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Transcript of Sanjay Banerjee, Ph.D.

Date: December 18, 2024

Case: Micron Technology, Inc. -v- Yangtze Memory Technologies Company, LTD.,
(PTAB)

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Conducted on December 18, 2024

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3	BEFORE THE PATENT TRIAL AND APPEAL BOARD	3	QUESTIONS INSTRUCTED NOT TO ANSWER:
4	-----	4	PAGE LINE
5	MICRON TECHNOLOGY, INC.,	5	(None)
6	Petitioner,	6	
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8	YANGTZE MEMORY TECHNOLOGIES COMPANY, LTD.,	8	REQUEST FOR PRODUCTION OF DOCUMENTS
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15	DEPOSITION OF	15	(None)
16	SANJAY KUMAR BANERJEE, Ph.D.	16	
17	WEDNESDAY, DECEMBER 18, 2024	17	
18	Remote Video Teleconference	18	QUESTIONS MARKED
19	8:00 a.m. PST	19	PAGE LINE
20	to	20	(None)
21	9:31 a.m. PST	21	
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23	Stenographically Reported by:	23	REPORTER'S NOTE:
24	Burgundy B. Ryan, RPR,	24	QUOTATION MARKS ARE USED FOR CLARITY AND DO NOT
25	CSR No. 11373	25	NECESSARILY REFLECT A DIRECT QUOTE.
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3	ON BEHALF OF THE PETITIONER:	3	EXAMINATION BY MR. BONNY..... 6
4	ORRICK, HERRINGTON & SUTCLIFFE LLP	4	
5	By: JASON LANG, Esquire	5	--o0o--
6	1000 Marsh Road	6	
7	Menlo Park, California 94025	7	E X H I B I T S
8	650.614.7400	8	EXHIBIT DESCRIPTION PAGE
9	jlang@orrick.com	9	(No exhibits were marked.)
10	ON BEHALF OF THE PATENT OWNER:	10	--o0o--
11	ROPES & GRAY LLP	11	
12	By: CHRISTOPHER M. BONNY, Esquire	12	
13	1900 University Avenue	13	
14	6th Floor	14	
15	East Palo Alto, California 94303	15	
16	650.617.4000	16	
17	christopher.bonny@ropesgray.com	17	
18	ALSO PRESENT:	18	
19	KELLI WELCH, Videographer	19	
20	Planet Depos	20	
21		21	
22		22	
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5 1 BE IT REMEMBERED that, pursuant to Notice 2 of Taking Deposition, and on Wednesday, December 18, 3 2024, commencing at 8:00 a.m. PST thereof, via 4 remote video teleconference, before me, Burgundy B. 5 Ryan, a Certified Shorthand Reporter in and for the 6 State of California, personally appeared 7 SANJAY KUMAR BANERJEE, Ph.D., 8 a witness called on behalf of PATENT OWNER, and who, 9 having been first duly sworn by me to testify to the 10 truth, was examined and testified as follows: 11 THE VIDEOGRAPHER: Here begins Media No. 1 12 in the videotaped deposition of Dr. Sanjay Banerjee 13 in the matter of Micron Technology Inc. v. Yangtze 14 Memory Technologies Company LTD, PTAB, in the United 15 States Patent and Trademark Office, before the 16 Patent Trial and Appeal Board, case number 17 IPR2024-00789. 18 Today's date is December 18th, 2024. 19 The time on the video monitor is 8:00 a.m. 20 Pacific time. 21 The remote videographer today is 22 Kelli Welch representing Planet Depos. 23 All parties of this video deposition are 24 attending remotely. 25 Would Counsel please voice-identify	7 1 the record? 2 A. Sanjay Kumar Banerjee. 3 Q. What is your address? 4 A. 1742 Canonero Drive -- my home address; 5 right? 6 Q. Correct. 7 A. Canonero Drive, C-a-n-o-n-e-r-o, Austin, 8 Texas 78746. 9 Q. What is your occupation? 10 A. I'm a professor of electrical and computer 11 engineering at the University of Texas at Austin 12 where I hold the Cockrell Regents Chair, and I'm 13 also director of the Microelectronics Research 14 Center out here. 15 Q. Do you have any other occupations? 16 A. No. 17 Q. Do you have anything -- strike that. 18 Do you have any materials or documents in 19 front of you? 20 A. I have a clean unmarked copy of my 21 declaration and unmarked three pages of the patent 22 '872, that's a cover page and the two last pages 23 listing the claims. 24 Q. And just to be clear, the declaration that 25 you're referring to is your declaration in
6 1 themselves and state whom they represent? 2 MR. BONNY: Christopher Bonny from Ropes & 3 Gray on behalf of Yangtze Memory Technologies 4 Company Limited, Patent Owner. 5 MR. LANG: Jason Lang on -- from Orrick on 6 behalf of Petitioner Micron. 7 THE VIDEOGRAPHER: The court reporter today 8 is Brooke Ryan representing Planet Depos. 9 The witness will now be sworn. 10 COURT REPORTER: Good morning. My name is 11 Burgundy Brooke Ryan, California CSR No. 11373. 12 (Whereupon, the witness was sworn.) 13 COURT REPORTER: Thank you very much. 14 Would you please state and spell your name 15 for -- for the record? 16 THE WITNESS: Sanjay, S-a-n-j-a-y, Kumar, 17 K-u-m-a-r, Banerjee, B-a-n-e-r-j-e-e. 18 COURT REPORTER: Thank you very much. 19 Counsel, you may proceed. 20 SANJAY KUMAR BANERJEE, Ph.D., 21 having been first duly sworn to tell the whole 22 truth, testified as follows: 23 EXAMINATION 24 By MR. BONNY: 25 Q. Would you please state your name again for	8 1 IPR2024-789? 2 A. Yes. 3 Q. Do you have any other materials in front of 4 you? 5 A. No. 6 Q. Do you have any electronic devices other 7 than the computer that you are using for this 8 deposition? 9 A. No. 10 Q. Do you understand that you are under oath 11 today? 12 A. Yes. 13 Q. So I'll just give you a brief refresher. 14 I'll be asking questions during the deposition and 15 you'll be answering them. I'll just ask to please 16 wait for me to finish and I will do the same and 17 wait for you to finish answering before I speak. 18 Does that make sense? 19 A. Yes. 20 Q. Is there any reason why you cannot testify 21 truthfully and fully today? 22 A. No. 23 Q. And if I ask a question that you don't 24 understand, you'll ask for clarification; correct? 25 A. Yes.

