UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG DISPLAY CO., LTD.,	:	
Petitioner,	:	
vs.	:	Case No.
PICTIVA DISPLAYS	:	IPR2024-01094
INTERNATIONAL, LTD.,	:	Patent No.
Patent Owner.	:	8,558,223 B2

Deposition of BARRY P. RAND, Ph.D.,

Washington, D.C.

Thursday, April 3rd, 2025

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Pages 1 - 258

Reported by: Robert M. Jakupciak, RPR

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Deposition of BARRY P. RAND, Ph.D., held at the offices of:

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Pursuant to Notice, before Robert Michael Jakupciak, RPR, a Notary Public in and for the District of Columbia, when were present on behalf of the respective parties:

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A P P E A R A N C E S

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Also Present: Kiersten Choi, Esquire (via Zoom)

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C O N T E N T S

THE WITNESS: BARRY P. RAND, Ph.D.

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E X H I B I T S

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Exhibit 2100	Journal of Industrial and Engineering Chemistry Article by Jun Yeob Lee	28
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E X H I B I T S

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(Exhibits attached to transcript.)

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P R O C E E D I N G S

Whereupon,

BARRY P. RAND, Ph.D.,

called as a witness, and having been first duly sworn, was examined and testified as follows:

EXAMINATION BY COUNSEL FOR PATENT OWNER

BY MS. ZHONG:

Q. Good morning, sir. Can you please state your name for the record?

A. My name is Barry Rand.

Q. You have submitted a declaration in this IPR proceeding, which is IPR 2024-01094; is that correct?

A. I would like to verify the number, so I'm going to open up my declaration.

(SDC Exhibit Number 1003
was marked for identification.)

BY MS. ZHONG:

Q. And let me just hand you your declaration, which is premarked as SDC Exhibit 1003.

A. Thank you. Can you repeat the

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number? I would like to look before I provide an answer.

Q. The proceeding number is IPR 2024-01094.

A. Apparently, it's not on here, but if you are just handing me my declaration and telling me, I can clearly see that it is.

Q. Can you please take a look at the Exhibit 1003 that I just handed you?

A. Yes.

Q. Is this a declaration that you have submitted in this IPR?

A. Yes.

Q. How many hours did you spend on the declaration?

A. Probably approximately 50.

Q. 50 hours? Does that include reviewing the exhibits cited in your declaration?

A. It does.

Q. Now, you have an understanding of the patent in this, in this proceeding, which is 8,558,223?

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MR. GARR: Objection.

BY MS. ZHONG:

Q. And you need to answer the question even if he objected.

A. Okay. I have an understanding of Patent 8,558,223.

Q. And you stated in your declaration that you applied the plain and ordinary meaning to interpret the claims; is that correct?

Why don't you go to page 21 of the declaration and paragraph 48.

A. Paragraph 48 states that I have been informed that claims in the IPR are construed in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history.

Q. What is the ordinary and customary meaning of a term?

A. Can you be a little bit more specific what you mean by a term?

Q. Have you heard of the phrase "claim

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term"?

A. I'm familiar with claims of a patent.

Q. Okay.

A. And so if you mean the phrasing of a claim, then I'm familiar with claim phrasing.

Q. Okay. So what's the ordinary and customary meaning of the phrasing in the claim?

A. It means that a POSA, a person of ordinary skill in the art, upon reading the statement in a claim, would interpret it in a way that such a person would do so that they would be able to understand what is being stated and said.

Q. And in light of the specification and the prosecution history; is that correct?

A. That's correct. Taking all of that into account.

Q. Okay. So in the context of the '223 patent, what's the meaning of metal complex?

A. I would like to refer to the '223 patent.

Q. Sure. That's Exhibit 1001.

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(SDC Exhibit Number 1001
was marked for identification.)

A. I have the definition of metal complex in '223.

Q. You have reviewed '223 before; correct?

A. I have. I'm just trying to find the language where they define metal complex so I can be as specific as possible.

Q. How many times have you reviewed the '223 patent?

A. It depends. Do you mean in its entirety or in part?

Q. How many times did you review the '223 patent in its entirety?

A. A handful. Three to five times in its entirety.

Q. And did you focus on certain portions of the '223 patent?

A. I did focus on certain portions of the '223 patent, yes.

Q. And which portions?

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A. Particularly the discussion surrounding which types of metal complexes were in consideration within scope of the '223 patent's claims, as well as which types of organic and heteroaromatic systems were the host matrices for those metal complex dopant, as well as the claims that were relevant to those metal complexes and heteroaromatic compounds.

Q. Does '223 exclude any type of metal complexes?

MR. GARR: Objection.

A. It's focus is on -- '223 focuses on metal complexes that have an organic component to them, so it would -- there is --

Q. Talking about --

A. There would need to be an organic component in the metal component. So a metal complex that has a fully inorganic ligand I guess would be excluded from '223. And that's an implicit assumption, but I would not say it's stated explicitly.

Q. So at least organometallic complex

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would fall within the scope of the metal complex?

MR. GARR: Objection.

MS. ZHONG: Strike that.

BY MS. ZHONG:

Q. So at least organometallic complexes will fall within the scope of the '223 patent; is that correct?

A. As it pertains to what?

Q. As pertains to metal complex.

MR. GARR: Objection to form.

A. When it comes to the joint vaporization of a metal complex with an organic compound, that metal complex is regarded to be an organometallic compound.

Q. Okay. Is aluminum Q3 an organometallic complex in your mind?

A. Aluminum Tris quinolate? Is this the compound that you just mentioned?

Q. Correct.

A. Also known as Alq3?

Q. Uh-huh.

A. That would be regarded as an

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organometallic compound.

Q. What about lithium 8-hydroxyquinolinato?

A. Also known as lithium quinolate or lithium Q, would also be considered to be an organometallic compound.

Q. Lithium Q includes an oxygen atom in the formulation; correct?

A. Correct.

Q. Okay.

A. There is an oxygen atom in lithium quinolate.

Q. And the fact that it includes an oxygen atom doesn't exclude it from the scope of the metal complex. Is that correct?

MR. GARR: Objection.

A. Oxygen is often used in organic compounds because it's a hetero atom that controls electron density in conjugated systems. Lithium quinolate includes oxygen, and therefore is a compound that has an organic component as well as a lithium component, a metal component

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and includes oxygen.

Q. You have reviewed the prosecution history; correct?

A. That is correct.

(SDC Exhibit Number 1002 was marked for identification.)

BY MS. ZHONG:

Q. Can you pull up Exhibit 1002, which is the Prosecution History of the '223 Patent?

A. I have two files here, a part one and a part two.

Q. I believe part one contains the part we are going to discuss.

A. Okay. It's loading. It's 1,100 pages.

Q. Correct. Can you please go to, I believe it's page 837? Can you take a look at page 837 and 838?

A. Okay. I have both of those up. I will review them.

Q. Do you recall reviewing these two pages as part of your declaration drafting?

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A. I do recall that.

