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Transcript of Bruce Smith, Ph.D.

Date: August 2, 2017

Case: Taiwan Semiconductor Manufacturing Co., LTD -v- Godo Kaisha IP Bridge 1
(PTAB)

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IP Bridge Exhibit 2040

TSMC v. IP Bridge

IPR2016-01376

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

- - - - - x

TAIWAN SEMICONDUCTOR : Cases IPR2016-01376,
MANUFACTURING COMPANY, LTD., : IPR2016-01377,
Petitioner, : IPR2016-01378,
v. : IPR2016-01379
GODO KAISHA IP BRIDGE 1, :
Patent Owner. : Patent 6,197,696

- - - - - X

Deposition of BRUCE SMITH, Ph.D.
Washington, DC
Wednesday, August 2, 2017
9:06 a.m.

Job No.: 153651
Pages 1 - 63
Reported by: Debra A. Whitehead

1 Deposition of BRUCE SMITH, Ph.D., held at the
2 offices of:

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12 Pursuant to notice, before Debra A. Whitehead, an
13 Approved Reporter of the United States District Court
14 and Notary Public of the District of Columbia.
15
16
17
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22

A P P E A R A N C E S

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C O N T E N T S

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By Mr. Davis 6

By Mr. Goldberg 57

EXHIBITS MARKED IN PRIOR SESSIONS

(Retained by Counsel)

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Exhibit 1005 U.S. Patent No. 6,140,226 40

Exhibit 1014 Translation of Japanese 12

Patent No. 10-079371

Exhibit 1030 Silicon VLSI Technology, 55

Fundamentals, Practice and

Modeling, by Plummer, et al.

Exhibit 1031 USLI Technology, Edited by 24

Chang and Sze

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Smith, Ph.D., in Support of

Petitioner's Reply

EXHIBITS MARKED IN PRIOR SESSIONS - CONTINUED

TSMC DEPOSITION EXHIBIT

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Exhibit 1050 Declaration of Dr. Bruce W.

7

Smith, Ph.D., in Support of

Petitioner's Reply

P R O C E E D I N G S

BRUCE SMITH, Ph.D.,

having been duly sworn, testified as follows:

EXAMINATION BY COUNSEL FOR PATENT OWNER

BY MR. DAVIS:

Q Good morning, Dr. Smith.

A Good morning.

Q You understand --

THE WITNESS: Close the door. Thanks.

Q You understand that you're under oath?

A I do.

Q And you understand that that means you
must testify truthfully as if you were in front of a
judge or in a courtroom?

A Yes, I do.

Q And is there any reason that would prevent
you from understanding my questions today that you
know of?

A I don't believe so, no.

Q Are you taking any medications that would
hinder your ability to understand questions?

A No, I'm not.

1	Q	How many times have you been deposed?	09:07:12
2	A	Somewhere around 15 to 20, maybe a little	09:07:17
3		bit more, times.	09:07:19
4	Q	Do you understand that you are being	09:07:23
5		deposed today concerning declarations that you	09:07:25
6		signed on July 21, 2017, in IPR 2006-01376 to 01379?	09:07:27
7	A	That's right.	09:07:37
8	Q	I'm going to hand you those four	09:07:37
9		declarations. And I believe those are Exhibit 1049	09:07:47
10		in the 1376 proceeding, and Exhibit 1050 in the	09:08:00
11		1377, 1378, and 1379 proceedings.	09:08:07
12		(TSMC Exhibit 1049 and Exhibit 1050,	09:08:07
13		previously marked, retained by counsel.)	09:08:07
14	Q	Is that correct?	09:08:11
15	A	That's what it says.	09:08:11
16	Q	Can I direct your attention to the -- I	09:08:12
17		think we'll be working mostly with the 1376	09:08:32
18		declaration that's Exhibit 1049.	09:08:35
19	A	Okay.	09:08:38
20	Q	I understand that there's some	09:08:39
21		similarities and a lot of overlap between each of	09:08:41
22		the four declarations. Is that correct?	09:08:45

1	A	That's right.	09:08:46
2	Q	Turning to Page 6 of Exhibit 1049.	09:08:46
3	A	I'm there.	09:08:58
4	Q	Are you discussing the meaning of using	09:08:59
5		the designated layer as a mask term here?	09:09:03
6	A	That's right.	09:09:07
7	Q	And particularly you're discussing what	09:09:07
8		the board's construction or preliminary construction	09:09:12
9		is for that term. Is that right?	09:09:15
10	A	That's right.	09:09:17
11	Q	Now, I want to ask you about your	09:09:17
12		understanding of that construction.	09:09:22
13		Does the board's construction preclude,	09:09:25
14		for example, a layer positioned between an overlying	09:09:29
15		layer and a layer being etched from acting as a mask	09:09:32
16		in an instance where the overlying layer also is	09:09:35
17		removed during the etching and, thus, the between	09:09:38
18		layer acts to shield the layer being etched during	09:09:41
19		etching?	09:09:44
20	A	A layer only becomes a mask if it defines	09:09:51
21		an area or areas for etching.	09:09:56
22		If, as you've described it, a layer is or	09:10:00

1 becomes a layer that is defined for etching, it may 09:10:06
2 become a mask. I would have to look at any 09:10:12
3 particular situation. 09:10:15

4 Q So you would agree with the statement that 09:10:17
5 I read, that it -- that the board's -- well, 09:10:19
6 actually, let me strike that. 09:10:25

7 Does the board's construction allow for 09:10:29
8 that situation, where an underlying layer becomes 09:10:30
9 exposed during the etching process and, therefore, 09:10:35
10 acts to shield the layer being etched during 09:10:39
11 etching? 09:10:43

12 A No, not necessarily. It's not just a 09:10:43
13 shield. It would have to act as a mask to define an 09:10:45
14 area for etching. Beyond that, I would have to look 09:10:49
15 at a particular example to give you my opinion on 09:10:51
16 that. 09:10:54

17 Q I'm handing you what is Paper Number 11 in 09:11:00
18 the 1376 proceeding, the institution decision. 09:11:29

19 Have you seen this document before? 09:11:44

20 A I have looked at this document, yes. 09:11:57

21 Q Can you turn to Page 18. 09:11:58

22 A I'm there. 09:12:05

1	Q	Do you see that Footnote 7 there on the	09:12:06
2		bottom of Page 18?	09:12:09
3	A	I see that.	09:12:12
4	Q	And you would agree with me that Footnote	09:12:21
5		7 reads, "Our construction does not preclude, for	09:12:27
6		example, a layer positioned between an overlying	09:12:30
7		layer and a layer being etched from acting as a mask	09:12:32
8		within the meaning of Claim 13, in an instance where	09:12:35
9		the overlaying layer also is removed during the	09:12:39
10		etching and, thus, the between layer acts to shield	09:12:41
11		the layer being etched during etching"?	09:12:44
12	A	I see that.	09:12:46
13	Q	And does that comport with your	09:12:46
14		understanding of the board's construction?	09:12:49
15	A	Yes. And as you've read, it says, our	09:12:51
16		construction does not preclude this.	09:12:53
17		So in a situation where this instance	09:12:56
18		might happen, I have to take a look at that instance	09:12:59
19		and decide or determine whether or not that an	09:13:01
20		underlying layer that was referred to would actually	09:13:06
21		act as a mask, and define area that would be etched	09:13:08
22		underneath it.	09:13:12

1 Q So the understanding of using a designated 09:13:13
2 layer as a mask that you applied does not depend 09:13:27
3 solely on whether the layer acts as a shield for the 09:13:34
4 layer being etched during etching? 09:13:43

5 A Well, as this statement says, it doesn't 09:13:46
6 preclude situations like that. Again, I would have 09:13:49
7 to look at the situation. 09:13:51

8 But merely being a shield doesn't 09:13:53
9 necessarily make it a mask. It would have to define 09:13:54
10 an area of etching itself, that underlying layer 09:13:59
11 would have to become a mask by defining an area that 09:14:02
12 would be etched. 09:14:04

13 Q So the understanding of the term "mask" 09:14:05
14 that you applied doesn't depend solely on whether or 09:14:11
15 not it is acting as a shield for the underlying 09:14:14
16 layer being etched? 09:14:16

