE COURT REPORTER: I'm sorry. You lost  
22 me there. Say that again.

23 BY MR. ENGLAND:

24 Q. Column 7, lines 34 to 36 and it's  
09:58 25 [As read] "Etching away the doped InAlGaN nitride

1 layer" -- column 7, lines 34 to 26 [As read]  
2 "Etching away the doped GaN layer and the doped  
3 InAlGaN nitride layer except for portions of the  
4 doped GaN layer and the doped InAl gallium  
09:58 5 nitride layer beneath the gate contact."

6 And so the photoresist could remain on  
7 top of the upper layer during both of those  
8 etching processes?

9 A. Yes.

09:59 10 Q. For future discussions when you  
11 use the term "photomask," you're talking about  
12 the -- sorry, scratch that. When you say  
13 "photomask," you're talking about the pattern  
14 photoresist that's being cured and used to etch  
09:59 15 the layer, right?

16 A. Yes. In this proceeding, yes.

17 Q. And when you say, "mask aligner,"  
18 you're saying the original pattern that is then  
19 projected on to the photomask -- sorry. How  
09:59 20 would you describe mask aligner?

21 A. A mask aligner is a tool -- if  
22 it's an optical alignment system it's a tool that  
23 has an optical source, usually carefully  
24 columnated that projects through a mask, which  
10:00 25 typically is quartz, which is pretty transparent

1 to the light, and then there's usually metal on  
2 the mask chromium is very common that actually  
3 has the pattern.

4 And then that gets projected down on the  
10:00 5 surface of the wafer and imaged on the resist  
6 surface to transfer that pattern from the mask to  
7 the semiconductor wafer.

8 Q. Returning to the problems being  
9 solved by the 508 patent, can you turn to column  
10:00 10 2, lines 5 to 6. The 508 patent describes that  
11 the two mask process in the background of the  
12 invention portion of the specification -- the two  
13 mask process leads to wider gate length than  
14 photo/etch minimum CD. What is CD?

10:01 15 MS. SPECHT: Objection. Foundation.

16 A. What comes to mind is a disk that  
17 you pop in a player to listen to music. CD must  
18 be defined somewhere here but it's not in the  
19 paragraph you reference.

10:01 20 BY MR. ENGLAND:

21 Q. Are you familiar with term,  
22 "critical dimension"?

23 A. Yes.

24 Q. And are you familiar with the  
10:01 25 statement the two-etch process needs to wider

1 gate length in the photo or etch minimum critical  
2 dimension. Would you understand what that means?

3 MS. SPECHT: Objection. Foundation.

4 BY MR. ENGLAND:

10:02 5 Q. What is a critical dimension?

6 MS. SPECHT: Objection. Form. Is the  
7 previous question withdrawn? Which question --

8 MR. ENGLAND: I'll scratch the previous  
9 question.

10:02 10 BY MR. ENGLAND:

11 Q. And what is a critical dimension?

12 A. Generally it's a dimension that's  
13 critical to the process you're trying to conduct.

14 Q. So what would be the minimum  
10:02 15 critical dimension?

16 MS. SPECHT: Objection. Foundation.

17 A. I guess I'm having a problem with  
18 the term photo/etch minimum critical dimension.

19 BY MR. ENGLAND:

10:03 20 Q. Can you explain why you have a  
21 problem with that?

22 A. I don't know what it means.

23 Q. So would it be fair to  
24 characterize that a disadvantage of two-mask  
10:03 25 process is a wider gate length?

1 MS. SPECHT: Objection. Form.

2 A. It depends on the tools you're  
3 using to do this. There are high resolution  
4 tools that would produce the same results. So it  
10:04 5 can mean that but not generally.

6 BY MR. ENGLAND:

7 Q. In the context of the 508 patent,  
8 does it mean that?

9 A. They don't discuss any  
10:04 10 lithography tools used to do any of this.

11 Q. Can you turn to paragraph 16 of  
12 your declaration?

13 A. Paragraph.

14 Q. 61?

10:04 15 A. Yes.

16 Q. Can you read into the record the  
17 last sentence of paragraph 61?

18 A. [As read] "508 patent identifies  
19 several disadvantages with the two mask process  
10:04 20 such as wider gate, high gate charge and increase  
21 manufacturing costs."

22 Q. I believe you missed a word.  
23 Length after water gate. Could you please reread  
24 the sentence?

10:04 25 A. [As read] "508 patent identifies

1 several disadvantages with the two mask process  
2 such as a wider gate length, high gate charge and  
3 increase manufacturing cost."

4 Q. So the 508 patent does discuss  
10:05 5 that wider gate length is a disadvantage of the  
6 prior art?

7 MS. SPECHT: Objection. Form.

8 A. Well, in the cited portion which  
9 I'll look at, I agree the patent says that, yes.

10:05 10 BY MR. ENGLAND:

11 Q. Earlier we were discussing the  
12 present invention at the column 3, line -- first  
13 paragraph of column 3. Do you recall that?

14 A. Yes.

10:06 15 Q. And the first paragraph of column  
16 3 which discusses a present invention further  
17 goes on to say at line 6 through 9, [As read]  
18 "Furthermore, a field plate at source potential  
19 is patterned and etched together with drain and  
10:06 20 source ohmic contact metal." Is that correct?

21 A. Yes.

22 Q. And that is in the same paragraph  
23 as the present invention that we discussed  
24 earlier?

10:06 25 A. Yes.

1 Q. Do you agree this disclosure is  
2 part of the described present invention?

3 MS. SPECHT: Objection. Foundation.  
4 Legal conclusion.

10:07 5 A. I see no mention of field plate  
6 in any claims.

7 BY MR. ENGLAND:

8 Q. Sorry. Actually, I'm not asking  
9 about the claim language right now, I'm asking  
10:07 10 about the paragraph at the beginning of column 3  
11 from lines 1 through 9 that begins with the  
12 present invention and then in line 6 says, [As  
13 read] "Furthermore field plate at source  
14 potential is patterned and etched together with  
10:07 15 drain and source ohmic contact metal."

16 Is that a portion of the present  
17 invention to your understanding?

18 MS. SPECHT: Same objections.

19 A. Not necessarily. Just because of  
10:08 20 the word furthermore it seems to be separating  
21 the first sentence of the paragraph with the  
22 last. So not necessarily is my answer.

23 BY MR. ENGLAND:

24 Q. Could you please turn to page  
10:08 25 2 -- or figure 2 of the 508 patent?

1 A. Okay.

2 Q. Is element 20 the source contact?

3 A. It's hard to see what it's  
4 pointing to but if it's pointing to the darkest  
10:08 5 metal, then yes.

6 Q. The source contact is made of  
7 ohmic metal in the 508 patent, correct?

8 A. Yes.

9 Q. Looking at this figure, you would  
10:09 10 agree the field plate is at source potential?

11 A. Yes.

12 Q. You would agree that the portion  
13 of element 20 of figure 2 extending over the gate  
14 structure is the identified in described field  
10:09 15 plate from column 3, lines 1 through 9?

16 A. I just want to check the -- would  
17 you please repeat the question.

18 Q. You would agree that portion  
19 element 20 of figure 2 extending over the gate  
10:10 20 structure is the identified and described field  
21 plate in column 3, lines 6 through 9?

22 A. The written description is  
23 consistent with this figure.

24 Q. And turning to column 4, lines 2  
10:10 25 and 3 it states [As read] "The source ohmic

1 contact metal 20 is provided over the gate and  
2 active field plate." Did I read that correctly?

3 A. Column 4, line 2 you said?

4 Q. Lines 2 to 3.

10:10 5 A. Yes.

6 Q. Column 4 is referring to figure  
7 3(e), correct -- sorry. Scratch that. In column  
8 4, lines 2 to 3 is referring to figure 3(e)?

9 A. The beginning of that paragraph  
10:11 10 refers to figure 3(e).

11 Q. Do the lines that I read into the  
12 record refer to figure 3(e)?

13 MS. SPECHT: Objection. Asked and  
14 answered.

10:11 15 A. Again, it was lines 2 to 3?

16 BY MR. ENGLAND:

17 Q. On column 4.

18 A. Yes.

19 Q. Turning to figure 3(e), do you  
10:12 20 see source contact 20?

21 A. Yes.

22 Q. And source contact 20 includes --  
23 sorry. Scratch that. Source contact 20 is the  
24 and extends over the gate as a field plate?

10:12 25 A. Yes.

1 Q. And it would be at potential of  
2 the source contact, the field plate?

3 A. Yes.

4 Q. Turning to figure 4. Do you see  
10:12 5 source contact element 20?

6 A. Yes.

7 Q. You agree this figure also  
8 includes a field gate at source potential --  
9 sorry. Scratch that. You agree this figure 4  
10:13 10 also includes a field plate at source potential?

11 MS. SPECHT: Objection. Foundation.

12 A. It's usually referred to as a  
13 source connected field plate.

14 BY MR. ENGLAND:

10:13 15 Q. But you would agree that the  
16 source connected field plate is at source  
17 potential?

18 A. Yes.

19 Q. Figure 5(e), can you please turn  
10:13 20 to figure 5(e). Here you would also agree that  
21 the source connected field plate is at source  
22 potential?

23 MS. SPECHT: Objection. Foundation.

24 A. Yes.

10:13 25 BY MR. ENGLAND:

1 Q. Then maybe to speed this up,  
2 figure 6 and 7(f) also show source connected  
3 field plate at source potential?

4 MS. SPECHT: Objection. Foundation.

10:14 5 A. 7(f) has a source connected field  
6 plate.

7 BY MR. ENGLAND:

8 Q. And figure 6?

9 A. Yes.

10:15 10 MR. ENGLAND: I know it's a little early,  
11 but I'm about to switch topics so would now be a  
12 good time to take a break for you?

13 THE WITNESS: Okay.

14 MR. ENGLAND: Okay. Let's go off the  
10:15 15 record.

16 (A break was taken from 10:15 a.m. to 10:30 a.m.)

17 BY MR. ENGLAND:

18 Q. Dr. Shealy, I'm handing you a  
19 document previously identified as Paper 1 in this  
10:30 20 proceeding. Please take a second to review the  
21 document.

22 Have you seen this document before?

23 A. Yes.

24 Q. And what is this document?

10:31 25 A. This is a petition for the IPR.

1 Q. In this proceeding?

2 A. Yes, for the 508 patent.

3 Q. If you can turn to the page

4 following page 95, it's entitled, claimed

10:31 5 appendix?

6 A. Yes.

7 Q. And this claimed appendix recites

8 claim annotations from claims 1 through 5, right?

9 A. Yes.

10:32 10 Q. And to the left of the claim

11 limitation -- sorry. Scratch that. To the left

12 of the claim language are bolded, bracketed

13 letters and numbers; is that correct?

14 A. They don't appear for claims 2

10:33 15 and 3 but the rest of them.

16 Q. Okay. Would you be okay if I

17 referred to those as claim element designations

18 or how would you prefer -- withdraw that

19 question.

10:33 20 How would you prefer to refer to those?

21 A. I often refer to an element in a

22 process as a collection of these, but if you want

23 to call them elements, I think we can keep it

24 straight as we go along.

10:34 25 Q. The intention is do these

1 designations correspond to the same designations  
2 you used in your declaration?

3 A. I've checked a few of them and  
4 they correspond.

10:34 5 Q. Okay. So it would be something  
6 that you would be able to use as a reference  
7 point when we talk about the claim designations  
8 you use in your declaration to speed up the  
9 process, but if you prefer to look at the  
10:34 10 declaration, that's fine as well.

11 A. Okay.

12 Q. Would you agree that claim one  
13 describes epitaxial growth process and a  
14 fabrication process?

10:35 15 A. Claim one describes a sequence of  
16 fabrication steps which includes several steps  
17 describing the epitaxy.

18 Q. Would the epitaxy be element 1A  
19 through 1D?

10:36 20 A. In this claim, yes, that's the  
21 epitaxy part of it.

22 Q. By referencing 1, I intended to  
23 discuss claim 1 with the claim designations as  
24 designations for claim 4 include the number 4 and  
10:36 25 claim 5 include claim 5. Do you understand?

1           A.     I believe you're saying the first  
2 number in bold refers to that claim.

3           Q.     Yes, and would you be okay with  
4 referring to it that way?

10:36 5           A.     Yes, if I get confused I'll let  
6 you know.

7           Q.     Thank you. So then elements 1E1  
8 through 1G5 and identified in the claim appendix  
9 would be the fabrication process?

10:37 10          A.     Could you repeat the which  
11 elements are you talking about?

12          Q.     Would elements 1E1 through 1G5  
13 identify the fabrication process?

14          A.     The -- I say it summarizes the  
10:38 15 fabrication process. There are many steps that  
16 don't appear as separate, but it's a summary of  
17 the fabrication process is what I would say.