Q. Okay.

MR. GARR: What page are you on?

MS. ZHONG: 837 and 838.

BY MS. ZHONG:

Q. And let me direct your attention specifically to the two paragraphs on page 838.

A. Okay.

Q. Which relates to the definition of metal oxides.

A. Okay. As clearly shown above?

Q. Yes.

A. Okay. Okay.

Q. And do you see the sentence by the applicant stating: "A person of ordinary skill in the art understands that a metal oxide is a compound composed of one or more metal atoms and one or more oxygen atoms"?

Do you see that sentence?

A. I do see that sentence.

Q. Given that statement, do you consider lithium Q to be a metal oxide?

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A. I consider lithium quinolate to contain a metal to oxygen bond, but I need to review further whether I would strictly classify it as a metal oxide.

Q. What is your understanding of what a metal oxide is?

A. My understanding of a metal oxide is a compound that predominantly, but not exclusively, contains metal to oxygen bonds where those metals can source from alkali, alkaline or groups 3 through 5 or transition metal atoms or combinations thereof.

Q. Okay. So applying that understanding, do you consider lithium Q to be a metal oxide?

A. I think it would depend.

Q. Depends on what?

A. For example, if we had a lithium oxide and terminated the surface of empty space with quinolate compound, one could say it has lithium quinolate surface but the bulk is lithium oxide.

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Q. I'm only referring to the lithium Q itself without lithium oxide.

A. I think this is an area where I would need to think a little more deeply and consult textbooks for definitions of metal oxides and what they may or may not contain to come to a complete answer, which I'm not prepared to do with the exhibits in front of me.

Q. Does lithium quinolate predominantly have lithium oxygen bond?

A. Can you be a little more specific?

Q. What do you mean?

A. Lithium quinolate is a molecule that contains more than 10 atoms. So I'm not entirely sure what you mean by your question.

Q. Well, you said metal oxide is a compound that predominantly includes metal oxygen bonds, so applying that definition or that understanding, does lithium quinolate have predominantly lithium oxygen bond?

A. When we go by bond count, the lithium to oxygen bond is not the most abundant

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in the compound. But as it pertains to the chemical activity of that compound, the lithium-to-oxygen bond is particularly important. And so when you say predominant, I don't exactly know what is meant.

Q. And what do you mean by predominant in your previous answer when I asked you what is a metal oxide?

A. What I meant was that in terms of its electronic structure and behavior, the metal-to-oxygen bond is an important factor.

Q. So under that understanding, is lithium quinolate a metal oxide?

A. Lithium quinolate contains a metal oxygen bond which is important to its electronic structure.

Q. And is lithium quinolate a metal complex within the scope of the '223 patent?

A. Again I would just ask you what you mean by the scope of the '223 patent?

Q. Claim number one. Does it fall within claim number one?

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A. Let me refer to claim number one. Give me a moment.

So the end of claim one is the most relevant. "Wherein the electron-conducting layer is obtained by joint vaporization of a metal complex, which comprises a central metal atom, with an organic compound."

And so as it pertains, if this is what you mean by the scope of '223, I would consider lithium quinolate to be a metal complex that could be the compound included in a POSA's interpretation of claim one of '223.

Q. Okay. And that's the plain and ordinary meaning of the term "metal complex" as understood by one of ordinary skill in the art in light of the prosecution history as well as the patent specification; is that correct?

MR. GARR: Objection.

A. Can you repeat that please?

Q. Is that the ordinary and customary meaning of "metal complex" as understood by one of ordinary skill in the art and the prosecution

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history?

MR. GARR: Objection.

A. I'm not sure I understand what you are referring to here, building off of the previous question regarding the scope of the definition of "metal complex" and whether lithium quinolate is within that scope. So I'm not sure I'm understanding and I'll ask you to rephrase the question.

Q. Well, you applied the -- you interpret the claims by applying the ordinary and customary meaning as understood by one of ordinary skill in the art and the prosecution history; correct?

A. That is correct and reflects what I've stated in the declaration.

Q. Okay. And using that standard, you have reached a conclusion that lithium Q falls within the scope of the '223 patent; correct?

A. That is correct.

Q. Okay. So the ordinary and customary meaning of the term "metal complex" as understood

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by one of ordinary skill in the art and the prosecution history would include lithium Q; correct?

MR. GARR: Objection. Scope.

A. We have established that lithium quinolate is in my opinion a metal complex that is included within the scope of '223, yes.

Q. And it's in light of the patent specification and the prosecution history; correct?

A. My opinion on lithium quinolate being a metal complex is not rooted in my reading and of '223 or its prosecution history. I believe that's what you are asking, so I tried to rephrase it.

Q. Okay. So in light of the patent prosecution history as well as the specification, is lithium Q, does lithium Q fall within the scope of the '223 patent?

MR. GARR: Objection. Scope.

A. Can you repeat that? In light of?

Q. In light of the prosecution history

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and the specification of the '223 patent, does lithium Q fall within the scope of the '223 patent, claim number one?

MR. GARR: Objection. Scope.

A. Again, I have already stated that lithium quinolate is a metal complex, and as such, would fall within the scope of claim one of '223, but I wouldn't phrase it in light of the '223 and its prosecution history. I would just state that what I've already stated.

Q. You understand that when you apply the plain and ordinary meaning of a term, that's in light of the specification and the prosecution history; correct?

MR. GARR: Objection.

A. When I state that I've used the customary meaning, I am also bringing to bear the knowledge of a person of ordinary skill in the art. And so that's why I'm uncomfortable with exclusively expressing that my understanding and opinion of lithium quinolate is a metal complex as pertains to claim one of '223 is from '223 and

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the prosecution history.

Q. So your conclusion that lithium Q falls within the scope of the '223 patent is in light of the prosecution history, what the '223 patent teaches, as well as the understanding of a person of ordinary skill in the art. Is that correct?

A. That is not correct. My understanding of lithium quinolate as a metal complex comes as a person with ordinary skill in the art and not specifically from the teaching of the '223 patent. The previous question that I agreed that lithium quinolate is a metal complex and falls within the scope of claim one of the '223 patent is different from that.

Q. So your interpretation of the claim excludes the teaching of the '223 patent and the prosecution history?

MR. GARR: Objection.

A. I am not stating that I am excluding what's stated in the specification or the claims of the '223 patent to come to my determination of

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lithium quinolate as a metal complex.

Q. So in view of the prosecution history as well as the '223 patent, would a person of ordinary skill in the art view the lithium quinolate as falling within the scope of the '223 patent?

A. Can you repeat that?

Q. In view of the prosecution history, the teaching of the '223 patent, would a person of ordinary skill in the art consider lithium quinolate to fall within the scope of the '223 patent?

A. A person of ordinary skill in the art would agree that lithium quinolate is a metal complex and falls within the scope of claim one of the '223 patent.

Q. After they read the '223 patent and the prosecution history?

A. Whether it's before or after that that person would do that is difficult to say, and I think would very much depend.

Q. After a person of ordinary skill in

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the art has reviewed the '223 patent, the prosecution history, would they consider lithium quinolate to fall within the scope of the '223 patent?

