

UNITED STATES PATENT AND TRADEMARK OFFICE  
BEFORE THE PATENT TRIAL AND APPEAL BOARD  
TAIWAN SEMICONDUCTOR MANUFACTURING COMPANY, LTD.  
(TSMC) and SAMSUNG ELECTRONICS., LTD  
Petitioner

v.

DSS TECHNOLOGY MANAGEMENT, INC.  
Patent Owner

Patent 5,652,084  
IPR2014-01030

Title: METHOD FOR REDUCED PITCH LITHOGRAPHY

-----  
ORAL DEPOSITION OF  
DR. CHRIS A. MACK  
MAY 14, 2015  
-----

ORAL DEPOSITION OF DR. CHRIS A. MACK, produced as a witness at the instance of the Petitioner, and duly sworn, was taken in the above-styled and numbered cause on May 14, 2015, from 9:03 a.m. to 1:08 p.m., before Larissa L. McPhearson, CSR in and for the State of Texas, reported by machine shorthand, at the offices of Nix, Patterson & Roach, LLP, 5215 North O'Connor Boulevard, Suite 1900, Irving, Texas 75039, pursuant to the Federal Rules of Civil Procedure.

DR. CHRIS A. MACK - May 14, 2015

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25

A P P E A R A N C E S

FOR THE PETITIONER, TAIWAN SEMICONDUCTOR MANUFACTURING COMPANY, LTD.:

Mr. Scott Cunning  
HAYNES AND BOONE, LLP  
800 17th Street, NW  
Suite 500  
Washington, D.C. 20006  
Phone: (202)306-4135  
Fax: (202)654-4267  
E-mail: scott.cunning@haynesboone.com

-and-

Mr. David M. O'Dell  
HAYNES AND BOONE, LLP  
2505 North Plano Road  
Suite 4000  
Richardson, Texas 75082  
Phone: (972)739-8635  
Fax: (972)692-9118  
E-mail: david.odell@haynesboone.com

FOR THE PETITIONER, SAMSUNG ELECTRONICS, LTD.:

Mr. Christopher Marando  
WEIL, GOTSHAL & MANGES LLP  
1300 Eye Street, NW  
Suite 900  
Washington, D.C. 20005  
Phone: (202)682-7000  
Fax: (202)857-0940  
E-mail: christopher.marando@weil.com

FOR THE PATENT OWNER:

Mr. Anton J. Hopen  
Mr. Andriy Lytvyn  
Mr. Nicholas Pfeifer  
SMITH & HOPEN  
180 Pine Avenue North  
Oldsmar, Florida 34677  
Phone: (800)807-3531  
Fax: (813)925-8525  
E-mail: anton.hopen@smithhopen.com  
andriy.lytvyn@smithhopen.com  
np@smithhopen.com

HANNA & HANNA, INC.  
713.840.8484

DR. CHRIS A. MACK - May 14, 2015

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25

A P P E A R A N C E S

-and-

Mr. Kirk Voss  
NIX, PATTERSON & ROACH, LLP  
5215 North O'Connor Boulevard  
Suite 1900  
Irving, Texas 75039  
Phone: (972)831-1188  
Fax: (972)444-0716  
E-mail: kirkvoss@nixlawfirm.com

HANNA & HANNA, INC.  
713.840.8484

DR. CHRIS A. MACK - May 14, 2015

1	INDEX	
2		PAGE
3	Appearances.....	2-3
4	DR. CHRIS A. MACK	
	Examination by Mr. Scott Cunning.....	5
5	Examination by Mr. Andriy Lytvyn.....	89
	Further examination by Mr. Scott Cunning.....	94
6	Signature and Changes.....	95
7	Reporter's Certificate.....	96
8		
9	EXHIBITS	
10	NO.    DESCRIPTION	PAGE IDENTIFIED
11	TSMC-1014    United States Patent 5,652,084.....	23
12	TSMC-1015    Patent Owner DSS Technology,	
13	Inc.'s Response to Petition.....	30
14	TSMC-1016    Claim Construction Memorandum and	
15	Order.....	85
16	MARKED IN PREVIOUS DEPOSITION, JUST REFERRED TO:	
17	DSS-2007    Declaration of Dr. Chris A. Mack, Ph.D.	19
18	TSMC-1004    Patent Application.....	72
19		
20		
21		
22		
23		
24		
25		

DR. CHRIS A. MACK - May 14, 2015

1 (On the record at 9:03 a.m.)

2 DR. CHRIS A. MACK,  
3 having been first affirmed, testified as follows:

4 EXAMINATION

5 BY MR. CUNNING:

6 Q. Good morning, Dr. Mack. Could you state your  
7 full name, please?

8 A. Chris Allen Mack.

9 Q. And what is your residence address?

10 A. 1605 Watchhill Road, Austin, Texas.

11 Q. And are you currently employed?

12 A. I work as a consultant.

13 Q. Okay. And do you --

14 A. And part-time at the University of Texas at  
15 Austin as adjunct faculty.

16 Q. Does your consulting business have a name?

17 A. No.

18 Q. So you just --

19 A. I sometimes -- I apologize for speaking over  
20 your -- any of your question. I sometimes use the name  
21 lithoguru.com, which is my website address, as my  
22 business name. That's an unofficial name, not an  
23 official name, for my consulting business.

24 Q. Have you given a deposition before?

25 A. I have.

HANNA & HANNA, INC.  
713.840.8484

DR. CHRIS A. MACK - May 14, 2015

1 Q. Okay. Well, you gave a deposition in a  
2 litigation related to this proceeding, correct?

3 A. Yes.

4 Q. Okay. Other than that deposition, have you  
5 been deposed before?

6 A. Yes.

7 Q. How many times?

8 A. Approximately 10 or 12.

9 Q. Okay. So you're somewhat familiar with the way  
10 these things work, but I like to kind of go over the  
11 procedures at the beginning to make sure everybody has  
12 that fresh in their mind. Everything that we say is  
13 being taken down by the court reporter, so for that  
14 reason, it's important to give verbal answers rather  
15 than nods or shakes of the head. Do you understand  
16 that?

17 A. I do.

18 Q. Okay. And because the court reporter is trying  
19 to take down both my questions and your answers, I will  
20 try not to begin a question in the middle of your  
21 answer. If you could try to wait until I finish my  
22 questions before beginning your answers, that'll make it  
23 easier for the court reporter. Is that fair?

24 A. Yes.

25 Q. Okay. If I ask you a question that you don't

## DR. CHRIS A. MACK - May 14, 2015

1 understand, I want to make sure that we understand each  
2 other today, so if you can let me know, I will attempt  
3 to clarify the question. Can you let me know if you  
4 don't understand one of my questions?

5 A. Yes.

6 Q. And we'll probably take a break about every  
7 hour, but there's nothing magic to that, so if you need  
8 a break for any reason, you know, you can just let me  
9 know and I'll accommodate that.

10 A. I will.

11 Q. And the only thing I would ask, though, if I  
12 have a question that's pending, if you could answer that  
13 question before we take a break. Can you agree to that?

14 A. Yes.

15 Q. Your attorneys may interpose objections to some  
16 of my questions today. For the most part, that's just  
17 for the record. If you understand the question,  
18 you're -- you can go ahead and answer the question. Do  
19 you understand that?

20 A. Yes.

21 Q. Is there any reason that you can't give full  
22 and truthful testimony today, or are you under the  
23 influence of any medications, for instance?

24 A. No.

25 Q. And I apologize about that question, but you

## DR. CHRIS A. MACK - May 14, 2015

1 never know if someone was in a car accident yesterday.

2 All right. Can you briefly describe your  
3 educational background after high school?

4 A. I attended Rose-Hulman Institute of Technology  
5 where I received four bachelor's degrees in chemistry,  
6 chemical engineering, physics, and electrical  
7 engineering. I attended the University of Maryland at  
8 College Park where I received a master's degree in  
9 electrical engineering, and I attended the University of  
10 Texas at Austin where I received a Ph.D. in chemical  
11 engineering.

12 Q. I grew up in Terre Haute, so I know  
13 Rose-Hulman.

14 A. It is a fabulous school.

15 Q. All right. When did you begin working with  
16 photolithography?

17 A. I began in photolithography in 1983.

18 Q. And what were the circumstances in which you  
19 began working with photolithography?

20 A. I was working for the National Security Agency  
21 in Fort Meade, Maryland and NSA has a fab for  
22 manufacturing semiconductor devices and a research  
23 organization to develop next generation processes for  
24 that fab. I worked in the research organization.

25 Q. What type of photolithography equipment were



## DR. CHRIS A. MACK - May 14, 2015

1 you using at the time?

2 A. I began using what's called contact printers,  
3 then moved on to the use of step-and-repeat lithography  
4 tools.

5 Q. And for the transfer of the desired pattern to  
6 the substrate for the contact printer, how does that  
7 work?

8 A. With the contact printer, the mask is put in  
9 direct contact with the photoresist covered wafer, or in  
10 a slight variation called proximity printing, a small  
11 gap in the order of tens of microns is maintained  
12 between the mask and the photoresist coated wafer.  
13 Light is shown through the mask to create a shadow of  
14 the mask pattern that then exposes the photoresist.

15 Q. And for -- is the -- I'm sorry, the proximity  
16 printing, is that a type of contact printing, or is that  
17 a separate type of printing?

18 A. They are sometimes considered together because  
19 they use the same -- often use the same tools, but they  
20 are sometimes considered as separate types of pattern --  
21 patterning.

22 Q. And the step-and-repeat equipment that you  
23 mentioned, how does that work for transferring the  
24 pattern to the imaging layer?

25 A. A step-and-repeat system is a type of

## DR. CHRIS A. MACK - May 14, 2015

1 projection optical lithography where a lens is used to  
2 project the image of a mask onto the photoresist coated  
3 wafer.

4 Q. Are there other types of projection optical  
5 lithography?

6 A. Yes.

7 Q. What other types of projection optical  
8 lithography are you familiar with?

9 A. Well, another style of projection optical  
10 lithography besides the step-and-repeat is the scanner  
11 where -- well, if I could back up and explain what a  
12 step-and-repeat is. That -- all of the projection  
13 optical systems require a method of covering the entire  
14 wafer which cannot be exposed all at one time. In a  
15 stepper, a small portion of the resist coated wafer is  
16 exposed at one time, then the wafer is stepped or moved  
17 to a new location and then a repeat of that exposure  
18 happens, step-and-repeat until the entire wafer is  
19 exposed with multiple copies of the mask.

20 Another style of projection optical  
21 lithography is the scanner. In a full wafer scanner,  
22 the mask has an entire wafer's worth of patterns on it,  
23 and then the entire mask and wafer are scanned past the  
24 exposure region so that the entire wafer is exposed by  
25 the entire mask.

## DR. CHRIS A. MACK - May 14, 2015

1           The next style of projection optical  
2 lithography, the one that is most commonly used today,  
3 is a hybrid of those two styles called the  
4 step-and-scan. Within one exposure field, the mask and  
5 the wafer are scanned past a slit which then exposes all  
6 of the mask to that portion of the wafer. The wafer is  
7 then stepped to a new location and the scanning  
8 operation is repeated.

9           Q. Other than step-and-repeat, the last one that  
10 you described, would that be called step-and-scan?

11          A. Step-and-scan is the common name for the last  
12 one I described.

13          Q. Step-and-scan, and then just scanning  
14 projection system. Any other types of projection  
15 optical lithography that you're familiar with?

16          A. There are a number of what I would call minor  
17 variations or alternate approaches that are not commonly  
18 used. One, for example, is called maskless lithography  
19 where we have a pattern that is created in some way  
20 besides the use of a mask. Usually, it's a very small  
21 region which is then scanned in some way on the wafer.

22                   One example would be a very simple approach  
23 of simply having a laser focused down to a small spot.  
24 That spot is scanned in a raster scan approach across an  
25 area, and the beam is turned on and off. This would be

## DR. CHRIS A. MACK - May 14, 2015

1 called a direct write lithography system.

2 Q. Are there other -- other than direct write, are  
3 there other types of maskless lithography systems?

4 A. There are -- there is a style which uses  
5 something called a digital multimirror. This is similar  
6 to the digital multimirrors used in the digital light  
7 projectors in movie theaters or home TVs where the  
8 mirrors are basically turned on and off by tilting them  
9 and that creates the pattern. The mirrors -- the  
10 digital multimirror is illuminated, and an image of that  
11 is then projected onto the wafer.

12 Q. Are you familiar with other types of maskless  
13 lithography systems?

14 A. There is -- there are systems that use electron  
15 beam lithography, beams of electrons rather than photons  
16 to ex -- excuse me, to expose the resist coated wafer.  
17 Besides direct write with the scanning spot, there is  
18 something called a cell projection. A small cell, maybe  
19 a -- it is a rectangle or some other primitive pattern  
20 is projected onto the wafer and then more complex  
21 patterns are built up through the use of combinations of  
22 those primitive cells.

23 Q. Can you elaborate on that? When you say a  
24 primitive pattern is projected onto the wafer, is the --  
25 are you projecting, you know, a limited set of features

## DR. CHRIS A. MACK - May 14, 2015

1 at a time?

2 A. Yes.

3 Q. Okay. So you would expose to do one portion of  
4 the die and then do a second exposure for a different  
5 portion of the die?

6 A. Typically, these primitive patterns are very  
7 small and maybe with a fairly simple shape, for example,  
8 a T pattern or an L pattern or simply a rectangle. Then  
9 more complicated patterns are decomposed into the small  
10 set of primitive patterns, and then one exposure at a  
11 time, the more complicated pattern is built up.

12 Q. Okay. What is the light source, if it is a  
13 light source, that's used with -- well, is it a photon?  
14 Is it a light source, like a traditional optical light  
15 source that's used with cell projection?

16 A. Typically, it is electron beams.

17 Q. Any other maskless systems that you're aware  
18 of, maskless lithography systems?

19 A. There's actually quite a large variety of what  
20 I would call research or -- well, let's just call them  
21 research lithography approaches. One, for example, is  
22 called dip-pen lithography. It is maskless. It uses  
23 something like an atomic force microscope tip with a  
24 chemically altered tip to chemically alter a substrate.

25 Q. Is that used in production?

## DR. CHRIS A. MACK - May 14, 2015

1 A. No.

2 Q. Was it used in a research context that the --  
3 well, in the 1994 time frame?

4 A. I don't believe so, but I'm not familiar with  
5 when dip-pen lithography first began.

6 Q. What about cell projection, is that used in  
7 commercial production today?

8 A. I believe that it is used in mask manufacturing  
9 which also involves a lithography process, but not in  
10 commercial wafer production.

11 Q. Cell projection was available in the 1994 time  
12 frame?

13 A. I believe so.

14 Q. Or how about E-beam lithography, is -- well,  
15 the E-beam lithography, the imaging, is that a version  
16 of direct write?

17 A. Most of the E-beam lithography approaches are  
18 direct write.

19 Q. So rather than using a laser to scan the  
20 pattern into the resist, the projection equipment is an  
21 E-beam?

22 A. That's correct.

23 Q. And how does the -- well, could you refer to  
24 the -- would it be appropriate to call it a projection  
25 apparatus, the -- that exposes the resist to the E-beam?

## DR. CHRIS A. MACK - May 14, 2015

1           A. In a scanning spot direct write lithography  
2 system, we generally wouldn't refer to the system that  
3 focuses the beam onto the resist coated wafer as a  
4 projection system.

5           Q. Okay. Well, what would be the term that you  
6 would use to refer to that tool, the E-beam tool?

7           A. We would generally call it a direct write  
8 E-beam tool.

9           Q. Okay. So how do you program the pattern into  
10 the direct write E-beam tool, if you don't use a mask?

11          A. You have what's called a beam blanker that  
12 turns the beam on and off. The beam blanker is driven  
13 by a database which contains the pattern information.

14          Q. So you program the series of instructions to  
15 the database telling the direct write E-beam tool when  
16 to expose and when to turn off the E-beam?

17          A. That's correct.

18          Q. And does the direct write E-beam tool, does it  
19 move across the substrate?

20          A. There are two motions involved. While the  
21 wafer is stationary, the beam is scanned over a very  
22 small region to expose that small region. Then the  
23 wafer is stepped to a new location and adjacent to the  
24 previous location, and again, the beam is scanned over  
25 the small area.

## DR. CHRIS A. MACK - May 14, 2015

1 Q. So the instructions that you program into the  
2 database that tell the E-beam tool when to turn on and  
3 off also program the E-beam tool how to scan across the  
4 section that's being exposed?

5 A. Yes.

6 Q. And how does the -- how do you relay the  
7 patterning information to a digital multimirror  
8 apparatus?

9 A. Like with a direct write E-beam tool, it begins  
10 with a description of the pattern that's desired to be  
11 printed. Often for both tools, that database will be in  
12 a file format called a GDS file. That serves as the  
13 information that serves to control or program the  
14 mirrors in the digital multimirror device, but it does  
15 involve some translation of format.

16 Q. Does the digital multimirror device scan across  
17 a portion of the wafer?

18 A. The systems I'm familiar with would not involve  
19 any scanning.

20 Q. And what's the radiation source that's used  
21 with the digital multimirror systems?

22 A. It would be a light source of some sort.

23 Q. And do you have direct experience working with  
24 E-beam lithography?

25 A. I have limited experience with E-beam



## DR. CHRIS A. MACK - May 14, 2015

1 lithography.

2 Q. What's your experience working with E-beam  
3 lithography?

4 A. I have been involved in contracting to have  
5 masks made by a mask maker who would use an E-beam  
6 lithography tool for that purpose. I have been involved  
7 in studying the physics of electron beam lithography and  
8 in the development of a lithography simulator to  
9 simulate electron beam lithography.

10 Q. I'm sorry, can I -- if we can go back, you say  
11 that you've been involved with consulting to have masks  
12 made that would be used with E-beam?

13 A. I didn't say consulting, but in some of my  
14 various jobs, I've required the purchase of photomasks,  
15 and that involved contracting with mask makers and  
16 specifying the types of lithography that would be used  
17 in the manufacture of those masks and understanding  
18 their capabilities and sources of errors.

19 Q. So I just want to make sure I understand  
20 because I thought, based on the earlier conversation,  
21 E-beam was a maskless system, so is a mask created and  
22 then the programming instructions for that mask are fed  
23 into the machine?

24 MR. HOPEN: Objection to form.

25 A. No.

## DR. CHRIS A. MACK - May 14, 2015

1 Q. I'll ask it this way, why would you contract  
2 with a mask maker for a photomask when dealing with  
3 E-beam lithography?

4 A. Let me try to be a little bit more clear. The  
5 photomask was being used for photolithography, optical  
6 lithography. The making of the photomask involved the  
7 use of E-beam lithography. So my experience with E-beam  
8 lithography is mostly involved in the use of E-beam  
9 lithography in the manufacture of masks.

10 Q. Do you have any experience with E-beam  
11 lithography in the translation of patterns into  
12 photoresist?

13 A. As I was saying, the manufacture of a photomask  
14 is a lithography process that involves the use of  
15 E-beams in exposing photoresist.

16 Q. Do you have experience using an E-beam  
17 lithography system to pattern a semiconductor device?

18 A. I'm very familiar with that technology, but I  
19 don't have direct experience in doing that.

20 Q. What about the cell projection technology, have  
21 you used cell projection technology to manufacture  
22 semiconductor devices?

23 A. No.

24 Q. The digital multimirror technology, have you  
25 used the digital multimirror technology to manufacture

DR. CHRIS A. MACK - May 14, 2015

1 semiconductor devices?

2 A. No.

3 Q. And the direct write lithography that you  
4 mentioned, that would use a laser as a light source, so  
5 it'd be an optical direct write lithography. Is that  
6 correct terminology?

7 A. Yes.

8 Q. Okay. Have you used optical direct write  
9 lithography to manufacture semiconductor devices?

10 A. No.

11 Q. Are you familiar with optical direct write  
12 lithography?

13 A. I am.

14 Q. I'm going to hand you what's previously been  
15 marked as DSS Exhibit 2007. And whenever I hand you a  
16 document today, please feel free to flip through it to  
17 the extent you need to do so to familiarize yourself  
18 with a document. I may ask a question about a specific  
19 portion, but you should read as much as you need to get  
20 the context for the question.

21 A. Okay.

22 Q. Okay. My first question is whether or not you  
23 recognize this?

24 A. Yes.

25 Q. And what is DSS 2007?

DR. CHRIS A. MACK - May 14, 2015

1 A. It's my declaration in this IPR case.

2 Q. On the last page of the document, page 11,  
3 there's a signature. Is that your signature?

4 A. Yes.

5 Q. Did you sign the declaration on March 13th,  
6 2015?

7 A. Yes.

8 Q. Did you read the declaration before you signed  
9 it?

10 A. Yes.

11 Q. Did you draft this declaration?

12 A. It was drafted in collaboration with the  
13 attorneys I was working with.

14 Q. Okay. Who were the attorneys that you were  
15 working with?

16 A. Mostly Andriy and Anton, sitting here.

17 Q. Did you --

18 A. Mostly Andriy.

19 Q. Did you work with anyone else in preparing this  
20 declaration?

21 A. I don't recall.

22 Q. Other than attorneys, did you work with anyone  
23 else in preparing the declaration?

24 A. No.

25 Q. So you don't have like a research assistant or

DR. CHRIS A. MACK - May 14, 2015

1 anything --

2 A. No.

3 Q. -- that would have had input into this?

4 A. No.

5 Q. If you look at paragraph 16 of your  
6 declaration --

7 A. I promise you I've read this, but I've just now  
8 noticed that a couple of paragraphs are out of order in  
9 their numbering, but I --

10 Q. Ah.

11 A. -- I have found paragraph 16.

12 Q. Yeah. Do you think paragraph 17 and 18 are  
13 important?

14 A. And --

15 Q. I'm just --

16 A. Well, all of the paragraphs, I believe, are in  
17 their proper order, but the numbering --

18 Q. Okay.

19 A. -- has been misapplied.

20 Q. Okay. Well, the paragraph 16 on page 4.

21 A. I see it.

22 Q. At the end of the paragraph, you say, I believe  
23 that a person of ordinary skill in the art would have a  
24 BS degree in engineering or similar field and several  
25 years of experience using photolithography methods for

DR. CHRIS A. MACK - May 14, 2015

1 semiconductor fabrication. Do you see that?

2 A. Yes.

3 Q. What different methods of semiconductor  
4 fabrication would a person of ordinary skill in the art  
5 have had experience with?

6 A. Semiconductor fabrication is by and large  
7 performed using step-and-repeat projection lithography  
8 and step-and-scan projection lithography. So those are  
9 the methods. One or both of those methods would be the  
10 methods I'm referring to here.

11 Q. Would a person of ordinary skill in the art  
12 have experience with E-beam lithography?

13 A. A person of ordinary skill in the art would be  
14 familiar with E-beam lithography.

15 Q. And what about optical direct write  
16 lithography, would a person of ordinary skill in the art  
17 have had experience with optical direct write  
18 lithography?

19 A. Optical direct write lithography is not  
20 generally used in semiconductor fabrication, so I  
21 believe a person of ordinary skill in the art would be  
22 familiar with that technology, but not necessarily have  
23 direct experience in its use.

24 Q. You reviewed the U.S. Patent 5,652,084 in  
25 preparing your declaration?

DR. CHRIS A. MACK - May 14, 2015

1 A. Yes.

2 Q. In your view, does the 084 patent claim methods  
3 of semiconductor fabrication that would include the use  
4 of E-beam direct write lithography?

5 A. I don't recall all the specifics -- methods  
6 mentioned in the 084 patent. Perhaps if I had a copy of  
7 that patent, I could refresh my memory.

8 Q. Just so happens I have copies.

9 MR. CUNNING: Let's mark this because this  
10 appears to be a copy other than one that was used  
11 previously, so can we mark this as TSMC-1014.

12 (Exhibit TSMC-1014 marked.)

13 Q. Do you recognize TSMC-1014?

14 A. Yes.

15 Q. And that is the 084 patent that you considered  
16 in preparing your declaration?

17 A. Yes.

18 Q. So my prior question was whether, in your view,  
19 the 084 patent claimed methods of semiconductor  
20 fabrication that included the use of E-beam direct write  
21 lithography?

22 A. Well, I note that in column 3 in line 45, it  
23 says, the term "radiation" may include ultraviolet  
24 light, x-ray radiation, electron beam or E-beam  
25 radiation, vacuum radiation, or ion beam radiation, for

## DR. CHRIS A. MACK - May 14, 2015

1 example. So it's clear that electron beam is  
2 contemplated, and it does say imaging layer may be  
3 exposed to the first mask using any suitable form of  
4 radiation. That is not direct write, though, that  
5 includes a mask. Let me see if I find a reference to  
6 direct write.

7 Q. Maybe I can help with that. If you look in  
8 column 12 --

9 A. Yes.

10 Q. -- it would be paragraph -- starting at around  
11 line 20.

12 A. Yes.

13 Q. Does that mean to you that the 084 patent would  
14 include lithography techniques that are maskless such as  
15 direct write exposure?

16 MR. HOPEN: Objection to form.

17 A. Yes.

18 Q. When -- I want to back up to a sort of  
19 traditional optical lithography technique that exposes a  
20 pattern in the photoresist through a mask. Can you kind  
21 of describe how that would work from start to finish?

22 A. Let me describe that in a basic projection  
23 optical lithography --

24 Q. Okay.

25 A. -- system. Now, when you say describe it from



## DR. CHRIS A. MACK - May 14, 2015

1 start to finish, there are lots and lots of details.

2 Q. Okay.

3 A. So I don't know to what level of detail you  
4 wish me to explain.

5 Q. Why don't you give me an overview, and then  
6 I'll ask follow-up questions, as necessary.

7 A. Okay. We begin with a projection optical tool  
8 that can project an image of a photomask onto a portion  
9 of a resist coated wafer. The photomask is put or  
10 mounted in the tool, and that photomask has alignment  
11 marks or registration marks that allow the photomask to  
12 be aligned to the optical system.

13 A wafer that has been previously coated  
14 with a photoresist is also loaded onto a wafer table and  
15 put into the system. That wafer is then aligned either  
16 directly or indirectly to the photomask. A shutter is  
17 opened which allows light to illuminate the photomask.  
18 Light is transmitted through the clear portions of the  
19 photomask blocked by the opaque portions of the  
20 photomask. And as the light profligates away from the  
21 photomask, it diffracts.

22 A projection lens, usually a very  
23 complicated and large lens system, collects a portion of  
24 the diffracted light and focuses it down to a plane that  
25 is meant to coincide with the surface of the resist

## DR. CHRIS A. MACK - May 14, 2015

1 coated wafer. On that plane, that surface, an image of  
2 the photomask is produced. That image then exposes the  
3 photoresist, causes chemical change in response to the  
4 amount of light that is exposing. At the end of the  
5 exposure, the allotted exposure time, the shutter is  
6 closed, and the wafer is removed. It then undergoes  
7 further processing, for example, development to develop  
8 and form patterns in the photoresist layer.

9 Q. In claim 1 of the 084 patent which is  
10 TSMC-1014 -- do you have that?

11 A. Yes.

12 Q. Column 13.

13 A. Yes.

14 Q. The limitation 1(b) when it -- where it states,  
15 patterning the first imaging layer in accordance with  
16 the first pattern to form a first pattern layer having a  
17 first feature -- you see that?

