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

CIRRUS LOGIC, INC.;
OMNIVISION TECHNOLOGIES, INC.;
Petitioners
v.
GREENTHREAD, LLC,
Patent Owner

Case: IPR2024-00001
U.S. Patent No. 10,734,481
Case: IPR2024-00016
U.S. Patent No. 10,510,842
Case: IPR2024-00017
U.S. Patent No. 8,421,195
Case: IPR2024-00018
U.S. Patent No. 9,190,502
Case: IPR2024-00019
U.S. Patent No. 11,316,014
Case: IPR2024-00020
U.S. Patent No. 11,121,222
Case: IPR2024-00021
U.S. Patent No. 11,121,222

Deposition of SANJAY BANERJEE, PH.D.
Conducted Remotely
Friday, July 19, 2024
10:00 a.m.

Reported by: Matthew Goldstein, RMR, CRR

DIGITAL EVIDENCE GROUP
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Washington, D.C. 20036
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Deposition of SANJAY BANERJEE, PH.D., conducted remotely:

Pursuant to Notice, before Matthew Goldstein, RMR, CRR, Notary Public in and for the District of Columbia.

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21 EMRE YUZAK

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1 C O N T E N T S

2 EXAMINATION OF SANJAY BANERJEE, PH.D. PAGE

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4 By MR. JAIRAM 6

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1 P R O C E E D I N G S
2 Whereupon,
3 SANJAY BANERJEE, PH.D.,
4 being first duly sworn or affirmed to testify to
5 the truth, the whole truth, and nothing but the
6 truth, was examined and testified as follows:
7 EXAMINATION BY COUNSEL FOR THE PATENT OWNER
8 BY MR. JAIRAM:
9 Q. Good morning, Dr. Banerjee. My name is
10 Arvind Jairam.
11 A. Good morning.
12 Q. And I'm going to be asking you some
13 questions today.
14 Will you please state and spell your
15 full name for the record?
16 A. Sanjay Kumar Banerjee, S-A-N-J-A-Y;
17 Kumar, K-U-M-A-R; Banerjee, B-A-N-E-R-J-E-E.
18 Q. Thank you.
19 Before we begin, I just want to remind
20 you of some basic ground rules. You may already
21 know this, but I'll just repeat for the sake of
22 completeness.

1 You understand you've been placed under
2 oath today just as though you were in court?
3 A. Yes.
4 Q. And you understand that you are bound to
5 answer my questions truthfully today?
6 A. Yes.
7 Q. If a question is unclear, please let me
8 know so that I may rephrase as necessary.
9 Otherwise, I will assume that you understood my
10 question. Okay?
11 A. Okay.
12 Q. Because your testimony is being
13 transcribed by a court reporter and particularly
14 because this remote deposition format means we are
15 not in the same room, do you understand that you
16 need to answer my questions verbally instead of
17 with gestures?
18 A. Yes.
19 Q. I'm going to do my best and I would ask
20 that you please do your best so that we do not
21 speak over one another to make the transcript
22 cleaner and the court reporter's life easier.

Is that okay?

A. Okay.

Q. In terms of breaks, we will take breaks during the deposition at least every hour. If you need one at any time, please let me know. I'll just ask that if a question is pending, I'll request that you answer the question before taking a break. And occasionally I might ask that we just wrap up a certain line of questioning before we take the break.

Is that okay?

A. Sure.

Q. Any questions from you, sir, before we proceed?

A. No.

Q. I see that there are at least some people in the room with you today. Could you tell me about how many?

A. Four, in addition to me.

Q. Okay. If it's possible, can you please tell me who is in the room with you?

A. Well --

1 MR. PAUL: This is Raj Paul, on behalf
2 of Covington & Burling, on behalf of petitioners.
3 Also with me is Anupam Sharma, also of Covington &
4 Burling, also on behalf of petitioners.
5 And also with me is Emre Yuzak and Kent
6 Cooper, on behalf of real party in interest
7 GlobalFoundries.
8 MR. JAIRAM: Thanks, Raj.
9 BY MR. JAIRAM:
10 Q. Dr. Banerjee, are you aware of any
11 reason that you may be unable to answer my
12 questions truthfully and fully today?
13 A. No.
14 Q. Are you taking any medications that
15 would prevent you from providing honest, accurate,
16 and complete answers?
17 A. No.
18 Q. Are there any health conditions that
19 would prevent you from providing honest, accurate,
20 and complete answers?
21 A. No.
22 Q. Do you understand that you have to

answer my questions even if your counsel objects, unless he directly instructs you not to answer?

A. Yes.

Q. I would also like to caution you not to discuss the substance of your testimony with counsel during any breaks.

Do you understand that?

A. Yes.

Q. I understand that you may have some hard copies. Can you please tell me what hard copy documents you may have with you?

A. I have unmarked copies of my declarations, the patents, and some of the cited prior art, main ones.

Q. Okay. And I have placed various electronic copies of documents in the chat window of this Zoom, and I believe that either the attorneys there or you should be able to access that. And if you are at any time unable to access the electronic copies, just let me know, and I will see what we can do. Okay?

A. Okay.

Q. I would just ask, sir, that if you do refer to any documents other than the ones that I am providing to you in the chat window, that you please let me know so that there is no confusion about which documents are being discussed.

Is that okay?

A. Okay.

Q. And I will just mention that because some of the prior art references appear in various ones of the IPRs, I have put in the chat window just a single copy of each one just, you know, to reduce the amount of clutter. But if there's any confusion about which document is for which IPR, please just ask me, and I will certainly clarify. Okay?

A. Okay.

Q. We're here today to discuss certain IPR proceedings that you provided declarations in.

Do you understand that?

A. Yes.

Q. Specifically, there are seven IPR proceedings. They are IPR 2024-00001, -00016,

-00017, -00018, -00019, -00020, and -00021.

Do you understand that?

A. Yes.

Q. For brevity, I'm going to suggest some short-form notations so that we can easily refer to these various IPRs. I may refer to the IPRs by the last three digits of the patent that is challenged in each IPR.

For example, the IPR who's last five digits are 00001 may be referred to as the "'481 IPR" or the "'481 patent IPR," because the patent that is challenged in that IPR has '481 as its last three digits.

Is that okay?

A. Yes.

Q. And, likewise, the 00016 IPR will be the "'842 patent IPR" or just the "'842 IPR," for short.

Is that okay?

A. Yes.

Q. And the 00017 IPR, we will call it the "'195 patent IPR" or the "'195 IPR."

1 Is that okay?
2 A. Yes.
3 Q. And the 00018 IPR is going to be called
4 the "'502 patent IPR" or "'502 IPR." Okay?
5 A. Yes.
6 Q. And the 00019 IPR will be called the
7 "'014 patent IPR" or the "'014 IPR." Okay?
8 A. Yes.
9 Q. And since you provided two declarations
10 in two IPRs against a patent who's three digits
11 end in '222, I will say that the -00020 IPR will
12 be called "'222 IPR No. 1," and the -00021 IPR is
13 "'222 IPR No. 2." Okay?
14 A. Okay.
15 Q. Of course, you know, these are arbitrary
16 kind of notations here, and I'm just trying to
17 find a way to easily discuss these with you. And
18 if you have any confusion or if you want to refer
19 to it in another way that's easily comprehensible,
20 that is fine. Okay?
21 A. Okay.
22 Q. I may refer to these seven IPRs

collectively in some short form, such as "the present IPRs" or "these IPRs." Okay?

A. Okay.

Q. You understand that Cirrus Logic and OmniVision Technologies are the remaining petitioners in these IPRs and that Greenthread LLC is the patent owner in these IPRs?

A. Yes.

Q. I will just call Cirrus Logic by "Cirrus" for convenience. Okay?

A. Okay.

Q. Have you done any work on behalf of Cirrus and OmniVision before the present IPRs?

A. No. Do you mean technical research or legal work?

Q. Anything.

Can you please explain fully if you have done any work on behalf of Cirrus Logic or OmniVision prior to these IPRs?

A. I've not done any research with either company. I cannot recall offhand if I represented either of these companies as part of litigation

work. You have my CV, and that is my litigation background.

Q. Thank you.

A. I may have worked for OmniVision in a previous case, but I don't remember exactly.

Q. Do you perhaps have the ability during a break today to kind of explore what, if anything, you may have done for OmniVision in a previous case?

A. I don't have my computer with me.

Q. May I suggest perhaps during a break you could check with, I believe, OmniVision's counsel, maybe either on the teleconference or with your own attorneys. If you could somehow please follow up, I may ask a follow-up question about that.

Is that okay?

A. Okay.

Q. You submitted declarations in these IPRs; right?

A. Yes.

Q. For convenience, I'll refer to the declaration that you submitted in the '842 IPR as

1 "your '842 declaration." Okay?
2 A. Okay.
3 Q. And I'll use a similar convention for
4 the other declarations, for example, '481
5 declaration, '195 declaration, and so forth.
6 Okay?
7 A. Okay.
8 Q. And for short convenience, I may refer
9 to your declarations in all of these IPRs as just
10 "your declarations." Okay?
11 A. Okay.
12 Q. And I'll call the patents at issue in
13 these IPRs "the challenged patents." Okay?
14 A. Okay.
15 Q. And I may refer to the claims that are
16 challenged in these IPRs by the petitioner of
17 these IPRs as "the challenged claims." Okay?
18 A. Okay.
19 Q. If you have any question or uncertainty
20 at any time about which patent or IPR or claim is
21 being mentioned, please just mention it, and I
22 will do my best to clarify. Okay?

A. Okay.

Q. Dr. Banerjee, have you been deposed before?

A. Yes.

Q. Can you tell me about how many times you have been deposed before?

A. Once again, it's in my CV, but off the top of my head, I think about between a dozen and two dozen times, I think.

Q. Do you know if that was only district court cases or at the PTAB only or some combination?

A. I've done IPRs -- or PTABs, several ITCs, and one district court.

Q. Thank you.

About how many times have you worked on behalf of patent owners in any kind of legal proceeding?

A. You mean for the plaintiff as opposed to the defendant?

Q. Yeah, if it's in district court, typically a patent owner would be the plaintiff.

If it's before the PTAB in an IPR, the patent owner is identified as the patent owner. I'm just trying to get a sense of about how many times you've done work in any of those types of legal proceedings on behalf of patent owner?

A. I believe it's about 50/50.

Q. Okay. Thank you.

Have you prepared expert invalidity or validity reports in district court or ITC cases before?

A. Once again, I don't remember exactly. I remember I've been in front of the ITC, I think, three or four times. District court, only once, the Northern District of California. And then quite a few PTABs.

Q. Okay. Have you ever testified in person at a trial in district court or at a hearing at an ITC proceeding?

A. Yes.

Q. About how many times have you testified in person at a trial or an ITC hearing?

A. I remember district court it's been only

once. The other cases settled before it went to trial. ITC, I think four or five times. But it's in my CV.

Q. In the district court case where you testified at trial, do you know if that was regarding infringement, noninfringement, validity, invalidity, or some combination?

A. It's been a while. I remember I was representing Rambus against Samsung. I don't remember. It's quite a few years.

Q. That's okay.

And about how many times have you worked on behalf of a petitioner in an IPR?

A. Once again, I don't remember exactly. I listed all my litigation experience in my CV. My impression is it's been about -- so I've done about -- I've worked on about a dozen cases where there's been substantial work such as writing expert reports or being deposed. In many of the cases, you get hired, and then it settles before you do any significant work. So I did not list those.

1 Of the cases where I did substantial
2 work, I believe there's about two dozen of those.
3 I think the split's been roughly 50/50 I've been
4 working for the plaintiff or the defendant. And
5 I've underlined them in my CV, the party that I
6 was working for.
7 Q. Thank you.
8 Dr. Banerjee, without telling me the
9 substance of any communications you may have had
10 with counsel, can you tell me what you have done
11 to prepare for your deposition today?
12 A. I met with counsel yesterday and then --
13 the morning yesterday and...
14 Q. Can you tell me approximately the length
15 of time that you spent in preparing for today's
16 deposition, whether spread out over multiple days
17 or over a single day, just kind of a total?
18 A. So during July -- I spent a lot of time
19 over the last two days, I'd say ten-plus hours.
20 And prior to that, during this month, I spent, you
21 know, whenever I had some free time, maybe three,
22 four hours. So I would say maybe 60 -- maybe 60,

1 70 hours total this month.
2 Q. Okay.
3 A. Prior to that -- prior to that, I didn't
4 do that much work on it. As you know better than
5 me, you work in spurts, right. So you put in a
6 fair bit of effort when you write the reports, and
7 then I don't do much work. And then you do more
8 work before the deposition.
9 Q. You mentioned that you met with counsel
10 yesterday. And can you please tell me who -- if
11 you are able to remember, who was in attendance?
12 A. The same folks who are in the room
13 today.
14 Q. Okay. And can you tell me what
15 documents, if any, you reviewed in preparing for
16 today's deposition?
17 MR. PAUL: I'll just caution the
18 witness, again, to the extent you can without
19 involving conversations with counsel.
20 THE WITNESS: Thank you.
21 I reviewed my declarations, the patents,
22 and the key prior art.

BY MR. JAIRAM:

Q. Okay. And I think we will be talking about each of those things a little bit later here today.

Regarding the declarations, can you tell me who wrote the declarations that you submitted in these IPRs?