A. Yes, they would.

Q. They would?

A. Yes.

Q. Okay.

A. But that doesn't mean that they might not consider that beforehand as well, just to be clear.

Q. Do you know what is the chemical structure of lithium quinolate?

A. I am familiar with the molecular structure of lithium quinolate.

Q. Do you know what is the actual structure of lithium quinolate?

A. Yes. I have that chemical structure here in front of me. Page 61 of the declaration, of my declaration.

Q. Okay. Is that how it exists in nature? Or does it exist in dimers, trimers or

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some other forms?

A. It depends.

Q. Okay. What is a structure that it would exist in film form?

A. Again it depends.

Q. What's the structure in your mind in your opinion?

A. Well, when you tell me in film form, I don't know if you are referring to a film of exclusively lithium quinolate or a film where lithium quinolate is there in varying quantities amidst an inert host, amidst a polymeric host, amidst a small molecular weight host, or amidst a host that is, has coordinated capability with lithium quinolate. So it very much depends. I'm unable to answer your question at the moment.

Q. If its NEAT lithium quinolate, what form would it exist?

A. Again it depends on how that solid structure was formed.

Q. Have you investigated what the solid structure would be?

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A. Firsthand I have not done so.

Q. Have you seen any papers that discuss the possible structures that lithium quinolate may exist in?

A. It's hard to recall whether I have or not.

Q. Do you recall searching, reviewing such papers.

A. I don't recall off the top of my head right now.

Q. Do you know how does the binding energy between lithium and quinolate compare to the binding energy between lithium and fluoride?

MR. GARR: Objection. Scope.

A. I've not opined on that matter as it pertains to my declaration.

Q. Do you have an opinion on that?

A. My opinion would be that lithium fluoride is an electrostatic salt-based ionic bond, much like sodium chloride.

Q. So how does the binding energy between lithium and quinolate compare to the

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binding energy between lithium and fluoride?

A. I would need to think about that matter further to come to a response.

Q. So I have just added an Exhibit 2100 to the Dropbox. Can you refresh the Dropbox and see whether it's there?

(SDC Exhibit Number 2100 was marked for identification.)

A. You said 2100?

Q. Correct. And for the record, Exhibit 2100 is an article by Jun Yeob Lee. The article name is Efficient Electron Injection in Organic Light-Emitting Diodes using lithium quinolate/Mg:Ag/Al Cathodes, published in Journal of Industrial and Engineering Chemistry, 2008, page 676 to 678.

Do you see that?

A. I see it. I have it open.

Q. Okay. And can you please go to page number two or the original page 677?

A. I am on that page.

Q. Can you please take a look in the

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Section 3, Results and Discussion?

A. I see it.

Q. Do you see the sentence:

Binding energy between lithium and quinolate unit is weaker than that of lithium fluoride and it can give better performance as an electron injection layer than lithium fluoride?

MR. GARR: Object.

A. I see that it says that and also that sentence also references another paper, reference ten.

MR. GARR: Did you get my objection?

BY MS. ZHONG:

Q. And --

MR. GARR: I just want to make sure.

BY MS. ZHONG:

Q. Do you have any facts to disagree with this conclusion?

MR. GARR: Objection. Scope.

A. I am uncomfortable agreeing or disagreeing with this conclusion without reading this paper, Exhibit 2100, in its entirety, and

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also looking at statements like this that have a reference at the end of it.

Q. And I have just put an Exhibit 2101 into the Dropbox.

(SDC Exhibit Number 2101 was marked for identification.)

BY MS. ZHONG:

A. I see it. I have it open.

Q. Do you have Exhibit 2100 open?

A. I do.

Q. And can you take --

A. Wait. 2100 or 2101?

Q. 2100?

A. 2100. No. I do not.

Q. Can you open that one again?

A. Okay. I can do that. Okay. I have Exhibit 2100 open.

Q. Okay. Exhibit 2100, what is the reference ten?

A. Reference ten is C. Schmitz, H. Schmidt, M. Thelakkat from Chemistry Materials, 2000, Volume 12, page 3,012.

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Q. Can you take a look at Exhibit 2101 and see whether that's the reference ten for Exhibit 2100?

A. It does appear to be that reference, yes. The names are the same and the start page, volume, journal year, are all the same.

Q. Have you seen this article before?

A. Not to my knowledge I have never seen this article before.

Q. Does the bonding energy between lithium and quinolate -- strike that.

Does the bonding energy between lithium and quinolate affect your conclusions in any respect?

MR. GARR: Objection. Form.

A. I did not need to consider the bonding energy, I don't know between what, because you didn't explain it, but I didn't need to consider binding energy in coming to my conclusion.

Q. Okay. So you don't think that the binding energy between lithium and a quinolate

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unit figures in any way in your conclusion regarding the validity of the patent; is that correct?

MR. GARR: Objection.

A. I didn't say that it doesn't matter. I just said I didn't consider it in coming to my conclusions.

Q. Now, what is n-dopant?

A. So N, as it refers to semiconductors and semiconductor physics, refers to the concentration of electrons in a solid, whereas PU would be concentration of holes or positive charged carriers in a cell. So when you use the term n-dopant, it would mean some action that influences the number of electrons in a solid and, therefore, the electron conductivity of a solid.

Q. So when lithium Q is mixed into BPhen, is lithium Q acting as an n-dopant?

A. When lithium quinolate is mixed into a solid with BPhen, the conductivity of that mixture will be larger than either the

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conductivity of BPhen or lithium quinolate in isolation as NEAT films, and with the definition I gave of n-dopant controlling the electron concentration and conductivity, yes, lithium quinolate mixed with BPhen is an n-dopant.

Q. And so n-dopant increases the number of electrons in the mixture; is that correct?

A. That's right.

Q. And how does lithium Q increase the electrons in BPhen? Bathophenanthroline.

A. The mixture of lithium quinolate and BPhen has a larger electron concentration, owing to coordination and interaction complex formation between lithium quinolate and BPhen.

Q. Do you know what a triazine is?

A. Yes. The heteroaromatic compound containing 3 nitrogen, 3 carbons and a ring structure.

Q. So if lithium quinolate is mixed with 1,3,5-triazine derivative, is it acting as an n-dopant?

MR. GARR: Objection. Scope.

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A. It depends. Am I mixing lithium quinolate in a compound that's effectively bare 1,3,5-triazine, or is it a larger compound? I'm not familiar with even the state of matter 1,3,5-triazine on film. I'm not familiar with even the state of matter, whether it's a liquid or solid at room temperature, even if we are talking about room temperature, for 1,3,5-triazine.

Q. If it is solid, is it an n-dopant?

MR. GARR: Same objections.

A. Again, I think it depends on what the exact structure of the molecule that contains 1,3,5-triazine is.

Q. So why don't I hand you Exhibit 2007.

(SDC Exhibit Number 2007 was marked for identification.)