18 A. Yes.

19 Q. Is the process that you just described that  
20 patterning step?

21 A. The process I described would fall under that  
22 claim element.

23 Q. Okay. It says that the photomask has alignment  
24 marks that allows you to align it with the optical  
25 system. What do you mean by that?

## DR. CHRIS A. MACK - May 14, 2015

1           A. There are two major goals in accurate  
2 patterning or forming a first pattern, a first pattern  
3 layer, for example, using the terminology of claim 1.  
4 One is to produce the correct size of the feature or  
5 shape of the pattern, and the second is to position that  
6 pattern in the proper spot on the wafer. One of  
7 ordinary skill in the art at the time frame of the 084  
8 patent would be well aware that these are the two  
9 criterion that lithographers worry about when assessing  
10 the quality of a lithographic process.

11                   A necessary step in achieving the proper  
12 placement of the pattern on the wafer is the proper  
13 placement of the photomask in the optical projection  
14 tool. That is accomplished by measuring alignment marks  
15 on the reticle after the reticle has been mounted in the  
16 projection optical tool so that a measurement of the  
17 exact position of that reticle in multiple degrees of  
18 freedom can be made.

19           Q. What is a reticle?

20           A. I'm sorry, a reticle is a -- simply another  
21 name for a photomask.

22           Q. So other than aligning the mask with the  
23 optical system, are there other types of alignment that  
24 are necessary for a projection photolithography system  
25 to accurately transfer the pattern to the wafer?

## DR. CHRIS A. MACK - May 14, 2015

1           A. Well, there are actually quite a large number,  
2 but the most important one that is done every single  
3 time that lithography tool is used is the alignment of  
4 the wafer. This can be done indirectly where the wafer  
5 is aligned to the projection optical system or a  
6 coordinate system associated with the projection optical  
7 system.

8                         In that case, because the reticle has been  
9 properly aligned to the projection optical system and  
10 the wafer is properly aligned to the projection optical  
11 system, the result is a proper alignment of the wafer to  
12 the reticle. Ultimately, the wafer can be aligned  
13 directly to the reticle without going through the  
14 intermediate step of the coordinate system of the  
15 projection optical system.

16           Q. If you misalign the mask to the optical system,  
17 will you transfer the same pattern to the wafer?

18           A. I'm not sure what pattern you're referring to.

19           Q. The pattern in the mask.

20           A. The pattern on the mask, when you say the same  
21 pattern, you can think of that independent of everything  
22 else and -- all right. I have to back up. I apologize.  
23 I think the correct answer is that very much depends on  
24 the situation.

25           Q. Okay.

## DR. CHRIS A. MACK - May 14, 2015

1           A. In a simplest thought experiment, simplest  
2 scenario, you have resist coated wafer that is not at  
3 all influenced by any of the existing patterns on the  
4 wafer projecting an image of that mask into that resist  
5 coated wafer, would then be -- produce patterns in the  
6 resist that were independent of the patterns underneath  
7 it. This will not always be the case, though.

8           Q. Why will it not always be the case?

9           A. Existing patterns on the wafer often involve  
10 topography, that is, the wafer is not perfectly flat  
11 after it has been previously patterned. When coating  
12 photoresist onto this topography wafer, the coating of  
13 the photoresist will have variations in the thickness of  
14 the photoresist that depend upon the topography on the  
15 wafer. In some cases, the variation and the thickness  
16 of the photoresist can be quite extreme with very thin  
17 regions of photoresist on the high parts of the wafer  
18 and very thick regions of photoresist in the low parts  
19 of the wafer.

20                       If I'm projecting a pattern onto this  
21 wafer, I could get very difficult results depending on  
22 whether the pattern is being projected onto the high  
23 part of the wafer with a thin photoresist or the low  
24 part of the wafer with a thick photoresist.

25           Q. And presumably in your design that I see and

DR. CHRIS A. MACK - May 14, 2015

1 particularly the lithography for this layer, you would  
2 -- taken that into account and have a desired placement  
3 of the pattern so that you get accurate transfer; is  
4 that correct?

5 A. That's correct.

6 Q. So if you misalign the mask and expose the  
7 pattern to a slightly different portion of the wafer,  
8 you would get a different pattern transfer?

9 A. That's possible.

10 Q. Let's take a more simple system, the -- we're  
11 going to coat on a layer of photoresist. It's our first  
12 coating of photoresist. The wafer has not been  
13 previously patterned, and there -- you know, actually,  
14 let's do this -- I apologize. Give me one second.

15 MR. CUNNING: I'll mark as TSMC1-1015  
16 Patent Owner DSS Technology, Inc.'s Petition -- Response  
17 to Petition.

18 MR. O'DELL: That's TSMC-1015?

19 MR. CUNNING: Yes, 1015.

20 MR. O'DELL: Okay. I thought I heard an  
21 extra 1.

22 THE REPORTER: You did.

23 MR. O'DELL: Okay.

24 MR. CUNNING: I apologize.

25 (Exhibit TSMC-1015 marked.)

## DR. CHRIS A. MACK - May 14, 2015

1 Q. Have you seen this document before?

2 A. Yes.

3 Q. Did you provide input into the preparation of  
4 the patent owner DSS Technology's response to the  
5 petition?

6 A. Outside of my declaration, no.

7 Q. Turn to page 3 of the document.

8 A. Yes.

9 Q. You see the figure depicted on page 3?

10 A. Yes.

11 Q. Is that figure a depiction of an optical  
12 projection type of photolithography that we -- similar  
13 to the one we've been discussing?

14 A. Yes.

15 Q. On the wafer that's coated with a photoresist,  
16 there's a -- what appears to be a grid with a series of  
17 small squares. You see that?

18 A. Yes.

19 Q. Does each one of those represent an individual  
20 die?

21 A. Possibly.

22 Q. So at least in some circumstances, the pattern  
23 that is depicted in the mask in figure -- let's label  
24 DSS-2006 at page 2 -- could correspond to a layer that  
25 would be used on a complete die?

## DR. CHRIS A. MACK - May 14, 2015

1 A. Yes.

2 Q. Now, if you were to misalign the mask with the  
3 optical projection system, you would expose -- could you  
4 expose that pattern such that it did not fall completely  
5 within a die?

6 A. I'm sorry, I don't understand your question.

7 Q. Okay. If we shift the mask a small degree to  
8 the left or right, it could fall half on a die and half  
9 off of a die, correct?

10 A. Are you referring to a die that already exists  
11 on the wafer -- a previous pattern on the wafer?

12 Q. No. So right now, what they're depicting is --  
13 what's being depicted in DSS 2006 at page 2, that's --  
14 the figure on page 3 of TSMC-1-1 --

15 A. Yes.

16 Q. -- 1015?

17 A. Yes.

18 Q. Is showing the projection of this pattern that  
19 is shown in the mask down onto an individual die on the  
20 wafer?

21 A. Well, I think this shows the printing of one  
22 layer of a die where approximately half of the wafer has  
23 already undergone the exposure --

24 Q. Uh-huh.

25 A. -- and half of the wafer has not yet undergone



## DR. CHRIS A. MACK - May 14, 2015

1 the exposure that's being depicted in the figure.

2 Q. And the idea is to repeat that pattern, that  
3 layer for each die on the wafer?

4 A. Well, let's assume a scenario where the mask  
5 only includes one die.

6 Q. Okay.

7 A. It's pretty typical to include more than one  
8 die on a mask, but I think for simplicity of our  
9 discussion, in describing a scenario where there's only  
10 one die on the reticle -- we'll make it easier.

11 Q. Okay.

12 A. So every time the wafer steps to a new  
13 location, an image of that layer of the die is projected  
14 and exposed into the photoresist.

15 Q. And for that die, if you were to move the mask,  
16 you would project a different pattern into that die?

17 A. Well, you would project the same pattern but  
18 somewhat misaligned or a slightly different position as  
19 it was projected onto the wafer.

20 Q. If the mask is off alignment, is it possible  
21 that a portion of the image -- a portion of the pattern  
22 would be on die and a portion of the pattern would be  
23 off die?

24 A. I'm not following exactly what you're referring  
25 to. So the reticle has a pattern of one layer of a die.

## DR. CHRIS A. MACK - May 14, 2015

1 Q. Uh-huh.

2 A. The wafer -- unless this is the very first  
3 lithography step that's being used, the wafer includes  
4 many prior patterns --

5 Q. Uh-huh.

6 A. -- from prior lithography and etching steps  
7 already on the wafer. So we are projecting an image of  
8 this layer of the photomask onto patterns that have been  
9 previously produced on that wafer.

10 Q. Okay. Let's take a simpler example where this  
11 is the very first layer that is being projected onto the  
12 wafer.

13 A. Okay.

14 Q. Yeah. It's important where you project the  
15 pattern onto the wafer, correct?

16 A. Yes.

17 Q. Okay. And if you project it in the wrong place  
18 on the wafer, is it possible that a portion of the  
19 pattern would be on die and a portion of the pattern  
20 would be off die?

21 A. Well, the pattern is the die.

22 Q. Yes. But the wafer is divided into a sort of  
23 grid space of multiple individual dies, correct?

24 A. It will be when we're finished.

25 Q. Okay. So is it important to project each

## DR. CHRIS A. MACK - May 14, 2015

1 successive layer into the same space so that they are on  
2 the same die?

3 A. Yes.

4 Q. And if the mask is off alignment, wouldn't it  
5 be possible to project the image onto -- instead of onto  
6 one die where a portion is on, say, die one and another  
7 portion is on die two?

8 A. When projecting a pattern of, let's say, one  
9 complete die --

10 Q. Uh-huh.

11 A. -- one layer of one complete die onto the  
12 wafer, it is spaced apart from the adjacent patterns of  
13 dies by a street or a region called a kerf.

14 Q. Okay.

15 A. This region eventually will be the area where a  
16 saw will cut the wafer to separate each individual die  
17 from each other.

18 Q. That'll happen when they're diced up in the  
19 packaging house?

20 A. That's exactly right.

21 Q. Okay.

22 A. The distance between one die and the next is  
23 sufficiently large to accommodate the width of the  
24 diamond tipped saw --

25 Q. Okay.

DR. CHRIS A. MACK - May 14, 2015

1           A. -- that's typically used for this cutting  
2 operation and on the order of a hundred microns.

3           Q. Okay.

4           A. That distance far exceeds any --

5           Q. The size of the die?

6           A. No.

7           Q. Okay.

8           A. That distance far exceeds any misalignment that  
9 can happen in the die so that if the reticle were  
10 misaligned by any normal, reasonable amount that is  
11 possible in a tool, it would still not be a sufficient  
12 level of misalignment so that the pattern of one die  
13 could possibly fall on top of a pattern of an adjacent  
14 die.

15           Q. Okay. Then let me ask it this way: If the  
16 mask was misaligned or the reticle was misaligned,  
17 couldn't you project the pattern to where it was  
18 partially on the die and partially on the curve (sic)?

19           A. The kerf, that's correct.

20           Q. And in that scenario, you would have a partial  
21 transfer of the pattern to the die?

22           A. I think a more accurate statement would be you  
23 would have a complete transfer of the pattern in  
24 misaligned form.

25           Q. On the die itself, would you have a complete

## DR. CHRIS A. MACK - May 14, 2015

1 transfer of the desired pattern?

2 A. Depending on what you mean desired.

3 Misalignment is not desired, but you would have a  
4 complete transfer of the pattern.

5 Q. Would it be on the die?

6 A. Yes.

7 Q. The kerf is part of the die?

8 A. The portion of the kerf that doesn't get cut  
9 off by the saw will be on the final die that is packaged  
10 and used.

11 Q. Okay. What if you project the portion -- a  
12 portion of the pattern onto the part of the kerf that is  
13 going to be cut off?

14 A. That would be a magnitude of misalignment far  
15 in excess of what one would expect to see in a  
16 manufacturing environment.

17 Q. It's possible?

18 A. Many things are possible.

19 Q. Okay. So if the mask is not -- is -- let's  
20 just say it's deliberately shifted. Couldn't you  
21 transfer a different pattern to the die using the same  
22 mask?

23 A. I don't know what you mean by a different  
24 pattern.

25 Q. Okay. If, when you're patterning the die, you

## DR. CHRIS A. MACK - May 14, 2015

1 want in this example where we're using one pattern per  
2 reticle, you want to transfer that complete pattern to  
3 the die, right? I mean, that -- is that correct that  
4 that is the goal?

5 A. Yes.

6 Q. Okay. And the goal of -- I think you mentioned  
7 there were two primary goals. One was to get the  
8 correct size, and the other was to get proper placement  
9 of the pattern on the wafer, correct?

10 A. Yes.

11 Q. Okay. And so if you transfer the pattern such  
12 that it is partially on the die and partially off the  
13 die, have you met one of the primary goals?

14 A. I thought we were referring to the very first  
15 patterning step where there's no existing patterns --

16 Q. Uh-huh.

17 A. -- on the wafer.

18 Q. Uh-huh.

19 A. The -- in this very first patterning step, the  
20 die is defined by the pattern that's projected onto the  
21 wafer, so the outline of the die at this point in the  
22 manufacturing process is the pattern that you've just  
23 projected and printed onto the wafer.

24 Q. Okay. But you're doing this multiple times,  
25 correct?

## DR. CHRIS A. MACK - May 14, 2015

1 A. Eventually, we will do this many, many times.

2 Q. I mean, even in -- the wafer contains many  
3 dies, so the wafer in a step-and-repeat system, every --  
4 which is -- I -- what is depicted here at page 3,  
5 correct? This is the -- this would be a step-and-repeat  
6 system?

7 A. Yes.

8 Q. Okay. So we scan and transfer this pattern  
9 from the reticle to an individual die, and then the  
10 wafer with the photoresist moves indexes to the next  
11 spot to repeat the pattern on the next die; is that  
12 correct?

13 A. Yes.

14 Q. Okay. If the wafer -- let's talk about  
15 movement of the wafer stage. If the wafer moves too  
16 far, you would get a transfer of a pattern that's  
17 possibly on die and off die, correct?

18 A. Are we now referring to not the first level of  
19 exposure but some subsequent layer?

20 Q. No. Let's stick with the first level.

21 A. All right. At the first level, there are no  
22 die on the wafer to project upon. There's only a wafer.

23 Q. Well, isn't the wafer mapped out into portions  
24 where you intend to place each die so you can build  
25 successfully -- successively on those layers?

## DR. CHRIS A. MACK - May 14, 2015

1 A. Yes.

2 Q. Okay. So we've done 150 dies and they're all  
3 in their predetermined grid space, and the next one,  
4 something happens. The wafer stage moves further than  
5 it is supposed to move. Wouldn't that end up with a die  
6 that is -- or a pattern that is transferred now  
7 partially on die and partially off die?

8 A. Well, again, there are no die yet. Only after  
9 we perform many lithography steps with many other  
10 processes in between do we build up layer by layer, the  
11 die. So I still don't understand what you mean by being  
12 off die if there is no die.

13 Q. So prior to -- let's look at, again, the figure  
14 on page 3, and we've got the individual repeated  
15 patterns in a grid on the left half of the wafer,  
16 correct?

17 A. Yes.

18 Q. This spacing pattern, isn't that -- is that  
19 intended to be repeated across the wafer?

20 A. It is intended to be a regular grid, yes.

21 Q. Okay. And so if you then now place one of  
22 these patterns at an irregular place on that grid,  
23 wouldn't it be on die and off die?

24 A. Well, it would be on grid versus off grid.

25 Q. Okay. And the grid is designed to define the



## DR. CHRIS A. MACK - May 14, 2015

1 spaces for the individual dies; is that correct?

2 A. Yes.

3 Q. For -- looking at the portion of the grid where  
4 the pattern was transferred where only a partial portion  
5 of the pattern was transferred, wouldn't that be  
6 different than if you had exposed it correctly on grid?

7 A. Well, again, I don't know what you mean by  
8 partial printing, partial transfer. We move the wafer  
9 and project an image of the entire reticle, the entire  
10 die onto the wafer. That process is never perfect, it  
11 is never perfectly on grid. There's going to be some  
12 level of error every single time. If those errors are  
13 sufficiently small, then we get high yielding, well  
14 working chips when we're done.

15 When those errors become sufficiently  
16 large, we suffer from yield loss from die that do not  
17 work properly because the patterns are mispositioned  
18 relative to each other.

19 Q. Okay. So let's start with a middle layer.  
20 We've already -- we've patterned at least one layer  
21 underneath, and we have the reticle misaligned for one  
22 of the dies. Couldn't you then have a pattern that was  
23 transferred to -- a portion of the pattern was on die  
24 and a portion of the pattern was off die?

25 A. If you deliberately misaligned far in excess of

## DR. CHRIS A. MACK - May 14, 2015

1 what a lithography tool used in semiconductor production  
2 is capable of, it would be possible to misalign a  
3 pattern so that some of the features in printing will be  
4 printed in the kerf rather than in the region that we  
5 would call a die.

6 Q. Okay. And the -- in that scenario, the pattern  
7 that was printed on the die would be different than the  
8 pattern that had been printed on a previous die where  
9 the reticle was aligned properly?

10 A. Well, if you're saying that if I misaligned by  
11 some huge amount so that a portion of the reticle  
12 pattern is printed in the kerf, then I think it's  
13 obvious to say that not all of the reticle pattern is  
14 printed in the die.

15 Q. Okay. And the pattern that did get printed in  
16 the die would be different than the pattern that was in  
17 the reticle?

18 A. That portion could potentially be the same or  
19 different.

20 Q. Okay. If you were to rotate the reticle by 45  
21 degrees, would you print the same pattern in the die?

22 A. I'm aware of no lithography tool that will  
23 enable you to rotate the reticle by 45 degrees.

24 Q. But if you did that, would you print the same  
25 pattern in the die?

## DR. CHRIS A. MACK - May 14, 2015

1 A. Rotated by 45-degree rectangle or maybe we'll  
2 say a square for simplicity, would print on top of an  
3 existing square representing the prior patterns in such  
4 a way that the corners of the newly printed image would  
5 fall outside of the die area --

6 Q. It would be different --

7 A. -- that exists on the wafer at that time.

8 Q. It would be a different pattern?

9 A. It would be the pattern rotated by 45 degrees.

10 Q. Okay. And do you consider that the same?

11 A. It depends on your perspective.

12 Q. Well, would it function the same?

13 A. Would the die function the same?

14 Q. Yes.

15 A. No.

16 Q. So would that be seen as an accurate or  
17 faithful pattern transfer?

18 A. For the purpose of chip making, no.

19 Q. Okay. So if your perspective is a lithography  
20 method in -- for the purpose of semiconductor  
21 manufacturer, would you have transferred the same  
22 pattern to the imaging layer?

23 A. Again, it -- I think you're transferring the  
24 pattern in the wrong place.

25 Q. And if you transfer the pattern in the wrong

## DR. CHRIS A. MACK - May 14, 2015

1 place, have you transferred the same pattern?

2 A. I think it depends on what you mean by the same  
3 pattern.

4 Q. Okay. With the perspective being using  
5 photolithography for semiconductor manufacturing, the  
6 placement of the pattern is important, correct?

7 A. Yes.

8 Q. So if your placement is wrong, have you  
9 faithfully transferred the same pattern?

10 A. A person of ordinary skill in the art in  
11 semiconductor manufacturing would know that faithful  
12 reproduction of the pattern involves both the shape and  
13 size of the pattern and its placement. If the placement  
14 error was sufficiently large to result in poor  
15 functioning of the die, you would say that you have not  
16 faithfully patterned or properly patterned the reticle.

17 Q. What if the placement error was sufficiently  
18 large and at the edge of the wafer such that a portion  
19 of the pattern was on the wafer and a portion of the  
20 pattern was off of the wafer?

21 A. Well, this happens on a regular basis. This  
22 is, in fact, typical of manufacturing. The edge die is  
23 what we call the die that are close to the edge of the  
24 wafer are often printed so that a portion of the die  
25 pattern falls off the edge of the wafer. This is

DR. CHRIS A. MACK - May 14, 2015

1 typical.

2 Q. And why is that done?

3 A. For two reasons. I think I mentioned earlier  
4 that it is quite common for a reticle pattern to contain  
5 more than one die. Two die, four die, six, eight, 12  
6 die. Often the size of the reticle that can be imaged  
7 at one time on the wafer is much larger than the size of  
8 the chip or the die that we are making.

9 Because of that, I can print the entire  
10 reticle onto the edge of the wafer and have a few of  
11 those die be whole and intact and completely on the  
12 wafer while a few others fall off the edge and are not  
13 completely intact. Because I want those few die on the  
14 wafer, I want to make them and I want to sell them, I go  
15 ahead and print even though only a portion of the  
16 reticle pattern is landing on top of the resist coated  
17 wafer. That's the first reason.

18 The second reason is that the uniformity of  
19 all of the processing, etching deposition, as well as  
20 lithography processes like developing, are enhanced when  
21 the patterns that we're printing completely cover the  
22 entire wafer. If I left edged portions unpatterned,  
23 that would produce a nonuniformity in pattern density  
24 that has negative impacts on many process steps in  
25 semiconductor manufacturing.

HANNA & HANNA, INC.  
713.840.8484

## DR. CHRIS A. MACK - May 14, 2015

1 Q. The die that are near the edge that only get a  
2 portion of the pattern transferred to them -- is that  
3 accurate? There's only a portion of the pattern in the  
4 reticle that gets transferred to some of the edge die?

5 A. As I said, that's very common.

6 Q. Okay. Is that pattern that is transferred to  
7 that portion of the wafer the same as the pattern that  
8 is transferred to the die where the entire image is  
9 transferred?

10 A. The portion that is transferred is the same,  
11 and the portion that is not transferred is obviously  
12 different than a portion that is transferred.

13 Q. Right. There's a -- there are portions that's  
14 the same, but not the entire pattern is transferred?

15 A. If I have a die that I cut off at, say,  
16 halfway --

17 Q. Uh-huh.

18 A. -- and only half of the die is patterned  
19 because it's on the edge of the wafer, then the other  
20 half is not printed.

21 Q. So -- and so that if you cut off the die  
22 halfway, that would be a different pattern than the full  
23 die?

24 A. Well, the pattern that's printed would be the  
25 same.

DR. CHRIS A. MACK - May 14, 2015

1 Q. The portion that's printed, but it -- but as  
2 compared to the full pattern in the reticle, it would be  
3 different?

4 A. So if by pattern you mean the entire reticle,  
5 the entire die pattern, then half of a die pattern is  
6 not the same as all of the die pattern.

7 Q. If --

8 MR. CUNNING: Well, actually, how long have  
9 we been going? I don't have my watch on.

10 MR. HOPEN: About an hour and 20.

11 MR. CUNNING: Okay.

12 Q. You want to take a break?

13 A. That would be great.

14 Q. Okay. I apologize for going a little over an  
15 hour.

16 (Break taken from 10:21 a.m. to 10:38 a.m.)

17 Q. Okay. So you had mentioned that often the mask  
18 has multiple dies contained on the same mask. Is that  
19 correct?

20 A. Yes.

21 Q. And describe for me how that works, how is a  
22 multiple die mask used in a typical -- let's just use  
23 step-and-repeat optical projection system.

24 A. It's used in essentially the same way as a  
25 simple die mask would be used.

## DR. CHRIS A. MACK - May 14, 2015

1 Q. And what is the pattern in the context of claim  
2 1, if you're talking about patterning the first imaging  
3 layer in accordance with the first pattern to form a  
4 first pattern layer having a first feature? Is it all  
5 of the different patterns contained in the mask that is  
6 the pattern?

7 A. My reading of the 084 pattern -- patent, excuse  
8 me, in claim 1, in particular, doesn't require that the  
9 first pattern layer encompass all of one die.

10 Q. Okay. So if you are using a multiple die mask,  
11 which of the dies would be the -- how would you  
12 determine what is -- what the pattern is when you use a  
13 multiple die mask to pattern a semiconductor wafer?

14 A. The pattern used to form the first pattern  
15 layer is silent on the issue of how big that pattern is,  
16 whether it encompasses an entire die or even multiple  
17 die. It could be that this first pattern layer is  
18 multiple die with kerfs in between and test patterns in  
19 the kerf, or it could be a portion of one die. For  
20 example, we might be printing not an entire die, even,  
21 but just, say, the memory array of a flash memory device  
22 where, instead of printing the -- a layer of the entire  
23 die, we only print the patterns associated with a  
24 portion of that die. That's certainly possible as well.

25 Q. How do you print the patterns -- only the



## DR. CHRIS A. MACK - May 14, 2015

1 patterns associated with a portion of the die?

2 A. That would depend on the lithography approach  
3 chosen.

4 Q. Using a mask, how would you do that? Would  
5 you -- would the mask only have that portion in it, or  
6 could the mask have additional portions?

7 A. In general, the mask would only have that  
8 portion in it. There is one variation on that being all  
9 projection lithography tools include what are called  
10 reticle blades.

11 Q. Uh-huh.

12 A. These are blades that are positioned very near  
13 the photomask, and they're movable so that portions of  
14 the photomask can be covered up by the blade and not  
15 projected onto the wafer.

16 Q. So if you were to blade off a portion of the  
17 photomask and project a portion of the photomask onto  
18 the wafer and then blade off a different portion of the  
19 photomask and project a different portion onto the  
20 wafer, would you have projected the same pattern onto  
21 the wafer or different patterns?

22 A. If you were to use reticle blades to block a  
23 portion of the photomask and reveal a separate portion,  
24 that would result in a pattern represented by the  
25 portion of the photomask that was not covered by the

## DR. CHRIS A. MACK - May 14, 2015

1 reticle blades. If I then move the reticle blades so  
2 that some other portion of the reticle that was  
3 previously covered is now revealed, when I project that  
4 portion, it would be a different pattern.

5 Q. So what's important in determining the pattern  
6 is the exposure that takes place on the wafer?

7 A. I'd say that's a fair statement.

8 Q. In other words, the mask doesn't necessarily  
9 define the pattern?

10 A. When you're projecting an image onto the wafer,  
11 the mask certainly does define the pattern.

12 Q. Well, but is it -- it's a part of it, but is it  
13 also the portion of the mask that you would expose?

14 A. It is possible to only use a portion of the  
15 mask when projecting that mask onto the wafer, though,  
16 in typical usage, the entire mask is being used to  
17 project that pattern onto the wafer.

18 Q. And in the case of blading off portions of the  
19 mask, a single mask can produce different patterns?

20 A. I think, as we discussed a few moments ago, if  
21 you blade off one portion and project that pattern onto  
22 the wafer, then in a second lithography operation move  
23 the blades to reveal a completely different portion that  
24 was covered by the blades, that new portion would be a  
25 different pattern.

DR. CHRIS A. MACK - May 14, 2015

1 Q. And that would be an example of using a single  
2 mask to create two different patterns?

3 A. Yes.

4 Q. And that -- was that something that was  
5 understood and -- by persons of ordinary skill in the  
6 art at the time of the filing of the 084 patent --

7 A. Yes.

8 Q. -- that technique?

9 A. I wouldn't call it a technique. That's not  
10 what's normally done. It's possible to do.

11 Q. Also in the case of a single mask that has  
12 multiple dies on the mask, you could use that mask to  
13 create multiple different patterns?