9 1 Q. Otherwise, if you do not -- do not ask for 2 clarification, I'll assume that you understand the 3 question. 4 Does that make sense? 5 A. Yes. 6 Q. Have you ever been deposed before, 7 Dr. Banerjee? 8 A. Yes. 9 Q. Approximately how many times? 10 A. A couple of dozen times. It's listed in my 11 CV, I think. 12 Q. If I shared your CV with you, would you be 13 able to provide a more accurate number? 14 A. Probably. 15 Q. I've placed in the chat box an exhibit that 16 is marked as Exhibit 1004, the curriculum vitae of 17 Dr. Banerjee. Would you please load up that 18 document on your screen, Dr. Banerjee? 19 MR. LANG: I don't see it here in the -- 20 THE WITNESS: I don't see it either. 21 MR. BONNY: What about now? 22 MR. LANG: Yeah, I see it now. Yeah. 23 By MR. BONNY: 24 Q. All right. So the document that I have 25 shared in the chat is Exhibit 1004, the curriculum	11 1 for patent litigation matters? 2 A. Yes. 3 Q. Do you do any other consulting other than 4 for patent litigation matters? 5 A. In the past, I have done a few but I've not 6 done any such consulting lately. 7 Q. Approximately how many times have you been 8 retained in a patent litigation matter? 9 A. Clearly more than 26 because those are 10 the -- so typically I listed only the cases where I 11 have done substantial work as in at least in writing 12 a report or being deposed. You know this better 13 than I do. I mean, many cases you get retained but 14 then you read the patents and then the case goes 15 away, so I have not listed those. I'm guessing if 16 you counted everything, probably 50 cases maybe. 17 But I'm guessing. 18 Q. What is your consulting rate currently? 19 A. On this case I'm charging 650 an hour. 20 Q. Is that your standard rate or is that rate 21 specific to this matter? 22 A. So sometimes I get recruited by search 23 firms and I know they -- they are going to put a fee 24 on top of my fee so in those cases I drop my fee a 25 little bit. And in some cases that I'm taking on
10 1 vitae of Dr. Banerjee. Please load that up and let 2 me know when you have that in front of you. 3 A. Yes, I have it. 4 MR. BONNY: Mr. Lang, do you have that up 5 as well? 6 MR. LANG: Yes. Thank you. 7 By MR. BONNY: 8 Q. Dr. Banerjee, approximately how many 9 depositions have you done previously? 10 A. I'm looking at the list. I think it's 11 about two dozen. 12 Q. And when was the last time that you were 13 deposed? 14 A. Earlier this month. So I only listed over 15 here cases that have ended. I generally don't list 16 the ones that are currently in process. So, yeah, I 17 did -- I did a deposition in early January -- early 18 December this year. 19 Q. Okay. And what -- remind me again what 20 is your -- your current job? 21 A. I'm the Cockrell Chair professor of 22 electrical and computer engineering at the 23 University of Texas at Austin, and I also direct the 24 Microelectronics Research Center out here. 25 Q. Am I correct that you also do consulting	12 1 now I have started charging 675 an hour. 2 Q. Do you recall if the 650 an hour that 3 you're charging in this matter includes any portion 4 for the search firm? 5 A. No. In this case I was recruited directly 6 by Mr. Lang so there is no such firm involved. 7 Q. Approximately how many hours a year do you 8 work on patent litigation consulting? 9 A. Per year? 10 Q. Correct. 11 A. It varies greatly year to year. Some years 12 are pretty lean; some years I'm a little bit more 13 active. 14 Q. How many -- throughout the year -- strike 15 that. 16 Approximately how many hours have you 17 worked on patent litigation matters in 2024? 18 A. I couldn't tell you without looking at my 19 record. 20 Q. Do you know if it was more or less than a 21 thousand? 22 A. I'm guessing once again. I'm almost 23 certain it's less than a thousand. 24 Q. Was it more or less than 500? 25 A. I couldn't tell you without looking at my

