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

SEMICONDUCTOR COMPONENTS)
INDUSTRIES, LLC,)
)
)
Petitioner,)
)
)
vs.)
)
)
GREENTHREAD, LLC,)
)
)
Patent Owner.)

Case IPR2023-01242
U.S. Patent No. 11,121,222
Case IPR2023-01243
U.S. Patent No. 10,510,842
Case IPR2023-01244
U.S. Patent No. 11,121,222

DEPOSITION OF ALEXANDER GLEW, PHD
July 16, 2024

Reported by: Dana Peabody, RDR, CRR, CSR No. 6332
Pages 1 through 153
Job No. HOU 6760791

Deposition of Alexander Glew, PhD, taken on behalf of Petitioner, at Baker Botts, 1001 Page Mill Road, Building One, Suite 200, Palo Alto, CA 94304-1007, commencing at 9:14 a.m., on July 16, 2024, before Dana Peabody, CSR No. 6332, via Zoom.

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I N D E X

E X A M I N A T I O N S

WITNESS	PAGE
ALEXANDER GLEW, PHD	
MR. SPEEGLE	5

E X H I B I T S

EXHIBIT	DESCRIPTION	PAGE
Exhibit 1100	Figure 5B from the '222 patent, with hand-drawn additions	38

1 PROCEEDINGS

2
3 ALEXANDER GLEW, PHD,
4 having been duly sworn, or affirmed, was examined
5 and testified as follows:
6

7 MR. SPEEGLE: This is Mark Speegle with
8 Baker Botts for Petitioner Semiconductor Components
9 Industries. With me, remotely, is also Dan Anderson
10 from Newman Jones and Ellyar Barazesh from Baker
11 Botts.

12 MR. WHITEHURST: And good morning,
13 everyone. This is Alan Whitehurst from McKool Smith
14 for the patent owner, Greenthread, and also for the
15 witness.

16 And I'm just going to note on the record
17 that there is a video camera here in the room with
18 us, but I've been instructed by counsel that the
19 video camera is just for the convenience of our
20 court reporter, who is remote this morning, and that
21 no video recording of this deposition is being made.

22 MR. SPEEGLE: We confirm our understanding
23 there is no video being made or recording being
24 made.

25 ///

EXAMINATION

BY MR. SPEEGLE:

Q. Good morning. Could you please state your name and address for the record.

A. Alexander Glew, G-L-E-W. My home address is 970 Aura Way, Los Altos, California, 94024.

Q. Thank you, Dr. Glew.

You understand you're under oath today?

A. Yes.

Q. Have you testified in depositions before?

A. Yes.

Q. Okay. So you're familiar with the ground rules for these kind of proceedings?

A. Generally, yes.

Q. Just to refresh you, we'll be having a series of questions and answers, and the court reporter will be taking down our answers on a transcript.

Because the court reporter is taking down everything we say, we need to give verbal answers, not just head nods or head shakes.

Does that make sense?

A. Yes, it does.

Q. Is there any reason why you cannot testify fully and truthfully today?

1 A. Not that I'm aware of.

2 Q. Okay. If you need a break -- I'll try to
3 take a break every hour or so, but if you need a
4 break at any time, will you let me know?

5 A. Yes.

6 Q. And if you ever do not understand my
7 question or need clarification on something, will
8 you please let me know that too?

9 A. Yes, I will try to do that.

10 Q. Okay. Dr. Glew, you've been retained by
11 patent owner Greenthread in a series of inter partes
12 reviews involving Semiconductor Components
13 Industries, right?

14 A. Yes, I have.

15 Q. Okay. And in front of you, there's three
16 documents. Do you recognize these documents as
17 declarations you've submitted in inter partes
18 reviews for Greenthread?

19 A. Yes, these are three declarations that I
20 submitted.

21 Q. Okay. And these declarations are each
22 Exhibit 2057, as you can see in the bottom
23 right-hand corner, for three separate IPR
24 proceedings that are IPR 2023-01242, IPR 2023-01243,
25 and IPR 2023-01244. Is that right?

1 A. That is correct, yes.

2 Q. Okay. So if I refer to the -- your
3 declaration in the 01242 IPR, will you know which
4 document I'm referring to?

5 A. Yes.

6 Q. And same for the declaration in the 01243
7 proceeding?

8 A. Yes.

9 Q. And in the declaration -- your third
10 declaration is from the 01244 proceeding, right?

11 A. Yes, that's the third one.

12 Q. Okay. And do the opinions that you're
13 offering in these proceedings -- let me back up.
14 Let me strike that.

15 You understand this deposition is a
16 consolidated deposition for use in all three of the
17 IPR proceedings that we just mentioned: The 01242,
18 01243, and 01244 proceeding?

19 A. That is my understanding.

20 Q. Okay. And if you ever need clarification
21 about the patents or declarations between these
22 different declarations as we go through this
23 deposition, will be please let me know?

24 A. Yes, I'll try to do that.

25 Q. Okay. So, Dr. Glew, your declaration that

Page 7

1 you submitted in the three IRPs that we just
2 mentioned, do these declarations in front of you
3 contain all of your opinions you intend to offer in
4 these proceedings?

5 A. They contain a summary of the opinions
6 that I had at the time I wrote them. As additional
7 information becomes available, I may form new --
8 additional opinions.

9 Q. Are there any statements in any of your
10 three declarations that you know are no longer your
11 opinion now?

12 A. No, not that I'm aware of.

13 Q. Any mistakes or typos that you've become
14 aware of in the declaration since you submitted
15 them?

16 A. I believe in my "Background" section, I
17 wrote that I had five patents. I think I have six.

18 Q. Okay. Anything else come to mind?

19 A. Not off the top of my head, no.

20 Q. Okay. Do you have a team of people
21 assisting you in your work in this matter or are you
22 working on your own?

23 MR. WHITEHURST: Object to form.

24 THE WITNESS: I generally work -- when I
25 do this kind of work, I have an attorney -- I have

1 an engineer who works at my firm who helps me with
2 stuff, as needed, and then I work with the attorneys
3 also in preparation.

4 BY MR. SPEEGLE:

5 Q. Is your firm being paid hourly for your
6 time in this matter?

7 A. Yes, it is.

8 Q. And if you look at -- we'll look at the
9 1243 declaration. I believe it's paragraph 3 on
10 page 1 states that your rate is \$700 per hour. Is
11 that accurate?

12 A. Yes.

13 Q. And is the engineer that you mentioned on
14 your team -- is he billing separately for this
15 matter as well?

16 A. He bills through my firm as separate -- he
17 bills as part of my firm, yes, so the billing is
18 done by the firm.

19 Q. Do you have an estimate for the total
20 number of hours that you've spent on the Greenthread
21 IPR matters?

22 A. Not off the top of my head.

23 Q. More than a hundred hours?

24 A. It's kind of hard sometimes to
25 differentiate in my head because I'm working on, I

Page 9

1 guess, a federal case too at the same time. So
2 just -- off the top of my head, certainly, I've put
3 in more than a hundred hours on this case. I
4 couldn't break it out by different patent or how
5 much was IPR and how much was the other matter.

6 Q. Okay. You understand these declarations
7 were submitted in support of Greenthread's patent
8 owner responses in each of these IPR proceedings,
9 right?

10 MR. WHITEHURST: Object to form.

11 THE WITNESS: I believe generally -- I
12 mean, these are declarations that I've made on this
13 matter. I understand that Greenthread had made a --
14 as a patent owner, had made a preliminary response
15 and filed a response.

16 BY MR. SPEEGLE:

17 Q. Are you familiar with Greenthread's final
18 response in any of these IRPs?

19 A. To some extent.

20 Q. Do you know if your declaration copied
21 directly from Greenthread's patent owner response?

22 MR. WHITEHURST: Object to form.

23 THE WITNESS: I didn't see their document
24 before it was submitted. I'm not sure -- I know,
25 generally, the law firms look to the experts in

1 support of the documents the writings. I'm
2 imagining there's got to be a fair amount of similar
3 description or -- of the subject matter.

4 BY MR. SPEEGLE:

5 Q. I'm going to back up.

6 Can you tell me what your current job
7 title is?

8 A. I am president and CEO of Glew Engineering
9 Consulting.

10 Q. What kind of work does Glew Engineering
11 Consulting do?

12 A. Well, it's a small engineering firm in
13 Mountain View, California. We do, lately, mainly
14 litigation support. We do also do some -- I would
15 say computer modeling. We have three different
16 computer-aided design programs. We use SolidWorks,
17 the Autodesk products, Inventor and Pro/E Creo,
18 which is 3D modeling for usually larger companies
19 and military, kind of aerospace.

20 I'm a licensed mechanical engineer, and we
21 also carry errors and omissions insurance, as
22 engineers, similar to a doctor would have errors and
23 omissions insurance.

24 So we do some work with different
25 companies where we might place an engineering stamp

Page 11

1 on things or review designs, that sort of stuff.

2 So, I'd say, it's mainly litigation
3 support in high tech. We do a little bit of
4 industrial and general engineering also. I've
5 worked on everything from -- you know, as an
6 engineer, soup to nuts sometimes.

7 Q. When you say "mainly litigation support,"
8 in terms of the percentage of revenue over the last
9 five years for Glew Engineering, would you say
10 litigation support is 75 percent of the revenue?

11 A. I'd say that's reasonable, yeah.

12 Q. Is it 90 percent of the revenue?

13 A. It depends on the years. During COVID, I
14 think it was. Engineering pretty much dried up.

15 Q. Okay.

16 A. Yeah, but usually, it's about
17 three-quarters.

18 Q. What was the last job you held outside of
19 Glew Engineering?

20 A. Last job I held was Applied Materials.
21 After I left Applied, I started Glew Engineering,
22 and I've been at Glew Engineering since.

23 Q. When did you leave Applied?

24 A. Officially beginning of '97, but, really,
25 end of '96.

1 Q. What made you leave?

2 A. I was returning to Stanford to finish a
3 PhD in material science. I had taken all the
4 coursework while I was at Applied and passed the
5 qualifying exams, so I needed to write the
6 dissertation.

7 Q. What was your dissertation?

8 A. I wrote a dissertation on plasma-enhanced
9 chemical vapor deposition of diamond-like carbon and
10 fluorinated amorphous carbon. These were dielectric
11 materials that were being evaluated for use in
12 electronics.

13 Q. Was your dissertation published in a
14 peer-reviewed journal?

15 A. I published papers while I was in graduate
16 school in peer-reviewed journals and then finished
17 with the dissertation, yes.

18 Q. Have you published any peer-reviewed
19 papers since you completed your PhD?

20 A. No, I've been in private practice.

21 Q. Are you currently running for any elected
22 office?

23 A. Yes, I am.

24 Q. Which one?

25 A. I am a candidate in the general election

1 of November 2024 for Senate District 13 in
2 California.

3 Q. Is it the first time you've run for an
4 elected office?

5 A. No, I've run before.

6 Q. Have you ever held a position in
7 government before?

8 A. I've been Commissioner of my city. That
9 would be probably the only official capacity, yes.

10 Q. And how many times have you run for office
11 before?

12 MR. WHITEHURST: Object to scope.

13 THE WITNESS: I didn't.

14 BY MR. SPEEGLE:

15 Q. Okay. How many times have you run for
16 office?

17 A. I ran for -- this office, this is the
18 second time. I ran four years ago and was top two
19 also. I ran before that for State Assembly in what
20 would be a sub -- half of this district essentially,
21 and I was top two in that.

22 Q. Okay. Would you describe yourself as a
23 politician?

24 MR. WHITEHURST: Object to scope.

25 THE WITNESS: No, not at all. I describe

1 myself as an engineer.

2 BY MR. SPEEGLE:

3 Q. Look at page 8 of your 1242 declaration.

4 A. What page?

5 Q. 8.

6 Can you see paragraph 17 and 18 of your
7 1242 declaration on page 8?

8 A. Yes, I do.

9 Q. Okay. And do these paragraphs address the
10 level of ordinary skill in the art that you applied
11 in making your opinions in this matter?

12 A. Yes, this is the level of one of ordinary
13 skill in the art that I applied.

14 Q. And you opined in paragraph 18 that you
15 would have had at least the qualifications of -- of
16 a POSITA, person of ordinary skill in the art, since
17 at least September 3rd, 2004. Is that right?

18 A. Yes.

19 Q. And would you compare that to page 9 of
20 your 1243 declaration, page 8 of your 1244
21 declaration?

22 A. Which?

23 Q. 9 of the 1243 and 8 of the 1244.

24 While you're reviewing, I'll tell you, my
25 question is going to be, if you applied the same

Page 15

1 understanding of a person of ordinary skill in the
2 art in all three declarations.

3 A. I did apply the same standard of one of
4 ordinary skill in the art.

5 Q. I'm going to pass you what is Exhibit 1003
6 in the 1242 IPR.

7 And do you recognize OnSemi's Exhibit 1003
8 is the declaration of Travis Blalock?

9 A. Yes.

10 Q. Have you seen this declaration before?

11 A. Yes.

12 Q. Why don't you turn to page 22 and
13 paragraph 48. The page number is confusing here.
14 There's an exhibit page number, and then there's a
15 printed page number. I'm looking at printed page
16 22, which is exhibit page 28.

17 Do you see paragraph 48?

18 A. Yes.

19 Q. And you see the definition of the POSITA
20 that Dr. Blalock applied in his declaration?

21 A. Yes.

22 Q. Would you agree with me that his
23 definition of POSITA is similar, but not identical
24 to the definition of the POSITA that you applied in
25 all three of your declarations?

1 MR. WHITEHURST: Object to form.

2 THE WITNESS: It's substantially similar,
3 yes.

4 BY MR. SPEEGLE:

5 Q. And would any of your opinions in this
6 matter change if you used Dr. Blalock's definition
7 of a POSITA instead of the one you provided in your
8 declarations?

9 A. I haven't considered that before, but off
10 the top of my head, they seem substantially similar.
11 I don't imagine it having a big impact.

12 Q. Okay. Now, I think one difference between
13 the definition of "POSITA" that she used in the
14 definition from Dr. Blalock is that you included a
15 longer list of potential degrees, putting things
16 like computer engineering and chemical engineering,
17 which Dr. Blalock did not include in his
18 declaration.

19 Can you help me understand why you
20 included those additional fields in your definition
21 of a POSITA?

22 A. Based on my experience, chemical
23 engineering is a very common degree in this field.
24 I worked with a lot of chemical engineers. Chemical
25 engineering is more of the applied chemistry, if you

Page 17

1 will. So it's -- I think a common -- yeah, it's a
2 relevant background from a technical sense, and from
3 my experience, it's a common degree that people had
4 in the field. That was the first question.

5 The second was electrical or computer
6 engineering.

7 A lot of departments call their programs
8 different things. For example, at Berkeley, it was
9 electrical engineering and computer science, EECS.
10 Other universities might call it electrical
11 engineering. So I think it's not necessarily much
12 difference to that.

13 Q. Turning back to your -- I'll introduce --
14 U.S. Patent Number 10510842 -- 8.

15 Do you see that?

16 A. Yes, I see the '842.

17 Q. Is this the patent that's at issue in the
18 IPR 2023-01243 that you opined on?

19 A. Yes, the '842 is in the 1243.

20 Q. I'm going to hand you the 11121222 patent.
21 Do you see this?

22 A. Yes, I do.

23 Q. And the 11121222 patent is at issue in
24 both IPR 2023-01242 and IPR 2023-01244, right?

25 A. Yes, the '222 patent is in the 1242 and

1 1244 IRPs.

2 Q. And there are different claims at issue
3 from the '222 patent in the 1242 and 1244 IPR,
4 right?

5 A. Yes, they address different --

6 Q. And the way I personally remember it is
7 that Claim 44 is at issue in the 1244.

8 A. Yes, it's an easy way to remember it.

9 Q. Okay. So with these patents in hand, I
10 want to direct you to paragraph 34 of your 1242
11 declaration, and this is spanning pages 13 and 14.

12 A. You said pages 13 to 14? Which paragraph?

13 Q. I'm looking at paragraph 34.

14 A. 34.

15 Q. Specifically, I'd direct you to the last
16 sentence of paragraph 34, and this sentence says,
17 "The claimed invention is clearly disclosed in EG
18 Figures 5B-5C of the challenged patent and the
19 corresponding parts of the specification."

20 Do you see that?

21 A. Yes.

22 Q. Do you still agree with that statement
23 that the claimed invention is disclosed in Figure
24 5G -- sorry -- 5B, for example?

25 A. Yes.

1 Q. So I've handed you the patent there, and
2 can you turn to Figure 5B?

3 What I'd like to do next is go through the
4 claim language for Claim 1 of the '222 patent and
5 understand your opinion here that Figure 5B
6 discloses the claimed invention.

7 Are you able to do that?

8 A. Okay. Yes.

9 Q. Let's make it easier. Let's go ahead and
10 tear Figure 5B out of the staple so that you can
11 look at it at the same time.

12 A. Okay.

13 Q. So starting with the preamble of the Claim
14 1 of the '222 patent, do you agree that Figure 5B
15 discloses what could be a VLSI semiconductor device?

16 A. Yes, it does. It describes, for example,
17 CMOS and DRAM.

18 Q. Okay. The next element of Claim 1 of the
19 '222 patent is, "A substrate of a first doping type
20 at a first doping level having a surface."

21 Do you see that?

22 A. Yes.

23 Q. And is that disclosed in Figure 5B?

24 A. Yes, it describes the substrate.

25 Q. That -- the P minus sign substrate, what

Page 20

1 you described as, "A" --

2 MR. WHITEHURST: Object to form.

3 BY MR. SPEEGLE:

4 Q. -- "substrate of a first doping type at a
5 first doping level having a surface"?

6 MR. WHITEHURST: Object to form.

7 THE WITNESS: Yes, the bottom larger
8 rectangular shape labeled "Substrate" is substrate.

9 BY MR. SPEEGLE:

10 Q. Okay. The next element is, "A first
11 active region disposed adjacent the surface with a
12 second doping type opposite in conductivity to the
13 first doping type and within which transistors can
14 be formed."

15 Do you see that?

16 A. Yes.

17 Q. Is that disclosed in Figure 5B?

18 A. It's disclosed in the description, "CMOS
19 complementary metal oxide semiconductor." So I know
20 that for each NPN, there's a PNP transistor. What
21 is shown visually here is an NPN -- NPN type
22 transistor, but there are also PNP transistors since
23 it's CMOS.

24 Q. Okay. Am I understanding correctly from
25 your answer that you'd accept that a PNP transistor

Page 21

1 is part of a first active region having a
2 conductivity type opposite to a P substrate?

3 MR. WHITEHURST: Object to form.

4 THE WITNESS: Could you repeat that
5 question?

6 BY MR. SPEEGLE:

7 Q. I'll break it down a little bit.

8 Am I understanding that you said Figure 5B
9 discloses the first active region element from Claim
10 1 because the caption tells you it's a CMOS device,
11 which would also have a PNP transistor? Did I
12 understand that right?

13 A. Yes, that's essentially what I said.

14 Q. Okay. And you agree with me that Figure
15 5B does show an NPN transistor, right?

16 A. What is in the figure, the image, is, yes,
17 a very small portion of CMOS circuit. It's showing
18 an NPN transistor, as well as a storage capacitor
19 as, you know, probably part of a DRAM.

20 Q. And you would not describe the NPN
21 transistor shown in Figure 5B as having an opposite
22 conductivity type from the p-type substrate?

23 MR. WHITEHURST: Object to form.

24 THE WITNESS: No, I wouldn't. The
25 substrate is p-type, but the active region in which

1 the transistor is formed is also p-type, so they are
2 not opposite.

3 BY MR. SPEEGLE:

4 Q. Okay. Can you explain to me why you think
5 the NPN transistor has a -- doping type?

6 A. As I wrote in my report, Figures 5B and
7 5C -- you know, I take these together --

8 MR. WHITEHURST: Counsel, do you have a
9 single-sided copy of the '222 patent? Because I
10 think the witness is going back and forth from
11 Figure 5A to 5B, and it's tough when they're on
12 opposite sides of this same page. Or maybe you have
13 an extra copy. Unfortunately, I've written on my
14 copy, so it would be inappropriate.

15 MR. SPEEGLE: Here's my copy.

16 MR. WHITEHURST: I think it's helpful.

17 Thank you.

18 BY MR. SPEEGLE:

19 Q. Let me ask my question again.

20 A. Yes, please.

21 Q. Okay. Why is an NPN transistor, as
22 pictured in Figure 5B, not opposite in conductivity
23 type to the p-type substrate in 5B?

24 A. Looking at Figure 5B, we see n-type source
25 and drain. One of skill in the art, as well as one

1 looking at Figure 5A, would understand that there
2 are different types of active areas. Looking back
3 at 5A, one can see a p-well and an n-well.
4 Basically, sources and drains are of the opposite
5 type of well or active area they're formed in, so
6 wells -- sources and drains are counter-doped. So
7 if I have an n-type source and drain, it will be
8 formed in a p-type region. If I have a p-type
9 source and drain, it's formed in an n-type region.

10 So that is the basis for why I say that.

11 Q. Okay. And when you -- you're interpreting
12 the conductivity of the second doping type, as used
13 in Claim 1 of the '222 patent, to refer to the
14 doping type of the well in which the transistor is
15 formed. Is that right?

16 MR. WHITEHURST: Object to form.

17 THE WITNESS: Essentially, yes. It states
18 a first active region in the second claim element.
19 It states -- for example, in the fourth claim
20 element, transistors formed in at least one of the
21 first active regions or second active regions.

22 So the active region exists before the
23 transistors, the well exists before the transistors
24 are formed, it has a type, n or p, and then the
25 transistors are formed in that doped region.

1 BY MR. SPEEGLE:

2 Q. Thank you. That's helpful.

3 The next element in our claim, as we go
4 down, refers to, "A second active region separate
5 from the first active region disposed adjacent to
6 the first active region and within which transistors
7 can be formed."

8 A. Yes.

9 Q. Is that disclosed in Figure 5B?

10 A. Figure 5B discloses that there's a CMOS
11 substrate. I think Figure 5A discloses it better.
12 Figure 5B shows active regions adjacent to each
13 other, whereas Figure 5B is kind of a blow-up within
14 one active region. It is a CMOS, so there has to be
15 a complementary type formed.

16 Q. Is your understanding that the device, as
17 claimed in Claim 1, has already been manufactured
18 with a transistor actually doped into the device or
19 is it referring to a device before the transistor is
20 doped in?

21 MR. WHITEHURST: Object to form.

22 MR. SPEEGLE: You raised your hand for
23 that.

24 MR. WHITEHURST: I wanted the witness to
25 know the objection was coming, and it was clearly a

Page 25

1 compound question, so I was just explaining my
2 objection for him.

3 THE WITNESS: I would explain it like
4 this: As the preamble describes, this as a device.
5 So it's a form device. In reading the different
6 elements of the claim, for example, the fourth one
7 reads, "Transistors formed in at least one of the
8 first active regions or second active regions."

9 So one can form an active region without
10 forming transistors in it, according to the fourth
11 claimed element.

12 So I think this claim, at its face,
13 teaches us that there may be active regions, wells,
14 if you will, something along those lines, tubs,
15 there are different terms, that exist with or
16 without transistors.

17 One of skill in the art would also
18 understand that forming of the different PN regions
19 is usually one of the first things done on a wafer
20 before the transistors are formed.

21 You know, the language also describes the
22 transistors are formed in the active region. So
23 when they are formed in the active region, I think
24 the active region has to be there.

25 You know, you -- that's my general

1 understanding.

2 BY MR. SPEEGLE:

3 Q. Okay. Thank you for that.

4 And when you say "the fourth element" in
5 that answer, you're referring to the element that
6 says, "Transistors formed in at least one of the
7 first active region or second active region," right?

8 A. Yes.

9 Q. Okay.

10 A. That's the fourth.

11 Q. When the transistors are formed in an
12 active region, dopants that create a source and
13 drain are added to the active region, right?

14 A. Yes. I've used the term "counter-doping,"
15 but yes, sources and drains are formed by heavily
16 counter-doping opposite the active region that's
17 there.

18 Q. Okay. So when a transistor is formed in
19 the first active region, per the fourth element,
20 it's a p-type well; n-type dopants would be added to
21 form the transistor, right?

22 A. Yes, n-type dopants are added to form the
23 source and drain. There may be other doping steps
24 involved. That's sort of a simplification. There
25 could be a number of doping steps, but yes, the

Page 27

1 source and drain are formed by counter-doping,
2 doping opposite the active region.

3 Q. In terms of a spatial understanding, the
4 source and drain are physically in the same space as
5 the active region well, right?

6 MR. WHITEHURST: Object to form.

7 THE WITNESS: I'd say generally, yes, the
8 source and drain are in the well in the active
9 region.

10 BY MR. SPEEGLE:

11 Q. Would you consider the source and drain
12 part of the active region?

13 MR. WHITEHURST: Object to form.

14 THE WITNESS: How should I put this?

15 The claim language describes transistors
16 formed in at least one of the first active region or
17 second active region. It describes the transistors
18 as a device, and the active region is a region. So
19 it's sort of like apples and oranges. They are
20 certainly -- on the top portion, they're made of the
21 active region. The active region is, for example,
22 silicon. And dopants, you know, boron or
23 phosphorous or something like that are added to the
24 silicon substrate.

25 ///

1 BY MR. SPEEGLE:

2 Q. Well, let's keep going through the claim
3 language.

4 The fifth element here in Claim 1 of the
5 '222 patent is, "At least a portion of at least one
6 of the first and second active regions having at
7 least one graded dopant concentration to aid carrier
8 movement from the first and second active regions
9 towards an area of the substrate where there are no
10 active regions."

11 Do you see that?

12 A. I see that, yes.

13 Q. Is that disclosed in Figure 5B of the '222
14 patent?

15 MR. WHITEHURST: Object to form.

16 THE WITNESS: Yes, it is.

17 BY MR. SPEEGLE:

18 Q. Can you explain to me how that's disclosed
19 in Figure 5B?

20 A. Well, 5B has a label. In the middle
21 rectangular area that says, "Graded dopant region to
22 pull minority carriers from the surface," it shows
23 the arrows starting in the region above it, which I
24 would think of as an active region wherein the
25 transistors are formed.

1 It's pulling things downward toward the
2 bottom of the substrate. That is a region where
3 there are -- which is not active.

4 Q. How do you know where the active region
5 begins and ends?

6 A. Well, when one forms wells or doped areas,
7 one generally isolates them from each other. They
8 can't really touch too much.

9 So there are isolation areas that define
10 the different wells.

11 Now, real estate is very expensive on
12 transistors and silicon wafers. So the goal is to
13 use nearly all of the active region with the
14 transistors that one's forming.

15 So, you know, I would say most of the area
16 between the isolation, it should be covered with
17 electronic devices, transistors, and that is the
18 active area. It's active because there's active
19 region circuitry there.

20 For example, one can't put a contact lead
21 down in that region without touching an electrical
22 circuit. One can't run a metal line over it without
23 touching an electrical circuit. So it's an active
24 region. It's very different -- insulating regions
25 are not active.

1 Q. Okay. When you talk about the real estate
2 being expensive on a semiconductor device, are you
3 talking about a planar surface real estate or are
4 you talking about depth, up and down, real estate?

5 MR. WHITEHURST: Object to form.

6 THE WITNESS: I was talking, in that last
7 instance where I spoke about the planar top,
8 parallel to the large dimension of the wafer, not
9 the vertical.

10 BY MR. SPEEGLE:

11 Q. Okay. You talked about isolating
12 different wells. Would that be like isolating the
13 PNP transistor from the NPN transistor in a CMOS
14 device?

15 MR. WHITEHURST: Object to form.

16 THE WITNESS: Yes, one doesn't want
17 current to flow from one to the other, so there is
18 an insulator, an isolation between.

19 BY MR. SPEEGLE:

20 Q. Have you ever heard the phrase "a channel
21 stopper region"?

22 A. Yes.

23 Q. Is that another way to describe that kind
24 of isolation?

25 A. Well, that's a different type -- it is

1 isolation. It's a different type of isolation.

2 Q. Okay. That would be isolation between an
3 NPN and a PNP?

4 A. Basically, to keep current away from the
5 channels, yeah.

6 An active area can have multiple
7 transistors in it. You know, it would typically
8 have multiple transistors in it. One transistor
9 alone doesn't occur a lot in logic. There are
10 building the transistors. That only occurs in
11 higher power devices usually.

12 Q. Okay. So I appreciate your answer, and it
13 helps explain, you know, the planar difference
14 between active regions.

15 How do you tell when you look at a device
16 in a cross-section like in Figure 5B where an active
17 region begins and ends depthwise?

18 A. Figure 5 is -- how should I put this -- a
19 figure, an illustration. It's not a to-scale
20 drawing.

21 So, typically, a substrate is about 500
22 microns thick. They might be thinned to 300
23 microns. By the time -- and there are some, but not
24 a lot, flexible circuits that might be less -- well
25 less than 50 microns. But most rigid circuits start

1 at 500 or 300 nowadays sometimes, and they might be
2 thinned down.

3 The active area is the top couple microns.

4 So it's easy to tell that there's a
5 substrate, which is potentially hundreds of microns
6 thick, and then there's a couple of microns at the
7 very top, which is where all the action takes place.

8 From that, one looks at the depth of the
9 transistor elements; for example, the source and
10 drain, specifically, and the general doping in the
11 area.

12 Q. Okay. You referred to the annotations on
13 Figure 5B and the label that says, "Graded dopant
14 region to pull minority carriers from surface." Is
15 that right?

16 A. Yes, I referred to that.

17 Q. And what's your understanding of what
18 those arrows pointing down illustrate in Figure 5B?

19 A. The arrows were just a general indication
20 of, I would say, force in motion in that direction.

21 The minority carriers were headed in that
22 direction. The driving force would be in that
23 direction.

24 Based upon the graded dopants, there would
25 be a dopant gradient in that direction also.

1 Q. Okay. So let's talk about the last
2 element of Claim 1 on the '222 patent.

3 It says, "At least one well region
4 adjacent to the first or second active region
5 containing at least one graded dopant region, the
6 graded dopant region to aid carrier movement from
7 the surface towards the area of the substrate where
8 there are no active regions, wherein at least some
9 of the transistors form digital logic of the VLSI
10 semiconductor device."

11 Do you see that?

12 A. Yes.

13 Q. Is that element disclosed in Figure 5B?

14 A. Yes, it is.

15 Q. Help me understand where it's disclosed.

16 A. Well, we can look at 5B and, you know, 5A
17 also, but 5B is sort of a blow-up of one well
18 region -- one region of a wafer.

19 So on the top, we have an active region.
20 And below that, there is a graded dopant region.
21 The well region is below the active region on the
22 top. The bottom P substrate, for example, does not
23 have active regions. That's just the substrate or
24 the wafer. It is described in the specification as
25 a CMOS substrate or DRAM. These are digital logic

Page 34

1 VLSI.

2 The aiding carrier movement is indicated,
3 of course, by the arrows and the label, "Graded
4 dopant to pull minority carriers from the surface."
5 It shows them heading toward the bottom.

6 Q. I see you've got a pen there. Could you
7 just draw a box on Figure 5B around the well?

8 MR. WHITEHURST: Object. We are not going
9 to create new exhibits using pen today.

10 You can hand me the pen, sir. Thank you.

11 MR. SPEEGLE: So, Counsel, you're
12 instructing the witness not to annotate the
13 exhibits?

14 MR. WHITEHURST: You can ask the question,
15 and he'll answer it, but I'm not going to have him
16 draw pictures. You can ask him questions all you
17 want.

18 MR. SPEEGLE: But you're instructing him
19 not to create any annotations?

20 MR. WHITEHURST: I am instructing you to
21 ask him questions and him to answer it to the best
22 of his ability.

23 If you would like to mark on it, that's
24 your prerogative, but to force the witness to
25 annotate it is not proper. If you would like to

1 draw --

2 MR. SPEEGLE: I disagree that that's a
3 proper instructions, but we'll move on.

4 MR. WHITEHURST: -- creating new evidence
5 in the case, so --

6 MR. SPEEGLE: He's a testifying expert.
7 Everything he says is new evidence.

8 MR. WHITEHURST: You can annotate this
9 yourself, counsel. There's nothing preventing you
10 from drawing on it.

11 MR. SPEEGLE: We disagree. But we'll move
12 on.

13 BY MR. SPEEGLE:

14 Q. Dr. Glew, if you did have the pen that
15 your counsel took away from you, would you be able
16 to draw a box around where the well region is on
17 Figure 5B?