14 A. In what sense?

15 Q. Well, if you expose -- how many die are  
16 typically included in a multi-die mask?

17 A. Anywhere from 2 to 36.

18 Q. Okay. And each one of those could be a  
19 different pattern, correct?

20 A. I don't know what you mean by a different  
21 pattern.

22 Q. Each die included on the mask could be  
23 patterned differently?

24 A. Typically, all of the die are identical. There  
25 is, however, the possibility of having different die

## DR. CHRIS A. MACK - May 14, 2015

1 that -- on the same mask.

2 Q. Okay. And then in that scenario, you could use  
3 a single mask to create different patterns, depending on  
4 which die you expose?

5 A. Well, generally, you would expose the entire  
6 mask at one time. The point of having multiple die on  
7 the mask is to expose them all at once.

8 Q. Are there multi-die masks that are used where  
9 you have different layers included on the same mask?

10 A. It is possible.

11 Q. In that scenario, do you expose all of the  
12 masks at the same time?

13 A. No.

14 Q. And how does the exposure take place in the  
15 scenario where you have different layers represented  
16 on -- multiple different layers on the mask?

17 A. Well, normally, we use the phrase a "different  
18 layer" to represent patterning that occurs at a  
19 different step in the fabrication process.

20 Q. Uh-huh.

21 A. If I had two layers, let's say, on one  
22 photomask and those two layers represented different  
23 places in the overall sequence of processing steps, say  
24 one of them was the polygate layer and another one was  
25 the metal one layer, I would, again, using the reticle

## DR. CHRIS A. MACK - May 14, 2015

1 blades, cover up the metal one layer when I was printing  
2 the polygate layer, and then I would use the reticle  
3 blades again to cover up the polygate layer and open up  
4 the metal one layer when I was performing that printing  
5 operation.

6 Q. And that technique was something that was  
7 within the skill of a person of ordinary skill in the  
8 art at the time of the 084 patent?

9 A. Yes.

10 Q. If you look at figure 2 of the 084 patent -- do  
11 you have that in front of you?

12 A. Yes.

13 Q. And what is your understanding of what is  
14 represented in figure 2 of the 084 patent?

15 A. Just to make sure I get everything right, I'll  
16 refer back to the specification that discusses figure 2.

17 Q. Okay.

18 A. So layer 220 is an imaging layer, and this is  
19 the first imaging layer that's formed over the  
20 semiconductor wafer. Layer 210 is some other material  
21 that might be already deposited onto the semiconductor  
22 wafer on 200. It says layer 210 may include a  
23 dielectric, for example. Then it says imaging layer  
24 220 -- I'm now at column 3, line 57 -- imaging layer 220  
25 may be exposed to radiation through a first mask having

## DR. CHRIS A. MACK - May 14, 2015

1 opaque feature 222 and having clear features 221 and  
2 223.

3                   So at the top of figure 2, we have the  
4 first mask, and this is where we are forming the first  
5 pattern in the first imaging layer.

6           Q. Okay. So in between the first mask and the  
7 first imaging layer 220, there may be additional  
8 material? For example, with a projection system there  
9 are lenses in there; is that correct?

10           A. That's correct.

11           Q. Okay. And the arrows in figure 2 represent the  
12 radiation source?

13           A. That's correct.

14           Q. So what's important is the -- because the  
15 lenses are going to change the magnification of the  
16 pattern, it's the pattern as it reaches the imaging  
17 layer?

18           A. That's what's important to the imaging step,  
19 yes.

20           Q. This first mask that's depicted in figure 2, is  
21 it your understanding that -- this is a cross-sectional  
22 diagram, correct?

23           A. Yes.

24           Q. Okay. So is it your understanding that the  
25 mask can continue to the left and the right, there may

## DR. CHRIS A. MACK - May 14, 2015

1 be other features that are not depicted?

2 A. There are two ways to interpret such a diagram  
3 in my experience in looking at patents, but I think the  
4 way that is most appropriate here is to consider that  
5 the mask could have features to the left or to the right  
6 that are not being depicted here.

7 Q. And the sizes of the features that are depicted  
8 here, is that limiting? In other words, feature 223,  
9 for example, is it your understanding that the 084  
10 patent in featuring -- feature 223 is limited to  
11 patterning rectangular shapes?

12 A. No.

13 Q. Is it limited to patterning shapes that operate  
14 in a straight line?

15 A. No.

16 Q. Okay. Are the sizes of the features depicted  
17 in -- is this to scale? Are these sizes important?

18 A. Well, there's two answers to that question.  
19 Those two questions, actually --

20 Q. Okay.

21 A. -- that you gave me. The first answer is, in  
22 general, we don't interpret figures in a patent as being  
23 to scale, and so I do not and have not interpreted these  
24 figures as being necessarily to scale. Second, there is  
25 a requirement -- a size requirement in, for example,

## DR. CHRIS A. MACK - May 14, 2015

1 claim 1, but that has to do with the combined first and  
2 second pattern layer that form a single pattern layer,  
3 and the requirement is that the first and second  
4 features are formed relatively closer to one another  
5 than is possible through a single exposure to radiation.  
6 So that is a size requirement and restriction in  
7 practicing claim 1.

8 Q. Okay. Turn to Figure 4. And what's your  
9 understanding of what's being depicted in figure 4?

10 A. This figure is depicting forming a second  
11 pattern with a second mask in a second imaging layer.

12 Q. How do you know it's a second mask?

13 A. Let's see, it begins describing figure 4 in  
14 column 5, line 57. But in column 6, line 26 -- oh,  
15 actually before up in 20 -- or 18. Imaging layer 240  
16 may be exposed to radiation through a second mask having  
17 opaque features 242 and 244 and clear features 241, 243,  
18 and 245. Those numbers appear on the mask in figure 4,  
19 so the patent refers to that mask as the second mask.

20 Q. It says it may be exposed through a second  
21 mask, correct?

22 A. This is describing an embodiment that uses a  
23 mask.

24 Q. Uh-huh. But it doesn't say that -- I mean,  
25 that's not restrictive language, correct?



DR. CHRIS A. MACK - May 14, 2015

1           A. The claim is broader than simply through the  
2 use of photomasks.

3           Q. Okay. How do you know that the -- you stated  
4 that the mask used in figure 2 may have additional  
5 features to the left and the right in the mask. Isn't  
6 it possible that the mask depicted in figure 4 could be  
7 the same mask where you've bladed off that first  
8 portion?

9           A. I don't know what you mean.

10          Q. If I were to have one mask that had features  
11 221, 222, and 223 in it and features 241 through 245,  
12 couldn't I pattern the first imaging layer as depicted  
13 in figure 2 by blading off features 241 to 245 and  
14 exposing features 221 to 223?

15          A. So I think I understand your question. We  
16 discussed earlier the possibility of having two layers,  
17 one layer for the polygate layer, for example, and one  
18 layer for metal one on the same mask. Would have two  
19 patterns on one photomask.

20          Q. Uh-huh.

21          A. In this double patterning scheme, as it's  
22 described in the 084 pattern -- excuse me, patent, it  
23 would also be possible to have two patterns on one mask.  
24 You'd have to first pattern that was used to image in  
25 the first imaging layer on that mask and then separately

HANNA & HANNA, INC.  
713.840.8484

## DR. CHRIS A. MACK - May 14, 2015

1 a second pattern that represents a -- the patterns  
2 required for patterning the second imaging layer to form  
3 the second pattern. It would be possible to have both  
4 of those two patterns on one mask in the same way and  
5 then bladed off, as we described before.

6 Q. And that would be covered by the claim of the  
7 084 patent?

8 A. Yes.

9 Q. By claim 1 of the 084 patent?

10 A. Yes. Assuming, of course, that it met all the  
11 other limitations.

12 Q. Let's talk about the -- go back to the direct  
13 write exposure. So if I wanted to program -- I'm sorry,  
14 if I want to pattern the first imaging layer using a  
15 direct write apparatus, I believe you said you program a  
16 series of coordinates into a database to tell the laser  
17 or the E-beam writing tool where to turn on and turn  
18 off?

19 A. This would not be done manually, but a GDS file  
20 that contains the original database of all the patterns,  
21 what shapes and sizes you want them to be and the  
22 locations you want them to be on the wafer, would form  
23 the input database which is then converted into the data  
24 that the writer would need to write those patterns on  
25 the wafer.

## DR. CHRIS A. MACK - May 14, 2015

1 Q. Okay. That's going to have -- well, is it  
2 correct, then, that that input program would give the X,  
3 Y coordinates for where the E-beam -- let's use E-beam  
4 as an example -- the E-beam apparatus is to scan to on  
5 the wafer?

6 A. Yes.

7 Q. And then a programming instruction on -- once  
8 it's in the proper X, Y plane of when to turn on and  
9 when to turn off?

10 A. Yes.

11 Q. If I have a pattern of repeating features and I  
12 want to now do a second pattern where I shift all of the  
13 features some distance to the left, could I program the  
14 E-beam apparatus and just give it an instruction saying,  
15 you know, add one micron to every X coordinate?

16 A. I am unfamiliar with the software capabilities,  
17 whether it would allow that. In general operation, you  
18 would supply a different database, different GDS file  
19 with all of the locations for the second set of patterns  
20 that you would like patterned programmed into that  
21 database.

22 Q. If the second set of pattern is -- if the only  
23 difference is that every feature has been shifted some  
24 specified distance to the left, is it the same pattern  
25 or a different pattern?

## DR. CHRIS A. MACK - May 14, 2015

1 A. In what sense?

2 Q. If I want to pattern a first imaging layer with  
3 a set of transistors and then I want to pattern a second  
4 imaging layer where I put additional transistors into  
5 the spaces between the transistors from the first  
6 imaging layer and I do that with an E-beam apparatus,  
7 the only difference in the second pattern is I shifted  
8 everything some specified distance to the left, is that  
9 a different pattern or is it the same pattern?

10 A. If you consider the way a lithography -- excuse  
11 me, a lithographer considers patterns as they're placed  
12 onto a wafer --

13 Q. Uh-huh.

14 A. -- a pattern that's placed in a different  
15 position is a different pattern.

16 Q. Okay. If I have two masks that have an  
17 identical pattern in them or two copies of the same  
18 mask, is -- are the patterns between the two masks the  
19 same or different?

20 A. I think your hypothetical describes them as  
21 identical, so identical would be the same.

22 Q. If I were to -- let's take Jinbo, for example.  
23 My understanding of your criticism of Jinbo is that, in  
24 your view, Jinbo uses a single mask between the two  
25 patterning steps. Is that accurate?

## DR. CHRIS A. MACK - May 14, 2015

1 MR. HOPEN: Objection to form.

2 A. Jinbo discloses only a single mask.

3 Q. Okay. If Jinbo had used a second mask with the  
4 same pattern, then shifted the wafer stage, would that  
5 be -- would that cure the defect in your view of Jinbo?

6 A. Jinbo very purposefully doesn't do that, and  
7 with a very valid and useful reason, and that is the  
8 accuracy with which the patterning can be carried out is  
9 much higher if the photomask is loaded and aligned to  
10 the stepper for the first patterning step and then is  
11 not changed or moved for the second patterning step.  
12 This produces a much preferred result of higher accuracy  
13 of the combined pattern. That benefit is lost if one  
14 were to take out the first photomask and then replace it  
15 with a second photomask.

16 Even though you are attempting -- in real  
17 life attempting to re-create the first photomask with  
18 the second photomask, that re-creation will never be  
19 perfect, right. Your hypothetical earlier said they  
20 were identical, but it is impossible to make two masks  
21 that are identical. I'm not being nitpicky, either.  
22 These are real concerns that lithographers spend a lot  
23 of time worrying about.

24 Q. Uh-huh.

25 A. Errors in the manufacture of the photomask is a

## DR. CHRIS A. MACK - May 14, 2015

1 significant portion of the overall sets of errors that  
2 result in the printed wafers. Jinbo describes a method  
3 of printing two patterns that are closer to each other  
4 than could be obtained with a single patterning step by  
5 very specifically using one mask and keeping it in the  
6 scanner throughout both the first and the second  
7 exposures resulting in a more accurate pattern than  
8 would be obtained through the use of two masks.

9 Q. Okay. So if I had a mask that was designed to  
10 be identical to the first mask within the tolerances  
11 that are allowed in the industry and I perform the  
12 method of Jinbo, but instead of using the same mask, I  
13 swapped out the identical mask, would that be the method  
14 that's described in the 084 patent?

15 A. You haven't given me a complete description of  
16 the method to know whether or not it practices all the  
17 elements of the claim, so I can't answer the question.

18 Q. Okay. The criticism that I understand that  
19 you've raised with Jinbo is that Jinbo uses a single  
20 mask. That's your interpretation of Jinbo, correct?

21 A. Correct.

22 Q. Okay. Because it uses a single mask, it's your  
23 argument that, in the second patterning step, Jinbo has  
24 not patterned with a second pattern, it's the same as  
25 the first pattern?

## DR. CHRIS A. MACK - May 14, 2015

1 A. That's correct.

2 Q. Okay. So following the same steps of Jinbo but  
3 prior to doing the second patterning step, removing the  
4 first mask and inserting an identical mask to the  
5 tolerances that can be created as normally accepted in  
6 the industry and using that second mask for the second  
7 patterning step, would that be the method described in  
8 the 084 patent?

9 A. Well, Jinbo includes shifting the wafer.

10 Q. Right.

11 A. And that's not discussed at all in the 084  
12 patent.

13 Q. Okay. The -- does changing the masks between  
14 the patterning steps affect your opinion of whether or  
15 not Jinbo discloses the method of the 084 patent?

16 A. Well, the 084, in my opinion, requires a second  
17 pattern --

18 Q. Uh-huh.

19 A. -- that is not identical to the first patent.

20 Q. Okay.

21 A. So if you had physically two masks that were  
22 otherwise identical and practiced what is described in  
23 Jinbo, you would still not have a second pattern. You  
24 would have the identical first pattern but just used on  
25 a second mask.

## DR. CHRIS A. MACK - May 14, 2015

1 Q. Okay.

2 A. The result would be a method that neither gave  
3 the benefits of Jinbo nor the benefits of the 084  
4 patent.

5 Q. If you had a second mask, so rather than  
6 shifting the wafer stage, you create a second mask and  
7 you shift the features in the mask by the same amount  
8 that Jinbo specifies to shift the wafer stage, is that a  
9 different pattern?

10 A. Yes.

11 Q. You said that the 084 patent doesn't teach  
12 shifting the wafer stage; is that correct?

13 A. It doesn't teach shifting the wafer stage  
14 between the first and the second patterning steps.

15 Q. Does it teach alignment of the photomask with  
16 the optical equipment?

17 A. No.

18 Q. Does it teach alignment of the wafer stage with  
19 the optical equipment and the reticle?

20 A. These would be operations that were standard in  
21 the industry at the time of the 084 patent.

22 Q. Does it provide a description of how to  
23 implement the 084 patent using direct write exposure?

24 A. None of the embodiments that are explained in  
25 some detail involve direct write.



## DR. CHRIS A. MACK - May 14, 2015

1 Q. Do you believe that the 084 patent would enable  
2 a person of ordinary skill in the art to practice its  
3 method using a direct write exposure?

4 A. Yes.

5 Q. Do you think it would enable a person of  
6 ordinary skill in the art to practice the method of the  
7 084 patent using radiation sources other than  
8 traditional photolithographic radiation sources?

9 A. I would suppose it would depend on what source  
10 you're talking about.

11 Q. Ultraviolet light. Does the 084 patent provide  
12 enough information to teach a person of ordinary skill  
13 in the art how to practice the invention using an  
14 ultraviolet light radiation source?

15 A. Yes.

16 Q. Same question for x-ray radiation.

17 A. Yes.

18 Q. And for E-beam radiation?

19 A. Yes.

20 Q. For vacuum UV radiation?

21 A. Yes.

22 Q. And for ion beam radiation?

23 A. Yes.

24 Q. Turn back to figure 2 for a second. Actually,  
25 I just want to -- what are the -- oh, never mind.

## DR. CHRIS A. MACK - May 14, 2015

1                   Going back to figure 2, so we discussed the  
2 possibility that there would be additional equipment in  
3 between the reticle and the first imaging layer,  
4 correct?

5           A. Yes.

6           Q. And that -- it's actually -- it's likely that  
7 there would be magnification optics, for example?

8           A. Yes.

9           Q. And in the magnification optics, the arrows  
10 that are depicted would not necessarily be perpendicular  
11 to the surface of the wafer?

12           A. I interpret the arrows being depicted as doing  
13 two things. One, showing the regions of the mask that  
14 are transparent, so the arrows are propagating through  
15 the mask and that represents the transparent area. And  
16 then the arrows point to the portions of the resist  
17 layer 220 that nominally will be exposed to light. I  
18 don't think that the arrows represent the true direction  
19 that the light is traveling in a physical sense.

20           Q. The light, in fact, is diffracted as it passes  
21 through the reticle; is that correct?

22           A. That is correct.

23           Q. And so the important -- what's important for  
24 the pattern transfer is the radiation pattern as it  
25 reaches the imaging layer, correct?

## DR. CHRIS A. MACK - May 14, 2015

1 A. Only the radiation pattern that reaches the  
2 imaging layer is at all effective at causing imaging.

3 Q. Okay. Let's turn back to your declaration in  
4 paragraph 27 on page 6.

5 A. Yes.

6 Q. Can you read the first sentence there.

7 A. The 084 patent explicitly discloses that the  
8 invention includes a technique of, quote, patterning by  
9 exposure to radiation in accordance with two separate  
10 patterns, end quote.

11 Q. And you're quoting from the abstract of the 084  
12 patent?

13 A. That's correct.

14 Q. Now, you say that the 084 patent includes a  
15 technique of patterning by exposure to two separate  
16 patterns, correct? You didn't say it was limited to.  
17 You used the word "include."

18 A. I don't believe I used the word "include." Oh,  
19 sorry. Yes, explicitly discloses that the invention  
20 includes a technique of -- yes, that's correct.

21 Q. Okay. Well, is it your view that the 084  
22 patent is limited to a technique patterning by exposure  
23 to radiation in accordance with two separate patterns?

24 A. I believe the claim 1 is so limited.

25 Q. And that the -- and that's why you quoted the

DR. CHRIS A. MACK - May 14, 2015

1 abstract, you believe it supports that limitation?

2 A. Yes.

3 Q. Okay. Can you read the full quote including  
4 the language that you omitted from the abstract?

5 A. For another embodiment, a single imaging layer  
6 is patterned by exposure to radiation in accordance with  
7 two separate patterns.

8 Q. So the language "for another embodiment,"  
9 doesn't that suggest that the previously described  
10 embodiments are not so limited?

11 A. If all we read was an abstract, I can see how  
12 you might conclude that, but this sentence, when read in  
13 conjunction with the rest of the specification, makes  
14 clear that the limitation of two separate patterns  
15 applies to the first embodiment described earlier in the  
16 abstract.

17 Q. So you think that was a fair characterization  
18 of the abstract by omitting the "for another embodiment"  
19 language?

20 A. Yes.

21 Q. And you say in the -- your declaration you  
22 continue that the 084 patent consistently states that  
23 the first pattern is embodied in the first mask and the  
24 second pattern is embodied in the second mask. You see  
25 that?

DR. CHRIS A. MACK - May 14, 2015

1 A. Yes.

2 Q. But the -- wouldn't you agree that the 084  
3 patent covers maskless lithography systems?

4 MR. HOPEN: Objection to form.

5 A. Yes, it does.

6 Q. So is it then inaccurate to say that the 04 --  
7 084 patent consistently states that the first pattern is  
8 embodied in the first mask and the second pattern is  
9 embodied in the second mask?

10 A. No.

11 Q. And how so?

12 A. I didn't imply -- I didn't mean to imply in the  
13 statement that the embodiment of using photomasks to  
14 create the pattern is the only embodiment described and  
15 claimed in the 084 patent, but in embodiments that use  
16 photomasks inconsistently describes that the first  
17 pattern is obtained from the first mask and the second  
18 pattern is obtained from the second mask.

19 Q. You cite to figures 7 -- well, 2, 4, 7, 9, 13,  
20 and 15 in the accompanying descriptions?

21 A. Yes.

22 Q. Are you aware that figure -- the embodiment  
23 corresponding to figures 7, 9, 13, and 15 are not  
24 claimed in the 084 patent?

25 A. I don't recall.

DR. CHRIS A. MACK - May 14, 2015

1 Q. Did you know that those figures were prosecuted  
2 and claimed in a divisional application from the 084  
3 patent?

4 A. I do recall something like that, yes.

5 Q. Did you review the divisional patent in forming  
6 your analysis?

7 A. I -- at -- very early in my work, I did review  
8 that divisional patent, but not specifically when  
9 forming my opinions and putting them down in this  
10 declaration.

11 Q. Did you review the file history for the  
12 divisional application?

13 A. I reviewed the file history for the 084. I  
14 don't recall whether that included the file history for  
15 the divisional.

16 Q. Are you aware that the patentee attempted to  
17 claim a second pattern different from the first pattern  
18 in the divisional application?

19 A. I don't recall.

20 Q. So you didn't consider that they attempted to  
21 add that claim amendment and then withdrew the claim  
22 amendment?

23 MR. HOPEN: Objection, form.

24 A. I do recall something about that, but I can't  
25 remember the details.

## DR. CHRIS A. MACK - May 14, 2015

1 Q. If you would turn to a question I asked you a  
2 little bit ago about programming a pattern in for a  
3 direct write lithography system and I asked if you could  
4 create a second pattern by providing an instruction that  
5 told the tool to just index every feature a specified  
6 distance in one direction. Do you recall that question?

7 A. I do.

8 Q. And I believe your answer was you were not  
9 aware of whether or not the system tools had that  
10 capability; is that correct?

11 A. That's correct.

12 Q. So assuming -- I'm going to ask you to make an  
13 assumption and assume that the tool does have that  
14 capability. Is it -- is there a distinction for you  
15 between programming individually all of the features  
16 into the tool for the second pattern versus telling the  
17 tool to just index every feature some distance to the  
18 left?

19 A. So I presume that you're asking me this  
20 question in the context of our discussion of the first  
21 pattern and the second pattern.

22 Q. Uh-huh.

23 A. So I said earlier that, if the second pattern  
24 had the same shape and size of the first pattern but was  
25 located in a different location, that that would be a

## DR. CHRIS A. MACK - May 14, 2015

1 separate pattern, a second pattern that is different  
2 from the first pattern. If I loaded in my database a  
3 set of information about where the patterns go and then  
4 through programming modified the location of all those  
5 patterns by indexing all of them a certain amount, I  
6 will have created a second pattern that is different  
7 from the first pattern.

8 Q. Okay. I'll give you an exhibit that's  
9 previously been marked as TSMC-1004. Do you recognize  
10 this?

11 A. Yes.

12 Q. And what is it?

13 A. It is a Japanese patent application that we  
14 have referred to as Jinbo.

15 MR. CUNNING: I apologize. Can we take a  
16 brief five-minute break?

17 MR. HOPEN: Sure.

18 (Break taken from 11:26 a.m. to 11:39 a.m.)

19 Q. Okay. Do you have Jinbo in front of you still?

20 A. I do.

21 Q. Okay. Do you agree that Jinbo provides a  
22 disclosure that would enable a person of ordinary skill  
23 in the art to create a composite resist pattern with a  
24 feature spacing that's beyond the resolution limit of  
25 the photolithography equipment used?

HANNA & HANNA, INC.  
713.840.8484



## DR. CHRIS A. MACK - May 14, 2015

1 A. I have not studied Jinbo to sufficient detail  
2 to make a legal determination of enablement.

3 Q. Okay. Do you think a person of ordinary skill  
4 in the art could replicate the method disclosed in  
5 Jinbo, the specific embodiment?

6 A. I have not studied Jinbo in any detail with  
7 respect to forming an opinion on that. The best I could  
8 offer would be an off-the-cuff opinion, not a reasoned  
9 opinion based on analysis.

10 Q. And what's your off-the-cuff opinion?

11 A. Yes.

12 Q. Do you agree that Jinbo achieves the same  
13 result of the 084 patent of creating a final resist  
14 pattern having dimensions beyond the resolution limits  
15 of the lithographic equipment?

16 A. Yes. The same result in that sense.

17 Q. And looking at page 3 of TSMC-1004 --

18 A. Oh, I'm sorry.

19 Q. Yeah, that's Jinbo. I'm sorry.

20 A. Page 3?

21 Q. Uh-huh.

22 A. Okay.

23 Q. Under the section at the bottom headed  
24 "operation," it reads, with construction -- with the  
25 construction of this invention, a final -- a first

## DR. CHRIS A. MACK - May 14, 2015

1 resist pattern and a second resist pattern are arranged  
2 in a prescribed relationship on a substrate. For  
3 example, a space of the second resist pattern is  
4 arranged in an area corresponding to a space section of  
5 the first resist pattern on the substrate for forming  
6 resist patterns, and the patterns can become the final  
7 resist pattern. Do you see that?

8 A. Yes.

9 Q. Jinbo refers to the patterns that are created  
10 as a first resist pattern and a second resist pattern,  
11 correct?

12 A. Yes.

13 Q. And Jinbo accomplishes creating a first resist  
14 pattern and a second resist pattern, in your view, using  
15 a single mask?

16 A. Yes.

17 Q. So it is possible to create a first resist  
18 pattern and a second resist pattern where the features  
19 are located in different places using a single mask?

20 A. Yes.

21 Q. Accepting your premise that Jinbo teaches the  
22 use of a single mask in between the first and second  
23 patterning steps, would a person of ordinary skill in  
24 the art at the time that the 084 patent was filed have  
25 been able to replicate the method taught in Jinbo but

## DR. CHRIS A. MACK - May 14, 2015

1 using a second mask where they patterned the features in  
2 the mask shifted a distance to the left rather than  
3 moving the wafer stage?

4 A. That's a difficult question. That is not  
5 necessarily obvious. Jinbo achieves results, for  
6 example, as shown in Figure 1(E). And my copy is a  
7 little bit blurry, but if I'm reading this correctly, we  
8 have a feature that's labeled as 15a.

9 Q. Uh-huh.

10 A. And then next to it, a feature that's labeled  
11 as 13b. Am I reading that correctly?

12 Q. I believe that's correct, yeah.

13 A. And then --

14 Q. I'm following you.

15 A. And then next to it a feature that's labeled as  
16 15a. One of the major difficulties in making a double  
17 patterning process like this work, either the double  
18 patterning process that's described in Jinbo or the  
19 double patterning process that's described in the 084 is  
20 the fact that positional errors in the printing of  
21 pattern 13b -- feature 13b, excuse me, results in  
22 dimensional errors in the gap between 13b and 15a.

23 So we see to the right of 13b a gap between  
24 that feature and the feature printed in the first resist  
25 labeled as 15a and a gap to the left between feature 13b

**DR. CHRIS A. MACK - May 14, 2015**

1 and feature 15a. Any positional errors in the printing  
2 of feature 13b say it's moved a little bit to the right  
3 would make the right side gap too small and the left  
4 side gap too large.