18          Q.     Do elements 1E1 through 1G5  
19 recite fabrication process elements?

10:38 20          A.     Yes.

21          Q.     And what is the difference  
22 between epitaxial growth and the fabrication  
23 process?

24          A.     There are many differences. The  
10:38 25 epitaxial growth process has to precede the

1 fabrication process because the fabrication  
2 process is executed on the epitaxial materials.

3 Q. And did the epitaxial materials  
4 have the same -- withdraw that. So focussing on  
10:39 5 the epitaxial growth process and elements 1A  
6 through 1D we just discussed, how is epitaxial  
7 growth performed according to 508 patent?

8 A. On my quick review of the patent,  
9 I don't see where they mention the technique  
10:42 10 that's used to do the epitaxial. I believe that  
11 was your question.

12 Q. A person (inaudible) would  
13 understand based upon, for example, column 3,  
14 lines 26 through 35 that the epi structure  
10:42 15 includes the recited layers in that paragraph?

16 MS. SPECHT: Objection. Form.

17 A. That paragraph describes the  
18 substrate and the sequence of layers that appear  
19 on the substrate.

10:42 20 BY MR. ENGLAND:

21 Q. Okay. We can -- let's move on to  
22 the fabrication process. So in discussing the  
23 fabrication process of claim 1, would it be okay  
24 if I -- scratch that. In discussing the  
10:43 25 fabrication process of claim 1, would it be okay

1 if I divided the different claim elements into  
2 four modules, and by that I mean claim elements  
3 1E1 through 1G5 which I will describe in a  
4 second?

10:43 5 A. So you want to group those  
6 together?

7 Q. I want to -- I will be explaining  
8 a subset of those groupings together for you.  
9 Would you be okay if I clearly defined them for  
10 you?

11 A. As long as it's clear, yes.

12 Q. So for the first, what I'm going  
13 to call module, I would like to identify claim  
14 elements 1E1 through 1E5 which I -- and you have  
10:44 15 previously grouped them in your declaration as  
16 1E; is that correct. Paragraph 115?

17 A. I just want to -- they are broken  
18 down in the declaration and 1E is broken into  
19 five pieces.

10:44 20 Q. Yes. And looking at page 55 of  
21 your declaration?

22 A. Yes.

23 Q. Header F, next to it is 1E and it  
24 includes those five elements 1E1 through 1E5.

10:44 25 Would you be okay if I designated that module 1E1

1 through 1E5 as module one?

2 A. Module one, okay.

3 Q. Okay. And the second module I  
4 would like would be to designate 1F1 as its own  
10:45 5 module?

6 A. So you -- what you're saying is  
7 you want the deposition of the dielectric layer  
8 to be its own module.

9 Q. Yes, do you understand?

10:45 10 A. Yes.

11 Q. And designate module 3 as 1F2  
12 through 1F4 and that would be applying a contact  
13 photo resistant pattern etching the dielectric  
14 layer to open the drain and switch contact layer  
10:45 15 and removing the contact photo resistant pattern  
16 as module 3?

17 A. Okay.

18 Q. And module 4 will be what you  
19 designated module 1G in paragraph 135, the  
10:46 20 declaration which includes claim designations 1G1  
21 through 1G5. Do you understand?

22 A. That is module number 4.

23 Q. Yes. So you agree that the  
24 first, third and the fourth modules include an  
10:46 25 etching step?

1           A.     You have to remind me where  
2 module 1 stops.

3           Q.     Sorry. So module 1 includes an  
4 etching step and that is from elements 1E1  
10:47 5 through 1E5 -- sorry. Withdraw that. Module 1  
6 includes at least one etching step and that is  
7 module 1E1 through 1E5?

8           A.     Module 1 includes 1E3 and 1E4,  
9 which are etching steps.

10:47 10           Q.     And module 3 includes an etching  
11 step and that is elements 1F2 through 1F4?

12           A.     Yes. It's one etching step  
13 within those.

14           Q.     And module 4 claim elements 1G1  
10:47 15 through 1G5 includes an etching step as well,  
16 right?

17           A.     Yes.

18           Q.     In the context of the 508 patent  
19 these would all be photolithography processes --  
10:48 20 sorry. Withdraw that. In the context of the 508  
21 patent, these etching steps of module 1, 3 and 5  
22 would be photolithography processes?

23           A.     All right. 1E2 is in which  
24 module again?

10:48 25           Q.     Module 1.

1 MS. SPECHT: John, it might be useful,  
2 there's a pen in front of Dr. Shealy, for him to  
3 just bracket which elements correspond to which  
4 module.

10:48 5 MR. ENGLAND: That will be fine.

6 THE WITNESS: Is that all right if I --

7 BY MR. ENGLAND:

8 Q. Would you like me to repeat them?

9 A. Yeah. Why not.

10:49 10 Q. Module 1 is 1E1 through 1E5.

11 Module 2 is 1F1?

12 A. Yeah, that's by itself. Okay.

13 Q. Module 3 is 1F2 through 1F4?

14 A. It's module 3.

10:49 15 Q. Three, correct. And module 4 is  
16 1G1 through 1G5?

17 A. That was four. Is that as far as  
18 we went?

19 Q. Yes.

10:49 20 A. Okay.

21 Q. In the context of the 508 patent,  
22 the etching steps for module 1, 3 and 4 would be  
23 photolithography processes; is that correct?

24 A. In each of these modules 1, 3, 4  
10:50 25 the etching is preceded by a step applying a

1 photo resistant pattern and it's -- sometimes  
2 there's a word between or preceding photo  
3 resistant pattern to indicate what its etching.

4 Q. Focusing on module 1, module 1  
10:51 5 reflects the -- actually, withdraw that. Module  
6 1 recites the steps involved in the gate  
7 formation process; is that correct?

8 A. Please repeat the question, then  
9 I'll --

10:51 10 Q. Module 1 recites the steps  
11 involved in the gate formation process; is that  
12 correct?

13 A. Yes.

14 Q. And as we previously discussed  
10:51 15 that column 3 of the 508 patent, lines 1 through  
16 6, the 508 patent discusses that the present  
17 invention is using a single photomask to pattern  
18 and etch the doped GaN or AlGaN material and the  
19 gate metal, correct?

10:52 20 A. Yes.

21 Q. Can we turn to paragraph 57 of  
22 your declaration. You state in paragraph 57, [As  
23 read] "It is desired that the gate in p-GaN" --

24 A. Wait a minute. You said page 57  
10:52 25 I thought.

1 Q. Sorry. I said can you please  
2 turn to paragraph 57 but for your reference, it  
3 is on page 24. Are you there?

4 A. Yes.

10:53 5 Q. In paragraph 57 you state, [As  
6 read] "It is desired that the gate and p-GaN  
7 layer are self-aligned such that a cost of  
8 applying a second mask to etch the p-GaN layer or  
9 gate can be avoided."

10:53 10 Did I read that correctly?

11 A. Yes.

12 Q. What is the self-aligned  
13 structure desired such that the cost of applying  
14 a second mask can be avoided?

10:53 15 A. Because it represents a  
16 simplification of the process.

17 Q. Can you please explain what you  
18 mean by that?

19 A. Well, you saved one mask step and  
10:53 20 generally process complexity or cost scales with  
21 the number of mask steps.

22 Q. So if I understand you correctly,  
23 what you're saying is that by reducing the number  
24 of steps that you perform as in preparing a  
10:54 25 second mask or -- sorry. Withdraw that.

1           So what you're saying is that removing a  
2   second photolithography process, which is I  
3   understand the step you're saying you're  
4   avoiding, it reduces the overall cost of the  
10:54 5   manufacturing process?

6           MS. SPECHT: Objection.  
7   Mischaracterization.

8           A.     What I said was a number of  
9   masking levels. Each masking level can involve  
10:54 10   different steps, generally speaking. So the cost  
11   to the process generally scales what the number  
12   of masks that are needed to complete it on mask  
13   steps if you like.

14   BY MR. ENGLAND:

10:55 15           Q.     So generally removing a mask step  
16   or combining a mask -- two mask steps into one  
17   mask step would reduce the cost; is that what  
18   you're saying?

19           A.     In a very general sense.

10:55 20           Q.     Would that still generally be  
21   true if you had to change the conditions of the  
22   etching process between the different layers  
23   being etched?

24           MS. SPECHT: Objection. Form.

10:55 25           A.     I say generally I could agree

1 with that. There's always exceptions, but.

2 BY MR. ENGLAND:

3 Q. Let's discuss module 3 which for  
4 the record would be 1F2 through 1F4 beginning at  
10:56 5 applying a contact photo resistant pattern and  
6 concluding, etching the dielectric layer to open  
7 the drain and source contact area and removing  
8 the contact photo resistant pattern.

9 Claim element 1F3 recites, [As read]

10:56 10 "Etching the dielectric layer to open the drain  
11 and source contact area." Right?

12 A. Yes.

13 Q. And in the 508 patent that is  
14 shown in figure 3D; is that correct? If you'd  
10:57 15 like to look at the specification, you can refer  
16 to column 3, line 57 to 61?

17 MS. SPECHT: Objection. Form.

18 A. Okay. Please give me that cite  
19 for the patent again.

10:57 20 BY MR. ENGLAND:

21 Q. That is column 3, lines 57 to  
22 61 -- I'll withdraw that. Do you see column 3,  
23 lines 57 to 61?

24 A. Yes.

10:58 25 Q. And that paragraph is referring

1 to figure 3D, correct?

2 A. Yes.

3 Q. It states [As read] "A contact  
4 photomask is used to pattern and etch the  
10:58 5 dielectric material 18 followed by a photoresist  
6 strip resulting in the structure shown in figure  
7 3D." Is that correct?

8 A. Well, the words aren't correct.

9 Q. Sorry. Would you please read the  
10:58 10 corrected words then?

11 A. A contact photomask doesn't etch  
12 the dielectric material.

13 Q. Oh, I apologize. You're saying  
14 that you're understanding the patent is the  
10:58 15 patent words are incorrect?

16 A. Yes, I don't see how a contact  
17 mask can etch the dielectric material.

18 Q. Okay. I apologize. I thought  
19 you said my reading of the words were incorrect?

10:59 20 A. No, your reading is fine.  
21 Whoever wrote them didn't write them down  
22 correctly.

23 Q. Okay. Turning to figure 3D, do  
24 you see dielectric material 18?

10:59 25 A. Yes.

1 Q. And do you see a -- looking at  
2 the figure 200A, do you see a gap in the  
3 continuous layer of 3D -- sorry. Withdraw that.  
4 Looking at figure 3D, do you see a gap between  
10:59 5 the two gate structures of dielectric 18?

6 A. Well, I wouldn't characterize the  
7 dielectric 18 as part of the gate structure. It  
8 goes over the gate structure but didn't you say  
9 it was part of the gate structure?

11:00 10 Q. Sorry. I will clarify. All  
11 right. Element 18 is the dielectric layer; is  
12 that correct?

13 A. Yes.

14 Q. And figure 3D shows the result of  
11:00 15 the etching of the dielectric layer; is that  
16 correct?

17 A. Yes.

18 Q. And as you can see on the left  
19 and the farthest left and farthest right of the  
11:00 20 200A figure or element, the dielectric layer is  
21 removed. Do you see that?

22 A. Yes.

23 Q. And between the two gate  
24 structures, the dielectric layer is removed. Do  
11:01 25 you agree?

1           A.     A portion of it is between the  
2 two gate structures.

3           Q.     And that corresponds to claim  
4 element 1F3 etching the dielectric layer to open  
11:01 5 the drainage source contact area. Do you agree  
6 with that?

7           MS. SPECHT: Objection. Form. Legal  
8 conclusion.

9           A.     Well, the paragraph describing 3D  
11:02 10 only discusses etching the dielectric and  
11 stripping the resist, but after that, that's what  
12 it appears like, and I don't think that  
13 corresponds to your question.

14           Q.     So let's clarify the question.  
11:02 15 So column 3, lines 57 through 61 describe a  
16 contact photomask that is used to -- in the  
17 language of the specification at pattern and etch  
18 the dielectric material 18. And that patterning  
19 and etching process results in figure 3D; is that  
11:02 20 correct?

21           A.     Yes.

22           Q.     If you turn to figure 3E?

23           A.     Okay.

24           Q.     Are you at figure 3E?

11:03 25           A.     Yes.

1 Q. Do you see source and drain  
2 contact 19 and 20?

3 A. Yes.

4 Q. And those contacts are at least  
11:03 5 personally deposited in the areas previously  
6 removed of the dielectric layer?

7 A. They're deposited over a larger  
8 area than just those openings.

9 Q. But they are deposited in the  
11:04 10 openings as well?

11 A. Yes.

12 Q. And so, for example, looking at  
13 source contact 20, the sidewall of the dielectric  
14 18 defines at least a portion of the width of  
11:04 15 source contact 20?