MR. GARR: Thank you.

BY MS. ZHONG:

Q. If lithium Q is mixed with one of these complexes, is lithium Q acting as an

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n-dopant?

MR. GARR: Objection. Form and scope.

A. I'm only seeing this paper, Exhibit 2000 -- sorry.

Q. 2007.

A. -- 2007, I haven't read this Exhibit 2007 in its entirety, so it would be difficult for me to comment on interactions between lithium quinolate and the 1,3,5-triazine derivatives mentioned in this paper, which there are multiple.

THE WITNESS: Before you ask a question, is it possible we can take a break? It doesn't need to be long.

MS. ZHONG: Okay.

THE WITNESS: I need to go to the rest room. And, Mr. Garr, if you could have the computer stop showing the little banner each time an email comes in, it's a little distracting.

(Recessed at 10:18 a.m.)

(Reconvened at 10:24 a.m.)

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BY MS. ZHONG:

Q. Now, you mentioned that you believe that BPhen coordinates to lithium Q; correct?

A. It depends. Do you mean in a jointly vaporized film?

Q. Under what conditions would BPhen coordinate to lithium quinolate?

A. Under conditions that BPhen and lithium quinolate intimately mix in a solid form, they would coordinate to one another.

Q. Could they react in the vapor phase?

A. Can you define what you mean by react?

Q. Let's take one step back. What do you mean by coordinate?

A. I mean that the two compounds, here we only speak of two different compounds, but it's understood that in a solid film it's a dense object, but the two compounds would have an interaction of their molecular orbitals.

Q. And what do you mean by there is interaction between the molecular orbitals of

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those two compounds?

A. Meaning that in their ground state there is interaction between electron density -- that's what I mean by molecular orbitals -- of one compound, with quinolate say, with the other compound, and its electron density and molecular orbitals, let's say BPhen.

Q. So under this definition does charge transfer complex is considered to be coordination?

A. One definition of coordination compound is where you set up a charge transfer complex, yes.

Q. And by charge transfer complex -- let me take a step back. What do you mean by charge transfer complex?

A. What I mean by charge transfer complex is an interaction between two molecules where some charge of one molecule has transferred to the other molecule, one being electron donating and the other being electron accepting.

Q. And can that charge transfer occur

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through ligand/ligand interaction rather than ligand/metal interaction?

A. Yes. It is possible that a ligand can interact with another ligand.

Q. So does that fall within your definition of coordination?

A. When a ligand of one molecule interacts with a ligand of another molecule such that there is a partial charge transfer or complete charge transfer, yes, I would say that that falls within my definition of charge transfer complex.

Q. Okay. So when there is a ligand/ligand charge transfer, does that mean the organic -- strike that.

So let's say the organic compound has -- strike that.

Let's say the organic compound and the ligand of the metal complex forms a ligand-to-ligand charge transfer complex. Does that mean the organic compound coordinates to the metal complex?

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MR. GARR: Objection. Scope.

A. So if I understand your question correctly, hypothetically if an organic compound has some degree of charge transfer with a ligand in a metal organic complex, then would we consider there to be a coordination between those two compounds?

Q. Correct.

A. In this situation yes, I would consider there to be a coordination between those two compounds.

Q. Okay. And within the scope of '223, claim number two, does a term -- is the term "coordinate" limited to dative bonding?

A. Can you define what you mean by dative bonding?

Q. What is your understanding of dative bonding?

A. I'm opening Exhibit 1 and going to claim two. I'm not comfortable expressing my definition of dative bonding, as it falls outside the considerations that I applied to

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understanding claim two.

Q. Do you have understanding of what dative bonding is?

A. I have a general understanding of what dative bonding is.

Q. What is dative bonding?

A. My understanding of dative bonding is mostly covalent sharing of electrons between two atoms.

Q. And applying that understanding of dative bonding, do you think that claim two, the term "coordinate" is limited to the dative bonding?

MR. GARR: Objection.

A. Again I'm uncomfortable providing that assessment because I didn't consider dative bonding and all of its types with respect to my understanding of claim two.

Q. Does the -- strike that. Does a ligand-to-ligand interaction that we just discussed a type of dative bonding?

A. I'm unsure. I would have to review

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to provide a comprehensive answer to that question.

Q. But do you believe the ligand-to-ligand charge transfer complex falls within claim two?

A. Claim two refers to a coordination of an organic compound to the metal complex. It doesn't refer specifically to aspects, certain parts of either the organic compound or the metal complex.

Q. So in your opinion does the charge transfer complex fall -- strike that.

So in your opinion, if there is a charge transfer complex formed between the organic compound and the metal complex, does that mean the organic compound coordinates to the metal complex?

A. Can you repeat that?

Q. So if there is a ligand-to-ligand -- strike that.

So if there is an organic compound to ligand charge transfer, does the organic

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compound coordinate to the metal complex?

A. When you say organic compound to ligand charge transfer, you mean the ligand of the metal complex?

Q. Correct.

A. If there is a degree of partial charge transfer, a degree of charge transfer I should say, between an organic compound, which under claim one refers to an organic compound comprising a heteroaromatic compound which is conjugated with an aromatic compound via a carbon/carbon bond, so that's my understanding of the organic compound.

So if a part of that organic compound, the ones in claim one, coordinate in some way to a ligand that's a metal complex, then I would consider that -- sorry -- has some degree of charge transfer with the ligand and the metal complex, then I would consider that a coordination, yes.

Q. So even if the organic compound does not form a covalent bond or a dative bond or a Pi

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bond to the metal itself, you would still consider there to be coordination between the organic compound to the metal complex as long as there is charge transfer between the organic compound and the metal complex?

MR. GARR: Objection.

A. I'll repeat my previous answer, which is the same answer to your very similar question; that if there is a degree of charge transfer between an organic compound as mentioned in claim one with the metal complex due to joint evaporation, even a ligand of that metal complex, then, yes, there is coordination.

Q. And that is the understanding by a person of ordinary skill in the art?

A. That's correct.

Q. When you say lithium quinolate coordinates to BPhen, did you conduct any experiment to verify that?

A. I did not personally conduct any experiment to verify the coordination between lithium quinolate and BPhen.

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Q. And did you conduct any simulation?

A. I did not conduct any simulation. My understanding of simulation is something like a density functional period simulation to derive that understanding, no.

Q. Now, when the conductivity of a material increases, it could be due to two facts; right? One is the increased number of electrons, the other is the increase in mobility? Correct?

A. That's correct.

Q. Okay. So when the -- so when liquid lithium quinolate is added to BPhen and you see an increase in conductivity, do you know what, which factor contributes to the increase in the conductivity?

MR. GARR: Objection.

A. Can you repeat it, your question?

Q. Okay. Okay. So when lithium quinolate is added to BPhen and you observe an increase in conductivity, do you know what is the cause of that increase in conductivity?

A. It depends. When you add lithium

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quinolate to the host matrix BPhen, the current observed at a specific voltage, which is related to the conductivity of that solid, goes up until a certain point, a certain loading of lithium quinolate in that BPhen matrix. But beyond a certain point it actually starts decreasing.