17 A If that shield defines those areas and the 09:14:18
18 underlying -- underlying layer that -- the 09:14:22
19 underlying -- the layer underlying it is being 09:14:26
20 etched by the masking of that layer, it would fit 09:14:29
21 into this definition. 09:14:32

22 But simply shielding it from -- shielding 09:14:35

1	it during etching -- during etching doesn't	09:14:39
2	necessarily make it a mask, unless it defines an	09:14:43
3	area that is etched under it.	09:14:45
4	Q Can you give me an example of a situation	09:14:47
5	where a layer would act as a shield for the	09:15:00
6	underlying layer being etched but would not define	09:15:05
7	an area that is etched?	09:15:08
8	A Sure. If that layer that is being etched	09:15:10
9	is actually not etched, no etching is occurring, no	09:15:14
10	removal of that layer is occurring.	09:15:18
11	Q Any other examples?	09:15:20
12	A I think broadly that's -- that would fit	09:15:22
13	into that.	09:15:25
14	Q I'm handing you now what's been marked as	09:15:26
15	Exhibit 1014 I believe in the 1376 proceedings.	09:15:55
16	(TSMC Exhibit 1014, previously marked,	09:15:55
17	retained by counsel.)	09:15:55
18	A Can I put the last exhibit aside?	09:15:59
19	Q You can, yes.	09:16:01
20	Now, this is the translation of the	09:16:06
21	Japanese '371 application that you relied on in your	09:16:08
22	declarations?	09:16:10

1	A	I can't be sure if it's the same	09:16:17
2		translation, but it looks like it's a translation of	09:16:19
3		the '371.	09:16:26
4	Q	Why can't you be sure?	09:16:27
5	A	I don't recognize the front page,	09:16:28
6		Certification of Translation. But I'm not saying	09:16:30
7		it's not the same one; I'm not sure.	09:16:42
8	Q	So turning past the front page, do you	09:16:44
9		recognize the remainder?	09:16:46
10	A	Yes, I do.	09:16:57
11	Q	So this is the translation of the Japanese	09:16:57
12		'371 translation that you relied on in your	09:17:00
13		declarations?	09:17:03
14	A	Again, I don't -- I know it is a	09:17:03
15		translation by Richard Patner. I don't recall if	09:17:05
16		the translation I used was the same one. But it	09:17:08
17		just -- it may be.	09:17:12
18	Q	You're not sure?	09:17:14
19	A	Again, I can't -- I can't recall seeing	09:17:16
20		this front page. I'm not saying it's not, though.	09:17:18
21	Q	Can you turn to Paragraph 93. And that is	09:17:22
22		on Page 15.	09:17:35

1	Are you there?	09:17:45
2	A I'm there.	09:17:45
3	Q And you see that Paragraph 93 is	09:17:46
4	describing Figure 16A?	09:17:50
5	A That's what it says, yes.	09:18:03
6	Q The last sentence of Paragraph 93 reads,	09:18:05
7	"In this case the second resist pattern 359 is	09:18:08
8	removed during the step of etching the organic film	09:18:13
9	354."	09:18:17
10	Do you see that?	09:18:17
11	A Let me just read through this paragraph	09:18:18
12	quickly.	09:18:21
13	I see that last sentence, yes.	09:19:05
14	Q And do you agree that the Japanese '371	09:19:06
15	application discloses that the second resist pattern	09:19:12
16	359 is removed during the step of etching the	09:19:18
17	organic film 354?	09:19:20
18	A It describes the removal of that resist	09:19:23
19	pattern 359 during the etching of -- which, I'm	09:19:26
20	sorry, that second resist pattern 359, which is an	09:19:30
21	organic photoresist pattern. It states that that	09:19:34
22	photoresist pattern 359 is being removed as the	09:19:43

1 organic film 354 is being etched. And that's 09:19:49
2 because they are etchable in the same etch chemistry 09:19:52
3 that would be used for that organic film 354. 09:19:57

4 Q So it's your testimony that the second 09:20:02
5 resist pattern 359 is removed during etching of the 09:20:04
6 organic film 354? 09:20:08

7 A Well, it doesn't say it's fully removed. 09:20:11
8 It's a statement that says that 359 is removed 09:20:13
9 during that step. That layer 359 would need to 09:20:16
10 remain at least partially, some of that material, 09:20:26
11 until all of 354 is etched through, becomes 354A. 09:20:28

12 And then as the Figure 16B shows, to 09:20:35
13 remove resist pattern 359A, one would continue the 09:20:41
14 etch process through the organic film 354. Which 09:20:45
15 would then completely remove 359. 09:20:49

16 Q So your interpretation of this sentence is 09:20:54
17 that the second resist pattern is at least partially 09:20:57
18 removed during this step of etching the organic film 09:21:01
19 354? 09:21:05

20 A That's right. It's a -- it's an artifact 09:21:06
21 or a consequence of etching an organic film like 354 09:21:09
22 with an organic photoresist like 359. 09:21:14

1	Q	I'm going to hand you Exhibit 1001, which	09:21:18
2		is the '696 patent.	09:21:28
3		(TSMC Exhibit 1001, previously marked,	09:21:28
4		retained by counsel.)	09:21:28
5	Q	Do you recognize this exhibit?	09:21:43
6	A	I do.	09:21:44
7	Q	Is this the patent at issue in these	09:21:44
8		proceedings, U.S. Patent Number 6,197,696?	09:21:47
9	A	It is, yes.	09:21:51
10	Q	If I refer to this as the '696 patent,	09:21:51
11		will you understand what I'm referring to?	09:21:54
12	A	Sure, I will.	09:21:56
13	Q	Can you turn to Figure 16B and C in the	09:21:56
14		'696 patent.	09:22:05
15	A	I'm there.	09:22:07
16	Q	Moving from Figure 16B to Figure 16C, is	09:22:07
17		film 355A being used as a mask in etching film 353?	09:22:16
18	A	You asked me is 355A being used as a film	09:22:27
19		to etch 353?	09:22:30
20	Q	I'll repeat the question.	09:22:34
21	A	Thank you.	09:22:35
22	Q	As the figures transition from 16B to 16C,	09:22:35

1	is film 355A being used as a mask in etching film	09:22:42
2	353?	09:22:49
3	A So the patent says, in Column 19, when it	09:24:07
4	describes what's going on between Figure 16B and	09:24:20
5	16C, Column 19, starting at Line 41, Next as shown	09:24:27
6	in Figure 16C, the first silicon dioxide film 353 is	09:24:31
7	dry etched using the patterned silicon dioxide film	09:24:40
8	355A and the pattern organic 354A as a mask.	09:24:45
9	355A -- I think this is the answer to your	09:24:51
10	question -- is used to -- used as the mask to dry	09:24:53
11	etch the silicon dioxide film 353.	09:25:07
12	Q So is your testimony that film 355A is	09:25:10
13	being used as a mask in etching film 353?	09:25:17
14	A The paragraph before says that the second	09:25:28
15	resist pattern is removed during the step of etching	09:25:34
16	the organic film 354. And it says that the second	09:25:38
17	silicon dioxide film 353 is dry etched using a	09:25:41
18	silicon dioxide film 355A. So those two statements	09:25:47
19	in combination tell me that 359, the photoresist	09:25:52
20	layer is gone, and that 355A is the mask for 353.	09:25:55
21	Q I'm just asking a simple question. Is it	09:26:02
22	your testimony that film 355A is being used as a	09:26:09

1	mask in etching film 353?	09:26:13
2	A That's right.	09:26:16
3	Q Is film 354A being used as a mask in	09:26:17
4	etching film 353?	09:26:23
5	A It says that in the specification, but	09:26:27
6	354A is not -- would not be part of the mask that	09:26:29
7	would be etching 353.	09:26:34
8	Q So it is your testimony that film 354A is	09:26:55
9	not being used as a mask in etching film 353? Well,	09:26:58
10	strike that. Let me ask a different question.	09:27:15
11	Turning to Figure 23B.	09:27:17
12	A Okay.	09:27:27
13	Q Do you see Figure 23B?	09:27:27
14	A I do.	09:27:33
15	Q And 23C? 23.	09:27:33
16	A I'm sorry. Which figures, again?	09:27:41
17	Q Figure 23B and 23C.	09:27:43
18	A I see that.	09:27:49
19	Q Is film 505A being used as a mask in	09:27:49
20	etching film 503?	09:27:59
21	A Can you repeat that, please.	09:28:02
22	Q Sure. Is film 505A being used as a mask	09:28:03

1 in etching film 503?