16 A. The source contact area is bound  
17 by dielectrics on either side.

18 Q. And then looking at figure 3E, do  
19 you agree that a portion of the source contact is  
11:05 20 above the dielectric material?

21 A. A portion of it is.

22 Q. Do you agree that a portion of  
23 the drain contact 19 is above the dielectric  
24 material?

11:05 25 A. It's shown that way, yes.

1 Q. To arrive at the -- withdraw the  
2 question. To arrive at the structure depicted in  
3 figure E an etching process occurs to remove a  
4 portion of the source and drain contact; is that  
11:05 5 correct -- material. Sorry. Withdraw that.

6 To arrive at the structure depicted in  
7 figure 3E, an etching process occurs to remove a  
8 portion of the ohmic material?

9 A. Is there a question?

11:06 10 Q. Would you agree that to arrive at  
11 the structure depicted in Figure 3E an etching  
12 process occurs to remove a portion of the ohmic  
13 material?

14 A. Yes, in spite of the confusion  
11:06 15 language in the description.

16 Q. Okay. So let's turn to paragraph  
17 34 of your declaration and paragraph 35. So you  
18 state [As read] "I have been asked for the  
19 purposes of this declaration to apply the plain  
11:07 20 and ordinary meaning of the claim terms as they  
21 would have been understood by POSA -- I'm sorry.  
22 Let me restate that. [As read] "I have been  
23 asked for the purposes of this declaration to  
24 apply the plain and ordinary meaning of the claim  
11:07 25 terms as they have been understood by a person of

1 ordinary skill in the art at the earliest claimed  
2 priority date of the 508 patent."

3 Did I read that correctly?

4 A. Yes.

11:08 5 Q. Do you believe any construction  
6 for any terms are necessary?

7 MS. SPECHT: Objection. Calls for a  
8 legal conclusion.

9 A. I'm reading this and losing your  
11:08 10 question, so.

11 BY MR. ENGLAND:

12 Q. Question is do you believe any  
13 constructions for any claim terms are necessary?

14 MS. SPECHT: Same objection.

11:08 15 A. Well, it says I apply the plain  
16 and ordinary meaning of each claim throughout the  
17 declaration.

18 MR. ENGLAND: I'm handing you a document  
19 that has been previously labeled as Paper 2.

11:09 20 BY MR. ENGLAND:

21 Q. Have you reviewed this document  
22 or have you seen this document before?

23 A. Yes. This is the institution  
24 decision of the 508 patent.

11:09 25 Q. Have you reviewed this document?

1 A. Yes.

2 Q. Could you please turn to page 12.

3 In the second paragraph up from the bottom it

4 states, [As read] "At this stage of the

11:10 5 proceeding, based on the present record, we

6 determine that the claims require that the

7 dielectric layer steps of 1F must occur before

8 the ohmic contact steps of 1G, but that the

9 claims do not require that the gate structure be

11:10 10 performed before the source and drain contacts."

11 Do you agree with the board's statement?

12 MS. SPECHT: Objection. Vague.

13 A. I generally agree with what the

14 board has decided, yes.

11:10 15 BY MR. ENGLAND:

16 Q. What is any disagreement -- I'll

17 withdraw that question.

18 A. Okay.

19 MR. ENGLAND: I'm going to hand you

11:11 20 another document that has been previously

21 identified as Exhibit 1004.

22 BY MR. ENGLAND:

23 Q. Have you seen this document

24 before?

11:12 25 A. Yes.

1 Q. What do you understand this  
2 document to be?

3 A. This is a prior art reference we  
4 referred to as Yoshida.

11:12 5 Q. So you would be okay if we -- in  
6 discussing this we refer to this document as  
7 Yoshida?

8 A. Yes.

9 Q. And you rely upon Yoshida as a  
11:12 10 prior referencing ground one in your declaration?

11 A. Yes.

12 Q. Turn to page 2 of the Yoshida  
13 document I provided. The figure at the top of  
14 the page illustrates the cross section of the  
11:13 15 device created according to the method described  
16 in Yoshida; is that correct?

17 A. It has most of the elements of  
18 concern here, yes.

19 Q. What do you mean elements of  
11:13 20 concern?

21 A. The figure in Yoshida does not  
22 show the dielectric material which is described  
23 in the text.

24 Q. So Yoshida also describes a  
11:14 25 process to manufacture its device shown in

1 figure -- in the D figure in Yoshida; is that  
2 correct?

3 A. There is a description of some of  
4 the fabrication that's done, yes.

11:15 5 Q. And in paragraph 74 of your  
6 declaration, you describe the process of Yoshida,  
7 right?

8 A. Paragraph 74 in my declaration  
9 generally describes the process of Yoshida.

11:16 10 Q. Okay. And beginning on page 34  
11 it states, [As read] "Third, deposited dielectric  
12 layer silicon dioxide film to cover the entire  
13 surface." Did I read that correctly?

14 A. Yes.

11:16 15 Q. Then it says, [As read] "Fourth,  
16 apply a mask and etch the dielectric layer to  
17 open the source and drain contact area. Yoshida  
18 [22]" Is that correct?

19 A. Yes.

11:16 20 Q. So according to your declaration,  
21 the fourth step comes after the third step; is  
22 that correct?

23 A. Yes, you can't X the dielectric  
24 if the dielectric is not there.

11:17 25 Q. Fair characterization. Okay.

1 Then continue on page 34 it says [As read]  
2 "Fifth, deposit source and drain electrodes of  
3 exposed n-type AlGa<sub>N</sub> layer." Correct? And that  
4 cites Yoshida 1322; is that correct?

11:17 5 A. That's correct.

6 Q. And using your nomenclature,  
7 fifth would come after fourth, correct?

8 MS. SPECHT: Objection. Vague.

9 A. It's paragraph 22 that describes  
11:18 10 the source and drain electrode formation.

11 BY MR. ENGLAND:

12 Q. Yes, I understand, but I'm going  
13 by your declaration. So you're stating that  
14 fifth deposited source and drain electrodes on  
11:18 15 the exposed n-type AlGa<sub>N</sub> layer, correct?

16 A. Yes.

17 Q. And at the beginning of paragraph  
18 74 you state, [As read] "Yoshida discloses  
19 gallium nitride transistor by the following  
11:19 20 steps." Is that correct?

21 A. Yes.

22 Q. And then you list first, second,  
23 third, fourth, fifth, and finally throughout that  
24 paragraph; is that correct?

11:19 25 A. That's the organization of the

1 paragraph, yes.

2 Q. So the fifth step, deposit the  
3 source and drain electrodes on the exposed n-type  
4 AlGaIn layer comes after the fourth step, apply a  
11:19 5 mask and etch the dielectric layer to open the  
6 source and drain contact area; is that correct?

7 MS. SPECHT: Objection.  
8 Mischaracterization.

9 A. The fourth step listed is etching  
11:20 10 the dielectric layer to open up the source and  
11 drain contact area. The fifth is the metal  
12 deposition.

13 BY MR. ENGLAND:

14 Q. It says fourth is apply a mask  
11:20 15 and etch the dielectric layer dope in the source  
16 and the drain contact area; fifth is deposit the  
17 source and drain electrodes --

18 A. Yes.

19 Q. And those proceed in that order?

11:20 20 MS. SPECHT: Objection. Vague.

21 A. What Yoshida is saying is the  
22 dielectric is deposited in pattern before the  
23 ohmic's metallization. Does that answer your  
24 question?

11:21 25 BY MR. ENGLAND:

1 Q. Not exactly. So I'm going by  
2 what you're saying about Yoshida. Your own  
3 testimony is the fourth step is apply a mask and  
4 etch -- apply a mask and etch the dielectric  
11:21 5 layer to open the source and drain contact area?

6 A. Yes.

7 Q. Fifth, deposit the source and  
8 drain electrodes on the exposed n-type AlGaIn  
9 layer, correct?

11:21 10 A. Yes.

11 Q. According to your statement, do  
12 those steps need to occur in that sequence?

13 MS. SPECHT: Objection. Vague.  
14 Mischaracterization.

11:22 15 A. In Yoshida that's the sequence  
16 that's described.

17 MS. SPECHT: Can we take a break? We've  
18 been going about 55 minutes.

19 MR. ENGLAND: I have a few questions about  
11:22 20 the paragraph and then we can take a break. Does  
21 that work?

22 MS. SPECHT: Dr. Shealy's call.

23 THE WITNESS: Okay.

24 BY MR. ENGLAND:

11:22 25 Q. Okay. And then the final

1 sentence says, [As read] "Finally, remove the  
2 mask and form the gate contact above the p-GaN  
3 layer to produce an enhancement mode transistor."  
4 Citing Yoshida paragraph 23; is that correct?

11:22 5 A. It says they remove the mask,  
6 that's consistent with the disclosure of Yoshida.

7 Q. So according to paragraph 74,  
8 which begins with Yoshida discloses forming the  
9 GaN transistor by the following steps, the  
11:23 10 declaration says [As read] "Finally, remove the  
11 mask and form the gate contact above the p-GaN  
12 layer to produce an enhancement mode GaN  
13 transistor."

14 By the use of finally, did you mean that  
11:23 15 was the last step?

16 MS. SPECHT: Objection. Vague.

17 A. If you look at the disclosure in  
18 Yoshida, the last mention in paragraph 23 of the  
19 fabrication of the device is a place in the gate  
11:24 20 electrode.

21 MR. ENGLAND: Would now be a good time  
22 for a break, Dr. Shealy?

23 THE WITNESS: Okay.

24 (A break was taken from 11:24 a.m. to 12:30 p.m.)

12:30 25 BY MR. ENGLAND:

1 Q. Dr. Shealy, I'm about to hand you  
2 a document previously identified as Exhibit 1005.  
3 Please take a look at the document. Are you  
4 finished looking at it?

12:32 5 A. I briefly looked it over.

6 Q. Have you seen this document  
7 before?

8 A. Yes.

9 Q. What do you know this document to  
12:32 10 be?

11 A. Prior art reference of Beach.

12 Q. When referring to international  
13 publication WO 2005/057 624 you would be okay if  
14 I just called it H?

12:32 15 A. Yes.

16 Q. So Beach describes that 3-N  
17 semiconductor device; is that correct?

18 A. A what semiconductor device?

19 Q. Three nitride?

12:32 20 A. Okay. Yes.

21 Q. And Beach just has a depletion  
22 mode device, right?

23 A. My recollection is that's not  
24 clear. There's a site somewhere where he uses

12:33 25 the terminology nominally on. I don't know what

1       that means. That's not a technical term.

2                   Q.     I believe you're referring to  
3       paragraph 4 of Beach. My apologies. I don't  
4       have a line number, but it looks to be  
12:33 5       approximately nine lines up from the bottom of  
6       paragraph 4. Is that what you're referring to by  
7       nominally on?

8                   A.     Nominally on but then he says or  
9       depletion mode, so.

12:34 10                  Q.     This is in the description  
11       related at section of speech, correct.

12                  A.     Yes. That was another site. I  
13       don't see it.

14                  Q.     Skipping along, were you  
12:35 15       referring to paragraph 39 of Beach?

16                  A.     No, that's not what I recall but.

17                  Q.     Does Beach disclose that it's an  
18       enhancement mode device?

19                  A.     He does not use that terminology  
12:36 20       that I recall.

21                  Q.     In paragraph 78 of your  
22       declaration you describe the process of forming  
23       the device of Beach; is that right?

24                  A.     Yes, that pertains to Beach.

12:37 25                  Q.     And it states second -- sorry.

1 78 says, states [As read] "Beach discloses  
2 forming the self-aligned gate and built GaN layer  
3 by the following steps." Is that correct?

4 A. Yes.

12:37 5 Q. And then Beach identifies first  
6 grow doped gallium nitride later 16 over layers  
7 10 and 12; is that correct?

8 A. That's what it says.

9 Q. So turning to page 37 of your  
12:37 10 declaration, and figure 1B -- actually withdraw  
11 that first, but I have a question.

12 Dr. Shealy, you're looking at the  
13 document in the binder currently while we're  
14 discussing Beach; is that correct?

12:38 15 A. Yes.

16 Q. And that document is the  
17 annotated and color version of Beach?

18 A. It's in color, yes.

19 Q. So you will be fine if I use  
12:38 20 references or color references to describe the  
21 materials that are colored?

22 A. Yes.

23 Q. So turning to figure 1B. Figure  
24 1B shows a picture of the device that does agree  
12:38 25 with your description that you -- that we just

1 discussed that said, [As read] "First, grow doped  
2 GaN 16 over layers 10 and 12, right?

3 A. Yes.

4 Q. Then it says, second, deposit  
12:39 5 ohmic material over -- sorry. Withdrawn.

6 Paragraph 74 of your declaration next says, [As  
7 read] "Second, deposit ohmic material 18 over  
8 doped GaN layer 16." Is that correct?