18 A. Yes. 5B is showing a portion of a well.
19 Again, 5B is a zoom-in of one transistor, which is a
20 portion of the well. I could show where a portion
21 of the well is, but yes.

22 Q. Okay. Would it be easier for you to show
23 with a pen that your counsel took away from you or
24 describe it verbally?

25 A. I can describe it verbally just as easily,

1 I think.

2 Q. Okay. Why don't you described as detailed
3 as you can verbally where the well begins and ends
4 on Figure 5B.

5 A. There are three rectangular regions in
6 Figure 5B: A top one, middle one labeled "Graded
7 dopant region to pull minority carriers from
8 surface," and a P substrate.

9 I'm going to review the text for a moment.

10 Q. Okay.

11 A. I'll carry on with my answer.

12 I would describe the well region as the
13 region in which the access transistor is formed. It
14 is the area beneath the access transistor where
15 there are arrows indicated.

16 Q. Thank you.

17 So does the well region begin at the upper
18 surface of the device or does it begin somewhere
19 below the upper surface?

20 MR. WHITEHURST: Object to the form.

21 THE WITNESS: Here, what I'm describing is
22 that the transistors are comprising the very upper
23 surface. So the transistors are on top.

24 If we refer to Figure 5A for reference,
25 but we can see that active devices are on top of the

1 wells. So the active devices are formed in the
2 wells, but then they end up being the top.

3 The active devices are doped. We spoke,
4 for example, of the source and drain being heavily
5 counter-doped.

6 So I would expect, of course, that the
7 source and drain have a different doping than the
8 well at that point because they've been altered.

9 So the well, as it was -- as it is
10 described as a well is actually -- it's underneath
11 the active devices.

12 BY MR. SPEEGLE:

13 Q. Okay. To help understand, I'm going to
14 hand you what I've labeled here as Exhibit 1100.

15 (Exhibit 1100 marked for identification.)

16 BY MR. SPEEGLE:

17 Q. And do you see Exhibit 1100 is Figure 5B
18 from the '222 patent that I've marked with a "1," a
19 "2," and a "3"?

20 A. Yes.

21 Q. Do you see that?

22 And you see the 1, 2, and 3 on my
23 Exhibit 1100 are next to horizontal lines?

24 A. Yes.

25 MR. WHITEHURST: Just so the record is

1 clear, these are -- this Figure 5B has been
2 annotated by counsel, so counsel has added
3 additional ink lines --

4 MR. SPEEGLE: And it's on the record.

5 MR. WHITEHURST: And referenced numerals
6 to the figure.

7 BY MR. SPEEGLE:

8 Q. Dr. Glew, do you see the 1 and 3 that I've
9 drawn on Figure 5B of the '222 patent?

10 A. Yes, I do.

11 Q. And is the horizontal line next to Number
12 1 in the region that you describe as the well
13 region?

14 MR. WHITEHURST: Object to form.

15 THE WITNESS: How far horizontally does
16 the 1 extend? This is important to understand
17 because I don't know if it extends through the
18 source and drain, which are counter-doped, or if
19 you're referring to just that spot where you've put
20 the dash.

21 BY MR. SPEEGLE:

22 Q. Let me edit it.

23 Okay. I've further added to Exhibit 1100
24 three dashes labeled "A," "B," and "C."

25 Do you see that?

1 A. Yes.

2 Q. And they are roughly parallel to 1, 2, and
3 3, but moved over, displaced horizontally. Is that
4 right?

5 A. I can assume that A is parallel to 1, and
6 B is parallel to 2, and C is parallel to 3.

7 Q. And I've drawn A, B, and C so that they
8 overlap with an n-doped region in Figure 5B. At
9 least A is entirely within the n-doped region in
10 Figure 5B, B is partially within the n-doped region
11 of Figure 5B, and C is outside of the n-doped region
12 of Figure 5B. Is that right?

13 A. Yes.

14 MR. WHITEHURST: Object to form.

15 BY MR. SPEEGLE:

16 Q. So let's assume that these dashes are not
17 extending any further than they are drawn here.
18 Would you describe the dash next to the 1 on
19 Exhibit 1100 as in the well region for Figure 5B?

20 MR. WHITEHURST: Object to form.

21 THE WITNESS: There is a condition or two
22 to answer that question.

23 Essentially, the well at one point in time
24 extended all the way to the top surface. Then it
25 was modified to form transistors. And the

1 modifications for the transistors, at least the
2 source and drain will change the doping type to the
3 opposite type.

4 So to the extent that the area of 1 is
5 unaltered, then it would be substantially similar to
6 the well that was -- that exists elsewhere.

7 BY MR. SPEEGLE:

8 Q. You said "substantially similar to the
9 well." Would it be in the well?

10 MR. WHITEHURST: Object to form.

11 THE WITNESS: At one point in time, it was
12 the well. The well did extend to the top. Then the
13 top of the well was altered to make the transistors.

14 So the doping in the active area is very
15 specific to make transistors. It's no longer doped
16 like the well is, a transistor, on top of the well
17 now.

18 BY MR. SPEEGLE:

19 Q. So your understanding is that after the
20 well region is doped to have a source and drain
21 region, regions that are now part of the source and
22 drain are no longer in the well?

23 MR. WHITEHURST: Object to form.

24 THE WITNESS: They are formed in the well,
25 but they have different doping in the well at that

1 point in time. So they have a different structure
2 than the rest of the well.

3 BY MR. SPEEGLE:

4 Q. Does that mean they're no longer part of
5 the well?

6 MR. WHITEHURST: Object to form.

7 THE WITNESS: The way one typically would
8 refer to it, I think, is shown in Figure 5A where
9 the active devices are shown on top of the well.
10 It's basically created a new structure, a
11 transistor, or, in this case, a transistor and a
12 storage capacitor for the DRAM. And these are not a
13 well anymore. It's a completely different structure
14 on top of the well. It was formed in the well,
15 though. It used to be well, at least where the
16 source and drain are.

17 The gate portion never was in the well.
18 It's on top of the well.

19 And the -- as this is drawn, this
20 particular storage capacitor appears to be on top of
21 the well. There used to be ones that were down into
22 the well, but this looks like it's on top.

23 BY MR. SPEEGLE:

24 Q. Okay. So, just so I understand, it's your
25 opinion that when the surface of a device is doped

1 with -- or counter-doped, as you said, with dopants
2 to create sources and drains in the well, that
3 entire depth of the device no longer constitutes a
4 well, right?

5 MR. WHITEHURST: Object to form.

6 THE WITNESS: I would say that it's
7 structurally different than the well. It's now a
8 transistor, whereas it's a device.

9 So in the context of the '122 patent, for
10 example, Figure 5A, it shows that the devices are on
11 top of the well.

12 One understands, of course, that they are
13 formed in the well of well material, at least for
14 the source and drain and channel.

15 MR. SPEEGLE: We've been going about an
16 hour. Time for a break.

17 MR. WHITEHURST: Sounds good.

18 THE WITNESS: That would be fine.

19 (Recess.)

20 MR. SPEEGLE: 10:31.

21 BY MR. SPEEGLE:

22 Q. Dr. Glew, do you still have that
23 Exhibit 1100 you're looking at?

24 A. Yes.

25 Q. And just to refresh, I believe we were

1 discussing what I've drawn as lines 1 and line A on
2 Exhibit 1100.

3 Those would, at some point, be in the well
4 before an active region and transistor is formed in
5 the device. But after an active region and a
6 transistor is formed, you would no longer consider
7 what I have as Exhibit -- on Exhibit 1100 as lines A
8 and line 1 as being within the well, right?

9 MR. WHITEHURST: Object to the form.

10 THE WITNESS: I would say they are formed
11 in the well. So they are formed in the well,
12 literally. But they are now of a different
13 structure than the well, so they aren't going to
14 behave like the rest of the well.

15 BY MR. SPEEGLE:

16 Q. So when you say "formed in the well," is
17 that a -- are you using "formed" as a verb, meaning
18 there's an act when they are formed in the well or
19 are you describing their static position as formed
20 in the well over time?

21 MR. WHITEHURST: Object to form.

22 THE WITNESS: I guess, both. They are
23 physically processed and manufactured out of well
24 material, and then subsequent to that, they exist
25 and are surrounded by the well. They are in the

1 well.

2 BY MR. SPEEGLE:

3 Q. So you would describe what I have
4 identified as line 1 as in the well at all times?
5 Is that what you're saying?

6 MR. WHITEHURST: Object to form.

7 THE WITNESS: It's -- in the well, but not
8 structurally the well anymore. It's now a
9 transistor.

10 BY MR. SPEEGLE:

11 Q. But it is still in the well?

12 A. Yes, it's formed in the well, and it's
13 surrounded by the well.

14 Q. Okay.

15 A. Actually, in this point, it's -- it's on
16 top of the well, really.

17 You know, if we look at Figure 5A, that
18 sort of gives a nice pictogram of it. And the
19 active devices are, you know, on top of unaltered
20 well material. There may be well -- unaltered well
21 material surrounding it that -- transistors don't
22 necessarily take up the entire well. They'll take
23 up a lot of it, but there will be potentially
24 unaltered well material around them also.

25 Q. Okay. And let's just -- you know, if you

Page 45

1 saw -- if there's a carrier, electron, at the
2 location that I've identified as 1 on Exhibit 1100,
3 would you describe that carrier as in the well or
4 not?

5 MR. WHITEHURST: Object to form.

6 THE WITNESS: 1's -- I'd say 3 is a well.
7 1's a little more difficult because this is a
8 schematic -- it's an illustration. It's not a CAD
9 drawing or electron micrograph. It's just a general
10 illustration. It's hard to know, you know, what's
11 happened underneath the storage capacitor that's
12 formed on top of it.

13 I would generally describe 1 as being in
14 the active area. You know --

15 BY MR. SPEEGLE:

16 Q. Maybe I can clarify.

17 Is -- if a carrier is in the active
18 region, does that necessarily mean that that carrier
19 is not in the well?

20 MR. WHITEHURST: Object to form.

21 THE WITNESS: If the carrier is in the
22 active region -- I should -- it's sort of simple.
23 It's in the active region. It's going to be acted
24 upon by the doping in the electrical fields that
25 exist within the transistor.

1 So the transistor controls the electrons
2 and charges in the active area.

3 Below the transistor, charges are going to
4 be controlled by the well.

5 BY MR. SPEEGLE:

6 Q. So it sounds like -- am I right to
7 interpret your answer as saying that electrons that
8 are in the active region should not be considered in
9 the well?

10 MR. WHITEHURST: Object to form.

11 THE WITNESS: I'd say for -- in a physical
12 sense, the carriers in the active region, in the
13 transistor areas, are controlled by the transistors.

14 So the well surrounds -- you know, it
15 comes up to the transactive area, they can surround
16 the active area, the transistors are formed in the
17 active area.

18 The source and drain are a little
19 different than the channel and the transistor.

20 BY MR. SPEEGLE:

21 Q. How so?

22 A. The source and drain are heavily doped,
23 counter-doped, opposite the well, whereas the
24 channel is of the same type as the well. So the
25 channel --

1 Q. Would you describe an electron in the
2 channel as in the well?

3 MR. WHITEHURST: Object to form.

4 THE WITNESS: I would describe carriers,
5 electrons or holes, in the channel as subject to
6 influence from the well, whereas the source and
7 drain, they -- the doping levels are so high, they
8 swamp it out, they swamp out the effect from the
9 well and the source and drain. That's the whole
10 point of the counter-doping.

11 BY MR. SPEEGLE:

12 Q. I thank you for that. And I understand
13 what you're saying in terms of what physical effects
14 will control.

15 Just from a spatial definition, would you
16 still say that the -- let me ask it this way: Would
17 you say that the source is in the well?

18 MR. WHITEHURST: Object to form.

19 THE WITNESS: The source and drains are
20 modifications so that it's not structurally a well
21 anymore, it's an active device. It was formed from
22 the well at one point, but at this point, it's an
23 active region.

24 BY MR. SPEEGLE:

25 Q. Okay. That brings up a good question.

1 I'd like to understand. I think -- it sounds like
2 the definition of these terms kind of changes over
3 time. So let's talk about the manufacturing
4 process.

5 MR. WHITEHURST: Object to form.

6 BY MR. SPEEGLE:

7 Q. I'll rephrase.

8 MR. WHITEHURST: That was an argument,
9 narrative. I don't want to detract from the
10 deposition, but object to form.

11 BY MR. SPEEGLE:

12 Q. Okay. These devices start as blank
13 silicon, right?

14 MR. WHITEHURST: Object to form.

15 THE WITNESS: Generally, there's a wafer,
16 yeah. Wafers come in p or n-type, but they're
17 essentially blank, yes.

18 BY MR. SPEEGLE:

19 Q. Okay. The silicon would be doped to form
20 a well, right?

21 A. The doping is subsequent processing on the
22 silicon after it's received, yes. There are
23 insulating isolation areas also separating the wells
24 that are formed, yes. That's one of the first
25 things that start the wafer is well formation.

1 Q. Just so we can be consistent with what
2 we're talking about, let's talk about the spot that
3 I've identified as dash Number 1 on Exhibit 1100.

4 A. Yes.

5 Q. So that spot would originally be a blank
6 silicon spot on the wafer, right?

7 A. Yes.

8 MR. WHITEHURST: Give me a second to
9 object.

10 Object to form.

11 BY MR. SPEEGLE:

12 Q. And then subsequent processing would dope
13 that area to form a well, right?

14 A. Most of the time. There's one other case
15 I described in my report, and it's also shown in
16 these figures.

17 Q. Are we talking about IGBT?

18 A. No. Maybe it's not in here.

19 Early processing, they used just a single
20 well. They might only have p-wells if it was an N
21 wafer or vice versa. But as time went on, and
22 things became more advanced, they went to twin
23 wells, p and n-type.

24 Q. Okay. After the doping that makes dash 1
25 in a well, would something happen to make that part

1 of an active region?

2 MR. WHITEHURST: Object to form.

3 THE WITNESS: Yes. As, I would say,
4 generally indicated in Figure 5A, there's a lot of
5 processing done to form active devices, transistors,
6 and these active devices alter the structure of the
7 upper surface of the well.

8 BY MR. SPEEGLE:

9 Q. Okay. And is that -- is that additional
10 processing that you're describing that alters the
11 upper surface of the well -- is that creating the
12 source and drain regions?

13 A. It would be -- that would be part of it.
14 The creation of the source and drain would be some
15 of that processing.

16 Q. What else is in that processing?

17 A. Well, there are -- source and drains could
18 be doped with titanium to form a silicide, a metal
19 on top of it, which kind of acts like a welding or
20 solder point for contacts.

21 The channel region can be further enhanced
22 so that it has better electrical properties than the
23 well as a whole.

24 You know, this patent is a simplification
25 of the semiconductor processing. Full device can

1 have thousands of process steps. Modern technology
2 may have 25 different doping steps. So there can be
3 additional doping of the channel region. There has
4 to be a formation of a gate on top of the channel
5 region. We see something like an access transistor,
6 but the top of the gate can be oxidized or say the
7 top of the channel can be oxidized or -- can be
8 deposited.

9 Electrodes are put on top of that.

10 This Figure 5B shows storage capacitors
11 being formed for memory.

12 Q. Now, if I'm recalling, when you talked
13 about the elements of Claim 1 of the '222 patent
14 that referred to a first active region and a second
15 active region, I believe you mentioned that
16 transistors had not yet been formed when these
17 become active regions. Is that right?

18 MR. WHITEHURST: Object to form.

19 THE WITNESS: Well, as the fourth claim
20 element describes transistors formed in at least one
21 of the first active regions or second active
22 regions. So the active region may not have
23 transistors formed in it.

24 BY MR. SPEEGLE:

25 Q. Okay. What processing steps have to occur

1 before a well region would be considered an active
2 region in the parlance of the patent?

3 MR. WHITEHURST: Objection. Form.

4 THE WITNESS: An active region isn't a
5 region in a general sense, not in the context of the
6 '222 patent, but, say, in a general industrial
7 sense.

8 An active region is a region that you
9 can't touch with an electrical contact because it
10 will -- it's somehow going to allow current flow.
11 Something's going to happen.

12 So an active region is, for design
13 purposes, understood to be a place where you can't
14 touch it with a metal contact.

15 BY MR. SPEEGLE:

16 Q. How is that disclosed in the Figure 5B?

17 MR. WHITEHURST: Object to form.

18 THE WITNESS: Well, what we see in 5B is
19 an active region on top of a well region. We see --
20 there's area here next to the transistor that is
21 active. So that's a region that would not be, for
22 example, open to contacts, metal layers and lines.

23 We see in 5C also, for example, this is
24 NAND, which is a string of 32 or more transistors in
25 series. So there's multiple transistors in an

1 active region. But there's still regions that
2 aren't covered by transistors. So those are areas
3 that you shouldn't touch electrically. Metal
4 shouldn't go there.

5 BY MR. SPEEGLE:

6 Q. So there are some transistors, but there
7 doesn't have to be a transistor in all of the active
8 regions? Is that what you're saying?

9 A. I'd say that you can't cover all of the
10 active region, necessarily, with transistors.

11 Active regions are typically rectangular,
12 sometimes like a polygon, a tilted rectangle. And
13 transistor's goal is to not waste space, to occupy
14 as much of the active area, but you still don't want
15 to drop metal contacts down next to the transistor
16 in the active region.

17 Q. Okay. Is it possible to have an active
18 region that has no transistors?

19 MR. WHITEHURST: Object to form.

20 THE WITNESS: Yes, Claim Element 4
21 describes a situation wherein transistors are formed
22 in at least one of the first active regions or
23 second active regions. It contemplates that there
24 are no transistors potentially. One could put
25 capacitors, which aren't transistors. One could put

1 resisters, that aren't transistors.

2 BY MR. SPEEGLE:

3 Q. So how would a POSITA recognize a region
4 as an active region if there are no transistors in
5 that region?

6 MR. WHITEHURST: Object to form.

7 THE WITNESS: A lot of the doping is
8 done -- or some of the doping is done -- let me
9 rephrase that. Some of the doping is done before a
10 lot of the structure exists. So there may be doping
11 of the wafer -- blanket doping of all -- of a bunch
12 of active areas, all the active areas, before
13 transistors are laid out. And so these would be
14 potentially active.

15 BY MR. SPEEGLE:

16 Q. Let's step to Claim 44 in the '222 patent.

17 A. Where?

18 Q. Claim 44 of the '222 patent.

19 And I am going to keep asking about Figure
20 5B.

21 A. Yes, Figure 44. I am there.

22 Q. The third element of Figure 44 says, "An
23 active region, including a source and a drain,"
24 right?

25 A. Yes, it does.

1 Q. All right. Is that a different usage of
2 the phrase "active region" than you were
3 interpreting in Claim 1?

4 MR. WHITEHURST: Object to form.

5 THE WITNESS: I don't believe so, no.

6 BY MR. SPEEGLE:

7 Q. So you do think that the source and drain
8 are part of the active region in Claim 1 as well?

9 MR. WHITEHURST: Object to form.

10 THE WITNESS: I think the source and drain
11 are formed in the active region or can be formed in
12 the active region, yes.

13 BY MR. SPEEGLE:

14 Q. So you think the active region includes
15 the source and drain?

16 MR. WHITEHURST: Object to form.

17 THE WITNESS: If there is a source and
18 drain, it's in the active region, yes.

19 BY MR. SPEEGLE:

20 Q. Okay. And would you -- with reference to
21 Figure 5B, is there any change to how you would
22 describe 5B imbibing the active region of Claim 44
23 compared to the active region in Claim 1?

24 A. No.

25 Q. Okay. The next element in Claim 44 is, "A

1 single drift layer disposed between the other
2 surface of the surface layer and the substrate, the
3 drift layer having a graded concentration of dopants
4 extending between the surface layer and the
5 substrate, the drift layer further having a first
6 static unidirectional electric drift field to aid
7 the movement of carriers from the surface layer to
8 an area of the substrate where there are no active
9 regions."

10 Did I get that right?

11 A. Yes.

12 Q. Is that disclosed in Figure 5B?

13 A. Yes, it is.

14 Q. Can you describe for me how that is
15 present in Figure 5B?

16 A. There is a single drift layer indicated by
17 the arrows in Figure 5B. It's between the surface
18 layer above it, and it's described as graded dopant
19 region, so it has a graded concentration of dopants.
20 It extends between the surface layer and the
21 substrate, so these arrows are between the surface
22 layer above it and the substrate, labeled
23 "substrate" below it.

24 This describes, "Having a first static
25 unidirectional electric field -- unidirectional

1 electric drift field to aid the movement of carriers
2 from the surface area to the substrate to an area of
3 the substrate where there are no active regions."

4 So the description below the arrows
5 describe pulling minority carriers from the surface,
6 so that is the movement of carriers from the
7 surface. It shows them headed toward the substrate
8 where there are no active regions. It is showing it
9 in one directional -- in one direction; that is,
10 unidirection.

11 Q. Okay. And the last element is, "At least
12 one well region disposed in the single drift layer,
13 the well region having a graded concentration of
14 dopants and a second static unidirectional electric
15 drift field to aid the movement of carriers from the
16 surface layer to the area of the substrate where
17 there are no active regions."

18 Is that right?

19 A. That's what that says, yes.

20 Q. Is that disclosed in Figure 5B?

21 MR. WHITEHURST: Also, you're free to go
22 back and look at your report as well, if that would
23 help.

24 Do you have the report for the '222
25 patent, which is 01244? I know you have a lot of

1 pages.

2 THE WITNESS: Yes. Could you repeat the
3 question?

4 BY MR. SPEEGLE:

5 Q. Sure. We were looking at the last element
6 of Claim 44, right?

7 A. Uh-huh.

8 Q. And my question was does Figure 5B
9 disclose this element?

10 A. Yes.

11 Q. Okay. Can you explain for me how Figure
12 5B discloses this element?

13 A. Well, the well region is the region below
14 the active region at the surface. So the well
15 region has -- is included within the area indicated
16 by the arrows showing the electric field or the
17 motion of the gradient to pull minority carries from
18 the surface.

19 Q. That's what you identified as the single
20 drift layer in a prior element as well?

21 A. Well, the single drift -- there is a
22 single drift layer underneath the active --
23 underneath the channel region of the active devices
24 that will extend down into the well. And then areas
25 are pulled in that direction, and so the -- the

Page 59

1 previous element describes a single drift layer
2 disposed between the other surface of the surface
3 layer. So the surface layer has a top and a bottom.
4 So the bottom of the surface layer --

5 MR. WHITEHURST: Sir, you're under oath.
6 Why don't you read the entire claim before you
7 answer the entire question.

8 MR. SPEEGLE: Alan, you need to let the
9 witness answer the questions.

10 MR. WHITEHURST: It's not a memorization
11 case. It's a consolidated deposition about three
12 different IRPs. He's got lots of reports in front
13 of him. He's got lots of papers. And he's -- as
14 you know, it's not a memorization test, and he is
15 reading the materials so that he can answer the
16 question to the best of his ability.

17 MR. SPEEGLE: Cutting the witness off in
18 his answer to tell him to go read the --

19 MR. WHITEHURST: I have not told him
20 anything other than to read the claim and his
21 report. Nothing more. That is not coaching the
22 witness.

23 THE WITNESS: Can you repeat the question?
24 (The requested portion was read back.)

25 MR. WHITEHURST: Object to form. I think

1 it's probably best if you just reask your question
2 because I think you were referring back to a
3 previous question.

4 Does the question stand?

5 MR. SPEEGLE: I'll ask a new question.

6 BY MR. SPEEGLE:

7 Q. Is the, at least, one well region
8 different from the single drift layer described in
9 Claim 44?

10 A. The single drift layer is larger than the
11 well region, as the claim describes. The well
12 region is in the single drift layer. The single
13 drift layer, however, extends from above.

14 The fourth claim element, a single drift
15 layer disposed between the other surface of the
16 surface layer and the substrate, so forth and so on.
17 The drift layer having a graded concentration. And
18 then it says that the well regions within the drift
19 layer in the fifth and final element. At least one
20 well region disposed in the single drift layer, the
21 well region having a graded concentration.

22 So the well region's in the drift layer.
23 The drift layer can be above the well, potentially,
24 as well as below.

25 Q. Can you identify any portion of Figure 5B

Page 61

1 that would be part of the single drift layer, but
2 not part of the well region?

3 MR. WHITEHURST: Object to form.

4 THE WITNESS: The area under the channel
5 could be part of the single drift layer, whereas the
6 source and drain are counter-doped to the opposite
7 height of the channel, is the same type as the
8 drift -- as the well. So, at some point, the
9 channel ends. The channel's fairly thin. When the
10 channel ends, then it's going to be similar in
11 composition to the rest of the well. Maybe some
12 slight difference in doping, but similar type. So
13 the drift field could start just below the well, and
14 then just below the transistor channel, and then
15 extend down into the well.

16 BY MR. SPEEGLE:

17 Q. I'm being confused now. Is the well
18 bigger than the drift layer or is the drift layer
19 bigger than the well?

20 A. The last claim element describes at least
21 one well region disposed in the single drift layer.
22 So the drift layer could potentially be bigger than
23 the well, yes.

24 Q. Okay. Are you saying that the channel
25 region is part of the drift layer, but not part of

1 the well?

2 MR. WHITEHURST: Object to form.

3 THE WITNESS: I was talking about the area
4 under the channel area.

5 BY MR. SPEEGLE:

6 Q. You described that as part of the single
7 drift layer, but not part of the well?

8 MR. WHITEHURST: Object to form.

9 THE WITNESS: Yes, the area under the
10 channel layer could potentially be still in the
11 active region, but part of the drift layer.

12 BY MR. SPEEGLE:

13 Q. Because it's part of the active region,
14 you would not call it part of the well?

15 MR. WHITEHURST: Object to form.

16 THE WITNESS: It's formed in the well, but
17 it could possibly have different doping than the
18 well. For example, if it's a p-well, it could have
19 additional p-type doping under the channel.

20 BY MR. SPEEGLE:

21 Q. And that would make it part of the single
22 drift layer, but not part of the well, Claim 44?

23 MR. WHITEHURST: Object to form.

24 THE WITNESS: It would be part of the
25 drift layer. I think -- the channel is clearly in

1 the active region. Source and drain are in the
2 active region. The area that is to the depth of the
3 source and drain, you know, at least is the active
4 region.

5 But the channel's not usually as deep as
6 the source and drain. So the area under the channel
7 that's not functionally a channel could be part of
8 the drift region.

9 BY MR. SPEEGLE:

10 Q. Okay. Is the second static unidirectional
11 electric field in Figure 5B different from the first
12 static unidirectional electric field in Figure 5B?

13 MR. WHITEHURST: Object to form.

14 THE WITNESS: Well, it describes a first
15 and a second, so I imagine they are different
16 fields, yes.

17 BY MR. SPEEGLE:

18 Q. Does Figure 5B disclose different fields?

19 MR. WHITEHURST: Object to form.

20 THE WITNESS: It's schematic or pictorial.
21 It just discloses region pulling carriers. It's not
22 very detailed in that regard.

23 BY MR. SPEEGLE:

24 Q. Fair to say, Figure 5B is not detailed
25 enough for you to tell if it practices Claim 44?

1 MR. WHITEHURST: Object to form,
2 argumentative.

3 THE WITNESS: As one of skill in the art,
4 I would understand that the region under the channel
5 is going to be slightly different than the well, at
6 a bare minimum. So, to me, it's reasonable that
7 there be a variation in doping concentrations from
8 just under the channel to the well.

9 BY MR. SPEEGLE:

10 Q. So any time you see a channel in a well
11 region, you would understand that there would be two
12 different static unidirectional electric fields in
13 that configuration?

14 MR. WHITEHURST: Objection to form.

15 THE WITNESS: I wouldn't say any time, but
16 it's reasonable -- it can happen.

17 BY MR. SPEEGLE:

18 Q. Do you think that's the most likely
19 inference from the schematics that you see in 5B?

20 MR. WHITEHURST: Objection to form.

21 THE WITNESS: I think I would need to read
22 Claim 44 and the figure together.

23 BY MR. SPEEGLE:

24 Q. What do you mean by that?

25 A. Well, Claim 44 is part of the patent, and

1 it describes the invention. As one skilled in the
2 art, I understand that channels are doped typically.
3 They're not counter-doped, but they are doped
4 usually to enhance -- further enhance the properties
5 for electrical conductivity so that it has enhanced
6 mobility. The charges move faster between the
7 source and the drain to the channel, so channels are
8 not -- not in this day and age, they're not left
9 just like the well. They're doped.

10 So it's been that way for a long time.
11 Certainly at the time of this invention, the
12 channels were routinely doped.

13 So I would expect that the concentration,
14 as one who is skilled in the art -- that the
15 concentration under the channel would be different
16 than the well.

17 Q. Is there any disclosure in the
18 specification about the channel region being
19 different from the well and this doping type?

20 MR. WHITEHURST: Object to form.

21 THE WITNESS: The specification describes
22 at column 3, line 64 in a paragraph discussing
23 illustrations 5A, B, and C. "Graded dopants can
24 also be implemented in a surface channel MOS
25 devices." It goes on to describe the channel

1 pinch-off is controlled by a graded channel at
2 column 4, line 4 roughly.

3 BY MR. SPEEGLE:

4 Q. Just to pause there, that's for a junction
5 field effect transistor, right?

6 A. Yes.

7 Q. Is that the same thing as we have in
8 Figure 5B?

9 A. Yeah, these are -- MOSFET is a metal oxide
10 semiconductor field effect transistor. So it's --
11 there's bipolar, and there's MOS -- there's FET.

12 Q. Okay.

13 A. It also describes, of course, for bipolar
14 graded bases in the text, and it also shows as prior
15 art Figure 1 that there are graded dopant
16 concentrations in the base of bipolar devices.

17 Q. What is a channel pinch-off?

18 A. Pinch-off means to restrict current flow,
19 essentially.

20 Q. Well, and how would that be --

21 A. Where are you now?

22 Q. This is the same sentence at the top of
23 column 4 you're talking about? "The graded dopant
24 can also be used to fabricate superior junction
25 field-effect transistors where the channel pinch-off

1 is controlled by a graded channel instead of a
2 uniformly doped channel."

3 A. Right.

4 Q. Is this what's described in Claim 44, in
5 your view?

6 MR. WHITEHURST: Objection to form.

7 THE WITNESS: Well, this is related in a
8 way that I see. I understand that channels are
9 doped, so this is an example of doping channels. As
10 one skilled in the art, I understand that there
11 are -- in this day and age, and even back then,
12 there were numerous implant steps to make a
13 transistor: High angle, low-depth implants, halo
14 implants for the -- there are all kinds of implants
15 done, extensions of the source drain to get them a
16 little closer to the channel. There's a lot of
17 implant engineering that goes into transistors,
18 MOSFETs and bipolar.

19 But the MOSFETs had, you know, even at
20 that time, a dozen implants wouldn't be unusual.

21 This is an example here in column 4
22 mentioning that they did dope the channels. So it
23 was commonplace to dope channels.

24 And then, of course, along with the
25 implantation is the annealing, the heating, part of

1 the doping process.

2 BY MR. SPEEGLE:

3 Q. We've talked a lot about Figure 5B, and
4 Figure 5C shows the graded dopant concentration
5 pushing carriers in the opposite direction, right?

6 A. Yes, Figure 5C is a NAND flash device. So
7 this is about getting charges stored on a floating
8 gate, I guess, essentially.

9 Q. And because this pushes carriers up
10 towards the active regions, it would not practice
11 Claim 1 or Claim 44 of the '222 patent, right?

12 MR. WHITEHURST: Object to form.

13 THE WITNESS: Figure 5C doesn't
14 necessarily aid carrier movement to an area where
15 there is no active region. It's accelerating
16 carriers toward the active region during
17 programming. That's what's described in 5C.

18 BY MR. SPEEGLE:

19 Q. So it does not practice Claim 1 or Claim
20 44?

21 MR. WHITEHURST: Object to form.

22 THE WITNESS: It would show some of the
23 claim elements in 1 and 44, but it doesn't show the
24 last claim element in 1 and 44. It's illustrative
25 for some purposes, but not for the last claim

1 element, no.

2 BY MR. SPEEGLE:

3 Q. This field that we're looking at in Figure
4 5C that accelerates carriers towards the surface,
5 would that be electrons or holes?