13 1 record. I'm guessing over here. Probably somewhere 2 in that range. 3 Q. What is the total annual compensation that 4 you make from patent litigation matters? 5 A. That also varies greatly year to year. 6 Q. Approximately how much have you made in 7 annual compensation so far for the year 2024 for 8 patent litigation matters? 9 A. I don't recall. I would have to look at my 10 invoices. 11 Q. Approximately how many -- how many -- 12 strike that. 13 Approximately how many expert reports or 14 declarations have you prepared in -- in your -- not 15 limited to this matter? 16 A. Over my entire career? 17 Q. Correct. 18 A. So once again, in looking at my CV where I 19 guess list 26 cases, I think I prepared expert 20 reports in those cases. In some of them I've worked 21 on multiple patents. So, once again, I'm guessing 22 over here. Probably 30, 35 maybe. 23 Q. Have you ever turned down a matter? 24 A. Lots of times. 25 Q. And have you ever --	15 1 don't agree with what they want me to say. 2 By MR. BONNY: 3 Q. Dr. Banerjee, do you have any patents in 4 your name? 5 A. Yes. 6 Q. Approximately how many patents? 7 A. Those are also listed in my CV. I think 35 8 patents. In fact, I was recently honored as a 9 Fellow of the National Academy of Inventors a couple 10 years ago. 11 Q. Do you understand that the patent at issue 12 in this proceeding is US Patent No. 10,861,872? 13 A. Yes. 14 Q. And if I refer to that patent as the '872 15 patent, you'll know what I'm referring to? 16 A. Yes. 17 Q. Do you have any patents that you would -- 18 that you would consider to be in the same field as 19 the '872 patent? 20 MR. LANG: Objection. Form. 21 THE WITNESS: Many of my patents deal with 22 memory. I started my career at Texas Instruments 23 where I worked on vertical DRAMs, dynamic 24 random-access memory, so quite a few patents on 25 that. I've also got patents on flash memory based
14 1 A. I -- I turn down the majority of my 2 cases -- the majority of the cases that people 3 approach me over, yeah. 4 Q. Sorry, I accidentally spoke over you. 5 You said you turn down the majority of the 6 cases that people approach you about? 7 A. Once again, I'm speaking from memory. I 8 think that's an accurate statement, yes. 9 Q. And in your patent litigation matters have 10 you ever refused to offer an opinion? 11 A. I'm not sure I understand your question. 12 Do you mean after I've been retained? 13 Q. Correct. After you've been retained for a 14 patent -- patent litigation matter, have you ever 15 refused to offer an -- an opinion? 16 MR. LANG: Objection. Form. 17 THE WITNESS: So I have been -- in every 18 case I stand by my -- my declarations or my reports. 19 So if there are instances where I do not agree with 20 what the attorneys want me to say, I will refuse to 21 do that. So every opinion that I've expressed in my 22 report in my mind are definitely accurate. So I -- 23 I probably haven't -- after I have been retained, I 24 don't think I've refused to continue working on the 25 case, but I push back on attorneys all the time if I	16 1 on my work done at the University of Texas. So, 2 yeah, I've -- if you will restrict the themes to 3 flash memory, I have several patents in that 4 space. 5 (Court Reporter clarification.) 6 THE WITNESS: I have several patents in 7 that space. 8 By MR. BONNY: 9 Q. Dr. Banerjee, what did you do to prepare 10 for this deposition? 11 A. I reviewed the patent. I reviewed my 12 declaration. I reviewed the cited prior art, Park 13 and Tessariol. And then I reviewed the various 14 exhibits that were cited by Micron, some in greater 15 depth than others. 16 Q. Other than those documents that you just 17 mentioned, did you review any other documents in 18 preparation for this deposition? 19 A. I don't think so. 20 Q. And other than the documents that you 21 listed in your declaration, were there any other 22 documents that you reviewed in preparation for this 23 deposition? 24 A. Let me look at my declaration. 25 I don't think so. And as I told you, some

17 1 of these I skimmed through. But some of the 2 documents, such as the patent, my declaration, I 3 reviewed more extensively. But some of these 4 exhibits are, I think, textbooks. I didn't read the 5 entire textbook preparing for this. 6 Q. Did you review the -- strike that. 7 I'm going to share with you a copy of 8 Exhibit 1003 which is your declaration in this 9 matter. Feel free to, if you have your paper copy, 10 you can keep referring to that but I'll just get 11 this in the record and everyone can pull it up on 12 their screen if they would like to. 13 A. Yeah. I have downloaded the copy that you 14 sent me but I also have my clean hard copy. 15 Q. Could you please turn to the last page of 16 your declaration? 17 A. Okay. 18 Q. And actually, before that, the document 19 marked as Exhibit 1003, do you recognize this as a 20 copy of the declaration that you submitted in 21 support of the Petition for IPR of the '872 22 patent? 23 A. Yes. 24 Q. And specifically, this is the declaration 25 that you submitted for IPR2024-789?	19 1 A. I reached my opinions based on knowledge as 2 hopefully an expert in the field. I've been working 3 in the field of semiconductors, including memory, 4 for over 40 years so -- and I consider everything 5 under the rubric of that general knowledge. But 6 specifically I depended on the exhibits that I 7 listed on page 13 of my declaration. 8 Q. Is there any information that you requested 9 from the attorneys for Micron that were not 10 provided? 11 A. No. 12 Q. Is there any information that you requested 13 from anyone else for use in this proceeding that you 14 were not provided? 15 A. I did not talk to anybody other than 16 Mr. Lang. 17 Q. Did you review the Petition itself in 18 preparing your declaration? 19 A. Yes, I believe I did look at that. 20 Q. Are you aware of the differences between 21 anticipation and obviousness? 22 A. I'm not a lawyer but I have a layman's 23 understanding. 24 Q. What is your understanding of the 25 difference between the two?
18 1 A. Yes. 2 Q. And on the last page of this document, 3 that's your signature; correct? 4 A. Yes. 5 Q. And you reviewed your declaration before 6 you signed it? 7 A. Yes. 8 Q. When you reviewed your declaration before 9 signing it, did you find any inaccuracies? 10 A. I don't think so. 11 Q. So this declaration reflects the opinions 12 that you've formulated in this matter? 13 A. Yes. 14 Q. What materials did you consider in 15 formulating your opinions? 16 A. So it includes the list of exhibits that 17 are listed on page 13 of my declaration. 18 Q. Did you consider any other materials aside 19 from those listed in the table on page 13 of your 20 declaration? 21 A. In terms of writing my report you mean? 22 Q. Correct. Yeah. In terms of formulating 23 your opinions for your declaration in this IPR, did 24 you consider any materials aside from those listed 25 in the table on page 13 of your declaration?	20 1 A. I know one anticipation is I think one of 2 two and obviousness is one of three. Let me look at 3 my declaration. 4 In this case I did not -- I did not make 5 any anticipation arguments, it's obviousness. So 6 when analyzing obviousness of subject matter, one 7 looks at the scope and content of the prior art, the 8 difference -- the differences between each claim of 9 the patent in the prior art, and the level of 10 ordinary skill in the art, the date the patent was 11 filed. I also consider objective factors of the 12 present that are secondary considerations that are 13 objective in this year of non-obviousness. I can -- 14 I can read through what I have in my declaration in 15 paragraphs 26, 27, all the rest -- 16 Q. Those paragraphs 26 and 27 of your 17 declaration, that is where you provide your 18 understanding of obviousness? 19 A. It goes on. It goes on to paragraph -- to 20 paragraph 38 in my declaration. 21 Q. So in paragraphs 25 through 38 of your 22 declaration you provide your understanding of the 23 law of obviousness? 24 A. That's correct. 25 Q. What is your understanding of