9 A. That's what it say.

12:39 10 Q. And figure 1D shows ohmic  
11 material 18 over 16?

12 A. 18 is over 16. Yes.

13 Q. And 18 is the pink layer that's  
14 shown in figure 1D; is that correct?

12:39 15 A. Yes.

16 Q. And the purple layer of figure 1D  
17 is 16; is that correct?

18 A. 16 is dope GaN layer.

19 Q. 16 is the layer you identified as  
12:40 20 the dope GaN layer in paragraph 78 of your  
21 declaration?

22 A. Yes.

23 Q. So yes, 16 is in purple in figure  
24 1D, correct?

12:40 25 A. Yes.

1 Q. And as shown in figure 1D, doped  
2 GaN layer 16 is above gate insulator layer 12; is  
3 that correct?

4 A. Yes.

12:40 5 Q. And Beach describes layer 12 can  
6 be formed of aluminum gallium nitride?

7 A. Which layer?

8 Q. Layer 12?

9 A. I have to look at Beach. Figure  
12:41 10 1A of 12 is an insulator, and I believe it's the  
11 same here.

12 Q. If you look at paragraph 41 of  
13 Beach, it states [As read] "Typically, layer 12  
14 is formed of aluminum gallium nitride." Did I  
12:42 15 read that correctly?

16 A. Layer 12 is a gate insulator, as  
17 I said, and it's also described as typically it  
18 can be formed with aluminum gallium nitride.

19 Q. Going back to layer 18, we were  
12:42 20 previously discussing Beach describes that the  
21 ohmic material 18, the pink layer, can be made of  
22 aluminum; is that correct?

23 A. If I recall I don't see the cite  
24 in Beach, but paragraph 47. I don't see it as I  
12:43 25 sit here but it is an ohmic material. Do you

1 want to --

2 Q. Would you -- maybe paragraph 45  
3 of Beach might refresh your recollection?

4 A. Yes. Aluminum is an example of  
12:44 5 the ohmic metal.

6 Q. That would be -- withdrawn. And  
7 that example of aluminum would be the ohmic  
8 material that is the pink layer 18 of figure 1D?

9 A. 18 is a metal layer.

12:44 10 Q. So turning to figure 1E, in this  
11 Beach describes doped GaN layer 16 as an n-type  
12 doped GaN layer; is that correct?

13 A. That's what I recall he describes  
14 it as when discussing this figure, yes.

12:45 15 Q. Turning to paragraph 46 of Beach,  
16 Beach teaches that -- sorry. I'll let you get to  
17 it. Are you there?

18 A. Yes.

19 Q. Beach teaches that the protective  
12:45 20 layer 16 counters the out diffusion process that  
21 would take place during the annealing step and  
22 protects damage from surfaces of layers 10 and  
23 12, right?

24 A. That's what it says.

12:45 25 Q. So Beach describes a process

1 where the gate and ohmic contact are formed in  
2 the same process step; is that correct?

3 A. That's not the way it's used in  
4 the combination of references to conclude  
12:46 5 obviousness. The gate part of the process is  
6 used and the gate formation, the ohmic part is  
7 used separately in the ohmic formation, that's  
8 the way it's used in the combination.

9 Q. But right now I'm talking about  
12:47 10 the Beach reference in and of itself?

11 A. I know. I just clarified how  
12 it's used.

13 Q. I'm not asking about the  
14 combination; I'm asking what Beach teaches?

12:47 15 A. He teaches a way to make a gate  
16 and a way to make an ohmic, and there's no reason  
17 why those two processes can't be conducted  
18 independently of each other.

19 Q. Beach server processes at first  
12:48 20 involves opening a contact window 11 as shown in  
21 figure 1B; is that right?

22 A. Yes, in figure 1B, Beach shows an  
23 opening through the insulator layer 12 and they  
24 call that an ohmic contact window.

12:49 25 Q. And how is that window opened?

1 MS. SPECHT: Objection. Foundation.

2 A. Presumably with a  
3 photolithographic step. I'm sure it's probably  
4 described.

12:49 5 BY MR. ENGLAND:

6 Q. And then after -- according to  
7 Beach, after the opening -- sorry. Withdraw that.  
8 According to Beach, after the opening is formed,  
9 ohmic material 18 is deposited into the opening;  
10 is that correct?

11 A. That's correct.

12 Q. Then to form the ohmic contact of  
13 Beach, Beach describes forming a photoresist 13  
14 over the ohmic material and then etching the  
15 ohmic material except in portions protected by  
16 the photoresist, right?

17 A. I believe that's what he  
18 describes.

19 Q. And the result of that step is  
12:50 20 depicted in figure 1E; is that correct?

21 A. The ohmic part of the step is on  
22 the right-hand side of figure 1E.

23 Q. And as can be seen in figure 1E,  
24 ohmic contact 17 extends above and beyond the  
12:51 25 ohmic window; is that correct?

1           A.     It's shown it extends a little  
2 bit beyond the ohmic window.

3           Q.     In paragraph 77 and 78 of your  
4 declaration, you assert that Beach describes a  
12:51 5 self-aligned gate structure; is that right?

6           A.     That's exactly what he describes.

7           Q.     And then comparing figure 1E with  
8 respect to the self-aligned gate structure --  
9 withdraw that. Looking to figure 1E, on the left  
12:52 10 gate contact 15 reflects the self-aligned gate  
11 structure; is that right?

12          A.     Yes. I'm just going to look at  
13 the colored version. Yes. On the left side that  
14 represents Beach's self-aligned gate process.

12:52 15          Q.     And on your annotated figure 1E,  
16 on page 30 in your declaration, you indicate that  
17 the gate structure is a self-aligned gate and  
18 doped GaN?

19          A.     Yes. Gate metal.

12:52 20          Q.     Sorry. I was just reading from  
21 the figure, the blue text.

22          A.     Okay.

23          Q.     And on the right of figure 1E  
24 it's the ohmic contact and that structure does  
12:53 25 not have vertically extending walls only; is that

1 correct?

2 A. Which structure are you referring  
3 to?

4 Q. And on the right of figure 1E the  
12:53 5 ohmic contact structure does not have vertically  
6 extending walls only; is that correct?

7 MS. SPECHT: Objection. Form.

8 A. I see vertically extending walls  
9 on it so, I wouldn't agree with what you said.

12:53 10 BY MR. ENGLAND:

11 Q. Do you agree that figure 1E has  
12 ohmic contact 17 depicted as a T shape?

13 A. The metal extends beyond the  
14 window as we earlier described. I don't know if  
12:54 15 I would call it a T shape.

16 MR. ENGLAND: I'm handing you a document  
17 that's been previously labeled as 1006 to this  
18 proceeding. Please review this document.

19 BY MR. ENGLAND:

12:56 20 Q. Do you know what this document  
21 is?

22 A. Yes.

23 Q. Have you seen this document  
24 before?

12:56 25 A. Yes.

1 Q. What is the document?

2 A. Prior art reference of Sheppard.

3 Q. That reference is U.S. patent

4 7,238,560; is that right?

12:56 5 A. Yes.

6 Q. And you and your staff refer to  
7 this patent at Sheppard, right?

8 A. Yes.

9 Q. You rely upon Sheppard in all  
12:56 10 three grounds in your declaration as part of the  
11 prior art, correct?

12 A. That's my recollection but I'll  
13 check. Yes.

14 Q. In ground one, you rely upon  
12:57 15 Sheppard as teaching transition layers or a  
16 series of transition layers; is that correct?

17 A. More than one transition layer.

18 Q. And you rely upon that same  
19 teaching for grounds 2 and 3; is that right?

12:58 20 A. Yeah, that same multiple  
21 transition layer is in those other grounds.

22 Q. Okay. And Sheppard describes  
23 forming the gate contact later or gate contact  
24 after it describes forming the ohmic contact; is  
12:58 25 that right?

1           A.     I don't recall. You want to  
2 point me to...

3           Q.     Looking at figure -- we'll start  
4 with the figures to see that's fine. Looking at  
12:58 5 figure 1C of Sheppard. On the right and left of  
6 the figure, do you see ohmic contact 30?

7           A.     Yes.

8           Q.     And in figure 1C, do you see a  
9 gate contact?

12:58 10          A.     No.

11          Q.     And turning to specification at 9  
12 to 12 to 25?

13          A.     Which.

14          Q.     Sorry. Still on Sheppard. I  
12:59 15 apologize. Turning to the specification at  
16 column 9, lines 12 to 25, does that paragraph  
17 describe figure 1C?

18          A.     That paragraph refers to figure  
19 1C.

12:59 20          Q.     And that paragraph discusses  
21 ohmic metal being patterned to provide the ohmic  
22 contact 30?

23          A.     Yes.

24          Q.     Then proceeding to figure 1F, do  
01:00 25 you see ohmic contact 30 in -- withdraw that. Do

1 you see ohmic contact 30 on the left and on the  
2 right of figure 1F?

3 A. Yes.

4 Q. And do you see gate contact 32?

01:00 5 A. Yes.

6 Q. Gate contact 32 is not in figure  
7 1C, right?

8 A. No.

9 Q. If you turn to column 10, lines  
01:01 10 46 to 60, the first sentence, does it describe  
11 forming the gate contact in the recess?

12 A. Yes.

13 Q. So is the gate contact formed  
14 after the ohmic contact in Sheppard?

01:01 15 A. It is but my opinion throughout  
16 this is that the gate contact can be formed  
17 before or after the ohmic contact, that's my  
18 opinion.

19 Q. Can I parse that? So in  
01:01 20 Sheppard, the gate contact is formed after the  
21 ohmic contact, right?

22 A. In this particular embodiment it  
23 is.

24 Q. But your opinion is that the gate  
01:02 25 -- according to the claims, the gate contact can

1 be made at any time with respect to the ohmic  
2 contact. Sorry.

3 MS. SPECHT: Objection,  
4 mischaracterization.

01:02 5 MR. ENGLAND: I'll withdraw that. I'll  
6 withdraw that question.

7 BY MR. ENGLAND:

8 Q. I'm going to hand you a document  
9 that's been previously labeled 1007 in this  
01:02 10 proceeding. Please take a second to review that  
11 document. Have you had a chance to review it?

12 A. Yes.

13 Q. Do you know what the document is?

14 A. This is a prior art reference  
01:03 15 Hikita which we refer to as Hikita 347 because  
16 there's more than one Hikita reference in the  
17 prior art.

18 Q. This is U.S. patent application  
19 publication 2006/0273347 which you identify as  
01:03 20 Hikita 347; is that right?

21 A. Yes.

22 Q. Hikita describes forming its gate  
23 contact after forming its source of drain  
24 contact; is that right? Actually withdraw that.  
01:04 25 Hikita describes forming its gate electrode after

1 forming its source and drain electrodes; is that  
2 right?

3 A. It forms part of the gate  
4 structure before the ohmic contact and part of it  
01:04 5 after the ohmic contact.

6 Q. Okay. I understand. So what  
7 part of the gate structure does it form after the  
8 ohmic contact?

9 A. The gate metallization.

01:04 10 Q. So the gate metal portion of the  
11 gate structure is formed after the ohmic contact?

12 A. The metal part of it.

13 Q. Hikita describes depositing a  
14 silicon nitride film over the etched PM material;  
01:05 15 is that right? Actually, I'll withdraw that  
16 question. If I use the term p-GaN, do you  
17 understand it to mean a GaN layer with exceptor  
18 type dopants?

19 A. Yes.

01:05 20 Q. So Hikita describes depositing a  
21 silicon nitride film over the etched p-GaN  
22 material; is that correct?

23 A. Figure 8D is when the silicon  
24 nitride is deposited and it goes over the entire  
01:06 25 surface.

1 Q. And when you reference 8D, you  
2 mean element 40A is the silicon nitride?

3 A. Yes.

01:06

4 Q. Then Hikita describes forming  
5 openings in the silicon nitride; is that right?

6 A. Yes.

7 Q. And that obviously has to occur  
8 after the silicon nitride is deposited, right?

01:07

9 A. Yes, which brings up another  
10 point about my opinions; the what I call process  
11 elements; gate, dielectric, and ohmics, they can  
12 occur in any order, okay. So the elements  
13 within -- I'm sorry. Elements within the  
14 elements -- the component of each process what  
15 I'm calling a process element, those generally  
16 follow the order which underscores the point you  
17 made, you can't etch a silicon nitride film  
18 unless it's there, so there's an implied order.

01:07

19 Q. Okay. I'm going to move to  
20 strike that. I'm asking about Hikita, not your  
21 opinion about how the order of the claims?

01:08

22 MS. SPECHT: We oppose your motion to  
23 strike. Obviously the expert is entitled to  
24 answer the question in the way he best sees fit.  
25 You can continue.

01:08

1           A.     I was just commenting on the  
2 order within each of those process elements, but  
3 you can move the process elements around just as  
4 a board.