A. These are my declarations that capture my opinions. Of course, you prepare them in collaboration with the attorneys.

Q. Okay. And approximately how long did you spend writing the declarations? I would say in total there's seven declarations. So if you could give a ballpark on how long you spent preparing all of the declarations.

A. I'm guessing, I don't remember exactly, but certainly 100-plus hours.

Q. Okay. Can you tell me about how much money you have billed so far to anyone for your work in these seven IPRs?

A. I don't have the breakdown per IPR, but I think I have a round sense of the total amount.

1 Probably -- not counting work done this month, for
2 which I've not submitted expenses, I believe
3 it's -- I'll do a rough $100,000.
4 Q. Okay.
5 A. Maybe less.
6 Q. Okay. Thank you.
7 Dr. Banerjee, do you have a typical
8 process that you follow when drafting a report or
9 a declaration?
10 A. I generally leave it up to the
11 attorneys. So in a few cases they've asked me to
12 write reports from scratch. For example, in the
13 Rambus/Samsung case, I remember they had me draft
14 it from scratch, and then they edited it. But in
15 general, it's a collaborative process with the
16 attorneys, and that has been the case in this
17 case.
18 Q. Okay. Can you tell me what your current
19 job title is, please?
20 A. I'm the Cockrell Chair Professor of
21 Electrical and Computer Engineering at the
22 University of Texas at Austin. And I'm also

1 director of Microelectronics Research Center.
2 Q. Do you hold any other job titles besides
3 those two?
4 A. I'm on the advisory board start-up, but
5 no, other than that, no.
6 Q. What is the start-up?
7 A. The name of the company is Applied Novel
8 Devices.
9 Q. Is that start-up listed on your CV that
10 you submitted?
11 A. Yes.
12 Q. Okay. Apart from that start-up, have
13 you held any other jobs outside of academia?
14 A. Yes. After I got my Ph.D., I started
15 working for Texas Instruments in Dallas.
16 Q. Did you know the inventor of the
17 challenged patents before the present IPRs?
18 A. So I did not work with him. I heard him
19 speak at a couple of company meetings, but
20 subsequently, I did meet him in connection with
21 another patent case where we were on the same side
22 as experts.

Q. So we're referring to Dr. Rao, who is the named inventor of the challenged patents. And you understand that he was previously employed by Texas Instruments; right?

A. Yes.

Q. Did your time of employment at Texas Instruments include any time at which Dr. Rao was, as far as you're aware, also at Texas Instruments?

A. Yes, we overlapped.

Q. And what impression did you have of Dr. Rao at the time that there was overlap?

MR. PAUL: Objection; form.

THE WITNESS: As I said, I did not have any technical interactions with him. I was a part of the corporate research and development group. He was in one of the business units, I believe is the name of that group. So I had no technical interactions with him.

BY MR. JAIRAM:

Q. Apart from -- strike that.

Had you heard anyone else relay any impressions of Dr. Rao to you in connection with

1 the time when you were both at Texas Instruments?
2 MR. PAUL: Objection to form.
3 THE WITNESS: I don't recall.
4 BY MR. JAIRAM:
5 Q. When you heard Dr. Rao speak at a couple
6 of company meetings, were those meetings giving
7 you an impression of Dr. Rao?
8 MR. PAUL: Objection to form.
9 THE WITNESS: It's been 40 years, I
10 believe. And I think I heard him only once at a
11 meeting, and it was a sort of general pep talk to
12 the troops. So I -- at this point, I can't think
13 of having any impression, positive or negative.
14 BY MR. JAIRAM:
15 Q. Was Dr. Rao ever your supervisor or in
16 your supervisory line of command?
17 A. No, as I said, I was part of the
18 corporate R&D group, he was in a business unit.
19 No overlap.
20 Q. Do you know if Dr. Rao's role in the
21 business unit would have had any influence or
22 control over anything that you did at Texas

Instruments?

MR. PAUL: Objection to form.

THE WITNESS: I don't believe so. As a fresh Ph.D. out of college, I was kind of focused on the technical part.

BY MR. JAIRAM:

Q. Did you ever read any of Dr. Rao's technical publications when you were at Texas Instruments?

A. No.

Q. Have you ever subsequently read any of Dr. Rao's publications after your time at Texas Instruments ended?

A. Other than these patents that have been asserted, I don't think so.

Q. Okay. Can you tell me about the subject matter, in a broad sense, that you worked on at Texas Instruments?

A. Yes, I was a part of the team, that being the world's first 4-megabit DRAM, D-R-A-M, dynamic random access memory.

(Reporter seeks clarification.)

THE WITNESS: DRAM, D-R-A-M, is the acronym. It stands for dynamic random access memory.

(Reporter seeks clarification.)

THE WITNESS: Yeah, 4-megabit, M-E-G-A-B-I-T.

BY MR. JAIRAM:

Q. Have you ever applied for a patent regarding any work of yours, either the memory-related work that you just mentioned or any other work?

A. Yes, I have 35 patents, some when I was at TI, and then some when I've -- when I joined the University of Texas. Those are listed in my CV. And I was elected a fellow of the National Academy of Inventors based on my patent portfolios.

Q. Can you tell me why you left TI?

A. I always wanted to be in academia. And for me it was not a question of if, but when. I have a younger brother who also is an electrical engineer, went to the same school for his Ph.D. at

Illinois and then he joined academia right away and he was enjoying it a lot.

So when I joined TI, my intention was always to join academia, but I wanted some industry experience. So that's why I switched. I had a great time at TI. I love the company.

Q. Okay. Did you work on trench capacitor DRAM at TI?

A. Yes. I worked on the physics of those memory cells.

Q. Did trench capacitor DRAM become commercially successful?

MR. PAUL: Objection to form.

THE WITNESS: The idea of trench capacitors was used in many different DRAM memories by multiple companies, and some of those in that time frame did become successful.

BY MR. JAIRAM:

Q. Did stacked capacitor DRAMs eventually become what was more commonly used compared to trench capacitor DRAM?

A. Given from the time frame that you're

1 looking at, in more recent times, indeed, stacked
2 capacitors have become more popular than trench
3 capacitors.
4 Q. Around the time that you left Texas
5 Instruments, were stacked capacitor DRAMs
6 beginning to replace trench capacitor DRAMs?
7 A. I don't remember exactly, but I think
8 so. There are two camps, that stacked capacitor
9 camp and the trench capacitor camp, and they were
10 both being researched.
11 Q. Did Texas Instruments begin to phase out
12 research in trench capacitor DRAMs about the time
13 that you left Texas Instruments?
14 A. Once again, I don't recall exactly, but
15 I think so. They got out of the memory business a
16 few years later. I do remember that.
17 Q. Do you know how long Dr. Rao -- just a
18 ballpark estimate, do you have any idea of how
19 long Dr. Rao worked at Texas Instruments?
20 A. I know that he was there for a long
21 time. I couldn't give you -- tell you exactly
22 when.

(Reporter seeks clarification.)

THE WITNESS: I know he was there for a long time, but I do not recall how long.

BY MR. JAIRAM:

Q. Okay. Yeah, sorry, I'm just a little bit confused because the transcript might be a little unclear. I'll ask the question again because there's just some ambiguity there.

Do you have any idea of how long Dr. Rao worked at Texas Instruments?

MR. PAUL: Objection to form.

THE WITNESS: I know he was there for a long time, but I do not recall -- or I do not know how many years.

BY MR. JAIRAM:

Q. Did it ever bother you that Dr. Rao was at Texas Instruments longer than you were?

MR. PAUL: Objection to form.

THE WITNESS: No.

BY MR. JAIRAM:

Q. Do you know if any of Dr. Rao's work at Texas Instruments was commercialized?

MR. PAUL: Objection to form.

THE WITNESS: I do not.

BY MR. JAIRAM:

Q. Do you know if any of Dr. Rao's products that he worked on at Texas Instruments were successful?

MR. PAUL: Objection to form.

BY MR. JAIRAM:

Q. In a commercial sense?

A. I do not know.

Q. Can you tell me if any of your work at Texas Instruments was commercialized in any way that you wish to describe?

MR. PAUL: Objection to form.

THE WITNESS: So I was in basic R&D. So in a broad sense, some of the things that I worked on went into products. It's hard to draw a direct line between basic R&D and a product that's not in a product group.

BY MR. JAIRAM:

Q. Can you tell me if anything that you have worked on at any point in your career, not

1 just Texas Instruments, has been commercially
2 successful?
3 MR. PAUL: Objection to form.
4 THE WITNESS: So what I do at the
5 University of Texas is academic research. And as
6 I said before, it's hard to draw a direct line
7 between academic research -- or basic research for
8 the end products.
9 Now, having said that, I have, I think,
10 about 35 patents, and many of them have been
11 collaborative with industry, some with Texas
12 Instruments and then subsequently some with
13 Micron. I had some joint research programs with
14 them. I believe some with AMD. And we could
15 certainly make a connection between some of that
16 work and products, maybe not a direct connection.
17 BY MR. JAIRAM:
18 Q. You mentioned that you have about
19 35 patents. Do you own any patents yourself?
20 A. No.
21 Q. Have you ever owned any patents that you
22 have sought to monetize?

MR. PAUL: Objection to form.

THE WITNESS: So some of the patents that I filed at the University of Texas, the rule is the university owns rights to half of that, and the inventors own the other half. And several of them have been licensed. So I did make some money from the licensing end.

BY MR. JAIRAM:

Q. Okay. Do any of your patents cover subject matter that is similar subject matter-wise to the seven patents that are challenged in these IPRs?

A. In a broad sense, many of them do.

Q. Can you elaborate, please?

A. Sure. So when I was at Texas Instruments, as I mentioned, I worked on DRAMs, and I have several patents on DRAMs. And that's discussed in some of the patents-in-suit. The patents-in-suit also refer to flash memory.

At the University of Texas, I have worked on flash memory for many years. I have several patents on that.

A lot of work I do falls under the category of CMOS, C-M-O-S, and I have several patents on that.

I have several patents on other types of nonvolatile memory. Let's see. I have patents on SRAMs. That was worked on in collaboration with Micron, and that has relevance, also.

Q. Okay. Are you aware that the challenged patents have been asserted against a number of companies?

A. I think I've heard that, yes.

Q. Have you ever tried or has the patent owner of any of your patents ever tried to license any of your patents to any of the companies that the challenged patents have been asserted against?

MR. PAUL: Objection to form.

THE WITNESS: Can you repeat that question, please?

BY MR. JAIRAM:

Q. Sure.

Do you have a sense of what the companies are that the challenged patents have

1 been asserted against?
2 A. Yes.
3 Q. For example, it includes, obviously,
4 Cirrus Logic and OmniVision. That's probably
5 apparent to you. But some other companies, as
6 well.
7 Do you have any knowledge about those
8 other companies?
9 A. I believe they sued Intel before. I
10 think I've heard ON Semiconductor mentioned, and a
11 few others.
12 Q. And have you ever tried or has whoever
13 owns your patents ever tried to get any of those
14 various companies to take a license on your
15 patents?
16 MR. PAUL: Objection to form.
17 THE WITNESS: I do not know.
18 BY MR. JAIRAM:
19 Q. Have you ever tried or has any of the
20 companies that owns any of your patents ever tried
21 to assert your patents against any of the
22 companies that have been --

MR. PAUL: Objection to form.
BY MR. JAIRAM:
Q. -- defendants with respect to the present challenged patents?
MR. PAUL: Objection to form.
THE WITNESS: I do not know.
BY MR. JAIRAM:
Q. Would it benefit you in the sense of -- some financial sense to have Dr. Rao's patents out of the way so that your patents can be monetized more effectively?
MR. PAUL: Objection to form.
THE WITNESS: No.
BY MR. JAIRAM:
Q. But you said that your patents and Dr. Rao's patents overlap in some subject matter; right?
MR. PAUL: Objection; mischaracterizes testimony.
THE WITNESS: I said they overlap in a broad sense.

BY MR. JAIRAM:

Q. Can you be more specific in the sense in which they overlap?

A. They're in the general area of CMOS, for example. It talks about memory, there's DRAMs, and flash. I'm not talking about specific details such as claims, et cetera.

Q. So if Dr. Rao's patents were invalidated, would it make it easier or harder for you to do something with your patents in the sense of monetization?

MR. PAUL: Objection to form, speculation.

THE WITNESS: It would have no impact, because the patents that I mentioned were sold to another party. So there's no ongoing revenue stream.

BY MR. JAIRAM:

Q. Can you tell me the approximate amount of -- strike that.

MR. JAIRAM: We can take a break here. So let's go off the record.

(Recess from the record.)

BY MR. JAIRAM:

Q. Dr. Banerjee, do you have experience with epitaxial layers in the context of semiconductor processing?

A. A lot of experience.

Q. The prior art reference Kawagoe, that's K-A-W-A-G-O-E, that you mentioned in some of your declarations, involves epitaxial layers; right?

A. Yes.

Q. Can you describe those epitaxial layers briefly, just kind of what epitaxial layers are and what is Kawagoe doing with epitaxial layers?

A. Yes, as I said, I've done a lot of research on epitaxy, including building epitaxial reactors. So the idea of epitaxy is you start with a single crystal substrate, and then you add atoms which will attach to the surface atoms of the substrate and will continue the single crystal structure of the substrate. So you have to have things like lattice matching. I have many papers on epitaxial building.

(Reporter seeks clarification.)

THE WITNESS: I have a lot of papers on that topic.