6 MR. WHITEHURST: Object to form.

7 THE WITNESS: Well, it's an n-channel
8 device. It's N source and drain, so it's pulling --
9 in order to conduct, it's going to have to pull
10 electrons. I believe this is probably pulling
11 electrons up until floating gate.

12 BY MR. SPEEGLE:

13 Q. So that field would accelerate holes down,
14 right?

15 MR. WHITEHURST: Object to form.

16 THE WITNESS: Well, but if it was
17 accumulating -- how should I put this? The general
18 effect of an electric field is to act in opposite
19 directions on different -- opposite charges. So to
20 the extent that it's carrying electrons up, it will
21 have some effect on holes; however, this device
22 functions by storing one type on a floating gate.
23 Presumably -- I mean, gate controls -- yeah, it's
24 kind of -- it's just a schematic. It's not very
25 detailed. But yeah, presumably, it's a floating

Page 70

1 gate, so it stores charge to stay on.

2 Let me read.

3 The question again, please?

4 BY MR. SPEEGLE:

5 Q. You know, I think you answered my
6 question. Let's move on.

7 MR. WHITEHURST: Are we at a good stopping
8 point?

9 MR. SPEEGLE: Sure.

10 (Luncheon recess.)

11 BY MR. SPEEGLE:

12 Q. All right, Dr. Glew, I would like to turn
13 to the '842 patent, if you have that in front of
14 you.

15 A. Let me clear some stuff.

16 Q. Make sure we keep Exhibit 1100 separate
17 from the rest of those. I think that's the bottom
18 paper in your hand.

19 And I'll start by asking you if Figure 5B
20 in the '842 patent is the same as Figure 5B that
21 we've been talking about in the '222 patent?

22 A. It should be, yes.

23 Q. And if we look at Claim 1 of the '842
24 patent, does Figure 5B also disclose what's in Claim
25 1 of the '842 patent?

Page 71

1 A. Similar to before. 5B generally discloses
2 it. It's a blow-up, so it's further disclosed in
3 adjacent figures to that.

4 Q. Okay. Is there any substantial
5 difference -- well, we'll just go through this.

6 5B shows a semiconductor device, right?

7 A. Yes, Figure 5B shows a semiconductor
8 device.

9 Q. And it has a substrate of a first doping
10 type, at a first doping level, having a first and
11 second surfaces?

12 A. Excuse me.

13 MR. WHITEHURST: Object to form.

14 THE WITNESS: Yes, it has a substrate of a
15 first doping type at a first doping level. I mean,
16 second surface.

17 BY MR. SPEEGLE:

18 Q. And the second element refers to a first
19 active region in Claim 1 of the '842 patent, right?

20 A. Yes, it refers to a first active region.

21 Q. And the first active region, is it similar
22 to what we discussed in Claim 1 of the '222 patent,
23 has a opposite doping type from the substrate?

24 MR. WHITEHURST: Object to form.

25 THE WITNESS: Yes, generally, that's --

1 BY MR. SPEEGLE:

2 Q. Is it generally the same as what we
3 discussed with Claim 1 of the '222 patent for Claim
4 1 of the '842?

5 A. For this claim element, yes, generally.

6 Q. And I believe you said before that because
7 Figure 5B shows an NPN device, that would have the
8 same doping type, in your view, as the p-type
9 substrate, but the CMOS complement would have the
10 PNP, which would be opposite to the p-type
11 substrate.

12 Am I reading that right?

13 A. Yes, as well as being shown in Figure 5A.

14 Q. Okay. And the third element in Claim 1 of
15 the '842 is a second active region.

16 Do you see that element?

17 A. Yes.

18 Q. And is that disclosed in Figure 5B similar
19 to what we discussed for Claim 1 of the '222 patent?

20 A. Yes, it's similar. 5B is CMOS and shown
21 in -- shown better in 5A.

22 Q. Okay. And the next element here are,
23 "Transistors formed in at least one of the first
24 active region or second active region," right?

25 A. Yes, that's what it says.

1 Q. Is that also shown in Figure 5B of '842?

2 A. Yes, it is.

3 Q. And the last element is, "At least a
4 portion of at least one of the first and second
5 active regions having at least one graded dopant
6 concentration to aid carrier movement from the first
7 surface to the second surface of the substrate."

8 Do you see that?

9 A. I see that, yes.

10 Q. Is that disclosed in Figure 5B?

11 A. Yes.

12 Q. And it's your understanding that the
13 graded dopant region disclosed in Figure 5B extends
14 into the active region?

15 MR. WHITEHURST: Object to form.

16 THE WITNESS: I have to review my report.

17 As indicated in Figure 5B, and as I've
18 indicated on page 17 of my declaration, on the '842
19 patent, IPR 01243, I've indicated the field starts
20 at the bottom of the -- the graded dopant region
21 pulls minority carriers from the bottom of the
22 active region, underneath the channel, downward.

23 BY MR. SPEEGLE:

24 Q. And the minority carriers in the
25 annotation you directed me to on page 17, are those

Page 74

1 holes or electrons?

2 A. In this case, the channel needs to be
3 formed out of N, electrons, so the holes would then
4 be minority carriers. So the majority carriers --
5 majority carrier for an N source drain is an N.

6 Q. Would you describe this graded dopant
7 region pointed to in this figure as pulling carriers
8 from the source to the drain?

9 MR. WHITEHURST: Object to form.

10 THE WITNESS: Are you referring to the
11 arrows, the downward-facing arrows? I don't think I
12 understand your question.

13 BY MR. SPEEGLE:

14 Q. Okay. Let's do it this way:

15 Would the graded dopant region described
16 in Figure 5B pull minority carriers between the
17 source and the drain of the transistors shown in 5B?

18 MR. WHITEHURST: Object to form.

19 THE WITNESS: The direction of pull is
20 downward, toward the area away from the active area,
21 active region. They may originate between the
22 source and drain, but the direction of the pull is
23 downward.

24 BY MR. SPEEGLE:

25 Q. Okay. At the end of paragraph 37, it

1 extends to the next page you have in front of you,
2 you cite column 3, line 38 through 43 of the '842
3 patent to support the statement that, "This improves
4 the speed and performance of the transistor."

5 Do you see that?

6 A. I see my text, yes.

7 Q. And my question is isn't the text that you
8 cite to here on column 3, lines 38 through 43 -- is
9 that described in the operation of an IGBT?

10 MR. WHITEHURST: Object to form.

11 THE WITNESS: The specific example given
12 is for an IGBT, although the last sentence in that
13 citation, "This can improve Toff -- Ton and Toff in the
14 same device," is essentially the idea I'm trying to
15 get across here, which is it will enhance on/off
16 speed.

17 BY MR. SPEEGLE:

18 Q. Prior sentence in column 3, the -- for
19 example, and I -- let me start over.

20 "For example, in an n-channel IGBT,
21 electrons can be swept from source to drain rapidly
22 while at the same time, holes can be recombined
23 closer to the n+ buffer layer."

24 Did I read that right?

25 A. You read that correctly, yes.

Page 76

1 Q. And can you explain why electrons being
2 swept from source to drain would improve Ton and Toff?

3 MR. WHITEHURST: Object to form.

4 THE WITNESS: This is a MOSFET, not a
5 bipolar device or IGBT, so it behaves a bit
6 differently.

7 General concept here is that the on/off
8 time, in this instance, would also be improved.
9 This type of invention is used for improving
10 speed -- on/off speed of a transistor.

11 BY MR. SPEEGLE:

12 Q. The physical mechanism by which on/off
13 time for an IGBT or a MOSFET would be improved is
14 different, right?

15 A. Yes, they are different mechanisms,
16 physically.

17 Q. And the physical mechanism that's being
18 described in the passage from the patent you've
19 cited is from actually accelerating electrons
20 between the source and drain, right?

21 MR. WHITEHURST: Object to form.

22 THE WITNESS: Yes, the IGBT functions
23 differently. Its speed is enhanced in a different
24 mechanism.

25 ///

1 BY MR. SPEEGLE:

2 Q. Okay. And the '842 patent doesn't say
3 that the on/off time for a MOSFET would be improved
4 by using the device, does it?

5 MR. WHITEHURST: Object to form.

6 THE WITNESS: The patent describes at
7 column 4, line 19, "Moreover, single-well and
8 triple-well CMOS fabrication techniques can also be
9 optimized to incorporate these embodiments
10 individually and collectively."

11 As one of skill in the art, I understand
12 that the mechanism for Figure 5B is as I described.

13 BY MR. SPEEGLE:

14 Q. Okay. And why would that mechanism in
15 Figure 5B improve on/off time?

16 A. Well, the gate -- the gate voltage -- the
17 gate electrode that provides the voltage has a job,
18 which is to, in this case, attract electrons to the
19 channel region and push away the holes. That's done
20 with a voltage. Any additional voltage that is
21 provided, for example, from a gradient, would aid
22 the effect of allowing conduction from the source to
23 the drain by enhancing the electron concentration in
24 the channel region.

25 Q. So the graded dopant concentration is

1 going in the same direction as the electric field
2 applied by the gate transistor? I'm sorry. Let me
3 say that again.

4 The graded dopant concentration applies an
5 electric field in the same direction as when the
6 gate is active on the transistor?

7 MR. WHITEHURST: Object to form.

8 THE WITNESS: Yes, essentially, it would
9 have, you know, a similar effect, yes, of pushing
10 electrons up, pulling electrons down.

11 BY MR. SPEEGLE:

12 Q. Wouldn't that slow down the off time?

13 A. Well, on and off or on and -- on and off
14 are two different things.

15 Q. So it would help the on time, but it would
16 hurt the off time?

17 MR. WHITEHURST: Object to form.

18 THE WITNESS: Generally, yeah, that's --
19 you can optimize one or the other.

20 BY MR. SPEEGLE:

21 Q. So the statement in column 3 that you
22 cited about improving both Ton and Toff in the same
23 device, that would not apply to the mechanism in 5B
24 because Toff would not be improved by the graded
25 dopant concentration we discussed?

1 A. Well, with a MOSFET device, you're going
2 to probably improve one or the other, bipolar
3 different structure.

4 Q. And I want to direct you to column 3,
5 lines 48 and 50. There's --

6 A. Column 3 at 48, 50?

7 Q. There's a sentence that starts with,
8 "Spurious minority carriers."

9 Do you see that?

10 A. Yes.

11 Q. And this is talking about specifically the
12 configuration, the MOSFETs for 5B, right?

13 A. It's talking, I think, specifically
14 about -- well, it makes a reference to NAND flash
15 and DRAM, so I'd have to look more at the context,
16 if you have a question.

17 Q. And do you agree with the patent says in
18 this paragraph about, "The graded dopant
19 concentration assisting with spurious minority
20 carriers"?

21 A. It does say -- it says spurious minority
22 carriers can be generated. The passage you cited
23 hasn't -- this paragraph eventually gets to other
24 subject.

25 That particular passage you cited, I

1 think, just mentions that spurious carriers are
2 generated by switching.

3 Q. Okay. And the next sentence says that --
4 it describes the down side of spurious carriers;
5 that they "can discharge dynamically held actively
6 high nodes." Is that right?

7 A. Yes.

8 Q. And then towards the bottom of the column
9 3, there's a sentence -- this is the next-to-last
10 sentence in column 3 says, "In a preferred
11 embodiment, the subterranean N layer has a graded
12 donor concentration to sweep the minority carriers
13 deep into the substrate."

14 Do you see that?

15 A. I see that passage.

16 Q. Do you agree that the graded dopant
17 concentration would assist with the spurious
18 minority carriers described here?

19 MR. WHITEHURST: Object to form.

20 THE WITNESS: I believe that this is one
21 of the possible benefits, yes.

22 BY MR. SPEEGLE:

23 Q. Are you familiar with the idea of spurious
24 minority carriers as a problem in transistors prior
25 to your work on this matter?

1 A. Yes, as it describes, just the act of
2 switching creates complications, noise, yeah, it's
3 memory -- the problem with memory is the amount of
4 time that it holds and refresh, noise and the image
5 sensors is common, so those are routine problems.

6 Q. How many carriers would be -- would need
7 to be present before they created an issue in the
8 noise that you're talking about?

9 MR. WHITEHURST: Object to form.

10 THE WITNESS: It depends on the device.
11 That's a very -- it's an incomplete hypothetical.

12 I would say, in general, the smaller the
13 device, the fewer it takes to create problems.

14 NAND is, you know, generally more
15 sensitive than DRAM with image sensors. Again, it
16 depends on how -- how high performance the sensor
17 is.

18 BY MR. SPEEGLE:

19 Q. Do the claims specify a number of carriers
20 that have to be impacted to practice the claims?

21 MR. WHITEHURST: Object to form.

22 THE WITNESS: I don't recall seeing a
23 limitation regarding the number of holes or
24 electrons that need to be transported, no.

25 ///

1 BY MR. SPEEGLE:

2 Q. I saw you reviewed that '842 patent to
3 give that answer. Would your answer be the same for
4 the '222 patent?

5 A. I've never looked for that. Based upon a
6 brief review, I don't see a follow-up for the number
7 of electrons or holes that need to be moved.

8 Q. Okay. Let's go to paragraph 33 in your
9 declaration for the 01243 -- the '842 declaration.

10 A. Paragraph 32?

11 Q. 33.

12 A. 33.

13 Q. At the end of this paragraph 33, you
14 describe a phenomenon that you call carrier drift.
15 Is that right?

16 A. Yes.

17 Q. And can you explain what carrier drift is
18 to me?

19 A. Well, as I've described in paragraph 33,
20 charged carriers that move in a direction of the
21 gradient, with the appropriate polarity, have the
22 net effect of drifting in one direction, the
23 direction of the gradient.

24 Q. And how does the -- how does a graded
25 dopant concentration relate to the idea of carrier

1 drift?

2 MR. WHITEHURST: Object to form.

3 THE WITNESS: There's really two things
4 that go on, but one is the gradient of a charge
5 causes electrical -- electrical field.

6 And I'll give a simple example. If you
7 accumulate charges, if you were to take a hundred
8 electrons and put them in one place, they give off
9 an electric field, they radiate an electric field.
10 If you increase the number of charges in one area,
11 then it increases the electric field around it. So
12 if I had a pile of a million electrons and a pile of
13 900,000 electrons and I work my way down to zero, I
14 would have a change in the charge density, which
15 would result in the change in the field given off
16 over a distance.

17 The gradient is just the first derivative.
18 It's a differential operator. So it's the slope,
19 literally.

20 So the slope of the charge densities are
21 proportional to the field that's given off. So this
22 charge gradient produces a field which will act upon
23 other charge particles.

24 BY MR. SPEEGLE:

25 Q. So when dopants are implanted in silicon

1 at differing concentrations, that creates an
2 imbalance in net charge over that piece of
3 silicon --

4 MR. WHITEHURST: Object to form.

5 BY MR. SPEEGLE:

6 Q. -- right?

7 A. I wouldn't call -- I wouldn't say that,
8 no. What I'd say is the charge neutrality condition
9 prevails, which means that in the end, everything's
10 neutral overall.

11 But what happens is there are either extra
12 electrons or extra holes in an area which are free
13 to float about and -- or relatively free. There are
14 three kinds of materials. There are insulators, in
15 which case an electric field doesn't cause anything
16 to move. It's an insulator. There's no current
17 flow. Nothing perceptible. No material is perfect,
18 but we'll say the perfect insulator, no current.

19 A metal, on the other hand, has what's
20 known as a sea of electrons. There are electrons
21 that are basically -- extremely loosely tied to the
22 atoms from which they originate.

23 So an electric field in a metal will cause
24 motion of electrons current, not -- I mean, it's got
25 to be beyond just minuscule, but, you know, any

1 reasonable electric field and a metal will cause
2 motion.

3 Semiconductor is in between. A perfect
4 semiconductor is a pretty good insulator. A highly
5 doped semiconductor. We're not really talking about
6 anything at this level here. It acts like a metal.
7 In the middle, it acts like -- a doped semiconductor
8 acts like a variable resistor, essentially. The
9 resistance changes based upon the doping levels.

10 There's sort of a threshold voltage which
11 it takes for anything to move, and then when it does
12 move, there's a significant amount of resistance
13 compared to a metal.

14 Wafers, for example, that aren't doped,
15 they're just basically insulators.

16 When you buy doped wafers, you buy them by
17 resistance action. What's the resistance of this
18 wafer?

19 So I wouldn't say that there's a net
20 charge per se. It's just -- it's a local phenomenon
21 where there's either extra electrons or extra holes
22 that are free -- relatively free, notwithstanding
23 their threshold voltage and their resistance to
24 move.

25 Q. Okay. Thank you for that detailed

1 description.

2 Is it accurate to say that the doping of a
3 silicon at different concentrations through some
4 mechanism results in a static electric field within
5 the silicon?

6 MR. WHITEHURST: Object to form.

7 THE WITNESS: It can, yes. This is a
8 local phenomena. Again, if there are a number of
9 charges piled up in an area and a different number
10 next to it, a gradient, a slope, then, yeah, the
11 voltage that charges give off varies with
12 concentration in the charges that are accumulated.

13 BY MR. SPEEGLE:

14 Q. Is that what's creating the downward force
15 we talked about in Figure 5B?

16 A. That's part of it. Mainly, what we talk
17 about, there is a diffusion, diffusional force too.
18 But, you know, if you think of a drop of ink in a
19 pool, you put it a corner, it doesn't stay there.
20 It will eventually diffuse out.

21 If I had a pile of electrons or holes in
22 one area, and I didn't have them -- I had a dearth
23 next to it, then there's a little bit of diffusional
24 driving force to get them to move. Usually they
25 don't move, really, on their own without some other

1 force, like a little bit of a temperature to
2 activate or a little bit of voltage, but there is a
3 diffusional force also.

4 There's other -- there's other forces that
5 cause things to happen that we're not discussing
6 here: Stress, energy. Any form of energy can cause
7 things to happen, potentially.

8 Q. Okay. So I'm trying to understand the
9 sentence you have in paragraph 33 that says, "When
10 the dopant concentration is graded in a particular
11 direction, other charge carriers will move in the
12 gradient direction or opposite direction, depending
13 on the charges -- charge carrier's polarity."

14 How does that relate to the forces you
15 were just describing?

16 A. Well, if I, say, pushed some electrons out
17 of a channel because I wanted it to be hole rich to
18 turn on or something, when these electrons see a
19 gradient that's friendly to them, a gradient in
20 charge, then it will see an electric field. And if
21 that field, you know, is pointing in the right
22 direction, it sort of pulls or pushes the electrons
23 along the gradient in the concentration of the
24 dopants because that's creating this electric field
25 that points in that direction, either points down or

1 up, you know.

2 Q. Okay. So the graded dopant concentration
3 creates a field that exerts force on charge
4 carriers?

5 MR. WHITEHURST: Object to form.

6 THE WITNESS: The graded dopant -- the
7 graded dopant concentration creates a potential that
8 can act on charge carriers, you know, bearing in
9 mind there is -- there is a threshold voltage. They
10 can't necessarily -- the charge carriers that are
11 free can't necessarily jump from atom to atom
12 without -- without overcoming a certain threshold
13 voltage.

14 BY MR. SPEEGLE:

15 Q. Is that the recombination rate?

16 A. That's a different problem, yeah.

17 So, basically, if there wasn't a threshold
18 voltage, everything would equilibrate immediately.
19 It doesn't happen, you know. There's what's -- you
20 know, for an electron to get from one atom to the
21 next atom, there's a resistance. It's very low in a
22 metal, but in an insulator, it's insurmountable, and
23 in a semiconductor, it's surmountable, but only
24 under certain conditions. Otherwise, you know,
25 there would be instantaneous motion of all material

1 in a semiconductor, which doesn't happen, zero
2 resistance. You know, it's not a superconductor.

3 So charge carriers have to have enough
4 potential on them to actually jump from atom to atom
5 to atom to atom, you know, in a crystal. So
6 crystal -- like, silicon is a crystal. It's
7 actually a single -- it's one big single crystal.
8 Kind of think of it like a diamond ring is one
9 crystal maybe. A semiconductor is one big crystal.
10 And that's why it has the properties it has.
11 Generally, all semiconductors are crystal.

12 So it's going to have this threshold to
13 get from one position to the next position. And,
14 you know -- and even if it does that, there's a
15 certain energy loss or resistance that goes into the
16 motion.

17 Q. You said the recombination raises a
18 different problem. What does the recombination rate
19 have to do with?

20 A. Well, if an electron and a hole meet, what
21 happens, essentially, a hole is a vacancy in a
22 valence band. So there's -- you know, if you have
23 an atom with, let's say -- we'll do a round
24 number -- eight electrons in its valence -- in its
25 valence shell, these are not electrons that are

1 free, they're bound to the electron. If one of
2 those is missing, that's a hole.

3 Now, if an extra electron comes along and
4 meets this missing spot in a valence, the best way
5 for the electron to reduce its energy is to drop
6 into the valence shell. So they cancel each other
7 out.

8 I don't want to say it's like credit and
9 debit, but, basically, the electron and the hole
10 meet, and that can -- that is known when they
11 recombine as the recombination.

12 Q. Atom photon?

13 A. Yes, it could.

14 Q. Could that photon potentially knock
15 another electron out of the valence layer?

16 MR. WHITEHURST: Object to form.

17 THE WITNESS: It depends on what it's
18 doing. It can emit photons, it can emit phonons.
19 So phonons are lattice vibrations. You might think
20 of it as heat, making the crystal vibrate, get
21 warmer.

22 So it can do phonons, it can do photons.
23 This is all quantum mechanics. The energies have to
24 line up, and so yeah, there's limitations.

25 ///

1 BY MR. SPEEGLE:

2 Q. You said that a graded dopant
3 concentration creates a potential. Am I remembering
4 that right?

5 MR. WHITEHURST: Object to form.

6 THE WITNESS: Essentially, something like
7 that, yes.

8 BY MR. SPEEGLE:

9 Q. Is that the same as creating an electric
10 field?

11 MR. WHITEHURST: Object to form.

12 THE WITNESS: Yeah, you know, the field --
13 electric field has a potential to it, a potential
14 energy. We use the term sometimes similarly.

15 BY MR. SPEEGLE:

16 Q. Okay. Electric fields are vectors, right?
17 They have a magnitude and a direction?

18 A. An electric field generally, yes, has X,
19 Y, and Z components.

20 Gradient is the same. A gradient is
21 actually the derivative with respect to each
22 direction, X, Y, or Z. Or if you're in a different
23 coordinate system, that coordinate system.

24 Q. Is the -- is magnitude to the electric
25 field proportional to the magnitude of the gradient?

1 MR. WHITEHURST: Object to form.

2 THE WITNESS: Yes. As I said earlier, you
3 know, the -- I believe I said that earlier, the
4 field -- the drift force, however you want to think
5 of it, is going to be proportional to the change in
6 charge -- charge density, which is the -- that
7 changes the gradient, and it's literally a vector in
8 each direction.

9 BY MR. SPEEGLE:

10 Q. Okay. Referring to paragraph 36, you say
11 that, "Positive electric field repels the positive
12 holes downwards while the negative electrons, red
13 circles, are attracted to move into the blue surface
14 layer."

15 Did I read that right?

16 A. Yes, I believe so.

17 Q. All right. So am I understanding
18 correctly that the direction in which an electric
19 field would move a carrier has to do with the
20 polarity of the carrier?

21 MR. WHITEHURST: Object to form.

22 THE WITNESS: Yes, the direction of
23 force -- whether the force is sufficient to move the
24 carrier or not is another question, but the
25 direction of force is opposite for opposite

1 polarities.

2 BY MR. SPEEGLE:

3 Q. You're talking about the -- this
4 particular quote that I was reading on paragraph 36
5 is talking about an electric field from the gate,
6 which you've illustrated on, I believe, it's page 16
7 of your '842 declaration. Is that right?

8 A. I'd have to double-check that, but -- I'm
9 not sure if I'm talking about 16 or 17 here yet.

10 I think 36 is directed toward the figure
11 at the end of it or in the middle of it.

12 Q. Okay. The one on page 17?

13 A. Yeah.

14 Q. Okay. That electric field that's being
15 described, and I believe it's annotated with little
16 plus signs above the oxide. Is that right?

17 A. There are plus signs above the oxide, yes.
18 Those are positive.

19 Q. Okay. That's a positive electric field
20 coming from that gate, correct?

21 A. Yes, the gate electrode provides, in this
22 case, it looks like a positive potential.

23 Q. Okay. All right. Is it accurate to state
24 that positive electric field from the gate would
25 impede the positive carriers moving up towards the

Page 94

1 gate?

2 MR. WHITEHURST: Object to form.

3 THE WITNESS: I mean, I think of it more
4 like it repels -- it literally pushes them away. So
5 there's an oxide underneath the gate, so that -- and
6 no current can go through the oxide, but the field,
7 the electric field, goes through the oxide.

8 Think of oxide is also thought of as glass
9 or something. So the electric field goes right
10 through, but the electrons don't. So the electric
11 field pushes -- goes through the oxide and then
12 pushes away positive charge and attracts the
13 negative charge up. This is known as the field
14 effect. That's why we call it FET.

15 BY MR. SPEEGLE:

16 Q. Does an electric field exert a force on
17 all charge particles in the field or just some of
18 them?

19 MR. WHITEHURST: Object to form.

20 THE WITNESS: Can you repeat the question?

21 BY MR. SPEEGLE:

22 Q. Does an electric field in a given space
23 exert a force on all charge particles in that space
24 or only some of the particles?

25 MR. WHITEHURST: Object to form.

1 THE WITNESS: That's a complicated
2 question. The electric field starts at one end of
3 it or one side of it, and it interacts with the
4 charge particles in the field or in the region.
5 Eventually the field is canceled out. So at some
6 point, the field no longer exists. It reads -- it
7 basically balances itself out.

8 You know, if you look at, like, the
9 transistor here as an example, the -- when enough
10 electrons accumulate underneath the oxide, they
11 start repelling any other electrons that might come
12 close. So it's kind of really complex interaction
13 between all of the charges in the region and an
14 electric field, and eventually they have to balance
15 out.

16 BY MR. SPEEGLE:

17 Q. Let me ask it this way: Will charge
18 particles that create an electric field interact
19 with all other charge particles in a given space or
20 will charge particles only interact with some other
21 charge particles?

22 MR. WHITEHURST: Object to form.

23 THE WITNESS: Again, complicated. The
24 charge particles interact to a certain distance, and
25 then at some point, that distance can be canceled

1 out or the charge is canceled out so they're no
2 longer -- interact.

3 You know, does -- and at some point, you
4 know, the field is -- the field is complicated. You
5 can apply an external field, and then the charges
6 build up a field of their own, but the charge is
7 over a sphere. So it goes -- it drops off as radius
8 cubed, volume of sphere.

9 BY MR. SPEEGLE:

10 Q. So the charges are R-cubed or R-squared?

11 A. Well, the surface is squared. The volume
12 is cubed. So eventually the charge has to diminish
13 that come from the --

14 Q. I would have sworn Coulomb's Law is
15 R-squared again. Maybe I misspoke. I'm sorry. I'm
16 trying to put this in --

17 MR. WHITEHURST: This transcript is
18 getting messy. I'm not sure if there's a Q --
19 question and answer, so --

20 THE WITNESS: Eventually -- so the charge
21 from the -- the field from the charges eventually
22 dies off. It drops off for distance, and it
23 interacts with the other charges.

24 The field that was external that was
25 applied to one side interacts with the charges.

So that's about, you know -- that's kind of a simple description of what's going on.

So there is interaction, but it's a complex interaction.

BY MR. SPEEGLE:

Q. You're familiar with Coulomb's Law, right?

A. Generally.

Q. It's the force between two charge particles --

A. Yeah.

Q. -- constant times --

MR. WHITEHURST: Wait. You guys are talking over each other. We need a question, and we need an answer. Otherwise, this transcript is going to be a mess.

MR. SPEEGLE: Okay.

BY MR. SPEEGLE:

Q. You recall that Coulomb's Law is a description of the force between two charge particles, correct?

A. Yes.

MR. WHITEHURST: Give me a chance to object.

Go ahead.

///

1 BY MR. SPEEGLE:

2 Q. All right. Coulomb's Law holds true for
3 any two particles interacting with each other,
4 right?

5 MR. WHITEHURST: Object to form.

6 THE WITNESS: Assuming they're interacting
7 with each other, yeah. They're not screened from
8 each other or something, yeah.

9 But what's going on in the -- well, if
10 you're just asking about Coulomb's Law -- what's
11 going on here is there's other charge particles in
12 between each other, so -- and there's also -- there
13 is a dielectric effect potentially where, you know,
14 the electric field changes when it goes through an
15 imperfect dielectric.

16 BY MR. SPEEGLE:

17 Q. What do you mean by that?

18 A. A -- some dielectrics pass the field
19 pretty well. Other dielectrics kind of interfere
20 with the passing of an electric field.

21 Q. We've been looking at this page 17 and
22 Figure 36 of your declaration. This is describing
23 the impact of electric fields on carriers
24 specifically in the active region, right?

25 MR. WHITEHURST: Object to form.

1 THE WITNESS: I think paragraph 36 is
2 talking specifically about the channel.

3 BY MR. SPEEGLE:

4 Q. Do you consider the channel part of the
5 active region?

6 A. The channel would be considered part of
7 the active region, yes.

8 Q. Okay. That's not the only place there's
9 going to be carriers in a semiconductor device,
10 right?

11 MR. WHITEHURST: Object to form.

12 THE WITNESS: Well, yeah, I mean, it's a
13 big electronic circuit. There's carriers throughout
14 the circuitry. In this figure, we're looking at the
15 channel -- the charges shown in the channel region.

16 BY MR. SPEEGLE:

17 Q. Let's look at paragraph 37, I guess, which
18 is the next paragraph there.

19 And you say in the first sentence of
20 paragraph 37, "It is possible to pull carriers from
21 the silicon's surface," right?

22 MR. WHITEHURST: Object to form.

23 THE WITNESS: Yes, it says "to pull
24 carriers."

25 ///

1 BY MR. SPEEGLE:

2 Q. And am I right that it's an electric field
3 that is pulling carriers, in this context?

4 A. Essentially, yes. And then the sentence
5 describes it as a graded concentration of dopants
6 resulting in a drift layer, yes. That's a, I
7 believe, field that's pulling.

8 Q. Let's turn -- I'm actually looking at -- I
9 think it's the same content, but I'm actually
10 looking at your '222 declaration in the 01242
11 patent.

12 MR. WHITEHURST: Which of the declarations
13 do you want us to look at?

14 MR. SPEEGLE: The first one. The 1242.

15 MR. WHITEHURST: Is there a particular
16 inquiry?

17 BY MR. SPEEGLE:

18 Q. Do you see at the bottom of page 26,
19 there's a section where you say, "There are three
20 possibilities." Do you see that section?

21 MR. WHITEHURST: You're looking at page
22 27?

23 MR. SPEEGLE: Yes, paragraph 49, bottom of
24 page 26.

25 THE WITNESS: Yes.

1 BY MR. SPEEGLE:

2 Q. You're saying here that the -- given
3 dopant concentration field can either teach that the
4 gradient -- concentration gradient aids carrier
5 movement, the concentration gradient impedes carrier
6 movement, or silent as to what the concentration
7 gradient aiding or impeding carrier movement. Is
8 that right?

9 A. I've written that essentially, yes.

10 Q. What do you mean by that?

11 A. Well, in some cases, the dopant
12 concentration can perform different functions. In
13 some cases, it may be interested in moving charge
14 from one point to another.

15 A simple example would be, we talked about
16 earlier, and I'm trying to pick things that are
17 non -- not an issue here, really. A graded channel
18 may help move a charge from a source to a drain.

19 On the other hand, sometimes they use
20 charges as barriers to keep charges from entering a
21 well or something.

22 They used to try -- it doesn't work real
23 well, and it was a long time ago, but they'd use
24 barriers around wells to keep the wells separate.

25 In the end, nothing worked better than an

1 isolation trench, a dielectric between the wells.
2 But they try to have a barrier to keep, you know,
3 like a gate to keep things out, to keep charge out.
4 Or it could be simply it doesn't tell you what it's
5 doing.