09:28:09

2 A It says in Column 24, describing the
3 patterning of the second organic film 505A and the
4 first organic film 503, using the mask pattern 509,
5 and the pattern first silicon dioxide 504A, as
6 respective masks. The organic -- first organic film
7 503 is therefore etched using the patterned first
8 silicon dioxide film 504A as a mask.

09:32:40

09:32:43

09:32:52

09:33:05

09:33:09

09:33:13

09:33:18

9 I think that answers your question.

09:33:33

10 Q I'm not sure it does, but you're reading
11 from Column 24, Lines 7 to 10?

09:33:34

09:33:36

12 A Yes, I'm sorry. That's where I'm reading
13 from.

09:33:40

09:33:42

14 Q My question was a bit different. Is film
15 505A being used as a mask in etching film 503?

09:33:42

09:33:47

16 A 505A is removed during the etch process
17 using 509 as the mask. The same process that etches
18 503.

09:34:14

09:34:17

09:34:24

19 504A becomes the defining mask for the
20 openings 512, these are the contact hole openings in
21 layer 503. And those are masked by 504A.

09:34:27

09:34:38

09:34:48

22 Q So is it your testimony that 505A is not

09:35:03

1	ever used as a mask in etching film 503?	09:35:08
2	A 505A is consumed during the process. It's	09:35:12
3	designed to be consumed during the process of	09:35:16
4	etching 503.	09:35:19
5	It defines the opening in 503 until 504A	09:35:26
6	is reached. 504A becomes the etch stop to remove	09:35:35
7	the contact holes 512.	09:35:43
8	So -- go ahead.	09:35:47
9	Q I don't mean to interrupt. Are you	09:35:49
10	finished?	09:35:51
11	A I'm finished, yeah. I'm ready for your	09:35:52
12	next question.	09:35:54
13	Q You said that film 505A defines the	09:35:54
14	opening in 503 during the etch process.	09:35:58
15	Is that right?	09:36:04
16	A Right. The etch process is directed	09:36:05
17	through the opening in 505A, which will act to mask	09:36:07
18	503 until 504A is reached. 504A is designed as an	09:36:18
19	etch stop in -- in 512. So 505A does act as -- as	09:36:24
20	the mask for 503.	09:36:36
21	Q Turning to Figure 32A and 32B. I have a	09:36:38
22	somewhat similar question.	09:36:53

1	Is film 605A being used as a mask in	09:36:54
2	etching film 603?	09:36:59
3	A 32B you are asking me?	09:37:13
4	Q 32A and B, yes.	09:37:15
5	A All right. Is -- can you repeat that,	09:37:17
6	please.	09:37:20
7	Q Sure. Is film 605A being used as a mask	09:37:20
8	in etching film 603?	09:37:26
9	A So the onset of etching 605A is removed	09:38:33
10	with the same etch process that etches 603.	09:38:42
11	The patent describes in Column 29, around	09:38:47
12	Line 6, the pattern second organic film 605A and the	09:38:52
13	first organic film 603 are dry etched using the mask	09:38:59
14	pattern 608, and the pattern silicon dioxide film	09:39:05
15	604A as respective masks.	09:39:10
16	So the patent describes 604A as a mask for	09:39:14
17	the etching of hole 611 into film 603.	09:39:18
18	Q Going back to my question. Is film 605A	09:39:30
19	being used as a mask in etching film 603?	09:39:35
20	A Prior to reaching 604A, the opening in	09:39:40
21	605 -- in 605A will act to mask etching until that	09:39:48
22	film is removed, until that film is completely	09:39:57

1	removed.	09:40:04
2	Q I'm done with the '696 patent for now.	09:40:04
3	After a dry etch, is the profile of the	09:40:47
4	side walls perfectly vertical?	09:40:51
5	A It depends on the dry etch.	09:40:54
6	Q Is it your testimony that there are	09:40:56
7	certain dry etches that give perfectly vertical side	09:41:08
8	wall profiles?	09:41:12
9	A Within the capability of measurement or	09:41:15
10	within the requirements of manufacturing, yes.	09:41:18
11	I -- the word "perfectly" would have to be	09:41:27
12	defined in that context.	09:41:31
13	Q A 90-degree angle relative to the base.	09:41:33
14	A Within the margin allowed through	09:41:40
15	measurement or manufacturing tolerances, yes.	09:41:43
16	Q What does that mean?	09:41:46
17	A It means there can be some allowance in	09:41:48
18	variation from that 90 degrees if, for one thing, it	09:41:52
19	can't be measured to be other than 90 degrees; or	09:41:55
20	the manufacturing influence on a side wall angle	09:42:01
21	less than 90 degrees has no impact on the process.	09:42:06
22	Q Do all dry etches generate a profile of	09:42:09

1 the side walls that is perfectly vertical? 09:42:17

2 A No. That's -- it's in the requirements of 09:42:19
3 engineering a dry etch, is that the side walls 09:42:23
4 should be vertical. If anisotropy, 09:42:25
5 A-N-I-S-O-T-R-O-P-Y, is required. 09:42:35

6 Q Would you agree that in -- or is it your 09:42:44
7 testimony that even in anisotropic etches, there can 09:42:48
8 be some finite angle less than 90 degrees from the 09:43:00
9 base of the feature towards the top? 09:43:03

10 MR. GOLDBERG: Objection. Form. 09:43:10

11 A The desired attribute of a multi-layer 09:43:11
12 process like dual-damascene and the requirements for 09:43:14
13 such a process to operate is the side wall angle 09:43:19
14 needs to be vertical. If it's less than 90 degrees, 09:43:24
15 it would need to be determined through analysis and 09:43:28
16 engineering of that process that its impact would 09:43:36
17 influence its use to yield good results. 09:43:39

18 Q Is it your testimony that in some 09:43:47
19 anisotropic etches there can be some finite angle 09:44:04
20 less than 90 degrees from the base of the feature 09:44:09
21 towards the top? 09:44:11

22 A A process wouldn't be designed that way, 09:44:14

1 and it wouldn't be desired. Whether it would be 09:44:16
2 allowed to some small extent, one would have to know 09:44:21
3 what all the process requirements are. 09:44:26

4 Without putting a number to it, some small 09:44:29
5 deviation from 90 degrees may be tolerable. To 09:44:32
6 understand how tolerable it would be, one would have 09:44:41
7 to look at the specific process. 09:44:43

8 Q I'm handing you what's been marked as 09:45:00
9 Exhibit 1031 in the 1376 proceedings. I believe it 09:45:36
10 is similar or the same exhibit that was used in the 09:45:43
11 other three proceedings. 09:45:46

12 (TSMC Exhibit 1031, previously marked, 09:45:46
13 retained by counsel.) 09:45:46

14 Q Do you recognize Exhibit 1031? 09:45:48

15 A I do, yes. 09:45:50

16 Q Is this the Chang and Sze, S-Z-E, 09:45:51
17 reference? 09:45:59

18 A It is, yes. 09:45:59

19 Q And that's what you referred to in your 09:46:00
20 declaration in each of these proceedings? 09:46:02

21 A That's right. 09:46:04

22 Q Did you review this document? 09:46:04

1	A	I did.	09:46:06
2	Q	Can you turn to Page 52.	09:46:07
3	A	The stamped Page 52?	09:46:14
4	Q	Stamped Page 52.	09:46:15
5		Is Section 7.3 discussing plasma etching?	09:46:30
6	A	7.3 is called Etch Mechanisms,	09:46:34
7		Selectivity, and Profile Control, yes.	09:46:39
8	Q	So Section 7.3 is discussing plasma	09:46:41
9		etching?	09:46:47
10	A	It's discussing certain attributes of	09:46:48
11		plasma etching, yes.	09:46:51
12	Q	And plasma etching is a form of dry	09:46:53
13		etching?	09:46:56
14	A	That's right.	09:46:57
15	Q	Turning to stamped Page 60.	09:46:58
16	A	I see that.	09:47:12
17	Q	Is it your understanding that this is a --	09:47:12
18		that Figure 10 is a cross-sectional image of a dry	09:47:19
19		etch?	09:47:25
20	A	It is, as it says, etching on a silicon	09:47:32
21		trench edge. So it's as described above the figure.	09:47:41
22		It says a typical trench is shown in Figure 10. And	09:47:46