So can you be a little bit more specific about what you mean? It actually goes up and down as you increase the lithium quinolate loading in BPhen.

Q. So when you initially see the increase, do you know what is the cause for that increase?

A. So you are saying for relatively small loading of lithium quinolate?

Q. It's actually the loading was not small. It increased up to at least 33 percent, right, as observed by Ma?

A. Let me refer to Ma.

Q. Okay. Why don't I -- Exhibit 1007.

(SDC Exhibit Number 1007 was marked for identification.)

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BY MS. ZHONG:

Q. This is the Ma reference.

A. I believe you are referring to Figure 5?

Q. Yes.

A. Okay. Initially, so that's the zero percent lithium quinolate in ETL. ETL here means electron transport layer and refers to BPhen as that electron transfer layer.

So BPhen on its own, a NEAT film of BPhen, features of the four curves in Figure 5, the lowest current density for all voltage that's been tested in this range, that's one to 12 volts; and as you add lithium quinolate to BPhen, first 17 percent by weight and then 33 percent by weight, you can see increases in the current at each voltage point. Beyond 33 percent, and the only data point here is 50 percent lithium quinolate by weight in BPhen, the current starts going down.

And the weight percentages can be given corresponding molar ratios to the number of

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molecules in the film by taking account of their relative molecular weight. And if you do that, then lithium quinolate being lighter than BPhen, you get the 33 weight percent. It's approximately a one-to-one molar ratio.

So when you increase lithium quinolate in BPhen up to approximately a one-to-one molar ratio, you see an increase in current density, which reflects an increase in conductivity. Beyond one-to-one molar weight you start to see a decrease.

Q. Okay. And if you can go to page 813, right-hand column, the first full paragraph.

A. These J-V characteristics?

Q. Yes. So according to the author of the paper, they believe that the observed increase in the current density is due to electron hopping exchange; correct?

A. That's an explanation that is provided in the paragraph on page 813, yes.

Q. And the improved electron hopping means the increase in electron mobility; correct?

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A. It appears to be that's what Ma and co-authors are referring to; that the electron hopping improvement is an increase in mobility, yes. That's my understanding and interpretation.

Q. And they didn't mention the increasing electron density; correct?

A. I need to refer to the entirety of Ma, but I can say that at least in this paragraph they don't refer to an increase in electron density, they do refer to an increase in conductivity and they discuss hopping.

Q. Do you have an understanding of the sentence starting with "transport manifolds", M-A-N-I-F-O-L-D-S, along with their LUMO? That sentence?

A. "Transport manifolds along with their LUMO are expected to exhibit a certain extent of overlap after a mixing ratio goes beyond 17 weight percent."

I'm not entirely sure what they are referring to, but I guess my opinion about what they are referring to has to do with that you

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need a certain amount of the gas, in this case lithium quinolate or Liq, to have a sufficient conductive formation or extent of overlap to increase conductivity. I believe that's what they are referring to.

Q. So what they are saying is that you need to have certain amount to reach a percolation in order to shorten the hopping distance?

A. Percolation is a good word to describe a conductive pathway, and because at some point you reach enough of the two molecules to allow for such paths of conduction to form. But I'm not sure if they are explicitly invoking the hopping mechanism in this sentence.

Q. Okay. And do you know what they mean by it is likely that a large energetic disorder between BPhen and Liq contributes to electron hopping?

A. I'm not entirely sure what they mean by energetic disorder. It doesn't necessarily refer to structural disorder. They are distinct

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but sometimes related. But I cannot say exactly what they are referring to.

Q. But their conclusion is a high electron conductivity of BPhen/lithium Q mixture is originating from short hopping distance for electron transport?

A. That's incorrect. Their conclusion is that high electron conductivity may originate from a short hopping length, not is. They are a little less assertive.

Q. But that's the only theory they concluded; right?

A. I would have to read the paper in its entirety, but in this paragraph that's the only one offered.

Q. Okay. And then they say like when it increased to beyond 33 percent, for example for the increase to 50 weight percent, it was likely due to carrier quench and generation of defects that caused the observed reduction in the current density; correct?

A. That's what they say.

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Q. Okay. Do you agree with that?

A. I think I need to understand a little bit more what they mean by effect of carrier quench and generation of defects. It's not given a lot of definition.

Q. You are a person of -- let me withdraw. You are at least a person of ordinary skill in the art; right?

A. Yes.

Q. And the paper is supposed to be written for a person of ordinary skill in the art; right?

A. That's right.

Q. So what is your understanding?

A. Again, without referring, without checking to see if they refer to the terms "carrier quench" and "generation of defects" elsewhere in the document, it's a little hard for me to opine constructively on what they mean by the term here.

Q. You can pull up Exhibit 1007 electronically and do a word search. I think

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"carrier quench" only appears in that paragraph.

A. It's not working well. It tells me there are three places where "quench" is mentioned. But the boxes are all in space. None of them are actually highlighting where words are.

Q. When I did "carrier quench" on my computer, it only shows up in one place.

A. For me as well with "carrier quench". I just did "quench".

Q. Quenching is, the first one, is also on page 813, left-hand column, first paragraph.

MR. GARR: I have it highlighted.

A. The other two mentions of the term "quench" are referring to exciton quenching --

Q. E-X-I-T-O-N.

A. -- and not carrier quenching. So they are different contexts.

So this is the only time in the paper that this term, "carrier quench", appears. Do you mind if I do a search on "defects" on this computer?

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Q. Go ahead.

A. It is also the only time that the word "defect" appears. So without reading the paper in its entirety and making sure that they didn't use synonyms to these terms, it's a little hard for me to give a specific interpretation of that sentence.

Q. You have reviewed the Ma previously; correct?

A. That's correct.

Q. And many times?

A. Again, if -- do you mean in its entirety or do you mean in part?

Q. How many times in its entirety?

A. Two or three.

Q. And are there portions that you spent more time on?

A. Yes.

Q. Which portions?

A. Specifically the analysis of Figure 5, the one that I discussed.

Q. And how many times on that one?

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A. A dozen maybe.

Q. Why do you think that portion is important?

A. I think that portion is particularly important, among others, because it shows that combination of lithium quinolate and BPhen can result in a film which is more conductive than BPhen on its own.

Q. Okay. And I assume that you also read the discussion of why there is such an observed increase in conductivity in Ma; correct?

A. Correct.

Q. So you have reviewed this particular paragraph several times as well; correct?

A. Yes. But fewer times than I have looked at the figure.

Q. Okay. And did you -- so you have seen the words "generation of defects" and "carrier quench" before; right?

A. Correct.

Q. And I assume that you have read the rest of the paper in order to reach an

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understanding of what "carrier quench" and "generation of defects" mean; correct?

MR. GARR: Objection.

A. I didn't devote a lot of time to considering what "carrier quench" and "generation of defects" meant in view of the entirety of the paper.