BY MR. JAIRAM:

Q. Thank you, Dr. Banerjee.

I think we will probably be discussing a lot of kind of technical content in the rest of today's session, and what I suggest for the ease of the court reporter is, you know, I will try and speak a little slower and, also, if there's any kind of complicated words, I'll probably spell them out.

And I would suggest if you could to also maybe speak a little slower, because I -- I understand what you are saying, but I suspect it may be harder for the court reporter.

If that's okay with you?

A. Yes.

Q. And you have published papers regarding epitaxy; is that correct?

A. Yes.

Q. And are all of the -- are papers

1 describing epitaxy mentioned in your CV?
2 A. All my papers are.
3 Q. Okay. Have you ever designed a
4 transistor, Dr. Banerjee?
5 A. Yes.
6 Q. Have you ever designed a CMOS
7 transistor?
8 A. Yes.
9 Q. Can you just briefly, like a one- or
10 two-paragraph kind of level of detail, tell me how
11 a CMOS transistor works?
12 A. So CMOS stands for complimentary metal
13 oxide semiconductor. And that involves having an
14 n-channel transistor and a p-channel transistor on
15 the same substrate.
16 In an n-channel transistor, you have to
17 have an n+ doped source and drain, and typically
18 you have a p-type channel in between. Then grow a
19 gate oxide, and you form a gate electrode on top
20 of the channel to straddle the source in the drain
21 regions.
22 In the case of an nMOS transistor, the

carriers are negatively charged electrons. You ground the source, and you have to apply a positive voltage to the drain to attract electrons from the source across the channel into the drain.

But because the channel is made in a p-type material, which has a deficit of electrons, you have to apply a high enough gate voltage, positive gate voltage, to push away the majority carrier holes and then attract minority carrier electrons, forming an n-type inversion layer, connecting the source to the drain.

And under those conditions, then you apply a positive drain bias. Electrons could flow from -- the source of electrons across the channel into the drain of electrons. Of course, because electrons have a negative charge, the current vector will point in the opposite direction of the flow.

Conversely, in CMOS, you also need a pMOS transistor. So now you have a p+ doped source and drain made in an n-type material, an n-type well. And the polarities are opposite. So

now you have to apply a negative -- high enough negative gate voltage in excess of the threshold voltage to attract minority carrier holes in the inversion layer CMOS.

You now apply a negative drain bias that attract positive holes from the source and the gate. And when the two work in concert, you have what is called CMOS, which is commonly used in ICs today.

Q. Thank you, Dr. Banerjee.

A. I can go into a lot more depth.

Q. Of course. Of course. But I appreciate that.

I think you mentioned for nMOS, you got negatively charged carriers. So that would be electrons; right?

A. Yes.

Q. And I guess for pMOS, you have positively charged carriers. That would be holes; correct?

A. Yes.

Q. So the carriers are electrons or holes;

1 right?
2 A. Yes.
3 Q. How do you know if a carrier is an
4 electron or a hole?
5 MR. PAUL: Objection to form.
6 THE WITNESS: If the charge carrier has
7 a negative sign, that's electron. A hole is a
8 so-called quasiparticle. You only have them in a
9 semiconductor medium where you have a deficit of
10 electrons which behaves like a positively charged
11 carrier.
12 BY MR. JAIRAM:
13 Q. And you mentioned majority carriers and
14 minority carriers. How do you know if a carrier
15 is a minority carrier or a majority carrier?
16 MR. PAUL: Objection to form.
17 THE WITNESS: A semiconductor is
18 typically doped with either donors, which give
19 rise to negatively charged electrons, which would
20 be the majority carriers. And here, the
21 positively charged holes will be the minority
22 carriers.

1 Conversely, if you dope a semiconductor
2 with acceptors, that creates a deficit of
3 electrons giving rise to majority carrier holes,
4 which are positively charged, and here the
5 electrons will be the minority carriers.
6 BY MR. JAIRAM:
7 Q. And you mentioned that in n-channel
8 transistors, you have n+ doped source, and I think
9 you said drain, and typically p-channel between
10 them; is that right?
11 A. The channel in between is initially
12 doped p-type.
13 Q. Can you ever have initially an n-type
14 channel between an N source and an N drain?
15 A. Yes, you could. Those are called
16 depletion transistors.
17 (Reporter seeks clarification.)
18 THE WITNESS: Depletion mode.
19 D-E-P-L-E-T-I-O-N, mode, M-O-D-E.
20 BY MR. JAIRAM:
21 Q. Are depletion mode transistors described
22 in any of the prior art references that you relied

on in any of these IPRs?

MR. PAUL: Objection to form.

THE WITNESS: I don't recall. Depletion mode transistors are not very commonly used.

BY MR. JAIRAM:

Q. Okay. We'll talk about the various prior art references in a little bit, and if -- and if you do see any depletion mode transistors in them, will you please let me know?

A. Yes.

Q. But sitting here today, is it your recollection right now that the transistors that are described in the prior art references that you relied upon other than depletion mode transistors?

MR. PAUL: Objection to form.

THE WITNESS: Yes.

BY MR. JAIRAM:

Q. Is there a word or a term for something that's other than a depletion mode transistor? Is there another type of transistor that's -- I don't know what the word for it is.

A. Yes.

Q. Can you tell me what that is?
A. Enhancement mode transistors.
Q. Okay.
A. E-N-H -- I speak with the court reporter. Did you get it, enhancement mode?
Q. So if we come across anything in the course of today where you see something or you want to mention something that's other than an enhancement mode transistor, you will tell me?
A. Yes.
Q. Okay. For the prior art references that you relied upon in the declarations in these IPRs, did you come up with those prior art references and combinations of references yourself?
MR. PAUL: Objection to form.
THE WITNESS: I don't think so. I think the attorneys provided them.
BY MR. JAIRAM:
Q. Did you come up yourself with the analysis, you know, the sentences, paragraphs, whatever, that are found in your declarations regarding the prior art references and how they

1 map allegedly to the challenged claims?
2 A. These are my reports, and they capture
3 my opinions. As I told you, I've written them in
4 collaboration with my attorneys.
5 Q. I understand that you are saying that
6 they are your reports and they capture your
7 opinions, but I'm asking if you came up with the
8 analysis regarding the prior art references and
9 the mapping to the claims?
10 MR. PAUL: Objection to form.
11 THE WITNESS: I remember in our
12 discussions they would ask me about some of the
13 basic --
14 BY MR. JAIRAM:
15 Q. I'll stop right there. I'll stop right
16 there. I will caution you myself to not reveal
17 the substance of any privileged or confidential
18 communications with counsel.
19 So please do not tell me about the
20 substance of discussions. I'm just asking if you
21 yourself came up with the analysis regarding the
22 prior art references and the mappings to the

1 claims?
2 MR. PAUL: Objection to form.
3 THE WITNESS: These reports, once again,
4 capture my opinions, and they're prepared in
5 collaboration with my attorneys.
6 BY MR. JAIRAM:
7 Q. Are you unable to tell me if you came up
8 with the analysis found in your declarations
9 regarding the prior art references and the
10 mappings?
11 MR. PAUL: Objection to form.
12 THE WITNESS: This analysis and the
13 mappings are my opinions as described in the
14 reports.
15 BY MR. JAIRAM:
16 Q. Okay. Are you aware that the challenged
17 patents have been the subject of prior IPRs
18 occurring previously in time before the present
19 IPRs that we're here for today?
20 A. Yes.
21 Q. Are you aware that Intel filed IPR
22 petitions against all of the challenged patents?

A. Yes, I believe so.

Q. Are you aware that Dell filed IPR petitions against some of the challenged patents?

A. I don't think I knew that.

Q. Are you aware that Sony filed IPR petitions against some of the challenged patents?

A. I was not aware of that either.

Q. Did you have any role in the Intel, Dell, or Sony IPRs?

MR. PAUL: Objection to form.

THE WITNESS: No.

BY MR. JAIRAM:

Q. Do you know who Intel's IPR expert was?

A. I saw the name. I don't -- I've never met him.

Q. Was Intel's IPR expert Travis Blalock?

A. I believe so.

Q. Did you say that you have never met Travis Blalock?

A. Yes.

Q. Have you ever -- when you say "met him," do you mean you've never met him in person or have

you met him over the phone or over e-mail or any kind of communication with Dr. Blalock?

MR. PAUL: Objection to form.

THE WITNESS: No, I was not aware of him.

BY MR. JAIRAM:

Q. Okay. Let's take a look at your '842 declaration, please. And as a reminder, that means that the patent challenged in it has the last three digits '842. I've previously put it in the chat window electronically, and I believe you have a paper copy of it.

Do you have it?

A. Yes.

Q. Your '842 declaration analyzes four unpatentability grounds based on prior art; correct?

A. Yes.

MR. JAIRAM: And for the benefit of the court reporter, I'll just mention that I'm going to mention some various names of prior art references. You'll find it all in the

1 declaration.
2 BY MR. JAIRAM:
3 Q. Dr. Banerjee, you are familiar with the
4 grounds that you put in your declaration, correct,
5 your '842 declaration?
6 A. Yes.
7 Q. Ground I is obviousness over Kawagoe?
8 A. Yes.
9 Q. Ground II is obviousness over Wieczorek
10 and Wolf?
11 A. Yes.
12 Q. Ground III is obviousness over Kawagoe
13 and Gupta?
14 A. Yes.
15 Q. And Ground 4 is obviousness over
16 Wieczorek, Wolf, and Gupta?
17 A. Yes.
18 Q. And your declaration in the '842 IPR
19 includes analysis for each of these four grounds?
20 A. Yes.
21 Q. Did you come up with the analysis for
22 these grounds yourself?

1 MR. PAUL: Objection to form.
2 THE WITNESS: These are my opinions as
3 captured in my report.
4 BY MR. JAIRAM:
5 Q. Would it surprise you to learn that
6 Intel previously filed an IPR petition against the
7 '842 patent, relying on the exact same four
8 grounds that are found in your '842 patent?
9 A. No.
10 Q. Why would that not surprise you, sir?
11 A. Because the attorneys gave me a copy of
12 that IPR.
13 Q. Okay. Can you explain how it came to be
14 that the grounds in your '842 declaration are the
15 exact same grounds in Intel's IPR against the
16 '842 patent?
17 A. So whenever I analyze patents, I read
18 the patents in detail. That's what I did in this
19 case. And I form some initial opinions about the
20 patents and what the claims mean.
21 And in this case, the attorneys had
22 given me copies of the cited prior art. So I read

1 through those in detail, also. And I formed my
2 opinion about the validity or invalidity of the
3 various claims in the '842 patent. And that's
4 what's captured in my report.
5 I was given a copy of the Blalock
6 report. I reviewed that. And I saw that in this
7 case, I believe many or all of my conclusions were
8 consistent with what Dr. Blalock had written. So
9 that's why I didn't see any point in reinventing
10 the wheel. So that's why there's similarities.
11 Q. Okay. So it would not surprise you that
12 for the claim elements and their alleged mapping
13 to prior art Intel's IPR for the '842 patent
14 matches your '842 declaration almost verbatim?
15 MR. PAUL: Objection to form,
16 foundation.
17 THE WITNESS: It does not surprise me.
18 BY MR. JAIRAM:
19 Q. Okay. Do you stand by all of the
20 opinions in the '842 declaration that you
21 submitted and your other declarations in these
22 IPRs?

A. Yes.

Q. Is there anything you disagree with in your declarations in these IPRs?

A. No.

Q. Is there anything you would change in your declarations in these IPRs?

A. No.

Q. Is there anything you wish to correct for the record regarding your declarations in these IPRs?

A. I think when I was reviewing them, I did find one or two minor typos, but nothing substantial.

Q. Were you able to understand everything in Dr. Blalock's declarations from the Intel IPRs, or was there anything that you could not understand?

MR. PAUL: Objection to form.

THE WITNESS: It's been a while since I reviewed that. If you would point me to any specific location, I can tell you.

1 BY MR. JAIRAM:
2 Q. Well, I'm just asking generally, because
3 I don't know any specific location. I'm asking if
4 there was perfect comprehension on your part of
5 everything in Dr. Blalock's declaration, or was
6 there anything that you had any confusion or
7 ambiguity about?
8 MR. PAUL: Objection to form.
9 THE WITNESS: It's been a while since I
10 looked at that report, but I believe I understood
11 everything.
12 BY MR. JAIRAM:
13 Q. Well, I mean, it sounds like -- okay.
14 Is Dr. Blalock's report substantially
15 identical for -- you know, whichever claims are in
16 your declarations substantially identical to your
17 declarations?
18 MR. PAUL: Objection to form.
19 THE WITNESS: There are similarities
20 between his report and mine, but as I told you,
21 these are my opinions.
22

1 BY MR. JAIRAM:
2 Q. And when you say there are similarities
3 between the two reports, would it be fair to say
4 that for claims that appear in both his report and
5 your report, that the analysis in Dr. Blalock's
6 report is substantially identical to the analysis
7 in your declaration?
8 MR. PAUL: Objection to form.
9 THE WITNESS: I haven't done a
10 line-by-line comparison of the two, but I believe
11 there's overlap.
12 BY MR. JAIRAM:
13 Q. Okay. Well, if we were to do a
14 line-by-line comparison here, would it surprise
15 you to find substantially identical lines and
16 sentences in paragraphs in Dr. Blalock's
17 declarations and your declarations?
18 MR. PAUL: Objection to form.
19 THE WITNESS: No, it did not surprise
20 me. Just as I told you, I read the patents, I
21 read the prior art, came to my opinions, then I
22 read Dr. Blalock's report and I agreed with any or

all of the statements he made in his reports. I did not -- I saw no point in, you know, reinventing the wheel and new language. So wherever it was appropriate, I incorporated sentences or paragraphs.

