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.

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EXHIBITS

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

DR. CHRIS A. MACK,

having been first affirmed, testified as follows:

EXAMINATION

BY MR. CUNNING:

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

A. Chris Allen Mack.

Q. And what is your residence address?

A. 1605 Watchhill Road, Austin, Texas.

Q. And are you currently employed?

A. I work as a consultant.

Q. Okay. And do you --

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

Q. Does your consulting business have a name?

A. No.

Q. So you just --

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

Q. Have you given a deposition before?

A. I have.

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

A. Yes.

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

A. Yes.

Q. How many times?

A. Approximately 10 or 12.

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

A. I do.

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

A. Yes.

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

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

A. Yes.

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

A. I will.

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

A. Yes.

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

A. Yes.

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

A. No.

Q. And I apologize about that question, but you

never know if someone was in a car accident yesterday.

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

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

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

A. It is a fabulous school.

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

A. I began in photolithography in 1983.

Q. And what was the circumstances in which you began working with photolithography?

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

Q. What type of photolithography equipment were

you using at the time?

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

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

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

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

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

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

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

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

Q. Are there other types of projection optical lithography?

A. Yes.

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

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

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

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

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

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

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

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

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

called a direct write lithography system.

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

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

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

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

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

at a time?

A. Yes.

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

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

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

A. Typically, it is electron beams.

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

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

Q. Is that used in production?

A. No.

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

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

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

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

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

A. I believe so.

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

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

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

A. That's correct.

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

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

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

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

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

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

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

A. That's correct.

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

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

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

A. Yes.

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

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

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

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

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

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

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

A. I have limited experience with E-beam

lithography.

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

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

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

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

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

MR. HOPEN: Objection to form.

A. No.

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

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

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

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

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

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

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

A. No.

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

semiconductor devices?

A. No.

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

A. Yes.

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

A. No.

Q. Are you familiar with optical direct write lithography?

A. I am.

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

A. Okay.

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

A. Yes.

Q. And what is DSS 2007?

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

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

A. Yes.

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

A. Yes.

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

A. Yes.

Q. Did you draft this declaration?

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

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

A. Mostly Andriy and Anton, sitting here.

Q. Did you --

A. Mostly Andriy.

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

A. I don't recall.

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

A. No.

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

anything --

A. No.

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

A. No.

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

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

Q. Ah.

A. -- I have found paragraph 16.

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

A. And --

Q. I'm just --

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

Q. Okay.

A. -- has been misapplied.

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

A. I see it.

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

semiconductor fabrication. Do you see that?

A. Yes.

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

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

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

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

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

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

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

A. Yes.

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

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

Q. Just so happens I have copies.

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

(Exhibit TSMC-1014 marked.)

Q. Do you recognize TSMC-1014?

A. Yes.

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

A. Yes.

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

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

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

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

A. Yes.

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

A. Yes.

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

MR. HOPEN: Objection to form.

A. Yes.

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

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

Q. Okay.

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

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

Q. Okay.

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

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

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

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

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

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

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

A. Yes.

Q. Column 13.

A. Yes.

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

A. Yes.

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

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

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

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

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

Q. What is a reticle?

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

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

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

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

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

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

Q. The pattern in the mask.

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

Q. Okay.

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

Q. Why will it not always be the case?

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

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

Q. And presumably in your design that I see and

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

A. That's correct.

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

A. That's possible.

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

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

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

MR. CUNNING: Yes, 1015.

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

THE REPORTER: You did.

MR. O'DELL: Okay.

MR. CUNNING: I apologize.

(Exhibit TSMC-1015 marked.)

Q. Have you seen this document before?

A. Yes.

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

A. Outside of my declaration, no.

Q. Turn to page 3 of the document.

A. Yes.

Q. You see the figure depicted on page 3?

A. Yes.

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

A. Yes.

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

A. Yes.

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

A. Possibly.

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

A. Yes.

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

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

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

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

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

A. Yes.

Q. -- 1015?

A. Yes.

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

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

Q. Uh-huh.

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

the exposure that's being depicted in the figure.