1	it's done with dry etching.	09:47:49
2	Q And is it your testimony that the side	09:47:56
3	wall profiles as shown in Figure 10 are vertical?	09:48:03
4	A No, they are not vertical.	09:48:08
5	Q They have some finite angle less than 90	09:48:13
6	degrees from the base relative to the top?	09:48:18
7	A Yes. If I can expand on my answer.	09:48:23
8	They're not vertical in the sense they are not	09:48:25
9	completely vertical. There is some angle which is	09:48:26
10	less than 90 degrees.	09:48:28
11	Q And the base is narrower than the top is?	09:48:30
12	A That's what the picture shows, yes.	09:48:33
13	Q Turning to Page 62.	09:48:35
14	Section 7.5 is also about plasma etching?	09:48:48
15	A That's right.	09:48:52
16	Q And that's, again, a form of dry etching?	09:48:52
17	A That's right.	09:48:57
18	Q Turning to Page 65.	09:48:57
19	A I see that.	09:49:03
20	Q Looking at Figure 22B at the bottom.	09:49:03
21	A I see that.	09:49:16
22	Q Is that, again, another etch -- or another	09:49:18

1 trench profile formed by dry etching? 09:49:23

2 A It is. It's a -- similar to the figure we 09:49:28
3 looked at, Figure 10, it is a trench etch. We see 09:49:33
4 micro marker bars in Figure 22A and B, which show 09:49:37
5 for Figure 22 an etch through, it looks like 09:49:46
6 approximately 5 microns of film. It looks like 09:49:50
7 Figure 22B may also be many microns. 09:49:59

8 And as we look at Figure 22A and 22B, you 09:50:05
9 can see there is the ability to control side wall 09:50:08
10 profile during the dry etch process depending on the 09:50:12
11 choice of things like pressure, gas, temperature, 09:50:16
12 and power. 09:50:20

13 Q I am finished with the Chang and Sze 09:50:22
14 reference for the moment. 09:50:47

15 What is undercutting? 09:50:48

16 A Undercutting is the -- in a very general 09:50:54
17 sense, referred to -- it refers to the removal of a 09:50:57
18 layer laterally under an overlying film. 09:51:02

19 Q What causes undercutting? 09:51:10

20 A Well, it can be a lot of things. In a 09:51:14
21 purely isotropic etch, like a wet etch, if the layer 09:51:17
22 being etched is etched downward, at the same or 09:51:37

1 similar rates that it is etched laterally, as 09:51:44
2 isotropic etching implies, if there is an overlying 09:51:49
3 masking layer on top of that film, there will be 09:51:53
4 removal under that overlying layer that undercuts 09:51:56
5 the layer above it. 09:52:01

6 Q What causes undercutting in an anisotropic 09:52:03
7 etch? 09:52:10

8 A Well, in a purely anisotropic etch, if 09:52:11
9 it's purely directional, one direction, as the name 09:52:15
10 implies, there would be no undercutting. 09:52:19

11 If there is some degree of isotropy in an 09:52:21
12 anisotropic etch, that degree of isotropy would 09:52:27
13 allow for undercutting. 09:52:31

14 Q What is lateral flow of etchant? 09:52:32

15 A It -- well, do you have a reference to 09:52:42
16 point me to that put that into context? 09:52:46

17 Q You just said that something can be etched 09:52:49
18 laterally. I'm referring to your earlier testimony. 09:53:09

19 What is lateral flow of etchant? 09:53:15

20 A I don't believe I used that term, "lateral 09:53:17
21 flow of etchant." If that term has been used 09:53:19
22 somewhere, I would like to look at it in context, I 09:53:22

1	can tell what you it means.	09:53:25
2	Q Have you ever used that phrase, "lateral	09:53:25
3	flow of etchant"?	09:53:27
4	A I may have.	09:53:29
5	Q Okay. What would it have meant to you?	09:53:29
6	A Again, it depends on the context. If	09:53:33
7	you -- if you're aware that I've used that, I would	09:53:35
8	be glad to explain what I meant.	09:53:38
9	Q In what way would it depend on the	09:53:40
10	context?	09:53:43
11	A It depends -- it would depend on what	09:53:46
12	etchant is being referred to.	09:53:49
13	Q In an anisotropic etch, what is lateral	09:53:50
14	flow of etchant?	09:53:55
15	A Again, I would have to look at the	09:53:56
16	chemistry involved to explain to you what that term	09:53:57
17	would mean.	09:54:02
18	Q So standing alone, you cannot answer my	09:54:02
19	question about lateral flow of etchant in the	09:54:14
20	context of an anisotropic etch?	09:54:17
21	A I could in -- in the context of the	09:54:20
22	specific -- specific etch we are talking about, or	09:54:23

1	the reference where the term is used. I think I	09:54:26
2	probably could. If you -- if you could point me to	09:54:28
3	where -- where you're referring to that term.	09:54:31
4	Q I'm just asking about the concept.	09:54:35
5	A Yeah, me too.	09:54:38
6	Q So you can't answer my question	09:54:39
7	generically or generally about that concept?	09:54:41
8	A It would depend on what the etchant is and	09:54:44
9	what might make it flow. In context, I can give you	09:54:47
10	an answer.	09:54:51
11	Q Is it your testimony that there is no	09:54:56
12	undercutting in reactive ion etching?	09:54:58
13	A No, I've never said that.	09:55:02
14	Q So there is undercutting in reactive ion	09:55:03
15	etching?	09:55:10
16	A Reactive ion etching is a very general	09:55:10
17	term. It refers to the enhancement of a plasma	09:55:13
18	etching process using reactive ions. Not all	09:55:21
19	reactive ion etch, or RIE, processes are the same.	09:55:26
20	The things that influence that process	09:55:30
21	would determine the degree of anisotropy, or	09:55:33
22	similarly the degree of isotropy in that RIE	09:55:40

1 process.

09:55:44

2 Q Is it your testimony that there can be
3 isotropy in an RIE process?

09:55:44

09:55:57

4 A It would depend on how well that RIE
5 process is designed to etch a given material. And
6 one could find situations where some degree of
7 isotropy might be desired in an RIE process.

09:56:05

09:56:08

09:56:16

09:56:20

8 Without looking at a specific process it's
9 tough to make any more conclusions than that.

09:56:24

09:56:26

10 Q Just so I understand your testimony. It
11 is your testimony that in reactive ion etching there
12 can be isotropy?

09:56:29

09:56:33

09:56:39

13 A My testimony is that the degree of
14 anisotropy or isotropy in an RIE process depends on
15 how that process is engineered, designed. It could
16 be designed to be completely anisotropic or not. It
17 depends on the process conditions, things like flow,
18 pressure, temperature, power, and gas mixture.

09:56:43

09:56:46

09:56:52

09:56:55

09:57:00

09:57:04

19 An engineer would engineer a process to
20 achieve the desired results.

09:57:13

09:57:14

21 Q Is it your testimony then that there can
22 be isotropy in reactive ion etching?

09:57:29

09:57:33

1 A Again, I've got to say the same thing. It 09:57:39
2 depends on how that process is designed. If it's 09:57:41
3 designed for no isotropy and it operates that way, 09:57:45
4 there would be no isotropy, it would be an 09:57:50
5 anisotropic edge. 09:57:53

6 There can be RIE processes that are 09:57:55
7 designed not to be anisotropic. 09:57:57

8 Q So it's your testimony that some RIE 09:58:01
9 processes are isotropic, or have isotropic 09:58:06
10 components to them? 09:58:11

11 A If it's so desired, yes, you could design 09:58:12
12 an RIE process to have some degree of isotropy. Or 09:58:15
13 whether or not it's desirable, an inadequate process 09:58:21
14 could be used that also might have some degree of 09:58:25
15 isotropy. 09:58:28

16 Q Can there be lateral flow of etchant in 09:58:29
17 reactive ion etching? 09:58:34

18 A The balance between the chemical and 09:58:42
19 physical etching of an RIE process could allow for 09:58:47
20 a -- could allow for chemical species to result in 09:59:01
21 an anisotropy. In that case that would be a lateral 09:59:06
22 effect, a lateral removal, which could be from the 09:59:10