BY MR. JAIRAM:

Q. Okay. In your declarations for these IPRs, you did not say that any claim terms need to be construed; is that correct?

A. I did not provide any opinions on claim terms.

Q. Is that because it was your opinion that any claim terms in the claims do not require construction?

MR. PAUL: Objection to form.

THE WITNESS: I believe I spoke --

MR. PAUL: I'm going to just caution you again not to reveal discussions you had with your attorneys.

THE WITNESS: I used the claim construction that was proposed by the patent owner.

BY MR. JAIRAM:

Q. But I'm asking your opinion, sir.

In your opinion, do any of the claim terms require construction?

MR. PAUL: Objection to form, scope.

THE WITNESS: It's my opinion that for this purpose, the claim terms do not need to be construed.

BY MR. JAIRAM:

Q. For what purpose, sir?

A. To resolve these prior art issues.

Q. So in order to figure out if the prior art teaches or suggests a certain limitation in the claims, none of those limitations need to be construed; is that right?

MR. PAUL: Objection to form.

THE WITNESS: No, what I said was that the claim terms used in the Rao patents do not need to be construed.

BY MR. JAIRAM:

Q. Okay. You provided your analysis in your declarations from the perspective of a person

of ordinary skill in the art; right?

A. Yes.

Q. I may refer to a person of ordinary skill in the art as a "POSITA," P-O-S-I-T-A, for short. Okay?

A. Okay.

Q. Are the claim terms of the challenged claims that you analyzed in your declarations understandable to a POSITA?

A. Yes.

Q. Are you unable to understand any of the terms of the challenged claims?

A. No.

MR. PAUL: Objection to form.

BY MR. JAIRAM:

Q. Let's turn to your '222 No. 2 declaration, please. And, again, that's -- there's two declarations on the '222 patent, and it's the one that has only a single claim addressed.

Do you understand?

A. You said that -- you said the 00020 or

1 the 21?
2 Q. It's -00021. It's Exhibit 1003 in the
3 00021 IPR proceeding.
4 A. Yes.
5 Q. Do you understand which one I'm
6 referring to?
7 A. Yes.
8 Q. There's a single claim, Claim 44,
9 addressed in this IPR; right?
10 A. Yes.
11 Q. Can you go to paragraph 69, please?
12 A. Okay.
13 Q. In this paragraph, you are analyzing
14 limitation 44.1, which is a surface layer; right?
15 A. Yes.
16 Q. You were able to understand "surface
17 layer" in this claim to map it to prior art;
18 correct?
19 MR. PAUL: Objection to form.
20 THE WITNESS: I understood the term
21 "surface layer" as construed by the patent owner,
22 and I applied that understanding to Payne. And

with that understanding, I believe Payne discloses the surface layer.

(Reporter seeks clarification.)

THE WITNESS: I applied that understanding to Payne, P-A-Y-N-E.

BY MR. JAIRAM:

Q. So you said you applied patent owner's understanding; is that correct?

A. In this case, yes.

Q. Why did you apply patent owner's understanding regarding surface layer?

MR. PAUL: Objection to form.

THE WITNESS: As I told you before, I did not provide any opinions about the claim terms. I did not feel that they need any construction. But wherever relevant, I applied the construction proposed by the patent owner.

BY MR. JAIRAM:

Q. Do you agree with patent owner's understanding regarding surface layer?

MR. PAUL: Objection to form, scope.

THE WITNESS: I've not provided any

1 opinion on that. I simply applied the patent
2 owner's construction.
3 BY MR. JAIRAM:
4 Q. Can you tell me what is patent owner's
5 construction?
6 A. The term "surface layer" is a layer at
7 the surface of the silicon --
8 Q. Do you --
9 A. -- or a layer at the surface of the
10 semiconductor device.
11 Q. Do you agree with the characterization
12 that you just now stated that you say is patent
13 owner's construction?
14 MR. PAUL: Objection to form, scope.
15 THE WITNESS: Once again, I did not
16 provide any opinions on the claim terms. In this
17 case, I adopted the construction provided by the
18 patent owner and applied it to my analysis.
19 BY MR. JAIRAM:
20 Q. Do you agree that a surface layer is a
21 layer at the surface?
22 MR. PAUL: Objection to form, scope,

1 asked and answered.
2 THE WITNESS: I applied the construction
3 that a surface layer is a layer at the surface of
4 the silicon or a layer at the surface of the
5 semiconductor device.
6 BY MR. JAIRAM:
7 Q. Sir, I'm not asking what construction
8 you applied. I am asking, again, do you agree
9 that a surface layer is a layer at the surface?
10 And for the record, to be clear, I
11 emphasized the words "do you agree."
12 MR. PAUL: Objection to form, scope,
13 asked and answered.
14 THE WITNESS: I feel that for this IPR,
15 claim terms do not need to be construed based on
16 the prior art issues. But as I said, I -- the
17 purpose of my analysis that I used is the
18 construction that was proposed by the patent
19 owner. In this case, a surface layer is a layer
20 at the surface.
21 BY MR. JAIRAM:
22 Q. Okay. Let's turn to your '842

1 declaration, please, and specifically
2 paragraph 127.
3 Can you please tell me when you are
4 there?
5 A. Yes.
6 Q. Do you see where you state in
7 paragraph 127 that Wolf describes a finite number
8 of known appropriate substrates?
9 A. Yes, I see that.
10 Q. And you cited Exhibit 1008C at page 530;
11 is that correct?
12 A. Yes.
13 Q. And part of the quote from page 530 of
14 that Wolf reference is that, "The substrate may be
15 either a likely doped wafer of n or p material, or
16 a thin, likely-doped epitaxial layer on a heavily
17 doped substrate"; right?
18 A. Yes.
19 Q. And you understand these disclosures
20 because, as you mentioned, you have substantial
21 experience with epitaxial layers; correct?
22 A. Yes.

Q. And so the substrate could be a thin, likely-doped epitaxial layer on a heavily doped substrate; right?

A. Yes.

Q. What does that mean?

MR. PAUL: Objection to form.

THE WITNESS: So, as I told you before, for epitaxy, you need a single crystal substrate, and then you attach atoms to it so that you can replicate the crystal structure of the substrate. So in this case, they're talking about a starting substrate that is heavily doped.

There's no clear-cut boundary about what "heavily doped" means, but a POSITA generally thinks of heavily doped substrates being on the order of 10 to the 20 dopant atoms per centimeter cubed.

On top of that --

(Reporter seeks clarification.)

THE WITNESS: -- thinks of the heavily doped substrate having a doping level of 10 to the power 20, so 10 superscript 20, dopant atoms per

1 centimeter cubed.
2 On top of that, for the epitaxial
3 growth, you flow in appropriate gases to create a
4 single crystal film of silicon. This is the
5 epitaxial layer. But along with that, you flow in
6 dopant gases, where the doping of the epitaxial
7 layer will be lower, very often on the order of 10
8 to the power 15 per centimeter cubed, or in that
9 neighborhood. The details depend on the exact
10 process, of course.
11 BY MR. JAIRAM:
12 Q. Okay. Would you understand Wolf as
13 describing a substrate that essentially has two
14 layers, a first layer being a thin, lightly doped
15 epitaxial layer and the second layer being the
16 heavily doped substrate?
17 A. So the term "substrate," in the context
18 of these IPRs according to the patent owner, means
19 an underlying layer. And then depending on the
20 specific patents, there's slightly different
21 interpretations of the word "substrate" that's
22 been proposed by the patent owner, and that's the

1 position I took in my analysis.
2 As far as Wolf is concerned, in this
3 particular case, the term "substrate" does refer
4 to this lightly doped epitaxial layer grown on top
5 of the heavily doped substrate.
6 Q. Okay. And do you see where the phrase
7 "on" appears in the quoted sentence that I
8 mentioned? I can read it out, but I'm just trying
9 to get you to look at it, you know, the words
10 before "heavily doped substrate."
11 Do you see that?
12 A. Yes, I see that.
13 Q. Okay. So when Wolf says that there is a
14 thin, lightly doped epitaxial layer on heavily
15 doped substrate, is Wolf describing that there is
16 this epitaxial layer on top of another layer,
17 which is the substrate layer?
18 MR. PAUL: Objection to form.
19 THE WITNESS: Can you repeat the
20 question, please?
21 BY MR. JAIRAM:
22 Q. Okay. Is Wolf saying that there is one

1 layer, this epitaxial layer, on top of another
2 layer, the substrate?
3 A. Yes.
4 Q. Is the substrate a layer, the substrate
5 that Wolf is describing in that sentence?
6 MR. PAUL: Objection to form.
7 THE WITNESS: So in this particular
8 case, the starting substrate typically will be of
9 the order of 25 mils, M-I-L-S, in thickness, which
10 is roughly 625 microns. And then on top of that,
11 you grow an epitaxial layer, which is generally on
12 the order of a few microns. Whether you call the
13 starting heavily doped substrate a layer, this
14 will be a matter of semantics.
15 BY MR. JAIRAM:
16 Q. Why would the substrate that's heavily
17 doped not be a layer?
18 MR. PAUL: Objection to form.
19 THE WITNESS: What is your definition of
20 a "layer"?
21 BY MR. JAIRAM:
22 Q. Sir, I'm asking the questions. I'm

1 asking you. If you want to respond, you can tell
2 me what your definition of it is in your response.
3 Let me repeat the question.
4 Why would the substrate described in the
5 sentence of Wolf that we were talking about, the
6 one that's heavily doped, why would that not be a
7 layer?
8 MR. PAUL: Objection to form.
9 THE WITNESS: So, once again, in this
10 case, the substrate would be a slab of generally
11 silicon material, on the order of 625 or
12 600 microns in thickness. And then on top of
13 that, you grow a thinner layer of the lightly
14 doped epitaxial layer.
15 BY MR. JAIRAM:
16 Q. Okay. So there is one layer down below
17 that's apparently thicker, and --
18 A. Yes.
19 Q. -- on top of that, there is a thinner
20 layer that's lightly doped; is that right?
21 A. In this case, yes, that's what Wolf is
22 talking about.

Q. Okay. So when Wolf is saying the substrate may be...a thin, lightly doped epitaxial layer on a heavily doped substrate, Wolf is saying that you can have a substrate with different levels of doping; right?

MR. PAUL: Objection to form.

THE WITNESS: I don't remember what the ellipses are, but in general -- sorry.

BY MR. JAIRAM:

Q. Yeah, I'm not trying to say anything that's tricky.

If you look, please, at page 530, the full sentence had a bunch of words that I was just trying to kind of, you know, shorten the question.

So do you see that the substrate may be either a first thing or a second thing, that's basically how that sentence in Wolf is formulated?

A. Yes, I see that.

Q. Okay. So do you see that under the second possibility, the substrate may be the second thing?

MR. PAUL: Objection to form.

1 THE WITNESS: If you read the first
2 sentence where Wolf talks about two separate wells
3 are formed on a lightly doped substrate, keeping
4 that in mind, going to the second sentence, a
5 lightly doped substrate in the second case would
6 have to refer to the epitax -- lightly doped
7 epitaxial layer on the underlined heavily doped
8 substrate. Because you cannot make devices in a
9 substrate that is very -- functional devices in a
10 very heavily doped substrate.
11 BY MR. JAIRAM:
12 Q. Okay. I will -- just for shortening it,
13 I will say that when I say "X," I mean a lightly
14 doped wafer of N or P material. Okay?
15 A. Okay.
16 Q. And when I say "Y," the letter Y, I mean
17 a thin, lightly doped epitaxial layer on a heavily
18 doped substrate. Okay?
19 A. Okay.
20 Q. So you see that the sentence in Wolf on
21 page 530, that we have been talking about,
22 basically says the substrate may be either X or Y?

MR. PAUL: Objection to form.

THE WITNESS: Can you please remind me again what X and Y are? I believe you said X is a lightly doped wafer of N or P material. And then Y was a thin, lightly doped epitaxial layer on a highly doped substrate; is that correct?

BY MR. JAIRAM:

Q. Yes, I'm asking if you see that.

A. Yes, I see that.

Q. So when it says the substrate may be either X or Y, that can be that the substrate could be Y; correct?

MR. PAUL: Objection to form.

THE WITNESS: Yes, the substrate could be just thinly -- a thin, lightly doped epitaxial layer on a heavily doped substrate, which you're calling Y.

BY MR. JAIRAM:

Q. Okay. So in that possibility, which you just read, there are two different dopings within the substrate, right; thin, lightly doped, and a few words later, heavily doped.

Do you see that?

A. Yes.

Q. Do you understand this sentence in Wolf?

A. Yes.

Q. Do you disagree with this sentence in Wolf?

A. No.

Q. Do you have any confusion about this sentence in Wolf?

A. I have no confusion in this particular context.

Q. Okay. Let's turn to paragraph 67, please, same declaration, the '842 declaration.

Please tell me when you're there.

A. Yes.

Q. In paragraph 67, you explain that the substrate, as shown below in orange, has a top surface and a bottom surface; right?

A. Yes.

Q. The substrate that you identified reaches all the way to the topmost surfaces of the source, drain, and channel; correct?

MR. PAUL: Objection to form.