01:08 5     BY MR. ENGLAND:

6           Q.     But Hikita does describe opening  
7 a hole in the dielectric; is that right?

8           A.     To place the ohmics, yes.

9           Q.     And how does Hikita describe  
01:08 10 opening the -- how does Hikita describe forming  
11 the openings in the silicon nitride film?

12           MS. SPECHT: Objection. Foundation.

13           A.     Well, if you look at paragraph 60  
14 in this reference he just says that opening to  
01:09 15 form the silicon nitride film, for example, by  
16 ICP, dry etching or the like.

17     BY MR. ENGLAND:

18           Q.     And ICP dry etching is a method  
19 to form openings in the silicon nitride film; is  
01:09 20 that right?

21           A.     It's one method and it's one  
22 method to etch openings in a silicon nitride film  
23 and there are other methods that fit within the  
24 description of ICP etching, that's the most  
01:09 25 common way to etch GaN, different chemistry, so

1 the technique is used for a lot of things.

2 Q. Is ICP dry etching a  
3 photolithography process?

4 A. Doesn't have to be.

01:10 5 Q. So some form -- are you saying  
6 some forms of ICP dry etching are  
7 photolithography and some forms are not?

8 A. ICP is an etching technique. You  
9 can etch into a variety of materials without  
01:10 10 etching a pattern into it.

11 Q. Okay. So as I -- please correct  
12 me if I'm wrong. So ICP is an etching process,  
13 but it doesn't necessarily describe what the  
14 patterning process is; is that right?

01:10 15 A. The patterning is a separate  
16 operation in this fabrication. There's  
17 patterning, then there's etching; two different  
18 operations.

19 Q. So your opinion is that Hikita  
01:10 20 347 describe the patterning to form the openings?

21 MS. SPECHT: Objection.  
22 Mischaracterization.

23 A. He gives you the technique that's  
24 used and I think he just assumes that it's so  
01:11 25 routine that one wouldn't need the disclosure

1 again. It appears elsewhere in the reference so  
2 its obvious.

3 BY MR. ENGLAND:

01:11 4 Q. It's obvious that there's a  
5 patterning step associated with opening the  
6 dielectric holes; is that what you're saying?

7 A. Yes.

01:11 8 Q. Hikita then as shown in figure 8E  
9 forms the source and drain electrodes in the  
10 openings; is that right?

11 A. First, the openings then the  
12 metal deposition and then the patterning of the  
13 metal.

01:12 14 Q. So to clarify, you're saying that  
15 figure E represents that there's a patterning  
16 step of the source and drain electrodes?

17 A. Yes, when it's deposited, it's  
18 going to cover the entire surface, so it has to  
19 be masked and etched.

01:12 20 Q. Hikita -- does Hikita disclose a  
21 masking or etching process to form or to pattern  
22 the source and drain electrodes?

01:12 23 A. Not in the section of the  
24 specification that refers to that figure. There  
25 may be other cites to it, I haven't looked.

1 Q. But looking at figure 8E, Hikita  
2 347 shows source and drain on the electrodes with  
3 vertical sidewalls exclusively?

4 MS. SPECHT: Objection. Form. There's  
01:13 5 no question there.

6 BY MR. ENGLAND:

7 Q. Looking at figure 8E, Hikita  
8 shows exclusively vertical sidewalls of the  
9 source and drain electrode; is that right?

01:13 10 A. In the schematic diagram, yes.

11 Q. Hikita 347's gate electrode is  
12 made of palladium, right?

13 A. In the discussion of figure 8,  
14 palladium is identified as the gate electrode.

01:14 15 Q. And I forgot to cover it but the  
16 source and drain electrodes that we were just  
17 discussing are made of a titanium layer and an  
18 aluminum layer; is that right?

19 A. Yes, that's a very common ohmic  
01:14 20 metallization.

21 MR. ENGLAND: I'm going to hand you a  
22 document previously labeled as Exhibit 1008 in  
23 this proceeding. Please take a second to look at  
24 the document?

01:15 25 A. Okay.

1 Q. Have you seen this document  
2 before?

3 A. Yes.

4 Q. What is this document?

01:15 5 A. This is a prior art reference  
6 that is identified in the declaration as Hikita  
7 023.

8 Q. By that you mean U.S. Patent  
9 Application Publication 2008/0,079,023?

01:15 10 A. Yes.

11 Q. And you rely upon this prior art  
12 reference in ground five -- sorry. I apologize.  
13 And you rely -- withdraw that. And you rely upon  
14 this prior art reference in ground 3 of your  
01:15 15 declaration contesting the obviousness of claim  
16 5; is that correct?

17 A. Yes.

18 Q. Are you familiar with JFETs?

19 A. Yes.

01:16 20 Q. What are JFETs?

21 A. It stands for Junction Field  
22 Effect Transistor. The gate electrode is a PN  
23 junction.

24 Q. Are JFETs depletional devices?

01:16 25 A. They can be either depletion or

1 enhancement mode devices.

2 Q. How would you make one a  
3 depletion mode device?

01:16 4 A. In the context of this case, I  
5 mean, are you talking about HEMTs or there are  
6 many form of JFETs.

7 Q. Thanks for the clarification. In  
8 the context of H-E-M-Ts or sorry, is H-E-M-T or  
9 HEMT better?

01:16 10 A. Whichever you prefer.

11 Q. In the content of gallium nitride  
12 HEMTs, how would you make a JFET depletion mode?

13 A. Whether it's depletion or it has  
14 to do with the dimension of the gate, the spacing  
01:17 15 of the gate with the 2D gas that will determine  
16 whether it behaves as enhancement or depletion  
17 mode, that's the primary. There's other  
18 considerations but that's the primary one.

19 Q. Thank you. Hikita 023 describes  
01:17 20 a gate loss process, right? I'll withdraw that.  
21 Hikita 023 describes forming the gate after  
22 forming the ohmic material; is that right?

23 A. I would have to review this. I  
24 don't recall. My recollection is part of the  
01:18 25 gate is done before the ohmics and part of the

1 gate is done after the chmics, that's my  
2 recollection.

3 Q. Hikita 023 -- Hikita 023  
4 describes forming the gate metal electrode after  
01:18 5 forming the source and drain electrodes; is that  
6 correct?

7 A. That's my recollection; it  
8 followed the same sequence as the other Hikita.

9 Q. I apologize for my unclearness in  
01:19 10 the first question. Does Hikita 023 describe  
11 forming the source and gate electrode through a  
12 lift-off method?

13 A. I don't recall. It may have been  
14 mentioned but --

01:19 15 Q. And maybe turning to paragraph 79  
16 of Hikita might help explain your opinion?

17 A. Lift-off is cited as an example.  
18 It's one way to do it.

19 Q. Is that the end of your response?  
01:20 20 I didn't want to cut you off.

21 MS. SPECHT: If it's not the end of your  
22 response, be sure you finish.

23 A. I'm just stating that, for  
24 example, by a lift-off method, there are other  
01:20 25 methods.

1 BY MR. ENGLAND:

2 Q. Similar to Hikita 347, in Hikita  
3 023 the source and drain electrodes are made of a  
4 titanium layer and an aluminum layer; is that  
01:20 5 right?

6 A. I don't know why they change but  
7 you might as well give me the --

8 Q. Paragraph 79 of Hikita 023?

9 A. Ti-aluminum, yes.

01:21 10 Q. And the gate electrode of Hikita  
11 023 is made of palladium also; is that correct?

12 A. Yes.

13 MR. ENGLAND: I think that concludes  
14 Hikita 023, so this would probably be a good time  
01:21 15 to take a break. Is that okay with you, Dr.  
16 Shealy?

17 THE WITNESS: Yes.

18 MR. ENGLAND: We can go off the record.

19 (A break was taken from 1:21 p.m. to 1:37 p.m.)

01:37 20 MR. ENGLAND: We pass the witness.

21 MS. SPECHT: Let's go back off the record  
22 and take a break.

23 (A break was taken from 1:38 p.m. to 1:58 p.m.)

24 EXAMINATION BY COUNSEL FOR INNOSCIENCE

01:58 25 BY MS. SPECHT:

1 Q. Dr. Shealy, I'm going to start  
2 with a document patent owner's counsel asked you  
3 about and it's paper 11, it's the institution  
4 decision. And let's turn to page 12 which is  
01:59 5 what patent owner's counsel asked you questions  
6 on. It's the third full paragraph down I believe  
7 is what they asked you about. Do you remember  
8 that?

9 A. Yes.

01:59 10 Q. The board's construction, right?

11 A. Uh-huh.

12 Q. And in response, you testified  
13 that you generally agreed with the board's  
14 construction. Do you remember that?

01:59 15 A. Yes.

16 Q. What did you mean by your  
17 statement that you generally agreed with the  
18 board's construction?

19 A. I agreed that the block of steps  
02:00 20 that corresponded the gate formation could occur  
21 before or after -- could occur in any order  
22 relative to the ohmic contacts. So that was one  
23 position the board took. And then the other  
24 position they took had to do with the dielectric  
02:00 25 preceding the ohmic contacts.

1 Now that, I think one skilled in the art  
2 would know that that is not a hard requirement;  
3 it can be done either way.

4 So but those are the two pieces of the  
02:00 5 board decision that regarding the process order.

6 Q. And is that the same process  
7 order you were referring to later in your  
8 testimony when patent owner's counsel was  
9 questioning you when you said that your opinion  
02:01 10 throughout is that the gate contact can be  
11 performed before of after the ohmic contact?

12 MR. ENGLAND: Objection leading.

13 A. That is my opinion, as I've  
14 earlier stated, that the gate formation step can  
02:01 15 occur before or after the ohmic step.

16 BY MS. SPECHT:

17 Q. So is it your opinion that the  
18 prior art and the combinations you propose teach  
19 various orderings of gate and ohmic formation?

02:01 20 A. Yes.

21 Q. So let's start with the Hikita  
22 347 reference.

23 MR. ENGLAND: Objection. Beyond the  
24 scope of cross.

02:01 25 BY MS. SPECHT:

1 Q. Can you explain -- let me start  
2 again. Let's start with Hikita 347. Can you  
3 explain how the combination in your declaration,  
4 Hikita 347, Sheppard and Beach teaches the  
02:01 5 various orderings of the process elements  
6 consistent with the opinion you just testified  
7 to?

8 MR. ENGLAND: Objection. Beyond the  
9 scope of cross.

02:02 10 A. Yes, I can. So the Hikita  
11 references, as I said earlier, places part of the  
12 gate structure before the ohmics and part after.  
13 So it's not a gate first or gate last process,  
14 it's some sort of hybrid in between.

02:02 15 BY MS. SPECHT:

16 Q. Dr. Shealy, I know you're  
17 preparing to answer my question, but are you  
18 preparing to make a drawing?

19 A. I would like to make a drawing of  
02:02 20 how you can reorder these process steps and still  
21 work -- still end up --

22 MR. ENGLAND: Objection.

23 A. -- with a functional device.

24 MR. ENGLAND: Objection. Beyond the  
02:02 25 scope of cross.

1 MS. SPECHT: Please proceed.

2 A. Okay --

3 MR. ENGLAND: Same objection.

4 A. Okay. The process elements are  
02:03 5 epitaxy, the first one; the second one is the --  
6 we have gate, dielectric and ohmic. So these are  
7 the four principle elements of the process.

8 Elements 2, 3 and 4, the gate, the dielectric and  
9 the ohmic are performed on the epitaxy. So the  
02:03 10 epitaxy has to come first; it cannot be  
11 reordered.

12 Now when a pacer (ph) looks at these  
13 three blocks of process steps, they would find  
14 certain advantages and motivations to try  
02:04 15 different process orders. So let's start with  
16 the ohmic process precedes the gate, so I'll  
17 indicate that with an O. O comes first, then the  
18 gate.

19 This has an advantage in that the gate  
02:04 20 electrode does not see -- if you allow me to use  
21 that -- does not see the ohmic anneal because the  
22 ohmic anneal occurred before the gate was formed.  
23 These gates on these devices are either a Shockey  
24 or an ohmic contact.

02:05 25 If the ohmic anneal is generally

1 optimized for achieving ohmic contacts on the  
2 source and drain, you cannot simultaneously  
3 optimize an anneal for the gate and the source  
4 and drain.

02:05 5 So you potentially are compromising the  
6 quality of the gate contact if you choose an  
7 order that doesn't begin with O and G is later in  
8 the process.

9 So that's one possibility. And then there  
02:05 10 are the -- I'll just point out the D followed by  
11 O, this is dielectric preceding the ohmic, this  
12 is what the board decision said; that the  
13 dielectric needs to precede the ohmics.