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

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

Q. Okay.

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

Q. Okay.

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

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

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

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

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

Q. Uh-huh.

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

Q. Uh-huh.

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

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

A. Okay.

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

A. Yes.

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

A. Well, the pattern is the die.

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

A. It will be when we're finished.

Q. Okay. So is it important to project each

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

A. Yes.

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

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

Q. Uh-huh.

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

Q. Okay.

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

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

A. That's exactly right.

Q. Okay.

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

Q. Okay.

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

Q. Okay.

A. That distance far exceeds any --

Q. The size of the die?

A. No.

Q. Okay.

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

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

A. The kerf, that's correct.

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

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

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

transfer of the desired pattern?

A. Depending on what you mean desired. Misalignment is not desired, but you would have a complete transfer of the pattern.

Q. Would it be on the die?

A. Yes.

Q. The kerf is part of the die?

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

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

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

Q. It's possible?

A. Many things are possible.

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

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

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

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

A. Yes.

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

A. Yes.

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

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

Q. Uh-huh.

A. -- on the wafer.

Q. Uh-huh.

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

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

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

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

A. Yes.

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

A. Yes.

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

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

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

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

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

A. Yes.

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

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

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

A. Yes.

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

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

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

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

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

spaces for the individual dies; is that correct?

A. Yes.

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

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

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

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

A. If you deliberately misaligned far in excess of

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

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

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

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

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

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

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

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

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

Q. It would be different --

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

Q. It would be a different pattern?

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

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

A. It depends on your perspective.

Q. Well, would it function the same?

A. Would the die function the same?

Q. Yes.

A. No.

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

A. For the purpose of chip making, no.

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

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

Q. And if you transfer the pattern in the wrong

place, have you transferred the same pattern?

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

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

A. Yes.

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

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

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

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

typical.

Q. And why is that done?

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

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

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

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

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

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

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

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

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

Q. Uh-huh.

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

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

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

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

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

Q. If --

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

MR. HOPEN: About an hour and 20.

MR. CUNNING: Okay.

Q. You want to take a break?

A. That would be great.

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

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

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

A. Yes.

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

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

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

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

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

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

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

patterns associated with a portion of the die?

A. That would depend on the lithography approach chosen.

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

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

Q. Uh-huh.

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

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

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

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

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

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

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

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

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

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

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

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

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

A. Yes.

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

A. Yes.

Q. -- that technique?

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

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

A. In what sense?

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

A. Anywhere from 2 to 36.

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

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

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

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

that -- on the same mask.

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

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

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

A. It is possible.

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

A. No.

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

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

Q. Uh-huh.

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

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

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

A. Yes.

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

A. Yes.

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

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

Q. Okay.

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

opaque feature 222 and having clear features 221 and 223.

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

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

A. That's correct.

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

A. That's correct.

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

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

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

A. Yes.

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

be other features that are not depicted?

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

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

A. No.

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

A. No.

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

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

Q. Okay.

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

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

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

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

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

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

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

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

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

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

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

A. I don't know what you mean.

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

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

Q. Uh-huh.

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

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

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

A. Yes.

Q. By claim 1 of the 084 patent?

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

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

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

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

A. Yes.

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

A. Yes.

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

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

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

A. In what sense?

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

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

Q. Uh-huh.

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

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

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

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

MR. HOPEN: Objection to form.

A. Jinbo discloses only a single mask.

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

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

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

Q. Uh-huh.

A. Errors in the manufacture of the photomask is a

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

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

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

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

A. Correct.

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

A. That's correct.

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

A. Well, Jinbo includes shifting the wafer.

Q. Right.

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

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

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

Q. Uh-huh.

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

Q. Okay.

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

Q. Okay.

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

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

A. Yes.

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

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

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

A. No.

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

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

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

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

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

A. Yes.

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

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

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

A. Yes.

Q. Same question for x-ray radiation.

A. Yes.

Q. And for E-beam radiation?

A. Yes.

Q. For vacuum UV radiation?

A. Yes.

Q. And for ion beam radiation?

A. Yes.

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

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

A. Yes.

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

A. Yes.

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

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

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

A. That is correct.

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

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

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

A. Yes.

Q. Can you read the first sentence there.

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

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

A. That's correct.

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

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

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

A. I believe the claim 1 is so limited.

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

abstract, you believe it supports that limitation?