1 flow of -- or the motion of chemical species. 09:59:16

2 Q So in some reactive ion etching, there can 09:59:21
3 be lateral flow of etchant, and which would cause a 09:59:28
4 lateral removal, as you said? 09:59:33

5 A It depends on what you're referring to, 09:59:41
6 etchant. There are multiple things going on through 09:59:44
7 the etching. 09:59:47

8 Again, I would have to -- as I said 09:59:48
9 before, I would have to look at a particular 09:59:50
10 situation to answer more specifically than that, to 09:59:52
11 understand what the etchant is we would be talking 09:59:55
12 about and what would be causing its flow. 10:00:02

13 Q You used the phrase "lateral removal." 10:00:05
14 What did you mean by that? 10:00:14

15 A Anisotropic etch conventionally is -- 10:00:20
16 conventionally is considered to be one direction 10:00:23
17 from the top layer above a substrate down towards 10:00:28
18 the substrate. 10:00:31

19 Lateral removal would be parallel to the 10:00:34
20 substrate in one or more directions. Or, actually, 10:00:36
21 if it's isotropic, in all directions. 10:00:41

22 Q So in the context of reactive ion etching, 10:00:43

1	there can be lateral removal?	10:00:53
2	A Again, "reactive ion etching" is a very	10:00:58
3	broad term that describes a multitude of processes.	10:01:01
4	A process could exist which would allow for some	10:01:04
5	lateral etching.	10:01:08
6	Q In reactive ion etching are both neutral	10:01:09
7	and ionic species present?	10:01:22
8	A Yes.	10:01:23
9	Q And ionic species are -- excuse me, highly	10:01:23
10	directional. Is that right?	10:01:31
11	A If they're designed appropriately, yes.	10:01:34
12	Q They are not perfectly directional, are	10:01:36
13	they?	10:01:41
14	MR. GOLDBERG: Objection. Form.	10:01:51
15	A I think I've got some paragraphs in my	10:01:59
16	report that describes the directionality in an RIE	10:02:01
17	process.	10:02:08
18	What perfectly would mean would depend on	10:02:09
19	the application, whether or not the lack of	10:02:11
20	directionality would have any influence in an actual	10:02:15
21	process or would even be measurable.	10:02:18
22	Q I think you're referring to Paragraph 13	10:02:27

1	on Page 9 of the 1049 declaration?	10:02:34
2	A That's right, Paragraphs 13 and 14.	10:02:38
3	Q In Paragraph 13, the second sentence, it	10:02:40
4	says, the ionic -- I'm sorry, the third sentence.	10:02:57
5	It says, "The ionic species are highly directional,	10:03:01
6	i.e., anisotropic."	10:03:05
7	What do you mean by "highly"?	10:03:08
8	A That they would lead to anisotropy as I've	10:03:10
9	described before. They travel from the one	10:03:16
10	electrode -- the direction of one electrode to	10:03:22
11	another electrode which is at the base of substrate.	10:03:24
12	Q Do they travel in a perfectly vertical	10:03:27
13	direction?	10:03:29
14	A They travel in a vertical direction,	10:03:33
15	again, depending on the design of the process.	10:03:38
16	One RIE process is not like the other.	10:03:42
17	I'll say it again. The things like power, pressure,	10:03:45
18	temperature, gas flow, those things will -- will	10:03:48
19	influence how directional the ionic species will	10:03:54
20	become.	10:03:58
21	But they can be highly directional.	10:04:00
22	Meaning, essentially, all traveling from an upper	10:04:05

1 electrode to a lower electrode, the lower electrode 10:04:09
2 is where the substrate is placed. 10:04:13

3 Q You said that they can be highly 10:04:15
4 directional but they are not necessarily highly 10:04:24
5 directional in all RIE processes. Is that correct? 10:04:27

6 A Well, this is what I have said before. 10:04:30
7 Not all RIE processes are the same. 10:04:32

8 If you change, for instance, how 10:04:36
9 electrodes are powered, you will change -- you will 10:04:40
10 change the impact -- it will impact the 10:04:47
11 directionality of the ionic species, how they are 10:04:52
12 accelerated from one electrode to the other. 10:04:55

13 Q So in some RIE processes, the ionic 10:04:57
14 species are not highly directional? 10:05:20

15 A You could design an RIE process at such a 10:05:24
16 low power level that the reactive ion assistance, or 10:05:30
17 the enhancement by the ions, is minimal. In that 10:05:35
18 case the etch would begin to approach a chemical 10:05:41
19 etch, which is less anisotropic, less directional. 10:05:45

20 Again, it depends on how the process is 10:05:50
21 set up. 10:05:52

22 Q We discussed before how there are both 10:05:53

1	neutral and ionic species present in reactive ion	10:06:04
2	etching. Is that correct?	10:06:09
3	A That's right.	10:06:10
4	Q Those neutral species, are those also	10:06:11
5	reactive?	10:06:15
6	A They -- the neutral species are reactive	10:06:25
7	in a sense that they provide physical removal of	10:06:27
8	material. So they are -- I'm sorry, what was your	10:06:33
9	question, again?	10:06:36
10	Q The neutral species in reactive ion	10:06:38
11	etching, are they reactive?	10:06:41
12	A They are not reactive in the sense of	10:06:54
13	being chemically reactive. They are only reactive	10:06:56
14	in the sense that they are physically reactive.	10:06:59
15	They can cause removal of material based on their	10:07:02
16	acceleration, based on their bombardment of the	10:07:04
17	surface.	10:07:09
18	Q And those neutral species will cause	10:07:10
19	lateral removal. Is that correct?	10:07:12
20	A They will -- well, it's not that simple.	10:07:15
21	It's not one thing does one -- one species does one	10:07:18
22	thing and another does another. It's the	10:07:22

1	combination of the chemically reactive and	10:07:24
2	chemically neutral species, it's the combination of	10:07:26
3	the chemical etch and the physical etch, that result	10:07:31
4	in things like the anisotropy of an RIE process.	10:07:35
5	Q So is it your testimony that both the	10:07:38
6	neutral and ionic components contribute to lateral	10:07:44
7	removal?	10:07:49
8	A Yes, they work together. They work, as I	10:07:59
9	said in my report, synergistically.	10:08:03
10	Q Can we turn back to -- or I guess you're	10:08:06
11	already looking at Exhibit 1049. Can you turn to	10:08:41
12	Page 37.	10:08:46
13	A I see that.	10:08:53
14	Q And just for clarity, this is originally	10:08:54
15	marked Page 37. I guess it's also Bates marked Page	10:08:58
16	39.	10:09:02
17	A Okay.	10:09:02
18	Q Do you see the first full paragraph at the	10:09:03
19	top of the page?	10:09:05
20	A I see that.	10:09:06
21	Q That paragraph reads, "A person of	10:09:07
22	ordinary skill in the art thus would have understood	10:09:12

1	that the photoresist layer 60 is removed after hard	10:09:14
2	mask layer 58 is etched."	10:09:19
3	Do you see that?	10:09:21
4	A I see that.	10:09:22
5	Q Do you agree with that statement?	10:09:23
6	A I'm going to read the whole paragraph	10:09:29
7	quickly.	10:09:31
8	That statement that photoresist layer 60	10:10:14
9	is removed after hard mask layer 58 is etched, did	10:10:16
10	you ask if I agree with that statement?	10:10:24
11	Q Yes.	10:10:25
12	A I do agree with that statement.	10:10:26
13	Q Is it your testimony that photoresist	10:10:27
14	layer 60 is necessarily removed after hard mask	10:10:29
15	layer 58 is etched?	10:10:34
16	A Well, the word "removed" in this context	10:10:37
17	does not mean it's being removed during anything.	10:10:41
18	It says it is removed after the etch.	10:10:44
19	So there is a process that is used to	10:10:49
20	strip that photoresist off. The term "strip" is	10:10:54
21	what we usually refer to for the removal of a	10:10:57
22	photoresist layer after it's done its masking.	10:11:01

1 Q Is it your testimony that photoresist
2 layer is necessarily removed after the hard mask
3 layer 58 is etched?

10:11:04

10:11:08

10:11:11

4 A Yes, I -- I stand by that. Yes.

10:11:17

5 MR. GOLDBERG: Counsel, we've been going
6 for over an hour now. Is this a -- I'm not sure
7 where you're at, if this is a good time for a break.