6 Q. Would you agree with me that a given
7 electric field can both impede movement and help
8 movement?

9 MR. WHITEHURST: Object to form.

10 THE WITNESS: It would depend upon the
11 context of what was going on. You know, in a
12 channel, for example, once the gate turns on, the
13 gate electrode is powered up, has a potential,
14 there's a certain type of carrier in the channel,
15 and then the graded channel would -- it would --
16 there would only be one type of carrier there. Its
17 only purpose would be to move the carriers from the
18 source to the drain.

19 BY MR. SPEEGLE:

20 Q. Okay. And an electric field that aids
21 movement of an electron in a given direction would
22 resist movement in the opposite direction by the
23 same electron, right?

24 MR. WHITEHURST: Object to form.

25 THE WITNESS: I would say generally an

1 electric field acts opposite on an electron -- or
2 positive in a negative charge. A positive --
3 negative field will attract a positive charge and
4 repel a negative charge.

5 BY MR. SPEEGLE:

6 Q. That's a good way to say it.

7 So if I have a positive electric field
8 going from X equals 0 to X equals 1, and I have an
9 electron trying to move from X equals 0 to X equals
10 1, the positive field is going to pull that electron
11 opposite of the way the electron is trying to move,
12 right?

13 MR. WHITEHURST: Object to form.

14 THE WITNESS: Like I said earlier,
15 basically, a positive field attracts electrons and
16 repels positive charges.

17 BY MR. SPEEGLE:

18 Q. Right.

19 A. That's just basic electrical field.

20 Q. So if an electron has a velocity going in
21 the -- away from a positive electric field, the
22 positive electric field will impede that motion --

23 MR. WHITEHURST: Object to form.

24 BY MR. SPEEGLE:

25 Q. -- right?

1 A. A positive electric field will attract the
2 electron toward it.

3 Q. Which is the opposite in my hypothetical.
4 The opposite direction of my electron's current
5 velocity, so it would be a breaking force on the
6 electron, right?

7 MR. WHITEHURST: Object to form.

8 THE WITNESS: In that language, a positive
9 charge, assuming, A, a positive field attracts a
10 negative charge, so yeah, if you fired an electron
11 in one direction, you can potentially decelerate it
12 with a positive charge.

13 BY MR. SPEEGLE:

14 Q. And if it was a negative electric field, I
15 fired my electron in the same direction, my negative
16 electric field would accelerate that electron going
17 away from the field, right?

18 MR. WHITEHURST: Object to form.

19 THE WITNESS: Generally, yeah, the --
20 negative field will repel a negative charge.

21 BY MR. SPEEGLE:

22 Q. And so whether the electron is repelled
23 or -- let me put it this way: Whether the electron
24 is accelerated or decelerated by a given electric
25 field depends on the alignment of the field and the

1 electron's intended velocity, right?

2 MR. WHITEHURST: Object to form.

3 THE WITNESS: The electric field direction
4 provides either a positive -- either an attractive
5 or repelling force on a charge, depending on the
6 direction of the field.

7 BY MR. SPEEGLE:

8 Q. And you need to know the direction of an
9 electron's velocity to know whether that force will
10 accelerate or decelerate the electron, right?

11 MR. WHITEHURST: Object to form.

12 THE WITNESS: Not exactly.

13 BY MR. SPEEGLE:

14 Q. How can you know if the -- if an electric
15 field will accelerate or decelerate an electron if
16 you don't know the electron's velocity relative to
17 the electric field?

18 A. Well, electric field provides a force on a
19 charge. The force will be in the direction of the
20 electrical vector. The velocity can have multiple
21 directions to it. It doesn't -- you know, the force
22 is only going to act on the -- in the direction of
23 the electrical field vector.

24 Q. Right. So the electric -- if the
25 electrical field vector is in the same direction as

1 the electron's velocity, that will result in
2 accelerating the electron, right?

3 MR. WHITEHURST: Object to form.

4 THE WITNESS: It doesn't matter what
5 direction it's going in. The electric field will
6 act in that direction.

7 BY MR. SPEEGLE:

8 Q. Whether the speed, which is the scaler,
9 increases or decreases will depend on if the current
10 velocity and the electric field vector are aligned,
11 right?

12 MR. WHITEHURST: Object to form.

13 THE WITNESS: No.

14 BY MR. SPEEGLE:

15 Q. Why not?

16 A. Well, the electric field will act on the
17 charge and provide it with an acceleration velocity
18 in the direction of the electric field. That
19 electric particle -- that particle, if it previously
20 had a velocity vector, now has a new velocity
21 vector, which is a combination of the old one and
22 the new one, so it has more velocity, unless it was
23 180 degrees opposed.

24 Q. Right. If the direction is 180 degrees
25 opposed, it would slow down based on the application

1 in the electric field vector?

2 MR. WHITEHURST: Object to form.

3 THE WITNESS: If it was 180 degree
4 opposed, yes, then it would slow down.

5 BY MR. SPEEGLE:

6 Q. You have to know the direction of the
7 velocity to know whether it's going to speed up or
8 slow down because if it is 180 degrees opposed, it
9 will slow down?

10 MR. WHITEHURST: Object to form.

11 THE WITNESS: 180 degrees opposed would
12 slow down, yes. The others would actually
13 accelerate.

14 BY MR. SPEEGLE:

15 Q. So when you talk about in paragraph 49 a
16 concentration gradient aiding carrier movement or
17 impeding carrier movement, that cannot be agnostic
18 to the direction of the carrier movement, right?

19 MR. WHITEHURST: Object to form.

20 THE WITNESS: Well, a field will provide a
21 force in a direction aiding -- direction -- aiding
22 movement in the direction of the force. That's just
23 basic physics. I'm not sure what --

24 BY MR. SPEEGLE:

25 Q. Unless --

1 MR. WHITEHURST: I don't think he had
2 finished the answer. You cut him off. Do you want
3 to let him finish?

4 BY MR. SPEEGLE:

5 Q. Please finish.

6 A. I'm not sure, beyond that, what there is
7 to say, you know. The field -- the force of the
8 electric field and its direction provide -- aids
9 movement in the direction of the field.

10 Q. And it impedes movement in the opposite
11 direction?

12 A. Yeah, in -- the 180 degree opposite
13 direction, yes, it will repel, and it pushes it
14 away.

15 MR. SPEEGLE: We've been going about an
16 hour. Let's take a break.

17 (Recess.)

18 BY MR. SPEEGLE:

19 Q. Dr. Glew, could you turn to page 28 in
20 your 1242 declaration.

21 A. Yes.

22 Q. And at the top of page 28, you have an
23 excerpt from the Kawagoe reference, right?

24 A. Yes.

25 Q. I've just handed you what's been marked in

1 each of these proceedings as Exhibit 1007.

2 Do you see that?

3 A. Yes.

4 Q. And this is the Kawagoe reference that's
5 issued in these IRPs, right?

6 A. Yes.

7 Q. Now, on page -- on the excerpt that you
8 have from column 16 of Kawagoe, I'm looking at page
9 28 of your declaration, there's a statement at the
10 top about, "The impurity concentration of the p-well
11 6P is given such a gradient that it is gradually
12 lowered in a depthwise direction from the surface of
13 the epitaxial layer 2E, so that the influence to be
14 caused by the carriers or electrons due to alpha ray
15 is lowered."

16 Do you see that?

17 A. Yes.

18 Q. If you look at Figure 17 in Exhibit 1007,
19 does the graph in Figure 17 show the reduction in
20 the impurity concentration in the p-well that's
21 being described in the quote from column 16 of
22 Kawagoe?

23 A. Yes, as described in column 15, this
24 paragraph is discussing Figure 16 and 17. So the
25 question specifically was is this the p-well?

Page 110

1 Q. Well, the -- I'm just trying to figure out
2 if the graph on Figure 17 reflects the features that
3 appear in the paragraph you quoted in your
4 declaration.

5 MR. WHITEHURST: Object to form.

6 THE WITNESS: I would say yes. Generally,
7 starting at column 15, lines 61, roughly, through
8 column 16, line 40 discusses Figure 16 and 17. I've
9 cited to a portion of that at page 20 of my report.
10 BY MR. SPEEGLE:

11 Q. Okay. So the impurity concentration shown
12 in Figure 17, the slope of the thick line identified
13 as NW, that's what reflects the dopant
14 concentration, right?

15 A. Let me review the text again briefly.

16 Column 16, line 27 describes, "The well
17 concentration NW of the p-well 6p," so forth and so
18 on.

19 Q. It's also at column 16, line 1 and 2,
20 right, the "impurity concentration NW"?

21 A. Yes, I was citing from the next paragraph,
22 which says specifically, "In Figure 17," so.

23 Q. Got it.

24 And when this says "impurity," is that
25 another word for dopant, like, we talk about a

1 gradient dopant concentration?

2 A. Yes, dopants are basically another term --
3 "impurities" and "dopants" are used almost
4 synonymously.

5 Q. Okay.

6 A. A good impurity is a dopant. A bad
7 impurity is a contamination.

8 Q. Okay. The slope shown in Figure 17,
9 it's -- is a nonzero slope beginning at depth zero
10 until past depth WW, right?

11 A. Yes, there is a nonzero slope in NW.

12 Q. And it's a consistently negative slope,
13 right?

14 A. Yes, in that, yes, it points downward.

15 Q. And so based on what we discussed earlier,
16 throughout that entire depth where there is a
17 nonzero slope, there would be a corresponding
18 electric field, right?

19 A. The gradient in the concentration shown in
20 NW should result in a field, yes.

21 Q. And that field would not change directions
22 at any point in between 0 and WW, right?

23 MR. WHITEHURST: Object to form.

24 THE WITNESS: It's -- it's not linear.

25 There's a slight curvature to it, it looks like, but

1 it's general -- it is always generally pointed
2 downward, yes.

3 BY MR. SPEEGLE:

4 Q. And relative to θ and WW on this depth,
5 which direction would the resulting electric field
6 point?

7 A. Well, this is -- an electric field is the
8 negative of the derivative; that it's -- you know --
9 pushing downward basically.

10 Q. Pushing electrons downward?

11 A. Pushing electrons downward, yes.

12 Q. So throughout the depth in Kawagoe from θ
13 past WW, there is an electric field pushing
14 electrons downward?

15 A. Yes, there's that field shown in Figure
16 17.

17 Q. And then in the section you quoted in
18 column 16, this is in the middle at lines 7 through
19 9, this says, "Specifically, the electrons produced
20 by the alpha ray are attracted to the substrate body
21 2S or the concentration gradient and prevented from
22 entering the p-well 6p."

23 Do you see that?

24 A. Yes, I see that.

25 Q. And what does it mean that, "Electrons

1 produced by the alpha ray are attracted to the
2 substrate body 2S"?

3 A. Well, they are pushed away. They were
4 repelled by the gradient we see in Figure 17, which
5 basically stops almost at the body, the substrate.
6 So below the well, the field stops, so it pushes
7 them downward, so the well -- the well has a force
8 away, and then the substrate doesn't, so they just
9 end up, you know, at the lowest energy point, which
10 is the substrate.

11 Q. The second half of that --

12 MR. WHITEHURST: I'm sorry. Did you
13 finish your answer?

14 MR. SPEEGLE: Sorry.

15 MR. WHITEHURST: Are you done?

16 THE WITNESS: Yeah, I'm done.

17 BY MR. SPEEGLE:

18 Q. The second half of that sentence says,
19 "And prevented from entering the p-well 6p."

20 Is that referring to motion in the
21 opposite direction?

22 A. I think the language speaks for itself.
23 It's basically trying to keep the electrons from
24 entering the p-well by using the gradient
25 established in Figure 17 shown by line NW.

1 Q. Okay. Does Kawagoe talk about any forces
2 that would be strong enough to overcome that field
3 and push electrons into the p-well?

4 A. I don't recall rebutting a point like
5 that. I don't recall that point being made. Yeah,
6 if it's in there, please point it out.

7 Q. I'm -- so the only statement in Kawagoe
8 about what happens to his electrons is that this
9 electric field from the gradient is sufficient to
10 prevent electrons from going up into the p-well,
11 right?

12 A. That's all I recall, off the top of my
13 head, without a total review of the document.

14 Q. Okay. You didn't cite anything in Kawagoe
15 that would talk about electric fields going in a
16 different direction, right?

17 A. I don't recall that, no.

18 Q. Sitting here today, you don't recall
19 anything in Kawagoe that would be a stronger
20 electric field than what's created by the gradient
21 in Figure 17?

22 A. Well, you know, what else is going on in
23 the Kawagoe -- I'm not sure how it's pronounced, but
24 I pronounce it Kawagoe. But whatever else is going
25 on in Kawagoe, I was addressing the aspect of the

1 gradient to repel solar-generated electrons from the
2 well. I don't recall examining it for that point
3 you brought up.

4 Q. I want to make sure I understand what
5 you're referring to.

6 What do you mean by solar-generated
7 electrons?

8 MR. WHITEHURST: Object to form.

9 THE WITNESS: Alpha rays are solar
10 generated, so alpha rays come from outer space,
11 enter the atmosphere. Some actually make it through
12 and end up hitting the --

13 BY MR. SPEEGLE:

14 Q. Okay. I think, looking at Footnote 4 on
15 page 27 of your declaration, is it right that you
16 have been familiar with alpha rays and have
17 experience with them in the time period preceding
18 2004?

19 A. I worked with -- I worked alpha particles,
20 so, you know, 2.8 megavolt kind of stuff, on silicon
21 for analytical purposes as a technique, so I'm
22 generally familiar with how alpha energy reacts with
23 silicon.

24 Q. And that includes before 2004?

25 A. Yes, I did this before 2004.

1 Q. Let's look at page 31 of your '222
2 declaration.

3 A. Page 31?

4 Q. Page 31 of the -- I'm sorry -- of the 1242
5 declaration, the one you have in front of you.

6 A. Yes.

7 Q. All right. And there's a figure in the
8 middle of the page annotated with a yellow box that
9 says "Kawagoe Carriers."

10 Do you see that?

11 A. Yes.

12 Q. What is that yellow box indicating?

13 A. It indicates carriers generated by the
14 alpha rays in the substrate.

15 Q. You're not trying to suggest that's the
16 only place where there's electrons in Kawagoe's
17 device, right?

18 MR. WHITEHURST: Object to form.

19 THE WITNESS: What I'm suggesting here is
20 that that is where the vast majority, and the
21 significant ones, are generated. So the substrate
22 is typically 500 microns thick, and the electronics
23 at the top are 2. If that's the case, then
24 one -- you know -- one out of 250 of the thickness
25 is at the top, but the top also has all the metal

Page 117

1 lines and silicon nitrate passivation, and it's
2 hardened compared to the back side of the silicon.
3 So the vast majority of particles are generated in
4 the substrate.

5 BY MR. SPEEGLE:

6 Q. You're talking about alpha ray-generated
7 particles, right?

8 A. Yes, alpha ray-generated electrons.

9 Q. Okay. Electrons from a variety of sources
10 would be found throughout the Kawagoe device, right?

11 MR. WHITEHURST: Object to form.

12 THE WITNESS: There are other electrons
13 generated from other things, yes. I'm just
14 addressing here the -- SEU-produced electrons.

15 BY MR. SPEEGLE:

16 Q. We discussed the spurious carriers created
17 by switching, right?

18 A. Switching can't create carriers.

19 Q. Those would be up in the active region?

20 MR. WHITEHURST: Object to form.

21 THE WITNESS: If, to the extent that they
22 existed, if it wasn't designed to eliminate those,
23 then they would be generated where there was
24 circuitry, yes.

25 ///

1 BY MR. SPEEGLE:

2 Q. Okay. And there have to be electrons in
3 order for a semiconductor to, in fact, have its gate
4 turn on, right?

5 MR. WHITEHURST: Object to form.

6 THE WITNESS: Are you talking about the
7 gate electrode voltage or the channel region? I'm
8 sorry.

9 BY MR. SPEEGLE:

10 Q. In the channel region, there has to be
11 electrons for the -- there's a combination of both
12 electrons and holes in the channel region of every
13 semiconductor transistor, right?

14 MR. WHITEHURST: Object to form.

15 THE WITNESS: Generally, one thinks of the
16 region as one type, but there will be still
17 electrons and holes.

18 BY MR. SPEEGLE:

19 Q. So if we look at Figure 17 again, is there
20 any point on -- and I'm sorry. This is Figure 17 in
21 Kawagoe -- whether or not from alpha particles or a
22 different source, there would be electrons found at
23 all of these depths from 0 to WW, right?

24 MR. WHITEHURST: Object to form.

25 THE WITNESS: This is a p-well, so this is

1 going to be essentially P, but even within P, there
2 are some holes. There's a minority in a p-well.

3 Excuse me. Let me completely rephrase
4 that. It's getting late in the day.

5 Your question was are there electrons or
6 are there holes?

7 MR. WHITEHURST: So the record is clear,
8 why don't you have him ask the question.

9 MR. SPEEGLE: I'll restate the question.
10 BY MR. SPEEGLE:

11 Q. For the device shown in Figure 17 of
12 Kawagoe, along the depth 0 to WW, is there any
13 region where there would not be electrons?

14 MR. WHITEHURST: Object to form.

15 THE WITNESS: This is a p-well, so it is
16 substantially holes. There are electrons as
17 minority species.

18 BY MR. SPEEGLE:

19 Q. And those minority electrons would be
20 throughout the depth?

21 MR. WHITEHURST: Object to form.

22 THE WITNESS: They are largely swamped,
23 meaning, you know, there's a minimum of typically a
24 thousand times as many holes as electrons. It's
25 intrinsic, meaning the undoped is 10 of the 14, and

1 the doped is 10 of the -- 16 or 17. There's
2 hundreds and thousands of times as many holes. So
3 they largely are recombined. They exist in greater
4 number when the electrode is turned on, so there's
5 really only a significant number of electrons in the
6 channel region when the voltage is applied to the
7 gate electrode. There are electrons, of course, in
8 the source and drain, but they're essentially
9 isolated from largely leaking out, you know.

10 BY MR. SPEEGLE:

11 Q. And this electric field resulting from the
12 graded dopant concentration of Figure 17 would sweep
13 those electrons from the active region down into the
14 substrate?

15 MR. WHITEHURST: Object to the form.

16 THE WITNESS: It doesn't disclose that it
17 does that.

18 BY MR. SPEEGLE:

19 Q. Whether the electrons actually move or
20 not, you would agree that the resulting electric
21 field from this greater dopant concentration exerts
22 a force that would push the electrons in that
23 direction, right?

24 MR. WHITEHURST: Object to form.

25 THE WITNESS: The electric field may not

1 be sufficient to actually move them. The patent --
2 the Kawagoe patent is silent about any effect that
3 this field designated or brought about by the dopant
4 gradient NW as shown in Figure 17 affects anything
5 within the well.

6 The patent only describes that this dopant
7 gradient is able to keep SEU electrons out of the
8 well. It doesn't tell you what's happening in the
9 well.

10 BY MR. SPEEGLE:

11 Q. Is there any reason, based on Figure 17,
12 to conclude that the field would be substantially
13 stronger in the well or out of the well?

14 A. The gradient he has shown here, basically
15 in the well, just barely leaving it, so most of the
16 gradient, and most of the field, would be in the
17 well, and it would present itself up to and just
18 beyond the well.

19 Q. And it says that that part is sufficient
20 to attract to the substrate body 2S the electrons,
21 right?

22 MR. WHITEHURST: Object to form.

23 BY MR. SPEEGLE:

24 Q. I'm reading directly to the middle of the
25 column 16 quote that's on page 28 of your

1 declaration.

2 MR. WHITEHURST: Object to form.

3 THE WITNESS: Yes, the way they've written
4 it is how they've written it. Figure 17, I think,
5 makes it clear that the gradient is in the well, so
6 that's where the field's going to be largely. So
7 it's going to push things away, and then the lowest
8 energy potential is going to be in the substrate
9 where the gradient is flat. It's just going to
10 what's called NS, which I think is the concentration
11 of the substrate. That's the wafer concentration as
12 purchased.

13 So the electrons are attracted to the
14 absence of this -- absence of the field generated by
15 the gradient NW.

16 BY MR. SPEEGLE:

17 Q. Okay. I'm going to hand you what has been
18 previously marked as Exhibit 2060.

19 Do you recognize Exhibit 2060?

20 A. Generally, yes.

21 Q. And this is a reference that you cited to
22 suggest that there are not electrons in the active
23 region, right?

24 A. Generally, yes.

25 Q. Looking at page 34 of your declaration, do

1 you see the quote from column 19 of Nishizawa that
2 you have there?

3 A. Yes.

4 Q. And I believe the suggestion here is that
5 they're not many electrons created in the active
6 region. Is that what you're suggesting?

7 A. Yes, generally.

8 Q. All right. So this passage of Nishizawa,
9 I think you're quoting from column 19, lines 21. I
10 want to read to you the figure that corresponds to
11 that section. I believe it's Figure 35, but why
12 don't you take a look at Figure 35, and see if it
13 corresponds to what you're quoting.

14 A. I'm confused with your question. 21
15 starts off, "As shown in Figure 33"?

16 Q. Figure 33, if you turn and look at it, is
17 a graph, and Figure 35 -- yeah, Figure 35 is the
18 device cross-section. And if you look at the rest
19 of that column 19, there are references to things
20 like the n+ type regions 12 and 13. I'd like to
21 understand if the n+ regions 12 and 13 in column 19
22 is the same as the n+ regions 12 and 13 on Figure
23 35.

24 MR. WHITEHURST: Object to form.

25 THE WITNESS: Okay. This will take a

1 minute.

2 I think Figure 35 is relevant to this
3 discussion, yes.

4 BY MR. SPEEGLE:

5 Q. Okay. So would you agree with me that the
6 n+ regions 12 and 13 in Figure 35 correspond to an
7 active region?

8 MR. WHITEHURST: Object to form.

9 THE WITNESS: I would say, generally,
10 these look to be part of an active region, yes.

11 BY MR. SPEEGLE:

12 Q. And if you look at column 19, line 41, 42,
13 this is just after the discussion you cited in your
14 report, right?

15 A. Same column, same paragraph, I think, yes.

16 Q. And there's a sentence at line 41 that
17 says, "In other words, several ten thousand
18 electrons will flow into the n+ type region 13" --

19 A. Yes.

20 Q. -- is that right?

21 So this is saying that several ten
22 thousand electrons will flow through the active
23 region as a result of the alpha ray strike?

24 MR. WHITEHURST: Object to form.

25 THE WITNESS: What it says is that several

1 ten thousands out of the -- compared to the
2 3 million that are stored is essentially
3 insignificant.

4 BY MR. SPEEGLE:

5 Q. But they would be tens of thousands of
6 electrons in that region, right?

7 MR. WHITEHURST: Object to form.

8 THE WITNESS: Essentially what it says is
9 yeah, when vertically radiated, I mean, directly
10 vertical at about .8 microns down, it will generate
11 perhaps that number, several ten thousands. When --
12 yeah, and that that number, given this capacitor
13 they've described of 3 million, is an insignificant
14 number, thus will not exhibit errors due to alpha
15 particles. It will exhibit orders -- errors even
16 when the memory cell was made ten times smaller.

17 BY MR. SPEEGLE:

18 Q. Nishizawa actually does propose further
19 adjustment to account for alpha ray-induced
20 electrons in n+13, right?

21 MR. WHITEHURST: Object to form.

22 THE WITNESS: Could you elaborate?

23 BY MR. SPEEGLE:

24 Q. Why don't you look at the column 20, lines
25 25 through 30.

1 And do you see that talks about "the
2 p-type buried region 33a"?

3 A. Yes.

4 Q. And Nishizawa is teaching to include this
5 p-type 33 -- p-type buried region 33a, "To eliminate
6 the adverse effect caused by those electrons excited
7 by alpha ray particles in the bit line at the time
8 of read-out operation," right?

9 MR. WHITEHURST: Object to form.

10 THE WITNESS: Yes, they do describe
11 Item 33 in that figure, a buried item.

12 BY MR. SPEEGLE:

13 Q. And that item is being arranged that way
14 because of adverse effects from alpha ray-created
15 electrons in the n+ 12 region, right?

16 MR. WHITEHURST: Object to form.

17 THE WITNESS: It's not clear why they
18 are -- or -- from your -- your comment -- or
19 question isn't necessarily supported by this
20 specification entirely.

21 At column 20, line 19 immediately
22 preceding the comment about Figure 35 in the p-type
23 barrier region 33, the patent describes at 20 --
24 column 20, 19, "That is the amount of electrons
25 created which adversely affect the memory action is

1 no greater than only 10 percent of the stored
2 electric charge, and thus it can be disregarded,"
3 end quote.

4 So they've essentially analyzed worst case
5 and decided that it's -- can still be disregarded.

6 Nonetheless, they go on and, you know,
7 describe this thing they've invented.

8 I'm not sure that the specification
9 supports that they created this invention is going
10 to solve necessarily a problem. But they have
11 created the structure.

12 BY MR. SPEEGLE:

13 Q. Let's turn to page 38 of -- page 37 of
14 your 1242 declaration.

15 A. Page 38?

16 Q. 37. I'm going to ask you about the
17 questions on 37 and 38.

18 Do you see the section here that talks
19 about the "first active region with the second
20 doping type opposite conductivity to the first
21 doping type"? Do you see that?

22 A. Yes.

23 Q. And you concluded that Kawagoe did not
24 disclose a first active region with the second
25 doping type opposite in conductivity to the first

Page 128

1 doping type, right?

2 A. I concluded Dr. Blalock's analysis of
3 Kawagoe was incorrect regarding this.

4 Q. Do you think that Kawagoe discloses a
5 first active region with a second doping type
6 opposite in conductivity to the first doping type?

7 MR. WHITEHURST: Object to form.

8 THE WITNESS: In the example that
9 Dr. Blalock analyzed, which I rebutted, it does not
10 disclose that.

11 BY MR. SPEEGLE:

12 Q. Are you referring to the figure on page 38
13 that's annotated as an NMOS transistor?

14 A. Yes, that would be the region.

15 Q. And you concluded that an NMOS transistor
16 was not in the -- opposite doping type for a p-type
17 substrate?

18 A. What I concluded was that the regions that
19 he pointed to were not of opposite doping type to
20 the substrate. There was a specific claim element
21 limitation requiring an opposite doping type to the
22 substrate. He pointed to a p-type region, and the
23 substrate was p-type also.

24 Q. You understand Dr. Blalock pointed to the
25 NMOS transistor 4N, right?

1 A. Yes.

2 Q. And you would consider the doping type of
3 the NMOS transistor to be P?

4 A. The well is P, the channel is P, yes,
5 that's what he pointed to.

6 Q. Okay. You see on the left-hand side of
7 this figure on 38, there's a PMOS transistor there,
8 right?

9 MR. WHITEHURST: Object to form.

10 THE WITNESS: Yes, there's a transistor
11 there.

12 BY MR. SPEEGLE:

13 Q. It's a PMOS transistor on the left side?
14 (The requested portion was read back.)

15 MR. WHITEHURST: Object to form.

16 THE WITNESS: I don't believe I analyzed
17 that transistor.

18 BY MR. SPEEGLE:

19 Q. Well, you see it's identified on the
20 bottom left, in the left-hand corner of that well,
21 as an n-type well, right?

22 MR. WHITEHURST: Object to form, object to
23 scope. This deposition is limited to the scope of
24 his declaration. You're going outside the scope of
25 his declaration.

1 MR. SPEEGLE: I'm asking about a figure in
2 his declaration.

3 MR. WHITEHURST: You can ask, but
4 objection. Scope.

5 MR. SPEEGLE: Okay.

6 THE WITNESS: I see the letter N.

7 BY MR. SPEEGLE:

8 Q. Yes, and for an n-type well, that would
9 mean this is a PNP transistor on the left side,
10 right?

11 MR. WHITEHURST: Object to form, object to
12 scope. This witness is not required to form
13 opinions about things that are not in his
14 declaration. You know the rules, and you're
15 breaking the rules.

16 MR. SPEEGLE: I disagree with your
17 characterization.

18 MR. WHITEHURST: Objection to scope. The
19 deposition is about opinions in his declaration.
20 He's already said on the record he hasn't formed any
21 opinions about this transistor.

22 MR. SPEEGLE: Your objection is noted.
23 You don't need to keep coaching him.

24 MR. WHITEHURST: I'm just saying we can
25 shut this down. We can shut the deposition down if

1 you're going to break the rules. You know the
2 rules.

3 MR. SPEEGLE: Alan, you've been coaching
4 this whole time.

5 MR. WHITEHURST: I'm not coaching him
6 about anything. You're breaking the rules, and
7 that's improper, and you know it. He already
8 answered your question.

9 MR. SPEEGLE: Your objection is noted. We
10 can disagree on the record. Let the witness take
11 his time.

12 MR. WHITEHURST: Let's take a break.
13 We've been going for an hour.

14 MR. SPEEGLE: There's a question pending.
15 I'd like an answer to the question.

16 MR. WHITEHURST: Answer the question so we
17 can take a break, sir.

18 THE WITNESS: I don't believe I analyzed
19 this.

20 MR. SPEEGLE: Great.

21 MR. WHITEHURST: That's it.

22 (Recess.)

23 BY MR. SPEEGLE:

24 Q. Dr. Glew, I was asking you about the
25 figure on page 38 of your 1242 declaration.

1 Do you see that?

2 A. Yes.

3 Q. And below that figure, you have a
4 statement that says, "A POSITA would have understood
5 that the channel in a CMOS transistor has the same
6 doping type as the well in which the source and
7 drain are formed."

8 Is that sentence describing this figure on
9 page 38?

10 MR. WHITEHURST: Object to form.

11 THE WITNESS: This -- I would say a
12 general statement that, you know, the channel
13 journal is a -- the same as the well type.

14 BY MR. SPEEGLE:

15 Q. And would you agree that the device shown
16 on page 38 is a CMOS device?

17 A. I analyzed the NMOS transistor on the
18 right. I didn't analyze the other one, so I
19 couldn't answer that.

20 Q. This is Figure 23 of Kawagoe. I think you
21 say that, right below it, you say, "It's citing
22 Exhibit 1007, Figure 23"?

23 A. Yes, I'm referring to Figure 23.

24 Q. And can you turn to paragraph 65 on the
25 next page of your declaration. And in paragraph 65,

1 you recognize that Dr. Blalock "annotated Figure 23
2 of Kawagoe and maps Kawagoe's source/drain 4Na/4Nb
3 and channel of NMOS 4N to the claimed first active
4 region and maps Kawagoe's source/drain 4Pa/4Pb and
5 channel of PMOS 4P to the claimed second active
6 region," right?

7 A. I see that, yes.

8 Q. You understand that, at least according to
9 Dr. Blalock, Figure 23 includes both the PMOS and
10 NMOS device, right?

11 MR. WHITEHURST: Object to form.

12 THE WITNESS: Yes, that is Dr. Blalock's
13 position.

14 BY MR. SPEEGLE:

15 Q. I believe when we were discussing Figure
16 5B earlier, you agreed that a PNP PMOS transistor
17 would have an opposite doping type from a p-type
18 substrate?

19 A. I'm sorry, you said Figure 5B?

20 Q. Figure 5B of the '222 and '842 patent.
21 Do you remember we were discussing that
22 this morning?

23 MR. WHITEHURST: Object to form.

24 THE WITNESS: Actually, no. Yeah, we
25 discussed 5B quite extensively.

1 BY MR. SPEEGLE:

2 Q. Right.

3 And you told me that you believed that
4 Figure 5B did have an active region conductivity
5 type that was opposite to the p-type substrate?

6 MR. WHITEHURST: Object to form.

7 THE WITNESS: Yes, you view Figure 5B
8 along with, of course, 5A, and the description that
9 says it's a CMOS substrate, it has both types.

10 BY MR. SPEEGLE:

11 Q. How is Figure 23 disclosure in Kawagoe
12 different from Figure 5B in -- in regards to the
13 conductivity of the active region?

14 MR. WHITEHURST: Object to form.

15 THE WITNESS: Which aspect or part of
16 Kawagoe Figure 23 are you referring to?

17 BY MR. SPEEGLE:

18 Q. Let's talk about the PMOS.

19 A. Are you referring to the portion on the
20 left of Kawagoe?

21 Q. Yes.

22 MR. WHITEHURST: Object to form.

23 THE WITNESS: I didn't analyze that, so I
24 really couldn't tell you the difference. I
25 restricted my analysis to rebutting Dr. Blalock's

1 position.