THE WITNESS: It reaches to what I label as the "first surface" in Figure 23.

BY MR. JAIRAM:

Q. And the substrate also reaches to the bottommost surface of the device; right?

A. Here it reaches to the lower surface that I have labeled a "second surface."

Q. Is there anything about these labelings or mappings that you disagree with there in your declaration?

MR. PAUL: Objection to form.

THE WITNESS: No.

BY MR. JAIRAM:

Q. So what is labeled at this paragraph 67 of your '842 declaration is, in your opinion, a correct characterization of the thing that you have marked as substrate in orange or brown?

MR. PAUL: Objection to form.

BY MR. JAIRAM:

Q. I'll rephrase.

So what you have labeled in orange at

1 paragraph 67 of your '842 declaration is, in your
2 opinion, a correct labeling of the portion of this
3 semiconductor cross section that is the substrate?
4 A. Yes. In this context, yes.
5 Q. And this substrate of Kawagoe that you
6 have labeled is not uniformly doped; correct?
7 MR. PAUL: Objection to form.
8 THE WITNESS: Kawagoe has several
9 embodiments. In some they are uniformly doped,
10 but in others they're not.
11 BY MR. JAIRAM:
12 Q. I'm referring to the portion or
13 embodiment or disclosure that you have
14 specifically annotated with labeling at your
15 paragraph 67. So let's talk about that. Okay?
16 A. Okay.
17 Q. And in this embodiment that you have
18 annotated at paragraph 67, the labeled substrate,
19 which you labeled in orange, is not uniformly
20 doped; correct?
21 MR. PAUL: Objection to form.
22 THE WITNESS: I believe that's true.

BY MR. JAIRAM:

Q. And this labeled substrate, which you labeled in orange, instead has nonuniform doping; right?

MR. PAUL: Objection to form.

THE WITNESS: Yeah, I believe in this case it has two different doping elements.

BY MR. JAIRAM:

Q. And the substrate that you have labeled in orange also includes both n- and p-type dopants; correct?

A. Those are introduced later in the process, in the substrate.

Q. Just to be clear, what you have drawn a dashed line box around in orange and labeled as "substrate" does include both N and P dopants; correct?

MR. PAUL: Objection to form.

THE WITNESS: Yes, here the substrate does have N and P dopants.

BY MR. JAIRAM:

Q. And this substrate of Kawagoe that you

have labeled in orange includes multiple layers, including a layer below the wells and then including the wells and also including the active regions; is that right?

MR. PAUL: Objection to form.

THE WITNESS: You start with the substrate, and then you form the wells and the active regions in the substrate.

BY MR. JAIRAM:

Q. Well, with Kawagoe, the substrate that you have mapped is non-uniformly doped; right?

MR. PAUL: Objection to form.

THE WITNESS: Kawagoe has several embodiments. I believe in embodiment one, the substrate is uniformly doped. But in this particular figure, 23, I believe refers to embodiment four, where there are two doping levels in the starting section.

BY MR. JAIRAM:

Q. Okay. Just to be clear, in the embodiment that you have mapped and annotated here at Figure 23 and paragraph 67 of your '842

declaration, the substrate that you labeled in orange is non-uniformly doped; correct?

MR. PAUL: Objection to form, asked and answered.

THE WITNESS: Kawagoe talks about substrates with different embodiments, some where he has the same doping level throughout the substrate, some where he has two different doping levels.

BY MR. JAIRAM:

Q. Sir, I am asking about the embodiment that you have analyzed and annotated at your paragraph 67.

Do you see that embodiment that you have annotated and labeled at paragraph 67?

A. Yes.

Q. So for that embodiment that you have labeled as paragraph 67, the substrate that you did label in orange is non-uniformly doped; correct?

MR. PAUL: Objection to form, asked and answered.

THE WITNESS: In this particular embodiment, the substrate has two different doping levels. But, once again, other embodiments in Kawagoe show substrates with the same doping level.

BY MR. JAIRAM:

Q. And in this particular embodiment, which you have labeled for your paragraph 67, the substrate includes both n- and p-type dopants; right?

MR. PAUL: Objection to form, asked and answered.

THE WITNESS: The substrate includes both n- and p-type dopants after the devices have been fabricated.

BY MR. JAIRAM:

Q. And Kawagoe's substrate in the embodiment that you have analyzed and annotated at your paragraph 67 has multiple layers; correct?

A. Here, what I'm calling the substrate has an epitaxial layer grown on top of the starting substrate.

Q. And so would that mean that you've got multiple layers?

MR. PAUL: Objection; form.

BY MR. JAIRAM:

Q. And so does Kawagoe's substrate that you have labeled in orange at paragraph 67 have multiple layers?

MR. PAUL: Objection to form.

THE WITNESS: If you call the epitaxial layer a separate layer from the starting substrate on which the epitaxial layer is grown, yes, it has multiple layers.

MR. JAIRAM: Okay. I think we've gone for probably about 50, 60 minutes. Let's take a break here. We can go off the record.

(Recess from the record.)

BY MR. JAIRAM:

Q. Dr. Banerjee, did you discuss any substance of testimony with anyone during your breaks?

A. No.

Q. Okay. Dr. Banerjee, do you have any

relatives who work or have worked at Cirrus Logic?

A. No.

Q. Do you --

A. Not that I know of. Not that I know of.

Q. Do you know Suman Banerjee?

A. No.

Q. You do not have a relative named Suman Banerjee?

A. Not a close relative.

Q. Okay. In the '222 patent, Claim 1 specifies a VLSI semiconductor device; correct?

A. Yes.

Q. What is VLSI?

A. Very-large-scale integration.

Q. Do you have experience with VLSI?

A. Yes.

Q. Can you briefly just tell me what your experience with VLSI is?

A. I started my career at Texas Instruments working on the 4-megabit DRAM, which is an example of a VLSI chip.

Q. Okay. And how would you know if a

1 device is a VLSI device?
2 A. There are no hard boundaries between
3 what constitutes VLSI. These terminologies relate
4 to something known as Moore's law, M-O-O-R-E 's
5 law, which has the transistor counts in
6 leading-edge chips as a function of time. And as
7 the technology has evolved and you put in more and
8 more transistors on leading-edge chips, you move
9 from one generation of technology to the other.
10 So VLSI, I don't remember the exact
11 transistor count, but I think it's in the order of
12 100,000 transistors to maybe several -- don't hold
13 me to the exact numbers -- millions, which counts
14 as VLSI. Below that, you have LSI, which is
15 large-scale integration. And above VLSI, you have
16 something known as ULSI, ultra-large-scale
17 integration.
18 Don't hold me to the exact transistor
19 count numbers, because those are not precise.
20 Q. Thank you.
21 Can you please turn in your '842
22 declaration to paragraph 79.

A. Yes.

Q. And you see that on the previous page, there's a section header indicating the claim element, and that's Element 1.2?

A. Yes.

Q. Okay. So Element 1.2 includes the phrase "first active region"; right?

A. Yes.

Q. And in paragraph 79, you said that -- referring to Kawagoe, that the source-drain regions 4Na and 4Nb form part of the claimed first active region, which also includes the channel region in between the source-drain regions and below the gate insulating film.

Do you see that?

I left out a few of the -- kind of the numerals, but I'm just trying to point you to the sentence.

Do you see that?

A. Yes.

Q. So looking at Kawagoe, you believe that the source, drain, and channel would have been

1 understood to be the active region?
2 MR. PAUL: Objection to form.
3 THE WITNESS: Yes, source, drain, and
4 channel are part of the active region where the
5 transistor action happens.
6 BY MR. JAIRAM:
7 Q. Would you say that the source or drain
8 alone is an active region?
9 MR. PAUL: Objection to form.
10 THE WITNESS: The source and drain are
11 part of the active region.
12 BY MR. JAIRAM:
13 Q. And what are the bounds or boundaries of
14 the active region?
15 MR. PAUL: Objection to form.
16 THE WITNESS: I adopted the construction
17 proposed by the patent owner, which I believe
18 is -- it's the region where the transistor action
19 happens. Let me confirm that.
20 It's a bulk silicon region at the
21 surface of a semiconductor device where a
22 transistor can be formed. So with that

1 understanding, the source, drain, and channel all
2 are parts of the active region.
3 BY MR. JAIRAM:
4 Q. Okay. Have you written any papers that
5 mention an active region?
6 A. I've written many papers and have a
7 textbook where we describe active regions. I
8 can't recall offhand if I've used the specific
9 terminology "active region." But I have numerous
10 papers where we have transistors in the source,
11 drain, and channel region.
12 Q. Would it surprise you if any of your
13 prior papers used the phrase "active region"?
14 MR. PAUL: Objection to form.
15 THE WITNESS: It would not surprise me.
16 I have --
17 BY MR. JAIRAM:
18 Q. Why would it not --
19 A. -- several papers --
20 Q. Sorry, please --
21 A. I believe I have over a thousand papers
22 over 40 years. So I don't remember the specifics.

Q. Okay. You later state in paragraph 79 that, "nMOS transistor 4N is formed in the first active region, which is adjacent to the first surface of the substrate."

Do you see that?

A. Yes.

Q. So if a transistor is formed in the active region, what does that mean?

A. So the transistor has a source, a drain, and a channel in between, and these are formed by doping different regions of the substrate appropriately.

And in the case of nMOS, that would imply n-type doping, high n-type doping in the source and drain regions from the channel is p-doped.

But to complete the transistor, you then have to grow a gate oxide and form a gate electrode on top of it, on top of the channel, straddling the source and the drain. So the gate electrode would be above the substrate, in this case while the source, drain, and channel are

1 embedded in the substrate. But you need
2 everything to form the transistor.
3 Q. Okay. What portion of the channel is
4 part of the active region?
5 MR. PAUL: Objection to form.
6 THE WITNESS: I want to say based on the
7 construction proposed by the patent owner, that it
8 will be the portion of the channel where
9 transistor action happens. And by that I mean --
10 my understanding would be you have the carriers,
11 in this case electrons, flowing from the source
12 across the channel into the drain.
13 But remember, the channel is
14 initially -- is p-doped, but then you have to
15 apply a positive voltage in this case to the gate,
16 push away the majority carrier holes in the
17 channel away from the surface, and start
18 attracting electrons.
19 In this case, this would be the minority
20 carrier electrons in the p-type channel. And
21 those minority carrier electrons form what is
22 known as an inversion layer between the n+ source

and the n+ drain. So then when you apply positive voltage to the drain, that comes off from the source to the drain that I described earlier on. The exact current contours depend on the biased conditions that you apply to the drain.

(Reporter seeks clarification.)

THE WITNESS: Exact current contours.

BY MR. JAIRAM:

Q. Okay. So in Limitation 1.2 of this '842 patent, do you understand what this claim element about "first active region" is?

MR. PAUL: Objection to form.

THE WITNESS: Yes, I understand.

BY MR. JAIRAM:

Q. Okay. And can you tell me what it is, apart from just saying that you applied patent owner's understanding?

MR. PAUL: Objection to form.

BY MR. JAIRAM:

Q. Can you tell me what the active region in Element 1.2 is, apart from just saying that you applied patent owner's understanding?

1 MR. PAUL: Objection to form.
2 THE WITNESS: Yes, I have an
3 understanding.
4 BY MR. JAIRAM:
5 Q. Okay. Can you please elaborate?
6 A. Sure. So that's the region where you're
7 forming the source and the drain in this case, n+,
8 typically it's by ion implantation into the
9 substrate, with a gap between the source and the
10 drain regions, which will form the channel.
11 So in this case, the second doping -- if
12 you're looking at an nMOS, you have n-type doping
13 in the source and drain, that would be one doping
14 type, while the p-type would be the first doping
15 type.
16 Q. Okay. And is this description that you
17 just now elaborated mentioned in your declaration?
18 A. Yes, I see that. I didn't read from the
19 declaration, but if you go to page 45, it says,
20 "The semiconductor regions 4Na and 4Nb are doped
21 with an n-type impurity." "Thus, in my opinion, I
22 have a second doping type (n-type) opposite in

conductivity to the first doping type (p-type) of the substrate."

Q. Okay. And is it your opinion that "active region" in the claims of the other challenged patents, besides the '842 patent, means the same thing as it does in the '842 patent?

A. Well, in a general sense, active regions already have useful circuit functionality. Transistors are just one type of useful semiconductor device. There are other semiconductor devices, also, which could be part of the active region. If you want to point me to a specific location, I could elaborate on that.

Q. Does Kawagoe have an NPN or instead a PNP configuration for its source, drain, and channel?

A. It has both. If you look at page 45, the figure on the top shows two transistors next to each other. The one on the left is pMOS, which would have the PNP configuration you pointed to. And the transistor on the right is nMOS, which has the NPN configuration.

Q. Is the thing in Kawagoe that you mapped to first active region, is that just composed of the source, drain, and channel, or is there anything else?

MR. PAUL: Objection to form.

THE WITNESS: Well, in this context, we're referring to the source, drain, and channel, which are in the substrate which constitute elements of a transistor. But those by itself are not going to give you a functional transistor.

As I mentioned, you also need to have a gate electrode on top of it. But the active region in this context is referring to the transistor portion in the substrate.

BY MR. JAIRAM:

Q. Can you tell me how an active region is formed?

A. Yes.

Q. How --

A. Do you want me to elaborate?

Q. Yes, please, could you elaborate? Thank you.

A. Sure. Yeah, so you start with the substrate, and then -- but there are many different process roads. I'll just give you a simple generic one.