10:11:41

10:11:42

10:11:45

8 MR. DAVIS: We can break now, that's fine.

10:11:47

9 MR. GOLDBERG: Say ten minutes?

10:11:51

10 MR. DAVIS: That's fine.

10:11:53

11 (A recess was taken.)

10:11:53

12 BY MR. DAVIS:

10:18:57

13 Q I'm handing you what's been marked as
14 Exhibit 1005 in the 1376 proceedings. I believe the
15 same reference was submitted in all four
16 proceedings.

10:19:02

10:19:03

10:19:10

10:19:12

17 Are you familiar with this document?

10:19:14

18 (TSMC Exhibit 1005, previously marked,
19 retained by counsel.)

10:19:15

10:19:15

20 A Yes, I am.

10:19:16

21 Q This is the Grill reference?

10:19:16

22 A That's right.

10:19:18

1	Q	That's the same Grill reference that you	10:19:18
2		referred to in all four proceedings?	10:19:20
3	A	That's right.	10:19:22
4	Q	Can you turn to Column 13. That's Claim	10:19:23
5		28. And particularly at Lines 47 to 50, do you see	10:19:38
6		where it says, "Transferring said via pattern in	10:19:48
7		said pattern first hard mask layer into said second	10:19:52
8		dielectric layer while concurrently removing said	10:19:56
9		via patterned second layer of resist."	10:20:00
10		Do you see that language?	10:20:04
11	A	I see that language, yes.	10:20:44
12	Q	And then directing you to the language in	10:20:45
13		Column 13 at Lines 53 to 57, where it says,	10:20:49
14		"Transferring at least partially concurrently said	10:20:58
15		via pattern into said first dielectric layer to form	10:21:01
16		via cavities corresponding to said via pattern and	10:21:05
17		said wiring pattern into said second dielectric	10:21:10
18		layer to form wiring cavities corresponding to said	10:21:14
19		wiring pattern"?	10:21:17
20	A	I see that.	10:21:20
21	Q	In your opinion, what is the difference	10:21:20
22		between the terms "transferring concurrently" as	10:21:26

1 shown in Column 13, Lines 47 to 50, and,

10:21:31

2 "transferring at least partially concurrently," as

10:21:35

3 shown in Column 13, Lines 53 to 57?

10:21:38

4 A In the second instance, line around 52

10:24:18

5 through 58, "partially concurrently" refers to the

10:24:26

6 transferring step. Meaning that a pattern is made

10:24:37

7 in the first dielectric layer at the same time a

10:24:45

8 pattern is made in the second dielectric layer. But

10:24:50

9 based on their material composition and thicknesses,

10:24:55

10 one may take longer to pattern through than the

10:24:59

11 other. So that's the partially concurrently.

10:25:02

12 If there is one film remaining while the

10:25:08

13 other is etched, there would no longer be the

10:25:11

14 concurrent etch of the film, it's removed.

10:25:13

15 In the language of the first instance,

10:25:16

16 Line 47-ish to Line 50, it talks about transferring

10:25:21

17 just a single pattern. It's the pattern into the

10:25:28

18 first hard mask -- I'm sorry, the pattern of the

10:25:32

19 first hard mask layer into the second dielectric

10:25:35

20 layer. And this language says that at the same time

10:25:38

21 the photoresist would be removed.

10:25:42

22 Q Thank you.

10:25:48

1	A	It would occur at the same time, depending	10:25:50
2		on the thickness of the photoresist. It may indeed	10:25:54
3		take longer to remove all the photoresist once	10:26:00
4		the -- once the second dielectric layer is removed.	10:26:05
5	Q	So it's your testimony that "concurrently	10:26:09
6		removing" in Lines 47 to 50 means at the same time?	10:26:13
7	A	Well, it's not a time thing. I'm sorry.	10:26:27
8		It's a process situation based on the chemistry	10:26:29
9		involved. The same chemistry used to etch the	10:26:33
10		second dielectric film is used to remove the second	10:26:38
11		resist layer.	10:26:42
12		So the concurrent removal and the	10:26:44
13		partially concurrent removal in both instances mean	10:26:45
14		that this is done through the same etch process, the	10:26:50
15		same etch chemistry. That's occurring -- they are	10:26:53
16		occurring together.	10:26:57
17		In that sense it would be at the same	10:27:03
18		time. Whether they take the same amount of time I	10:27:08
19		don't think is influenced by either -- either	10:27:10
20		reference.	10:27:12
21	Q	So what is the difference between at least	10:27:12
22		partially concurrently and concurrently in those two	10:27:15

1	passages in Column 13?	10:27:20
2	A I think partially concurrently, in the	10:27:23
3	second instance, is useful because it applies to the	10:27:24
4	etching of two films. It says, the etching happens	10:27:29
5	in the same process, at least together for some	10:27:36
6	amount of time, partially concurrently.	10:27:41
7	Since the first instance is the removal of	10:27:43
8	the photoresist, I think partial -- partial	10:27:45
9	concurrently wouldn't be necessary in that case.	10:27:54
10	Q You said you think partially concurrently	10:27:59
11	wouldn't be necessary in that case?	10:28:04
12	A No, because it's not etching of two films	10:28:07
13	in that first instance.	10:28:10
14	Q What is the difference between	10:28:12
15	concurrently and partially concurrently?	10:28:14
16	A In the case of partially concurrently,	10:28:38
17	since the etching is being done in two layers, the	10:28:44
18	first dielectric and the second dielectric,	10:28:46
19	simply -- that simply said, concurrently, it	10:28:49
20	wouldn't cover the situation where one layer is	10:28:55
21	removed before another layer is completely removed.	10:28:57
22	Q Okay.	10:29:04

1 A If in the first instance there is a
2 situation where not -- for instance, not all the
3 photoresist is gone during the concurrent removal,
4 one would know that an overetch would strip the
5 photoresist. So I don't think "partially
6 concurrently" is appropriate in the first instance.

7 Q So I understand your testimony, you're
8 saying that in Column 13, Lines 47 to 50, it would
9 be inappropriate to refer to removal as being
10 partially concurrent?

11 A No. I think the language is correct.
12 This is a transferring process, which is an etch
13 process. There are two things being etched in those
14 transfer processes. They are occurring
15 concurrently. But since they may not take the same
16 time to complete, they would only be partially
17 concurrent. Or they may only be partially
18 concurrent, or at least partially concurrent. I
19 think that language is appropriate.

20 In the first case, Lines -- I'm sorry, I'm
21 referring to -- I think I mixed up lines we're
22 talking about. That was referring to Line 53

1	through 57. I believe that's not the question you	10:30:47
2	asked me, though. Can we start over?	10:30:49
3	Q Yeah, we can start over.	10:30:55
4	So I understand your testimony, you're	10:30:57
5	saying that Column 13, Lines 47 to 50, it would be	10:30:59
6	inappropriate to refer to the removal as being	10:31:02
7	partially concurrent?	10:31:04
8	A No, I didn't say that. I think the	10:31:07
9	language refers to a single etch and the removing of	10:31:09
10	the photoresist.	10:31:20
11	I think concurrent is appropriate, since	10:31:20
12	it's talking about an etch step and a resist removal	10:31:23
13	step.	10:31:27
14	One would know the resist would have to be	10:31:28
15	there, would have to remain through the entire	10:31:30
16	pattern transfer step. So as that pattern is	10:31:34
17	transferred, the photoresist is concurrently	10:31:38
18	removed. If there is photoresist remaining, there	10:31:44
19	wouldn't -- there needs to be -- the photoresist	10:31:47
20	can't be gone before the film is etched. If there	10:31:52
21	is any photoresist remaining, one would know that	10:31:55
22	that would be -- that would be stripped in an	10:31:57

1 overetch. 10:32:01

2 Q So your understanding of Column 13, Lines 10:32:02
3 47 to 50, would allow for the situation where the 10:32:07
4 second layer of resist is not removed at the same 10:32:19
5 time that the transfer of the via pattern occurs? 10:32:24

6 A No, I wouldn't say that. 10:32:28

7 In order to move from that transferring 10:32:30
8 step to the step that follows, an etch process would 10:32:33
9 continue beyond the transferring of the via pattern 10:32:42
10 in the pattern first hard mask layer into the second 10:32:48
11 dielectric layer. That etching would continue until 10:32:55
12 all the photoresist was removed. 10:32:59