2 BY MR. SPEEGLE:

3 Q. So sitting here today, you're not prepared
4 to identify any distinction between those two?

5 A. I didn't analyze the transistor on the
6 left of Figure 23 in Kawagoe, so without further
7 analysis, which I haven't performed, I wouldn't be
8 comfortable analyzing or giving opinions on
9 something I haven't analyzed yet.

10 I do recall that there were a number of
11 typos and idiosyncrasies/contradictions in the
12 Kawagoe specifications, so I'd be very careful in
13 reviewing that again, if I had to, if I was asked to
14 analyze that.

15 Q. Do you agree that the n-type source and
16 drain in the NMOS of -- on the right-hand side of
17 Kawagoe, that the source and drain are opposite in
18 doping type to the p-type substrate, right?

19 MR. WHITEHURST: Object to form.

20 THE WITNESS: I didn't analyze the
21 transistor on the left side of Kawagoe.

22 BY MR. SPEEGLE:

23 Q. That's the right side.

24 A. The right side. Repeat your question,
25 please.

1 Q. The n-type source and drain for the NMOS
2 on the right-hand side of Kawagoe, an n-type source
3 and drain is opposite in conductivity type to a
4 p-type substrate, right?

5 MR. WHITEHURST: Object to form.

6 THE WITNESS: An n-type source and drain
7 is n-type. A p-type substrate is a p-type, so they
8 would be opposite, yes.

9 BY MR. SPEEGLE:

10 Q. Would you say that the source and drain
11 are part of the active region?

12 MR. WHITEHURST: Object to form.

13 THE WITNESS: Sources and drains are part
14 of the active region, yes.

15 BY MR. SPEEGLE:

16 Q. Let's look at paragraph -- well, let's
17 look at page 40 of the 01242 declaration.

18 A. Page 40?

19 Q. Yes, page 40. This is typed page 40, not
20 exhibit page.

21 And do you see the figure at the top of
22 page 40 that's, again, an annotated version of
23 Figure 23 from Kawagoe?

24 A. Yes, I see the figure at the top of page
25 40. I believe this was -- yes.

Page 137

1 Q. Okay. What's your understanding of the
2 function of Isolation Region (3) highlighted in
3 yellow on that figure?

4 A. The Kawagoe patent '114 describes at
5 column 8, line 40, quote, "Over the principal
6 surface of epitaxial layer 2E, there is formed a
7 field insulating film 3, which is made of silicon
8 dioxide (SiO₂), for example."

9 So this is described thusly: A field
10 insulating film of field oxide, a FOX sometimes it
11 could be called. It's an insulating layer of
12 dielectric around a well.

13 Q. What's its purpose?

14 MR. WHITEHURST: Object to form.
15 BY MR. SPEEGLE:

16 Q. I can ask a better question.

17 Are you familiar with insulating films
18 like insulating film 3, in general?

19 A. In general, yes.

20 Q. And, in general, what is the general
21 purpose of an insulating film like that?

22 MR. WHITEHURST: Object to form.

23 THE WITNESS: Generally, insulating film
24 electrically isolates one thing from another.

25 ///

1 BY MR. SPEEGLE:

2 Q. Would insulating film 3 in Kawagoe
3 electrically isolate the 4P and 4N in Figure 23?

4 MR. WHITEHURST: Object to form.

5 THE WITNESS: We're looking at this in two
6 directions -- I mean, in two dimensions. It's
7 actually a three-dimensional structure, and we're
8 just looking at a cross-section.

9 I'm assuming that 3 would isolate the
10 well, for example, from whatever was around it, on
11 all sides, all four sides. That's normally how
12 something like this works.

13 BY MR. SPEEGLE:

14 Q. So you're saying you would isolate it
15 from -- let me ask it different. You're saying
16 insulating film 3 would isolate, for example, 4P
17 from 4N and from other things on the front and back
18 into the page?

19 MR. WHITEHURST: Object to form.

20 THE WITNESS: Well, it's only on the
21 surface. So, as we see, it doesn't really isolate
22 when they're touching. What it does provide at the
23 surface, on the top, it would usually -- usually
24 these kind of things are rectangular, and then
25 the -- you know, something like 3 would probably go

1 around the perimeter of the rectangle.

2 BY MR. SPEEGLE:

3 Q. What is LOCOS in terms of semiconductor
4 manufacturing?

5 MR. WHITEHURST: Object to form.

6 THE WITNESS: Local oxidation of silicon,
7 LOCOS.

8 BY MR. SPEEGLE:

9 Q. Do you know how LOCOS works?

10 A. It's a usually either steam or ozone --
11 high-temperature oxygen oxidation of a silicon --
12 areas of a silicon substrate.

13 Q. Okay. And does it -- if you make a film
14 using LOCOS, would that resulting film just sit on
15 the surface of your silicon wafer or would it go
16 into the body of the silicon wafer?

17 MR. WHITEHURST: Object to form.

18 THE WITNESS: It typically is what's known
19 as a formed oxide, not a deposited oxide. So it
20 consumes the silicon that is formed from, so you mix
21 it with oxygen or steam, which has oxygen in it,
22 something like that, ozone maybe, which is O₃, very
23 reactive. And it consumes a portion of the silicon
24 and works its way downward. It doesn't get very
25 deep, but it does consume some of the surface

1 silicon downward.

2 BY MR. SPEEGLE:

3 Q. Why don't you look at Kawagoe, column 11,
4 line 28 through 35.

5 MR. WHITEHURST: Which column? Which
6 line?

7 MR. SPEEGLE: Column 11, line 28 through
8 35.

9 BY MR. SPEEGLE:

10 Q. And let me know when you've had a chance
11 to look at it.

12 A. I have read that paragraph.

13 Q. Okay. Does this paragraph tell you that
14 the insulating film 3 would actually be deposited
15 inside of the silicon and not deposited on top of
16 the silicon?

17 MR. WHITEHURST: Object to form.

18 THE WITNESS: Well, what it describes is
19 insulating film 3 made of silicon oxide, or the
20 likeness, formed over the principal surface of the
21 epitaxial layer 2E by the LOCOS method or the like.

22 So, to me, it's clear that it's over the
23 surface. It's -- "formed" often means, like I said,
24 that it's -- it's not deposited, per se. It uses
25 oxygen, and then the silicon is already there to

Page 141

1 react it to form downward -- you know, over the top
2 and downward a bit.

3 BY MR. SPEEGLE:

4 Q. You say in paragraph 66 of your 1242
5 declaration -- you say at the first and second --
6 are you there?

7 A. Yes.

8 Q. Okay. You say, "A POSITA would have
9 understood that the first and second active regions
10 extend to about the depth of the epitaxial layer 2E
11 and abut each other laterally."

12 Do you see that?

13 A. Yes.

14 Q. Would a channel stopper region below
15 insulating film 3 prevent -- I'm sorry. I lost my
16 place. I'll ask that question again.

17 Would a channel stopper region below
18 insulating film 3 prevent the first and second
19 active regions from abutting each other laterally?

20 MR. WHITEHURST: Object to form.

21 THE WITNESS: It would depend how deep the
22 channel stopper region went.

23 BY MR. SPEEGLE:

24 Q. From a design perspective, is there any
25 reason you would have a channel stopper region that

1 did not encompass the entire active region depth?

2 MR. WHITEHURST: Object to form.

3 THE WITNESS: Essentially, its purpose is
4 to stop errant carriers from migrating from one
5 transistor to another. It needs to be deep enough
6 to do that, but not deeper.

7 So, generally, the purpose is just that.

8 So they make them adequate for the
9 purpose. It depends on what the performance level
10 is, how large things are, how close they are as to
11 the geometry of this particular design feature.

12 BY MR. SPEEGLE:

13 Q. All right. Let's shift gears and go to
14 your 1244 declaration.

15 I'm going to direct you specifically to
16 paragraph 56. That's not right. Oh, yes, it's
17 paragraph 56, page 30. Are you there?

18 A. Yes.

19 Q. So paragraph 56 is where you begin
20 discussing the Payne only ground in the 1244 IPR,
21 right?

22 A. Yes, that's Payne reference.

23 Q. And continuing through from paragraph 56
24 through paragraph 58, it's your position that, "The
25 magnitude of the slope is essential to determine the

1 magnitude of the force the dopant gradient places on
2 the carrier and thus the net force." Is that right?

3 A. In this context, yes.

4 Q. After that paragraph, do you see paragraph
5 59, you have some arguments about Wang and
6 single-event upsets.

7 Do you see that paragraph 59?

8 A. Yes.

9 Q. Is that anything to do with Payne?

10 A. Let me see if this was an errant
11 paragraph.

12 MR. WHITEHURST: Which paragraph are we
13 looking at?

14 MR. SPEEGLE: Yeah, it's paragraph 59, and
15 it continues all the way to the end of the
16 declaration, but there's discussion of Kawagoe and
17 single-event upsets, and I'm asking if those have
18 any relationship to Payne.

19 THE WITNESS: It appears this needs a
20 header. It lost its header.

21 BY MR. SPEEGLE:

22 Q. So the Payne arguments are confined to
23 paragraphs 56 through 58, and the remainder relate
24 to Kawagoe again?

25 A. Yes.

1 Q. So focusing again on paragraph 58 -- well,
2 let me introduce, Dr. Glew, I've handed you what's
3 OnSemi Exhibit 1005 in the 1244 IPR.

4 Do you see that?

5 A. Yes.

6 Q. And this is the Payne reference, right?

7 A. Yes, it is.

8 Q. And you're discussing in paragraph 58,
9 "The magnitude of the slope is essential to
10 determine the magnitude of the force the dopant
11 gradient places on the carriers."

12 Now, is that slope and dopant gradient
13 reflected on Figure 11 of Payne?

14 MR. WHITEHURST: Object to form.

15 THE WITNESS: The gradient is generally
16 reflected on 11. As I point out, it's absent actual
17 values, though.

18 BY MR. SPEEGLE:

19 Q. And do you agree that the gradient dopant
20 concentration reflected in Figure 11 of Payne would
21 exert some force on carriers in those regions of
22 Payne?

23 MR. WHITEHURST: Object to form.

24 THE WITNESS: To the extent that carriers
25 are not shielded from the field, it would act on the

1 carriers, not necessarily in a manner sufficient to
2 cause any motion or current flow, but it would be
3 normal for fields to act on charges that they aren't
4 shielded from.

5 BY MR. SPEEGLE:

6 Q. Okay. And you didn't identify any
7 disclosure of shielding in Payne, right?

8 MR. WHITEHURST: Object to form.

9 THE WITNESS: I don't believe I mentioned
10 the source of shielding.

11 BY MR. SPEEGLE:

12 Q. And you didn't identify any contrary
13 forces that would act opposite of the graded dopant
14 concentration in Payne?

15 MR. WHITEHURST: Object to form.

16 THE WITNESS: One with skill in the art
17 would understand these are semiconductors, so
18 there's always some resistance to a semiconductor.

19 BY MR. SPEEGLE:

20 Q. But you did not identify anywhere in Payne
21 that discusses contrary forces going in the opposite
22 direction?

23 MR. WHITEHURST: Object to form.

24 BY MR. SPEEGLE:

25 Q. Did you?

1 A. No, I was rebutting Dr. Blalock. He
2 didn't actually fill any aid of movement in the
3 carriers. There wasn't much to rebut there.

4 Q. All right. Let's turn to your -- the 1243
5 on the '842, and I'm going to point you to paragraph
6 58.

7 A. I am at 58.

8 Q. Okay. And this is part of your analysis
9 regarding the Wieczoerek grounds in the '842 patent,
10 right?

11 A. Yes, this is the Wieczoerek analysis.

12 Q. Let me introduce -- so I've handed you
13 what was marked as OnSemi Exhibit 1006 in the 1242
14 and 1243 IRPs.

15 Do you recognize Exhibit 1006?

16 A. Yes.

17 Q. And I see the last sentence of paragraph
18 58 in your '842 declaration says, "The magnitude of
19 the slope is essential to determine the magnitude of
20 the force the dopant gradient places on the carrier
21 and thus the net force."

22 Do you see that sentence?

23 A. I see that sentence, yes.

24 Q. Is that substantially the same as the
25 paragraph 59 we just looked at in the 1244?

1 A. I think, yeah, it's a similar argument,
2 that without any knowledge of the actual
3 concentrations of the gradient, it's difficult to
4 assert that they are doing something.

5 There are -- you know, if you manufacture
6 it yourself, you might know the values, but if
7 you're just looking at a printout of a chart, you
8 need to know the values on the chart.

9 Q. Can you look at paragraph 60 in the 1242
10 declaration?

11 A. We're going back to 1242?

12 Q. Yes, for a second. Paragraph 60.

13 Is it right that your arguments regarding
14 Wieczoerek in the 1242 and the 1243 IPR are
15 substantially identical?

16 MR. WHITEHURST: Object to form.

17 THE WITNESS: They should be. Let me
18 confirm this. Yes.

19 BY MR. SPEEGLE:

20 Q. All right. So if you look at Figure 2B of
21 Wieczoerek, does Figure 2B reflect the slope and
22 dopant gradient that you're referring to in the last
23 sentence of paragraph 60 of the 1242 declaration and
24 paragraph 58 of the 1243 declaration?

25 MR. WHITEHURST: Object to form.

1 THE WITNESS: As in the last reference, it
2 shows slope in a -- say a general schematic form,
3 but without concentration and depth values, one
4 can't actually know the gradient.

5 BY MR. SPEEGLE:

6 Q. You don't dispute that this slope would
7 exert some force on carriers in that region, right?

8 MR. WHITEHURST: Object to form.

9 THE WITNESS: Let me briefly review.

10 In general, the gradient of the dopants
11 would provide some field and result in force on
12 charge particles. The magnitude and the effect is
13 what I can't determine without additional
14 information.

15 BY MR. SPEEGLE:

16 Q. Okay. Do you see in Wieczoerek the Figure
17 2A and 2B? On the left-hand, 2A is called "as
18 implanted," and 2B is "after anneal."

19 Do you see that?

20 A. Yes.

21 Q. What does "anneal" mean?

22 A. Annealing is heating, so the ion
23 implantation is literally firing ions at very high
24 energy velocity, anywhere from 20,000 to half
25 a million volts typically, and they go into a

1 different depth depending on the energy and the mass
2 of the ion.

3 But they cause a lot of damage to the
4 crystal. And they also have a fairly sharp -- often
5 have a sharp profile, like one sees on the left.
6 That's the implantation.

7 The heating, or annealing, allows two
8 things to occur. It is the healing of the crystal,
9 so the crystal -- the silicon itself can reform into
10 its crystalline structure and repair the damage. And
11 the dopants then also diffuse. It sort of smooths
12 out the profile. They spread out based upon
13 diffusion. So there's annealing and now rapid
14 thermal annealing.

15 This is -- basically it would -- I'm not
16 familiar with ion implantation without annealing.

17 Q. As long as they've been doing ion
18 implantation, they've been doing annealing to spread
19 out the dopant curves?

20 MR. WHITEHURST: Object to form.

21 THE WITNESS: For a long time. Maybe in
22 the early days, but it causes -- let me back that
23 up. There is -- there might be some implantation --
24 just a modern implantation that's actually just done
25 on top of the silicides, the contacts, but it's not

1 into the silicon exactly. It's sort of very odd
2 implantation. Maybe that is annealed, but,
3 generally, when it's damaging the crystal, it needs
4 to be annealed.

5 BY MR. SPEEGLE:

6 Q. Okay. And in the Wieczoerek arguments you
7 have, were 1242 and 1243 declarations, you don't
8 identify any contrary forces that would act in the
9 opposite direction from the graded dopant
10 concentrations in Wieczoerek, do you?

11 MR. WHITEHURST: Object to form.

12 THE WITNESS: No, I was just rebutting
13 Dr. Blalock's opinions, and there wasn't any
14 evidence of aiding carrier movement or magnitude of
15 analysis of the gradient.

16 MR. SPEEGLE: Okay. And if we could take
17 a quick break, I may be about to wrap up.

18 (Recess.)

19 MR. SPEEGLE: No further questions.

20 MR. WHITEHURST: Dr. Glew, I don't have
21 any further questions either.

22 Thank you for your time today. We
23 certainly appreciate your testimony.

24 I know it's been a long day, but the good
25 news is this concludes your deposition. So with

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that, we can go off the record.

(At 3:48 p.m. the proceedings were
concluded.)

CERTIFICATE

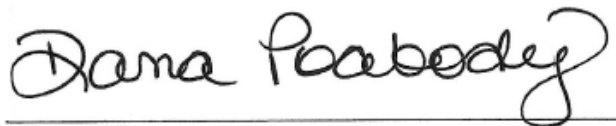
I, Dana Peabody, a California Certified
Shorthand Reporter, do hereby certify:

That prior to being examined, the witness
in the foregoing proceedings was by me duly sworn to
testify to the truth, the whole truth, and nothing
but the truth;

That said proceedings were taken before me
at the time and place therein set forth and were
taken down by me in shorthand and thereafter
transcribed into typewriting under my direction and
supervision;

I further certify that I am neither
counsel for, nor related to, any party to said
proceedings, nor in any way interested in the
outcome thereof.

In witness whereof, I have hereunto
subscribed my name at Yuma, Arizona, this 29th day
of July, 2024.



Dana Peabody

CSR No. 6332

Page 153

1 Semiconductor Components Industries, LLC. v. Greenthread LLC
2 Dr. Alexander Glew (#6760791)
3 E R R A T A S H E E T
4 PAGE_____ LINE_____ CHANGE_____
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6 REASON_____
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23 _____
24 Dr. Alexander Glew Date
25

Semiconductor Components Industries, LLC. v. Greenthread LLC
Dr. Alexander Glew (#6760791)

ACKNOWLEDGEMENT OF DEPONENT

I, Dr. Alexander Glew, do hereby declare that I
have read the foregoing transcript, I have made any
corrections, additions, or changes I deemed necessary as
noted above to be appended hereto, and that the same is
a true, correct and complete transcript of the testimony
given by me.

Dr. Alexander Glew

Date

*If notary is required

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0	1001 2:2	148:14,24	18 15:6,14
0 104:8,9	1003 16:5,7	151:7	180 107:23,24
112:22 113:4	1005 145:3	1244 15:20,23	108:3,8,11
113:12 119:23	1006 147:13,15	19:1,3,7	109:12
120:12	1007 110:1,18	143:14,20	19 78:7 124:1,9
01242 7:3,17	133:22	145:3 147:25	124:19,21
101:10 137:17	10510842 18:14	13 14:1 19:11	125:12 127:21
01243 7:6,18	10:31 43:20	19:12 124:20	127:24
74:19 83:9	11 141:3,7	124:21,22	1999 2:17
01244 7:10,18	145:13,16,20	125:6,18	1st 2:11,13
58:25	11,121,222 1:13	126:20	2
03 140:22	1:15	1300 2:11,13	2 38:19,22 40:2
1	1100 3:9 38:14	14 19:11,12	40:6 111:19
1 1:24 9:10	38:15,17,23	120:25	117:23
20:4,14,18	39:23 40:19	15 110:23	2.8 116:20
22:10 24:13	43:23 44:2,7	111:7	20 111:9
25:17 29:4	46:2 50:3	153 1:24	126:24 127:21
34:2 38:18,22	71:16	16 1:19 2:4	127:23,24
39:8,12,16	11121222 18:20	94:6,9 110:8	155:15
40:2,5,18 41:4	18:23	110:21,24	20,000 149:24
44:1,8 45:4	114 138:4	111:8,8,16,19	200 2:3
46:2,13 50:3	12 124:20,21,22	113:18 121:1	20006 2:18
50:24 52:13	125:6 127:15	122:25	2004 15:17
56:3,8,23	122 43:9	17 15:6 74:18	116:18,24,25
67:15 69:11,19	1242 15:3,7	74:25 94:9,12	2023-01242
69:23,24 71:23	16:6 18:25	99:21 110:18	6:24 18:24
71:25 72:19,22	19:3,10 101:14	110:19,24	2023-01243
73:3,4,14,19	109:20 117:4	111:2,8,12,22	6:24 18:18
104:8,10	128:14 132:25	112:8 113:16	2023-01244
111:19	142:4 147:13	114:4,25	6:25 18:24
1's 46:6,7	148:9,11,14,23	115:21 119:19	2024 1:19 2:4
10 120:25	151:7	119:20 120:11	14:1 153:22
121:1 128:1	1243 9:9 15:20	121:1,12 122:4	2057 6:22
10,510,842 1:14	15:23 18:19	122:11 123:4	2060 123:18,19
	147:4,14		

[21 - 5b]

21 124:9,14 22 16:12,16 222 3:9 18:25 19:3 20:4,14 20:19 23:9 24:13 29:5,13 34:2 38:18 39:9 52:13 53:6 55:16,18 58:24 69:11 71:21 72:22 73:3,19 83:4 101:10 117:1 134:20 23 133:20,22,23 134:1,9 135:11 135:16 136:6 137:23 139:3 25 52:2 126:25 250 117:24 26 101:18,24 27 101:22 111:16 116:15 28 16:16 109:19,22 110:9 122:25 141:4,7 28850 153:23 29th 153:21 2a 149:17,17 2b 148:20,21 149:17,18 2e 110:13 138:6 141:21 142:10	2s 113:21 114:2 122:20	128:13,16,17 38 3:9 76:2,8 128:13,15,17 129:12 130:7 132:25 133:9 133:16 3:48 152:2 3d 11:18 3rd 15:17	4na 134:2 4nb 134:2 4p 134:5 139:3 139:16 4pa 134:4 4pb 134:4
	3	3 9:9 38:19,22 39:8 40:3,6 46:6 66:22 76:2,8,18 79:21 80:4,6 81:9,10 126:2 126:13 138:2,7 138:18 139:2,9 139:16,25 141:14,19 142:15,18	5
	30 126:25 143:17 300 32:22 33:1 31 117:1,3,4 32 53:24 83:10 33 83:8,11,12 83:13,19 88:9 124:15,16 127:5,11,23 33a 127:2,5 34 19:10,13,14 19:16 123:25 35 124:11,12,17 124:17,23 125:2,6 127:22 141:4,8 36 93:10 94:4 94:10 99:22 100:1 37 75:25 100:17,20	4	5 3:5 32:18 50 32:25 80:5,6 500 32:21 33:1 117:22 56 143:16,17,19 143:23 144:23 58 143:24 144:23 145:1,8 147:6,7,18 148:24 59 144:5,7,14 147:25 5a 23:11 24:1,3 25:11 34:16 37:24 42:8 43:10 45:17 51:4 66:23 73:13,21 135:8 5b 3:9 19:18,24 20:2,5,10,14,23 21:17 22:8,15 22:21 23:6,11 23:22,23,24 25:9,10,12,13 29:13,19,20 32:16 33:13,18 34:13,16,17 35:7 36:17,18
		4 54:20 67:2,2 67:23 68:21 78:7 116:14 40 111:8 137:17,18,19 137:19,22,25 138:5 401 2:11,13 41 125:12,16 42 125:12 43 76:2,8 44 19:7 55:16 55:18,21,22 56:22,25 59:6 61:9 63:22 64:25 65:22,25 68:4 69:11,20 69:23,24 48 16:13,17 80:5,6 49 101:23 108:15 4n 129:25 134:3 139:3,17	

[5b - active]

36:19 37:4,6 38:17 39:1,9 40:8,10,11,12 40:19 52:10 53:16,18 55:20 56:21,22 57:12 57:15,17 58:20 59:8,12 61:25 64:11,12,18,24 65:19 67:8 69:3 71:19,20 71:24 72:1,6,7 73:7,18,20 74:1,10,13,17 75:16,17 78:12 78:15 79:23 80:12 87:15 134:16,19,20 134:25 135:4,7 135:12 5c 19:18 23:7 53:23 69:4,6 69:13,17 70:4 5g 19:24	6p 110:11 111:17 113:22 114:19	a	accumulated 87:12 accumulating 70:17 accurate 9:11 87:2 94:23 acknowledge... 155:3 act 44:18 70:18 82:1 84:22 89:8 106:22 107:6,16 145:25 146:3 146:13 151:8 acted 46:23 action 33:7 86:17 127:25 activate 88:2 active 21:11 22:1,9,25 24:2 24:5,18,21,21 24:22 25:4,5,6 25:12,14 26:8 26:8,9,13,22,23 26:24 27:7,7 27:12,13,16,19 28:2,5,8,12,16 28:17,18,21,21 29:6,8,10,24 30:3,4,13,18,18 30:18,23,25 32:6,14,16 33:3 34:4,8,19 34:21,23 37:25 38:1,3,11
	7	a.m. 2:4 ability 35:22 60:16 able 20:7 36:15 122:7 above 29:23 57:18,22 61:13 61:23 94:16,17 155:7 absence 123:14 123:14 absent 145:16 abut 142:11 abutting 142:19 accelerate 70:13 105:16 106:10,15 108:13 accelerated 105:24 accelerates 70:4 accelerating 69:15 77:19 107:2 acceleration 107:17 accept 21:25 access 37:13,14 52:5 account 126:19 accumulate 84:7 96:10	
	8		
	8 15:3,5,7,20,23 18:14 126:10 138:5 842 18:16,19 71:13,20,23,25 72:19 73:4,15 74:1,18 76:2 78:2 83:2,9 94:7 134:20 147:5,9,18		
	9		
	9 15:19,23 113:19 90 12:12 900,000 84:13 94024 5:6 94304-1007 2:3 96 12:25 97 12:24 970 5:6 9:14 2:4		
6			
60 148:9,12,23 61 111:7 6332 1:23 2:5 153:25 64 66:22 65 133:24,25 66 142:4 6760791 1:25 154:2 155:2			

[active - analysis]

41:14 42:9 44:4,5 45:19 46:14,17,22,23 47:2,8,12,16,17 48:21,23 51:1 51:5,6 52:14 52:15,17,21,21 52:22 53:1,4,8 53:12,19,21 54:1,7,10,11,14 54:16,17,22,23 55:4,12,12,14 55:23 56:2,8 56:11,12,14,18 56:22,23 57:8 58:3,8,17 59:14,22,23 63:11,13 64:1 64:2,3 69:10 69:15,16 72:19 72:20,21 73:15 73:24,24 74:5 74:14,22 75:20 75:21 79:6 99:24 100:5,7 118:19 121:13 123:22 124:5 125:7,10,22 128:19,24 129:5 134:3,5 135:4,13 137:11,14 142:9,19 143:1 actively 81:5	acts 51:19 86:6 86:7,8 104:1 actual 145:16 148:2 actually 25:18 38:10 45:15 77:19 90:4,7 92:21 101:8,9 108:12 116:11 121:19 122:1 126:18 134:24 139:7 141:14 147:2 149:4 150:24 added 27:13,20 27:22 28:23 39:2,23 additional 8:6 8:8 17:20 39:3 51:9 52:3 63:19 78:20 149:13 additions 3:9 155:6 address 5:4,5 15:9 19:5 addressing 115:25 118:14 adequate 143:8 adjacent 21:11 25:5,12 34:4 72:3 adjustment 126:19	advanced 50:22 adverse 127:6 127:14 adversely 127:25 aerospace 11:19 affect 127:25 affects 122:4 affirmed 4:4 age 66:8 68:11 agnostic 108:17 ago 14:18 102:23 agree 16:22 19:22 20:14 22:14 80:17 81:16 103:6 121:20 125:5 133:15 136:15 145:19 agreed 134:16 ahead 20:9 98:24 aid 29:7 34:6 57:6 58:1,15 69:14 74:6 78:21 147:2 aided 11:16 aiding 35:2 102:7 108:16 108:21,21 151:14	aids 102:4 103:20 109:8 alan 2:17 4:13 60:8 132:3 alexander 1:18 2:1 3:5 4:3 5:5 154:2,24 155:2 155:4,12 aligned 107:10 alignment 105:25 allow 53:10 allowing 78:22 allows 150:7 alpha 110:14 113:20 114:1 116:9,10,16,19 116:22 117:14 118:6,8 119:21 125:23 126:14 126:19 127:7 127:14 alter 51:6 altered 38:8 41:13 alters 51:10 alto 2:3 altos 5:6 amorphous 13:10 amount 11:2 82:3 86:12 127:24 analysis 129:2 135:25 136:7
--	--	---	---

[analysis - attract]

147:8,11 151:15 analytical 116:21 analyze 133:18 135:23 136:5 136:14,20 analyzed 128:4 129:9 130:16 132:18 133:17 136:9 analyzing 136:8 anderson 4:9 angle 68:13 anneal 149:18 149:21 annealed 151:2 151:4 annealing 68:25 149:22 150:7,13,14,16 150:18 annotate 35:12 35:25 36:8 annotated 39:2 94:15 117:8 129:13 134:1 137:22 annotation 74:25 annotations 33:12 35:19 answer 21:25 27:5 32:12	35:15,21 37:11 40:22 47:7 60:7,9,15,18 83:3,3 97:19 98:14 109:2 114:13 132:15 132:16 133:19 answered 71:5 132:8 answers 5:16 5:17,20 anymore 42:13 45:8 48:21 appeal 1:2 appear 111:3 appearances 2:7 appears 42:20 144:19 appended 155:7 apples 28:19 application 107:25 applied 12:20 12:21,23 13:4 15:10,13,25 16:20,24 17:25 79:2 97:25 121:6 applies 79:4 apply 16:3 79:23 97:5 appreciate 32:12 151:23	appropriate 83:21 area 24:5 29:9 29:21 30:15,18 32:6 33:3,11 34:7 37:14 41:4,14 46:14 47:2,15,16,17 50:13 53:20 54:14 57:8 58:2,2,16 59:15 62:4 63:3,4,9 64:2,6 69:14 75:20,20 84:10 85:12 87:9,22 areas 24:2 30:6 30:9 47:13 49:23 54:2 55:12,12 59:24 140:12 argument 49:8 148:1 argumentative 65:2 arguments 144:5,22 148:13 151:6 arizona 153:21 arranged 127:13 arrows 29:23 33:18,19 35:3 37:15 57:17,21 58:4 59:16	75:11,11 art 15:10,13,16 16:2,4 23:25 26:17 65:3 66:2,14 67:15 68:10 78:11 146:16 asked 136:13 asking 55:19 71:19 99:10 131:1 132:24 144:17 aspect 115:25 135:15 assembly 14:19 assert 148:4 assist 81:17 assisting 8:21 80:19 assume 40:5,16 assuming 99:6 105:9 139:9 atmosphere 116:11 atom 89:11,11 89:20,21 90:4 90:4,5,5,23 91:12 atoms 85:22 attorney 8:25 attorneys 9:2 attract 78:18 104:3 105:1 122:20
--	---	---	---

[attracted - break]

attracted 93:13 113:20 114:1 123:13 attractive 106:4 attracts 95:12 104:15 105:9 aura 5:6 austin 2:11,14 autodesk 11:17 available 8:7 aware 6:1 8:12 8:14 awhitehurst 2:18	balances 96:7 band 90:22 barazesh 2:13 4:10 bare 65:6 barely 122:15 barrier 103:2 127:23 barriers 102:20 102:24 base 67:16 based 17:22 33:24 83:5 86:9 107:25 112:15 122:11 150:12 bases 67:14 basic 104:19 108:23 basically 24:4 32:4 42:10 85:21 86:15 89:17 91:9 96:7 104:15 112:2 113:9 114:5,23 122:14 150:15 basis 24:10 bearing 89:8 beginning 12:24 112:9 begins 30:5 32:17 37:3 behalf 2:1	behave 44:14 behaves 77:5 believe 8:16 9:9 10:11 43:25 52:15 56:5 70:10 73:6 81:20 93:3,16 94:6,15 101:7 124:4,11 130:16 132:18 134:15 137:25 146:9 believed 135:3 beneath 37:14 benefits 81:21 berkeley 18:8 best 35:21 60:16 61:1 91:4 better 25:11 51:22 73:21 102:25 138:16 beyond 85:25 109:6 122:18 big 17:11 90:7 90:9 100:13 bigger 62:18,19 62:22 billing 9:14,17 bills 9:16,17 bipolar 67:11 67:13,16 68:18 77:5 80:2 bit 12:3 22:7 77:5 87:23	88:1,2 127:7 142:2 blalock 16:8,20 17:14,17 129:9 129:24 134:1,9 147:1 blalock's 17:6 129:2 134:12 135:25 151:13 blank 49:12,17 50:5 blanket 55:11 blow 25:13 34:17 72:2 blue 93:13 board 1:2 body 113:20 114:2,5 122:20 140:16 boron 28:22 bottom 6:22 21:7 30:2 34:22 35:5 60:3,4 71:17 74:20,21 81:8 101:18,23 130:20 botts 2:2,10 4:8 4:11 bound 91:1 box 35:7 36:16 117:8,12 break 6:2,3,4 10:4 22:7 43:16 109:16
b			
b 3:7 39:24 40:6,7,10 66:23 back 7:13 11:5 18:13 23:10 24:2 58:22 60:24 61:2 68:11 118:2 130:14 139:17 148:11 150:22 background 8:16 18:2 bad 112:6 baker 2:2,10 4:8,10 bakerbotts.com 2:12,14 balance 96:14			