21 1 anticipation? 2 MR. LANG: Objection. Form. Scope. 3 THE WITNESS: As I told you, we have not 4 made any anticipation arguments in this case. And 5 I'm not a lawyer. All that I have is a layman's 6 understanding of the term anticipation from my prior 7 cases which may not be completely accurate. 8 By MR. BONNY: 9 Q. What is your understanding from those prior 10 cases? 11 A. Once again, with the caveat that I'm not a 12 lawyer and I'm speaking from recollection based on 13 prior cases, I think in the case of anticipation it 14 has to be based on a single prior art and I think 15 every claim element in the challenge patent has to 16 be clearly disclosed in that single prior art are -- 17 I'm going out on a limb over here. One second. I 18 don't want you to take my words out of context. 19 Basically, I think it has to be based on a 20 single prior art and all the claim elements have to 21 be clearly discussed in that single prior art. 22 Something along those lines. 23 Q. As part of your analysis in this matter, 24 you analyzed certain claims of the '872 patent; is 25 that right?	23 1 Q. And so what are the differences between 2 claim 1 of the '872 patent and the Park prior art 3 reference? 4 A. I'm reading the preamble of Claim 1. A 5 3-dimensional memory device comprising a substrate. 6 Park certainly meets that. 7 A memory stack comprising interleaved 8 conductive layers and dielectric layers on the 9 substrate. Park discloses that. 10 Claim Element 1C is a stately structure of 11 one side of the memory stack. Park discloses that 12 in Figure 1 of Park. 13 Claim Element 1D is a status contact in the 14 status structure. As I state in paragraph 133, Park 15 discloses that. Park renders it obvious. 16 Claim Element 1E is a plurality of dummy 17 source structures each extending vertically through 18 the stately structure. The plurality of dummy 19 source structures surrounding the status contact. 20 Here, the -- the Petitioner and the patent owner 21 have some disagreement about the meaning of dummy 22 source structure. I believe the Petitioner's 23 position is the correct one, but I analyzed it under 24 both party's constructions. 25 And I describe my opinions in paragraphs
22 1 A. Yes. 2 Q. And in your analysis did you find that any 3 of the claims of the '872 patent were anticipated by 4 prior art? 5 A. I did not provide that opinion. 6 Q. Why not? 7 A. I mean, some of it I wasn't asked by my 8 lawyers to do that kind of analysis. The -- the 9 opinions in my declaration are mine, the quote is 10 mine, but as you know, you write these in 11 collaboration with the lawyers and they do not ask 12 you to provide any anticipation analysis. I also 13 didn't do any prior art search in that matter. 14 Q. When assessing the obviousness -- strike 15 that. 16 You did provide opinions on the obviousness 17 of certain claims of the '872 patent; correct? 18 A. Yes. 19 Q. And when assessing the obviousness -- 20 strike that. 21 When providing your obviousness analysis, 22 did you evaluate the differences between each claim 23 of the patent and the prior art? 24 A. Yes, based on the guidelines that I 25 described in my declaration.	24 1 138 through 154 of my declaration. I would be happy 2 to read all of that into the record if you want me 3 to. 4 Q. No, I don't -- I don't think that's 5 necessary, but thank you. 6 Other than what you've just described, are 7 there any other differences that you evaluated 8 between Claim 1 of the '872 patent and the prior art 9 reference? 10 A. For the final safe element is 1F -- 11 (Court Reporter clarification.) 12 THE WITNESS: Wherein each of the dummy 13 source structures comprises a conductive contact. I 14 believe Park discloses this limitation also. 15 By MR. BONNY: 16 Q. For clarification, the Park prior art 17 reference, you understand that that's the document 18 that was marked as Exhibit 1005 in this IPR 19 proceeding? 20 A. That is correct. 21 Q. And specifically Park is US Patent No. 22 9,859,297? 23 A. Yes. 24 Q. Dr. Banerjee, have you ever designed a 25 memory device?