Q. Okay. And did you try to understand this paragraph in view of the entirety of the paper?

A. I did. Yes.

Q. So you do have an understanding of this paragraph?

A. I do have an understanding of this paragraph.

Q. And do you disagree with the theory given here?

A. I do not disagree with the plausible hypotheses put forth to explain the data in this paper.

Q. And does the plausible theory proposed here indicate there is, there is

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coordination between BPhen and lithium Q?

A. Given our previous discussion of coordination, yes.

Q. Why?

A. Because one, because in this paragraph they refer to -- the paragraph on page 813 starting "these J-V characteristics" -- they mention that there is a certain extent of overlap in transferring to orbitals for electron density, which in our previous conversation is a part of coordination.

Q. And if coordination is limited to covalent bonds, dative bonds or Pi bonds, does this paragraph indicate there is coordination?

A. Insofar as it talks about LUMO's lowest unoccupied molecular orbitals, which are predominately comprised of Pi bond, and that they are in the author's words of Exhibit 1007 expected to exhibit a certain extent of overlap, then yes, pie bonds would be included in this coordination.

Q. But Pi bonding is actually from HOMO

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to LUMO, not LUMO to LUMO; correct?

A. I was thinking of Pi electrons rather than Pi bonds. My apologies.

Q. Okay. So if coordination is limited to Pi bonding, dative bonding, does this paragraph suggest there is coordination between BPhen and lithium Q?

A. When one takes into account the knowledge base of a POSA in 2008, as well as the entirety of this paper, including the data that are presented, not this -- rather than this paragraph in isolation, then that POSA would come away with lithium quinolate coordinating to BPhen to form a layer which has increased its electron conductivity.

Q. You are not answering my question. So if coordination requires forming a chemical bond between two atoms in which a shared pair of electrons forms a bond and the pair has been supplied by one of the two atoms, does Ma suggest there is coordination between BPhen and lithium Q?

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MR. GARR: Objection to form, to the question.

A. Sorry. Which two atoms?

Q. If coordinate means form a chemical bond between two atoms in which a shared pair of electrons forms a bond, and the pair has been supplied by one of the two atoms.

MR. GARR: Same objection.

A. I have limited my opinions and declaration to the scope of coordination between molecules rather than between atoms, so I'm not able to answer that question in the way it's currently phrased.

Q. Well, when you form a bond between two molecules, the bond is formed between two atoms; correct?

A. It depends.

Q. If it is a dative bond or covalent bond, that's formed between two atoms; correct?

A. Again it depends. If you have a delocalized conjugated molecule, I'm not comfortable with making that assumption.

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Q. So are you disagreeing with Samsung's position that coordinate in the Patent '223 means forms a chemical bond between two atoms in which a shared pair of electrons forms a bond and the pair has been supplied by one of the two atoms; correct?

MR. GARR: Objection. Form.

A. I think I would like to read that statement somewhere.

Q. Okay. I can get that and mark the exhibit.

MS. ZHONG: Can we take five minutes while I create the exhibit? Let's go off the record.

(Recessed at 11:03 a.m.)

(Reconvened at 11:07 a.m.)

(SDC Exhibit Numbers 2102 and 2103 were marked for identification.)

BY MS. ZHONG:

Q. We can go back on the record. So I've put -- can you refresh the exhibits?

A. Yes.

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Q. Do you see Exhibit 2102, which is a Word document? And there is also an Exhibit 2103, which is a Markman hearing transcript?

A. I have those documents.

Q. Can you please open up the exhibits?

A. Which one?

Q. Both of them.

A. I can only open one at a time.

Q. Oh. Then open up Exhibit 2102 first.

A. Okay.

Q. So Exhibit 2102, I have cut and pasted two paragraphs. The top one is from Samsung's expert report where he stated his understanding that Samsung proposed the construction forms a dative bond with; stated his understanding that "coordinate" means forms a dative bond with. Do you see that paragraph?

MR. GARR: Excuse me, counsel. Object to the document. Where is this coming from?

MS. ZHONG: It's from Samsung's

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expert report that they recently served.

MR. GARR: Object to using this unless you provide the full document.

MS. ZHONG: You can see it. There is information that's in the protective order.

MR. GARR: Well, I object to Exhibit 2102 insofar as it's an incomplete document.

MS. ZHONG: That's fine.

BY MS. ZHONG:

Q. And do you also see underneath that --

MR. GARR: As well as to the scope.

BY MS. ZHONG:

Q. -- there is a box that puts Pictiva's proposed construction and Samsung's proposed construction for coordinate? That's a different document. I'm just putting it there because you say you want to see it in a written form for the proposal by Samsung regarding the coordinate; correct?

A. I don't see it. I only see this paragraph and the rest is blank. Let me try

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refreshing this.

Q. When I put it up, there is --

A. I will try to reopen it. Now I see it.

Q. Okay.

MR. GARR: So this comes from two separate documents?

MS. ZHONG: Two separate documents.

MR. GARR: What is the second document?

MS. ZHONG: The second one is from the infringement report. All I want to do is to show him what the proposed construction.

BY MS. ZHONG:

Q. Do you have it in written form now?

A. I have it in a written form.

Q. Okay. So --

MR. GARR: Is this from the IPR proceeding?

MS. ZHONG: It's from the District Court, but the parties have agreed the information in this report can be used in the IPR

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proceeding.

BY MS. ZHONG:

Q. So given the definition for "coordinate", that means forms a dative bond with or forms a chemical bond between two atoms in which a shared pair of electrons forms a bond and the pair has been supplied by one of the two atoms, does BPhen form, form a dative bond with lithium Q?

MR. GARR: Object. Scope.

A. Without reading these two documents in their entirety, I'm uncomfortable answering this line of questions.

Q. Does BPhen form a chemical bond between nitrogen and lithium in which a shared pair of electrons forms a bond and the pair has been supplied by nitrogen to lithium?

MR. GARR: Same objection.

A. I'm uncomfortable answering this question without reading these two documents in their entirety.

Q. I'm not asking to read the document.

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I'm asking a factual question.

A. You are asking me a question based upon language that comes from two different documents which I have not had any opportunity --

Q. I'm asking you a question. Is your opinion that BPhen and lithium Q forms a chemical bond between nitrogen and lithium?

A. Can you repeat that? Just for the record, I have closed that document because it's not relevant to my understanding.

Q. Does BPhen form a chemical bond between nitrogen -- strike that.

When BPhen and lithium Q are mixed together in Ma, is a chemical bond formed between lithium and nitrogen? Or let me put it when BPhen and lithium Q are mixed in Ma, is a chemical bond formed between the lithium atom of the lithium Q and the nitrogen atom in BPhen?

A. There are multiple nitrogen atoms in BPhen.

Q. Does it form a bond with any of them?

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A. Lithium quinolate when combined with BPhen as a host matrix, will interact so as to increase the conductivity and form these conductive pathways in such a way.

Q. You are not answering question.

MR. GARR: Objection.