13 Q So it's your testimony that Column 13, 10:33:01
14 Lines 47 to 50, would cover the situation where the 10:33:39
15 second layer resist is removed, or at least 10:33:51
16 partially removed, after the via pattern is 10:33:58
17 transferred? 10:34:02

18 A For this process to work the way it's 10:34:10
19 described, the photoresist cannot be removed before 10:34:12
20 the dielectric layer is patterned. 10:34:21

21 Indeed, during that concurrent removal of 10:34:24
22 the photoresist during that etch process, when the 10:34:27

1 second dielectric layer is completely etched, there 10:34:35
2 would likely be photoresist remaining. That 10:34:40
3 photoresist would be removed through the 10:34:44
4 continuation of that step until all the photoresist 10:34:48
5 is gone, and overetch would occur. 10:34:50

6 Q So is it your testimony that there is -- 10:35:00
7 strike that. 10:35:24

8 Is it your testimony that in the situation 10:35:24
9 described in Claim 28, some of the second layer of 10:35:32
10 resist will be removed after the via pattern is 10:35:44
11 transferred? 10:35:50

12 A If there is photoresist removing -- 10:35:55
13 photoresist remaining, it would be removed in the 10:35:57
14 same pattern transfer step, in the same etch 10:36:01
15 chemistry, that is used to etch the second 10:36:07
16 dielectric layer, by continuing on with that etch 10:36:09
17 process until all the photoresist is removed. 10:36:15

18 Q And that's after the via pattern is 10:36:18
19 transferred? 10:36:20

20 A Well, it's during the same operation. 10:36:22
21 It's after the second dielectric layer is removed in 10:36:25
22 that via pattern -- via pattern opening, but it's 10:36:29

1 still part of the same process. It's part of that 10:36:33
2 transferring process. 10:36:36

3 Q So that's after the via pattern is 10:36:36
4 transferred, though. Is that right? 10:36:53

5 A It's after -- no. It's still part of the 10:36:56
6 transfer step. It's after the second dielectric 10:36:59
7 layer is completely etched, its transfer step is 10:37:02
8 complete through the continuation of that etch 10:37:08
9 process until the second layer photoresist is gone. 10:37:12

10 Q To transfer the via pattern, the second 10:37:18
11 dielectric layer -- a portion of the second 10:37:33
12 dielectric layer is removed. Is that right? 10:37:36

13 A That area, which is not protected, which 10:37:42
14 is not covered by the pattern first hard mask, those 10:37:46
15 regions -- those regions are removed, they're 10:37:52
16 etched. 10:38:02

17 Q And it's your testimony that some of the 10:38:02
18 second layer of resist would then be removed after 10:38:12
19 those portions of the second dielectric layer were 10:38:18
20 removed? 10:38:22

21 A It's my testimony that the process would 10:38:31
22 continue until all the photoresist is gone. 10:38:33

1 Q So it's your testimony that the process
2 would continue even after those portions of the
3 second dielectric layer were removed?

4 A Well, the process isn't done yet, until
5 the photoresist is removed.

6 Q Can you turn to your declaration, Exhibit
7 1049, Paragraph 57, Page 46. And that's marked Page
8 48.

9 A I see that.

10 Q You're talking about features of two
11 different areas in this paragraph. Is that right?

12 A In the first sentence I'm referring to a
13 statement out of Grill in Column 7, where all
14 features of smaller area (a via pattern)
15 substantially overlap with the features of the
16 larger area (a wiring pattern).

17 Q Now, what are the features of those areas
18 that you're trying to depict about Paragraph 57 in
19 those two images?

20 A I think I say this in the last sentence.
21 I say the dual relief pattern collectively refers to
22 the openings in the blue layer, that's a wiring

1 pattern, and a green layer, a via pattern. In both 10:40:36
2 those figures they represent those two -- those two 10:40:42
3 areas. 10:40:45

4 Q So the features that are being referred to 10:40:48
5 are openings. Is that your testimony? 10:40:51

6 A It is the openings -- well, these are -- 10:40:58
7 this is a dual relief pattern, which, yes, these are 10:41:05
8 the openings in these two layers. The single 10:41:10
9 pattern is the two openings. 10:41:16

10 Q So those features are the -- the features 10:41:19
11 that you're referring to are the openings? 10:41:23

12 A In this case, referring to that figure, 10:41:42
13 the features I'm referring to in that last sentence 10:41:46
14 is the dual relief pattern, which collectively 10:41:54
15 refers to those openings, yes. 10:41:58

16 Q In that second sentence of the paragraph, 10:41:59
17 you say, substantially, even completely. 10:42:10

18 Do you see that? 10:42:15

19 A I see that. 10:42:20

20 Q So your understanding of the term 10:42:21
21 "substantially" there would encompass also the term 10:42:27
22 "completely"? 10:42:34

1	A	Sure, yeah. That's right.	10:42:39
2	Q	Can you turn to Grill. That's Exhibit	10:42:40
3		1005 that we looked at earlier.	10:42:57
4	A	Right.	10:42:59
5	Q	Figure 5A to 5H.	10:42:59
6		Do you see those figures?	10:43:18
7	A	I see that, yeah.	10:43:19
8	Q	And those are figures that you relied on	10:43:20
9		in the course of your analysis of the Grill	10:43:25
10		reference. Is that right?	10:43:26
11	A	That's right.	10:43:31
12	Q	And these are -- Figures 5A to 5H are	10:43:31
13		two-dimensional cross-sections. Is that right?	10:43:38
14	A	Yes, just two dimensions.	10:43:41
15	Q	Going into the page or coming out of the	10:43:43
16		page, would other two-dimensional cross-sections	10:43:49
17		necessarily look the same as what's shown in Figures	10:43:53
18		5A to 5H?	10:43:56
19	A	It depends on where the slice is. If a	10:43:58
20		slice was in the center of a contact, they would	10:44:04
21		still look like 5H. If you took a slice in a region	10:44:09
22		where the contact didn't exist, you wouldn't see	10:44:15

1	those contact openings like we see in 5H.	10:44:20
2	Q So other cross-sections going into the	10:44:24
3	page might look different than what's shown in these	10:44:28
4	figures, depending on where that cross-section was	10:44:32
5	taken?	10:44:35
6	A Sure.	10:44:36
7	Q Can you turn to Column 8, Lines 24 to 31.	10:44:36
8	A Okay.	10:45:00
9	Q This portion of Grill is describing Figure	10:45:00
10	6A. Is that correct?	10:45:08
11	A That's what it -- the paragraph starts off	10:45:27
12	saying Figure 6A shows, so, yes, I believe that's	10:45:31
13	true.	10:45:34
14	Q Is it your testimony that this passage,	10:45:34
15	Column 8, 24 to 31, describes Figure 5?	10:45:46
16	A No. It says Figure 6A.	10:45:55
17	Q Can you turn back to Exhibit 1049,	10:45:58
18	Paragraph 36. That's your declaration.	10:46:02
19	A Okay. Stamped or page?	10:46:14
20	Q Page. Stamped Page 30.	10:46:18
21	A Okay. Which -- okay.	10:46:31
22	Q Do you see the term "overetch" that you	10:46:34

1	use here in the middle of this partial paragraph?	10:46:40
2	It's about seven lines down?	10:46:44
3	A Right.	10:46:52
4	Q Do you remember seeing the term "overetch"	10:46:52
5	in the '696 patent?	10:46:55
6	A I can't recall.	10:46:57
7	Q Do you recall seeing the term "overetch"	10:47:01
8	in the Japanese '371 application.	10:47:03
9	A The term itself, "overetch"?	10:47:05
10	Q Yes.	10:47:07
11	A I can't recall.	10:47:07
12	Q You're relying on the Chang and the Sze	10:47:08
13	reference here in this paragraph. Is that correct?	10:47:15
14	A Among other things, including Plummer and	10:47:23
15	what I have talked about. In that particular	10:47:25
16	sentence you pointed me to, things that were known	10:47:28
17	by those of ordinary skill. So there are other	10:47:30
18	things I'm referring to in this paragraph.	10:47:33
19	Q And in particular the citation that you	10:47:35
20	have for the Chang and Sze reference is to Page 341.	10:47:38
21	Is that correct?	10:47:43
22	A That's also included, yes.	10:47:43