25 1 A. There is different types of memory. As I 2 told you, I started my career at Texas Instruments 3 where I was part of the team that designed videos 4 with DRAM. In fact, we won the best speaker award 5 at the IECC. Of course, as you probably know, these 6 teams are made up of several individuals, so I 7 played my part in it in designing that memory. And 8 then subsequently when I joined University I worked 9 on different kinds of memory for a period. I think 10 what is germane to this patent is my work on flash 11 memory, and I've designed flash memory cells. 12 Q. When you say you've "designed flash memory 13 cells," what -- what -- what is involved in that 14 process for you? 15 A. In flash memories such as NAND flash -- 16 excuse me -- you have to have a semi-conducting 17 channel. And then on top of that you go have thin 18 oxide, which is known as a tunnel oxide. On top of 19 that you have to have a storage layer which is 20 called a floating gate. There is multiple types of 21 floating gates and I have worked on many of them. 22 Each of them have their pros and cons. After that 23 you have to grow what is called a control oxide. 24 And then after that is put down, the second control 25 gate. From a device physics point of view, each of	27 1 flash memory cells? 2 A. So I've made memory cells based on silicon 3 as well as silicon-germanium channels. I've worked 4 on different kinds of tunnel oxide designs based on 5 a single tunnel oxide or stacks of different tunnel 6 oxides with different band gaps. These are known I 7 believe as variot structures, v-a-r-i-o-t. 8 I have published extensively on different 9 types of floating gate structures, including one 10 called quantum dot floating gates which are 11 disconnected from each other, other than being a 12 continuous silicon floating electrode that works 13 when recognized by the community when we published 14 that at IEDM as one of the highlight papers. 15 I've worked on different material stresses 16 of the top control oxide based on different types of 17 High-k dielectrics such has hafnium oxide, zirconium 18 oxide. Yeah, so it's been an extensive set of 19 design fabrication, testing, analysis related to 20 these memory cells. 21 Q. You mentioned thermal oxide. What is 22 thermal oxide? 23 A. So thermal oxide is often grown on silicon 24 where you flow in an oxygen-containing gas, it could 25 be O2 or in some cases it can be H2O if you grow
26 1 these involve many design aspects. 2 I have published many papers on those. And 3 my students have won at least one best paper award 4 based on that. Yeah, at least one best paper award 5 based on that kind of work. There is a lot of 6 design involved in optimizing these memory cells. 7 Q. Did your work pertain to a single memory 8 cell or did it also consider the relationship 9 between adjacent memory cells? 10 A. The work at TI involved all chips, forms of 11 DRAM chips. The work at the University mostly dealt 12 with individual memory cells because, you know, in 13 academic lab you don't make complete complex chips 14 with millions of transistors, but I did collaborate 15 with companies such as AMD where they make some -- 16 it's not full chips but at least reaggregate 17 circuits and I collaborated with them and we 18 published some papers. But the work done in my lab 19 at University of Texas I think pertains to 20 individual memory cells. But I could -- 21 Q. When you said pertaining to flash memory 22 cells, did you -- were you involved in the selection 23 of materials for the flash memory? 24 A. Yes. 25 Q. What kinds of materials have you used in	28 1 what are called wet thermal oxides. And what you do 2 is you react the oxygen that you flow in in the 3 furnace with silicon from the substrate, those are 4 called thermal oxides, as opposed to what are called 5 chemical vapor deposited oxides where you flow in 6 both the silicon-containing gas, for example xylene, 7 and react that with oxygen. 8 Q. What is a control oxide? 9 A. A control oxide is generally thicker than 10 the tunnel oxide. The tunnel oxide is grown right 11 above the channel. And as that term implies, it has 12 to involve this quantum mechanical phenomena called 13 tunneling which requires that the tunnel oxides be 14 thin compared to the -- the control oxide which is a 15 thicker oxide between the top control gate and the 16 floating gate which is in between the control gate 17 and the channel. You don't want current leakage 18 through that, that's why you make that thicker. 19 Q. What do you mean by "you don't want 20 anything coming through that?" 21 A. You do not want any leakage currents going 22 through the control oxide, or any that we described, 23 that's why you make that a thicker oxide than the 24 tunnel oxide. In the case of the tunnel oxide, you 25 do want carriers to go through to program any

29 1 degrees of floating gate. 2 Q. What materials is the control oxide made 3 out of? 4 A. Different people use different materials. 5 It can be silicon dioxide which is deposited or it 6 can be the so-called High-k gate dielectrics such as 7 hafnium oxide or zirconium oxide. There is not a 8 universal answer. 9 Q. Are those materials insulators? 10 (Court Reporter clarification.) 11 A. Yes. 12 Q. What is the -- the purpose -- strike that. 13 You mentioned that one of the purpose of 14 the control oxide is to stop any leakage current 15 from passing through. Are there any other benefits 16 of using a control oxide in a memory cell? 17 A. No. The control gate, which is on the very 18 top, has to have some electrostatic impact on the 19 channel. So, yeah, depending on the capacitive 20 coupling of this control oxide. You do not want it 21 to leak current but you do want the capacity of 22 coupling between the control oxide and the floating 23 gate. 24 Q. And what does "capacitive coupling" mean in 25 this context?	31 1 the witness not to answer. So if you are going to 2 tie it to something in this proceeding, I'll let you 3 continue. 4 By MR. BONNY: 5 Q. Why don't we just turn to page -- paragraph 6 175 of your declaration, Dr. Banerjee, which is the 7 exhibit marked as 1003. 8 A. Okay. 9 Q. Are you at paragraph 175 of your 10 declaration? 11 A. Yes. 12 Q. Please look to that paragraph. Do you see 13 where you say, "This insulation layer is formed on 14 the sidewalls. It acts as a spacer between the 15 conductive core and the memory stack?" 16 A. Yes, I have read that paragraph. 17 Q. You also go on to say that, "It is 18 necessary because the gate layers are conductive; 19 thus, without the spacer there would be electrical 20 shorts between the conductive core and the gate 21 layers." 22 Do you see that? 23 A. Yes. 24 Q. So in what you're describing here, the 25 insulator -- insulator is preventing electrical
30 1 A. A capacitor is the ability of a circuit 2 element to store charge. And the simplest example 3 of that would be a parallel plate capacitor where 4 you have two metallic electrodes with an insulator 5 in between. In that case if you apply, say, a 6 positive voltage to one of the electrodes, it will 7 dump positive charge on that electrode and that will 8 cause spindling use, equal and opposite negative 9 charge on the other electrode and these charges on 10 the two electrodes result in electric field between 11 the insulator which hopefully will not leak 12 conduction current. 13 Q. What would happen if there was a leak of 14 conduction current? 15 MR. LANG: I'm going to -- Christopher, it 16 seems like you've gone well outside of the -- this 17 declaration in this proceeding. What is this -- how 18 is this in any way related to this proceeding? It 19 seems like you are asking about another IPR. 20 MR. BONNY: I am not and it will, I think, 21 be pretty clear that I'm not momentarily. 22 MR. LANG: All right. 23 MR. BONNY: But, anyway, please limit your 24 objections to the ones that are permitted. 25 MR. LANG: It was related to instructing	32 1 shorts between the conductive core and the gate 2 layers? 3 A. That's correct. 4 Q. What does it mean for an insulator to 5 prevent electrical shorts? 6 A. As we were discussing a few minutes back, 7 in this case an insulator means electrical 8 insulator. So when you apply a voltage across that 9 insulated layer, there should not be any significant 10 conduction currents flowing through it. 11 Q. Why is there such a requirement? 12 A. In the context of paragraph 175? 13 Q. Correct. Why -- why is -- would there be a 14 requirement that there not be electrical significant 15 conduction current, as you say, flowing through the 16 insulator? 17 A. Well, in this particular case we have the 18 word lines in the memory which are separated by 19 insulators in between the word lines which extend in 20 the horizontal direction. Now, if you have this 21 openings in Park, the openings marked 122 in Figure 22 1 that is extending in the vertical direction, if 23 you did not have the insulator on the sidewalls of 24 that opening, the conductive coil that you put into 25 the cavity would end up short-circuiting the word