So you start with the substrate, and then focusing just on the -- so you start with the substrate. You have formed isolation regions in this case. Region three, for example, which is formed by a technique called, in this case, LOCOS, L-O-C-O-S, which separates neighboring active regions. And in the active region, you form a gate oxide.

In those days, it would typically be done by oxidizing the silicon from a layer of SIO2. Then you deposit the gate electrode. Very often that would be highly doped polycrystalline silicon. You pattern the thing using photolithography.

And you etch the gate electrode using what is known as reactive ion etching, which is a plasma-based etch which gives you vertical sidewalls on either side of the gate electrode.

1 Then use that as -- what is known as a
2 cell-aligned implant mast to implant the
3 source-drain regions on either side of the gate
4 electrode.
5 Now, the schematic is a general
6 schematic. So in many cases, what is done is you
7 then deposit a pattern and etch what are called
8 sidewall spacers on either side. And very often
9 use that as the separate implant step for a
10 deeper, heavier source drain. The earlier source
11 drain that I mentioned is called a lightly doped
12 drain. I don't recall offhand if Kawagoe goes
13 into that much detail.
14 Q. Okay. Thank you.
15 Does the active region extend any deeper
16 than the source or drain?
17 MR. PAUL: Objection to form.
18 THE WITNESS: As I told you, the exact
19 paths along which the current goes between the
20 source and the drain depend on the biased
21 conditions. So suppose I apply a gate voltage in
22 excess of what is known as the threshold voltage.

1 That will be sufficient to turn the p-type channel
2 and the surface into an n-type region, which is
3 called an inversion layer, between the source and
4 the drain.
5 And then as you start ramping up the
6 drain voltage, current will flow essentially near
7 the surface within the inversion layer, which is
8 very thin, on the order of 50 angstroms or so,
9 much thinner than the typical source-drain
10 junction beds, which, depending on the technology,
11 may be several thousand angstroms deep.
12 So then what happens is as you keep
13 increasing the drain voltage, you increase what is
14 called the deficient medians near the source --
15 near the drain junction. And then the current
16 flow vectors cave more and more into the channel
17 region for the flow into the drain. So these
18 boundaries, along which the current flows, varies
19 a little, depending on the voltage conditions.
20 BY MR. JAIRAM:
21 Q. Thank you.
22 In Kawagoe, is the active region that

you have mapped in a well?

A. Yes.

Q. Why is the active region in a well?

MR. PAUL: Objection to form.

THE WITNESS: If I look at the figure on page 45, which is Figure 23 of Kawagoe, he's showing this more or less rectangular region he's labeled P. That will be an example of what's called a p-well. And then he made the n-channel passage drain there. Conversely, you make a pMOS device in the n-well on the left-hand side.

(Reporter seeks clarification.)

THE WITNESS: Conversely, you make the pMOS transistor on the left-hand side in an n-well.

BY MR. JAIRAM:

Q. Okay. In semiconductor devices generally, not just what's in Kawagoe, does the active region get formed in a well?

MR. PAUL: Objection to form.

THE WITNESS: Are you referring to all semiconductor devices or CMOS?

BY MR. JAIRAM:

Q. I don't know. I'm asking you if you can please explain. If there's a distinction, please explain that.

A. Sure. I mean, you can make very simple semiconductor devices which do not require a well. But for CMOS, you have to have wells, because you need both types of these localized substrate doping, which are known as the wells. There are other technologies, also, in order to be able to make both nMOS and pMOS.

Q. Okay. Are the prior art references that you analyzed and relied upon in your declarations describing CMOS transistors or something other than CMOS transistors?

A. So Kawagoe is CMOS. I believe Onoda is CMOS. Wieczorek is CMOS. And then Payne is CMOS. Those are the main ones. And then Wolf certainly is CMOS.

Q. Okay. Can there be more than one transistor in a well?

A. Yes.

Q. If there are multiple transistors in a well, does the active region extend between the transistors?

A. No, you separate each active region with an isolation region. So the active regions are the regions that are bounded by isolation regions.

Q. Are isolation regions the same as passive or field regions?

MR. PAUL: Objection to form.

THE WITNESS: Isolation regions are also called field regions.

BY MR. JAIRAM:

Q. Okay. I believe you mentioned field regions at paragraph 130 of your '842 declaration. If you may please turn to that, I'll ask you a question about it.

A. Okay. Yeah.

Q. Okay. So these field regions are, you say, also passive regions. Can you tell me how they are different from active regions?

A. Where do I use the term "passive"?

Q. Do you know if you used the term

"passive regions" in your declaration?

A. I don't think I do it, but -- oh, yeah, I did, yeah. The passive regions, yes.

Q. Do you know what passive regions are?

A. Yes. In this context, yes. So you have the active regions where the transistor action happens. But you don't want one transistor to bump the neighboring transistor on this chip, such as a VLSI chip, unless they're connected by wiring, depending on the circuitry you're trying to build.

So that's why you have to separate each active region from hitting a transistor from neighboring active regions from other transistors to prevent unintentional cross talk in them. So those regions are known as the isolation or field or passive regions.

And the way you accomplish that is you have an oxide, which is much thicker than the gate oxide in the MOSFET, as shown, for example, in the cartoon view in Kawagoe, or in this case, this rectangular region shown in Figure 1B in

1 Wieczorek.
2 So let's look at Figure 1B reference.
3 This would be an example of what is known as
4 shallow trench isolation, or STI. And as you can
5 see from the crosshatch region, that's oxide
6 there, which is much thicker than the gate
7 dialectic transistor, such as layer 135.
8 And the upshot of that is this, the
9 threshold voltage to the channel of the transistor
10 will be much lower than any unintentional
11 parasitic transistor that can be formed below the
12 isolation region.
13 If you look at the expression for the
14 threshold voltage, a thicker oxide will lead to a
15 lower capacitance. And in the field or isolation
16 or passive region that will leave these -- the
17 threshold voltage of any unintentional transistor
18 underneath that, you should connect the transistor
19 144, say, on the left, transistor 134 on the
20 right.
21 So the way you get this isolation is
22 electrical isolation. That's important. And the

way you achieve that is you make the threshold voltage of that isolation region much higher than the power supply voltages on the chip, and that will guarantee electrical isolation between neighboring transistors and the neighboring active regions.

Q. Okay. Can you please turn to the Payne reference? That's P-A-Y-N-E. That's Exhibit 1005 in the '195 IPR, and I believe it's in at least one other IPR, as well.

A. Yes, I have.

Q. So Payne teaches a double-deck well structure; right?

A. I believe that's the terminology he uses.

Q. Do you have experience with double-deck well structures?

A. I'm very familiar with the terminology certainly in the context of papers that I've read in connection with my research. I can't recall offhand if I've used double-deck structures in the transistors that I've made. I might have. I

can't remember.

Q. Do you have experience with setting what the doping concentrations should be at different depths in a semiconductor device?

A. Yes.

Q. Can you tell me your experience with that, please?

A. Yes. I did my Ph.D. at the University of Illinois on ion implantation in semiconductors. I actually ran the ion implanter during my Ph.D., and that's a standard technique that is used to fuse dopants in a semiconductor. And that can be used to control the concentrations and the depths.

If you increase the implant energy, the dopants will travel further. If you increase the so-called implant dose, the concentration goes up. So that's what I did for my Ph.D.

And subsequent to that, when I worked at TI and at the University of Texas, I've been working on transistors, essentially, all my life that involved carefully engineering the doping concentrations at the depths.

Q. Do you have experience with alpha rays?

A. Well, we're all subject to alpha rays, whether we want to be or not. You know, we have all kinds of radiation surrounding us.

Q. That sounds ominous. I suppose I should clarify.

Do you have experience with alpha rays in the context of semiconductor processing?

A. I'm familiar with the impact of alpha rays on semiconductors as in what are called single event upsets, SEU, and which can create soft error rates. I believe I have patents related to that.

Q. Are the patents relating to the alpha rays mentioned in your CV?

A. Yes.

Q. Okay. If we were to turn to your CV, would you be able to point out which ones?

A. I think so.

Q. Okay. Let me put in the chat window your CV from the '842 IPR, but I think it's probably also in the other IPRs.

Please let me know when you see it.

A. Do you have a hard copy?

Q. If you have a hard copy of it, that's fine.

A. I don't have one with me.

Q. It's okay. I can share on the screen. I'm not trying to trick you or anything. I'm just trying to find where this is that you're talking about. So I'll put it on the screen.

A. If you go to the list of patents.

Q. Yeah, just one sec, please. I will open it here on my screen.

I'm sharing the screen. I don't know if you can see it on the Zoom. It doesn't really matter. Because if you can explain this to me, that's fine.

A. Yeah, I can.

Q. Okay. I will go to the list of patents. Hold on.

A. Yes.

Q. Can you tell me about where that is, because I'm not able to find that?

A. Keep scrolling down.
Q. Yeah, hold on.
Are you able to see my screen?
A. Yes, I can. Yeah.
Q. Okay. I'll start at page 1, and I will scroll down because I'm just trying to find it.
Okay. It looks like it's starting around page 17. It looks like there's approximately 35. So let's just take a look at them real quick.
A. Yeah, go to the end of the list.
Q. Sure. I'm on the page 18 of your CV.
A. Yeah, so Patent No. 34.
Q. Okay. The one ending in '374?
A. Yeah.
Q. Oh, I see. It has "alpha particle" in the title.
Okay. All right. Is there any -- a different one in this, or is that the only one?
A. I may have published papers where you look at that aspect, also, but I can't recall offhand.

Q. Okay.

A. I'm not sure.

MR. JAIRAM: Why don't we take a break now. Let's go off the record.

(Recess from the record.)

BY MR. JAIRAM:

Q. Dr. Banerjee, let's take a look at Onoda, which is Exhibit 1042 in the '195 IPR. And I think it's also in some of the other IPRs.

Can you please turn to Figure 3 of Onoda?

A. Yes.

Q. Can you just briefly tell me what does Figure 3 of Onoda show?

A. It's showing a cross section of a CMOS device with flash memory devices in the middle, which is a -- I'm trying to look at the labeling. I guess I1 through I31 or something.

Then on the left-hand side, they show an example of an nMOS transistor. Of course, in a typical you have many of these. On the right-hand side, they show an nMOS transistor and

a pMOS transistor and another nMOS transistor. Once again, these are exemplary.

Q. So where is the surface in Figure 3 of Onoda?

MR. PAUL: Objection to form.

THE WITNESS: With which declaration are you -- with respect to which declaration are you asking that?

BY MR. JAIRAM:

Q. Oh, I'm just referring to Onoda generally, the reference itself.

Can you tell me where in Figure 3 of Onoda is the surface?

MR. PAUL: Objection to form.

THE WITNESS: So I can understand your question, which surface are you referring to? There's many surfaces.

BY MR. JAIRAM:

Q. I'm just asking if there's any surface, as you understand the surface in Figure 3 of Onoda, if there's multiple surfaces, can you tell me where the multiple surfaces are?

MR. PAUL: Objection to form.

THE WITNESS: For example, there's one surface at the bottom of the wafer in Figure 101. So we know that would be one surface as one example.

BY MR. JAIRAM:

Q. Okay. Is the top of the cross section shown in Figure 3 a surface?

MR. PAUL: Objection to form.

THE WITNESS: A surface of the -- it would be a surface, yeah.

BY MR. JAIRAM:

Q. Okay. Where is the surface of semiconductor substrate 100?

MR. PAUL: Objection to form.

THE WITNESS: So in this case, substrate 101, you think of the top surface as the boundary between 101 and 102.

BY MR. JAIRAM:

Q. So you see in Figure 2 of Onoda --

A. Figure 2?

Q. Yeah.

You see in Figure 2 of Onoda, there is a reference numeral 100 at the very bottom left?

A. Yes.

Q. What is 100 which is labeled in -- okay. Let me rephrase.

Do you see Onoda at this -- on page 29 of Onoda, according to the page numbers at the bottom right where it says 29/37 -- can you go to page 29?

A. Yes.

Q. Okay. You see on the right column, there's a section that says, "Explanation of Reference Symbols? About six lines down or seven lines down.

I'll just put it on the screen. I'm not trying to confuse you. Hold on.

A. Yeah, I see that, yes.

Q. Okay. I'm just trying to help you find the things that are described in Onoda.

Do you see how 100 is saying that it's the semiconductor substrate?

A. Yeah, that's what it's labeled.

Q. Right. So I'm asking where is the surface of the semiconductor substrate in Figure 3?

A. So the lower surface would be at the bottom of the figure, and in this case, the upper surface of the substrate would be this line demarcating 101 and 102.

Q. You're saying the upper surface of semiconductor substrate 100 would be the line demarcating 101 and 102?

Is that what you were saying?

A. Yeah, that would be the upper surface of the substrate.

Q. Of the substrate 100?

A. Yes.

Q. Okay. And the surface of substrate 100 would not be something higher than the line demarcating 101 and 102?

A. In this case, no. The substrate would be the line between 101 and 102.

Q. Okay. Can you turn to the Wieczorek reference, please? It's 1006 in the '842 IPR, and

it's also in some of the other IPRs.