5           Jinbo has a clever solution to that  
6 problem. That solution is to use a single photomask  
7 mounted in the projection lithography tool and aligned  
8 and then not moved between the first and the second  
9 patterning steps. Instead, the position of the stage is  
10 used to accurately position the wafer underneath the  
11 first pattern to create the second resist pattern. This  
12 solution to a difficult problem is not what happens in  
13 the 084 patent.

14           The 084 patent uses separate masks, two  
15 separate patterns and suffers. As a result, the more  
16 difficult problem of getting the second pattern properly  
17 positioned underneath the first pattern, though it adds  
18 the benefits of extra flexibility in having different  
19 patterns possible than is possible in Jinbo.

20           Q. In Jinbo, between the first and the second  
21 pattern, the wafer is removed from the wafer stage,  
22 correct?

23           A. Yes.

24           Q. So the wafer still has to be placed back onto  
25 the wafer stage and aligned with the exposure apparatus

DR. CHRIS A. MACK - May 14, 2015

1 and the reticle in between the two patterning steps?

2 A. Yes.

3 Q. Is that correct?

4 A. That's correct.

5 Q. In the 084 patent, you describe that it  
6 confronts and solves a more difficult problem of  
7 aligning the second pattern over the first pattern when  
8 it uses a second mask. Is that a fair characterization  
9 of your testimony?

10 A. No, I don't believe I said that it confronts  
11 and solves that problem.

12 Q. Okay. Well, what was it that you said?

13 A. The method described in the 084 patent will  
14 suffer from greater errors in, for example, the  
15 dimensional gap between a first pattern placed in close  
16 proximity to a second pattern as compared to Jinbo.

17 Q. Does the 084 patent anywhere in its  
18 specification address those dimensional error -- the  
19 issue of the errors that are being countered by placing  
20 the second pattern over the first pattern?

21 A. No.

22 Q. Does it tell a person of ordinary skill in the  
23 art how to solve the problem of the greater dimensional  
24 errors that would be encountered by placing a second  
25 pattern over the first pattern?

## DR. CHRIS A. MACK - May 14, 2015

1           A. A person of ordinary skill in the art was well  
2 aware and was -- well established standard practice in  
3 the industry that the -- what we call overlay errors,  
4 the positioning accuracy error of one layer relative to  
5 another layer, influences the closest distance that  
6 you're allowed to put two layers to each other. This  
7 was ubiquitous practice in understanding in the  
8 semiconductor industry in the 1994 time frame.

9                         We had what we called design rules that  
10 said you're not allowed to print one pattern any closer  
11 than X or Y or some number to a previously printed  
12 pattern because of the inaccuracies in overlay. This  
13 method of taking into account the inevitable overlay  
14 errors was a standard part of the practice of  
15 lithography for decades before the 084 patent was filed  
16 and was part of the knowledge of a person of ordinary  
17 skill in the art at the time of the 084 patent.

18           Q. And that knowledge was separate and apart from  
19 the 084 patent?

20           A. Yes.

21           Q. The 084 patent doesn't make any contribute --  
22 contribution to that knowledge?

23           A. That's correct.

24           Q. And in the 1994 time frame, are you -- do you  
25 recall what -- you mentioned that there were design

## DR. CHRIS A. MACK - May 14, 2015

1 rules that would specify, you know, how close you could  
2 print one feature to another feature. Do you know what  
3 those distances were?

4 A. No.

5 Q. So returning back to my question about a person  
6 of ordinary skill in the art who has Jinbo in front of  
7 them and decides, instead of shifting the wafer stage, I  
8 want to attempt to create a second mask and I'll move  
9 all the features over by a distance .3 microns in the  
10 mask. Would the person of ordinary skill in the art at  
11 the time have been able to do that?

12 A. Without going too far afield of your question,  
13 I think you're referring to, when you said a shift of  
14 .3 microns, a particular place in the Jinbo  
15 specification that I think is a typographical error.

16 Q. .6 microns?

17 A. Yes.

18 Q. Okay.

19 A. So I think we all understand that it's supposed  
20 to be .6 microns --

21 Q. Uh-huh.

22 A. -- in the Jinbo patent, and that's the proper  
23 distance that the wafer should be shifted. So let me  
24 try to repeat your question --

25 Q. Uh-huh.

## DR. CHRIS A. MACK - May 14, 2015

1 A. -- and see if I understood it. You asked would  
2 it be within the capabilities of a person of ordinary  
3 skill in the art to create a second mask that was  
4 otherwise identical to the first mask, though its  
5 patterns were shifted by .06 microns?

6 Q. I think it's .6 microns, isn't it?

7 A. Oh, point -- yes, of course, .6 microns.

8 Q. Yes.

9 A. And my answer is, yes, I believe that would be  
10 within the scale of a person of ordinary skill in the  
11 art.

12 Q. And a person -- at the time, a person of  
13 ordinary skill in the art would have a reasonable  
14 expectation of success in designing that mask and  
15 practicing the method disclosed in Jinbo?

16 A. That is less clear. Because the actual  
17 application of the hypothetical that you just stated, I  
18 create a second mask that has not only the same features  
19 but are not only shifted by an amount .6 microns would  
20 result in a larger distribution, a larger range of  
21 errors in the gaps between, say, Feature 13b and feature  
22 15a, as shown in Figure 1(E) of Jinbo.

23 This distribution could easily have been,  
24 at the time of Jinbo, too large for the application that  
25 Jinbo was -- the result that Jinbo is trying to achieve.



## DR. CHRIS A. MACK - May 14, 2015

1 Since Jinbo doesn't teach that method, it's unclear if  
2 it was achievable.

3 Q. At the time that the 084 patent was filed,  
4 would that have been within the scale of a person of  
5 ordinary skill in the art?

6 A. Would what have been in the scale?

7 Q. Taking the method described in Jinbo and  
8 instead of shifting the wafer stage by .6 microns in the  
9 X direction, creating a second mask, shifting the  
10 features in the mask .6 microns, and creating a second  
11 pattern with the features placed into the spaces between  
12 the features in the first pattern?

13 MR. HOPEN: Objection to form.

14 A. Well, I think I testified earlier that it was  
15 within the scale of a person of ordinary skill in the  
16 art to be able to create that mask and use it. What I  
17 was unclear about was whether or not, especially for the  
18 dimension -- specific dimensions described in Jinbo, the  
19 result would be adequate. That, I'm not sure of.

20 At the time of the 084 patent, because the  
21 084 patent invents the use of a second mask with a  
22 second pattern, it was within the capabilities of a  
23 person of ordinary skill in the art at that time since  
24 it was invented at that time.

25 Q. Okay. So just prior to the filing of the 084

## DR. CHRIS A. MACK - May 14, 2015

1 patent, without the benefit of the disclosure of the 084  
2 patent, would a person of ordinary skill in the art have  
3 been able to take the method described in Jinbo and  
4 create a second mask with the feature shifted at  
5 .6 microns and place the features within the spaces  
6 created by the first patterning layer?

7 MR. HOPEN: Objection, form.

8 A. I suspect it would have been possible just  
9 before the filing of the 084 patent to modify Jinbo in  
10 such a way.

11 Q. Okay. And the difficulties that you described  
12 regarding differences in positional placement tolerances  
13 for overlay of a second mask over the layer created by a  
14 first mask, the 084 patent provides no information in  
15 one skill -- one of skill in the art as to how to solve  
16 those problems?

17 A. That's correct.

18 Q. Were -- would there be -- would a person of  
19 ordinary skill in the art have a reason to create two  
20 separate masks with different patterns rather than a  
21 single mask shifted?

22 A. Yes.

23 Q. And what would be some of the reasons that a  
24 person of ordinary skill in the art would have desired  
25 to create a second mask with a separate pattern rather

## DR. CHRIS A. MACK - May 14, 2015

1 than a -- use the first mask shifted in the X direction,  
2 for example?

3 A. Well, first and foremost, the shift of the  
4 wafer, as described in Jinbo, occurs and can occur only  
5 in one direction. Thus, the benefit of getting patterns  
6 closer to each other as possible in a single patterning  
7 step is only achieved in one direction. It is in the  
8 direction of the shift. Our wafers and devices and  
9 patterns that we're trying to print are, in fact, too  
10 dimensional, and we would get no benefit in the other  
11 direction, the direction not shifted when applying the  
12 teachings of Jinbo.

13 The 084, on the other hand, by using the  
14 second mask, would enable us to get features closer to  
15 each other that could be achieved with a single  
16 patterning step in both the X direction and the Y  
17 direction. That's the first major advantage. The  
18 second limitation of Jinbo that is overcome by the 084  
19 patent is that all of the patterns being printed in the  
20 second photoresist must be identical to the first  
21 pattern being printed and the wafer is shifted by one  
22 amount. This amount is optimal for patterns that have a  
23 single pitch.

24 Now, there are certainly some applications  
25 where that is exactly what is needed and that is all

## DR. CHRIS A. MACK - May 14, 2015

1 that is needed, so Jinbo has value.

2 Q. All right.

3 A. But the 084, by enabling a second mask, also  
4 allows a variety of pitches to be used and to benefit  
5 from the invention.

6 Q. At the time of Jinbo, was it standard in the  
7 industry to have resist patterns that did not consist  
8 merely of repeating features with a single pitch?

9 A. There are many devices and device layers which  
10 predominantly are made up of single layer with single  
11 features going in one direction with one pitch, in  
12 particular, the memory array of a memory cell. However,  
13 there were even more examples of device layers that had  
14 more complicated features than just lines and spaces of  
15 one pitch and one direction.

16 Q. And that was true at the time that Jinbo was  
17 filed?

18 A. Yes.

19 Q. Was it -- in manufacturing a chip even back in  
20 1994, was it well known and conventional to use  
21 different masks in the same lithography tool at  
22 different times?

23 A. Yes.

24 Q. And would you agree that, even in Jinbo, there  
25 is a second patterning step, a second exposure of the

DR. CHRIS A. MACK - May 14, 2015

1 resist, that occurs later in time than the first  
2 patterning step?

3 A. Yes.

4 Q. Have you reviewed the claim construction order  
5 that the district court issued in the companion  
6 litigation that DSS has filed against TSMC and Samsung  
7 related to the 084 patent?

8 A. I have briefly read it. I haven't reviewed it  
9 in any detail.

10 MR. CUNNING: Can we mark as TSMC-1016 --

11 MR. LYTVYN: Do you have an extra copy for  
12 us?

13 MR. CUNNING: -- yes -- claim construction  
14 memorandum and order.

15 (Exhibit TSMC-1016 marked.)

16 Q. Do you recognize TSMC1-1016? I'm sorry,  
17 TSMC-1016.

18 A. It looks familiar.

19 Q. Okay. And this is the claim construction  
20 memorandum order issued in DSS Technology, Inc. vs.  
21 Taiwan Semiconductor Manufacturing Company, Limited, et  
22 al., Civil Action No. 2:14-CV-199; is that correct?

23 A. Yes.

24 Q. Okay. Sorry. Give me a second.

25 MR. CUNNING: Why don't we do this, give

DR. CHRIS A. MACK - May 14, 2015

1 me --

2 MR. HOPEN: Scott, did we get notice for  
3 this -- for this depo?

4 MR. CUNNING: I don't know what you're  
5 asking me.

6 MR. HOPEN: For this claim construction.

7 MR. CUNNING: I don't know what you're  
8 asking me.

9 MR. HOPEN: Did we get notice of this  
10 exhibit on our list of exhibits on this deposition?

11 MR. CUNNING: Oh, on the deposition  
12 notice --

13 MR. HOPEN: Yeah.

14 MR. CUNNING: -- was the exhibit called  
15 out?

16 MR. HOPEN: I just don't recall seeing  
17 this.

18 MR. CUNNING: I don't believe that it was.  
19 I don't know that -- I don't believe it's required to  
20 list --

21 MR. LYTVYN: It is.

22 MR. HOPEN: All right. We just -- we'll  
23 just put it on --

24 MR. CUNNING: Okay. You have an objection?

25 MR. HOPEN: I've got an objection on that,

DR. CHRIS A. MACK - May 14, 2015

1 but go ahead.

2 MR. CUNNING: I have a different  
3 interpretation of the rule, but let's go off the record.  
4 I've got just a couple of questions on this. Let me  
5 organize, and then I think we'll be -- that way, I can  
6 proceed through the last bit fairly efficiently and  
7 probably be done pretty soon.

8 MR. HOPEN: Great.

9 (Break taken from 12:06 p.m. to 12:14 p.m.)

10 Q. Welcome back. I won't promise I only have one  
11 question because no attorney that says that is telling  
12 the truth. I'll say I only have a few questions left.

13 If you can turn to page 18 of TSMC-1016  
14 which is the claim construction order for the district  
15 court. And at the top of the page there in bold, do you  
16 see the court's construction of first pattern and second  
17 pattern?

18 A. Yes.

19 Q. Okay. If you were to apply the district  
20 court's construction of first pattern and second  
21 pattern, would Jinbo read on the claim 1 of the 084  
22 patent?

23 A. In forming my opinions that I put down in my  
24 declaration --

25 Q. Uh-huh.

## DR. CHRIS A. MACK - May 14, 2015

1 A. -- I used the construction provided in the --  
2 by the PTAB.

3 Q. Uh-huh.

4 A. All my opinions as set forth in the declaration  
5 are based on that construction. I have not attempted to  
6 analyze Jinbo in view of the construction presented in  
7 this document and have formed no opinion about that.

8 Q. And under the PTABs construction, it's your  
9 view that the first pattern must be different than the  
10 second pattern, correct?

11 MR. HOPEN: Objection, form.

12 A. I mean, it depends a little bit on what you  
13 mean by different, but basically, yes.

14 Q. And as construed by the district court here in  
15 TSMC-1016, there's no requirement that the first pattern  
16 is different than the second pattern; is that correct?

17 A. This construction that we just read does not  
18 describe that requirement.

19 Q. So if you applied the district court's  
20 construction, would Jinbo disclose each limitation of  
21 the -- of claim 1 of the 084 patent?

22 A. To answer that question would require a fair  
23 amount of analysis that I haven't done. The  
24 construction in this document involves all of -- many of  
25 the terms in claim 1, and I would have to review all of



DR. CHRIS A. MACK - May 14, 2015

1 those constructions before answering your question.

2 Q. All right.

3 MR. CUNNING: I don't have any further  
4 questions for the witness.

5 MR. HOPEN: Are you closing your cross?

6 MR. CUNNING: Yes.

7 MR. HOPEN: All right.

8 MR. CUNNING: With the reservation that I  
9 may ask questions if you choose to examine the witness.

10 MR. HOPEN: Okay. I think we're going to  
11 want to take a quick break. Maybe it's a good time to  
12 have lunch --

13 MR. CUNNING: Okay.

14 MR. HOPEN: -- and probably do redirect.

15 MR. CUNNING: Okay.

16 (Break taken from 12:17 p.m. to 12:59 p.m.)

17 EXAMINATION

18 BY MR. LYTVYN:

19 Q. Okay. So first question is, refer to --  
20 referring to the 084 patent -- I'm not sure what exhibit  
21 number this one is.

22 A. I have it.

23 Q. So you were talking about abstract earlier and  
24 how there's a sentence that begins, for the embodiment.  
25 Could you, Dr. Mack, describe the embodiments disclosed

## DR. CHRIS A. MACK - May 14, 2015

1 in abstract?

2 A. Especially with regard to what the abstract  
3 points out, there's two basic flavors or embodiments  
4 that are discussed in the 084 which have many  
5 similarities but one major difference, and the major  
6 difference is whether or not two imaging layers are used  
7 or one imaging layer. So in the first embodiment, we  
8 use two separate imaging layers, and in the second  
9 embodiment, we use only one imaging layer.

10 Q. Okay. Is there any difference in how these two  
11 embodiments use radiation to pattern the resist layers?

12 A. The embodiments are described using almost  
13 identical language when discussing the two separate  
14 patterns that are being used to form patterns in the  
15 imaging layer, phrases like using a first mask to form  
16 the first pattern and using a second mask to form the  
17 second pattern. The language is essentially identical  
18 when describing all the embodiments.

19 Q. Okay. Next question, if we can look at pattern  
20 owner's DSS response to the petition. I'll just refer  
21 to the same diagram Scott referred to earlier on page 3.

22 A. Okay.

23 Q. So let's also take a look at the 084 patent,  
24 claim 1.

25 A. Okay.

## DR. CHRIS A. MACK - May 14, 2015

1 Q. So the step B and E include language where  
2 we're patterning an imaging layer in accordance with  
3 either first pattern or second pattern step E. So  
4 keeping this language in mind for all consistency  
5 purposes, could you describe what happens when we change  
6 the alignment of different elements of the projection  
7 device as depicted in the diagram on the page 3 of the  
8 patent owner's response?

9 A. Well, one thing that came out in my earlier  
10 testimony under direct examination was the idea that the  
11 pattern that's being exposed into the photoresist is  
12 what really matters, and so the step -- the phrase  
13 "pattern" can be used in multiple ways. Here, it's used  
14 as a verb patterning as in the process of forming the  
15 pattern in the first imaging layer. And then we could  
16 also use the word "pattern" to discuss what's on the  
17 mask. We could also use the word "mask" to discuss what  
18 is being exposed into the photoresist or what the final  
19 result is at the end of exposure and development in the  
20 photoresist.

21 But specifically in claim 1, patterning --  
22 pattern is used three times, right, so patterning refers  
23 to imaging layer, I'm referring to 1(b), is the act of  
24 performing the patterning step in accordance with a  
25 first pattern. So this first pattern is the pattern

## DR. CHRIS A. MACK - May 14, 2015

1 that's being projected onto the photoresist to form a  
2 first pattern layer which is the result of the  
3 patterning step at the end.

4 Now, if I -- your question was what happens  
5 if I start moving things around, like move the wafer --

6 Q. Correct.

7 A. -- Jinbo describes moving the wafer by a  
8 certain amount. Well, you can -- using this figure to  
9 help us visualize this, the figure on page 3 of the  
10 patent owner's response to petition, you can think of  
11 the pattern that's being projected onto the wafer as the  
12 distribution of light as it's showing focusing down to a  
13 small square. If I move the wafer back and forth, that  
14 doesn't change that pattern at all. It's the same  
15 pattern. The wafer's moving, but the pattern that's  
16 being projected onto the wafer remains the same.

17 If I go up to the reticle and I move the  
18 reticle around, that changes the light distribution that  
19 exposes the wafer and potentially changes the pattern  
20 that's being projected onto the wafer, so moving the  
21 reticle and moving the wafer result in -- provide  
22 different results when thinking about the claim language  
23 in the 084 patent.

24 Q. Okay. Perfect. Now, keeping that in mind,  
25 let's flip over to Jinbo. It's Exhibit TSMC-1004.

## DR. CHRIS A. MACK - May 14, 2015

1 A. Okay.

2 Q. And does Jinbo disclose altering the light  
3 distribution that's being projected onto a wafer, in  
4 your opinion?

5 A. I think Jinbo is very careful and clear to make  
6 sure that the reader of this patent understands that the  
7 light distribution that's projected onto the wafer is  
8 not changed between the first patterning step and the  
9 second patterning step.

10 Q. Okay. And a quick follow-up on that, during  
11 cross-examination different techniques were discussed  
12 about changes as far as the reticle, blading, or mask  
13 shifting. What's your understanding of a person in the  
14 ordinary skill in the art after reading the disclosure  
15 of Jinbo? Are such techniques covered by the method of  
16 Jinbo?

17 A. Well, I don't think Jinbo discloses using  
18 masking blades, Jinbo doesn't disclose moving the mask  
19 or changing the mask in any way.

20 Q. Okay. And I know on the cross exam you were  
21 asked a question if such techniques were known in the  
22 art and if they were possible. I'm going to ask a  
23 slightly different question. Are those techniques in  
24 any way necessary to carry out the method of Jinbo to  
25 achieve the intended result?

DR. CHRIS A. MACK - May 14, 2015

1 A. No.

2 MR. LYTVYN: No further questions. Close  
3 redirect.

4 FURTHER EXAMINATION

5 BY MR. CUNNING:

6 Q. When you move -- you were asked about moving  
7 the wafer versus moving the reticle and exposing the  
8 pattern onto an imaging layer. I believe you said that  
9 moving the reticle changes the pattern, but moving the  
10 wafer doesn't change the pattern. Is that a fair  
11 summary of your testimony?

12 A. First of all, as I said, we use the word  
13 "pattern" in different ways, so I was specifically  
14 referring to the pattern that's being projected at the  
15 bottom of the projection lens.

16 Q. When you move the wafer, the pattern that is  
17 being projected at the bottom of the projected lens is  
18 projected into a different location on the wafer,  
19 correct?

20 A. Yes.

21 Q. Okay.

22 MR. CUNNING: I don't have any further  
23 questions.

24 MR. LYTVYN: Nothing else.

25 (Deposition concluded at 1:08 p.m.)

DR. CHRIS A. MACK - May 14, 2015

1	CHANGES AND SIGNATURE		
2	WITNESS NAME: DR. CHRIS A. MACK		DATE: MAY 14, 2015
3	PAGE LINE	CHANGE	REASON
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19	I declare under penalty of perjury that the		
20	foregoing is true and correct with the above changes, if		
21	any.		
22	Executed on (date) _____.		
23			
24	_____ Signature		
25			

HANNA & HANNA, INC.  
713.840.8484

1 STATE OF TEXAS )

2 I, Larissa L. McPhearson, Certified Shorthand  
3 Reporter in and for the State of Texas, hereby certify  
4 to the following:

5 That the witness, DR. CHRIS A. MACK, was duly sworn  
6 by me and that the transcript of the oral deposition is  
7 a true record of the testimony given by the witness and  
8 the statements of counsel;

9 That the witness requested a review of the  
10 deposition. Changes, if any, will be provided to the  
11 parties after the 30-day period has expired.

12 That the time used by counsel for the parties is as  
13 follows:

14 Mr. Scott Cunning - 02 Hours:37 Minutes

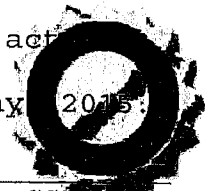
15 Mr. Andriy Lytvyn - 00 Hours:08 Minutes

16 I further certify that I am neither counsel for,  
17 related to, nor employed by any of the parties or  
18 attorneys in the action in which this proceeding was  
19 taken, and further that I am not financially or  
20 otherwise interested in the outcome of the act

21 Certified to by me this 19th day of May 2015

22 *Larissa L. McPhearson*

Larissa L. McPhearson, Texas CSR 8371  
23 Expiration Date: 12/31/16  
24 Hanna & Hanna  
1812 West Sam Houston Parkway North  
Houston, Texas  
25 (713)840-8484





## DR. CHRIS A. MACK - May 14, 2015

<b>A</b>	70:21	<b>allows</b> 25:17	<b>appear</b> 56:18	74:24, 77:23
<b>able</b> 74:25	<b>additional</b> 49:6	26:24, 84:4	<b>Appearances.....</b>	78:1, 78:17
79:11, 81:16	54:7, 57:4, 60:4	<b>alter</b> 13:24	4:3	79:6, 79:10
82:3	66:2	<b>altered</b> 13:24	<b>appears</b> 23:10	80:3, 80:11
<b>above-styled</b>	<b>address</b> 5:9	<b>altering</b> 93:2	31:16	80:13, 81:5
1:19	5:21, 77:18	<b>alternate</b> 11:17	<b>application</b> 70:2	81:16, 81:23
<b>abstract</b> 67:11	<b>adds</b> 76:17	<b>amendment</b>	70:12, 70:18	82:2, 82:15
68:1, 68:4	<b>adequate</b> 81:19	70:21, 70:22	72:13, 80:17	82:19, 82:24
68:11, 68:16	<b>adjacent</b> 15:23	<b>amount</b> 26:4	80:24	93:14, 93:22
68:18, 89:23	35:12, 36:13	36:10, 42:11	<b>Application.....</b>	<b>asked</b> 71:1, 71:3
90:1, 90:2	<b>adjunct</b> 5:15	64:7, 72:5	4:18	80:1, 93:21
<b>accepted</b> 63:5	<b>advantage</b>	80:19, 83:22	<b>applications</b>	94:6
<b>Accepting</b> 74:21	83:17	83:22, 88:23	83:24	<b>asking</b> 71:19
<b>accident</b> 8:1	<b>affect</b> 63:14	92:8	<b>applied</b> 88:19	86:5, 86:8
<b>accommodate</b>	<b>affirmed</b> 5:3	<b>analysis</b> 70:6	<b>applies</b> 68:15	<b>assessing</b> 27:9
7:9, 35:23	<b>afield</b> 79:12	73:9, 88:23	<b>apply</b> 87:19	<b>assistant</b> 20:25
<b>accompanying</b>	<b>Agency</b> 8:20	<b>analyze</b> 88:6	<b>applying</b> 83:11	<b>associated</b> 28:6
69:20	<b>ago</b> 50:20, 71:2	<b>Andriy</b> 2:20, 4:5	<b>approach</b> 11:22	48:23, 49:1
<b>accomplished</b>	<b>agree</b> 7:13, 69:2	20:16, 20:18	11:24, 49:2	<b>assume</b> 33:4
27:14	72:21, 73:12	96:15	<b>approaches</b>	71:13
<b>accomplishes</b>	84:24	<b>andriy.lytvyn...</b>	11:17, 13:21	<b>assuming</b> 58:10
74:13	<b>Ah</b> 21:10	2:24	14:17	71:12
<b>account</b> 30:2	<b>ahead</b> 7:18	<b>answer</b> 6:21	<b>appropriate</b>	<b>assumption</b>
78:13	45:15, 87:1	7:12, 7:18	14:24, 55:4	71:13
<b>accuracy</b> 61:8	<b>al</b> 85:22	28:23, 55:21	<b>approximately</b>	<b>atomic</b> 13:23
61:12, 78:4	<b>align</b> 26:24	62:17, 71:8	6:8, 32:22	<b>attempt</b> 7:2
<b>accurate</b> 27:1	<b>aligned</b> 25:12	80:9, 88:22	<b>area</b> 11:25	79:8
30:3, 36:22	25:15, 28:5	<b>answering</b> 89:1	15:25, 35:15	<b>attempted</b> 70:16
43:16, 46:3	28:9, 28:10	<b>answers</b> 6:14	43:5, 66:15	70:20, 88:5
60:25, 62:7	28:12, 42:9	6:19, 6:22	74:4	<b>attempting</b>
<b>accurately</b>	61:9, 76:7	55:18	<b>argument</b> 62:23	61:16, 61:17
27:25, 76:10	76:25	<b>Anton</b> 2:20	<b>arranged</b> 74:1	<b>attended</b> 8:4
<b>achievable</b> 81:2	<b>aligning</b> 27:22	20:16	74:4	8:7, 8:9
<b>achieve</b> 80:25	77:7	<b>anton.hopen@s...</b>	<b>array</b> 48:21	<b>attorney</b> 87:11
93:25	<b>alignment</b> 25:10	2:24	84:12	<b>attorneys</b> 7:15
<b>achieved</b> 83:7	26:23, 27:14	<b>apart</b> 35:12	<b>arrows</b> 54:11	20:13, 20:14
83:15	27:23, 28:3	78:18	66:9, 66:12	20:22, 96:18
<b>achieves</b> 73:12	28:11, 33:20	<b>apologize</b> 5:19	66:14, 66:16	<b>Austin</b> 5:10
75:5	35:4, 64:15	7:25, 28:22	66:18	5:15, 8:10
<b>achieving</b> 27:11	64:18, 91:6	30:14, 30:24	<b>art</b> 21:23, 22:4	<b>available</b> 14:11
<b>act</b> 91:23	<b>Allen</b> 5:8	47:14, 72:15	22:11, 22:13	<b>Avenue</b> 2:22
<b>action</b> 85:22	<b>allotted</b> 26:5	<b>apparatus</b> 14:25	22:16, 22:21	<b>aware</b> 13:17
96:18, 96:20	<b>allow</b> 25:11	16:8, 58:15	27:7, 44:10	27:8, 42:22
<b>actual</b> 80:16	59:17	59:4, 59:14	51:6, 53:8, 65:2	69:22, 70:16
<b>add</b> 59:15	<b>allowed</b> 62:11	60:6, 76:25	65:6, 65:13	71:9, 78:2
	78:6, 78:10	<b>APPEAL</b> 1:2	72:23, 73:4	