33 1 lines, which are also conductors, one to each other. 2 You do not want that for the memory to function. 3 Q. What would be the consequence if there was 4 a short? 5 A. You would not be able to operate the NAND 6 memory because in a NAND memory string you have a 7 whole bunch of these memory cells in series and then 8 after you've, say, programmed one of those memory 9 elements, when it comes to reading that memory, you 10 have to apply what are called bath voltages to all 11 the other word lines above and below that so that 12 they conduct. But then you apply a word line 13 voltage to the selective memory cell with a volt -- 14 with a so-called read voltage which would have a 15 voltage between the two threshold states of that 16 memory cell. So when you program and erase a NAND 17 memory, you store or erase charges from this 18 floating gate and that will determine what the 19 threshold voltage of the selective memory cell is. 20 So the cell that I'm trying to read, you 21 have to apply a word line voltage in between the 22 high and the low threshold voltages while all the 23 other memory cells in the string you apply a higher 24 gate voltage -- word line voltage so that they are 25 able to conduct. That's why they are called VAST	35 1 CVD, or PECVD." 2 Do you see that? 3 A. Yes. 4 Q. What does it mean to have a high breakdown 5 voltage? 6 A. So insulators are not supposed to conduct 7 conduction current when you apply DC voltages to 8 electrodes on either side of the insulator. 9 However, to keep increasing the voltage to be 10 applied to the two plates on either side of the 11 insulator, at some point insulators also 12 electrically break down and that can lead to a high 13 conduction current within the two electrodes on 14 either side and, in fact, it can lead to a 15 catastrophic breakdown of the material where it will 16 no longer function as a insulator. 17 Q. So if that happened where there was a 18 breakdown of the material and it no longer functions 19 as an insulator, the memory device would no longer 20 function? 21 A. Depending on where that happened, the 22 answer would be yes. 23 Q. What is low leakage current? 24 A. So insulators once again are not meant to 25 allow conduction current to flow through them when
34 1 voltages. 2 Now, if I didn't have this insulator in 3 this cavity, I would not be able to apply different 4 word line voltages to the different word lines. 5 Q. So in the normal operation of a functioning 6 memory cell, the insulator prevents conduction with 7 adjacent structures? 8 MR. LANG: Objection. Form. 9 THE WITNESS: It depends on what you mean 10 by normal functioning. Presumably you want a memory 11 that works. If in that sense, yes. 12 By MR. BONNY: 13 Q. Could you please look to paragraph 176 of 14 your declaration? Let me know when you have that. 15 A. Yes, I have read it. 16 Q. The third sentence of paragraph 176 you 17 state that, "The term insulator layer, particularly 18 in insulating liner layer, is understood as a 19 dielectric material, such as silicon dioxide." 20 A. Yes. 21 Q. And then in the next sentence you state 22 that, "This is because silicon dioxide is one of the 23 most common insulators in the field with high 24 breakdown voltages and low leakage current, and 25 which can be deposited at low temperatures by ALD,	36 1 you apply voltages on the electrodes on either side 2 of this insulator, unless of course you applied such 3 a high voltage that it breaks down. But below the 4 breakdown voltage, if you apply a finite voltage 5 across the insulator, you will get some current. 6 It's not going to be zero but hopefully it will be 7 low enough. Now, there is not a definite metric for 8 what is low. That's context dependent. 9 Q. What is ALD? 10 A. Atomic layer deposition. 11 Q. And am I correct that ALD can be used to 12 deposit an insulator such as silicon -- silicon 13 dioxide? 14 A. Yes, if you have the right precursors. 15 Q. And what is CVD? 16 A. Chemical vapor deposition. 17 Q. CVD can also be used to deposit silicon 18 dioxide? 19 A. Yes. 20 Q. And what is PECVD? 21 A. Plasma-enhanced chemical vapor 22 deposition. 23 Q. How is that different from CVD? 24 A. To begin with, in CVD you flow in precursor 25 gases. So in the case of silicon dioxide, as I