A. Yes.

Q. Can you please turn to paragraph 4 of Wieczorek.

A. Okay.

Q. Paragraph 4 says that field effect transistors are formed on an appropriate substrate; correct?

A. Yes.

Q. Is the substrate described in Wieczorek?

A. I don't see any explicit description of what a substrate is.

Q. Can you please turn to your '842 declaration at paragraph 127?

A. Okay.

Q. At paragraph 127, at the bottom of page 73, you discussed using a uniformly doped p- or n-type substrate as a suitable substrate for the CMOS device in Figure 1 of -- I'm sorry, Figure 1b of Wieczorek; correct?

A. I see that.

Q. In the sentence that spans pages 73 and

74 of your '842 declaration, you said that doing so would have been obvious to try because it involves nothing more than choosing one of a finite number of known appropriate substrates that are described by Wolf.

Do you see that?

A. Yes.

Q. Why did you say that there are a finite number of known appropriate substrates described in Wolf?

A. By "finite number," I meant, in terms of doping type, there's only two choices, n- or p-type doping. And then you could have a case where the substrate has only one doping level, or you could have a substrate which is heavily doped and then you could grow a lightly doped epitaxial layer on top. So if you look at the various formulations and combinations, you get a fairly small number of choices.

Q. You're saying that for doping type, there are only two choices possible, right, n or p?

A. Yes.

Q. And there are no other choices possible; correct?

A. For doping type, yes, there's no other choices.

Q. Okay. So you have reviewed the Wolf textbook; right?

A. Yes.

Q. And you are familiar with the Wolf textbook; right?

A. I've been teaching a graduate course at the university for the last 40 years on device application, where my students make transistors, and one of the books that we refer to is Wolf under the secondary references.

Q. Okay. Can you please turn to your '195 declaration at paragraph 71?

A. Yes.

Q. In paragraph 71, you mentioned an Internet search; right?

A. Yes.

Q. Why did you write in that paragraph

about an Internet search for the Wolf textbook?

MR. PAUL: Objection to form.

THE WITNESS: It demonstrates that Wolf is a well-respected reference used by many professors.

BY MR. JAIRAM:

Q. How do you know that the Internet search yields over 800 results, as you wrote in that paragraph of your declaration?

MR. PAUL: Objection to form.

THE WITNESS: I did not do that search myself. My lawyers did.

BY MR. JAIRAM:

Q. And you did not verify if that sentence is accurate?

MR. PAUL: Objection to form.

THE WITNESS: No, I did not. But as I told you, I have used Wolf as a reference for many years when I teach my graduate course, as do my colleagues at other top-tier universities. So independent of this, I feel that Wolf is a good encyclopedic reference.

1 BY MR. JAIRAM:
2 Q. Okay. Is there anything else in this
3 declaration, your '195 declaration, that you did
4 not verify yourself but rather relied upon your
5 lawyers for?
6 MR. PAUL: Objection to form,
7 mischaracterizes.
8 THE WITNESS: Everything in the
9 declaration reflects my opinion. If you can point
10 me to specific places, I can probably give you a
11 more specific answer.
12 BY MR. JAIRAM:
13 Q. Do you think it mischaracterizes your
14 opinion if I ask you -- strike that.
15 Do you think it mischaracterizes your
16 opinion to say that you relied on your lawyers
17 regarding the 800 results instead of verifying
18 that yourself?
19 MR. PAUL: Objection to form.
20 THE WITNESS: In this particular
21 instance, I relied on my lawyers. I did not do an
22 independent search.

1 BY MR. JAIRAM:
2 Q. But the sentence about the 800 results
3 is part of your analysis and your opinions;
4 correct?
5 MR. PAUL: Objection to form.
6 THE WITNESS: I mean, it's part of the
7 report, but, you know, my conclusions about the
8 patents where I use Wolf are not [inaudible].
9 Like I told you, I used this --
10 (Reporter seeks clarification.)
11 THE WITNESS: Do not depend on this
12 specific number of 800 search results.
13 BY MR. JAIRAM:
14 Q. Do you know if the sentence about 800
15 search results is accurate?
16 A. I did not verify independently.
17 Q. So sitting here today, you do not know
18 if that sentence is accurate?
19 MR. PAUL: Objection to form, asked and
20 answered.
21 THE WITNESS: As I said, I did not
22 verify independently. So I --

BY MR. JAIRAM:

Q. I know you are saying you did not verify it. I am asking you a different question, sir.

Do you know sitting here today whether that sentence is accurate or inaccurate?

MR. PAUL: Objection to form, asked and answered.

THE WITNESS: I do not know.

BY MR. JAIRAM:

Q. Is there any other part of your opinions that you do not know is accurate or inaccurate?

MR. PAUL: Objection to form.

THE WITNESS: I can't think of any.

BY MR. JAIRAM:

Q. Would it surprise you to learn of any other portions of your analysis and opinions in these declarations that are portions that you have not yourself verified?

MR. PAUL: Objection to form.

THE WITNESS: If you can point me to a specific location, I can answer that.

1 BY MR. JAIRAM:
2 Q. Well, I'm asking you if it would
3 surprise you. We may turn to some in a minute,
4 but, first, I want to find out if it would be
5 surprising to you. I'll reask the question.
6 Would it surprise you to learn of any
7 other portions of your analysis and opinions in
8 your declarations in these IPRs that you have not
9 yourself verified, but instead relied upon your
10 lawyers for?
11 MR. PAUL: Objection to form, asked and
12 answered.
13 THE WITNESS: It may not surprise me,
14 but if you were to point me to some specific
15 location, I can answer that definitive.
16 BY MR. JAIRAM:
17 Q. Why may it not surprise you to learn
18 that there are portions of your declarations that
19 you have not yourself verified, but instead relied
20 upon your lawyers for?
21 MR. PAUL: Objection to form.
22 THE WITNESS: As I've told you, the

1 opinions in my report are mine. But in drafting
2 the report, I worked collaboratively with counsel.
3 So in some cases I may have relied on them some
4 parts to work.
5 BY MR. JAIRAM:
6 Q. But you said you stand by your
7 declarations; correct?
8 A. Yes.
9 Q. Do you stand by all parts of your
10 declarations?
11 A. Yes.
12 Q. How can you stand by parts of your
13 declarations if you relied on your counsel and did
14 not independently verify them?
15 MR. PAUL: Objection to form.
16 THE WITNESS: I definitely verified what
17 I regard as substantive matters. The thing that
18 you mentioned about 800 citations to Wolf is a
19 peripheral issue. I'm very familiar with Wolf as
20 a reliable textbook, independent of that.
21 BY MR. JAIRAM:
22 Q. Are there any insubstantive matters that

1 you did not verify?
2 MR. PAUL: Objection to form.
3 THE WITNESS: I did not necessarily
4 verify the specific page numbers of the various
5 citations, et cetera, et cetera, for example. I
6 relied on my lawyers for that.
7 BY MR. JAIRAM:
8 Q. Did you include the sentence about 800
9 results to help bolster the point that Wolf is
10 clearly used as a teaching resource in many, many
11 universities and widely cited in scientific works?
12 MR. PAUL: Objection to form.
13 THE WITNESS: In the case of Wolf, my
14 main basis for my opinion that it's a reliable
15 reference is the fact that I've used it for many
16 years in my graduate course at the university
17 where we talk about CMOS device fabrication. So
18 that's my primary basis for the opinion. This
19 800 number is sort of the cherry on top, if you
20 will.
21 BY MR. JAIRAM:
22 Q. But the part that's below the cherry,

your main basis, you didn't put that in your declaration; did you?

MR. PAUL: Objection to form.

THE WITNESS: I did not use the phrase "cherry on top" with respect to the 800 number in the declaration.

BY MR. JAIRAM:

Q. I'm not asking about the phrase. I'm saying, what you just now characterized as your main basis for your opinion, the fact that you used it for many years allegedly in your graduate course at the university, that is not mentioned in your declaration -- or any of your declarations; is it?

MR. PAUL: Objection to form, mischaracterizes testimony.

THE WITNESS: I do not mention that explicitly. That's kind of implicit in the statement I'm familiar with the Wolf textbook. But I could have been specific, I guess.

BY MR. JAIRAM:

Q. But the very next statement in that

1 paragraph, paragraph 71, is a sentence that is
2 apparently unverified by you, and even now you do
3 not know if it is accurate.
4 So how would it be implicit from the
5 preceding sentence that something which is not
6 even present in your declaration holds true?
7 MR. PAUL: Objection to form, asked and
8 answered, argumentative.
9 THE WITNESS: As referring to the
10 sentence, I'm familiar with the Wolf textbook, and
11 the basis of that is the fact that I've used it
12 for many years in my graduate course. That's what
13 I -- I mean, I could have, I suppose, added a
14 sentence that I've used the textbook in my
15 graduate course.
16 BY MR. JAIRAM:
17 Q. But you didn't include that, did you, a
18 sentence about using it in your graduate course?
19 A. No, I did not.
20 Q. Instead, you used the sentence that
21 Dr. Blalock used and that perhaps your attorneys
22 gave you, which you have not verified and you do

not even know right now if it is accurate; correct?

MR. PAUL: Objection to form.

THE WITNESS: I cannot attest to the accuracy of the number 800 search results.

BY MR. JAIRAM:

Q. But you are saying the 800 results is insubstantive; is that right?

MR. PAUL: Objection to form.

THE WITNESS: It will not change my opinions in terms of how relevant Wolf is vis-a-vis various claims. I'm very familiar with Wolf independent of the search results, because I've, as I said, used it in my graduate course. I refer to it as part of my research. So regardless of what the search results numbers are, it will not change my opinions.

BY MR. JAIRAM:

Q. So whether Wolf is used in many, many universities and widely cited in scientific works is not a substantive matter, correct, according to you?

MR. PAUL: Objection to form, mischaracterizes testimony.

THE WITNESS: I did not say that. I was only referring to the search results number. I've seen that textbook, referred to it, papers and all. So that's certainly an important data point.

BY MR. JAIRAM:

Q. Do you see that the last sentence of paragraph 71 begins with the word "thus"?

A. Yes.

Q. So you were relying on what came earlier in that paragraph to conclude what appears in the rest of the sentence after the word "thus."

Would that be a fair reading?

A. Not at all. Not at all. I've seen Wolf be referred to in various publications. Whether that corresponds to an Internet search using the number 800 is the part that I've not verified. But regardless of that, I've certainly seen Wolf cited in many papers that I've read. I've used that in my course, as I've told you several times.

Q. And suppose the judges read through this

1 paragraph of Wolf -- I'm sorry, of your
2 declaration, paragraph 71, how are they to know
3 which portions you have verified and which
4 portions you have not verified and which portions
5 are substantive and which portions are not
6 substantive?
7 MR. PAUL: Objection to form.
8 BY MR. JAIRAM:
9 Q. I'll break that down into smaller
10 questions.
11 When the judges read paragraph 71 of
12 your declaration, how are they to know which
13 portions you have verified and which portions you
14 have not verified and instead relied on your
15 attorneys for?
16 MR. PAUL: Objection to form.
17 BY MR. JAIRAM:
18 Q. And I would remind you, sir, that you
19 are under oath.
20 A. I don't know how they could tell. As
21 far as technical opinions regarding the validity
22 of the claims, I do stand by those opinions. I

1 think that's most important.
2 Q. Okay. Let's go back to paragraph 140 of
3 the same declaration, your '195 declaration.
4 A. Okay.
5 Q. Okay. Do you recall that we have talked
6 about this a little while ago, maybe before the
7 break?
8 A. Yes.
9 Q. And do you recall that you said that the
10 surface of Onoda's semiconductor substrate is the
11 line demarcating 101 and 102?
12 A. Yes.
13 Q. And do you recall that I asked you if
14 the surface of Onoda's semiconductor substrate 100
15 was anything higher than that, higher in the
16 figure?
17 A. I don't recall that.
18 Q. Okay. We can have the court reporter
19 read it back.
20 MR. JAIRAM: Will the court reporter
21 please read back the question and answer that
22 according to the transcript start at 13:20:45.

THE COURT REPORTER:

"QUESTION: Okay. And the surface of substrate 100 would not be something higher than the line demarcating 101 and 102?

"ANSWER: In this case, no. The substrate would be the line between 101 and 102."

BY MR. JAIRAM:

Q. Dr. Banerjee, do you stand by that response?

A. In this context, yes.

Q. Okay. And if you look at paragraph 140 of your declaration, I would give you the page number, but there are no page numbers. On the second page in which that paragraph is discussed.

Do you see that page?

A. Are you referring to paragraph 140 still?

Q. Yes, paragraph 140 appears to span three pages. Do you see that?

A. Yes.

Q. And I'm referring to the second page of paragraph 140.

Do you see that?

A. Yes.

Q. And on that second page of paragraph 140 in your '195 declaration, can you read the full sentence that begins, "As I have indicated below"?

A. As I have indicated below, Onoda's surface layer blue -- (blue) is at the surface of semiconductor substrate 100.

Q. Yeah. So you see that portion of your paragraph; right?

A. Yes.

Q. And I just asked you about the surface of semiconductor substrate 100 earlier in this deposition, and we had the court reporter read your response out loud.

Do you recall that from just, like, one or two minutes ago?

MR. PAUL: Objection to form, mischaracterizes testimony.

THE WITNESS: Do you mind repeating the question, please?

BY MR. JAIRAM:

Q. Okay. In paragraph 140, you are referring to the surface of semiconductor substrate 100; right?

A. Yes.

Q. And you have included some annotations in the figures right below that on that page. This is, again, within paragraph 140; right?

A. Yes.

Q. And you have, in fact, drawn a blue box around something, and you have called it "Surface Layer."

Do you see that?