## DR. CHRIS A. MACK - May 14, 2015

<b>B</b>	82:1, 83:5 83:10, 84:4	<b>build</b> 39:24 40:10	<b>certainly</b> 48:24 50:11, 83:24	26:9, 26:22 27:3, 48:1, 48:8
<b>bachelor's</b> 8:5	<b>benefits</b> 64:3	<b>built</b> 12:21 13:11	<b>Certificate</b> ..... 4:7	56:1, 56:7, 57:1 58:6, 58:9
<b>back</b> 10:11	64:3, 76:18	<b>business</b> 5:16 5:22, 5:23	<b>Certified</b> 96:2 96:21	62:17, 67:24 70:17, 70:21
17:10, 24:18	<b>best</b> 73:7		<b>certify</b> 96:3 96:16	70:21, 85:4 85:13, 85:19
28:22, 53:16	<b>beyond</b> 72:24 73:14	<b>C</b>	<b>change</b> 26:3 54:15, 91:5	86:6, 87:14 87:21, 88:21
58:12, 65:24	<b>big</b> 48:15	<b>call</b> 11:16, 13:20 13:20, 14:24	92:14, 94:10 95:3	88:25, 90:24 91:21, 92:22
66:1, 67:3	<b>bit</b> 18:4, 71:2 75:7, 76:2, 87:6	15:7, 42:5 44:23, 51:9 78:3	<b>changed</b> 61:11 93:8	<b>claimed</b> 23:19 69:15, 69:24 70:2
76:24, 79:5	<b>bladed</b> 57:7 58:5	<b>called</b> 9:2, 9:10 11:3, 11:10	<b>changes</b> 92:18 92:19, 93:12	<b>clarify</b> 7:3 <b>clear</b> 18:4, 24:1
84:19, 87:10	<b>blade</b> 49:14 49:16, 49:18	11:18, 12:1 12:5, 12:18	94:9, 95:1 95:20, 96:10	25:18, 54:1 56:17, 68:14
92:13	50:21	13:22, 15:11 16:12, 35:13	<b>Changes</b> ..... 4:6	80:16, 93:5 <b>clever</b> 76:5
<b>background</b> 8:3	<b>bladed</b> 57:7 58:5	49:9, 78:9 86:14	<b>changing</b> 63:13 93:19	<b>close</b> 44:23 77:15, 79:1 94:2
<b>based</b> 17:20	<b>blades</b> 49:10 49:12, 49:22	<b>capabilities</b> 17:18, 59:16	<b>characterization</b> 68:17, 77:8	<b>closed</b> 26:6 <b>closer</b> 56:4, 62:3
73:9, 88:5	50:1, 50:1	80:2, 81:22	<b>chemical</b> 8:6 8:10, 26:3	78:10, 83:6 83:14
<b>basic</b> 24:22 90:3	50:23, 50:24	<b>capability</b> 71:10 71:14	<b>chemically</b> 13:24, 13:24	<b>closest</b> 78:5 <b>closing</b> 89:5
<b>basically</b> 12:8 88:13	53:1, 53:3	<b>capable</b> 42:2	<b>chemistry</b> 8:5 <b>chip</b> 43:18, 45:8	<b>coat</b> 30:11 <b>coated</b> 9:12
<b>basis</b> 44:21	93:18	<b>car</b> 8:1	84:19	10:2, 10:15 12:16, 15:3
<b>beam</b> 11:25	<b>blading</b> 50:18 57:13, 93:12	<b>careful</b> 93:5	<b>chips</b> 41:14	25:9, 25:13 26:1, 29:2, 29:5
12:15, 15:3	<b>blanker</b> 15:11 15:12	<b>carried</b> 61:8	<b>choose</b> 89:9	31:15, 45:16 <b>coating</b> 29:11
15:11, 15:12	<b>block</b> 49:22	<b>carry</b> 93:24	<b>chosen</b> 49:3	29:12, 30:12 <b>coincide</b> 25:25
15:12, 15:21	<b>blocked</b> 25:19	<b>case</b> 20:1, 28:8 29:7, 29:8	<b>Chris</b> 1:13, 1:17 4:4, 4:17, 5:2	<b>collaboration</b> 20:12
17:9, 23:24	<b>blurry</b> 75:7	50:18, 51:11	5:8, 95:2, 96:5	<b>collects</b> 25:23 <b>College</b> 8:8
23:25, 24:1	<b>BOARD</b> 1:2	<b>cases</b> 29:15	<b>Christopher</b> 2:14	<b>column</b> 23:22 24:8, 26:12
65:22	<b>bold</b> 87:15	<b>cause</b> 1:19	<b>christopher.ma...</b> 2:18	
<b>beams</b> 12:15	<b>BOONE</b> 2:4 2:9	<b>causes</b> 26:3	<b>circumstances</b> 8:18, 31:22	
13:16	<b>bottom</b> 73:23 94:15, 94:17	<b>causing</b> 67:2	<b>cite</b> 69:19	
<b>began</b> 8:17, 8:19	<b>Boulevard</b> 1:24 3:4	<b>cell</b> 12:18, 12:18 13:15, 14:6	<b>Civil</b> 1:25, 85:22	
9:2, 14:5	<b>break</b> 7:6, 7:8 7:13, 47:12	14:11, 18:20 18:21, 84:12	<b>claim</b> 4:14, 23:2	
<b>beginning</b> 6:11 6:22	47:16, 72:16	<b>cells</b> 12:22		
<b>begins</b> 16:9	72:18, 87:9	<b>certain</b> 72:5 92:8		
56:13, 89:24	89:11, 89:16			
<b>believe</b> 14:4	<b>brief</b> 72:16			
14:8, 14:13	<b>briefly</b> 8:2, 85:8			
21:16, 21:22	<b>broader</b> 57:1			
22:21, 58:15	<b>BS</b> 21:24			
65:1, 67:18				
67:24, 68:1				
71:8, 75:12				
77:10, 80:9				
86:18, 86:19				
94:8				
<b>benefit</b> 61:13				

## DR. CHRIS A. MACK - May 14, 2015

53:24, 56:14 56:14 <b>combinations</b> 12:21 <b>combined</b> 56:1 61:13 <b>commercial</b> 14:7, 14:10 <b>common</b> 11:11 45:4, 46:5 <b>commonly</b> 11:2 11:17 <b>companion</b> 85:5 <b>Company</b> 1:3 2:2, 85:21 <b>compared</b> 47:2 77:16 <b>complete</b> 31:25 35:9, 35:11 36:23, 36:25 37:4, 38:2 62:15 <b>completely</b> 32:4 45:11, 45:13 45:21, 50:23 <b>complex</b> 12:20 <b>complicated</b> 13:9, 13:11 25:23, 84:14 <b>composite</b> 72:23 <b>concerns</b> 61:22 <b>conclude</b> 68:12 <b>concluded</b> 94:25 <b>confronts</b> 77:6 77:10 <b>conjunction</b> 68:13 <b>consider</b> 43:10 55:4, 60:10 70:20 <b>considered</b> 9:18 9:20, 23:15 <b>considers</b> 60:11 <b>consist</b> 84:7 <b>consistency</b> 91:4 <b>consistently</b>	68:22, 69:7 <b>construction</b> 4:14, 73:24 73:25, 85:4 85:13, 85:19 86:6, 87:14 87:16, 87:20 88:1, 88:5, 88:6 88:8, 88:17 88:20, 88:24 <b>constructions</b> 89:1 <b>construed</b> 88:14 <b>consultant</b> 5:12 <b>consulting</b> 5:16 5:23, 17:11 17:13 <b>contact</b> 9:2, 9:6 9:8, 9:9, 9:16 <b>contain</b> 45:4 <b>contained</b> 47:18 48:5 <b>contains</b> 15:13 39:2, 58:20 <b>contemplated</b> 24:2 <b>context</b> 14:2 19:20, 48:1 71:20 <b>continue</b> 54:25 68:22 <b>contract</b> 18:1 <b>contracting</b> 17:4, 17:15 <b>contribute</b> 78:21 <b>contribution</b> 78:22 <b>control</b> 16:13 <b>conventional</b> 84:20 <b>conversation</b> 17:20 <b>converted</b> 58:23 <b>coordinate</b> 28:6 28:14, 59:15	<b>coordinates</b> 58:16, 59:3 <b>copies</b> 10:19 23:8, 60:17 <b>copy</b> 23:6, 23:10 75:6, 85:11 <b>corners</b> 43:4 <b>correct</b> 6:2 14:22, 15:17 19:6, 27:4 28:23, 30:4 30:5, 32:9 34:15, 34:23 36:19, 38:3 38:8, 38:9 38:25, 39:5 39:12, 39:17 40:16, 41:1 44:6, 47:19 51:19, 54:9 54:10, 54:13 54:22, 56:21 56:25, 59:2 62:20, 62:21 63:1, 64:12 66:4, 66:21 66:22, 66:25 67:13, 67:16 67:20, 71:10 71:11, 74:11 75:12, 76:22 77:3, 77:4 78:23, 82:17 85:22, 88:10 88:16, 92:6 94:19, 95:20 <b>correctly</b> 41:6 75:7, 75:11 <b>correspond</b> 31:24 <b>corresponding</b> 69:23, 74:4 <b>counsel</b> 96:8 96:12, 96:16 <b>countered</b> 77:19 <b>couple</b> 21:8	87:4 <b>course</b> 58:10 80:7 <b>court</b> 6:13, 6:18 6:23, 85:5 87:15, 88:14 <b>court's</b> 87:16 87:20, 88:19 <b>cover</b> 45:21 53:1, 53:3 <b>covered</b> 9:9 49:14, 49:25 50:3, 50:24 58:6, 93:15 <b>covering</b> 10:13 <b>covers</b> 69:3 <b>create</b> 9:13 51:2, 51:13 52:3, 64:6 69:14, 71:4 72:23, 74:17 76:11, 79:8 80:3, 80:18 81:16, 82:4 82:19, 82:25 <b>created</b> 11:19 17:21, 63:5 72:6, 74:9, 82:6 82:13 <b>creates</b> 12:9 <b>creating</b> 73:13 74:13, 81:9 81:10 <b>criterion</b> 27:9 <b>criticism</b> 60:23 62:18 <b>cross</b> 89:5 93:20 <b>cross-examinat...</b> 93:11 <b>cross-sectional</b> 54:21 <b>CSR</b> 1:21, 96:22 <b>Cunning</b> 2:3 5:5, 23:9, 30:15 30:19, 30:24	47:8, 47:11 72:15, 85:10 85:13, 85:25 86:4, 86:7 86:11, 86:14 86:18, 86:24 87:2, 89:3, 89:6 89:8, 89:13 89:15, 94:5 94:22, 96:14 <b>Cunning.....</b> 4:4 <b>Cunning.....94</b> 4:5 <b>cure</b> 61:5 <b>currently</b> 5:11 <b>curve</b> 36:18 <b>cut</b> 35:16, 37:8 37:13, 46:15 46:21 <b>cutting</b> 36:1
<b>D</b>				
<b>D.C</b> 2:5, 2:16 <b>data</b> 58:23 <b>database</b> 15:13 15:15, 16:2 16:11, 58:16 58:20, 58:23 59:18, 59:21 72:2 <b>date</b> 95:2, 95:22 96:23 <b>David</b> 2:9 <b>david.odell@h...</b> 2:12 <b>day</b> 96:21 <b>dealing</b> 18:2 <b>decades</b> 78:15 <b>decides</b> 79:7 <b>declaration</b> 4:17 20:1, 20:5, 20:8 20:11, 20:20 20:23, 21:6 22:25, 23:16				

HANNA & HANNA, INC.  
713.840.8484

## DR. CHRIS A. MACK - May 14, 2015

31:6, 67:3 68:21, 70:10 87:24, 88:4 <b>declare</b> 95:19 <b>decomposed</b> 13:9 <b>defect</b> 61:5 <b>define</b> 40:25 50:9, 50:11 <b>defined</b> 38:20 <b>degree</b> 8:8 21:24, 32:7 <b>degrees</b> 8:5 27:17, 42:21 42:23, 43:9 <b>deliberately</b> 37:20, 41:25 <b>density</b> 45:23 <b>depend</b> 29:14 49:2, 65:9 <b>depending</b> 29:21, 37:2 52:3 <b>depends</b> 28:23 43:11, 44:2 88:12 <b>depicted</b> 31:9 31:23, 32:13 33:1, 39:4 54:20, 55:1 55:6, 55:7 55:16, 56:9 57:6, 57:12 66:10, 66:12 91:7 <b>depicting</b> 32:12 56:10 <b>depiction</b> 31:11 <b>depo</b> 86:3 <b>deposed</b> 6:5 <b>deposited</b> 53:21 <b>deposition</b> 1:12 1:17, 4:16, 5:24 6:1, 6:4, 45:19 86:10, 86:11 94:25, 96:6	96:10 <b>describe</b> 8:2 24:21, 24:22 24:25, 47:21 77:5, 88:18 89:25, 91:5 <b>described</b> 11:10 11:12, 26:19 26:21, 57:22 58:5, 62:14 63:7, 63:22 68:9, 68:15 69:14, 75:18 75:19, 77:13 81:7, 81:18 82:3, 82:11 83:4, 90:12 <b>describes</b> 60:20 62:2, 69:16 92:7 <b>describing</b> 33:9 56:13, 56:22 90:18 <b>description</b> 4:10 16:10, 62:15 64:22 <b>descriptions</b> 69:20 <b>design</b> 29:25 78:9, 78:25 <b>designed</b> 40:25 62:9 <b>designing</b> 80:14 <b>desired</b> 9:5 16:10, 30:2 37:1, 37:2, 37:3 82:24 <b>detail</b> 25:3 64:25, 73:1 73:6, 85:9 <b>details</b> 25:1 70:25 <b>determination</b> 73:2 <b>determine</b> 48:12 <b>determining</b>	50:5 <b>develop</b> 8:23 26:7 <b>developing</b> 45:20 <b>development</b> 17:8, 26:7 91:19 <b>device</b> 16:14 16:16, 18:17 48:21, 84:9 84:13, 91:7 <b>devices</b> 8:22 18:22, 19:1 19:9, 83:8, 84:9 <b>diagram</b> 54:22 55:2, 90:21 91:7 <b>diamond</b> 35:24 <b>diced</b> 35:18 <b>die</b> 13:4, 13:5 31:20, 31:25 32:5, 32:8, 32:9 32:10, 32:19 32:22, 33:3 33:5, 33:8 33:10, 33:13 33:15, 33:16 33:22, 33:23 33:25, 34:19 34:20, 34:21 35:2, 35:6, 35:6 35:7, 35:9 35:11, 35:16 35:22, 36:5 36:9, 36:12 36:14, 36:18 36:21, 36:25 37:5, 37:7, 37:9 37:21, 37:25 38:3, 38:12 38:13, 38:20 38:21, 39:9 39:11, 39:17 39:17, 39:22 39:24, 40:5	40:7, 40:7, 40:8 40:11, 40:12 40:12, 40:23 40:23, 41:10 41:16, 41:23 41:24, 42:5 42:7, 42:8 42:14, 42:16 42:21, 42:25 43:5, 43:13 44:15, 44:22 44:23, 44:24 45:5, 45:5, 45:5 45:6, 45:8 45:11, 45:13 46:1, 46:4, 46:8 46:15, 46:18 46:21, 46:23 47:5, 47:5, 47:6 47:22, 47:25 48:9, 48:10 48:13, 48:16 48:17, 48:18 48:19, 48:20 48:23, 48:24 49:1, 51:15 51:22, 51:24 51:25, 52:4 52:6 <b>dielectric</b> 53:23 <b>dies</b> 34:23 35:13, 39:3 40:2, 41:1 41:22, 47:18 48:11, 51:12 <b>difference</b> 59:23 60:7, 90:5, 90:6 90:10 <b>differences</b> 82:12 <b>different</b> 13:4 22:3, 30:7, 30:8 33:16, 33:18 37:21, 37:23 41:6, 42:7 42:16, 42:19	43:6, 43:8 46:12, 46:22 47:3, 48:5 49:18, 49:19 49:21, 50:4 50:19, 50:23 50:25, 51:2 51:13, 51:19 51:20, 51:25 52:3, 52:9 52:15, 52:16 52:17, 52:19 52:22, 59:18 59:18, 59:25 60:9, 60:14 60:15, 60:19 64:9, 70:17 71:25, 72:1 72:6, 74:19 76:18, 82:20 84:21, 84:22 87:2, 88:9 88:13, 88:16 91:6, 92:22 93:11, 93:23 94:13, 94:18 <b>differently</b> 51:23 <b>difficult</b> 29:21 75:4, 76:12 76:16, 77:6 <b>difficulties</b> 75:16, 82:11 <b>diffracted</b> 25:24 66:20 <b>diffracts</b> 25:21 <b>digital</b> 12:5 12:6, 12:6 12:10, 16:7 16:14, 16:16 16:21, 18:24 18:25 <b>dimension</b> 81:18 <b>dimensional</b> 75:22, 77:15
--	--	---	--	---

HANNA & HANNA, INC.  
713.840.8484

## DR. CHRIS A. MACK - May 14, 2015

77:18, 77:23 83:10 <b>dimensions</b> 73:14, 81:18 <b>dip-pen</b> 13:22 14:5 <b>direct</b> 9:9, 12:1 12:2, 12:17 14:16, 14:18 15:1, 15:7 15:10, 15:15 15:18, 16:9 16:23, 18:19 19:3, 19:5, 19:8 19:11, 22:15 22:17, 22:19 22:23, 23:4 23:20, 24:4 24:6, 24:15 58:12, 58:15 64:23, 64:25 65:3, 71:3 91:10 <b>direction</b> 66:18 71:6, 81:9, 83:1 83:5, 83:7, 83:8 83:11, 83:11 83:16, 83:17 84:11, 84:15 <b>directly</b> 25:16 28:13 <b>disclose</b> 88:20 93:2, 93:18 <b>disclosed</b> 73:4 80:15, 89:25 <b>discloses</b> 61:2 63:15, 67:7 67:19, 93:17 <b>disclosure</b> 72:22 82:1, 93:14 <b>discuss</b> 91:16 91:17 <b>discussed</b> 50:20 57:16, 63:11 66:1, 90:4 93:11	<b>discusses</b> 53:16 <b>discussing</b> 31:13 90:13 <b>discussion</b> 33:9 71:20 <b>distance</b> 35:22 36:4, 36:8 59:13, 59:24 60:8, 71:6 71:17, 75:2 78:5, 79:9 79:23 <b>distances</b> 79:3 <b>distinction</b> 71:14 <b>distribution</b> 80:20, 80:23 92:12, 92:18 93:3, 93:7 <b>district</b> 85:5 87:14, 87:19 88:14, 88:19 <b>divided</b> 34:22 <b>divisional</b> 70:2 70:5, 70:8 70:12, 70:15 70:18 <b>document</b> 19:16 19:18, 20:2 31:1, 31:7, 88:7 88:24 <b>doing</b> 18:19 38:24, 63:3 66:12 <b>double</b> 57:21 75:16, 75:17 75:19 <b>Dr</b> 1:13, 1:17 4:4, 4:17, 5:2 5:6, 89:25, 95:2 96:5 <b>draft</b> 20:11 <b>drafted</b> 20:12 <b>driven</b> 15:12 <b>DSS</b> 1:6, 4:12 19:15, 19:25	30:16, 31:4 32:13, 85:6 85:20, 90:20 <b>DSS-2006</b> 31:24 <b>DSS-2007</b> 4:17 <b>duly</b> 1:18, 96:5  <b>E</b>  <b>E-beam</b> 14:14 14:15, 14:17 14:21, 14:25 15:6, 15:8 15:10, 15:15 15:16, 15:18 16:2, 16:3, 16:9 16:24, 16:25 17:2, 17:5 17:12, 17:21 18:3, 18:7, 18:7 18:8, 18:10 18:16, 22:12 22:14, 23:4 23:20, 23:24 58:17, 59:3 59:3, 59:4 59:14, 60:6 65:18 <b>E-beams</b> 18:15 <b>E-mail</b> 2:7, 2:12 2:18, 2:24, 3:6 <b>earlier</b> 17:20 45:3, 57:16 61:19, 68:15 71:23, 81:14 89:23, 90:21 91:9 <b>early</b> 70:7 <b>easier</b> 6:23 33:10 <b>easily</b> 80:23 <b>edge</b> 44:18 44:22, 44:23 44:25, 45:10 45:12, 46:1 46:4, 46:19	<b>edged</b> 45:22 <b>educational</b> 8:3 <b>effective</b> 67:2 <b>efficiently</b> 87:6 <b>eight</b> 45:5 <b>either</b> 25:15 61:21, 75:17 91:3 <b>elaborate</b> 12:23 <b>electrical</b> 8:6 8:9 <b>electron</b> 12:14 13:16, 17:7 17:9, 23:24 24:1 <b>ELECTRONICS</b> 1:3, 2:13 <b>electrons</b> 12:15 <b>element</b> 26:22 <b>elements</b> 62:17 91:6 <b>embodied</b> 68:23 68:24, 69:8 69:9 <b>embodiment</b> 56:22, 68:5 68:8, 68:15 68:18, 69:13 69:14, 69:22 73:5, 89:24 90:7, 90:9 <b>embodiments</b> 64:24, 68:10 69:15, 89:25 90:3, 90:11 90:12, 90:18 <b>employed</b> 5:11 96:17 <b>enable</b> 42:23 65:1, 65:5 72:22, 83:14 <b>enablement</b> 73:2 <b>enabling</b> 84:3 <b>encompass</b> 48:9 <b>encompasses</b>	48:16 <b>encountered</b> 77:24 <b>engineering</b> 8:6 8:7, 8:9, 8:11 21:24 <b>enhanced</b> 45:20 <b>entire</b> 10:13 10:18, 10:22 10:23, 10:24 10:25, 41:9 41:9, 45:9 45:22, 46:8 46:14, 47:4 47:5, 48:16 48:20, 48:22 50:16, 52:5 <b>environment</b> 37:16 <b>equipment</b> 8:25 9:22, 14:20 64:16, 64:19 66:2, 72:25 73:15 <b>error</b> 41:12 44:14, 44:17 77:18, 78:4 79:15 <b>errors</b> 17:18 41:12, 41:15 61:25, 62:1 75:20, 75:22 76:1, 77:14 77:19, 77:24 78:3, 78:14 80:21 <b>especially</b> 81:17 90:2 <b>essentially</b> 47:24, 90:17 <b>established</b> 78:2 <b>et</b> 85:21 <b>etching</b> 34:6 45:19 <b>eventually</b> 35:15, 39:1
--	--	--	--	---

HANNA & HANNA, INC.  
713.840.8484

## DR. CHRIS A. MACK - May 14, 2015

<b>everybody</b> 6:11 <b>ex</b> 12:16 <b>exact</b> 27:17 <b>exactly</b> 33:24 35:20, 83:25 <b>exam</b> 93:20 <b>examination</b> 4:4 4:5, 4:5, 5:4 89:17, 91:10 94:4 <b>examine</b> 89:9 <b>example</b> 11:18 11:22, 13:7 13:21, 24:1 26:7, 27:3 34:10, 38:1 48:20, 51:1 53:23, 54:8 55:9, 55:25 57:17, 59:4 60:22, 66:7 74:3, 75:6 77:14, 83:2 <b>examples</b> 84:13 <b>exceeds</b> 36:4 36:8 <b>excess</b> 37:15 41:25 <b>excuse</b> 12:16 48:7, 57:22 60:10, 75:21 <b>Executed</b> 95:22 <b>exhibit</b> 19:15 23:12, 30:25 72:8, 85:15 86:10, 86:14 89:20, 92:25 <b>exhibits</b> 4:9 86:10 <b>existing</b> 29:3 29:9, 38:15 43:3 <b>exists</b> 32:10 43:7 <b>expect</b> 37:15 <b>expectation</b>	80:14 <b>experience</b> 16:23, 16:25 17:2, 18:7 18:10, 18:16 18:19, 21:25 22:5, 22:12 22:17, 22:23 55:3 <b>experiment</b> 29:1 <b>Expiration</b> 96:23 <b>expired</b> 96:11 <b>explain</b> 10:11 25:4 <b>explained</b> 64:24 <b>explicitly</b> 67:7 67:19 <b>expose</b> 12:16 13:3, 15:16 15:22, 30:6 32:3, 32:4 50:13, 51:15 52:4, 52:5, 52:7 52:11 <b>exposed</b> 10:14 10:16, 10:19 10:24, 16:4 24:3, 33:14 41:6, 53:25 56:16, 56:20 66:17, 91:11 91:18 <b>exposes</b> 9:14 11:5, 14:25 24:19, 26:2 92:19 <b>exposing</b> 18:15 26:4, 57:14 94:7 <b>exposure</b> 10:17 10:24, 11:4 13:4, 13:10 24:15, 26:5 26:5, 32:23 33:1, 39:19	50:6, 52:14 56:5, 58:13 64:23, 65:3 67:9, 67:15 67:22, 68:6 76:25, 84:25 91:19 <b>exposures</b> 62:7 <b>extent</b> 19:17 <b>extra</b> 30:21 76:18, 85:11 <b>extreme</b> 29:16 <b>Eye</b> 2:15  <b>F</b>  <b>fab</b> 8:21, 8:24 <b>fabrication</b> 22:1 22:4, 22:6 22:20, 23:3 23:20, 52:19 <b>fabulous</b> 8:14 <b>fact</b> 44:22 66:20, 75:20 83:9 <b>faculty</b> 5:15 <b>fair</b> 6:23, 50:7 68:17, 77:8 88:22, 94:10 <b>fairly</b> 13:7, 87:6 <b>faithful</b> 43:17 44:11 <b>faithfully</b> 44:9 44:16 <b>fall</b> 26:21, 32:4 32:8, 36:13 43:5, 45:12 <b>falls</b> 44:25 <b>familiar</b> 6:9 10:8, 11:15 12:12, 14:4 16:18, 18:18 19:11, 22:14 22:22, 85:18 <b>familiarize</b> 19:17	<b>far</b> 36:4, 36:8 37:14, 39:16 41:25, 79:12 93:12 <b>Fax</b> 2:6, 2:12 2:17, 2:23, 3:6 <b>feature</b> 26:17 27:4, 48:4, 54:1 55:8, 55:10 59:23, 71:5 71:17, 72:24 75:8, 75:10 75:15, 75:21 75:24, 75:24 75:25, 76:1 76:2, 79:2, 79:2 80:21, 80:21 82:4 <b>features</b> 12:25 42:3, 54:1, 55:1 55:5, 55:7 55:16, 56:4 56:17, 56:17 57:5, 57:10 57:11, 57:13 57:14, 59:11 59:13, 64:7 71:15, 74:18 75:1, 79:9 80:18, 81:10 81:11, 81:12 82:5, 83:14 84:8, 84:11 84:14 <b>featuring</b> 55:10 <b>fed</b> 17:22 <b>Federal</b> 1:25 <b>feel</b> 19:16 <b>field</b> 11:4, 21:24 <b>figure</b> 31:9 31:11, 31:23 32:14, 33:1 40:13, 53:10 53:14, 53:16 54:3, 54:11 54:20, 56:8	56:9, 56:10 56:13, 56:18 57:4, 57:6 57:13, 65:24 66:1, 69:22 75:6, 80:22 92:8, 92:9 <b>figures</b> 55:22 55:24, 69:19 69:23, 70:1 <b>file</b> 16:12, 16:12 58:19, 59:18 70:11, 70:13 70:14 <b>filed</b> 74:24 78:15, 81:3 84:17, 85:6 <b>filing</b> 51:6 81:25, 82:9 <b>final</b> 37:9, 73:13 73:25, 74:6 91:18 <b>financially</b> 96:19 <b>find</b> 24:5 <b>finish</b> 6:21 24:21, 25:1 <b>finished</b> 34:24 <b>first</b> 5:3, 14:5 19:22, 24:3 26:15, 26:16 26:16, 26:17 27:2, 27:2 30:11, 34:2 34:11, 38:14 38:19, 39:18 39:20, 39:21 45:17, 48:2 48:3, 48:4, 48:4 48:9, 48:14 48:17, 53:19 53:25, 54:4 54:4, 54:5, 54:6 54:7, 54:20 55:21, 56:1 56:3, 57:7
---	--	---	---	--