37 1 described in paragraph 176, it could react xylene 2 with oxygen and you heat it up to certain 3 temperatures so that the two molecules react. It 4 creates intermediate products which diffuse to the 5 surface of the substrate and you end up getting a 6 deposition of SiO₂ molecules. So the reaction is 7 driven by heat. 8 On the other hand, in the case of 9 plasma-enhanced CVD you also have plasma excitation 10 provided to the deposition chamber, and there is 11 different types of plasma excitation that you can 12 talk about. And essentially what that does is it 13 breaks up these precursor molecules into fragments 14 or radicals and thereby it can overwhelm these 15 chemical reactions at a lower temperature. 16 So with PECVD in general you can do the 17 deposition at a lower temperature than with just CVD 18 alone which is driven by thermal means. 19 However, it's all context dependent, but broad terms 20 this is what happens. 21 Q. Do CVD and PECVD provide any differences in 22 the structure of the deposited silicon oxide -- or 23 silicon dioxide, rather? 24 A. It could. 25 Q. What differences?	39 1 Q. And then ALD, are there any differences in 2 the structure of the silicon dioxide that's 3 deposited by ALD as compared to CVD or PECVD? 4 A. There can be. So ALD stands for atomic 5 layer deposition and you do the deposition under 6 conditions where you switch between the two 7 precursors which gives you what I call digital 8 control over layered thicknesses as opposed to CVD 9 and PECVD where you get what are called analog 10 control. And one impact of that is that with ALD 11 you generally get even more conformal things than 12 with CVD and PECVD. 13 Q. What do you mean by "even more conformal?" 14 A. So the term conformality refers to the fact 15 that if you have topography on the surface of the 16 substrate, as in coils or hills, when you deposit 17 the film you can have different film thicknesses on 18 the flat horizontal surfaces versus the vertical 19 surfaces. A conformal film would have more or less 20 the same thickness on horizontal and vertical 21 surfaces while a non-conformal film may not be -- 22 (Court Reporter clarification.) 23 THE WITNESS: -- uniformly thick. 24 MR. BONNY: We have been going about an 25 hour, Dr. Banerjee, do you prefer to just keep going
38 1 A. So sticking to these precursors in 2 paragraph 176, generally what will happen is in the 3 case of CVD either the film, which is closer to the 4 right spectrometry of silicon dioxide, which is 5 SiO₂. 6 In the case of PECVD, on the other hand, 7 because I have hydrogen atoms in the xylene 8 molecules, which is SiH₄, you very often can get a 9 certain percentage of hydrogen incorporated into the 10 SiO₂ films, so you get an alloy, if you will, of 11 silicon, oxygen and hydrogen where the hydrogen 12 content depends on the PECVD deposition 13 conditions. 14 Q. Are there any difference -- differences in 15 how and where the -- strike that. 16 With respect to CVD and PECVD, are there 17 any differences in terms of where the material is 18 deposited? 19 A. You can have PECVD in different types of 20 PECVD chambers. Similarly with CVD you can do CVD 21 in different types of processes in chambers. But on 22 a very broad level, both of these can be conformal. 23 And the term conformal means it conforms to the 24 topography on the substrate. So you should get 25 deposition on the sidewalls of this cavity.	40 1 or do you want to take a break? 2 THE WITNESS: A break would be nice. 3 MR. BONNY: Okay. Let's go off the 4 record. 5 THE VIDEOGRAPHER: We're going off the 6 record at 9:05. 7 (Recess.) 8 THE VIDEOGRAPHER: Back on the record at 9 9:16. 10 By MR. BONNY: 11 Q. Dr. Banerjee, could you please turn to 12 paragraph 47 of your declaration? 13 A. Okay. 14 Q. In paragraph 47 of your declaration you 15 refer to something called a floating gate; is that 16 right? 17 A. Yes, I see that. 18 Q. And near the middle of the paragraph you 19 say that, "A floating gate is surrounded by 20 electrical insulators on all sides -- it 21 electrically floats in the insulation -- and 22 therefore has no direct electrical contact to the 23 rest of the device;" is that right? 24 A. I see that. 25 Q. What does it mean to "electrically float?"