1	Q	And you relied on that sentence there that	10:47:44
2		you've quoted, "In the case of a via etch, a large	10:47:48
3		amount of overetch time is required."	10:47:51
4		Is that correct?	10:47:52
5	A	I have not relied on that for the sentence	10:47:56
6		that follows. I have said this technique of	10:47:58
7		overetch was commonly known, and that a reference of	10:48:01
8		Chang and Sze shows an instance where the term is	10:48:05
9		used, and is actually required.	10:48:09
10	Q	So you're using Chang and Sze to -- let me	10:48:13
11		rephrase that.	10:48:24
12		You are relying on the sentence from Chang	10:48:25
13		and Sze?	10:48:29
14	A	No. I'm using it to support what I've	10:48:31
15		said before, that this was something that was	10:48:33
16		commonly known, and one of ordinary skill would have	10:48:35
17		carried this out.	10:48:38
18	Q	You also refer to the Plummer reference.	10:48:39
19	A	That's right.	10:48:53
20	Q	I'm handing you what's been marked as	10:48:54
21		Exhibit 1030 in the 1376 proceeding.	10:49:21
22		(TSMC Exhibit 1030, previously marked,	10:49:25

1	retained by counsel.)	10:49:25
2	Q Is that the Plummer reference that you	10:49:25
3	relied on?	10:49:27
4	A It looks like it, yes.	10:49:29
5	Q Can you turn to Page 614 of that	10:49:31
6	reference.	10:49:50
7	A I've got it.	10:49:56
8	Q And Page 614 is the page that you cited	10:49:57
9	from the Plummer reference in this sentence?	10:49:58
10	A That's right.	10:50:01
11	Q The Page 614 is not referring to etching	10:50:01
12	of a photoresist, is it?	10:50:13
13	A It says in the first full paragraph, As	10:50:24
14	mentioned earlier, some overetching is normally part	10:50:27
15	of every etch process. So it's common throughout,	10:50:30
16	whether it's overetching to remove photoresist or	10:50:37
17	overetching to remove residual material.	10:50:40
18	Q The example given at the bottom of Page	10:50:44
19	614 is referring to etching, or removal of an oxide	10:50:47
20	material. Is that correct?	10:50:53
21	A The whole page talks about overetching	10:51:54
22	many times. An additional excerpt says, So some	10:51:57

1 overetch is always done in manufacturing to ensure 10:52:01
2 the etch goes to completion everywhere. That could 10:52:03
3 also apply to overetch for removal of a masking film 10:52:10
4 like photoresist. 10:52:16

5 Q That wasn't my question. 10:52:17

6 My question was, the example given at the 10:52:18
7 bottom of Page 614 is referring to the removal of an 10:52:20
8 oxide material. Is that correct? 10:52:24

9 A Yes, that particular example is on the 10:52:26
10 bottom of this page. 10:52:30

11 Q And that's not a photoresist. 10:52:32

12 Is that correct? 10:52:34

13 A Well, that particular example isn't 10:52:37
14 photoresist, you're right. 10:52:39

15 MR. DAVIS: No further questions at this 10:52:40
16 time. 10:52:42

17 MR. GOLDBERG: Okay. Let's take a break. 10:52:44

18 MR. DAVIS: We can go off the record. 10:52:54

19 (A recess was taken.) 10:52:57

20 EXAMINATION BY COUNSEL FOR PETITIONER 11:25:23

21 BY MR. GOLDBERG: 11:25:23

22 Q Can we look at Exhibit 1001. This is the 11:25:31

1	'696 patent, Column 19, Lines 4 to 5.	11:25:36
2	A I see that.	11:25:52
3	Q And what does that section of the '696	11:25:52
4	patent indicate the component 53 is made out of?	11:25:55
5	A It is referring to Figure 15A on the	11:26:19
6	bottom of Column 18. And it says in those Lines 4	11:26:26
7	and 5, "The first silicon dioxide film 353 (first	11:26:30
8	insulating film) is formed to be 1 micron thick."	11:26:39
9	So it is a 1 micron silicon dioxide film.	11:26:47
10	Q And if you look a couple lines below there	11:26:54
11	in Column 19, Lines 8 to 10, what is the component	11:27:02
12	355 made out of?	11:27:10
13	A So at Line 8 it says, "A second silicon	11:27:17
14	dioxide film 355 (first insulating film) is also	11:27:23
15	silicon dioxide."	11:27:31
16	Q And how thick is the film 355?	11:27:34
17	A It says it's 50 nanometers thick, for	11:27:40
18	example.	11:27:42
19	Q So both films 353 and 355 are made out of	11:27:42
20	silicon dioxide?	11:27:49
21	MR. DAVIS: Objection. Form.	11:27:50
22	A Both those films are silicon dioxide	11:27:53

1	films, 353 and 355.	11:27:56
2	Q Is the silicon dioxide film 353 thicker	11:28:02
3	than the silicon dioxide film 355?	11:28:05
4	MR. DAVIS: Objection. Form.	11:28:08
5	A Yes, it is. In this example it's 1 micron	11:28:10
6	thick versus 50 nanometers thick.	11:28:14
7	Q Does the process illustrated in Figure 16B	11:28:16
8	and 16C etch both layers 353 and 355 together?	11:28:25
9	MR. DAVIS: Objection. Form.	11:28:34
10	A I'm sorry, could you repeat that?	11:29:01
11	Q Does the process illustrated in Figure 16B	11:29:04
12	and 16C etch both layers 353 and 355 together?	11:29:08
13	A Yes, it would.	11:29:13
14	MR. DAVIS: Same objection.	11:29:14
15	A Yes, it would.	11:29:16
16	Q And is the layer 355 completely removed	11:29:16
17	before layer 353 is completely etched?	11:29:21
18	MR. DAVIS: Objection. Form.	11:29:25
19	A It would be, yes.	11:29:27
20	Q Does layer 354 become a mask during this	11:29:28
21	process, after layer 355 is completely removed?	11:29:34
22	MR. DAVIS: Objection. Form.	11:29:38

1 A 354, once 355A is removed -- and 354 being 11:29:42
2 the organic film, or an organic film -- would then 11:29:52
3 be masking 353. 11:29:56

4 MR. GOLDBERG: No further questions. 11:30:21

5 MR. DAVIS: No further questions. 11:30:27

6 Thank you, Dr. Smith. 11:30:31

7 THE WITNESS: Thank you. 11:30:35

8 (Off the record at 11:30 a.m.)
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ACKNOWLEDGMENT OF DEPONENT

I, BRUCE SMITH, Ph.D., do hereby acknowledge that I
have read and examined the foregoing testimony, and
the same is a true, correct and complete transcription
of the testimony given by me and any corrections
appear on the attached Errata sheet signed by me.

(DATE)

(SIGNATURE)

C E R T I F I C A T E

I, Debra Ann Whitehead, Certified Reporter and
Notary Public within and for the District of Columbia,
do hereby certify:

That BRUCE SMITH, Ph.D., the witness whose
deposition is hereinbefore set forth, was duly sworn
by me before the commencement of such deposition and
that such deposition was taken before me and is a true
record of the testimony given by such witness.

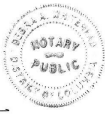
I further certify that the adverse party,
TAIWAN SEMICONDUCTOR MANUFACTURING COMPANY, LTD., was
represented by counsel at the deposition.

I further certify that the deposition of
BRUCE SMITH, Ph.D., occurred at the offices of
FINNEGAN, HENDERSON, FARABOW, GARRETT & DUNNER, LLP,
901 New York Avenue, NW, Washington, DC 20001-4413, on
Wednesday, August 2, 2017, from 9:06 a.m. to 11:30
a.m.

1 I further certify that I am not related to
2 any of the parties to this action by blood or
3 marriage, I am not employed by or an attorney to any
4 of the parties to this action, and that I am in no way
5 interested, financially or otherwise, in the outcome
6 of this matter.

7
8 IN WITNESS WHEREOF, I have hereunto set my
9 hand this 4th day of August, 2017.

10
11 My commission expires:
12 September 14, 2018

13
14  *Debra A. Whitfield*

15 -----
16 NOTARY PUBLIC IN AND FOR THE
17 DISTRICT OF COLUMBIA

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Transcript of Bruce Smith, Ph.D.
Conducted on August 2, 2017

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