Q. Is a chemical bond formed between the lithium atom of lithium Q and any one of the nitrogen atoms of BPhen when the two are mixed?

A. When lithium quinolate and BPhen are mixed, they will interact in numerous ways because of the inherent disorder in that film, as alluded to in the language of Ma in the paragraph you referred to a few moments ago, and one such interaction among potential of many is that lithium quinolate will interact with the Pi system of BPhen in order to coordinate and form conductive pathways, which can includes the lithium on lithium quinolate as a metal atom and the nitrogen which is part of the Pi system in BPhen.

Q. Is a chemical bond formed between

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the lithium and nitrogen?

A. I'm uncomfortable with saying it has to be between those exact atoms, one of the nitrogen atoms on BPhen and one of the lithium -- and the lithium atom on lithium quinolate.

Q. Okay. Do you know whether a chemical bond is formed between the lithium atom and the nitrogen atom of the BPhen?

A. Again, I can't say that that's the only interaction between those two molecules.

Q. But do you know whether such -- regardless of whether there are other interactions going on, is it your opinion that a chemical bond has formed between the lithium atom of the lithium quinolate and any one of the nitrogen atoms of BPhen?

MR. GARR: Object to the form and to this line of questioning as beyond the scope.

A. As I mentioned, I feel like the evidence in Ma points to coordination between lithium quinolate and BPhen and they express that clearly and the data show that clearly. But to

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be very specific about the nature of that interaction as being between specific atoms in each of those molecules is a step further than I considered in my analysis and which was needed to interpret Ma.

Q. Okay. So you disagree with Samsung that coordination means forming a dative bond; correct?

MR. GARR: Objection.

A. I never said that.

Q. So you agree with Samsung that coordination means forming a dative bond; correct?

MR. GARR: Objection.

A. I never said that.

Q. So do you agree with Samsung that coordination means forming a dative bond?

MR. GARR: Objection. Form.

A. Can you repeat the question?

Q. Do you agree with Samsung that in the context of the '223 patent, coordinate means forms a particular kind of interaction, a

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particular kind of bonding, and that particular interaction is dative bonding?

MR. GARR: Objection. Form. Scope. And lack of foundation.

A. In my analysis I have never been specific of a type of form of bonding as pertains to forming a coordination between two molecules.

Q. Okay. Why don't you pull up Exhibit 2103, which is the Markman hearing transcript?

A. Okay.

Q. Can you please go to page 84, starting from line 19, to 85; 14.

MR. GARR: What page?

MS. ZHONG: 84;19 to 85;14.

MR. GARR: Can you say the page?

MS. ZHONG: 84 and 85. For the record, Ms. Baily is Samsung's attorney in the district court action.

THE WITNESS: Thank you for providing that context.

BY MS. ZHONG:

Q. Do you agree with her claim that in

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the context of '223 patent, the term "coordinate" specifies a particular kind of interaction, a particular kind of bonding and in particular a dative bonding?

MR. GARR: Objection. Scope. Lack of foundation.

A. I haven't had time to review this document in its entirety. I only read approximately three quarters of the page that you directed me to just now. So I would have to take further context into account in order to provide an agreement or disagreement with this statement in this page.

Q. Do you agree that a dative bond is a synonym for coordinate? They both mean the same thing?

MR. GARR: Objection. Same objection.

A. Again I would need to review this document in its entirety to understand the context of the question.

Q. And do you agree that "coordinate"

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means a chemical bond between two atoms and the key is that there is a shared pair of electrons that forms a bond and that they are supplied by one of the two atoms?

MR. GARR: Objection. Scope.

Q. And go to page 85, 17 to 25.

MR. GARR: I object to the document 2103.

MS. ZHONG: On what grounds?

MR. GARR: At least scope.

MS. ZHONG: You don't think Samsung's position of the meaning of "coordinate" has no relevance to the proceeding?

MR. GARR: Not what I said.

A. I would need to go back and consider the statements I made in my declaration with respect to how I viewed "coordinate" by looking at this entire document.

Q. And when you provided the understanding, you did not limit the coordinate to a particular type of bond; correct?

A. When I considered coordination, I

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wasn't specifically thinking about one versus another type of coordination between two molecules.

Q. And you did not limit yourself to dative bonds; correct?

A. Again when I considered coordination, I didn't limit myself to a specific type. I allowed interpretation in the broadest meaning of the word.

Q. Okay. So you did not limit yourself to chemical bond or dative bonds; correct?

A. Correct.

Q. And you understand the principle that the same meaning -- strike that.

And you understand the principle that the term should be interpreted in the same way for invalidity and for infringement; correct?

MR. GARR: Objection.

A. In my declaration I was asked to consider if prior art exists that would have taught a POSA the material contained in the '223 patent.

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Q. Okay. And in light of the terms properly construed; correct?

A. Let me turn back to my declaration. There are no specialized constructions that are necessary to understand the claim.

Q. Okay. So you did not apply any specialized understanding, as the attorney for Samsung is trying to do in this report; right?

MR. GARR: Objection.

A. I would consider a POSA to have specialized understanding and so I did apply that.

Q. Okay. So the specialized understanding by the POSA in respect to coordinate is that it is a dative bond?

MR. GARR: Objection.

A. As I mentioned, there are numerous ways that coordination can be interpreted.

Q. In the context of '223, what is a proper way to interpret that term?

A. When I approached the '223 patent, I considered coordination in a very dated sense, in

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the broadest sense, that there are numerous ways that one could coordinate between molecules.

Q. So you applied the broadest reasonable meaning of the term?

MR. GARR: Objection.

A. I considered coordination in a broad sense to a POSA.

Q. Okay. And is that in light of the specification and the prosecution history?

A. I used the specification and claims of '223 and the prosecution history in order to inform myself about what it was the inventors were disseminating and trying to protect. But that was not the sole context by which I reached conclusions.

Q. Okay. And it is your opinion that the specification and the prosecution history did not limit the coordination to a specific type of interaction; correct?

A. I interpreted '223 and the history in a broad sense.

Q. Do you think that you interpreted

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the term correctly?

A. As far as I'm concerned, I think I interpreted the term correctly to a POSA in a broad sense.

Q. Is it proper for you to interpret it in a broad sense?

MR. GARR: Objection.

A. In my understanding of the field of OLEDs and coordination of compounds to form conductive pathways, which is what's relevant to an understanding of Ma in the context of the '223 patent, I think I interpreted it in the proper way.

Q. Okay. So you disagree with Samsung's counsel then?

MR. GARR: Objection. Foundation. Scope. Form.

A. I didn't say that I disagreed with Samsung.

Q. Then you agree with them?

A. I also did not say that.

Q. You either agree or disagree.

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MR. GARR: Objection.

Q. You either agree with the statement or you disagree with the statement; right?

A. That was a statement. There was no question.

Q. No. I asked you you either agree with that statement or disagree with that statement; correct?

A. Now you have made it into a question. Before it was statement; you either agree or you disagree.

Q. I said "right".

A. Yes. Okay. Understood now. Before I didn't understand.

In the world of scholarly output, there is scope for both agreement and disagreement, and I don't feel comfortable labeling black or white one way or the other.