## DR. CHRIS A. MACK - May 14, 2015

57:12, 57:24 57:25, 58:14 60:2, 60:5 61:10, 61:14 61:17, 62:6 62:10, 62:25 63:4, 63:19 63:24, 64:14 66:3, 67:6 68:15, 68:23 68:23, 69:7 69:8, 69:16 69:17, 70:17 71:20, 71:24 72:2, 72:7 73:25, 74:5 74:10, 74:13 74:17, 74:22 75:24, 76:8 76:11, 76:17 76:20, 77:7 77:15, 77:20 77:25, 80:4 81:12, 82:6 82:14, 83:1 83:3, 83:17 83:20, 85:1 87:16, 87:20 88:9, 88:15 89:19, 90:7 90:15, 90:16 91:3, 91:15 91:25, 91:25 92:2, 93:8 94:12 <b>five-minute</b> 72:16 <b>flash</b> 48:21 <b>flat</b> 29:10 <b>flavors</b> 90:3 <b>flexibility</b> 76:18 <b>flip</b> 19:16, 92:25 <b>Florida</b> 2:22 <b>focused</b> 11:23 <b>focuses</b> 15:3 25:24	<b>focusing</b> 92:12 <b>follow-up</b> 25:6 93:10 <b>following</b> 33:24 63:2, 75:14 96:4 <b>follows</b> 5:3 96:13 <b>force</b> 13:23 <b>foregoing</b> 95:20 <b>foremost</b> 83:3 <b>form</b> 17:24 24:3, 24:16 26:8, 26:16 36:24, 48:3 48:14, 56:2 58:2, 58:22 61:1, 69:4 70:23, 81:13 82:7, 88:11 90:14, 90:15 90:16, 92:1 <b>format</b> 16:12 16:15 <b>formed</b> 53:19 56:4, 88:7 <b>forming</b> 27:2 54:4, 56:10 70:5, 70:9, 73:7 74:5, 87:23 91:14 <b>Fort</b> 8:21 <b>forth</b> 88:4 92:13 <b>found</b> 21:11 <b>four</b> 8:5, 45:5 <b>frame</b> 14:3 14:12, 27:7 78:8, 78:24 <b>free</b> 19:16 <b>freedom</b> 27:18 <b>fresh</b> 6:12 <b>front</b> 53:11 72:19, 79:6 <b>full</b> 5:7, 7:21 10:21, 46:22	47:2, 68:3 <b>function</b> 43:12 43:13 <b>functioning</b> 44:15 <b>further</b> 4:5 26:7, 40:4, 89:3 94:2, 94:4 94:22, 96:16 96:19  <b>G</b>  <b>gap</b> 9:11, 75:22 75:23, 75:25 76:3, 76:4 77:15 <b>gaps</b> 80:21 <b>GDS</b> 16:12 58:19, 59:18 <b>general</b> 49:7 55:22, 59:17 <b>generally</b> 15:2 15:7, 22:20 52:5 <b>generation</b> 8:23 <b>getting</b> 76:16 83:5 <b>give</b> 6:14, 7:21 25:5, 30:14 59:2, 59:14 72:8, 85:24 85:25 <b>given</b> 5:24 62:15, 96:7 <b>go</b> 6:10, 7:18 17:10, 45:14 58:12, 72:3 87:1, 87:3 92:17 <b>goal</b> 38:4, 38:6 <b>goals</b> 27:1, 38:7 38:13 <b>going</b> 19:14 28:13, 30:11 37:13, 41:11	47:9, 47:14 54:15, 59:1 66:1, 71:12 79:12, 84:11 89:10, 93:22 <b>good</b> 5:6, 89:11 <b>GOTSHAL</b> 2:15 <b>great</b> 47:13 87:8 <b>greater</b> 77:14 77:23 <b>grew</b> 8:12 <b>grid</b> 31:16 34:23, 40:3 40:15, 40:20 40:22, 40:24 40:24, 40:25 41:3, 41:6 41:11  <b>H</b>  <b>half</b> 32:8, 32:8 32:22, 32:25 40:15, 46:18 46:20, 47:5 <b>halfway</b> 46:16 46:22 <b>hand</b> 19:14 19:15, 83:13 <b>Hanna</b> 96:23 96:23 <b>happen</b> 35:18 36:9 <b>happens</b> 10:18 23:8, 40:4 44:21, 76:12 91:5, 92:4 <b>Haute</b> 8:12 <b>HAYNES</b> 2:4 2:9 <b>head</b> 6:15 <b>headed</b> 73:23 <b>heard</b> 30:20 <b>help</b> 24:7, 92:9	<b>high</b> 8:3, 29:17 29:22, 41:13 <b>higher</b> 61:9 61:12 <b>history</b> 70:11 70:13, 70:14 <b>home</b> 12:7 <b>Hopen</b> 2:20 2:21, 17:24 24:16, 47:10 61:1, 69:4 70:23, 72:17 81:13, 82:7 86:2, 86:6, 86:9 86:13, 86:16 86:22, 86:25 87:8, 88:11 89:5, 89:7 89:10, 89:14 <b>hour</b> 7:7, 47:10 47:15 <b>Hours:08</b> 96:15 <b>Hours:37</b> 96:14 <b>house</b> 35:19 <b>Houston</b> 96:24 96:24 <b>huge</b> 42:11 <b>hundred</b> 36:2 <b>hybrid</b> 11:3 <b>hypothetical</b> 60:20, 61:19 80:17  <b>I</b>  <b>idea</b> 33:2, 91:10 <b>identical</b> 51:24 60:17, 60:21 60:21, 61:20 61:21, 62:10 62:13, 63:4 63:19, 63:22 63:24, 80:4 83:20, 90:13 90:17 <b>IDENTIFIED</b>
--	--	---	--	--

HANNA & HANNA, INC.  
713.840.8484

## DR. CHRIS A. MACK - May 14, 2015

4:10 <b>illuminate</b> 25:17 <b>illuminated</b> 12:10 <b>image</b> 10:2 12:10, 25:8 26:1, 26:2, 29:4 33:13, 33:21 34:7, 35:5, 41:9 43:4, 46:8 50:10, 57:24 <b>imaged</b> 45:6 <b>imaging</b> 9:24 14:15, 24:2 26:15, 43:22 48:2, 53:18 53:19, 53:23 53:24, 54:5 54:7, 54:16 54:18, 56:11 56:15, 57:12 57:25, 58:2 58:14, 60:2 60:4, 60:6, 66:3 66:25, 67:2 67:2, 68:5, 90:6 90:7, 90:8, 90:9 90:15, 91:2 91:15, 91:23 94:8 <b>impacts</b> 45:24 <b>implement</b> 64:23 <b>imply</b> 69:12 69:12 <b>important</b> 6:14 21:13, 28:2 34:14, 34:25 44:6, 50:5 54:14, 54:18 55:17, 66:23 66:23 <b>impossible</b> 61:20 <b>inaccuracies</b> 78:12	<b>inaccurate</b> 69:6 <b>Inc.'s</b> 4:13 30:16 <b>include</b> 23:3 23:23, 24:14 33:7, 49:9 53:22, 67:17 67:18, 91:1 <b>included</b> 23:20 51:16, 51:22 52:9, 70:14 <b>includes</b> 24:5 33:5, 34:3, 63:9 67:8, 67:14 67:20 <b>including</b> 68:3 <b>inconsistently</b> 69:16 <b>independent</b> 28:21, 29:6 <b>index</b> 4:1, 71:5 71:17 <b>indexes</b> 39:10 <b>indexing</b> 72:5 <b>indirectly</b> 25:16 28:4 <b>individual</b> 31:19 32:19, 34:23 35:16, 39:9 40:14, 41:1 <b>individually</b> 71:15 <b>industry</b> 62:11 63:6, 64:21 78:3, 78:8, 84:7 <b>inevitable</b> 78:13 <b>influence</b> 7:23 <b>influenced</b> 29:3 <b>influences</b> 78:5 <b>information</b> 15:13, 16:7 16:13, 65:12 72:3, 82:14 <b>input</b> 21:3, 31:3 58:23, 59:2 <b>inserting</b> 63:4	<b>instance</b> 1:18 7:23 <b>Institute</b> 8:4 <b>instruction</b> 59:7 59:14, 71:4 <b>instructions</b> 15:14, 16:1 17:22 <b>intact</b> 45:11 45:13 <b>intend</b> 39:24 <b>intended</b> 40:19 40:20, 93:25 <b>interested</b> 96:20 <b>intermediate</b> 28:14 <b>interpose</b> 7:15 <b>interpret</b> 55:2 55:22, 66:12 <b>interpretation</b> 62:20, 87:3 <b>interpreted</b> 55:23 <b>invented</b> 81:24 <b>invention</b> 65:13 67:8, 67:19 73:25, 84:5 <b>invents</b> 81:21 <b>involve</b> 16:15 16:18, 29:9 64:25 <b>involved</b> 15:20 17:4, 17:6 17:11, 17:15 18:6, 18:8 <b>involves</b> 14:9 18:14, 44:12 88:24 <b>ion</b> 23:25, 65:22 <b>IPR</b> 20:1 <b>IPR2014-01030</b> 1:8 <b>irregular</b> 40:22 <b>Irving</b> 1:24, 3:5 <b>issue</b> 48:15 77:19	<b>issued</b> 85:5 85:20 <b>it'd</b> 19:5  <b>J</b>  <b>Japanese</b> 72:13 <b>Jinbo</b> 60:22 60:23, 60:24 61:2, 61:3, 61:5 61:6, 62:2 62:12, 62:19 62:19, 62:20 62:23, 63:2 63:9, 63:15 63:23, 64:3 64:8, 72:14 72:19, 72:21 73:1, 73:5, 73:6 73:12, 73:19 74:9, 74:13 74:21, 74:25 75:5, 75:18 76:5, 76:19 76:20, 77:16 79:6, 79:14 79:22, 80:15 80:22, 80:24 80:25, 80:25 81:1, 81:7 81:18, 82:3 82:9, 83:4 83:12, 83:18 84:1, 84:6 84:16, 84:24 87:21, 88:6 88:20, 92:7 92:25, 93:2 93:5, 93:15 93:16, 93:17 93:18, 93:24 <b>jobs</b> 17:14  <b>K</b>  <b>keeping</b> 62:5	91:4, 92:24 <b>kerf</b> 35:13 36:19, 37:7 37:8, 37:12 42:4, 42:12 48:19 <b>kerfs</b> 48:18 <b>kind</b> 6:10, 24:20 <b>Kirk</b> 3:3 <b>kirkvoss@nixl...</b> 3:6 <b>know</b> 7:2, 7:3 7:8, 7:9, 8:1 8:12, 12:25 25:3, 30:13 37:23, 41:7 44:11, 51:20 56:12, 57:3 57:9, 59:15 62:16, 70:1 79:1, 79:2, 86:4 86:7, 86:19 93:20 <b>knowledge</b> 78:16, 78:18 78:22 <b>known</b> 84:20 93:21  <b>L</b>  <b>label</b> 31:23 <b>labeled</b> 75:8 75:10, 75:15 75:25 <b>landing</b> 45:16 <b>language</b> 56:25 68:4, 68:8 68:19, 90:13 90:17, 91:1 91:4, 92:22 <b>large</b> 13:19 22:6, 25:23 28:1, 35:23 41:16, 44:14 44:18, 76:4
--	---	---	---	---



## DR. CHRIS A. MACK - May 14, 2015

80:24	<b>layers</b> 39:25	68:10, 85:21	60:10, 69:3	17:23
<b>larger</b> 45:7	52:9, 52:15	<b>limiting</b> 55:8	71:3, 76:7	<b>Mack</b> 1:13, 1:17
80:20, 80:20	52:16, 52:21	<b>limits</b> 73:14	78:15, 84:21	4:4, 4:17, 5:2
<b>Larissa</b> 1:21	52:22, 57:16	<b>line</b> 23:22, 24:11	<b>lithoguru.com</b>	5:6, 5:8, 89:25
96:2, 96:22	78:6, 84:9	53:24, 55:14	5:21	95:2, 96:5
<b>laser</b> 11:23	84:13, 90:6	56:14, 56:14	<b>litigation</b> 6:2	<b>magic</b> 7:7
14:19, 19:4	90:8, 90:11	95:3	85:6	<b>magnification</b>
58:16	<b>left</b> 32:8, 40:15	<b>lines</b> 84:14	<b>little</b> 18:4, 47:14	54:15, 66:7
<b>layer</b> 9:24, 24:2	45:22, 54:25	<b>list</b> 86:10, 86:20	71:2, 75:7, 76:2	66:9
26:8, 26:15	55:5, 57:5	<b>lithographer</b>	88:12	<b>magnitude</b>
26:16, 27:3	59:13, 59:24	60:11	<b>LLP</b> 1:23, 2:4	37:14
30:1, 30:11	60:8, 71:18	<b>lithographers</b>	2:9, 2:15, 3:3	<b>maintained</b> 9:11
31:24, 32:22	75:2, 75:25	27:9, 61:22	<b>loaded</b> 25:14	<b>major</b> 27:1
33:3, 33:13	76:3, 87:12	<b>lithographic</b>	61:9, 72:2	75:16, 83:17
33:25, 34:8	<b>legal</b> 73:2	27:10, 73:15	<b>located</b> 71:25	90:5, 90:5
34:11, 35:1	<b>lens</b> 10:1, 25:22	<b>lithography</b> 1:9	74:19	<b>maker</b> 17:5
35:11, 39:19	25:23, 94:15	9:3, 10:1, 10:5	<b>location</b> 10:17	18:2
40:10, 40:10	94:17	10:8, 10:10	11:7, 15:23	<b>makers</b> 17:15
41:19, 41:20	<b>lenses</b> 54:9	10:21, 11:2	15:24, 33:13	<b>making</b> 18:6
43:22, 48:3	54:15	11:15, 11:18	71:25, 72:4	43:18, 45:8
48:4, 48:9	<b>level</b> 25:3, 36:12	12:1, 12:3	94:18	75:16
48:15, 48:17	39:18, 39:20	12:13, 12:15	<b>locations</b> 58:22	<b>MANAGEMENT...</b>
48:22, 52:18	39:21, 41:12	13:18, 13:21	59:19	1:6
52:24, 52:25	<b>life</b> 61:17	13:22, 14:5	<b>long</b> 47:8	<b>MANGES</b> 2:15
53:1, 53:2, 53:3	<b>light</b> 9:13, 12:6	14:9, 14:14	<b>look</b> 21:5, 24:7	<b>manually</b> 58:19
53:4, 53:18	13:12, 13:13	14:15, 14:17	40:13, 53:10	<b>manufacture</b>
53:18, 53:19	13:14, 13:14	15:1, 16:24	90:19, 90:23	17:17, 18:9
53:20, 53:22	16:22, 19:4	17:1, 17:3, 17:6	<b>looking</b> 41:3	18:13, 18:21
53:23, 53:24	23:24, 25:17	17:7, 17:8, 17:9	55:3, 73:17	18:25, 19:9
54:5, 54:7	25:18, 25:20	17:16, 18:3	<b>looks</b> 85:18	61:25
54:17, 56:2	25:24, 26:4	18:6, 18:7, 18:8	<b>loss</b> 41:16	<b>manufacturer</b>
56:2, 56:11	65:11, 65:14	18:9, 18:11	<b>lost</b> 61:13	43:21
56:15, 57:12	66:17, 66:19	18:14, 18:17	<b>lot</b> 61:22	<b>manufacturing</b>
57:17, 57:17	66:20, 92:12	19:3, 19:5, 19:9	<b>lots</b> 25:1, 25:1	1:3, 2:2, 8:22
57:18, 57:25	92:18, 93:2	19:12, 22:7	<b>low</b> 29:18, 29:23	14:8, 37:16
58:2, 58:14	93:7	22:8, 22:12	<b>lunch</b> 89:12	38:22, 44:5
60:2, 60:4, 60:6	<b>limit</b> 72:24	22:14, 22:16	<b>Lytvyn</b> 2:20	44:11, 44:22
66:3, 66:17	<b>limitation</b> 26:14	22:18, 22:19	85:11, 86:21	45:25, 84:19
66:25, 67:2	68:1, 68:14	23:4, 23:21	89:18, 94:2	85:21
68:5, 78:4, 78:5	83:18, 88:20	24:14, 24:19	94:24, 96:15	<b>mapped</b> 39:23
82:6, 82:13	<b>limitations</b>	24:23, 28:3	<b>Lytvyn.....</b>	<b>Marando</b> 2:14
84:10, 90:7	58:11	30:1, 34:3, 34:6	4:5	<b>March</b> 20:5
90:9, 90:15	<b>limited</b> 12:25	40:9, 42:1	<b>M</b>	<b>mark</b> 23:9
91:2, 91:15	16:25, 55:10	42:22, 43:19		23:11, 30:15
91:23, 92:2	55:13, 67:16	45:20, 49:2	<b>machine</b> 1:22	85:10
94:8	67:22, 67:24	49:9, 50:22		<b>marked</b> 4:16

HANNA & HANNA, INC.  
713.840.8484

## DR. CHRIS A. MACK - May 14, 2015

19:15, 23:12 30:25, 72:9 85:15 <b>marks</b> 25:11 25:11, 26:24 27:14 <b>Maryland</b> 8:7 8:21 <b>mask</b> 9:8, 9:12 9:13, 9:14, 10:2 10:19, 10:22 10:23, 10:25 11:4, 11:6 11:20, 14:8 15:10, 17:5 17:15, 17:21 17:22, 18:2 24:3, 24:5 24:20, 27:22 28:16, 28:19 28:20, 29:4 30:6, 31:23 32:2, 32:7 32:19, 33:4 33:8, 33:15 33:20, 35:4 36:16, 37:19 37:22, 47:17 47:18, 47:22 47:25, 48:5 48:10, 48:13 49:4, 49:5, 49:6 49:7, 50:8 50:11, 50:13 50:15, 50:15 50:16, 50:19 50:19, 51:2 51:11, 51:12 51:12, 51:16 51:22, 52:1 52:3, 52:6, 52:7 52:9, 52:16 53:25, 54:4 54:6, 54:20 54:25, 55:5 56:11, 56:12	56:16, 56:18 56:19, 56:19 56:21, 56:23 57:4, 57:5, 57:6 57:7, 57:10 57:18, 57:23 57:25, 58:4 60:18, 60:24 61:2, 61:3, 62:5 62:9, 62:10 62:12, 62:13 62:20, 62:22 63:4, 63:4, 63:6 63:25, 64:5 64:6, 64:7 66:13, 66:15 68:23, 68:24 69:8, 69:9 69:17, 69:18 74:15, 74:19 74:22, 75:1 75:2, 77:8, 79:8 79:10, 80:3 80:4, 80:14 80:18, 81:9 81:10, 81:16 81:21, 82:4 82:13, 82:14 82:21, 82:25 83:1, 83:14 84:3, 90:15 90:16, 91:17 91:17, 93:12 93:18, 93:19 <b>masking</b> 93:18 <b>maskless</b> 11:18 12:3, 12:12 13:17, 13:18 13:22, 17:21 24:14, 69:3 <b>masks</b> 17:5 17:11, 17:17 18:9, 52:8 52:12, 60:16 60:18, 61:20 62:8, 63:13	63:21, 76:14 82:20, 84:21 <b>master's</b> 8:8 <b>material</b> 53:20 54:8 <b>matters</b> 91:12 <b>McPhearson</b> 1:21, 96:2 96:22 <b>Meade</b> 8:21 <b>mean</b> 24:13 26:25, 37:2 37:23, 38:3 39:2, 40:11 41:7, 44:2, 47:4 51:20, 56:24 57:9, 69:12 88:12, 88:13 <b>meant</b> 25:25 <b>measurement</b> 27:16 <b>measuring</b> 27:14 <b>medications</b> 7:23 <b>memorandum</b> 4:14, 85:14 85:20 <b>memory</b> 23:7 48:21, 48:21 84:12, 84:12 <b>mentioned</b> 9:23 19:4, 23:6, 38:6 45:3, 47:17 78:25 <b>merely</b> 84:8 <b>met</b> 38:13 58:10 <b>metal</b> 52:25 53:1, 53:4 57:18 <b>method</b> 1:9 10:13, 43:20 62:2, 62:12 62:13, 62:16 63:7, 63:15	64:2, 65:3, 65:6 73:4, 74:25 77:13, 78:13 80:15, 81:1 81:7, 82:3 93:15, 93:24 <b>methods</b> 21:25 22:3, 22:9, 22:9 22:10, 23:2 23:5, 23:19 <b>micron</b> 59:15 <b>microns</b> 9:11 36:2, 79:9 79:14, 79:16 79:20, 80:5 80:6, 80:7 80:19, 81:8 81:10, 82:5 <b>microscope</b> 13:23 <b>middle</b> 6:20 41:19 <b>mind</b> 6:12 65:25, 91:4 92:24 <b>minor</b> 11:16 <b>Minutes</b> 96:14 96:15 <b>mirrors</b> 12:8 12:9, 16:14 <b>misalign</b> 28:16 30:6, 32:2, 42:2 <b>misaligned</b> 33:18, 36:10 36:16, 36:16 36:24, 41:21 41:25, 42:10 <b>misalignment</b> 36:8, 36:12 37:3, 37:14 <b>misapplied</b> 21:19 <b>mispositioned</b> 41:17 <b>modified</b> 72:4 <b>modify</b> 82:9	<b>moments</b> 50:20 <b>morning</b> 5:6 <b>motions</b> 15:20 <b>mounted</b> 25:10 27:15, 76:7 <b>movable</b> 49:13 <b>move</b> 15:19 33:15, 40:5 41:8, 50:1 50:22, 79:8 92:5, 92:13 92:17, 94:6 94:16 <b>moved</b> 9:3 10:16, 61:11 76:2, 76:8 <b>movement</b> 39:15 <b>moves</b> 39:10 39:15, 40:4 <b>movie</b> 12:7 <b>moving</b> 75:3 92:5, 92:7 92:15, 92:20 92:21, 93:18 94:6, 94:7, 94:9 94:9 <b>multi-die</b> 51:16 52:8 <b>multimirror</b> 12:5, 12:10 16:7, 16:14 16:16, 16:21 18:24, 18:25 <b>multimirrors</b> 12:6 <b>multiple</b> 10:19 27:17, 34:23 38:24, 47:18 47:22, 48:10 48:13, 48:16 48:18, 51:12 51:13, 52:6 52:16, 91:13
--	--	---	---	--

HANNA & HANNA, INC.  
713.840.8484

## DR. CHRIS A. MACK - May 14, 2015

<b>N</b>	2:25 NSA 8:21 number 11:16 28:1, 78:11 89:21 numbered 1:19 numbering 21:9 21:17 numbers 56:18 NW 2:4, 2:15	13:12, 15:5 15:9, 19:8 19:21, 19:22 20:14, 21:18 21:20, 24:24 25:2, 25:7 26:23, 28:25 30:20, 30:23 32:7, 33:6 33:11, 34:10 34:13, 34:17 34:25, 35:14 35:21, 35:25 36:3, 36:7 36:15, 37:11 37:19, 37:25 38:6, 38:11 38:24, 39:8 39:14, 40:2 40:21, 40:25 41:19, 42:6 42:15, 42:20 43:10, 43:19 44:4, 46:6 47:11, 47:14 47:17, 48:10 51:18, 52:2 53:17, 54:6 54:11, 54:24 55:16, 55:20 56:8, 57:3, 59:1 60:16, 61:3 62:9, 62:18 62:22, 63:2 63:13, 63:20 64:1, 67:3 67:21, 68:3 72:8, 72:19 72:21, 73:3 73:22, 77:12 79:18, 81:25 82:11, 85:19 85:24, 86:24 87:19, 89:10 89:13, 89:15 89:19, 90:10	90:19, 90:22 90:25, 92:24 93:1, 93:10 93:20, 94:21 Oldsmar 2:22 omitted 68:4 omitting 68:18 once 52:7, 59:7 opaque 25:19 54:1, 56:17 open 53:3 opened 25:17 operate 55:13 operation 11:8 36:2, 50:22 53:5, 59:17 73:24 operations 64:20 opinion 63:14 63:16, 73:7 73:8, 73:9 73:10, 88:7 93:4 opinions 70:9 87:23, 88:4 optical 10:1 10:4, 10:7, 10:9 10:13, 10:20 11:1, 11:15 13:14, 18:5 19:5, 19:8 19:11, 22:15 22:17, 22:19 24:19, 24:23 25:7, 25:12 26:24, 27:13 27:16, 27:23 28:5, 28:6, 28:9 28:10, 28:15 28:16, 31:11 32:3, 47:23 64:16, 64:19 optics 66:7, 66:9 optimal 83:22 oral 1:12, 1:17	96:6 order 9:11, 21:8 21:17, 36:2 85:4, 85:14 85:20, 87:14 Order..... 4:14 ordinary 21:23 22:4, 22:11 22:13, 22:16 22:21, 27:7 44:10, 51:5 53:7, 65:2, 65:6 65:12, 72:22 73:3, 74:23 77:22, 78:1 78:16, 79:6 79:10, 80:2 80:10, 80:13 81:5, 81:15 81:23, 82:2 82:19, 82:24 93:14 organization 8:23, 8:24 organize 87:5 original 58:20 outcome 96:20 outline 38:21 outside 31:6 43:5 overall 52:23 62:1 overcome 83:18 overlay 78:3 78:12, 78:13 82:13 overview 25:5 owner 1:6, 2:19 4:12, 30:16 31:4 owner's 90:20 91:8, 92:10
	<b>O</b> O'Connor 1:23 3:4 O'Dell 2:9 30:18, 30:20 30:23 objection 17:24 24:16, 61:1 69:4, 70:23 81:13, 82:7 86:24, 86:25 88:11 objections 7:15 obtained 62:4 62:8, 69:17 69:18 obvious 42:13 75:5 obviously 46:11 occur 83:4 occurs 52:18 83:4, 85:1 off-the-cuff 73:8 73:10 offer 73:8 OFFICE 1:1 offices 1:22 official 5:23 oh 56:14, 65:25 67:18, 73:18 80:7, 86:11 Okay 5:13, 6:1 6:4, 6:9, 6:18 6:25, 13:3			
name 5:7, 5:16 5:20, 5:22, 5:22 5:23, 11:11 27:21, 95:2 National 8:20 near 46:1, 49:12 necessarily 22:22, 50:8 55:24, 66:10 75:5 necessary 25:6 27:11, 27:24 93:24 need 7:7, 19:17 19:19, 58:24 needed 83:25 84:1 negative 45:24 neither 64:2 96:16 never 8:1, 41:10 41:11, 61:18 65:25 new 10:17, 11:7 15:23, 33:12 50:24 newly 43:4 Nicholas 2:21 nitpicky 61:21 Nix 1:23, 3:3 nods 6:15 nominally 66:17 nonuniformity 45:23 normal 36:10 normally 51:10 52:17, 63:5 North 1:23, 2:10 2:22, 3:4, 96:24 note 23:22 notice 86:2, 86:9 86:12 noticed 21:8 np@smithhope...				