A. Yes.

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

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

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

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

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

A. Yes.

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

A. Yes.

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

MR. HOPEN: Objection to form.

A. Yes, it does.

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

A. No.

Q. And how so?

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

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

A. Yes.

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

A. I don't recall.

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

A. I do recall something like that, yes.

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

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

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

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

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

A. I don't recall.

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

MR. HOPEN: Objection, form.

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

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

A. I do.

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

A. That's correct.

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

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

Q. Uh-huh.

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

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

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

A. Yes.

Q. And what is it?

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

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

MR. HOPEN: Sure.

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

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

A. I do.

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

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

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

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

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

A. Yes.

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

A. Yes. The same result in that sense.

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

A. Oh, I'm sorry.

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

A. Page 3?

Q. Uh-huh.

A. Okay.

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

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

A. Yes.

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

A. Yes.

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

A. Yes.

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

A. Yes.

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

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

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

Q. Uh-huh.

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

Q. I believe that's correct, yeah.

A. And then --

Q. I'm following you.

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

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

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

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

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

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

A. Yes.

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

and the reticle in between the two patterning steps?

A. Yes.

Q. Is that correct?

A. That's correct.

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

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

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

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

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

A. No.

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

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

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

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

A. Yes.

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

A. That's correct.

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

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

A. No.

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

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

Q. .6 microns?

A. Yes.

Q. Okay.

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

Q. Uh-huh.

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

Q. Uh-huh.

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

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

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

Q. Yes.

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

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

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

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

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

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

A. Would what have been in the scale?

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

MR. HOPEN: Objection to form.

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

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

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

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

MR. HOPEN: Objection, form.

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

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

A. That's correct.

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

A. Yes.

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

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

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

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

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

that is needed, so Jinbo has value.

Q. All right.

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

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

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

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

A. Yes.

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

A. Yes.

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

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

A. Yes.

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

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

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

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

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

(Exhibit TSMC-1016 marked.)

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

A. It looks familiar.

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

A. Yes.

Q. Okay. Sorry. Give me a second.

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

me --

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

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

MR. HOPEN: For this claim construction.

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

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

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

MR. HOPEN: Yeah.

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

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

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

MR. LYTVYN: It is.

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

MR. CUNNING: Okay. You have an objection?

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

but go ahead.

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

MR. HOPEN: Great.

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

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

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

A. Yes.

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

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

Q. Uh-huh.

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

Q. Uh-huh.

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

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

MR. HOPEN: Objection, form.

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

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

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

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

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

those constructions before answering your question.

Q. All right.

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

MR. HOPEN: Are you closing your cross?

MR. CUNNING: Yes.

MR. HOPEN: All right.

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

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

MR. CUNNING: Okay.

MR. HOPEN: -- and probably do redirect.

MR. CUNNING: Okay.

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

EXAMINATION

BY MR. LYTVYN:

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

A. I have it.

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

in abstract?

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

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

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

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

A. Okay.

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

A. Okay.

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

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

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

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

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

Q. Correct.

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

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

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

A. Okay.

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

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

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

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

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

A. No.

MR. LYTVYN: No further questions. Close redirect.

FURTHER EXAMINATION

BY MR. CUNNING:

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

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

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

A. Yes.

Q. Okay.

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

MR. LYTVYN: Nothing else.

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

CHANGES AND SIGNATURE

WITNESS NAME: DR. CHRIS A. MACK DATE: MAY 14, 2015

PAGE	LINE	CHANGE	REASON

I declare under penalty of perjury that the foregoing is true and correct with the above changes, if any.

Executed on (date) _____.

_____
Signature

STATE OF TEXAS)

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

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

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

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

Mr. Scott Cunning - 02 Hours:37 Minutes

Mr. Andriy Lytvyn - 00 Hours:08 Minutes

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

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

Larissa L. McPhearson, Texas CSR 8371
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