14 I don't believe that's the case, and I'll  
02:06 15 illustrate that in a minute. And then finally if  
16 D is first, this has a distinct advantage of  
17 protecting the gate surface during subsequent  
18 processing. So you've encapsulated the gate  
19 region to avoid contamination during subsequent  
02:06 20 process steps.

21 Okay. So I'd like to illustrate three  
22 different process orders. D, O, G, these are  
23 the -- this stands for dielectric occurring  
24 first, ohmic second, gate last. Okay. Then  
02:07 25 another process order you could think about is

1 reversing -- so this -- you could see from what  
2 I've written above, this particular sequence will  
3 meet the board's decision because O follows D. O  
4 follows D.

02:07 5 Then if you wanted to -- you could also  
6 reverse the position of -- you could do a gate  
7 first and G, D, O sequence. Gate followed by  
8 dielectric followed by ohmic. This also follows  
9 the board's construction because O follows D.

02:08 10 Okay. And then the last one would be  
11 maybe an O, G, D and the O, G, D, this is just an  
12 illustration that you can build a functional  
13 device with the dielectric following both the  
14 ohmic and gate steps. Okay.

02:08 15 Now before I make the drawings, I wanted  
16 to comment on the dielectric first approach. The  
17 dielectric first approach is the approach that  
18 was taken in my lab from 1995 to 2005 when we  
19 built HEMT devices at Cornell. We built the  
02:08 20 first operational HEMT on silicon which is kind  
21 of the backbone of this whole power converter  
22 industry that's emerged from that. We were the  
23 first to do it.

02:09 24 We were the first to build an insulating  
25 gate device on a HEMT structure in gallium

1 nitride.

2 We developed what's called the Cornell  
3 nucleation process, there's two nucleation  
4 processes used for gallium nitride materials  
02:09 5 around the world; one came from Cornell, my lab;  
6 one came from Nakamura who is a little bit better  
7 known than I am. He came from Nichia in Japan.

8 Lastly, so that technique was used to  
9 produce all these materials and with the  
02:09 10 dielectric first, we built this result about 20  
11 years ago, ten gigahertz high power microwave  
12 transistors whose performance metrics had yet to  
13 been -- 20 years later nobody's matched the  
14 performance of those devices in both power added  
02:10 15 efficiency, gain and output power density. We've  
16 established benchmark for all three of those and  
17 they haven't been matched.

18 So those three results on devices, kind  
19 of, speak to the effectiveness of bringing the  
02:10 20 dielectric first because that's where the  
21 majority of my experience is and we were the  
22 first to do many of these things.

23 Q. So, Dr. Shealy, if I can ask  
24 another question --

02:10 25 MR. ENGLAND: Objection. I'm going to

1 move to strike as beyond the scope of cross, your  
2 declaration and the questions.

3 MS. SPECHT: I'm sorry. You're moving to  
4 strike his declaration.

02:10 5 MR. ENGLAND: No. Objection. Calls for  
6 narrative. I'm going to move to strike the  
7 answer to the extent it's beyond the scope of  
8 cross, his declaration and the question.

9 MS. SPECHT: He's -- I'm going to ask my  
02:11 10 next question. This is certainly within the  
11 scope of cross because you asked him questions  
12 about the board's construction --

13 MR. DAVIS: It was a completely improper  
14 answer. He went on for 10 minutes, come on.

02:11 15 MR. LAVENUE: We're double teaming?  
16 We're not double teaming here please, Wally.

17 MS. SPECHT: Mr. Davis --

18 MR. LAVENUE: One attorney versus one  
19 attorney. If we're going to do two attorneys  
02:11 20 versus two attorneys, then we can do that. But  
21 let's not do that for now. Let's keep it one  
22 attorney to one attorney, please. That's the  
23 appropriate manner for a deposition. You know  
24 that.

02:11 25 MR. DAVIS: Relax. Relax.

1 MR. LAVENUE: Let's keep it that way.  
2 MR. DAVIS: Relax.  
3 MS. SPECHT: Let's follow the rules.  
4 MR. LAVENUE: Let's follow the rules.  
02:11 5 MR. DAVIS: You guys have done the same  
6 thing --  
7 MR. LAVENUE: No we have not. We have not  
8 two on two.  
9 MS. SPECHT: Today? Today we've done  
02:11 10 that?  
11 MR. DAVIS: Not today, in general.  
12 MR. LAVENUE: Okay. This is a deposition  
13 in the PTO. Let's keep it appropriate, please.  
14 MR. DAVIS: Can we go off the record a  
02:11 15 second.  
16 MS. SPECHT: We would prefer to stay on  
17 the record.  
18 MR. LAVENUE: No, we're not going off the  
19 record. Until we all say we go off the record.  
02:11 20 We're on the record. You cannot go off the  
21 record unless all attorneys agree; that is a  
22 federal rule and it's also a rule in the PTO.  
23 MR. DAVIS: Licnel, there's no reason  
24 for you to be rude.  
02:12 25 MR. LAVENUE: Let's keep it one attorney

1 to one attorney.

2 MR. DAVIS: I understand that, but I was  
3 trying to have a back and forth without the  
4 rudeness.

02:12 5 MS. SPECHT: We're all in agreement on  
6 the one attorney versus one attorney. So I'm  
7 going to continue responding to objection which I  
8 think I've already done but I'm going to  
9 reiterate that the question was absolutely  
02:12 10 appropriate. It was within the scope of cross.

11 In addition, it was responsive to the  
12 board's construction which could not have been  
13 addressed in Dr. Shealy's opening declaration and  
14 he has a right to explain why he supports or does  
02:12 15 not support the board's construction, which was a  
16 question that was asked on cross-examination.

17 He's going to continue explaining his  
18 understanding of the board's construction and his  
19 reasons for why he agrees or disagrees with  
02:12 20 portions of the board's construction.

21 I'm now going to ask my next question  
22 unless there's anything further.

23 BY MS. SPECHT:

24 Q. So Dr. Shealy, in response to the  
02:13 25 board's construction you've outlined three

1 potential options that you've written down and  
2 what we're going to mark as Petitioner's Exhibit  
3 1038, but we're going to wait until you finish  
4 with this line of questioning to do that. The  
02:13 5 first one is D, O, G. Can you explain what the  
6 D, O, G process flow looks like?

7 A. Yes.

8 MR. ENGLAND: Same objection.

9 MS. SPECHT: And same response.

02:13 10 A. In all of these drawings I'm only  
11 going to start from the bottom because all the  
12 device detail is on top with the gallium nitride  
13 layer that contains the two dimensional electron  
14 gas. This is the AlGaN barrier layer and then  
02:13 15 following that is the p-type GaN layer. Okay.  
16 This is -- this is the E part of the process  
17 flow. This has to occur first. Okay.

18 So in the D, O, G the dielectric comes  
19 first. So in order to deposit the dielectric, a  
02:14 20 mask has to be placed, which I'll show here, and  
21 an etch through the p-type GaN has to occur;  
22 that's to expose the surface you're going to put  
23 the dielectric on.

24 So when that's been done, I'll shave this  
02:14 25 in, this is the barrier layer again. And now we

1 have a pattern p-type material that was etched  
2 down to the barrier. So I guess I'm just going  
3 to -- the AlGaIn layer is shown in black.

4 Next we put the dielectric on. Okay. The  
02:15 5 dielectric is on and now we need to open holes in  
6 the dielectric because the ohmic process is  
7 following. So we're going to open holes in the  
8 dielectric, and I'll indicate where those are.

9 BY MS. SPECHT:

02:15 10 Q. While you're making that drawing,  
11 Dr. Shealy, do you recall counsel for patent  
12 owner asking you specific questions about opening  
13 holes in the dielectric using an etching process  
14 during their cross exam?

02:16 15 A. Yes.

16 MR. ENGLAND: Same objection.

17 MS. SPECHT: You're now objecting for me  
18 asking whether he answered your question earlier  
19 as outside the scope.

02:16 20 MR. ENGLAND: To the extent that you're  
21 leading him about this being in context of  
22 discussion claim construction when we're talking  
23 about prior art references, yes, it is outside  
24 the scope of cross-examination and it's

02:16 25 outside -- same objection that I objected to

1 before going beyond the cross and beyond his  
2 declaration in providing this hypothetical.

3 MS. SPECHT: If your position is that him  
4 answering questions about whether he answered a  
02:16 5 question on cross is outside the scope of cross,  
6 we obviously oppose that objection. Dr. Shealy  
7 is going to continue. Thank you, Dr. Shealy.

8 A. This is -- this particular  
9 diagram -- so this is the dielectric. Now  
02:17 10 we've -- I've indicated where we're opening holes  
11 in the dielectric for source and drain just as we  
12 were discussing earlier and then the ohmic metal  
13 is put down by depositing metal, putting resist  
14 on top of it, masking it and etching it.

02:17 15 So here's the ohmic's. Then finally to  
16 get to the end, we open up a window here so that  
17 the -- okay. I'm just catching up with the  
18 features of the previous diagram. Okay. So we  
19 open a window here so that we can -- what I'm  
02:18 20 going to show is I'll show a -- we open this  
21 window, we deposit a gate metal and pattern it.  
22 And now we're ready to perform this -- there's a  
23 photoresist mask on top of here to pattern it.

24 So this is photoresist, P-R stands for  
02:19 25 photoresist, and then we perform the self-aligned

1 gate etch as described by Beach. And then when  
2 we're done with that, we have a finished device.

3 And now that we've done the self-aligned  
4 gate etch we'll strip the resist so the p-type  
02:20 5 GaN which is shown in blue here and then we have  
6 the metal, the gate metal on top of it, and we  
7 end up with the rest of the structure.

8 It looks something like this (indicating)  
9 and the ohmic metal. Okay. Then over here and  
02:21 10 then the other ohmic metal.

11 Okay. So that basically completes the  
12 device and this of course is the gate. So in  
13 this case, the gate came after the ohmic anneal  
14 which --

02:21 15 BY MS. SPECHT:

16 Q. Please continue.

17 A. Which means the gate in this  
18 process does see the ohmic anneal and in some  
19 devices that will kill the operation of the  
02:21 20 device; not necessarily here, but it certainly is  
21 not going to optimize the gate contact if you  
22 follow that sequence. So there are good reasons  
23 not to necessarily choose that path.

24 Q. Let's talk about the G, D, O  
02:22 25 which is the second one listed in your list of

1 three possible combinations. Would you like to  
2 make another drawing of how the G, D, O would  
3 flow?

4 A. The G, D, O has --

02:22 5 MR. ENGLAND: Objection. Leading and  
6 maintain the same previous objection.

7 MS. SPECHT: Same response to all the  
8 previous objections.

9 A. I want to draw all three of  
02:22 10 those, so I'm now on number 2. This is the G, D,  
11 O process, the gate occurs first. So again we  
12 start with the epitaxial stack with the same  
13 three set of layers, gallium nitride that  
14 contains the 2D gas, AlGaN barrier layer, and the  
02:22 15 p-type gallium nitride.

16 We're going to start by performing a  
17 self-alignment here. Now, by the way, this is  
18 the epi. I'm now going to indicate -- we're  
19 going to put a resist on there. I'm using black  
02:23 20 for resist, and we're going to put a gate metal.

21 So I'm going to just show it with the gate  
22 metal already been etched. Here's the  
23 photoresist mask. So this is in the middle, if  
24 you like, of the self-aligned process. The gate  
02:23 25 metal's been etched and we're going to continue

1 to etch down to the barrier layer like so.

2 So this is again, metal photoresist that's  
3 been obviously patterned and the metal, the metal  
4 wasn't patterned initially; it was deposited over  
02:24 5 the entire surface but in this diagram, I've  
6 shown the metal already been removed under the  
7 photoresist and then we continue etching to  
8 remove the p-type GaN.

9 So when we do that, if same barrier layer  
02:24 10 now that we have performed our self-aligned gate,  
11 we have the p-type GaN layer and the gate metal  
12 right on top of it. So there's the self-aligned  
13 gate structure.

14 All right. Next we take this structure  
02:25 15 and -- okay. We take the self-aligned gate  
16 structure that was previously done, and now we're  
17 going to put the dielectric on it. And I should  
18 label this as D, O, G and this is G, D, O.

19 So the dielectric I've been showing in red  
02:26 20 is more or less conformal using the most popular  
21 techniques to do this.

22 So and then of course we have to -- what  
23 precedes this -- what follows this is the ohmic,  
24 so we have to cut holes in this dielectric mask  
02:26 25 again and they're going to show up right there.

1 So this is the dielectric step. Then we open  
2 these holes up and when we do that -- so this is  
3 a conformal coding of the dielectric and then we  
4 deposit and pattern the ohmic contacts, so it  
02:27 5 looks something like that.

6 So here's the O. So that's an operational  
7 device using another process sequence, gate  
8 first, followed by dielectric, followed by  
9 ohmics.