## DR. CHRIS A. MACK - May 14, 2015

<b>P</b>	<b>patent</b> 1:1, 1:2	13:8, 13:8	45:23, 46:2	74:5, 74:7
	1:6, 1:7, 2:19	13:11, 14:20	46:3, 46:6, 46:7	74:10, 74:10
<b>p.m</b> 1:20, 87:9	4:11, 4:12, 4:18	15:9, 15:13	46:14, 46:22	74:14, 74:14
87:9, 89:16	22:24, 23:2	16:10, 18:17	46:24, 47:2	74:18, 74:18
89:16, 94:25	23:6, 23:7	24:20, 26:16	47:4, 47:5, 47:5	75:21, 76:11
<b>packaged</b> 37:9	23:15, 23:19	26:16, 27:2	47:6, 48:1, 48:3	76:11, 76:16
<b>packaging</b>	24:13, 26:9	27:2, 27:5, 27:6	48:4, 48:6, 48:7	76:17, 76:21
35:19	27:8, 30:16	27:12, 27:25	48:9, 48:12	77:7, 77:7
<b>page</b> 4:2, 4:10	31:4, 48:7, 51:6	28:17, 28:18	48:13, 48:14	77:15, 77:16
20:2, 20:2	53:8, 53:10	28:19, 28:20	48:14, 48:15	77:20, 77:20
21:20, 31:7	53:14, 55:10	28:21, 29:20	48:17, 49:20	77:25, 77:25
31:9, 31:24	55:22, 56:19	29:22, 30:3	49:24, 50:4	78:10, 78:12
32:13, 32:14	57:22, 58:7	30:7, 30:8	50:5, 50:9	81:11, 81:12
39:4, 40:14	58:9, 62:14	31:22, 32:4	50:11, 50:17	81:22, 82:25
67:4, 73:17	63:8, 63:12	32:11, 32:18	50:21, 50:25	83:21, 87:16
73:20, 87:13	63:15, 63:19	33:2, 33:16	51:19, 51:21	87:17, 87:20
87:15, 90:21	64:4, 64:11	33:17, 33:21	54:5, 54:16	87:21, 88:9
91:7, 92:9, 95:3	64:21, 64:23	33:22, 33:25	54:16, 56:2	88:10, 88:15
<b>paragraph</b> 21:5	65:1, 65:7	34:15, 34:19	56:2, 56:11	88:16, 90:11
21:11, 21:12	65:11, 67:7	34:19, 34:21	57:12, 57:22	90:16, 90:17
21:20, 21:22	67:12, 67:14	35:8, 36:12	57:24, 58:1	90:19, 91:3
24:10, 67:4	67:22, 68:22	36:13, 36:17	58:3, 58:14	91:3, 91:11
<b>paragraphs</b>	69:3, 69:7	36:21, 36:23	59:11, 59:12	91:13, 91:15
21:8, 21:16	69:15, 69:24	37:1, 37:4	59:22, 59:24	91:16, 91:22
<b>Park</b> 8:8	70:3, 70:5, 70:8	37:12, 37:21	59:25, 60:2	91:25, 91:25
<b>Parkway</b> 96:24	72:13, 73:13	37:24, 38:1	60:3, 60:7, 60:9	91:25, 92:2
<b>part</b> 7:16, 29:23	74:24, 76:13	38:2, 38:9	60:9, 60:14	92:11, 92:14
29:24, 37:7	76:14, 77:5	38:11, 38:20	60:15, 60:17	92:15, 92:15
37:12, 50:12	77:13, 77:17	38:22, 39:8	61:4, 61:13	92:19, 94:8
78:14, 78:16	78:15, 78:17	39:11, 39:16	62:7, 62:24	94:9, 94:10
<b>part-time</b> 5:14	78:19, 78:21	40:6, 40:18	62:25, 63:17	94:13, 94:14
<b>partial</b> 36:20	79:22, 81:3	41:4, 41:5	63:23, 63:24	94:16
41:4, 41:8, 41:8	81:20, 81:21	41:22, 41:23	64:9, 66:24	<b>patterned</b> 29:11
<b>partially</b> 36:18	82:1, 82:2, 82:9	41:24, 42:3	66:24, 67:1	30:13, 41:20
36:18, 38:12	82:14, 83:19	42:6, 42:8	68:23, 68:24	44:16, 44:16
38:12, 40:7	85:7, 87:22	42:12, 42:13	69:7, 69:8	46:18, 51:23
40:7	88:21, 89:20	42:15, 42:16	69:14, 69:17	59:20, 62:24
<b>particular</b> 48:8	90:23, 91:8	42:21, 42:25	69:18, 70:17	68:6, 75:1
79:14, 84:12	92:10, 92:23	43:8, 43:9	70:17, 71:2	<b>patterning</b> 9:21
<b>particularly</b>	93:6	43:17, 43:22	71:4, 71:16	16:7, 26:15
30:1	<b>patentee</b> 70:16	43:24, 43:25	71:21, 71:21	26:20, 27:2
<b>parties</b> 96:11	<b>patents</b> 55:3	44:1, 44:3, 44:6	71:23, 71:24	37:25, 38:15
96:12, 96:17	<b>pattern</b> 9:5	44:9, 44:12	72:1, 72:1, 72:2	38:19, 48:2
<b>parts</b> 29:17	9:14, 9:20, 9:24	44:13, 44:19	72:6, 72:7	52:18, 55:11
29:18	11:19, 12:9	44:20, 44:25	72:23, 73:14	55:13, 57:21
<b>passes</b> 66:20	12:19, 12:24	45:4, 45:16	74:1, 74:1, 74:3	58:2, 60:25

HANNA &amp; HANNA, INC.

713.840.8484

IPR2014-01030 / TSMC-1017

Page 108 of 117

## DR. CHRIS A. MACK - May 14, 2015

61:8, 61:10	3:3	2:17, 2:23, 3:5	<b>phrase</b> 52:17	16:17, 19:19
61:11, 62:4	<b>penalty</b> 95:19	<b>photolithograp...</b>	91:12	25:8, 25:23
62:23, 63:3	<b>pending</b> 7:12	65:8	<b>phrases</b> 90:15	30:7, 33:21
63:7, 63:14	<b>perfect</b> 41:10	<b>photolithograp...</b>	<b>physical</b> 66:19	33:21, 33:22
64:14, 67:8	61:19, 92:24	8:16, 8:17, 8:19	<b>physically</b> 63:21	34:18, 34:19
67:15, 67:22	<b>perfectly</b> 29:10	8:25, 18:5	<b>physics</b> 8:6	35:6, 35:7, 37:8
74:23, 75:17	41:11	21:25, 27:24	17:7	37:11, 37:12
75:18, 75:19	<b>perform</b> 40:9	31:12, 44:5	<b>Pine</b> 2:22	41:3, 41:4
76:9, 77:1, 82:6	62:11	72:25	<b>pitch</b> 1:9, 83:23	41:23, 41:24
83:6, 83:16	<b>performed</b> 22:7	<b>photomask</b> 18:2	84:8, 84:11	42:11, 42:18
84:25, 85:2	<b>performing</b>	18:5, 18:6	84:15	44:18, 44:19
91:2, 91:14	53:4, 91:24	18:13, 25:8	<b>pitches</b> 84:4	44:24, 45:15
91:21, 91:22	<b>period</b> 96:11	25:9, 25:10	<b>place</b> 34:17	46:2, 46:3, 46:7
91:24, 92:3	<b>perjury</b> 95:19	25:11, 25:16	39:24, 40:21	46:10, 46:11
93:8, 93:9	<b>perpendicular</b>	25:17, 25:19	40:22, 43:24	46:12, 47:1
<b>patterns</b> 10:22	66:10	25:20, 25:21	44:1, 50:6	48:19, 48:24
12:21, 13:6	<b>person</b> 21:23	26:2, 26:23	52:14, 79:14	49:1, 49:5, 49:8
13:9, 13:10	22:4, 22:11	27:13, 27:21	82:5	49:16, 49:17
18:11, 26:8	22:13, 22:16	34:8, 49:13	<b>placed</b> 60:11	49:18, 49:19
29:3, 29:5, 29:6	22:21, 44:10	49:14, 49:17	60:14, 76:24	49:23, 49:23
29:9, 34:4, 34:8	53:7, 65:2, 65:5	49:17, 49:19	77:15, 81:11	49:25, 50:2
35:12, 38:15	65:12, 72:22	49:23, 49:25	<b>placement</b>	50:4, 50:13
40:15, 40:22	73:3, 74:23	52:22, 57:19	27:12, 27:13	50:14, 50:21
41:17, 43:3	77:22, 78:1	61:9, 61:14	30:2, 38:8, 44:6	50:23, 50:24
45:21, 48:5	78:16, 79:5	61:15, 61:17	44:8, 44:13	57:8, 62:1
48:18, 48:23	79:10, 80:2	61:18, 61:25	44:13, 44:17	<b>portions</b> 25:18
48:25, 49:1	80:10, 80:12	64:15, 76:6	82:12	25:19, 39:23
49:21, 50:19	80:12, 81:4	<b>photomasks</b>	<b>places</b> 52:23	45:22, 46:13
51:2, 51:13	81:15, 81:23	17:14, 57:2	74:19	49:6, 49:13
52:3, 57:19	82:2, 82:18	69:13, 69:16	<b>placing</b> 77:19	50:18, 66:16
57:23, 58:1	82:24, 93:13	<b>photon</b> 13:13	77:24	<b>position</b> 27:5
58:4, 58:20	<b>persons</b> 51:5	<b>photons</b> 12:15	<b>plane</b> 25:24	27:17, 33:18
58:24, 59:19	<b>perspective</b>	<b>photoresist</b> 9:9	26:1, 59:8	60:15, 76:9
60:11, 60:18	43:11, 43:19	9:12, 9:14, 10:2	<b>Plano</b> 2:10	76:10
62:3, 67:10	44:4	18:12, 18:15	<b>please</b> 5:7	<b>positional</b> 75:20
67:16, 67:23	<b>petition</b> 30:16	24:20, 25:14	19:16	76:1, 82:12
68:7, 68:14	30:17, 31:5	26:3, 26:8	<b>point</b> 38:21	<b>positioned</b>
72:3, 72:5, 74:6	90:20, 92:10	29:12, 29:13	52:6, 66:16	49:12, 76:17
74:6, 74:9	<b>Petition.....</b> 30	29:14, 29:16	80:7	<b>positioning</b> 78:4
76:15, 76:19	4:13	29:17, 29:18	<b>points</b> 90:3	<b>possibility</b> 51:25
80:5, 82:20	<b>Petitioner</b> 1:4	29:23, 29:24	<b>polygate</b> 52:24	57:16, 66:2
83:5, 83:9	1:18, 2:2, 2:13	30:11, 30:12	53:2, 53:3	<b>possible</b> 30:9
83:19, 83:22	<b>Pfeifer</b> 2:21	31:15, 33:14	57:17	33:20, 34:18
84:7, 90:14	<b>Ph.D</b> 8:10	39:10, 83:20	<b>poor</b> 44:14	35:5, 36:11
90:14	<b>Ph.D.19</b> 4:17	91:11, 91:18	<b>portion</b> 10:15	37:17, 37:18
<b>Patterson</b> 1:23	<b>Phone</b> 2:6, 2:11	91:20, 92:1	11:6, 13:3, 13:5	42:2, 48:24

HANNA &amp; HANNA, INC.

713.840.8484

## DR. CHRIS A. MACK - May 14, 2015

50:14, 51:10 52:10, 56:5 57:6, 57:23 58:3, 74:17 76:19, 76:19 82:8, 83:6 93:22 <b>possibly</b> 31:21 36:13, 39:17 <b>potentially</b> 42:18, 92:19 <b>practice</b> 65:2 65:6, 65:13 78:2, 78:7 78:14 <b>practiced</b> 63:22 <b>practices</b> 62:16 <b>practicing</b> 56:7 80:15 <b>predetermined</b> 40:3 <b>predominantly</b> 84:10 <b>preferred</b> 61:12 <b>premise</b> 74:21 <b>preparation</b> 31:3 <b>preparing</b> 20:19 20:23, 22:25 23:16 <b>prescribed</b> 74:2 <b>presented</b> 88:6 <b>presumably</b> 29:25 <b>presume</b> 71:19 <b>pretty</b> 33:7 87:7 <b>previous</b> 4:16 15:24, 32:11 42:8 <b>previously</b> 19:14, 23:11 25:13, 29:11 30:13, 34:9 50:3, 68:9, 72:9 78:11	<b>primary</b> 38:7 38:13 <b>primitive</b> 12:19 12:22, 12:24 13:6, 13:10 <b>print</b> 42:21 42:24, 43:2 45:9, 45:15 48:23, 48:25 78:10, 79:2 83:9 <b>printed</b> 16:11 38:23, 42:4 42:7, 42:8 42:12, 42:14 42:15, 43:4 44:24, 46:20 46:24, 47:1 62:2, 75:24 78:11, 83:19 83:21 <b>printer</b> 9:6, 9:8 <b>printers</b> 9:2 <b>printing</b> 9:10 9:16, 9:16, 9:17 32:21, 41:8 42:3, 45:21 48:20, 48:22 53:1, 53:4, 62:3 75:20, 76:1 <b>prior</b> 23:18 34:4, 34:6 40:13, 43:3 63:3, 81:25 <b>probably</b> 7:6 87:7, 89:14 <b>problem</b> 76:6 76:12, 76:16 77:6, 77:11 77:23 <b>problems</b> 82:16 <b>Procedure</b> 1:25 <b>procedures</b> 6:11 <b>proceed</b> 87:6 <b>proceeding</b> 6:2 96:18	<b>process</b> 14:9 18:14, 26:19 26:21, 27:10 38:22, 41:10 45:24, 52:19 75:17, 75:18 75:19, 91:14 <b>processes</b> 8:23 40:10, 45:20 <b>processing</b> 26:7 45:19, 52:23 <b>produce</b> 27:4 29:5, 45:23 50:19 <b>produced</b> 1:17 26:2, 34:9 <b>produces</b> 61:12 <b>production</b> 13:25, 14:7 14:10, 42:1 <b>profligates</b> 25:20 <b>program</b> 15:9 15:14, 16:1 16:3, 16:13 58:13, 58:15 59:2, 59:13 <b>programmed</b> 59:20 <b>programming</b> 17:22, 59:7 71:2, 71:15 72:4 <b>project</b> 10:2 25:8, 33:16 33:17, 34:14 34:17, 34:25 35:5, 36:17 37:11, 39:22 41:9, 49:17 49:19, 50:3 50:17, 50:21 <b>projected</b> 12:11 12:20, 12:24 29:22, 33:13 33:19, 34:11	38:20, 38:23 49:15, 49:20 92:1, 92:11 92:16, 92:20 93:3, 93:7 94:14, 94:17 94:17, 94:18 <b>projecting</b> 12:25, 29:4 29:20, 34:7 35:8, 50:10 50:15 <b>projection</b> 10:1 10:4, 10:7, 10:9 10:12, 10:20 11:1, 11:14 11:14, 12:18 13:15, 14:6 14:11, 14:20 14:24, 15:4 18:20, 18:21 22:7, 22:8 24:22, 25:7 25:22, 27:13 27:16, 27:24 28:5, 28:6, 28:9 28:10, 28:15 31:12, 32:3 32:18, 47:23 49:9, 54:8, 76:7 91:6, 94:15 <b>projectors</b> 12:7 <b>promise</b> 21:7 87:10 <b>propagating</b> 66:14 <b>proper</b> 21:17 27:6, 27:11 27:12, 28:11 38:8, 59:8 79:22 <b>properly</b> 28:9 28:10, 41:17 42:9, 44:16 76:16 <b>prosecuted</b> 70:1	<b>provide</b> 31:3 64:22, 65:11 92:21 <b>provided</b> 88:1 96:10 <b>provides</b> 72:21 82:14 <b>providing</b> 71:4 <b>proximity</b> 9:10 9:15, 77:16 <b>PTAB</b> 88:2 <b>PTABs</b> 88:8 <b>purchase</b> 17:14 <b>purpose</b> 17:6 43:18, 43:20 <b>purposefully</b> 61:6 <b>purposes</b> 91:5 <b>pursuant</b> 1:24 <b>put</b> 9:8, 25:9 25:15, 60:4 78:6, 86:23 87:23 <b>putting</b> 70:9
<b>Q</b>				
<b>quality</b> 27:10 <b>question</b> 5:20 6:20, 6:25, 7:3 7:12, 7:13, 7:17 7:18, 7:25 19:18, 19:20 19:22, 23:18 32:6, 55:18 57:15, 62:17 65:16, 71:1 71:6, 71:20 75:4, 79:5 79:12, 79:24 87:11, 88:22 89:1, 89:19 90:19, 92:4 93:21, 93:23 <b>questions</b> 6:19 6:22, 7:4, 7:16				

## DR. CHRIS A. MACK - May 14, 2015

25:6, 55:19 87:4, 87:12 89:4, 89:9, 94:2 94:23 <b>quick</b> 89:11 93:10 <b>quite</b> 13:19 28:1, 29:16 45:4 <b>quote</b> 67:8 67:10, 68:3 <b>quoted</b> 67:25 <b>quoting</b> 67:11	<b>reads</b> 73:24 <b>real</b> 61:16 61:22 <b>really</b> 91:12 <b>reason</b> 6:14, 7:8 7:21, 45:17 45:18, 61:7 82:19, 95:3 <b>reasonable</b> 36:10, 80:13 <b>reasoned</b> 73:8 <b>reasons</b> 45:3 82:23 <b>recall</b> 20:21 23:5, 69:25 70:4, 70:14 70:19, 70:24 71:6, 78:25 86:16 <b>received</b> 8:5, 8:8 8:10 <b>recognize</b> 19:23 23:13, 72:9 85:16 <b>record</b> 5:1, 7:17 87:3, 96:7 <b>rectangle</b> 12:19 13:8, 43:1 <b>rectangular</b> 55:11 <b>redirect</b> 89:14 94:3 <b>REDUCED</b> 1:9 <b>refer</b> 14:23 15:2, 15:6 53:16, 89:19 90:20 <b>reference</b> 24:5 <b>referred</b> 4:16 72:14, 90:21 <b>referring</b> 22:10 28:18, 32:10 33:24, 38:14 39:18, 79:13 89:20, 91:23 94:14	<b>refers</b> 56:19 74:9, 91:22 <b>refresh</b> 23:7 <b>regard</b> 90:2 <b>regarding</b> 82:12 <b>region</b> 10:24 11:21, 15:22 15:22, 35:13 35:15, 42:4 <b>regions</b> 29:17 29:18, 66:13 <b>registration</b> 25:11 <b>regular</b> 40:20 44:21 <b>related</b> 6:2, 85:7 96:17 <b>relationship</b> 74:2 <b>relative</b> 41:18 78:4 <b>relatively</b> 56:4 <b>relay</b> 16:6 <b>remains</b> 92:16 <b>remember</b> 70:25 <b>removed</b> 26:6 76:21 <b>removing</b> 63:3 <b>repeat</b> 10:17 33:2, 39:11 79:24 <b>repeated</b> 11:8 40:14, 40:19 <b>repeating</b> 59:11 84:8 <b>replace</b> 61:14 <b>replicate</b> 73:4 74:25 <b>reported</b> 1:22 <b>reporter</b> 6:13 6:18, 6:23 30:22, 96:3 <b>Reporter's</b> 4:7 <b>represent</b> 31:19 52:18, 54:11	66:18 <b>represented</b> 49:24, 52:15 52:22, 53:14 <b>representing</b> 43:3 <b>represents</b> 58:1 66:15 <b>reproduction</b> 44:12 <b>requested</b> 96:9 <b>require</b> 10:13 48:8, 88:22 <b>required</b> 17:14 58:2, 86:19 <b>requirement</b> 55:25, 55:25 56:3, 56:6 88:15, 88:18 <b>requires</b> 63:16 <b>research</b> 8:22 8:24, 13:20 13:21, 14:2 20:25 <b>reservation</b> 89:8 <b>residence</b> 5:9 <b>resist</b> 10:15 12:16, 14:20 14:25, 15:3 25:9, 25:25 29:2, 29:4, 29:6 45:16, 66:16 72:23, 73:13 74:1, 74:1, 74:3 74:5, 74:6, 74:7 74:10, 74:10 74:13, 74:14 74:17, 74:18 75:24, 76:11 84:7, 85:1 90:11 <b>resolution</b> 72:24 73:14 <b>respect</b> 73:7 <b>response</b> 4:13 26:3, 30:16	31:4, 90:20 91:8, 92:10 <b>rest</b> 68:13 <b>restriction</b> 56:6 <b>restrictive</b> 56:25 <b>result</b> 28:11 44:14, 49:24 61:12, 62:2 64:2, 73:13 73:16, 76:15 80:20, 80:25 81:19, 91:19 92:2, 92:21 93:25 <b>resulting</b> 62:7 <b>results</b> 29:21 75:5, 75:21 92:22 <b>reticle</b> 27:15 27:15, 27:17 27:19, 27:20 28:8, 28:12 28:13, 33:10 33:25, 36:9 36:16, 38:2 39:9, 41:9 41:21, 42:9 42:11, 42:13 42:17, 42:20 42:23, 44:16 45:4, 45:6 45:10, 45:16 46:4, 47:2, 47:4 49:10, 49:22 50:1, 50:1, 50:2 52:25, 53:2 64:19, 66:3 66:21, 77:1 92:17, 92:18 92:21, 93:12 94:7, 94:9 <b>returning</b> 79:5 <b>reveal</b> 49:23 50:23 <b>revealed</b> 50:3 <b>review</b> 70:5
<b>R</b>				
<b>radiation</b> 16:20 23:23, 23:24 23:25, 23:25 23:25, 24:4 53:25, 54:12 56:5, 56:16 65:7, 65:8 65:14, 65:16 65:18, 65:20 65:22, 66:24 67:1, 67:9 67:23, 68:6 90:11 <b>raised</b> 62:19 <b>range</b> 80:20 <b>raster</b> 11:24 <b>re-create</b> 61:17 <b>re-creation</b> 61:18 <b>reaches</b> 54:16 66:25, 67:1 <b>read</b> 19:19, 20:8 21:7, 67:6, 68:3 68:11, 68:12 85:8, 87:21 88:17 <b>reader</b> 93:6 <b>reading</b> 48:7 75:7, 75:11 93:14				

## DR. CHRIS A. MACK - May 14, 2015

70:7, 70:11 88:25, 96:9 <b>reviewed</b> 22:24 70:13, 85:4 85:8 <b>Richardson</b> 2:11 <b>right</b> 8:2, 8:15 28:22, 32:8 32:12, 35:20 38:3, 39:21 46:13, 53:15 54:25, 55:5 57:5, 61:19 63:10, 75:23 76:2, 76:3, 84:2 86:22, 89:2 89:7, 91:22 <b>Roach</b> 1:23, 3:3 <b>Road</b> 2:10, 5:10 <b>Rose-Hulman</b> 8:4, 8:13 <b>rotate</b> 42:20 42:23 <b>rotated</b> 43:1 43:9 <b>rule</b> 87:3 <b>rules</b> 1:25, 78:9 79:1	81:6, 81:15 <b>scan</b> 11:24 14:19, 16:3 16:16, 39:8 59:4 <b>scanned</b> 10:23 11:5, 11:21 11:24, 15:21 15:24 <b>scanner</b> 10:10 10:21, 10:21 62:6 <b>scanning</b> 11:7 11:13, 12:17 15:1, 16:19 <b>scenario</b> 29:2 33:4, 33:9 36:20, 42:6 52:2, 52:11 52:15 <b>scheme</b> 57:21 <b>school</b> 8:3, 8:14 <b>Scott</b> 2:3, 4:4 4:5, 86:2, 90:21 96:14 <b>scott.cunning@...</b> 2:7 <b>second</b> 13:4 27:5, 30:14 45:18, 50:22 55:24, 56:2 56:3, 56:10 56:11, 56:11 56:12, 56:16 56:19, 56:20 58:1, 58:2, 58:3 59:12, 59:19 59:22, 60:3 60:7, 61:3 61:11, 61:15 61:18, 62:6 62:23, 62:24 63:3, 63:6, 63:6 63:16, 63:23 63:25, 64:5 64:6, 64:14	65:24, 68:24 68:24, 69:8 69:9, 69:17 69:18, 70:17 71:4, 71:16 71:21, 71:23 72:1, 72:6, 74:1 74:3, 74:10 74:14, 74:18 74:22, 75:1 76:8, 76:11 76:16, 76:20 77:7, 77:8 77:16, 77:20 77:24, 79:8 80:3, 80:18 81:9, 81:10 81:21, 81:22 82:4, 82:13 82:25, 83:14 83:18, 83:20 84:3, 84:25 84:25, 85:24 87:16, 87:20 88:10, 88:16 90:8, 90:16 90:17, 91:3 93:9 <b>section</b> 16:4 73:23, 74:4 <b>Security</b> 8:20 <b>see</b> 21:21, 22:1 24:5, 26:17 29:25, 31:9 31:17, 37:15 56:13, 68:11 68:24, 74:7 75:23, 80:1 87:16 <b>seeing</b> 86:16 <b>seen</b> 31:1, 43:16 <b>sell</b> 45:14 <b>semiconductor</b> 1:3, 2:2, 8:22 18:17, 18:22 19:1, 19:9, 22:1	22:3, 22:6 22:20, 23:3 23:19, 42:1 43:20, 44:5 44:11, 45:25 48:13, 53:20 53:21, 78:8 85:21 <b>sense</b> 51:14 60:1, 66:19 73:16 <b>sentence</b> 67:6 68:12, 89:24 <b>separate</b> 9:17 9:20, 35:16 49:23, 67:9 67:15, 67:23 68:7, 68:14 72:1, 76:14 76:15, 78:18 82:20, 82:25 90:8, 90:13 <b>separately</b> 57:25 <b>sequence</b> 52:23 <b>series</b> 15:14 31:16, 58:16 <b>serves</b> 16:12 16:13 <b>set</b> 12:25, 13:10 59:19, 59:22 60:3, 72:3, 88:4 <b>sets</b> 62:1 <b>shadow</b> 9:13 <b>shakes</b> 6:15 <b>shape</b> 13:7, 27:5 44:12, 71:24 <b>shapes</b> 55:11 55:13, 58:21 <b>shift</b> 32:7, 59:12 64:7, 64:8 79:13, 83:3 83:8 <b>shifted</b> 37:20 59:23, 60:7 61:4, 75:2	79:23, 80:5 80:19, 82:4 82:21, 83:1 83:11, 83:21 <b>shifting</b> 63:9 64:6, 64:12 64:13, 79:7 81:8, 81:9 93:13 <b>shorthand</b> 1:22 96:2 <b>showing</b> 32:18 66:13, 92:12 <b>shown</b> 9:13 32:19, 75:6 80:22 <b>shows</b> 32:21 <b>shutter</b> 25:16 26:5 <b>sic</b> 36:18 <b>side</b> 76:3, 76:4 <b>sign</b> 20:5 <b>signature</b> 4:6 20:3, 20:3, 95:1 95:24 <b>signed</b> 20:8 <b>significant</b> 62:1 <b>silent</b> 48:15 <b>similar</b> 12:5 21:24, 31:12 <b>similarities</b> 90:5 <b>simple</b> 11:22 13:7, 30:10 47:25 <b>simpler</b> 34:10 <b>simplest</b> 29:1 29:1 <b>simplicity</b> 33:8 43:2 <b>simply</b> 11:23 13:8, 27:20 57:1 <b>simulate</b> 17:9 <b>simulator</b> 17:8 <b>single</b> 28:2 41:12, 50:19
<b>S</b>				
<b>Sam</b> 96:24 <b>Samsung</b> 1:3 2:13, 85:6 <b>saw</b> 35:16 35:24, 37:9 <b>saying</b> 18:13 42:10, 59:14 <b>says</b> 23:23 26:23, 53:22 53:23, 56:20 87:11 <b>scale</b> 55:17 55:23, 55:24 80:10, 81:4				

HANNA &amp; HANNA, INC.