41 1 A. Well, what it means is the floating gate is 2 not connected directly to a terminal where I apply a 3 voltage where it can have -- you can have the 4 conductive vat to an external terminal where it can 5 apply voltage. 6 Q. What does it mean to have no direct 7 electrical contact with the rest of the device? 8 A. So when using a flash memory cell, for 9 example, you have the transistor made in the 10 substrate where you have essentially a source and a 11 drain and you -- and a flow current between the 12 source and the drain, for example, when I'm reading 13 the memory cell. So the source could be 14 electrically connected to the drawn potential while 15 the top of the NAND/NOR string is dielectrically 16 connected to the bit line which is only held at a 17 certain voltage, depending on what I'm doing to the 18 memory cell. 19 Similarly, the control gate, which is also 20 known as the word line, you have direct electrical 21 access to. You can apply appropriate word line 22 voltages during the various operations. You do not 23 have such electrical contact directly to the 24 floating gate. You only have, as I describe in this 25 paragraph, capacitive coupling. Why is it a	43 1 where they cannot spontaneously come out because the 2 barrier to come out is very, very large and that 3 requires having insulators on all sides of the 4 floating gate. 5 By MR. BONNY: 6 Q. Some of the claim terms that you opined on 7 in this proceeding include the term "nominally equal 8 lateral distances;" is that right? 9 A. Can you point me to its location? 10 Q. Sure. Just a moment. So, for example, 11 Claims 3 and 4 of the '872 patent include the term 12 "nominally equal lateral distances;" correct? 13 A. Yes. 14 Q. And you have -- you have offered opinions 15 in this matter regarding those claim terms? 16 A. Yes. 17 Q. What is your understanding of the term 18 "nominally equal lateral distance" -- or distances 19 plural, rather? 20 A. So I'm looking at paragraph 162 of my 21 declaration as an example. So here I say that, 22 "Nominally equal lateral distances includes being," 23 quote, unquote, "evenly or uniformly distributed." 24 The dummy source lines are positioned nominally 25 equal lateral distances to the contact plugs."
42 1 capacitor? Before the break we were talking about a 2 capacitor being made up of an insulator and 3 dielectric with electrodes on either side and that 4 is what you have in this scenario. 5 So the floating gate would be, say, one of 6 the electrodes, the control oxide would be the 7 insulator, and then the control gate would be the 8 other electrode as one example. 9 Q. I see. So the -- the insulator material is 10 what's used to create the scenario where you have no 11 direct electrical contact with the rest of the 12 device? 13 A. That's correct. 14 Q. Why is that desirable? 15 MR. LANG: Objection. Form. 16 THE WITNESS: It's desirable because flash 17 memories are so-called non-volatile memories, 18 meaning that you've retained the information in the 19 floating gate for a long time. Typically I think 20 the benchmark for most non-volatile flash memories 21 is, I believe, ten years of storage so that requires 22 that the floating gate be electrically insulated on 23 all sides so that it acts as what we call a 24 potential well. So you put charges into this 25 potential well where they cannot spontaneously --	44 1 Q. So the -- am I right that the understanding 2 of that term that you applied was evenly or 3 uniformly distributed? 4 MR. LANG: Objection to form. 5 THE WITNESS: It includes being evenly or 6 uniformly distributed, but the -- the plain language 7 also means that the lateral or the horizontal 8 spacing, for example in Figure 1 between the 9 staircase contact, which are highlighted in my 10 declaration in Figure 1, should be approximately the 11 same distance between the dummy source structures. 12 By MR. BONNY: 13 Q. When you say "Figure 1," are you referring 14 to Figure 1 in the Park prior art reference? 15 A. That's correct. 16 Q. Could you walk me through the process that 17 you applied to determine whether two structures in 18 the prior art are nominally equal lateral distances 19 to another structure? 20 MR. LANG: Objection. Form. 21 THE WITNESS: At a high level I look at the 22 figures in the '872 patent or the various prior art 23 patents. So going back to Figure 1 of Park, when I 24 look at the figure -- the spacing between the 25 staircase contacts and the dummy source

45 1 structures, they visually look the same. Now I 2 realize, of course, that these are schematics, but a 3 POSITA would know that the patent had a certain 4 thing in mind. That's one thing. 5 Furthermore, the core of the memory is a 6 highly regular structure. You have theoretic areas 7 of word lines and bit lines which crisscross each 8 other in orthogonal directions. But then the 9 question arises why use the term nominal. When you 10 make these patterns, you use photographic techniques 11 where you have to align one set of structures with a 12 set of pre-existing structures and -- and then you 13 have some finite precision. However, in the context 14 of this patent I believe it meets the requirement 15 that they are nominally equally -- equal distant to 16 the staircase contact. 17 By MR. BONNY: 18 Q. And is that generally the same process that 19 you applied when analyzing the other prior art 20 reference, the Tessariol prior art reference? 21 A. Yeah. I looked to the figures and the 22 specifications to gain an understanding of what the 23 patent holder had in mind but then I also looked at 24 that under the rubric of my general knowledge in the 25 field that I have developed over 40 years.	47 1 (Proceedings concluded.) 2 ---o0o--- 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
46 1 Q. So in your -- in rendering your obviousness 2 opinions, did you consider -- strike that. 3 Did you consider secondary considerations 4 after you con- -- after you concluded that the 5 challenged claims were obvious? 6 A. As I described in paragraph 233 of my 7 declaration, I was not aware of any evidence 8 suggesting the existence of any secondary indicia or 9 considerations of non-obviousness. 10 MR. BONNY: Counsel, I don't have any 11 additional questions. No further questions. 12 MR. LANG: Let's take a 10-minute break. 13 THE VIDEOGRAPHER: We're going off the 14 record at 9:28. 15 (Recess.) 16 THE VIDEOGRAPHER: We're back on the record 17 at 9:31. 18 MR. BONNY: All right. So as I mentioned 19 before, I have no further questions for the witness. 20 MR. LANG: No questions for Petitioner. 21 MR. BONNY: Thank you. 22 THE VIDEOGRAPHER: This marks the end of 23 the video deposition of Dr. Sanjay Banerjee. 24 We are going off the record at 9:31 Pacific 25 time.	48 1 CERTIFICATE OF STENOGRAPHIC REPORTER 2 3 4 I, BURGUNDY B. RYAN, a Certified Shorthand 5 Reporter, hereby certify that the witness in the 6 foregoing deposition, 7 SANJAY KUMAR BANERJEE, Ph.D., 8 was by me duly sworn to tell the truth, the whole 9 truth, and nothing but the truth, in the 10 within-entitled cause; that said deposition was 11 taken at the time and place therein named; that the 12 testimony of said witness was stenographically 13 reported by me, a disinterested person, and was 14 thereafter transcribed into typewriting. 15 I further certify that I am not of counsel 16 or attorney for either or any of the parties to said 17 deposition, nor in any way interested in the outcome 18 of the cause named in said caption. 19 20 DATED: Monday, December 30, 2024. 21  22 23 Burgundy B. Ryan, CSR No. 11373, RPR 24 25

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