[break - channel]

132:1,12,17 151:17 breaking 105:5 131:15 132:6 brief 83:6 briefly 111:15 149:9 brings 48:25 brought 116:3 122:3 buffer 76:23 build 97:6 building 2:3 32:10 bunch 55:11 buried 127:2,5 127:11 buy 86:16,16	candidate 13:25 capacitor 22:18 42:12,20 46:11 126:12 capacitors 52:10 54:25 capacity 14:9 caption 22:10 carbon 13:9,10 careful 136:12 carrier 29:7 34:6 35:2 46:1 46:3,17,18,21 69:14 74:6 75:5 83:14,17 83:25 93:19,20 93:24 102:4,5 102:7 103:14 103:16 108:16 108:17,18 144:2 147:20 151:14 carrier's 88:13 carriers 29:22 33:14,21 35:4 37:7 47:12 48:4 57:7 58:1 58:5,6,15 64:21 69:5,9 69:16 70:4 74:21,24 75:4 75:4,7,16 80:8 80:20,22 81:1 81:4,12,18,24	82:6,19 83:20 88:11 89:4,8 89:10 90:3 94:25 99:23 100:9,13,20,24 101:3 103:17 110:14 117:9 117:13 118:16 118:18 143:4 145:11,21,24 146:1 147:3 149:7 carries 59:17 carry 11:21 37:11 carrying 70:20 case 1:12,13,14 10:1,3 36:5 42:11 50:14 60:11 75:2 78:18 85:15 94:22 117:23 128:4 cases 102:11,13 cause 85:15,23 86:1 88:5,6 146:2 150:3 caused 110:14 127:6 causes 84:5 150:22 cell 126:16 ceo 11:8 certain 89:12 89:24 90:15	96:24 103:14 certainly 10:2 28:20 66:11 151:23 certificate 153:1 certified 153:4 certify 153:5,15 challenged 19:18 chance 98:22 141:10 change 17:6 41:2 56:21 84:14,15 93:5 112:21 154:4,7 154:10,13,16 154:19 changes 49:2 86:9 93:7 99:14 155:6 channel 31:20 43:14 47:19,24 47:25 48:2,5 51:21 52:3,4,7 59:23 62:4,7,9 62:10,14,24 63:4,10,19,25 64:6,7 65:4,8 65:10 66:7,15 66:18,24,25 67:1,17,25 68:1,2,16 70:7 74:22 75:2 76:20 78:19,24
c			
c 39:24 40:6,7 40:11 66:23 ca 2:3 cad 46:8 california 5:6 11:13 14:2 153:4 call 18:7,10 63:14 83:14 85:7 95:14 called 123:10 138:11 149:17 camera 4:17,19 cancel 91:6 canceled 96:5 96:25 97:1			

[channel - comes]

88:17 100:2,4 100:6,15,15 102:17 103:12 103:14,15 119:7,10,12 121:6 130:4 133:5,12 134:3 134:5 142:14 142:17,22,25 channel's 62:9 64:5 channels 32:5 66:2,7,12 68:8 68:9,22,23 characterizati... 131:17 charge 71:1 84:4,14,20,22 84:23 85:2,8 86:20 88:11,13 88:20 89:3,8 89:10 90:3 93:6,6 95:12 95:13,17,23 96:4,17,19,20 96:21,24 97:1 97:6,12,20 98:8,19 99:11 102:13,18 103:3 104:2,3 104:4 105:9,10 105:12,20 106:5,19 107:17 128:2 149:12	charged 83:20 charges 47:2,3 66:6 69:7 70:19 84:7,10 87:9,11,12 88:13 96:13 97:5,10,21,23 97:25 100:15 102:20,20 104:16 146:3 chart 148:7,8 check 94:8 chemical 13:9 17:16,22,24,24 chemistry 17:25 circles 93:13 circuit 22:17 30:22,23 100:13 circuitry 30:19 100:14 118:24 circuits 32:24 32:25 citation 76:13 cite 76:2,8 115:14 cited 77:19 79:22 80:22,25 111:9 123:21 125:13 citing 111:21 133:21 city 14:8	claim 19:7 20:4 20:4,13,18 22:9 24:13,18 24:19 25:3,17 26:6,12 28:15 29:2,4 34:2 52:13,19 54:20 55:16,18 56:3 56:8,22,23,25 59:6 60:6,20 61:9,11,14 62:20 63:22 64:25 65:22,25 68:4 69:11,11 69:19,19,23,24 69:25 71:23,24 72:19,22 73:3 73:3,5,14,19 129:20 claimed 19:17 19:23 20:6 25:17 26:11 134:3,5 claims 19:2 82:19,20 clarification 6:7 7:20 clarify 46:16 clear 39:1 71:15 120:7 123:5 127:17 141:22 clearly 19:17 25:25 63:25	close 96:12 143:10 closer 68:16 76:23 cmos 20:17 21:18,23 22:10 22:17 25:10,14 31:13 34:25 73:9,20 78:8 133:5,16 135:9 coaching 60:21 131:23 132:3,5 collectively 78:10 column 66:22 67:2,23 68:21 76:2,8,18 78:7 79:21 80:4,6 81:8,10 110:8 110:21,23 111:7,8,16,19 113:18 122:25 124:1,9,19,21 125:12,15 126:24 127:21 127:24 138:5 141:3,5,7 combination 107:21 119:11 come 8:18 49:16 96:11 97:13 116:10 comes 47:15 91:3
---	--	--	---

[comfortable - continues]

comfortable 136:8 coming 25:25 94:20 commencing 2:4 comment 127:18,22 commissioner 14:8 common 17:23 18:1,3 82:5 commonplace 68:23 companies 11:18,25 compare 15:19 compared 56:23 86:13 118:2 126:1 complement 73:9 complementary 21:19 25:15 complete 155:8 completed 13:19 completely 42:13 120:3 complex 96:12 98:4 complicated 96:1,23 97:4 complications 82:2	components 1:4 4:8 6:12 92:19 154:1 155:1 composition 62:11 compound 26:1 comprising 37:22 computer 11:15,16 17:16 18:5,9 concentration 29:7 57:3,19 58:13 61:17,21 66:13,15 69:4 74:6 78:23,25 79:4,25 80:19 81:12,17 83:25 87:12 88:10,23 89:2,7 92:3 101:5 102:3,4 102:5,6,12 108:16 110:10 110:20 111:11 111:14,17,20 112:1,19 113:21 121:12 121:21 123:10 123:11 145:20 146:14 149:3 concentrations 65:7 67:16 85:1 87:3 148:3 151:10	concept 77:7 conclude 122:12 concluded 128:23 129:2 129:15,18 152:3 concludes 151:25 condition 40:21 85:8 conditions 89:24 conduct 70:9 conduction 78:22 conductivity 21:12 22:2,22 23:22 24:12 66:5 128:20,25 129:6 135:4,13 137:3 configuration 65:13 80:12 confined 144:22 confirm 4:22 148:18 confused 62:17 124:14 confusing 16:13 consider 28:11 44:6 100:4 130:2	considered 17:9 47:8 53:1 100:6 consistent 50:1 consistently 112:12 consolidated 7:16 60:11 constant 98:11 constitutes 43:3 consulting 11:9 11:11 consume 140:25 consumes 140:20,23 contact 30:20 53:9,14 contacts 51:20 53:22 54:15 150:25 contain 8:3,5 containing 34:5 contamination 112:7 contemplates 54:23 content 101:9 context 43:9 53:5 80:15 101:3 103:11 144:3 continues 144:15
---	---	--	--

[continuing - declaration]

continuing 143:23 contradictions 136:11 contrary 146:12,21 151:8 control 48:14 controlled 47:4 47:13 67:1 68:1 controls 47:1 70:23 convenience 4:19 coordinate 92:23,23 copied 10:20 copy 23:9,13,14 23:15 corner 6:23 87:19 130:20 correct 7:1 94:20 98:20 155:8 corrections 155:6 correctly 21:24 76:25 93:18 correspond 125:6 corresponding 19:19 112:17 corresponds 124:10,13	coulomb's 97:14 98:6,18 99:2,10 counsel 4:18 23:8 35:11 36:9,15,23 39:2,2 153:16 counter 24:6 27:14,16 28:1 38:5 39:18 43:1 47:23 48:10 62:6 66:3 couple 33:3,6 course 35:3 38:6 43:12 67:13 68:24 121:7 135:8 coursework 13:4 court 4:20 5:16 5:19 cover 54:9 covered 30:16 54:2 covid 12:13 create 27:12 35:9,19 43:2 82:13 96:18 118:18 created 42:10 82:7 115:20 118:16 124:5 127:14,25 128:9,11	creates 82:2 85:1 89:3,7 92:3 creating 36:4 51:11 87:14 88:24 92:9 creation 51:14 credit 91:8 creo 11:17 cross 32:16 124:18 139:8 crr 1:23 crystal 90:5,6,6 90:7,9,9,11 91:20 150:4,8 150:9 151:3 crystallin 150:10 csr 1:23 2:5 153:25 cubed 97:8,10 97:12 current 11:6 31:17 32:4 53:10 67:18 85:16,18,24 95:6 105:4 107:9 146:2 currently 13:21 curvature 112:25 curves 150:19 cut 109:2 cutting 60:17	d d 3:1 damage 150:3 150:10 damaging 151:3 dan 4:9 dana 1:23 2:5 153:4,24 daniel 2:23 dash 39:20 40:18 50:3,24 dashes 39:24 40:16 date 154:24 155:12 day 66:8 68:11 120:4 151:24 153:21 155:15 days 150:22 dc 2:18 dearth 87:22 debit 91:9 decelerate 105:11 106:10 106:15 decelerated 105:24 decided 128:5 declaration 7:3 7:6,9,10,25 8:14 9:9 10:20 15:3,7,20,21 16:8,10,20 17:18 19:11
--	--	---	---

[declaration - device]

74:18 83:9,9 94:7 99:22 101:10 109:20 110:9 111:4 116:15 117:2,5 123:1,25 128:14 130:24 130:25 131:2 131:14,19 132:25 133:25 137:17 142:5 143:14 144:16 147:18 148:10 148:23,24 declarations 6:17,19,21 7:21,22 8:2,10 10:6,12 16:2 16:25 17:8 101:12 151:7 declare 155:4 decreases 107:9 deemed 155:6 deep 64:5 81:13 140:25 142:21 143:5 deeper 143:6 define 30:9 definition 16:19,23,24 17:6,13,14,20 48:15 49:2 degree 17:23 18:3 108:3	109:12 degrees 17:15 107:23,24 108:8,11 densities 84:20 density 84:14 93:6 departments 18:7 depend 103:10 107:9 142:21 depending 88:12 106:5 150:1 depends 12:13 82:10,16 91:17 105:25 143:9 deponent 155:3 deposited 52:8 140:19 141:14 141:15,24 deposition 1:18 2:1 4:21 7:15 7:16,23 13:9 49:10 60:11 130:23 131:19 131:25 151:25 depositions 5:10 depth 31:4 33:8 43:3 64:2 68:13 112:9,10 112:16 113:4 113:12 120:12 120:20 142:10	143:1 149:3 150:1 depths 119:23 depthwise 32:17 110:12 derivative 84:17 92:21 113:8 describe 14:22 14:25 22:20 31:23 36:24,25 37:12 39:12 40:18 45:3 46:3,13 48:1,4 56:22 57:14 58:5 66:25 75:6 83:14 127:10 128:7 described 21:1 34:24 37:2 38:10 50:15 57:18 61:8 63:6 68:4 69:17 75:15 76:9 77:18 78:12 81:18 83:19 94:15 110:21,23 126:13 138:9 describes 20:16 20:24 26:4,21 28:15,17 52:20 54:21 57:24 60:1 61:11 62:20 64:14	66:1,21 67:13 78:6 81:4 82:1 101:5 111:16 122:6 127:23 138:4 141:18 describing 37:21 44:19 51:10 88:15 99:22 133:8 description 3:8 11:3 21:18 58:4 87:1 98:2 98:19 135:8 design 11:16 53:12 142:24 143:11 designated 122:3 designed 118:22 designs 12:1 detailed 37:2 64:22,24 70:25 86:25 determine 143:25 145:10 147:19 149:13 detract 49:9 device 20:15 22:10 25:16,18 25:19 26:4,5 28:18 31:2,14 32:15 34:10 37:18 42:25 43:3,8 44:5
--	--	---	--

[device - discussing]

48:21 51:25 69:6 70:8,21 72:6,8 73:7 76:14 77:5 78:4 79:23 80:1 82:10,13 100:9 117:17 118:10 120:11 124:18 133:15 133:16 134:10 devices 30:17 32:11 37:25 38:1,3,11 42:9 43:10 45:19 49:12 51:5,6 59:23 66:25 67:16 diamond 13:9 90:8 dielectric 13:10 99:13,15 103:1 138:12 dielectrics 99:18,19 dies 97:22 difference 17:12 18:12 32:13 62:12 72:5 135:24 different 7:22 10:4 11:15,24 18:8 19:2,5 24:2 26:5,15 26:18 30:10,24 31:12,25 32:1	38:7 41:25 42:1,13 43:7 44:12 47:19 52:2 56:1 60:12 61:8 63:17 64:11,15 64:18 65:5,12 66:15,19 70:19 77:14,15,23 79:14 80:3 87:3,9 89:16 90:18 92:22 102:12 115:16 119:22 135:12 139:15 150:1 differential 84:18 differentiate 9:25 differently 77:6 77:23 differing 85:1 difficult 46:7 148:3 diffuse 87:20 150:11 diffusion 87:17 150:13 diffusional 87:17,23 88:3 digital 34:9,25 dimension 31:8 dimensional 139:7	dimensions 139:6 diminish 97:12 dioxide 138:8 direct 19:10,15 80:4 143:15 directed 74:25 94:10 direction 33:20 33:22,23,25 58:9 59:25 69:5 75:19,22 79:1,5 83:20 83:22,23 88:11 88:12,12,22,25 92:17,22 93:8 93:18,22,25 103:21,22 105:4,11,15 106:3,6,8,19,22 106:25 107:5,6 107:18,24 108:6,18,21,21 108:22 109:8,9 109:11,13 110:12 113:5 114:21 115:16 121:23 146:22 151:9 153:13 directional 58:9 directions 70:19 106:21 112:21 139:6	directly 10:21 122:24 126:9 disagree 36:2 36:11 131:16 132:10 discharge 81:5 disclose 59:9 64:18 71:24 121:16 128:24 129:10 disclosed 19:17 19:23 20:23 21:17,18 25:9 29:13,18 34:13 34:15 53:16 57:12 58:20 72:2 73:18 74:10,13 discloses 20:6 20:15 22:9 25:10,11 59:12 64:21 72:1 129:4 disclosure 66:17 135:11 146:7 discussed 72:22 73:3,19 79:25 112:15 118:16 134:25 discusses 111:8 146:21 discussing 44:1 66:22 88:5 110:24 134:15
---	---	--	---

[discussing - drains]

134:21 143:20 145:8 discussion 125:3,13 144:16 displaced 40:3 disposed 21:11 25:5 57:1 58:12 60:2 61:15,20 62:21 dispute 149:6 disregarded 128:2,5 dissertation 13:6,7,8,13,17 distance 84:16 96:24,25 97:22 distinction 136:4 district 14:1,20 doctor 11:22 document 7:4 10:23 115:13 documents 6:16,16 11:1 doing 91:18 103:5 148:4 150:17,18 donor 81:12 dopant 29:7,21 33:13,25 34:5 34:6,20 35:4 37:7 57:18 67:15,23 69:4 74:5,13,20	75:6,15 78:25 79:4,25 80:18 81:16 83:25 88:10 89:2,6,7 92:2 102:3,11 111:13,25 112:1,6 121:12 121:21 122:3,6 144:1 145:10 145:12,19 146:13 147:20 148:22 150:19 151:9 dopants 27:12 27:20,22 28:22 33:24 43:1 57:3,19 58:14 66:23 84:25 88:24 101:5 112:2,3 149:10 150:11 dope 50:12 68:22,23 doped 24:6,25 25:18,20 30:6 38:3,5 39:18 40:8,9,10,11 41:15,20 42:25 43:1 47:22,23 49:19 51:18 62:6 66:2,3,3,9 66:12 68:2,9 86:5,7,14,16 121:1	doping 20:19 20:20 21:4,5 21:12,13 23:5 24:12,14 27:14 27:16,23,25 28:1,2 33:10 38:7 41:2,14 41:25 46:24 48:7,10 49:21 50:24 52:2,3 55:7,8,9,10,11 62:12 63:17,19 65:7 66:19 68:9 69:1 72:9 72:10,15,15,23 73:8 86:9 87:2 128:20,21,25 129:1,5,6,16,19 129:21 130:2 133:6 134:17 136:18 double 94:8 downward 30:1 74:22 75:11,20,23 87:14 112:14 113:2,9,10,11 113:14 114:7 140:24 141:1 142:1,2 downwards 93:12 dozen 68:20 dr 5:7 6:10 7:25 16:20	17:6,14,17 36:14 39:8 43:22 71:12 109:19 129:2,9 129:24 132:24 134:1,9,12 135:25 145:2 147:1 151:13 151:20 154:2 154:24 155:2,4 155:12 drain 23:25 24:7,9 27:13 27:23 28:1,4,8 28:11 33:10 38:4,7 39:18 41:2,20,22 42:16 43:14 47:18,22 48:7 48:9 51:12,14 55:23 56:7,10 56:15,18 62:6 64:1,3,6 66:7 68:15 70:8 75:5,8,17,22 76:21 77:2,20 78:23 102:18 103:18 121:8 133:7 134:2,4 136:16,17 137:1,3,6,10 drains 24:4,6 27:15 43:2 48:19 51:17 137:13
--	--	---	---

[dram - electrons]

dram 20:17 22:19 34:25 42:12 80:15 82:15 draw 35:7,16 36:1,16 drawing 32:20 36:10 46:9 drawn 3:9 39:9 40:7,17 42:19 44:1 dried 12:14 drift 57:1,3,5,6 57:16 58:1,12 58:15 59:20,21 59:22 60:1 61:8,10,12,13 61:14,17,18,20 61:22,23 62:1 62:5,8,13,18,18 62:21,22,25 63:7,11,22,25 64:8 83:14,17 84:1 93:4 101:6 drifting 83:22 driving 33:22 87:24 drop 54:15 87:18 91:5 drops 97:7,22 due 110:14 126:14 duly 4:4 153:7	dynamically 81:5	election 13:25 electric 57:6,25 58:1,14 59:16 64:11,12 65:12 70:18 79:1,5 84:9,9,11 85:15,23 86:1 87:4 88:20,24 92:9,13,16,18 92:24 93:11,18 94:5,14,19,24 95:7,9,10,16,22 96:2,14,18 99:14,20,23 101:2 103:7,20 104:1,7,21,22 105:1,14,16,24 106:3,14,17,18 106:24 107:5 107:10,16,18 107:19 108:1 109:8 112:18 113:5,7,13 115:9,15,20 121:11,20,25 128:2 electrical 18:5 18:9,10 30:21 30:23 46:24 51:22 53:9 66:5 84:5,5 104:19 106:20 106:23,25 electrically 54:3 138:24	139:3 electrode 78:17 94:21 103:13 119:7 121:4,7 electrodes 52:9 electron 46:1,9 48:1 78:23 89:20 90:20 91:1,3,5,9,15 103:21,23 104:1,9,10,11 104:20 105:2,6 105:10,15,16 105:22,23 106:10,15 107:2 electron's 105:4 106:1,9 106:16 107:1 electronic 30:17 100:13 electronics 13:12 117:22 electrons 47:1 47:7 48:5 70:5 70:10,11,20 75:1,3 76:21 77:1,19 78:18 79:10,10 82:24 83:7 84:8,12 84:13 85:12,20 85:20,24 86:21 87:21 88:16,18 88:22 90:24,25 93:12 95:10
	e		
	e 3:1,3,7 5:5 11:17 154:3,3 154:3 earlier 93:2,3 102:16 104:14 112:15 134:16 early 50:19 150:22 easier 20:9 36:22 easily 36:25 easy 19:8 33:4 edit 39:22 eees 18:9 effect 48:8 67:5 67:10,25 70:18 70:21 78:22 79:9 83:22 95:14 99:13 122:2 127:6 149:12 effects 48:13 127:14 eight 90:24 either 85:11 86:21 88:25 102:3 106:4,4 140:10 151:21 elaborate 126:22 elected 13:21 14:4		

[electrons - example]

96:10,11 104:15 110:14 113:10,11,14 113:19,25 114:23 115:3,8 115:10 116:1,7 117:16 118:8,9 118:12,14 119:2,11,12,17 119:22 120:5 120:13,16,19 120:24 121:5,7 121:13,19,22 122:7,20 123:13,22 124:5 125:18 125:22 126:6 126:20 127:6 127:15,24 element 20:18 21:10 22:9 24:18,20 25:3 26:11 27:4,5 27:19 29:4 34:2,13 52:20 54:20 55:22 56:25 58:11 59:5,9,12,20 60:1 61:14,19 62:20 69:24 70:1 72:18 73:5,14,16,22 74:3 129:20 elements 26:6 33:9 52:13	69:23 eliminate 118:22 127:5 ellyar 2:13 4:10 ellyar.barazesh 2:14 embodiment 81:11 embodiments 78:9 emit 91:18,18 encompass 143:1 ends 30:5 32:17 37:3 62:9,10 energies 91:23 energy 88:6,6 90:15 91:5 92:14 114:9 116:22 123:8 149:24 150:1 engineer 9:1,13 11:20 12:6 15:1 engineering 11:8,10,12,25 12:4,9,14,19,21 12:22 17:16,16 17:23,25 18:6 18:9,11 68:17 engineers 11:22 17:24 enhance 66:4,4 76:15	enhanced 13:8 51:21 66:5 77:23 enhancing 78:23 enter 116:11 entering 102:20 113:22 114:19,24 entire 43:3 45:22 60:6,7 112:16 143:1 entirely 40:9 127:20 epitaxial 110:13 138:6 141:21 142:10 equals 104:8,8 104:9,9 equilibrate 89:18 errant 143:4 144:10 errors 11:21,22 126:14,15 esq 2:10,13,17 2:23 essential 143:25 145:9 147:19 essentially 14:20 22:13 24:17 40:23 49:17 67:19 69:8 76:14	79:8 86:8 90:21 92:6 101:4 102:9 120:1 121:8 126:2,8 128:4 143:3 established 114:25 estate 30:11 31:1,3,4 estimate 9:19 evaluated 13:11 event 144:6,17 eventually 80:23 87:20 96:5,14 97:12 97:20,21 everything's 85:9 evidence 36:4,7 151:14 exactly 106:12 151:1 examination 5:1 examined 4:4 153:6 examining 116:2 example 18:8 19:24 20:16 24:19 26:6 28:21 30:20 33:9 34:22
---	--	--	---

[example - field]

38:4 43:10 53:22,23 63:18 68:9,21 76:11 76:19,20 78:21 84:6 86:14 96:9 102:15 103:12 129:8 138:8 139:10 139:16 exams 13:5 excerpt 109:23 110:7 excited 127:6 excuse 72:12 120:3 exert 95:16,23 145:21 149:7 exerts 89:3 121:21 exhibit 3:8,9 6:22 16:5,7,14 16:16 38:14,15 38:17,23 39:23 40:19 43:23 44:2,7,7 46:2 50:3 71:16 110:1,18 123:18,19 126:14,15 133:22 137:20 145:3 147:13 147:15 exhibits 35:9 35:13	exist 26:15 44:24 46:25 121:3 existed 118:22 exists 24:22,23 41:6 55:10 96:6 expect 38:6 66:13 expensive 30:11 31:2 experience 17:22 18:3 116:17 expert 36:6 experts 10:25 explain 23:4 26:3 29:18 32:13 59:11 77:1 83:17 explaining 26:1 extend 39:16 41:12 59:24 62:15 142:10 extended 40:24 extending 40:17 57:4 extends 39:17 57:20 61:13 74:13 76:1 extensions 68:15 extensively 134:25	extent 10:19 41:4 70:20 118:21 145:24 external 97:5 97:24 extra 23:13 85:11,12 86:21 86:21 91:3 extremely 85:21	67:5,10,25 70:3,13,18 74:19 79:1,5 84:5,9,9,11,15 84:21,22 85:15 85:23 86:1 87:4 88:20,21 88:24 89:3 92:10,12,13,18 92:25 93:4,11 93:19 94:5,14 94:19,24 95:6 95:7,9,11,13,16 95:17,22 96:2 96:4,5,6,14,18 97:4,4,5,6,21 97:24 99:14,18 99:20 101:2,7 102:3 103:7,20 104:1,3,7,10,15 104:19,21,22 105:1,9,14,16 105:17,20,25 105:25 106:3,6 106:15,17,18 106:23,25 107:5,10,16,18 108:1,20 109:7 109:8,9 112:18 112:20,21 113:5,7,13,15 114:6 115:2,9 115:20 121:11 121:21,25 122:3,12,16
		f	
		fabricate 67:24 fabrication 78:8 face 26:12 facing 75:11 fact 119:3 fair 11:2 64:24 fairly 62:9 150:4 familiar 5:12 10:17 81:23 98:6 116:16,22 138:17 150:16 far 39:15 faster 66:6 feature 143:11 features 111:2 federal 10:1 fet 67:11 95:14 fewer 82:13 field 17:23 18:4 57:6,25 58:1 58:15 59:16 62:13 64:11,12	

[field - force]

123:14 138:7,9 138:10 145:25 149:11 field's 123:6 fields 17:20 46:24 64:16,18 65:12 92:16 99:23 115:15 146:3 fifth 29:4 61:19 figure 3:9 19:23 20:2,5 20:10,14,23 21:17 22:8,14 22:16,21 23:11 23:22,24 24:1 25:9,10,11,12 25:13 29:13,19 32:16,18,19 33:13,18 34:13 35:7 36:17 37:4,6,24 38:17 39:1,6,9 40:8,10,11,12 40:19 42:8 43:10 45:17 51:4 52:10 53:16 55:19,21 55:22 56:21 57:12,15,17 58:20 59:8,11 61:25 64:11,12 64:18,24 65:22 67:8,15 69:3,4 69:6,13 70:3	71:19,20,24 72:7 73:7,13 73:18 74:1,10 74:13,17 75:7 75:16 78:12,15 87:15 94:10 99:22 100:14 110:18,19,24 111:1,2,8,12,22 112:8 113:15 114:4,25 115:21 117:7 119:19,20 120:11 121:12 122:4,11 123:4 124:10,11,12 124:15,16,17 124:17,22 125:2,6 127:11 127:22 129:12 130:7 131:1 132:25 133:3,8 133:20,22,23 134:1,9,15,19 134:20 135:4,7 135:11,12,16 136:6 137:21 137:23,24 138:3 139:3 145:13,20 148:20,21 149:16 figures 19:18 23:6 50:16 72:3	filed 10:15 fill 147:2 film 138:7,10 138:18,21,23 139:2,16 140:13,14 141:14,19 142:15,18 films 138:17 final 10:17 61:19 fine 43:18 finish 13:2 109:3,5 114:13 finished 13:16 109:2 fired 105:10,15 firing 149:23 firm 9:1,5,16 9:17,18 11:12 firms 10:25 first 14:3 18:4 20:19,20 21:4 21:5,10,13 22:1,9 24:18 24:21 25:5,6 26:8,19 27:7 27:19 28:16 29:6,8 34:4 49:24 52:14,21 54:22 57:5,24 64:11,14 72:9 72:10,10,15,15 72:18,20,21 73:23 74:4,6	84:17 100:19 101:14 128:19 128:20,24,25 129:5,6 134:3 142:5,9,18 five 8:17 12:9 flash 69:6 80:14 flat 123:9 flexible 32:24 float 85:13 floating 69:7 70:11,22,25 flow 31:17 53:10 67:18 85:17 125:18 125:22 146:2 fluorinated 13:10 focusing 145:1 follow 83:6 follows 4:5 footnote 116:14 force 33:20,22 35:24 87:14,17 87:24 88:1,3 89:3 93:4,23 93:23,25 95:16 95:23 98:8,19 105:5 106:5,9 106:18,19,21 108:21,22 109:7 114:7 121:22 144:1,2 145:10,21
---	---	--	--

[force - further]

147:20,21 149:7,11 forces 88:4,14 115:1 146:13 146:21 151:8 foregoing 153:7 155:5 form 8:7,23 10:10,22 17:1 21:2,6 22:3,23 24:16 25:21 26:5,9 27:21 27:22 28:6,13 29:15 31:5,15 34:9 37:20 39:14 40:14,20 40:25 41:10,23 42:6 43:5 44:9 44:21 45:6 46:5,20 47:10 48:3,18 49:5 49:10,14,19 50:10,13 51:2 51:5,18 52:18 53:3,17 54:19 55:6 56:4,9,16 60:25 62:3 63:2,8,15,23 64:13,19 65:1 65:14,20 66:20 68:6 69:12,21 70:6,15 72:13 72:24 74:15 75:9,18 76:10 77:3,21 78:5	79:7,17 81:19 82:9,21 84:2 85:4 87:6 88:6 89:5 91:16 92:5,11 93:1 93:21 95:2,19 95:25 96:22 99:5,25 100:11 100:22 103:9 103:24 104:13 104:23 105:7 105:18 106:2 106:11 107:3 107:12 108:2 108:10,19 111:5 112:23 116:8 117:18 118:11,20 119:5,14,24 120:14,21 121:15,24 122:22 123:2 124:24 125:8 125:24 126:7 126:21 127:9 127:16 129:7 130:9,15,22 131:11,12 133:10 134:11 134:23 135:6 135:14,22 136:19 137:5 137:12 138:14 138:22 139:4 139:19 140:5	140:17 141:17 142:1,20 143:2 145:14,23 146:8,15,23 148:16,25 149:2,8 150:20 151:11 formation 49:25 52:4 formed 21:14 23:1 24:5,8,9 24:15,20,24,25 25:7,15 26:7 26:20,22,23 27:6,11,15,18 28:1,16 29:25 37:13 38:1 41:24 42:14 43:13 44:4,6 44:10,11,16,17 44:18,19 45:12 46:12 47:16 48:21 49:24 52:11,16,20,23 54:21 56:11,11 63:16 73:23 75:3 131:20 133:7 138:6 140:19,20 141:20,23 forming 26:10 26:18 30:14 forms 30:6 forth 23:10 61:16 111:17	153:11 found 118:10 119:22 four 14:18 139:11 fourth 24:19 26:6,10 27:4 27:10,19 52:19 61:14 fox 138:10 free 58:21 85:12,13 86:22 86:22 89:11 91:1 friendly 88:19 front 6:15 8:2 60:12 71:13 76:1 117:5 139:17 full 51:25 fully 5:25 function 138:2 functionally 64:7 functions 70:22 77:22 102:12 further 39:23 40:17 51:21 57:5 66:4 72:2 126:18 136:6 151:19,21 153:15
---	--	---	--