713.840.8484



## DR. CHRIS A. MACK - May 14, 2015

51:1, 51:11 52:3, 56:2, 56:5 60:24, 61:2 62:4, 62:19 62:22, 68:5 74:15, 74:19 74:22, 76:6 82:21, 83:6 83:15, 83:23 84:8, 84:10 84:10 <b>sitting</b> 20:16 <b>situation</b> 28:24 <b>six</b> 45:5 <b>size</b> 27:4, 36:5 38:8, 44:13 45:6, 45:7 55:25, 56:6 71:24 <b>sizes</b> 55:7, 55:16 55:17, 58:21 <b>skill</b> 21:23, 22:4 22:11, 22:13 22:16, 22:21 27:7, 44:10 51:5, 53:7, 53:7 65:2, 65:6 65:12, 72:22 73:3, 74:23 77:22, 78:1 78:17, 79:6 79:10, 80:3 80:10, 80:13 81:5, 81:15 81:23, 82:2 82:15, 82:15 82:19, 82:24 93:14 <b>slight</b> 9:10 <b>slightly</b> 30:7 33:18, 93:23 <b>slit</b> 11:5 <b>small</b> 9:10 10:15, 11:20 11:23, 12:18 13:7, 13:9	15:22, 15:22 15:25, 31:17 32:7, 41:13 76:3, 92:13 <b>SMITH</b> 2:21 <b>software</b> 59:16 <b>solution</b> 76:5 76:6, 76:12 <b>solve</b> 77:23 82:15 <b>solves</b> 77:6 77:11 <b>somewhat</b> 6:9 33:18 <b>soon</b> 87:7 <b>sorry</b> 9:15 17:10, 27:20 32:6, 58:13 67:19, 73:18 73:19, 85:16 85:24 <b>sort</b> 16:22 24:18, 34:22 <b>source</b> 13:12 13:13, 13:14 13:15, 16:20 16:22, 19:4 54:12, 65:9 65:14 <b>sources</b> 17:18 65:7, 65:8 <b>space</b> 34:23 35:1, 40:3, 74:3 74:4 <b>spaced</b> 35:12 <b>spaces</b> 41:1 60:5, 81:11 82:5, 84:14 <b>spacing</b> 40:18 72:24 <b>speaking</b> 5:19 <b>specific</b> 19:18 73:5, 81:18 <b>specifically</b> 62:5 70:8, 91:21 94:13	<b>specification</b> 53:16, 68:13 77:18, 79:15 <b>specifics</b> 23:5 <b>specified</b> 59:24 60:8, 71:5 <b>specifies</b> 64:8 <b>specify</b> 79:1 <b>specifying</b> 17:16 <b>spend</b> 61:22 <b>spot</b> 11:23 11:24, 12:17 15:1, 27:6 39:11 <b>square</b> 43:2 43:3, 92:13 <b>squares</b> 31:17 <b>stage</b> 39:15 40:4, 61:4, 64:6 64:8, 64:12 64:13, 64:18 75:3, 76:9 76:21, 76:25 79:7, 81:8 <b>standard</b> 64:20 78:2, 78:14 84:6 <b>start</b> 24:21, 25:1 41:19, 92:5 <b>starting</b> 24:10 <b>state</b> 1:21, 5:6 96:1, 96:3 <b>stated</b> 57:3 80:17 <b>statement</b> 36:22 50:7, 69:13 <b>statements</b> 96:8 <b>states</b> 1:1, 4:11 26:14, 68:22 69:7 <b>stationary</b> 15:21 <b>step</b> 26:20 27:11, 28:14 34:3, 38:15 38:19, 52:19 54:18, 61:10	61:11, 62:4 62:23, 63:3 63:7, 83:7 83:16, 84:25 85:2, 91:1, 91:3 91:12, 91:24 92:3, 93:8, 93:9 <b>step-and-repeat</b> 9:3, 9:22, 9:25 10:10, 10:12 10:18, 11:9 22:7, 39:3, 39:5 47:23 <b>step-and-scan</b> 11:4, 11:10 11:11, 11:13 22:8 <b>stepped</b> 10:16 11:7, 15:23 <b>stepper</b> 10:15 61:10 <b>steps</b> 33:12 34:6, 40:9 45:24, 52:23 60:25, 63:2 63:14, 64:14 74:23, 76:9 77:1 <b>stick</b> 39:20 <b>straight</b> 55:14 <b>street</b> 2:4, 2:15 35:13 <b>studied</b> 73:1 73:6 <b>studying</b> 17:7 <b>style</b> 10:9, 10:20 11:1, 12:4 <b>styles</b> 11:3 <b>subsequent</b> 39:19 <b>substrate</b> 9:6 13:24, 15:19 74:2, 74:5 <b>success</b> 80:14 <b>successfully</b> 39:25	<b>successive</b> 35:1 <b>successively</b> 39:25 <b>suffer</b> 41:16 77:14 <b>suffers</b> 76:15 <b>sufficient</b> 36:11 73:1 <b>sufficiently</b> 35:23, 41:13 41:15, 44:14 44:17 <b>suggest</b> 68:9 <b>suitable</b> 24:3 <b>Suite</b> 1:24, 2:5 2:10, 2:16, 3:4 <b>summary</b> 94:11 <b>supply</b> 59:18 <b>supports</b> 68:1 <b>suppose</b> 65:9 <b>supposed</b> 40:5 79:19 <b>sure</b> 6:11, 7:1 17:19, 28:18 53:15, 72:17 81:19, 89:20 93:6 <b>surface</b> 25:25 26:1, 66:11 <b>suspect</b> 82:8 <b>swapped</b> 62:13 <b>sworn</b> 1:19 96:5 <b>system</b> 9:25 11:14, 12:1 15:2, 15:2, 15:4 17:21, 18:17 24:25, 25:12 25:15, 25:23 26:25, 27:23 27:24, 28:5 28:6, 28:7, 28:9 28:11, 28:14 28:15, 28:16 30:10, 32:3 39:3, 39:6
---	---	--	--	---

HANNA &amp; HANNA, INC.

713.840.8484

## DR. CHRIS A. MACK - May 14, 2015

47:23, 54:8 71:3, 71:9 <b>systems</b> 10:13 12:3, 12:13 12:14, 13:17 13:18, 16:18 16:21, 69:3	18:20, 18:21 18:24, 18:25 22:22, 30:16 85:20 <b>Technology's</b> 31:4 <b>tell</b> 16:2, 58:16 77:22 <b>telling</b> 15:15 71:16, 87:11 <b>tens</b> 9:11 <b>term</b> 15:5, 23:23 <b>terminology</b> 19:6, 27:3 <b>terms</b> 88:25 <b>Terre</b> 8:12 <b>test</b> 48:18 <b>testified</b> 5:3 81:14 <b>testimony</b> 7:22 77:9, 91:10 94:11, 96:7 <b>Texas</b> 1:22, 1:24 2:11, 3:5, 5:10 5:14, 8:10, 96:1 96:3, 96:22 96:24 <b>theaters</b> 12:7 <b>thick</b> 29:18 29:24 <b>thickness</b> 29:13 29:15 <b>thin</b> 29:16 29:23 <b>thing</b> 7:11, 91:9 <b>things</b> 6:10 37:18, 66:13 92:5 <b>think</b> 21:12 28:21, 28:23 32:21, 33:8 36:22, 38:6 42:12, 43:23 44:2, 45:3 50:20, 55:3 57:15, 60:20	65:5, 66:18 68:17, 73:3 79:13, 79:15 79:19, 80:6 81:14, 87:5 89:10, 92:10 93:5, 93:17 <b>thinking</b> 92:22 <b>thought</b> 17:20 29:1, 30:20 38:14 <b>three</b> 91:22 <b>tilting</b> 12:8 <b>time</b> 9:1, 10:14 10:16, 13:1 13:11, 14:3 14:11, 26:5 27:7, 28:3 33:12, 41:12 43:7, 45:7, 51:6 52:6, 52:12 53:8, 61:23 64:21, 74:24 78:8, 78:17 78:24, 79:11 80:12, 80:24 81:3, 81:20 81:23, 81:24 84:6, 84:16 85:1, 89:11 96:12 <b>times</b> 6:7, 38:24 39:1, 84:22 91:22 <b>tip</b> 13:23, 13:24 <b>tipped</b> 35:24 <b>Title</b> 1:9 <b>today</b> 7:2, 7:16 7:22, 11:2, 14:7 19:16 <b>told</b> 71:5 <b>tolerances</b> 62:10 63:5, 82:12 <b>tool</b> 15:6, 15:6 15:8, 15:10 15:15, 15:18	16:2, 16:3, 16:9 17:6, 25:7 25:10, 27:14 27:16, 28:3 36:11, 42:1 42:22, 58:17 71:5, 71:13 71:16, 71:17 76:7, 84:21 <b>tools</b> 9:4, 9:19 16:11, 49:9 71:9 <b>top</b> 36:13, 43:2 45:16, 54:3 87:15 <b>topography</b> 29:10, 29:12 29:14 <b>TRADEMARK</b> 1:1 <b>traditional</b> 13:14, 24:19 65:8 <b>transcript</b> 96:6 <b>transfer</b> 9:5 27:25, 28:17 30:3, 30:8 36:21, 36:23 37:1, 37:4 37:21, 38:2 38:11, 39:8 39:16, 41:8 43:17, 43:25 66:24 <b>transferred</b> 40:6, 41:4, 41:5 41:23, 43:21 44:1, 44:9, 46:2 46:4, 46:6, 46:8 46:9, 46:10 46:11, 46:12 46:14 <b>transferring</b> 9:23, 43:23 <b>transistors</b> 60:3 60:4, 60:5	<b>translation</b> 16:15, 18:11 <b>transmitted</b> 25:18 <b>transparent</b> 66:14, 66:15 <b>traveling</b> 66:19 <b>TRIAL</b> 1:2 <b>true</b> 66:18 84:16, 95:20 96:7 <b>truth</b> 87:12 <b>truthful</b> 7:22 <b>try</b> 6:20, 6:21 18:4, 79:24 <b>trying</b> 6:18 80:25, 83:9 <b>TSMC</b> 1:3, 85:6 <b>TSMC-1-1</b> 32:14 <b>TSMC-1004</b> 4:18, 72:9 73:17, 92:25 <b>TSMC-1014</b> 4:11, 23:11 23:12, 23:13 26:10 <b>TSMC-1015</b> 4:12, 30:18 30:25 <b>TSMC-1016</b> 4:14, 85:10 85:15, 85:17 87:13, 88:15 <b>TSMC1-1015</b> 30:15 <b>TSMC1-1016</b> 85:16 <b>turn</b> 15:16, 16:2 31:7, 56:8 58:17, 58:17 59:8, 59:9 65:24, 67:3 71:1, 87:13 <b>turned</b> 11:25 12:8
---	---	--	--	---

HANNA &amp; HANNA, INC.

713.840.8484

## DR. CHRIS A. MACK - May 14, 2015

<b>turns</b> 15:12	60:13, 61:24	9:19, 9:19	<b>view</b> 23:2, 23:18	39:3, 39:10
<b>TVs</b> 12:7	63:18, 71:22	11:20, 12:14	60:24, 61:5	39:14, 39:15
<b>two</b> 11:3, 15:20	73:21, 75:9	12:21, 15:6	67:21, 74:14	39:15, 39:22
27:1, 27:8, 35:7	79:21, 79:25	15:10, 17:5	88:6, 88:9	39:22, 39:23
38:7, 45:3, 45:5	87:25, 88:3	18:7, 18:8	<b>visualize</b> 92:9	40:4, 40:15
51:2, 52:21	<b>Ultimately</b>	18:14, 19:4	<b>Voss</b> 3:3	40:19, 41:8
52:22, 55:2	28:12	22:23, 23:3	<b>vs</b> 85:20	41:10, 43:7
55:18, 55:19	<b>ultraviolet</b>	23:20, 47:22		44:18, 44:19
57:16, 57:18	23:23, 65:11	48:12, 49:22	<b>W</b>	44:20, 44:24
57:23, 58:4	65:14	50:14, 51:12		44:25, 45:7
60:16, 60:17	<b>unclear</b> 81:1	52:2, 52:17	<b>wafer</b> 9:9, 9:12	45:10, 45:12
60:18, 60:24	81:17	53:2, 57:2, 59:3	10:3, 10:14	45:14, 45:17
61:20, 62:3	<b>undergoes</b> 26:6	62:8, 69:15	10:15, 10:16	45:22, 46:7
62:8, 63:21	<b>undergone</b>	74:22, 76:6	10:18, 10:21	46:19, 48:13
66:13, 67:9	32:23, 32:25	81:16, 81:21	10:23, 10:24	49:15, 49:18
67:15, 67:23	<b>underneath</b>	83:1, 84:20	11:5, 11:6, 11:6	49:20, 49:21
68:7, 68:14	29:6, 41:21	90:8, 90:9	11:21, 12:11	50:6, 50:10
76:14, 77:1	76:10, 76:17	90:11, 91:16	12:16, 12:20	50:15, 50:17
78:6, 82:19	<b>understand</b>	91:17, 94:12	12:24, 14:10	50:22, 53:20
90:3, 90:6, 90:8	6:15, 7:1, 7:1	<b>useful</b> 61:7	15:3, 15:21	53:22, 58:22
90:10, 90:13	7:4, 7:17, 7:19	<b>uses</b> 12:4, 13:22	15:23, 16:17	58:25, 59:5
<b>type</b> 8:25, 9:16	17:19, 32:6	56:22, 60:24	25:9, 25:13	60:12, 61:4
9:17, 9:25	40:11, 57:15	62:19, 62:22	25:14, 25:15	63:9, 64:6, 64:8
31:12	62:18, 79:19	76:14, 77:8	26:1, 26:6, 27:6	64:12, 64:13
<b>types</b> 9:20, 10:4	<b>understanding</b>	<b>usually</b> 11:20	27:12, 27:25	64:18, 66:11
10:7, 11:14	17:17, 53:13	25:22	28:4, 28:4	75:3, 76:10
12:3, 12:12	54:21, 54:24	<b>UV</b> 65:20	28:10, 28:11	76:21, 76:21
17:16, 27:23	55:9, 56:9		28:12, 28:17	76:24, 76:25
<b>typical</b> 33:7	60:23, 78:7	<b>V</b>	29:2, 29:4, 29:5	79:7, 79:23
44:22, 45:1	93:13		29:9, 29:10	81:8, 83:4
47:22, 50:16	<b>understands</b>	<b>vacuum</b> 23:25	29:12, 29:15	83:21, 92:5
<b>typically</b> 13:6	93:6	65:20	29:17, 29:19	92:7, 92:11
13:16, 36:1	<b>understood</b> 51:5	<b>valid</b> 61:7	29:21, 29:23	92:13, 92:16
51:16, 51:24	80:1	<b>value</b> 84:1	29:24, 30:7	92:19, 92:20
<b>typographical</b>	<b>unfamiliar</b>	<b>variation</b> 9:10	30:12, 31:15	92:21, 93:3
79:15	59:16	29:15, 49:8	32:11, 32:11	93:7, 94:7
	<b>uniformity</b>	<b>variations</b> 11:17	32:20, 32:22	94:10, 94:16
	45:18	29:13	32:25, 33:3	94:18
	<b>United</b> 1:1, 4:11	<b>variety</b> 13:19	33:12, 33:19	<b>wafer's</b> 10:22
<b>ubiquitous</b> 78:7	<b>University</b> 5:14	84:4	34:2, 34:3, 34:7	92:15
<b>Uh-huh</b> 32:24	8:7, 8:9	<b>various</b> 17:14	34:9, 34:12	<b>wafers</b> 62:2
34:1, 34:5	<b>unofficial</b> 5:22	<b>verb</b> 91:14	34:15, 34:18	83:8
35:10, 38:16	<b>unpatterned</b>	<b>verbal</b> 6:14	34:22, 35:12	<b>wait</b> 6:21
38:18, 46:17	45:22	<b>version</b> 14:15	35:16, 38:9	<b>want</b> 7:1, 17:19
49:11, 52:20	<b>usage</b> 50:16	<b>versus</b> 40:24	38:17, 38:21	24:18, 38:1
56:24, 57:20	<b>use</b> 5:20, 9:3	71:16, 94:7	38:23, 39:2	38:2, 45:13

HANNA &amp; HANNA, INC.

713.840.8484

IPR2014-01030 / TSMC-1017

Page 115 of 117

DR. CHRIS A. MACK - May 14, 2015

45:14, 45:14 47:12, 58:14 58:21, 58:22 59:12, 60:2 60:3, 65:25 79:8, 89:11 <b>wanted</b> 58:13 <b>Washington</b> 2:5 2:16 <b>watch</b> 47:9 <b>Watchhill</b> 5:10 <b>way</b> 6:9, 11:19 11:21, 18:1 36:15, 43:4 47:24, 55:4 58:4, 60:10 82:10, 87:5 93:19, 93:24 <b>ways</b> 55:2 91:13, 94:13 <b>we've</b> 31:13 40:2, 40:14 41:20, 41:20 <b>website</b> 5:21 <b>WEIL</b> 2:15 <b>Welcome</b> 87:10 <b>West</b> 96:24 <b>width</b> 35:23 <b>wish</b> 25:4 <b>withdrew</b> 70:21 <b>witness</b> 1:18 89:4, 89:9, 95:2 96:5, 96:7, 96:9 <b>word</b> 67:17 67:18, 91:16 91:17, 94:12 <b>words</b> 50:8 55:8 <b>work</b> 5:12, 6:10 9:7, 9:23, 20:19 20:22, 24:21 41:17, 70:7 75:17 <b>worked</b> 8:24 <b>working</b> 8:15 8:19, 8:20	16:23, 17:2 20:13, 20:15 41:14 <b>works</b> 47:21 <b>worry</b> 27:9 <b>worrying</b> 61:23 <b>worth</b> 10:22 <b>write</b> 12:1, 12:2 12:17, 14:16 14:18, 15:1 15:7, 15:10 15:15, 15:18 16:9, 19:3, 19:5 19:8, 19:11 22:15, 22:17 22:19, 23:4 23:20, 24:4 24:6, 24:15 58:13, 58:15 58:24, 64:23 64:25, 65:3 71:3 <b>writer</b> 58:24 <b>writing</b> 58:17 <b>wrong</b> 34:17 43:24, 43:25 44:8  <b>X</b>  <b>x-ray</b> 23:24 65:16  <b>Y</b>  <b>yeah</b> 21:12 34:14, 73:19 75:12, 86:13 <b>years</b> 21:25 <b>yesterday</b> 8:1 <b>yield</b> 41:16 <b>yielding</b> 41:13  <b>0</b>  <b>00</b> 96:15	<b>02</b> 96:14 <b>04</b> 69:6 <b>06</b> 80:5 <b>084</b> 23:2, 23:6 23:15, 23:19 24:13, 26:9 27:7, 48:7, 51:6 53:8, 53:10 53:14, 55:9 57:22, 58:7 58:9, 62:14 63:8, 63:11 63:15, 63:16 64:3, 64:11 64:21, 64:23 65:1, 65:7 65:11, 67:7 67:11, 67:14 67:21, 68:22 69:2, 69:7 69:15, 69:24 70:2, 70:13 73:13, 74:24 75:19, 76:13 76:14, 77:5 77:13, 77:17 78:15, 78:17 78:19, 78:21 81:3, 81:20 81:21, 81:25 82:1, 82:9 82:14, 83:13 83:18, 84:3 85:7, 87:21 88:21, 89:20 90:4, 90:23 92:23  <b>1</b>  <b>1</b> 26:9, 27:3 30:21, 48:2 48:8, 56:1, 56:7 58:9, 67:24 87:21, 88:21 88:25, 90:24	91:21 <b>1(b)</b> 26:14, 91:23 <b>1(E)</b> 75:6, 80:22 <b>1:08</b> 1:20, 94:25 <b>10</b> 6:8 <b>10:21</b> 47:16 <b>10:38</b> 47:16 <b>1015</b> 30:19 32:16 <b>11</b> 20:2 <b>11:26</b> 72:18 <b>11:39</b> 72:18 <b>12</b> 6:8, 24:8 45:5 <b>12/31/16</b> 96:23 <b>12:06</b> 87:9 <b>12:14</b> 87:9 <b>12:17</b> 89:16 <b>12:59</b> 89:16 <b>13</b> 26:12, 69:19 69:23 <b>1300</b> 2:15 <b>13b</b> 75:11, 75:21 75:21, 75:22 75:23, 75:25 76:2, 80:21 <b>13th</b> 20:5 <b>14</b> 1:14, 1:20 95:2 <b>15</b> 69:20, 69:23 <b>150</b> 40:2 <b>15a</b> 75:8, 75:16 75:22, 75:25 76:1, 80:22 <b>16</b> 21:5, 21:11 21:20 <b>1605</b> 5:10 <b>17</b> 21:12 <b>17th</b> 2:4 <b>18</b> 21:12, 56:15 87:13 <b>180</b> 2:22 <b>1812</b> 96:24 <b>1900</b> 1:24, 3:4 <b>1983</b> 8:17 <b>1994</b> 14:3, 14:11	78:8, 78:24 84:20 <b>19th</b> 96:21  <b>2</b>  <b>2</b> 31:24, 32:13 51:17, 53:10 53:14, 53:16 54:3, 54:11 54:20, 57:4 57:13, 65:24 66:1, 69:19 <b>2:14-CV-199</b> 85:22 <b>20</b> 24:11, 47:10 56:15 <b>200</b> 53:22 <b>20005</b> 2:16 <b>20006</b> 2:5 <b>2006</b> 32:13 <b>2007</b> 19:15 19:25 <b>2015</b> 1:14, 1:20 20:6, 95:2 96:21 <b>202)306-4135</b> 2:6 <b>202)654-4267</b> 2:6 <b>202)682-7000</b> 2:17 <b>202)857-0940</b> 2:17 <b>210</b> 53:20, 53:22 <b>220</b> 53:18, 53:24 53:24, 54:7 66:17 <b>221</b> 54:1, 57:11 57:14 <b>222</b> 54:1, 57:11 <b>223</b> 54:2, 55:8 55:10, 57:11 57:14 <b>240</b> 56:15 <b>241</b> 56:17, 57:11
---	---	--	--	--

HANNA & HANNA, INC.  
713.840.8484

DR. CHRIS A. MACK - May 14, 2015

57:13 242 56:17 243 56:17 244 56:17 245 56:18, 57:11 57:13 2505 2:10 26 56:14 27 67:4	<b>6</b>  <b>6</b> 56:14, 67:4 79:16, 79:20 80:6, 80:7 80:19, 81:8 81:10, 82:5			
	<b>7</b>			
<b>3</b>	<b>7</b> 69:19, 69:19 69:23 <b>713)840-8484</b> 96:25 <b>75039</b> 1:24, 3:5 <b>75082</b> 2:11 <b>77043</b> 96:24			
<b>3</b> 23:22, 31:7 31:9, 32:14 39:4, 40:14 53:24, 73:17 73:20, 79:9 79:14, 90:21 91:7, 92:9 <b>30-day</b> 96:11 <b>34677</b> 2:22 <b>36</b> 51:17	<b>8</b>  <b>800</b> 2:4 <b>800)807-3531</b> 2:23 <b>813)925-8525</b> 2:23 <b>8371</b> 96:22			
<b>4</b>	<b>9</b>			
<b>4</b> 21:20, 56:8 56:9, 56:13 56:18, 57:6 69:19 <b>4000</b> 2:10 <b>45</b> 23:22, 42:20 42:23, 43:9 <b>45-degree</b> 43:1	<b>9</b> 69:19, 69:23 <b>9:03</b> 1:20, 5:1 <b>900</b> 2:16 <b>972)444-0716</b> 3:6 <b>972)692-9118</b> 2:12 <b>972)739-8635</b> 2:11 <b>972)831-1188</b> 3:5			
<b>5</b>				
<b>5</b> 56:14 <b>5,652,084</b> 1:7 22:24 <b>5,652,084.....23</b> 4:11 <b>500</b> 2:5 <b>5215</b> 1:23, 3:4 <b>57</b> 53:24, 56:14				

HANNA & HANNA, INC.  
713.840.8484