02:27 10 BY MS. SPECHT:

11 Q. So let's talk about the last one  
12 on your list now O, G, D, ohmic, gate,  
13 dielectric. Can you explain how that flow would  
14 work?

02:27 15 A. Yes.

16 MR. ENGLAND: Same objections.

17 MS. SPECHT: Same responses.

18 A. The O, G, E sequence starts with  
19 the ohmic contacts, so what that means is you  
02:28 20 have to -- again, we'll draw the epi. And again  
21 this is the gallium nitride that contains the 2D  
22 electron gas, the device channel it's sometimes  
23 called. This is the aluminum gallium nitride  
24 barrier layer and this is the gallium nitride  
02:28 25 p-type layer. Okay.

1           So the first thing we have to do here is  
2       because the ohmics are coming first, we have to  
3       expose the surface where the ohmics go, so we're  
4       going to perform an etch. So I can put some  
02:28 5       photoresist on top of here.

6           Photoresist is now placed on the surface  
7       and we now etch the p-type GaN layer away so that  
8       we can form the ohmic contacts. So the ohmic  
9       contacts are deposited, patterned and etched.

02:29 10           By the way, I'm showing these with  
11       vertical walls and they rarely appear with  
12       vertical walls in practice when you -- no matter  
13       how you put that metal down. So this is now the  
14       ohmic. Now we're going to start processing the  
02:30 15       gate.

16           So in order to do that -- so we again want  
17       to do a self-aligned gate so we will place a gate  
18       metal -- I showed that in blue before -- and  
19       again there's photoresist on top of this and what  
02:30 20       I'm drawing here we've already started the  
21       self-aligned etch.

22           The metal has been removed, and now we're  
23       going to etch down through the p-type GaN so that  
24       we have a self-aligned gate structure. So that  
02:31 25       looks like that. And then we end up with a

1 self-aligned gate structure which looks like  
2 this, and then the final step is to -- so this is  
3 the gate and then we follow it by the dielectric.  
4 The dielectric then covers the entire surface and  
02:31 5 windows have to be opened to expose all three  
6 device contacts.

7 So I'm going to go ahead and show the  
8 dielectric as it would appear. So this is an  
9 operational transistor using the O, G, D sequence  
02:32 10 and you can look at each of these and decide the  
11 motivating factors are really here. There's a  
12 motivation to put the dielectric first, which was  
13 dielectric first is our D, O, G, we had the etch  
14 to put it down.

02:33 15 But there's motivation to do it this way  
16 because you protect the most sensitive surface of  
17 the device with a high quality dielectric which  
18 if it's the right kind of dielectric it will  
19 encapsulate and protect it during -- prevent  
02:33 20 contamination during what is a relatively dirty  
21 process to follow.

22 So if you want to follow what the board  
23 said, then you would look for D followed by O, so  
24 these two would follow the board's construction  
02:33 25 as it now stands.

1           If you want to do the dielectric last, I  
2   just illustrated this to show there's nothing  
3   that prevents you from doing that; you can make a  
4   working device with the dielectric glass and you  
02:33 5   could argue maybe that process might be a little  
6   simpler than the first process, the DOG or the D,  
7   O, G in that there's a little less going on  
8   between the contacts.

9           So anyway, those -- and by the way, there's  
02:34 10   a total of six variations of this and what we've  
11   just shown is three of them. There's three  
12   others you could draw.

13           MS. ENGLAND: Okay. I just want to put  
14   on the record that Ms. Specht asked a single  
02:34 15   question or potentially a couple of questions for  
16   a narrative and you're response was --

17           MS. SPECHT: The record already reflects  
18   my question and his response; you don't need to  
19   summarize what the record already reflects.

02:34 20           MR. ENGLAND: Was 35 minutes for a single  
21   question about a single paragraph.

22           MS. SPECHT: That's false.

23           MR. ENGLAND: Thank you.

24           MS. SPECHT: That is incorrect, but moving  
02:34 25   on, let's go ahead and mark all four of these as

1     Petitioner's Exhibit 1038.

2             THE WITNESS: Can I finish the question?

3             MS. SPECHT: I'm going to ask you a new  
4     question.

02:35 5     BY MS. SPECHT:

6             Q.     So referring now to Exhibit 1038,  
7     Dr. Shealy, which prior art combinations from  
8     your declaration are these representative of.

9             A.     These are representative of  
02:35 10    Yoshida --

11            MR. ENGLAND: Objection. Beyond the  
12    scope of cross-examination.

13            MS. SPECHT: Let me briefly respond, Dr.  
14    Shealy. This is not beyond the scope of  
02:35 15    cross-examination. Dr. Shealy was cross-examined  
16    extensively on each of the primary references and  
17    their combination including on the ordering of  
18    the process steps within each. He's entitled to  
19    explain his previous responses with reference to  
02:36 20    the drawings he chose to create. Go ahead, Dr.  
21    Shealy.

22            A.     The primary references which are  
23    Yoshida and Hikita generally describe the  
24    creation of enhancement mode devices, and we  
02:36 25    combine this with Beach because Beach teaches a

1 self-aligned gate and Beach also teaches ohmic  
2 formation.

3 So we're using those and we're allowing  
4 the flexibility that anyone skilled in the art  
02:36 5 would have to order these process sequences to  
6 obtain the best results in the device. And so  
7 the primary references with Beach allows us to do  
8 that. We can do that in any order.

9 BY MS. SPECHT:

02:37 10 Q. When you referenced Hikita in  
11 your answer just then, are you -- there were two  
12 Hikita references, which Hikita reference are you  
13 testifying about?

14 A. The 347.

02:37 15 Q. Is your opinion the same for  
16 Hikita 023?

17 A. It appears to follow the same  
18 process. It's the same author as well.

19 Q. Okay. I need to correct the  
02:37 20 record briefly. This exhibit that we've marked  
21 1038 should actually be Petitioner's Exhibit  
22 1040.

23 (Petitioner's Exhibit 1040 was marked.)

24 BY MS. SPECHT:

02:37 25 Q. Dr. Shealy, do you recall

1     testifying on your cross-examination that Beach  
2     does not use the term enhancement mode  
3     specifically?

4             A.     Yes.

02:37   5             Q.     And does Beach have any  
6     disclosure that suggest it could be an  
7     enhancement mode device?

8             A.     I think the point I was making  
9     it's not really clear, but even if it is a  
02:38   10    depletion mode device we're using Beach for the  
11    contact formations, ohmic and gate. And so the  
12    epitaxy, the underlying epitaxy which may or may  
13    not be different for an enhancement depletion  
14    mode, it depends on how you build the enhancement  
02:38   15    mode device, the -- so the point is, is that  
16    we're using it for the contacts, and the contacts  
17    are virtually the same for an enhancement in a  
18    depletion mode device.

19             So the -- so we're not relying on it to  
02:39   20    be enhancement depletion mode because we're  
21    getting the contact formation from Beach.

22             Q.     Would Beach's self-aligned  
23    etching process be performed the same regardless  
24    of what mode the device was?

02:39   25             A.     Yes.

1 MR. ENGLAND: Objection. Leading.

2 A. The only difference in this  
3 technique to achieve an enhancement mode device  
4 is the presence of one additional p-type layer  
02:39 5 above the barrier; everything else about the  
6 structure is the same, and of course, one skilled  
7 in the art very likely works on both including I  
8 believe Beach has papers in both.

9 But in any case, one skilled in the art  
02:39 10 is familiar with both devices and they process  
11 the same as far as the chmic and gate contacts.  
12 BY MS. SPECHT:

13 Q. Do you recall testifying during  
14 your cross-examination about a lift-off process?

02:40 15 A. Yes.

16 Q. What is your opinion about how a  
17 person skilled in the art would perceive lift-off  
18 as opposed to etching?

19 A. Lift-off is generally avoided in  
02:40 20 manufacturing processes unless it's absolutely  
21 needed. It's expensive and the reason it's  
22 expensive, it requires precise processing of a  
23 photoresist to achieve what I call a negative  
24 angle, and undercut so that the lift-off process  
02:40 25 will actually function.

1           So it's -- the other point about  
2 lift-off versus masking and etching which is what  
3 we're talking about here is that there's no built  
4 in advantage of one being a higher resolution  
02:41 5 method than the other; that is just not correct.  
6 There's no reason why one is more accurate than  
7 the other.

8           In fact, the complex processing of the  
9 resist may result in more variations in the metal  
02:41 10 dimensions when you process. Humidity goes up in  
11 the clean room, the resist processing changes,  
12 the dimensions change; that's how sensitive  
13 resist processing can be. So lift-off is avoided  
14 in a manufacturing environment at almost all  
02:41 15 costs.

16           MS. SPECHT: No further questions.

17           MR. ENGLAND: Okay. I think we take a  
18 5-minute break probably, see if we can ask a  
19 question or two then end this hopefully.

02:41 20           MS. SPECHT: Perfect.

21           (A break was taken from 2:41 p.m. to 2:50 p.m.)

22           MR. ENGLAND: No further questions from  
23 us.

24           MS. SPECHT: All right.

02:50 25           THE WITNESS: That means it's over?

1 MR. DAVIS: It's over. Thank you for  
2 your time.

3 THE COURT REPORTER: Counsel, can I get  
4 your transcript orders on the record, please?

02:50 5 Counsel for Blank Rome, could I get  
6 your transcript order, please?

7 MR. DAVIS: Yes, whatever our other  
8 order was; same. I think 3, 4 days.

9 THE COURT REPORTER: That's fine.  
02:52 10 And for you, Ms. Specht?

11 MS. SPECHT: Whatever they're doing.

12 (Deposition concluded at 2:50 p.m.)

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CERTIFICATE

I, Okeemah S. Henderson, RPR, the officer before whom the foregoing deposition was taken, do hereby certify that the foregoing transcript is a true and correct record of the testimony given; that said testimony was taken by me stenographically and thereafter reduced to typewriting under my direction; that reading and signing was requested; and that I am neither counsel for, related to, nor employed by any of the parties to this case and have no interest, financial or otherwise, in its outcome.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my notarial seal this 30th day of May, 2024.

My commission expires:

November 30, 2027



Okeemah S. Henderson, RPR

Official Court Reporter

| Exhibits                                                                                                                       |  |                                                                                     |                                                                                                                                                                                                  |
|--------------------------------------------------------------------------------------------------------------------------------|--|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Shealy Exhibit 1040</b><br>5:11 103:21,22,23                                                                                |  | <b>115</b><br>37:16                                                                 | 60:10,23,24 64:21,22                                                                                                                                                                             |
| <b>0</b>                                                                                                                       |  | <b>11:24</b><br>57:24                                                               | <b>1C</b><br>69:5,8,17,19 70:7                                                                                                                                                                   |
| <b>023</b><br>78:7 79:19,21 80:3,10<br>81:3,8,11,14 103:16                                                                     |  | <b>12</b><br>51:2 60:7 61:2 62:2,5,8,<br>10,13,16 63:23 64:23<br>69:12,16 82:4      | <b>1D</b><br>34:19 36:6 61:10,14,16,<br>24 62:1 63:8                                                                                                                                             |
| <b>1</b>                                                                                                                       |  | <b>12:30</b><br>57:24                                                               | <b>1E</b><br>37:16,18,23 63:10<br>65:20,22,23 66:7,9,15,<br>23 67:4,11                                                                                                                           |
| <b>1</b><br>12:16 14:15 15:7 28:11<br>29:15 32:19 33:8 34:22,<br>23 36:23,25 39:2,3,5,8,<br>21,25 40:10,22,24 41:4,<br>6,10,15 |  | <b>13</b><br>65:13                                                                  | <b>1E1</b><br>35:7,12,18 37:3,14,24,<br>25 39:4,7 40:10                                                                                                                                          |
| <b>10</b><br>15:23 60:7 61:2 63:22<br>70:9 89:14                                                                               |  | <b>1322</b><br>54:4                                                                 | <b>1E2</b><br>39:23                                                                                                                                                                              |
| <b>1001</b><br>11:4                                                                                                            |  | <b>135</b><br>38:19                                                                 | <b>1E3</b><br>39:8                                                                                                                                                                               |
| <b>1003</b><br>11:12                                                                                                           |  | <b>148</b><br>12:2                                                                  | <b>1E4</b><br>39:8                                                                                                                                                                               |
| <b>1004</b><br>51:21                                                                                                           |  | <b>15</b><br>16:5 66:10                                                             | <b>1E5</b><br>37:14,24 38:1 39:5,7<br>40:10                                                                                                                                                      |
| <b>1005</b><br>58:2                                                                                                            |  | <b>16</b><br>26:11 60:6 61:2,8,11,<br>12,17,18,19,23 62:2<br>63:11,20               | <b>1F</b><br>51:7 69:24 70:2                                                                                                                                                                     |
| <b>1006</b><br>67:17                                                                                                           |  | <b>17</b><br>16:4 65:24 67:12                                                       | <b>1F1</b><br>38:4 40:11                                                                                                                                                                         |
| <b>1007</b><br>71:9                                                                                                            |  | <b>18</b><br>45:5,24 46:5,7,11 47:18<br>48:14 61:7,11,12,13<br>62:19,21 63:8,9 65:9 | <b>1F2</b><br>38:11 39:11 40:13 44:4                                                                                                                                                             |
| <b>1008</b><br>77:22                                                                                                           |  | <b>19</b><br>48:2,23                                                                | <b>1F3</b><br>44:9 47:4                                                                                                                                                                          |
| <b>1038</b><br>92:3 102:1,6 103:21                                                                                             |  | <b>1995</b><br>87:18                                                                | <b>1F4</b><br>38:12 39:11 40:13 44:4                                                                                                                                                             |
| <b>1040</b><br>103:22,23                                                                                                       |  | <b>1:21</b><br>81:19                                                                | <b>1G</b><br>38:19 51:8                                                                                                                                                                          |
| <b>10:15</b><br>32:16                                                                                                          |  | <b>1:37</b><br>81:19                                                                | <b>1G1</b><br>38:20 39:14 40:16                                                                                                                                                                  |
| <b>10:30</b><br>32:16                                                                                                          |  | <b>1:38</b><br>81:23                                                                | <b>1G5</b><br>35:8,12,18 37:3 38:21<br>39:15 40:16                                                                                                                                               |
| <b>11</b><br>64:20 82:3                                                                                                        |  | <b>1:58</b><br>81:23                                                                | <b>2</b><br>24:10 28:25 29:13,19,<br>24 30:3,4,8,15 33:14<br>40:11 50:19 52:12<br>68:19 85:8 96:10                                                                                               |
|                                                                                                                                |  | <b>1A</b><br>34:18 36:5 62:10                                                       |                                                                                                                                                                                                  |
|                                                                                                                                |  | <b>1B</b>                                                                           |                                                                                                                                                                                                  |
|                                                                                                                                |  |                                                                                     | <b>20</b><br>29:2,13,19 30:1,20,22,<br>23 31:5 48:2,13,15<br>88:10,13                                                                                                                            |
|                                                                                                                                |  |                                                                                     | <b>2005</b><br>87:18                                                                                                                                                                             |
|                                                                                                                                |  |                                                                                     | <b>2005/057</b><br>58:13                                                                                                                                                                         |
|                                                                                                                                |  |                                                                                     | <b>2006/0273347</b><br>71:19                                                                                                                                                                     |
|                                                                                                                                |  |                                                                                     | <b>2008/0,079,023</b><br>78:9                                                                                                                                                                    |
|                                                                                                                                |  |                                                                                     | <b>200A</b><br>46:2,20                                                                                                                                                                           |
|                                                                                                                                |  |                                                                                     | <b>2023-01383</b><br>7:24                                                                                                                                                                        |
|                                                                                                                                |  |                                                                                     | <b>22</b><br>53:18 54:9                                                                                                                                                                          |
|                                                                                                                                |  |                                                                                     | <b>23</b><br>57:4,18                                                                                                                                                                             |
|                                                                                                                                |  |                                                                                     | <b>24</b><br>42:3                                                                                                                                                                                |
|                                                                                                                                |  |                                                                                     | <b>25</b><br>69:12,16                                                                                                                                                                            |
|                                                                                                                                |  |                                                                                     | <b>26</b><br>23:1 36:14                                                                                                                                                                          |
|                                                                                                                                |  |                                                                                     | <b>28</b><br>12:7                                                                                                                                                                                |
|                                                                                                                                |  |                                                                                     | <b>2:41</b><br>106:21                                                                                                                                                                            |
|                                                                                                                                |  |                                                                                     | <b>2:50</b><br>106:21 107:12                                                                                                                                                                     |
|                                                                                                                                |  |                                                                                     | <b>2D</b><br>13:20 79:15 96:14<br>98:21                                                                                                                                                          |
|                                                                                                                                |  |                                                                                     | <b>3</b><br>3<br>12:15,16 14:14 15:7<br>27:12,13,16 28:10<br>29:15,21,25 30:4,8,15<br>33:15 36:13 38:11,16<br>39:10,21 40:13,14,22,<br>24 41:15 44:3,16,21,22<br>47:15 68:19 78:14 85:8<br>107:8 |

|                                                                                                                        |                                                                                                                                                                                            |                                                                   |                                                                                                                                                  |
|------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>3(e)</b><br>30:7,8,10,12,19                                                                                         | <b>46</b><br>63:15 70:10                                                                                                                                                                   | <b>7,238,560</b><br>68:4                                          | <b>accurate</b><br>106:6                                                                                                                         |
| <b>3-N</b><br>58:16                                                                                                    | <b>47</b><br>62:24                                                                                                                                                                         | <b>74</b><br>53:5,8 54:18 57:7 61:6                               | <b>achieve</b><br>105:3,23                                                                                                                       |
| <b>30</b><br>66:16 69:6,22,25 70:1                                                                                     | <hr/> <b>5</b> <hr/>                                                                                                                                                                       | <b>77</b><br>66:3                                                 | <b>achieving</b><br>86:1                                                                                                                         |
| <b>32</b><br>70:4,6                                                                                                    | <b>5</b><br>24:10 33:8 34:25 39:21<br>78:16                                                                                                                                                | <b>78</b><br>59:21 60:1 61:20 66:3                                | <b>acknowledged</b><br>14:23                                                                                                                     |
| <b>34</b><br>22:24 23:1 49:17 53:10<br>54:1                                                                            | <b>5(e)</b><br>31:19,20                                                                                                                                                                    | <b>79</b><br>80:15 81:8                                           | <b>active</b><br>30:2                                                                                                                            |
| <b>347</b><br>71:15,20 75:20 77:2<br>81:2 83:22 84:2,4<br>103:14                                                       | <b>5-minute</b><br>106:18                                                                                                                                                                  | <hr/> <b>8</b> <hr/>                                              | <b>add</b><br>16:14                                                                                                                              |
| <b>347's</b><br>77:11                                                                                                  | <b>508</b><br>8:3 9:20,22,24 10:18<br>11:9 12:8,16,20 14:14,<br>15 15:21 16:1,9 19:1<br>22:15 24:9,10 26:7,18,<br>25 27:4 28:25 29:7 33:2<br>36:7 39:18,20 40:21<br>41:15,16 44:13 50:2,24 | <b>8</b><br>77:13                                                 | <b>added</b><br>88:14                                                                                                                            |
| <b>35</b><br>22:15 36:14 49:17<br>101:20                                                                               | <b>55</b><br>37:20 56:18                                                                                                                                                                   | <b>8,404,508</b><br>7:25                                          | <b>addition</b><br>91:11                                                                                                                         |
| <b>36</b><br>22:24                                                                                                     | <b>57</b><br>41:21,22,24 42:2,5<br>44:16,21,23 47:15                                                                                                                                       | <b>8D</b><br>72:23 73:1                                           | <b>additional</b><br>105:4                                                                                                                       |
| <b>37</b><br>60:9                                                                                                      | <hr/> <b>6</b> <hr/>                                                                                                                                                                       | <b>8E</b><br>76:8 77:1,7                                          | <b>addressed</b><br>91:13                                                                                                                        |
| <b>39</b><br>59:15                                                                                                     | <b>6</b><br>24:10 27:17 28:12<br>29:21 32:2,8 41:16                                                                                                                                        | <hr/> <b>9</b> <hr/>                                              | <b>advantage</b><br>85:19 86:16 106:4                                                                                                            |
| <b>3D</b><br>44:14 45:1,7,23 46:3,4,<br>14 47:9,19                                                                     | <b>60</b><br>70:10 74:13                                                                                                                                                                   | <b>9</b><br>12:17 14:15 15:7 27:17<br>28:11 29:15,21 69:11,<br>16 | <b>advantages</b><br>85:14                                                                                                                       |
| <b>3E</b><br>47:22,24 48:18 49:7,11                                                                                    | <b>61</b><br>26:14,17 44:16,22,23<br>47:15                                                                                                                                                 | <b>95</b><br>33:4                                                 | <b>agree</b><br>16:9 27:9 28:1 29:10,<br>12,18 31:7,9,15,20<br>34:12 38:23 43:25<br>46:25 47:5 48:19,22<br>49:10 51:11,13 60:24<br>67:9,11 90:21 |
| <hr/> <b>4</b> <hr/>                                                                                                   | <b>62</b><br>12:5,13                                                                                                                                                                       | <hr/> <b>A</b> <hr/>                                              | <b>agreed</b><br>82:13,17,19                                                                                                                     |
| <b>4</b><br>15:23 21:21 22:14<br>29:24 30:3,6,8,17 31:4,<br>9 34:24 38:18,22 39:14<br>40:15,22,24 59:3,6 85:8<br>107:8 | <b>624</b><br>58:13                                                                                                                                                                        | <b>a.m.</b><br>32:16 57:24                                        | <b>agreement</b><br>91:5                                                                                                                         |
| <b>40A</b><br>73:2                                                                                                     | <hr/> <b>7</b> <hr/>                                                                                                                                                                       | <b>abbreviated</b><br>8:11                                        | <b>agrees</b><br>91:19                                                                                                                           |
| <b>41</b><br>62:12                                                                                                     | <b>7</b><br>15:23 22:24 23:1                                                                                                                                                               | <b>above-described</b><br>16:3                                    | <b>ahead</b><br>100:7 101:25 102:20                                                                                                              |
| <b>45</b><br>9:5 63:2                                                                                                  | <b>7(f)</b><br>32:2,5                                                                                                                                                                      | <b>absolutely</b><br>91:9 105:20                                  | <b>Algan</b><br>14:18 41:18 54:3,15<br>55:4 56:8 92:14 93:3<br>96:14                                                                             |
|                                                                                                                        |                                                                                                                                                                                            | <b>abstract</b><br>15:19,20                                       | <b>aligned</b><br>19:22                                                                                                                          |
|                                                                                                                        |                                                                                                                                                                                            | <b>accommodate</b><br>9:5                                         |                                                                                                                                                  |
|                                                                                                                        |                                                                                                                                                                                            | <b>accordance</b><br>16:3                                         |                                                                                                                                                  |

|                                                                   |                                                                                                                                            |                                                                                                                                                                                                |                                                                                       |
|-------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| <b>aligner</b><br>19:10,23,24 20:2 23:17,<br>20,21                | 55:4,14 56:3,4                                                                                                                             | <b>avoid</b><br>86:19                                                                                                                                                                          | <b>benchmark</b><br>88:16                                                             |
| <b>alignment</b><br>23:22                                         | <b>applying</b><br>38:12 40:25 42:8,13<br>44:5                                                                                             | <b>avoided</b><br>42:9,14 105:19 106:13                                                                                                                                                        | <b>beneath</b><br>23:5                                                                |
| <b>aligns</b><br>18:13                                            | <b>approach</b><br>87:16,17                                                                                                                | <b>avoiding</b><br>43:4                                                                                                                                                                        | <b>beneficial</b><br>11:16                                                            |
| <b>allowing</b><br>103:3                                          | <b>approximately</b><br>59:5                                                                                                               | <b>B</b>                                                                                                                                                                                       | <b>binder</b><br>9:13,17 60:13                                                        |
| <b>aluminum</b><br>22:19 62:6,14,18,22<br>63:4,7 77:18 81:4 98:23 | <b>area</b><br>44:7,11 47:5 48:8,16<br>53:17 55:6,11,16 56:5                                                                               | <b>back</b><br>14:13 22:2 62:19 81:21<br>91:3                                                                                                                                                  | <b>bit</b><br>66:2 88:6                                                               |
| <b>amount</b><br>17:16                                            | <b>areas</b><br>20:3,4 48:5                                                                                                                | <b>backbone</b><br>87:21                                                                                                                                                                       | <b>black</b><br>93:3 96:19                                                            |
| <b>angle</b><br>105:24                                            | <b>argue</b><br>101:5                                                                                                                      | <b>background</b><br>24:11                                                                                                                                                                     | <b>Blank</b><br>7:9 107:5                                                             |
| <b>anneal</b><br>85:21,22,25 86:3 95:13,<br>18                    | <b>arrive</b><br>49:1,2,6,10                                                                                                               | <b>bar</b><br>17:23                                                                                                                                                                            | <b>block</b><br>82:19                                                                 |
| <b>annealing</b><br>63:21                                         | <b>art</b><br>13:13 14:23 15:11<br>16:12 27:6 50:1 52:3<br>58:11 68:2,11 71:14,17<br>78:5,11,14 83:1,18<br>93:23 102:7 103:4<br>105:7,9,17 | <b>barrier</b><br>92:14,25 93:2 96:14<br>97:1,9 98:24 105:5                                                                                                                                    | <b>blocks</b><br>85:13                                                                |
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