[g - gradient]

g	145:15 151:3	155:12	123:8,9,17
g 5:5	generate	go 7:22 20:3,9	128:9,16
gate 42:17 52:4	126:10	25:3 54:4	130:24 132:1
52:6 69:8	generated	58:21 60:18	132:13 143:15
70:11,22,23	80:22 81:2	72:5 83:8 84:4	146:21 147:5
71:1 78:16,16	116:1,6,10	95:6 98:24	148:11
78:17 79:2,6	117:13,21	128:6 139:25	good 4:12 5:3
94:5,20,21,24	118:3,6,8,13,23	140:15 143:13	43:17 48:25
95:1,5 103:3	123:14	149:25 152:1	71:7 86:4
103:12,13	geometry	goal 30:12	104:6 112:6
119:3,7 121:7	143:11	54:13	151:24
gears 143:13	getting 69:7	goes 66:25	government
general 12:4	97:18 120:4	68:17 90:15	14:7
13:25 26:25	give 5:20 50:8	95:7,9,11 97:7	graded 29:7,21
33:10,19 46:9	83:3 84:6,8	99:14	33:13,24 34:5
53:5,6 70:17	87:11 98:22	going 4:16 11:5	34:6,20 35:3
77:7 82:12	given 76:11	15:25 16:5	37:6 57:3,18
113:1 133:12	84:15,21 95:22	18:20 23:10	57:19 58:13
138:18,19,20	96:19 102:2	29:2 35:8,15	61:17,21 66:23
138:20 149:2	103:6,21	37:9 38:13	67:1,14,15,23
149:10	105:24 110:11	43:15 44:13	68:1 69:4 74:5
generally 5:14	126:12 155:9	46:23 47:3	74:13,20 75:6
8:24 10:11,25	gives 45:18	53:10,11 55:19	75:15 78:25
28:7 30:7	giving 136:8	62:10 65:5	79:4,24 80:18
46:13 49:15	glass 95:8	70:9 79:1 80:1	81:11,16 83:24
51:4 72:1,25	glew 1:18 2:1	90:12 93:5	88:10 89:2,6,7
73:2,5 79:18	3:5 4:3 5:5,7	98:2,14 99:9	92:2 101:5
82:14 90:11	6:10 7:25 11:8	99:11 100:9	102:17 103:15
92:18 98:7	11:10 12:9,19	103:11 104:8	121:12 146:13
103:25 105:19	12:21,22 36:14	104:10,20	151:9
111:6 113:1	39:8 43:22	105:16 106:22	gradient 33:25
116:22 119:15	71:12 109:19	107:5 108:7	59:17 78:21
123:20,24	132:24 145:2	109:15 115:10	83:21,23 84:4
124:7 125:9	151:20 154:2	115:15,22,24	84:17,22 87:10
138:23 143:7	154:24 155:2,4	120:1 123:6,7	88:12,19,19,23

[gradient - hurt]

92:20,20,25	guys 98:12	10:2 17:10	highly 86:4
93:7 102:4,4,5	h	115:13	hitting 116:12
102:7 108:16	h 3:7 154:3	headed 33:21	holds 82:4 99:2
110:11 112:1	half 14:20	58:7	hole 88:17
112:19 113:21	114:11,18	header 144:20	90:20,21 91:2
114:4,24 115:9	149:24	144:20	91:9
115:20 116:1	halo 68:13	heading 35:5	holes 48:5 70:5
122:4,7,14,16	hand 3:9 6:23	healing 150:8	70:13,21 75:1
123:5,9,15	18:20 19:9	heard 31:20	75:3 76:22
144:1 145:11	25:22 35:10	heat 91:20	78:19 82:23
145:12,15,19	38:14 71:18	heating 68:25	83:7 85:12
147:20 148:3	85:19 102:19	149:22 150:7	86:21 87:21
148:22 149:4	123:17 130:6	heavily 27:15	93:12 119:12
149:10 151:15	130:20 136:16	38:4 47:22	119:17 120:2,6
gradually	137:2 149:17	height 62:7	120:16,24
110:11	handed 20:1	held 12:18,20	121:2
graduate 13:15	109:25 145:2	14:6 81:5	home 5:5
graph 110:19	147:12	help 17:19	horizontal
111:2 124:17	happen 50:25	34:15 38:13	38:23 39:11
great 132:20	53:11 65:16	58:23 79:15	horizontally
greater 121:3	88:5,7 89:19	102:18 103:7	39:15 40:3
121:21 128:1	90:1	helpful 23:16	hou 1:25
greenthread	happened	25:2	hour 6:3 9:10
1:9 4:14 6:11	46:11	helps 9:1 32:13	43:16 109:16
6:18 9:20	happening	hereto 155:7	132:13
10:13 154:1	122:8	hereunto	hourly 9:5
155:1	happens 85:11	153:20	hours 9:20,23
greenthread's	90:21 115:8	high 12:3 48:7	10:3
10:7,17,21	hard 9:24	68:13 81:6	huh 59:7
ground 5:12	46:10	82:16 140:11	hundred 9:23
143:20	hardened	149:23	10:3 84:7
grounds 147:9	118:2	higher 32:11	hundreds 33:5
guess 10:1	he'll 35:15	highlighted	121:2
44:22 69:8	head 5:21,21	138:2	hurt 79:16
100:17	8:19 9:22,25		

[hypothetical - insulating]

hypothetical 82:11 105:3	imbalance 85:2	79:24	indication 33:19
i	imbibing 56:22	improves 76:3	individually 78:10
idea 76:14 81:23 83:25	immediately 89:18 127:21	improving 77:9 79:22	induced 126:19
identical 16:23 148:15	impact 17:11 99:23	impurities 112:3	industrial 12:4 53:6
identification 38:15	impacted 82:20	impurity 110:10,20	industries 1:4 4:9 6:13 154:1 155:1
identified 45:4 46:2 50:3	impede 94:25 103:7 104:22	111:11,20,24	inference 65:19
59:19 111:12 130:19	impedes 102:5 109:10	112:6,7	influence 48:6 110:13
identify 61:25 136:4 146:6,12	impeding 102:7 108:17	inappropriate 23:14	information 8:7 149:14
146:20 151:8	imperfect 99:15	include 17:17 127:4	ink 39:3 87:18
idiosyncrasies 136:11	implant 68:12 68:17	included 17:14 17:20 59:15	inquiry 101:16
igbt 50:17 76:9 76:12,20 77:5 77:13,22	implantation 68:25 149:23	includes 56:14 116:24 134:9	inside 141:15
illustrate 33:18	150:6,16,18,23	including 55:23	insignificant 126:3,13
illustrated 94:6	150:24 151:2	incomplete 82:11	instance 31:7 77:8
illustration 32:19 46:8,10	implanted 84:25 149:18	incorporate 78:9	instantaneous 89:25
illustrations 66:23	implants 68:13 68:14,14,20	incorrect 129:3	instructed 4:18
illustrative 69:24	implemented 66:24	increase 84:10	instructing 35:12,18,20
image 22:16 82:4,15	important 39:16	increases 84:11 107:9	instructions 36:3
imagine 17:11 64:15	improper 132:7	indicated 35:2 37:15 51:4	insulating 30:24 49:23
imagining 11:2	improve 76:13 77:2 78:15	57:16 59:15	138:7,10,11,17
	80:2	74:17,18,19	138:18,21,23
	improved 77:8 77:13 78:3	indicates 117:13	139:2,16
		indicating 117:12	141:14,19

[insulating - know]

142:15,18 insulator 31:18 85:16,18 86:4 89:22 insulators 85:14 86:15 insurance 11:21,23 insurmounta... 89:22 intend 8:3 intended 106:1 inter 6:11,17 interact 96:18 96:20,24 97:2 interacting 99:3,6 interaction 96:12 98:3,4 interacts 96:3 97:23,25 interested 102:13 153:17 interfere 99:19 interpret 47:7 interpreting 24:11 56:3 intrinsic 120:25 introduce 18:13 145:2 147:12 invented 128:7 invention 19:17 19:23 20:6	66:1,11 77:9 128:9 inventor 11:17 involved 27:24 involving 6:12 ion 149:22 150:2,16,17 ions 149:23 ipr 6:23,24,24 6:25 7:3,17 9:21 10:5,8 16:6 18:18,24 18:24 19:3 74:19 143:20 145:3 148:14 ipr2023-01242 1:12 ipr2023-01243 1:13 ipr2023-01244 1:14 irps 8:1 10:18 19:1 60:12 110:5 147:14 isolate 139:3,9 139:14,16,21 isolated 121:9 isolates 30:7 138:24 isolating 31:11 31:12 isolation 30:9 30:16 31:18,24 32:1,1,2 49:23 103:1 138:2	issue 18:17,23 19:2,7 82:7 102:17 issued 110:5 item 127:11,11 127:13 j job 1:25 11:6 12:18,20 78:17 jones 2:23,23 4:10 journal 13:14 133:13 journals 13:16 july 1:19 2:4 153:22 jump 89:11 90:4 junction 67:4 67:24 k k 2:17 kawagoe 109:23 110:4,8 110:22 113:12 115:1,7,14,19 115:23,24,25 117:9 118:10 119:21 120:12 122:2 128:23 129:3,4 133:20 134:2 135:11 135:16,20 136:6,12,17,21	137:2,23 138:4 139:2 141:3 144:16,24 kawagoe's 117:16 134:2,4 keep 29:2 32:4 55:19 71:16 102:20,24 103:2,3,3 114:23 122:7 131:23 kind 5:13 8:25 9:24 11:10,19 25:13 31:23 49:2 51:19 70:24 90:8 96:12 98:1 99:19 116:20 139:24 kinds 68:14 85:14 knock 91:14 know 6:4,8 7:3 7:23 8:10 10:20,24 12:5 21:19 22:19 23:7 25:25 26:21,25 28:22 30:4,15 32:7 32:13 34:16 39:17 45:17,19 45:25 46:10,10 46:14 47:14 51:24 58:25 60:14 64:3
--	---	--	---

[know - longer]

68:19 71:5 79:9 82:14 85:25 87:18 88:21 89:1,8 89:19,20,24 90:2,5,14,22 92:12 93:3 96:8 97:3,4 98:1 99:13 103:2,11 106:8 106:9,14,16,21 108:6,7 109:7 113:8 114:9 115:22 116:20 117:24 120:23 121:9 128:6 131:14 132:1,7 133:12 139:25 140:9 141:10 142:1 148:5,6 148:8 149:4 151:24 knowledge 148:2 known 85:20 91:10 95:13 140:18	laid 55:13 language 20:4 26:21 28:15 29:3 105:8 114:22 large 31:8 143:10 largely 120:22 121:3,9 123:6 larger 11:18 21:7 61:10 late 120:4 lately 11:13 laterally 142:11,19 lattice 91:19 law 10:25 97:14 98:6,18 99:2,10 layer 57:1,2,3,4 57:5,7,16,18,20 57:22 58:12,16 59:20,22 60:1 60:3,3,4 61:8 61:10,12,13,15 61:16,17,19,20 61:22,23 62:1 62:5,18,18,21 62:22,25 63:7 63:10,11,22,25 76:23 81:11 91:15 93:14 101:6 110:13 138:6,11 141:21 142:10	layers 53:22 lead 30:20 leaking 121:9 leave 12:23 13:1 leaving 122:15 left 12:21 66:8 130:6,13,20,20 131:9 135:20 136:6,21 149:17 150:5 letter 131:6 level 15:10,12 20:20 21:5 72:10,15 86:6 143:9 levels 48:7 86:9 licensed 11:20 likely 65:18 likeness 141:20 limitation 82:23 129:21 limitations 91:24 limited 130:23 line 30:22 39:11 44:1,8 45:4 66:22 67:2 76:2 78:7 91:24 111:8,12 111:16,19 114:25 125:12 125:16 127:7 127:21 138:5 141:4,6,7	154:4,7,10,13 154:16,19 linear 112:24 lines 26:14 38:23 39:3 44:1,7 53:22 76:8 80:5 111:7 113:18 118:1 124:9 126:24 list 17:15 literally 44:12 84:19 93:7 95:4 149:23 litigation 11:14 12:2,7,10 little 12:3 22:7 46:7 47:18 68:16 87:23 88:1,2 94:15 llc 1:4,9 154:1,1 155:1,1 local 86:20 87:8 140:6 location 46:2 locos 140:3,7,9 140:14 141:21 logic 32:9 34:9 34:25 long 66:10 102:23 150:17 150:21 151:24 longer 8:10 17:15 41:15,22 42:4 43:3 44:6
I			
I 2:17 5:5 label 29:20 33:13 35:3 labeled 21:8 37:6 38:14 39:24 57:22			

[longer - memory]

96:6 97:2 look 9:8,8 10:25 15:3 20:11 32:15 34:16 45:17 58:22 71:23 80:15 96:8 100:17 101:13 110:18 117:1 119:19 124:12 124:16,18 125:10,12 126:24 137:16 137:17 141:3 141:11 148:9 148:20 looked 83:5 147:25 looking 16:15 19:13 23:24 24:1,2 43:23 59:5 70:3 99:21 100:14 101:8,10,21 110:8 116:14 123:25 139:5,8 144:13 148:7 looks 33:8 42:22 94:22 112:25 loosely 85:21 los 5:6 loss 90:15 lost 142:15 144:20	lot 17:24 18:7 32:9,24 45:23 51:4 55:7,10 58:25 68:16 69:3 150:3 lots 60:12,13 low 68:13 89:21 lowered 110:12 110:15 lowest 114:9 123:7 luncheon 71:10 m m 3:3 made 4:21,23 4:24 10:12,13 10:14 13:1 28:20 115:5 126:16 138:7 141:19 155:5 magnitude 92:17,24,25 143:25 144:1 145:9,10 147:18,19 149:12 151:14 majority 75:4,5 117:20 118:3 make 5:22 20:9 41:13,15 50:25 63:21 68:12 71:16 116:4,11 140:13 143:8	makes 50:24 80:14 123:5 making 15:11 91:20 manner 146:1 manufacture 148:5 manufactured 25:17 44:23 manufacturing 49:3 140:4 maps 134:2,4 mark 2:10 4:7 35:23 mark.speegle 2:12 marked 38:15 38:18 109:25 123:18 147:13 mass 150:1 material 13:3 43:13 44:24 45:20,21,24 85:17 89:25 materials 12:20 13:11 60:15 85:14 matter 8:21 9:6 9:15 10:5,13 11:3 15:11 17:6 81:25 107:4 matters 9:21 mckool 2:16 4:13	mckoolsmith.... 2:18 mean 10:12 42:4 46:18 65:24 70:23 72:15 85:24 95:3 99:17 100:12 102:10 113:25 116:6 126:9 131:9 139:6 149:21 meaning 44:17 120:23,25 means 67:18 85:9 141:23 mechanical 11:20 mechanics 91:23 mechanism 77:12,17,24 78:12,14 79:23 87:4 mechanisms 77:15 meet 90:20 91:10 meets 91:4 megavolt 116:20 memorization 60:10,14 memory 52:11 82:3,3 126:16 127:25
---	---	---	---

[mentioned - need]

mentioned 7:17 8:2 9:13 52:15 146:9 mentioning 68:22 mentions 81:1 mess 98:15 messy 97:18 metal 21:19 30:22 51:18 53:14,22 54:3 54:15 67:9 85:19,23 86:1 86:6,13 89:22 117:25 method 141:21 micrograph 46:9 microns 32:22 32:23,25 33:3 33:5,6 117:22 126:10 middle 29:20 37:6 86:7 94:11 113:18 117:8 122:24 migrating 143:4 military 11:19 mill 2:2 million 84:12 126:2,13 149:25 mind 8:18 89:9	minimum 65:6 120:23 minority 29:22 33:14,21 35:4 37:7 58:5 59:17 74:21,24 75:4,16 80:8 80:19,21 81:12 81:18,24 120:2 120:17,19 minus 20:25 minuscule 85:25 minute 125:1 missing 91:2,4 misspoke 97:15 mistakes 8:13 mix 140:20 mobility 66:6 modeling 11:15 11:18 modern 52:1 150:24 modifications 41:1 48:20 modified 40:25 moment 37:9 morning 4:12 4:20 5:3 134:22 mos 66:24 67:11 mosfet 67:9 77:4,13 78:3 80:1	mosfets 68:18 68:19 80:12 motion 33:20 59:17 85:24 86:2 89:25 90:16 104:22 114:20 146:2 mountain 11:13 move 36:3,11 66:6 71:6 83:20 85:16 86:11,12,24 87:24,25 88:11 93:13,19,23 102:18 103:17 104:9,11 121:19 122:1 moved 40:3 83:7 movement 29:8 34:6 35:2 57:7 58:1,6,15 69:14 74:6 102:5,6,7 103:7,8,21,22 108:16,17,18 108:22 109:9 109:10 147:2 151:14 moving 94:25 102:13 multiple 32:6,8 53:25 106:20	n n 3:1,3,3 23:24 24:3,7,9,24 27:20,22 40:8 40:9,10,11 49:16 50:20,23 70:7,8 75:3,5,5 76:20,23 81:11 124:20,21,22 125:6,18 126:20 127:15 130:21 131:6,8 136:15 137:1,2 137:6,7 name 5:4 153:21 nand 53:24 69:6 80:14 82:14 narrative 49:9 nearly 30:13 necessarily 18:11 45:22 46:18 54:10 69:14 89:10,11 127:19 128:10 146:1 necessary 155:6 need 5:20 6:2,3 6:7 7:20 60:8 65:21 82:6,24 83:7 98:13,14 106:8 131:23 148:8
--	---	--	---

[needed - object]

needed 9:2 13:5 needs 75:2 143:5 144:19 151:3 negative 93:12 95:13 104:2,3 104:4 105:10 105:14,15,20 105:20 112:12 113:8 neither 153:15 net 83:22 85:2 86:19 144:2 147:21 neutral 85:10 neutrality 85:8 never 42:17 83:5 new 8:7 35:9 36:4,7 42:10 61:5 107:20,22 newman 2:23 4:10 news 151:25 nice 45:18 nishizawa 124:1,8 126:18 127:4 nitrate 118:1 nmos 129:13,15 129:25 130:3 133:17 134:3 134:10 136:16 137:1	nodes 81:6 nods 5:21 noise 82:2,4,8 non 102:17 nonzero 112:9 112:11,17 normal 146:3 normally 139:11 notary 155:13 155:19 note 4:16 noted 131:22 132:9 155:7 notwithstandi... 86:22 november 14:1 nowadays 33:1 npn 21:20,21 21:21 22:15,18 22:20 23:5,21 31:13 32:3 73:7 ns 123:10 number 9:20 16:13,14,15 18:14 27:25 39:11 50:3 82:19,23 83:6 84:10 87:8,9 90:24 121:4,5 126:11,12,14 136:10 numerals 39:5	numerous 68:12 nuts 12:6 nw 2:17 111:13 111:17,20 112:11,20 114:25 122:4 123:15	75:9,18 76:10 77:3,21 78:5 79:7,17 81:19 82:9,21 84:2 85:4 87:6 89:5 91:16 92:5,11 93:1,21 95:2 95:19,25 96:22 98:23 99:5,25 100:11,22 103:9,24 104:13,23 105:7,18 106:2 106:11 107:3 107:12 108:2 108:10,19 111:5 112:23 116:8 117:18 118:11,20 119:5,14,24 120:14,21 121:15,24 122:22 123:2 124:24 125:8 125:24 126:7 126:21 127:9 127:16 129:7 130:9,15,22,22 131:11,11 133:10 134:11 134:23 135:6 135:14,22 136:19 137:5 137:12 138:14 138:22 139:4
		o	
		o 3:3 oath 5:8 60:5 object 8:23 10:10,22 14:12 14:24 17:1 21:2,6 22:3,23 24:16 25:21 28:6,13 29:15 31:5,15 35:8 37:20 39:14 40:14,20 41:10 41:23 42:6 43:5 44:9,21 45:6 46:5,20 47:10 48:3,18 49:5,10,14 50:9,10 51:2 52:18 53:17 54:19 55:6 56:4,9,16 60:25 62:3 63:2,8,15,23 64:13,19 65:1 66:20 69:12,21 70:6,15 72:13 72:24 74:15	

[object - owner]

139:19 140:5 140:17 141:17 142:20 143:2 145:14,23 146:8,15,23 148:16,25 149:8 150:20 151:11 objection 25:25 26:2 53:3 65:14,20 68:6 131:4,18,22 132:9 occupy 54:13 occur 32:9 52:25 150:8 occurs 32:10 odd 151:1 offer 8:3 offering 7:13 office 1:1 13:22 14:4,10,16,17 official 14:9 officially 12:24 oh 143:16 okay 5:12 6:2 6:10,15,21 7:2 7:12,20,25 8:18,20 10:6 12:15 14:15,22 15:9 17:12 19:9 20:8,12 20:18 21:10,24 22:14 23:4,21 24:11 27:3,9	27:18 31:1,11 32:2,12 33:12 34:1 36:22 37:2,10 38:13 39:23 42:24 45:14,25 48:25 49:12,19 50:24 51:9 52:25 54:17 56:20,25 58:11 59:11 62:24 64:10 67:12 72:4 73:14,22 75:14 75:25 78:2,14 81:3 83:8 86:25 88:8 89:2 92:16 93:10 94:12,14 94:19,23 98:16 100:8 103:20 111:11 112:5,8 115:1,14 116:14 118:9 119:2 123:17 124:25 125:5 130:6 131:5 138:1 140:13 141:13 142:8 146:6 147:8 149:16 151:6 151:16 old 107:21 omissions 11:21,23	once 103:12 one's 30:14 ones 42:21 117:21 onsemi 145:3 147:13 onsemi's 16:7 open 53:22 operation 76:9 127:8 operator 84:18 opined 15:14 18:18 opinion 8:11 20:5 42:25 opinions 7:12 8:3,5,8 15:11 17:5 131:13,19 131:21 136:8 151:13 opposed 107:23 107:25 108:4,8 108:11 opposite 21:12 22:2,21 23:2 23:12,22 24:4 27:16 28:2 41:3 47:23 62:6 69:5 70:18,19 72:23 73:10 88:12 93:25,25 103:22 104:1 104:11 105:3,4 109:10,12	114:21 128:20 128:25 129:6 129:16,19,21 134:17 135:5 136:17 137:3,8 146:13,21 151:9 optimize 79:19 optimized 78:9 oranges 28:19 order 70:9 119:3 orders 126:15 ordinary 15:10 15:12,16 16:1 16:4 originally 50:5 originate 75:21 85:22 outcome 153:18 outer 116:10 outside 12:18 40:11 130:24 overall 85:10 overcome 115:2 overcoming 89:12 overlap 40:8 own 8:22 87:25 97:6 owner 1:10 2:15 4:14 6:11 10:8,14,21
--	---	--	--

[oxidation - patent]

oxidation 140:6 140:11 oxide 21:19 67:9 94:16,17 95:5,6,7,8,11 96:10 138:10 140:19,19 141:19 oxidized 52:6,7 oxygen 140:11 140:21,21 141:25 ozone 140:10 140:22	p.m. 152:2 page 2:2 3:4,8 9:10 15:3,4,7 15:19,20 16:12 16:13,14,15,15 16:16 23:12 74:18,25 76:1 94:6,12 99:21 101:18,21,24 109:19,22 110:7,8 111:9 116:15 117:1,3 117:4,8 122:25 123:25 128:13 128:13,15 129:12 132:25 133:9,16,25 137:17,18,19 137:19,20,22 137:24 139:18 143:17 154:4,7 154:10,13,16 154:19 pages 1:24 19:11,12 59:1 paid 9:5 palo 2:3 paper 71:18 papers 13:15 13:19 60:13 paragraph 9:9 15:6,14 16:13 16:17 19:10,12 19:13,16 66:22 75:25 80:18,23	83:8,10,13,19 88:9 93:10 94:4 100:1,17 100:18,20 101:23 108:15 110:24 111:3 111:21 125:15 133:24,25 137:16 141:12 141:13 142:4 143:16,17,19 143:23,24 144:4,4,7,11,12 144:14 145:1,8 147:5,17,25 148:9,12,23,24 paragraphs 15:9 144:23 parallel 31:8 40:2,5,6,6 parlance 53:2 part 9:17 22:1 22:19 28:12 41:21 42:4 50:25 51:13 56:8 62:1,2,5 62:25,25 63:6 63:7,11,13,14 63:21,22,24 64:7 65:25 68:25 87:16 100:4,6 122:19 125:10 135:15 137:11,13 147:8	partes 6:11,17 partially 40:10 particle 107:19 107:19 particles 84:23 95:17,23,24 96:4,18,19,20 96:21,24 98:9 98:20 99:3,11 116:19 118:3,7 119:21 126:15 127:7 149:12 particular 42:20 80:25 88:10 94:4 101:15 143:11 parts 19:19 party 153:16 pass 16:5 99:18 passage 77:18 80:22,25 81:15 124:8 passed 13:4 passing 99:20 passivation 118:1 past 112:10 113:13 patent 1:1,2,10 1:13,14,15 2:15 3:9 4:14 6:11 10:4,7,14 10:21 18:14,17 18:20,23,25 19:3,18 20:1,4
p			
p 20:25 22:2,22 22:25 23:1,23 24:3,8,8,24 27:20 34:22 37:8 49:16 50:20,23 63:18 63:19 73:8,10 110:10,20,25 111:17 113:22 114:19,24 115:3,10 119:25 120:1,1 120:2,15 127:2 127:5,5,22 129:16,22,23 130:3,4,4 134:17 135:5 136:18 137:4,7 137:7			

[patent - polarity]

20:14,19 23:9 24:13 29:5,14 34:2 38:18 39:9 43:9 51:24 52:13 53:2,6 55:16 55:18 58:25 65:25 69:11 71:13,20,21,24 71:25 72:19,22 73:3,19 74:19 76:3 77:18 78:2,6 80:17 83:2,4 101:11 122:1,2,6 127:23 134:20 138:4 147:9 patents 7:21 8:17 19:9 pause 67:4 payne 143:20 143:22 144:9 144:18,22 145:6,13,20,22 146:7,14,20 peabody 1:23 2:5 153:4,24 peer 13:14,16 13:18 pen 35:6,9,10 36:14,23 pending 132:14 people 8:20 18:3	percent 12:10 12:12 128:1 percentage 12:8 perceptible 85:17 perfect 85:17 85:18 86:3 perform 102:12 performance 76:4 82:16 143:9 performed 136:7 perimeter 140:1 period 116:17 person 15:16 16:1 personally 19:6 perspective 142:24 petitioner 1:6 2:2,9 4:8 phd 1:18 2:1 3:5 4:3 13:3,19 phenomena 87:8 phenomenon 83:14 86:20 phonons 91:18 91:19,22 phosphorous 28:23	photon 91:12 91:14 photons 91:18 91:22 phrase 31:20 56:2 physical 47:11 48:13 77:12,17 physically 28:4 44:23 77:16 physics 108:23 pick 102:16 pictogram 45:18 pictorial 64:20 pictured 23:22 pictures 35:16 piece 85:2 pile 84:12,12 87:21 piled 87:9 pinch 67:1,17 67:18,25 place 11:25 33:7 53:13 84:8 100:8 117:16 142:16 153:11 places 144:1 145:11 147:20 planar 31:3,7 32:13 plasma 13:8 please 5:3 6:8 7:23 23:20	71:3 109:5 115:6 136:25 plus 94:16,17 pmos 130:7,13 134:5,9,16 135:18 pn 26:18 pnp 21:20,22 21:25 22:11 31:13 32:3 73:10 131:9 134:16 point 38:8 40:23 41:11 42:1 44:3 45:15 48:10,22 48:22 51:20 62:8 71:8 96:6 96:25 97:3 102:14 112:22 113:6 114:9 115:4,5,6 116:2 119:20 145:16 147:5 pointed 75:7 113:1 129:19 129:22,24 130:5 pointing 33:18 88:21 points 88:25,25 112:14 polarities 94:1 polarity 83:21 88:13 93:20
--	---	--	--

[politician - proportional]

politician 14:23	103:13 123:8	prevails 85:9	10:8 110:1
polygon 54:12	potentially	prevent 115:10	152:2 153:7,10
pool 87:19	33:5 45:23	142:15,18	153:17
portion 22:17	54:24 55:14	prevented	process 49:4
28:20 29:5	61:23 62:22	113:21 114:19	52:1 69:1
36:18,20,20	63:10 88:7	preventing	processed
42:17 60:24	91:14 99:13	36:9	44:23
61:25 74:4	105:11	previous 60:1	processing
111:9 130:14	power 32:11	61:3	49:21 50:12,19
135:19 140:23	powered	previously	51:5,10,15,16
posita 15:16	103:13	107:19 123:18	51:25 52:25
16:19,23,24	practice 13:20	principal 138:5	produced
17:7,13,21	69:10,19 82:20	141:20	113:19 114:1
55:3 133:4	practices 64:25	printed 16:15	118:14
142:8	preamble 20:13	16:15	produces 84:22
position 14:6	26:4	printout 148:7	products 11:17
44:19 90:13,13	preceding	prior 59:20	profile 150:5
134:13 136:1	116:17 127:22	67:14 76:18	150:12
143:24	preferred	81:24 153:6	programming
positive 93:11	81:10	private 13:20	69:17
93:11 94:18,19	preliminary	pro 11:17	programs
94:22,24,25	10:14	probably 14:9	11:16 18:7
95:12 104:2,2	preparation	22:19 61:1	pronounce
104:3,7,10,15	9:3	70:10 80:2	115:24
104:16,21,22	prepared 136:3	139:25	pronounced
105:1,8,9,12	prerogative	problem 81:24	115:23
106:4	35:24	82:3 89:16	proper 35:25
possibilities	present 2:23	90:18 128:10	36:3
101:20	57:15 82:7	problems 82:5	properties
possible 54:17	122:17	82:13	51:22 66:4
81:21 100:20	president 11:8	proceeding 7:7	90:10
possibly 63:17	presumably	7:10,18	proportional
potential 17:15	70:23,25	proceedings	84:21 92:25
89:7 90:4 92:3	pretty 12:14	4:1 5:13 6:24	93:5
92:13,13 94:22	86:4 99:19	7:13,17 8:4	

[propose - reasonable]

propose 126:18 provide 107:17 108:20 109:8 139:22 149:11 provided 17:7 78:21 provides 78:17 94:21 106:4,18 public 155:19 published 13:13,15,18 pull 29:22 33:14 35:4 37:7 59:17 70:9 75:16,19 75:22 100:20 100:23 104:10 pulled 59:25 pulling 30:1 58:5 64:21 70:8,10 75:7 79:10 101:3,7 pulls 74:21 88:22 purchased 123:12 purpose 103:17 138:13,21 143:3,7,9 purposes 53:13 69:25 116:21 push 78:19 115:3 121:22 123:7	pushed 88:16 114:3 pushes 69:9 88:22 95:4,11 95:12 109:13 114:6 pushing 69:5 79:9 113:9,10 113:11,13 put 10:2 28:14 30:20 32:18 39:19 52:9 54:24,25 70:17 84:8 87:19 97:16 105:23 putting 17:15	120:9 124:14 127:19 132:8 132:14,15,16 136:24 138:16 142:16 questions 5:16 35:16,21 60:9 128:17 151:19 151:21 quick 151:17 quite 134:25 quote 94:4 110:21 122:25 124:1 128:3 138:5 quoted 111:3 113:17 quoting 124:9 124:13	126:19 127:7 127:14 rays 116:9,10 116:16 117:14 rdr 1:23 react 142:1 reactive 140:23 reacts 116:22 read 60:6,18,20 60:24 65:21 71:2 76:24,25 93:15 124:10 127:8 130:14 141:12 155:5 reading 26:5 60:15 73:12 94:4 122:24 reads 26:7 96:6 real 30:11 31:1 31:3,4 102:22 really 12:24 30:8 45:16 84:3 86:5 87:25 96:12 102:17 121:5 135:24 139:21 reask 61:1 reason 5:24 122:11 142:25 154:6,9,12,15 154:18,21 reasonable 12:11 65:6,16 86:1
	q		
	qualifications 15:15 qualifying 13:5 quantum 91:23 quarters 12:17 question 6:7 15:25 18:4 22:5 23:19 26:1 35:14 40:22 48:25 59:3,8 60:7,16 60:23 61:1,3,4 61:5 71:3,6 75:12 76:7 80:16 93:24 95:20 96:2 97:19 98:13 110:25 120:5,8	r	
		r 97:10,10,15 154:3,3 radiate 84:9 radiated 126:9 radius 97:7 raised 25:22 raises 90:17 ran 14:17,18,19 rapid 150:13 rapidly 76:21 rate 9:10 89:15 90:18 ray 110:14 113:20 114:1 118:6,8 125:23	