A. Yes.

Q. And all of that in Onoda is above, is higher than the line demarcating 101 and 102 of Figure 3; is that not correct?

A. It's above the line between 101 and 102, that's correct.

Q. And yet you testified, and we even had the court reporter read back your testimony, that you are saying that the surface of semiconductor

1 substrate 100 is not above the line demarcating
2 101 and 102, and I'm emphasizing the word "not";
3 correct?
4 MR. PAUL: Objection to form --
5 objection to form, mischaracterizes testimony.
6 THE WITNESS: So if you look at
7 paragraph 66 of my report where we talk about
8 Onoda, here we say that, Onoda discloses a
9 lightly-doped P-type semiconductor layer (second
10 semiconductor layer 102) is formed over a
11 heavily-doped P-type substrate (the first
12 semiconductor layer 101).
13 So for the heavily doped substrate,
14 which is what we are starting with, the surface is
15 the line demarcating 101 and 102. And then when
16 you grow this epitaxial layer, you have the new
17 surface, which is on top of 102. I don't see a
18 number indicating that. And that's where you're
19 making these activations, which is shown
20 highlighted in blue at the bottom of
21 paragraph 140.
22 So the regional surface in this

1 particular case of the substrate is buried
2 underneath the epitaxial layer. The epitaxial
3 layer 102 is grown on top of the starting heavily
4 doped semiconductor substrate 101.
5 (Reporter seeks clarification.)
6 THE WITNESS: On top of the heavily
7 doped substrate 101. And the surface of substrate
8 101 in this case is buried.
9 BY MR. JAIRAM:
10 Q. Are you done with your response, sir?
11 A. Yeah.
12 Q. Okay. So you said at paragraph 140 that
13 the surface of semiconductor substrate 100 is
14 something, and you've included in some annotations
15 to that effect. And yet you testified today that
16 the surface is not above -- the surface of
17 semiconductor substrate 100 is not above the line
18 demarcating 101 and 102.
19 How do you reconcile those two
20 statements?
21 MR. PAUL: Objection to form,
22 mischaracterizes testimony.

THE WITNESS: I said that the surface of the starting substrate, the heavily doped substrate 101, is not above the line demarcating 101, 102. But then in this case, you are growing this epitaxial layer above that. And that clearly moves the surface of the epitaxial layer to the top of 102, and that's where you make the active regions in.

BY MR. JAIRAM:

Q. You did not make the annotations of the figures that are found in paragraph 140 of your declaration; did you, sir?

MR. PAUL: Objection to form.

THE WITNESS: I worked collaboratively with my attorneys.

BY MR. JAIRAM:

Q. And you relied on your attorneys to do so without verifying the underlying accuracy; is that right?

MR. PAUL: Objection to form.

THE WITNESS: No, that's not right.

BY MR. JAIRAM:

Q. Can you elaborate, please?

A. I stand by the conclusions in the report. In preparing the report, I did work with my attorneys. So I did not draw these annotations myself, but I stand by them.

Q. To be clear, you stand by the annotations of active region and surface layer that are found in the bottom left and in the bottom right of the second page of paragraph 140 of your '195 declaration; correct?

A. Yes.

Q. Okay.

MR. JAIRAM: We can take a break here. We can go off the record.

(Recess from the record.)

MR. JAIRAM: Okay. I don't have any further questions for you, Dr. Banerjee.

I'll pass Dr. Banerjee over to petitioner.

MR. PAUL: Can we take a break for 20 minutes?

1 MR. JAIRAM: Sure.
2 (Recess from the record.)
3 EXAMINATION BY COUNSEL FOR THE PETITIONER CIRRUS
4 LOGIC, INC.
5 BY MR. PAUL:
6 Q. Good afternoon, Dr. Banerjee.
7 A. Good afternoon.
8 Q. I just have a few questions.
9 Do you recall being asked questions
10 earlier this morning about the Kawagoe prior art
11 reference?
12 A. Yes.
13 Q. Do you recall being asked questions
14 about your mapping of Kawagoe to the claim
15 substrate of the '842 patent?
16 A. Yes.
17 Q. If you can please go to paragraph 69 of
18 your '842 declaration.
19 A. Yes.
20 Q. Can you explain what you stated here?
21 A. Here I talk about the embodiment in
22 Kawagoe where the epitaxial layer 2E is doped at

the same level as the substrate 2S. So that the entire substrate is at a first doping level.

Q. And this is with respect to Ground I of your '842 declaration; correct?

A. Yes.

Q. And you were asked questions about Figure 23 that's shown in Kawagoe.

Do you recall that?

A. Yes.

Q. Okay. And if you go to paragraph 72 of your '842 declaration.

A. Yeah.

Q. You start off by explaining, "a POSITA would have understood that Kawagoe teaches forming the twin-well CMOS device illustrated in Figure 23 (Embodiment 4)" --

(Reporter seeks clarification.)

MR. JAIRAM: And could counsel identify himself? Is that you Raj? I can't tell.

MR. PAUL: Yeah, that's me.

MR. JAIRAM: Thank you.

BY MR. PAUL:

Q. And I'll start off again.

Paragraph 72 states -- you stated here, "a POSITA would have understood that Kawagoe teaches forming the twin-well CMOS device illustrated in Figure 23 (Embodiment 4) on either a uniformly-doped epitaxial substrate described in Embodiment 1 or the optional latchup-resistant substrate described in Embodiment 4."

Did I read that accurately?

A. Yes.

Q. And so for Ground I of your '842 declaration, do you rely on Figure 23 as shown, or do you rely on a modification of Figure 23?

MR. JAIRAM: Objection to form.

THE WITNESS: I rely on a modification of 23 inasmuch as doping levels of the epitaxial layer and the substrate are the same.

BY MR. PAUL:

Q. And did you describe the benefits of that modification as part of your analysis for Element 1?

A. Yes.

Q. And can you please remind us what those benefits include?

A. Among other things, if the doping levels are the same, that reduces manufacturing cost, as discussed, for example, in Wolf.

Q. So your modification entails a benefit of reduced manufacturing cost?

A. Yes.

Q. Okay. I want to next ask about the Onoda reference. Do you recall being asked questions about that reference this morning?

A. Yes.

Q. And do you recall being asked specifically about Onoda's description of a, quote-unquote, semiconductor substrate 100?

A. Yes.

Q. And if I can refer you to the '195 declaration.

A. Okay.

Q. And you were asked -- do you recall being asked about paragraph 140 in your '195

1 declaration?
2 A. Yes.
3 Q. And do you recall being asked
4 specifically on the second page of your analysis,
5 starting -- going into paragraph 140, a statement,
6 "Onoda's surface layer (blue) is at the surface of
7 semiconductor substrate 100"?
8 A. Yes.
9 Q. I read that characterization accurately?
10 A. Yes.
11 Q. And you stand by that mapping?
12 A. So in this case, I interpret the term
13 "substrate" as patent owner used it in the '195
14 patent. And with that understanding of the term
15 "substrate," 101 is the starting substrate, and
16 then you grow the epitaxial layer on top 102 to
17 the surface from the boundary between 101 and
18 102 --
19 (Reporter seeks clarification.)
20 THE WITNESS: Yeah, starting substrate
21 101. And then you grow the epitaxial layer 102 on
22 top of that. And then you make the transistors on

1 top of layer 102.
2 BY MR. PAUL:
3 Q. If I can direct your attention to
4 Element 1.2, which starts right above
5 paragraph 145.
6 A. Okay.
7 Q. And this relates to your mapping of the
8 claim substrate of the '195 patent to the Onoda
9 reference?
10 A. Yes.
11 Q. Okay. And do you see you have an
12 annotation on the next page?
13 A. Yes.
14 Q. Could you briefly explain your mapping
15 of the claim substrate of the '195 patent to
16 Figure 3 of Onoda?
17 A. Sure. I annotated the Figure 5(b) of
18 '195 as Figure 3 or 4 -- yeah, '195 and Figure 3
19 in Onoda with the same -- for the correspondence.
20 So in both cases the substrate is shown in gray,
21 and then you grow the epitaxial layer 102 on top
22 of that, Onoda.

Q. And just to clarify, there is an annotation -- a second annotation going into the third page, right above where it says "Element [1.3]."

Do you see that?

A. Yes.

Q. And is that your annotation, or the annotation of the patent owner?

A. That's the annotation of the patent owner.

Q. And so your annotating of Figure B of Onoda is related to the patent owner's annotation of Figure 5(b)?

A. Yes.

Q. Okay. And how is that related to your annotation?

A. So the patent owner showed the surface layer in 5(b) as this blue shaded rectangle as the active layer. So, similarly, in Onoda, it points out transistor region. And that's shown in paragraph 140. So I'm showing -- the second page of the paragraph, it's expanded use of nMOS and

pMOS. I'm showing the blue highlighted rectangles, the active region. That's a direct correspondence with the annotation of the patent owner.

Q. You mentioned the --

(Reporter seeks clarification.)

THE WITNESS: On the second page of paragraph 140. And that's in direct correspondence with the annotation used by the patent owner.

BY MR. PAUL:

Q. Okay. And you talked about the surface layer and -- can you explain how the patent owner's mapping of substrate corresponds to your mapping of substrate in Figure 3 of Onoda?

A. So if you look at the --

Q. And I might direct your attention to the -- paragraph 146 of your '195 declaration, to patent owner's annotation of the substrate in the 5(b) in the '195 patent.

A. In '195, the patent owner uses the term "substrate" as an underlying layer. Onoda's

1 substrate shows the substrate as this gray region,
2 which underlies this tannish region, which is in
3 the epitaxial layer.
4 Q. And under patent owner's construction,
5 is it your opinion that the gray area you
6 indicated qualifies as the claimed substrate of
7 the '195 patent?
8 A. Yes.
9 Q. Lastly, do you recall being asked
10 questions regarding transistors in active regions?
11 A. Yes.
12 Q. Do you recall being asked questions
13 regarding the number of transistors you can have
14 in an active region?
15 A. Yes.
16 Q. Okay. And if I can direct you to --
17 sticking -- turning to your '842 declaration, I'll
18 go to paragraph 167, which is labeled, Grounds III
19 and IV.
20 A. Okay.
21 Q. And here, you note that several claimed
22 elements of the challenged claims recite,

quote-unquote, transistors or devices, quote-unquote?

A. Yes.

Q. And you go on to state, As I have discussed above under Grounds I and II, I understand that the Patent Owner interprets these claim elements as requiring one or more transistors, and not a plurality of transistors.

Did I read that accurately?

A. Read that, please.

Q. The sentence says, "As I discussed above under Grounds I and II, I understand that the Patent Owner interprets these claim elements as requiring one or more transistors, and not a plurality of transistors."

A. Right.

Q. Okay. And then if I go on to paragraph 168, and you wrote, "The present Grounds III and IV mirror Grounds I and II, respectively, except that I have combined Gupta with the ground references (Kawagoe of Ground I, Wieczorek-Wolf of Ground II) to render obvious those claim elements

1 under an interpretation of 'transistors' or
2 'devices' to require a plurality of such devices."
3 Did I read that accurately?
4 A. Yes.
5 Q. And you recall analyzing the Gupta
6 reference?
7 A. Yes.
8 Q. Okay. And if you go to paragraph 170.
9 A. Okay.
10 Q. There you have included an annotation of
11 Figure 4 of Gupta.
12 A. Yes.
13 Q. Can you briefly explain what you're
14 showing here in Gupta?
15 A. Yeah. So here the active regions are
16 shown in green. And they're showing how to build
17 nMOS transistors, for example, in this active
18 region.
19 Q. So Figure 4 shows that you can have
20 multiple transistors in an active region?
21 A. Yeah. This shows the pMOS transistors
22 are in the green active region. And the nMOS are

in this purple region after that.

MR. PAUL: Okay. I don't have any further questions.

MR. JAIRAM: I don't have any questions either. So this deposition is concluded.

We can go off the record.

(Off the record at 3:52 p.m.)

STATE OF MARYLAND)
ss:
COUNTY OF MONTGOMERY)

I, Matthew Goldstein, Notary Public within and for the State of Maryland, do hereby certify:

That I reported the proceedings in the within entitled matter, and that the within transcript is a true record of said proceedings.

I further certify that I am not related to any of the parties to the action by blood or marriage, and that I am in no way interested in the outcome of this matter.

IN WITNESS WHEREOF, I have hereunto set my hand this 21st day of July, 2024.

Matthew Goldstein, RMR, CRR

Sanjay Banerjee, Ph.D., c/o
COVINGTON & BURLING, LLP
850 Tenth Street, NW, One City Center
Washington, DC 20001

Case: Cirrus Logic, Inc. et al. v. Greenthread, LLC
Date of deposition: July 19, 2024
Deponent: Sanjay Banerjee, Ph.D.

Please be advised that the transcript in the above referenced matter is now complete and ready for signature. The deponent may come to this office to sign the transcript, a copy may be purchased for the witness to review and sign, or the deponent and/or counsel may waive the option of signing. Please advise us of the option selected. Please forward the errata sheet and the original signed signature page to counsel noticing the deposition, noting the applicable time period allowed for such by the governing Rules of Procedure. If you have any questions, please do not hesitate to call our office at (202)-232-0646.

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Witness Name: Sanjay Banerjee, Ph.D.
Deposition Date: July 19, 2024

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ERRATA SHEET

Case: Cirrus Logic, Inc. et al. v. Greenthread, LLC
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