[rebut - region]

rebut 147:3	37:5 54:11	refresh 5:15	56:2,8,11,12,14
rebutted 129:9	139:24	43:25 82:4	56:18,22,23
rebutting 115:4	red 93:12	regard 64:22	57:19 58:12,13
135:25 147:1	reduce 91:5	regarding	59:13,13,14,15
151:12	reduction	82:23 129:3	59:23 61:7,11
recall 82:22	110:19	147:9 148:13	61:12,20,21
98:18 115:4,5	refer 7:2 24:13	regards 135:12	62:2,21,25
115:12,17,18	37:24 42:8	region 21:11	63:11,13 64:1
116:2 136:10	reference 37:24	22:1,9,25 24:8	64:2,4,8,21
recalling 52:12	56:20 80:14	24:9,18,22,25	65:4,11 66:18
received 49:22	109:23 110:4	25:4,5,6,14	69:15,16 72:19
recess 43:19	123:21 143:22	26:9,22,23,24	72:20,21 73:15
71:10 109:17	145:6 149:1	27:7,7,12,13,16	73:24,24 74:13
132:22 151:18	referenced 39:5	27:19 28:2,5,9	74:14,20,22
recognize 6:16	references	28:12,16,17,18	75:7,15,21
16:7 55:3	124:19	28:18,21,21	78:19,24 96:4
123:19 134:1	referred 33:12	29:21,23,24	96:13 99:24
147:15	33:16 52:14	30:2,4,13,19,21	100:5,7,15
recombination	referring 7:4	30:24 31:21	118:19 119:7
89:15 90:17,18	25:19 27:5	32:17 33:14	119:10,12,16
91:11	39:19 61:2	34:3,4,5,6,18	120:13 121:6
recombine	75:10 93:10	34:18,19,20,21	121:13 123:23
91:11	114:20 116:5	34:21 36:16	124:6 125:7,10
recombined	129:12 133:23	37:7,12,13,17	125:18,23
76:22 121:3	135:16,19	39:12,13 40:8	126:6 127:2,5
record 4:16 5:4	148:22	40:9,10,11,19	127:15,23
38:25 39:4	refers 25:4	41:20,21 44:4	128:19,24
120:7 131:20	72:18,20	44:5 46:18,22	129:5,14,22
132:10 152:1	reflect 148:21	46:23 47:8,12	134:4,6 135:4
recording 4:21	reflected	48:23 51:1,21	135:13 137:11
4:23	145:13,16,20	52:3,5,14,15,22	137:14 138:2
rectangle 54:12	reflects 111:2	53:1,2,4,5,8,8	142:14,17,22
140:1	111:13	53:12,19,19,21	142:25 143:1
rectangular	reform 150:9	54:1,10,16,18	149:7
21:8 29:21		55:3,4,5,23	

[region's - right]

region's 61:22	remote 4:20	146:18	rich 88:17
regions 24:21	remotely 4:9	resisters 55:1	right 6:13,23
24:21 25:12	repair 150:10	resistor 86:8	6:25 7:10 10:9
26:8,8,13,18	repeat 22:4	respect 92:21	15:17 18:24
29:6,8,10	59:2 60:23	response 10:14	19:4 22:12,15
30:24 32:14	95:20 136:24	10:15,18,21	24:15 27:7,13
34:8,23 37:5	repel 104:4	responses 10:8	27:21 28:5
41:21 51:12	105:20 109:13	rest 42:2 44:14	33:15 40:4,12
52:17,21,22	116:1	62:11 71:17	43:4 44:8 47:6
54:1,8,11,22,23	repelled 105:22	124:18	49:13,20 50:6
57:9 58:3,8,17	114:4	restate 120:9	50:13 52:17
61:18 69:10	repelling 96:11	restrict 67:18	55:24 56:1
74:5 124:20,21	106:5	restricted	57:10 58:18
124:22 125:6	repels 93:11	135:25	59:6 67:5 68:3
129:18 142:9	95:4 104:16	result 84:15	69:5,11 70:14
142:19 145:21	rephrase 49:7	107:1 112:20	71:12 72:6,19
relate 83:25	55:9 120:3	125:23 149:11	73:12,24 76:24
88:14 144:23	report 23:6	resulting 101:6	77:14,20 80:12
related 68:7	50:15 58:22,24	113:5 121:11	81:6 83:15
153:16	60:21 74:16	121:20 140:14	85:6 88:21
relationship	111:9 125:14	results 87:4	92:4,16 93:15
144:18	reported 1:23	retained 6:10	93:17 94:7,16
relative 106:16	reporter 4:20	returning 13:2	94:23 95:9
113:4	5:17,19 153:5	revenue 12:8	98:6 99:2,4,24
relatively 85:13	reports 60:12	12:10,12	100:10,21
86:22	requested	review 12:1	101:2 102:8
relevant 18:2	60:24 130:14	37:9 74:16	103:23 104:12
125:2	required	83:6 111:15	104:18,25
remainder	131:12 155:13	115:13 149:9	105:6,17 106:1
144:23	requiring	reviewed 13:14	106:10,24
remember 19:6	129:21	13:16,18 83:2	107:2,11,24
19:8 134:21	resist 103:22	reviewing	108:18 109:23
remembering	resistance 86:9	15:24 136:13	110:5 111:14
92:3	86:12,17,17,23	reviews 6:12,18	111:20 112:10
	89:21 90:2,15		112:13,18,22

[right - semiconductor]

115:11,16	running 13:21	scope 14:12,24	52:5 53:18,19
116:15 117:7	s	130:23,23,24	53:23 65:10,19
117:17 118:7	s 3:3,7 154:3	131:4,12,18	68:8 73:16
118:10,17	saw 46:1 83:2	screened 99:7	74:8,9 76:5,6
119:4,13,23	saying 45:5	se 86:20 141:24	80:9 81:14,15
121:23 122:21	47:7 48:13	sea 85:20	83:6 88:18,20
123:23 124:8	54:8 62:24	second 14:18	101:18,20
125:14,20	102:2 125:21	18:5 21:12	110:2,16
126:6,20 127:8	131:24 139:14	24:12,18,21	113:23,24
127:15 129:1	139:15	25:4 26:8 27:7	114:4 117:10
129:25 130:8	says 19:16 27:6	28:17 29:6,8	124:1,12 127:1
130:21 131:10	29:21 33:13	34:4 50:8	128:18,21
133:18,21	34:3 36:7	52:14,21 54:23	130:6,19 131:6
134:6,10 135:2	55:22 58:19	58:14 64:10,15	133:1 134:7
136:16,18,23	61:18 73:25	72:11,16,18	137:21,24
136:24 137:2,4	80:17,21 81:3	73:15,24 74:4	139:21 142:12
143:13,16,21	81:10 88:9	74:7 114:11,18	144:4,7,10
144:2 145:6	100:23 111:22	128:19,24	145:4 147:17
146:7 147:4,10	111:24 113:19	129:5 134:5	147:22,23
148:13,20	114:18 117:9	142:5,9,18	149:16,19
149:7	122:19 125:17	148:12	seeing 82:22
rigid 32:25	125:25 126:8	section 8:16	seem 17:10
ring 90:8	133:4 135:9	32:16 101:19	seen 16:10
road 2:2	147:18	101:20 113:17	sees 150:5
room 4:17	scale 32:19	124:11,18	semiconductor
roughly 40:2	scaler 107:8	128:18 139:8	1:4 4:8 6:12
67:2 111:7	schematic 46:8	see 6:22 10:23	20:15 21:19
round 90:23	64:20 70:24	15:6 16:17,19	31:2 34:10
routine 82:5	149:2	18:15,16,21	51:25 67:10
routinely 66:12	schematics	19:20 20:21	72:6,7 86:3,4,5
rules 5:13	65:19	21:15 23:24	86:7 89:23
131:14,15	school 13:16	24:3 29:11,12	90:1,9 100:9
132:1,2,6	science 13:3	34:11 35:6	119:3,13 140:3
run 14:3,5,10	18:9	37:25 38:17,21	146:18 154:1
14:15 30:22		38:22 39:8,25	155:1

[semiconductors - slight]

semiconduct... 90:11 146:17 senate 14:1 sense 5:22 18:2 47:12 53:5,7 sensitive 82:15 sensor 82:16 sensors 82:5,15 sentence 19:16 19:16 67:22 76:12,18 80:7 81:3,9,10 88:9 100:19 101:4 114:18 125:16 133:8 147:17 147:22,23 148:23 separate 6:23 9:16 25:4 71:16 102:24 separately 9:14 separating 49:23 september 15:17 series 5:16 6:11 53:25 set 153:11 seu 118:14 122:7 several 125:17 125:21,25 126:11 shakes 5:21	shape 21:8 sharp 150:4,5 shell 90:25 91:6 shielded 145:25 146:4 shielding 146:7 146:10 shift 143:13 shorthand 153:5,12 show 22:15 36:20,22 69:22 69:23 110:19 showing 22:17 36:18 58:8 59:16 shown 21:21 22:21 42:8,9 50:15 73:13,20 73:21 74:1 75:17 100:15 111:11 112:8 112:19 113:15 114:25 120:11 122:4,14 124:15 133:15 shows 25:12 29:22 35:5 43:10 52:10 58:7 67:14 69:4 72:6,7 73:7 149:2 shut 131:25,25 side 81:4 96:3 97:25 118:2	130:6,13 131:9 136:16,21,23 136:24 137:2 sided 23:9 sides 23:12 139:11,11 sign 20:25 signature 153:23 significant 86:12 117:21 121:5 signs 94:16,17 silent 102:6 122:2 silicide 51:18 silicides 150:25 silicon 28:22,24 30:12 49:13,19 49:22 50:6 84:25 85:3 87:3,5 90:6 116:20,23 118:1,2 138:7 140:6,11,12,15 140:16,20,23 141:1,15,16,19 141:25 150:9 151:1 silicon's 100:21 similar 11:2,22 16:23 17:2,10 41:5,8 62:10 62:12 72:1,21 73:18,20 79:9	148:1 similarly 92:14 simple 46:22 84:6 98:2 102:15 simplification 27:24 51:24 simply 103:4 single 23:9 50:19 57:1,16 58:12 59:19,21 59:22 60:1 61:8,10,12,12 61:14,20 62:1 62:5,21 63:6 63:21 78:7 90:7,7 144:6 144:17 sio2 138:8 sir 35:10 60:5 132:17 sit 140:14 sitting 115:18 136:3 situation 54:21 six 8:17 skill 15:10,13 15:16 16:1,4 23:25 26:17 65:3 78:11 146:16 skilled 66:1,14 68:10 slight 62:12 112:25
--	--	--	---

[slightly - speegle]

slightly 65:5 slope 84:18,20 87:10 111:12 112:8,9,11,12 112:17 143:25 145:9,12 147:19 148:21 149:2,6 slow 79:12 107:25 108:4,8 108:9,12 small 11:12 22:17 smaller 82:12 126:16 smith 2:16 4:13 smooths 150:11 solar 116:1,6,9 solder 51:20 solidworks 11:16 solve 128:10 something's 53:11 sorry 19:24 79:2 97:15 114:12,14 117:4 119:8,20 134:19 142:15 sort 12:1 27:24 28:19 34:17 45:18 46:22 86:10 88:22 150:11 151:1	sounds 43:17 47:6 49:1 soup 12:6 source 23:24 24:7,9 27:12 27:23 28:1,4,8 28:11 33:9 38:4,7 39:18 41:2,20,21 42:16 43:14 47:18,22 48:6 48:9,17,19 51:12,14,17 55:23 56:7,10 56:15,17 62:6 64:1,3,6 66:7 68:15 70:8 75:5,8,17,22 76:21 77:2,20 78:22 102:18 103:18 119:22 121:8 133:6 134:2,4 136:15 136:17 137:1,2 137:6,10 146:10 sources 24:4,6 27:15 43:2 118:9 137:13 south 2:11,13 space 28:4 54:13 95:22,23 96:19 116:10 spanning 19:11	spatial 28:3 48:15 speaks 114:22 species 120:17 specific 41:15 76:11 129:20 specifically 19:15 33:10 80:11,13 99:24 100:2 110:25 111:22 113:19 143:15 specification 19:19 34:24 66:18,21 127:20 128:8 specifications 136:12 specify 82:19 speed 76:4,16 77:10,10,23 107:8 108:7 speegle 2:10 3:5 4:7,7,22 5:2 9:4 10:16 11:4 14:14 15:2 17:4 21:3 21:9 22:6 23:3 23:15,18 25:1 25:22 27:2 28:10 29:1,17 31:10,19 35:11 35:18 36:2,6 36:11,13 38:12 38:16 39:4,7	39:21 40:15 41:7,18 42:3 42:23 43:15,20 43:21 44:15 45:2,10 46:15 47:5,20 48:11 48:24 49:6,11 49:18 50:11 51:8 52:24 53:15 54:5 55:2,15 56:6 56:13,19 59:4 60:8,17 61:5,6 62:16 63:5,12 63:20 64:9,17 64:23 65:9,17 65:23 67:3 69:2,18 70:2 70:12 71:4,9 71:11 72:17 73:1 74:23 75:13,24 76:17 77:11 78:1,13 79:11,20 81:22 82:18 83:1 84:24 85:5 87:13 89:14 92:1,8,15 93:9 94:2 95:15,21 96:16 97:9 98:5,16,17 99:1,16 100:3 100:16 101:1 101:14,17,23 102:1 103:19
---	---	---	--

[speegle - substrate]

104:5,17,24 105:13,21 106:7,13 107:7 107:14 108:5 108:14,24 109:4,15,18 111:10 113:3 114:14,17 116:13 118:5 118:15 119:1,9 119:18 120:9 120:10,18 121:10,18 122:10,23 123:16 125:4 125:11 126:4 126:17,23 127:12 128:12 129:11 130:12 130:18 131:1,5 131:7,16,22 132:3,9,14,20 132:23 133:14 134:14 135:1 135:10,17 136:2,22 137:9 137:15 138:15 139:1,13 140:2 140:8 141:2,7 141:9 142:3,23 143:12 144:14 144:21 145:18 146:5,11,19,24 148:19 149:5 149:15 151:5	151:16,19 spent 9:20 sphere 97:7,8 spoke 31:7 38:3 spot 39:19 50:2 50:5,6 91:4 spread 150:12 150:18 spurious 80:8 80:19,21 81:1 81:4,17,23 118:16 squared 97:10 97:11,15 stamp 11:25 stand 61:4 standard 16:3 stanford 13:2 staple 20:10 start 32:25 49:12,25 62:13 71:19 76:19 96:11 started 12:21 starting 20:13 29:23 111:7 starts 74:19 80:7 96:2 124:15 state 5:3 14:19 94:23 statement 19:22 76:3 79:21 110:9 115:7 133:4,12	statements 8:9 states 1:1 9:10 24:17,19 static 44:19 57:6,24 58:14 64:10,12 65:12 87:4 stay 71:1 87:19 steam 140:10 140:21 step 55:16 steps 27:23,25 52:1,2,25 68:12 stop 143:4 stopper 31:21 142:14,17,22 142:25 stopping 71:7 stops 114:5,6 storage 22:18 42:12,20 46:11 52:10 stored 69:7 126:2 128:1 stores 71:1 storing 70:22 street 2:11,13 2:17 stress 88:6 strike 7:14 125:23 string 53:24 strong 115:2	stronger 115:19 122:13 structurally 43:7 45:8 48:20 structure 42:1 42:10,13 44:13 51:6 55:10 80:3 128:11 139:7 150:10 stuff 9:2 12:1 71:15 116:20 sub 14:20 subject 11:3 48:5 80:24 submitted 6:17 6:20 8:1,14 10:7,24 subscribed 153:21 155:14 subsequent 44:24 49:21 50:12 substantial 72:4 substantially 17:2,10 41:5,8 120:16 122:12 147:24 148:15 substrate 20:19 20:24,25 21:4 21:8,8 22:2,22 22:25 23:23 25:11 28:24 29:9 30:2
---	--	--	---

[substrate - tell]

32:21 33:5 34:7,22,23,25 37:8 57:2,5,8 57:21,22,23 58:2,3,7,16 61:16 72:9,14 72:23 73:9,11 74:7 81:13 113:20 114:2,5 114:8,10 117:14,21 118:4 121:14 122:20 123:8 123:11 129:17 129:20,22,23 134:18 135:5,9 136:18 137:4,7 140:12 subterranean 81:11 sufficient 93:23 115:9 122:1,19 146:1 suggest 117:15 123:22 suggesting 117:19 124:6 suggestion 124:4 suite 2:3,11,13 summary 8:5 superconductor 90:2 superior 67:24	supervision 153:14 support 10:7 11:1,14 12:3,7 12:10 76:3 supported 127:19 supports 128:9 sure 10:24 59:5 71:9,16 94:9 97:18 108:23 109:6 115:23 116:4 128:8 surface 20:20 21:5,11 29:22 31:3 33:14 34:7 35:4 37:8 37:18,19,23 40:24 42:25 51:7,11 57:2,2 57:4,7,17,20,21 58:2,5,7,16 59:14,18 60:2 60:2,3,4 61:15 61:16 66:24 70:4 72:16 74:7,7 93:13 97:11 100:21 110:12 138:6 139:21,23 140:15,25 141:20,23 surfaces 72:11 surmountable 89:23	surround 47:15 surrounded 44:25 45:13 surrounding 45:21 surrounds 47:14 swamp 48:8,8 swamped 120:22 sweep 81:12 121:12 swept 76:21 77:2 switching 81:2 82:2 118:17,18 sworn 4:4 97:14 153:7 155:14 synonymously 112:4 system 92:23 92:23 t t 3:3,7 154:3,3 take 6:3 23:7 45:22,22 84:7 109:16 124:12 124:25 132:10 132:12,17 151:16 taken 2:1 13:3 153:10,12 takes 33:7 82:13 86:11	talk 31:1 34:1 49:3 50:2 87:16 108:15 111:25 115:1 115:15 135:18 talked 31:11 52:12 69:3 87:15 102:15 talking 31:3,4,6 50:2,17 63:3 67:23 71:21 80:11,13 82:8 86:5 94:3,5,9 98:13 100:2 118:6 119:6 talks 127:1 128:18 teach 102:3 teaches 26:13 teaching 127:4 team 8:20 9:14 tear 20:10 tech 12:3 technical 18:2 technique 116:21 techniques 78:8 technology 52:1 tell 11:6 15:24 32:15 33:4 60:18 64:25 103:4 122:8 135:24 141:13
--	--	--	---

[tells - top]

tells 22:10 temperature 88:1 140:11 ten 125:17,21 126:1,11,16 tens 126:5 term 27:14 92:14 112:2 terms 12:8 26:15 28:3 48:13 49:2 140:3 test 60:14 testified 4:5 5:10 testify 5:24 153:8 testifying 36:6 testimony 151:23 155:8 texas 2:11,14 text 37:9 67:14 76:6,7 111:15 thank 5:7 23:17 25:2 27:3 35:10 37:16 48:12 86:25 151:22 thereof 153:18 thermal 150:14 thick 32:22 33:6 111:12 117:22 thickness 117:24	thin 62:9 thing 67:7 128:7 138:24 things 12:1 17:15 18:8 26:19 30:1 49:25 50:22 79:14 84:3 88:5,7 102:16 103:3 118:13 123:7 124:19 131:13 139:17 139:24 143:10 150:8 think 8:17 12:14 17:12 18:1,11 23:4 23:10,16 25:11 26:12,23 29:24 37:1 42:8 49:1 56:7,10,14 60:25 61:2 63:25 65:18,21 71:5,17 75:11 80:13 81:1 87:18 90:8 91:19 93:4 94:10 95:3,8 100:1 101:9 109:1 114:22 116:14 123:4 123:10 124:9 125:2,15 129:4 133:20 148:1	thinks 119:15 thinned 32:22 33:2 third 7:9,11 55:22 73:14 thought 95:8 thousand 120:24 125:17 125:22 thousands 52:1 121:2 126:1,5 126:11 three 6:15,19 6:23 7:16 8:1 8:10 11:15 12:17 16:2,25 37:5 39:24 60:11 85:14 101:19 139:7 threshold 86:10,23 89:9 89:12,17 90:12 thusly 138:9 tied 85:21 tilted 54:12 time 6:4 8:6 9:6 10:1 14:3,18 20:11 32:23 40:23 41:11 42:1 43:16 44:20 49:3 50:14,21 65:10 65:15 66:10,11 68:20 76:22 77:8,13 78:3	78:15 79:12,15 79:16 82:4 102:23 116:17 127:7 132:4,11 150:21 151:22 153:11 times 14:10,15 45:4 98:11 120:24 121:2 126:16 titanium 51:18 title 11:7 today 5:8,25 35:9 115:18 136:3 151:22 toff 76:13,13 77:2 79:22,24 together 23:7 65:22 told 60:19 135:3 ton 76:13 77:2 79:22 took 36:15,23 top 8:19 9:22 10:2 14:18,21 17:10 28:20 31:7 33:3,7 34:19,22 37:6 37:23,25 38:2 40:24 41:12,13 41:16 42:9,14 42:18,20,22 43:11 45:16,19 46:12 51:19
---	--	--	---

52:4,6,7,9 53:19 60:3 67:22 109:22 110:10 115:12 117:23,25,25 137:21,24 139:23 141:15 142:1 150:25 total 9:19 115:13 touch 30:8 53:9 53:14 54:3 touching 30:21 30:23 139:22 tough 23:11 toward 30:1 35:5 58:7 69:16 75:20 94:10 105:2 towards 29:9 34:7 69:10 70:4 81:8 94:25 trademark 1:1 transactive 47:15 transcribed 153:13 transcript 5:18 97:17 98:14 155:5,8 transistor 21:20,22,25 22:11,15,18,21 23:1,5,21	24:14 25:18,19 27:18,21 31:13 31:13 32:8 33:9 36:19 37:13,14 41:16 42:11,11 43:8 44:4,6 45:9 46:25 47:1,3 47:13,19 52:5 53:20 54:7,15 62:14 67:5,10 68:13 76:4 77:10 79:2,6 96:9 119:13 129:13,15,25 130:3,7,10,13 130:17 131:9 131:21 133:5 133:17 134:16 136:5,21 143:5 transistor's 54:13 transistors 21:13,22 24:20 24:23,23,25 25:6 26:7,10 26:16,20,22 27:6,11 28:15 28:17 29:25 30:12,14,17 32:7,8,10 34:9 37:22,23 40:25 41:1,13,15 45:21 47:13,16 51:5 52:16,20	52:23 53:24,25 54:2,6,10,18,21 54:24,25 55:1 55:4,13 67:25 68:17 73:23 75:17 81:24 transported 82:24 travis 16:8 trench 103:1 trial 1:2 triple 78:8 true 99:2 155:8 truth 153:8,8,9 truthfully 5:25 try 6:2,9 7:24 102:22 103:2 trying 76:14 88:8 97:16 102:16 104:9 104:11 111:1 114:23 117:15 tubs 26:14 turn 16:12 20:2 71:12 88:18 101:8 109:19 119:4 124:16 128:13 133:24 147:4 turned 121:4 turning 18:13 turns 103:12 twin 50:22 two 14:18,21 40:21 65:11	79:14 84:3 98:8,19 99:3 136:4 139:5,6 150:7 type 20:19 21:4 21:12,13,21 22:2,22,22,25 23:1,5,23,23,24 24:5,7,8,8,9,12 24:14,24 25:15 27:20,20,22 31:25 32:1 41:2,3 47:24 49:16 50:23 62:7,12 63:19 66:19 70:22 72:10,15,23 73:8,8,10 77:9 103:14,16 119:16 124:20 125:18 127:2,5 127:5,22 128:20,21,25 129:1,5,6,16,16 129:19,21,22 129:23 130:2 130:21 131:8 133:6,13 134:17,17 135:5,5 136:15 136:18,18 137:1,2,3,4,6,7 137:7,7 typed 137:19
---	--	---	---

[types - voltage]

types 24:2 135:9 typewriting 153:13 typically 32:7 32:21 42:7 54:11 66:2 117:22 120:23 140:18 149:25 typos 8:13 136:11	68:8,10 75:12 78:11 88:8 116:4 124:21 129:24 134:8 146:17 understanding 4:22 7:19 16:1 21:24 22:8 25:16 27:1 28:3 33:17 41:19 74:12 93:17 138:1 understands 43:12 understood 53:13 133:4 142:9 undoped 120:25 unfortunately 23:13 unidirection 58:10 unidirectional 57:6,25,25 58:14 64:10,12 65:12 uniformly 68:2 united 1:1 universities 18:10 unusual 68:20 upper 37:17,19 37:22 51:7,11	upsets 144:6,17 usage 56:1 use 7:16 11:16 13:11 30:13 92:14 102:19 102:23 used 17:6,13 24:12 27:14 42:15,21 50:19 67:24 77:9 102:22 112:3 uses 141:24 using 35:9 44:17 78:4 114:24 140:14 usually 11:18 12:16 26:19 32:11 64:5 66:4 87:24 139:23,23 140:10	vast 117:20 118:3 vector 93:7 106:20,23,25 107:10,20,21 108:1 vectors 92:16 velocity 104:20 105:5 106:1,9 106:16,20 107:1,10,17,20 107:20,22 108:7 149:24 verb 44:17 verbal 5:20 verbally 36:24 36:25 37:3 versa 50:21 version 137:22 vertical 31:9 126:10 vertically 126:9 vibrate 91:20 vibrations 91:19 vice 50:21 video 4:17,19 4:21,23 view 11:13 68:5 73:8 135:7 visually 21:21 vlsi 20:15 34:9 35:1 voltage 78:16 78:17,20,20
u	u.s. 1:13,14,15 18:14 uh 59:7 unaltered 41:5 45:19,20,24 under 5:8 60:5 62:4 63:4,9,19 64:6 65:4,8 66:15 89:24 153:13 underneath 38:10 46:11 59:22,23 74:22 95:5 96:10 understand 5:8 6:6 7:15 10:6 10:13 17:19 20:5 22:12 24:1 26:18 34:15 38:13 39:16 42:24 48:12 49:1 65:4,11 66:2	v	
	v 154:1 155:1 vacancy 90:21 valence 90:22 90:24,25 91:4 91:6,15 values 145:17 148:6,8 149:3 vapor 13:9 variable 86:8 variation 65:7 varies 87:11 variety 118:9		

[voltage - wieczoerek]

86:10,23 87:11 88:2 89:9,13 89:18 119:7 121:6 volts 149:25 volume 97:8,11 vs 1:7	75:14 84:13 91:4 96:17 104:6,11 105:23 123:3 127:13 140:24 144:15 153:17 we've 43:15 69:3 71:21 99:21 109:15 132:13 welding 51:19 wells 24:6 26:13 30:6,10 31:12 38:1,2 49:23 50:20,23 102:24,24 103:1 went 50:21,22 142:22 whereof 153:20 whitehurst 2:17 4:12,13 8:23 10:10,22 14:12,24 17:1 21:2,6 22:3,23 23:8,16 24:16 25:21,24 28:6 28:13 29:15 31:5,15 35:8 35:14,20 36:4 36:8 37:20 38:25 39:5,14 40:14,20 41:10 41:23 42:6 43:5,17 44:9	44:21 45:6 46:5,20 47:10 48:3,18 49:5,8 49:14 50:8 51:2 52:18 53:3,17 54:19 55:6 56:4,9,16 58:21 60:5,10 60:19,25 62:3 63:2,8,15,23 64:13,19 65:1 65:14,20 66:20 68:6 69:12,21 70:6,15 71:7 72:13,24 74:15 75:9,18 76:10 77:3,21 78:5 79:7,17 81:19 82:9,21 84:2 85:4 87:6 89:5 91:16 92:5,11 93:1,21 95:2 95:19,25 96:22 97:17 98:12,22 99:5,25 100:11 100:22 101:12 101:15,21 103:9,24 104:13,23 105:7,18 106:2 106:11 107:3 107:12 108:2 108:10,19 109:1 111:5 112:23 114:12	114:15 116:8 117:18 118:11 118:20 119:5 119:14,24 120:7,14,21 121:15,24 122:22 123:2 124:24 125:8 125:24 126:7 126:21 127:9 127:16 129:7 130:9,15,22 131:3,11,18,24 132:5,12,16,21 133:10 134:11 134:23 135:6 135:14,22 136:19 137:5 137:12 138:14 138:22 139:4 139:19 140:5 140:17 141:5 141:17 142:20 143:2 144:12 145:14,23 146:8,15,23 148:16,25 149:8 150:20 151:11,20 wieczoerek 147:9,11 148:14,21 149:16 151:6 151:10
w			
w 5:5 wafer 26:19 31:8 34:18,24 49:15,25 50:6 50:21 55:11 86:18 123:11 140:15,16 wafers 30:12 49:16 86:14,16 wait 98:12 wang 144:5 want 19:10 31:16 35:17 49:9 54:14 80:4 91:8 93:4 101:13 109:2 116:4 124:10 wanted 25:24 88:17 warmer 91:21 washington 2:18 waste 54:13 way 5:6 19:6,8 31:23 40:24 42:7 48:16 66:10 68:8			

[witness - zoom]

witness 3:4 4:15 8:24 10:11,23 14:13 14:25 17:2 21:7 22:4,24 23:10 24:17 25:24 26:3 28:7,14 29:16 31:6,16 35:12 35:24 37:21 39:15 40:21 41:11,24 42:7 43:6,18 44:10 44:22 45:7 46:6,21 47:11 48:4,19 49:15 51:3 52:19 53:4,18 54:20 55:7 56:5,10 56:17 59:2 60:9,17,22,23 62:4 63:3,9,16 63:24 64:14,20 65:3,15,21 66:21 68:7 69:13,22 70:7 70:16 72:14,25 74:16 75:10,19 76:11 77:4,22 78:6 79:8,18 81:20 82:10,22 84:3 87:7 89:6 91:17 92:6,12 93:2,22 95:3 95:20 96:1,23	97:20 99:6 100:1,12,23 101:25 103:10 103:25 104:14 105:8,19 106:3 106:12 107:4 107:13 108:3 108:11,20 111:6 112:24 114:16 116:9 117:19 118:12 118:21 119:6 119:15,25 120:15,22 121:16,25 123:3 124:25 125:9,25 126:8 126:22 127:10 127:17 129:8 130:10,16 131:6,12 132:10,18 133:11 134:12 134:24 135:7 135:15,23 136:20 137:6 137:13 138:23 139:5,20 140:6 140:18 141:18 142:21 143:3 144:19 145:15 145:24 146:9 146:16 148:17 149:1,9 150:21 151:12 153:6	153:20 word 111:25 words 125:17 work 8:21,24 8:25 9:2 11:10 11:24 81:25 84:13 102:22 worked 12:5 17:24 102:25 116:19,19 working 8:22 9:25 works 9:1 139:12 140:9 140:24 worst 128:4 wrap 151:17 write 13:5 writings 11:1 written 23:13 102:9 123:3,4 wrote 8:6,17 13:8 23:6 ww 112:10,22 113:4,13 119:23 120:12	49:16 67:9 70:23,25 79:18 82:2 87:10 89:16 91:24 92:12 94:13 98:10 99:7,8 100:12 105:10 105:19 109:12 114:16 115:5 124:17 126:9 126:12 134:24 144:14 148:1 years 12:9,13 14:18 yellow 117:8,12 138:3 yuma 153:21
			z
			z 92:19,22 zero 84:13 90:1 112:9 zoom 2:5 36:19
		x	
		x 3:1,3,7 92:18 92:22 104:8,8 104:9,9	
		y	
		y 2:13 92:19,22 yeah 12:11,16 18:1 32:5	

Federal Rules of Civil Procedure

Rule 30

(e) Review By the Witness; Changes.

(1) Review; Statement of Changes. On request by the deponent or a party before the deposition is completed, the deponent must be allowed 30 days after being notified by the officer that the transcript or recording is available in which:

(A) to review the transcript or recording; and

(B) if there are changes in form or substance, to sign a statement listing the changes and the reasons for making them.

(2) Changes Indicated in the Officer's Certificate.

The officer must note in the certificate prescribed by Rule 30(f)(1) whether a review was requested and, if so, must attach any changes the deponent makes during the 30-day period.

DISCLAIMER: THE FOREGOING FEDERAL PROCEDURE RULES ARE PROVIDED FOR INFORMATIONAL PURPOSES ONLY.

THE ABOVE RULES ARE CURRENT AS OF APRIL 1, 2019. PLEASE REFER TO THE APPLICABLE FEDERAL RULES OF CIVIL PROCEDURE FOR UP-TO-DATE INFORMATION.

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COMPANY CERTIFICATE AND DISCLOSURE STATEMENT

Veritext Legal Solutions represents that the foregoing transcript is a true, correct and complete transcript of the colloquies, questions and answers as submitted by the court reporter. Veritext Legal Solutions further represents that the attached exhibits, if any, are true, correct and complete documents as submitted by the court reporter and/or attorneys in relation to this deposition and that the documents were processed in accordance with our litigation support and production standards.

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