Q. Okay. So Samsung's counsel is saying that coordination should be afforded a specific meaning in a very narrow sense. Do you agree with that?

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MR. GARR: Objection. Foundation. Scope.

A. I haven't read this Exhibit 2103 in its entirety, so it's difficult for me to agree or disagree with the statement about what Samsung thinks.

Q. But you certainly did not limit yourself to the dative bonds that they are trying to restrict the meaning to; correct?

MR. GARR: Objection. Form. Foundation.

A. In my reading of '223 and its history, as well as the other supporting documents to which I've referred, I didn't restrict my understanding of coordination. I took the broad interpretation as a POSA would do.

Q. And you believe that interpretation is correct?

A. I believe that everything in my declaration is correct.

Q. Now, regarding Ma, do you know what kind of evaporator or deposition system they are

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using?

A. Can you be a little more specific about what kind?

Q. Do you know how they performed their vaporization or deposition?

A. It says that -- specifically it refers to BPhen and the quinolate because I think that's the most relevant here, that the BPhen/lithium Q mixture was co-deposited on the emissive layer, on the layer that was below it.

It's going to be a little bit different for the electron transport -- the electron-only devices, but that's what they say in their experiment, so I'm keeping myself to that. And -- oh, no. They say it in the next paragraph. It's consistent. It's the same.

But the organic sources, referring to BPhen and Liq, were independently controlled and the deposition rates were monitored using two independent quartz sensors.

And it says conventional thermal evaporation in a high-vacuum chamber with a base

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pressure of one times ten to the minus 5 torr. The deposition rates were maintained at .5, plus or minus .2 angstroms per second for the organic material. And so your question is about whether I understand this process?

Q. No.

A. Could you repeat your question?

Q. What is the evaporator? How are the sources constructed and configured? Where is the substrate?

A. They are constructed in such a way that the flux from the two sources, because they mention they are independently controlled, so that that flux can be seen by the two independent quartz sensors, and that those fluxes would have some relationship to the flux that's being experienced by the substrate.

Q. So could -- do you know whether it's a point source or crucibles in a way that shutters, that controls when the vapor from one of the source comes out and --

A. It doesn't go into the level of

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detail to know if there are sources -- there are shutters on the substrate or if there is only one shutter between the sources and the substrate.

Q. Okay. So can it be -- and you don't know whether they are rotating the substrate, for example?

A. We also do not know that for certain.

Q. Okay. So could the co-deposition happen in such a way that -- and you don't know the trajectory of the vapor; right? Whether it is a point that just goes up or if there is more of a wide angle?

A. There's never going to be an exact point.

Q. Yeah. But it's like the angle of the trajectory? Like how it hits the substrate, like the vapor trajectory? You don't really know that either; right?

A. In a vacuum chamber with a base pressure of one times 10 to the minus five torr, we can assume that most molecules will experience

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a linear trajectory from the source to wherever they may land. But we don't have sufficient information to know the exact geometry of the chamber, nor the exact geometry of the source.

Q. Okay. So you don't really know, for example, the co-deposition happens in such a way that material A hits the substrate, then material B hits it, then it goes back to material A, then it goes back to material B? Do you know what I mean?

A. I think I know what you mean, and I'll give an answer and you can tell me if I have understood what you mean.

Q. Okay.

A. Which is, we know that these are being co-deposited, but they are not being deposited subsequently or interchangeably in that way. So we know that both molecules are being deposited simultaneously. That is clear from this text.

Q. But the word "co-deposition" can mean that it's instead of saying like you build

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up a thick layer of material A, then you build a layer of material B, what can happen is that you have a mono layer of A, then B, then A and B, then A and B, so that will also be co-deposition; correct?

MR. GARR: Objection.

A. It depends.

Q. But you don't know; right? Because you don't know the geometry of that evaporation and its exact control mechanism?

A. We know that the two sources are simultaneously on and being at such a temperature that both sources are evaporating simultaneously. And those fluxes are landing on the surface of the substrate, among other places in the chamber. Other places certainly include the quartz sensors.

Q. But you don't really know when the shutter opens for each one of them; correct?

A. We do know that the deposition rate was maintained at .5 angstroms per second for the organic materials.

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Q. But that's over --

A. During the time of the deposit of the film formation that the rates were being somehow maintained.

Q. But that's average; right?

A. Plus or minus .2, but it's not going to zero.

Q. Yeah. But all you need to do is you open it, material A comes out, then it goes to material B, then deposits, then come back. That's still maintaining it.

A. I'm not sure I understand.

Q. I'm saying that you can still maintain it if they shoot out at one, for example, like one interval, then it goes to the position where it's going to be hit by the source for material B? You are having -- the deposition rate is still being maintained, but they don't really necessarily land at a substrate at the same time?

A. I'm not sure I understand the question. I am sure that I don't understand the

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question.

Q. Can you please refresh your exhibits to see if Exhibit 2104 has come up?

(SDC Exhibit Number 2104 was marked for identification.)

MR. GARR: This computer has lost activity. Let me fix it.

MS. ZHONG: I may have lost my connection as well. Can we just take five minutes?

(Recessed at 11:42 a.m.)

(Reconvened at 11:55 a.m.)

BY MS. ZHONG:

Q. Back on the record. Can you refresh your Dropbox?

A. Okay.

Q. Do you see an Exhibit 2104?

A. Yes.

Q. Can you please open up that document, which is an article called P-Type Metal Oxide Semiconductor Thin Films: Synthesis and Chemical Sensor Application?

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A. I've opened it.

Q. Okay. Please go to PDF page number eight.

A. Okay.

Q. Do you see that on that particular page there is a Figure 4?

A. I see that.

Q. And the Figure 4 shows the schematic of the thermal evaporation apparatus; correct?

A. It does. Figure 4(a) specifically.

Q. And would that be the type of apparatus used by Ma for evaporation?

A. I've not read this paper in detail, so I can't exactly say the types of materials they are evaporating, but as it pertains to the schematic, the vacuum vessel as they call it, with the substrate holder, some place where you pump and remove gas, and you have in this case they are calling it a furnace or something that gets hot and causes a plume or vapor of some thing -- again I don't know what they are pertaining to here -- that eventually hits a

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substrate, then yes, it's going to be similar in scope from a schematic point of view.

Q. But instead of single source, there will be two sources in Ma?

A. At least.

Q. Okay. And so could it be that one of the source is the vaporized, the vapor from that source is only hitting one or two of those red circles, and source number two is only hitting some of the other red circles and you rotate the substrate so you get coating by both sources? That's two-coat deposition; correct?

MR. GARR: Objection.

A. I don't think we have enough detail in this schematic or in Ma's description to state whether one or both of the plumes has a very uneven coverage of the substrate, and as it pertains here, the size of their substrate itself, which probably is not, you know, on the scale of centimeters, not on a scale of, you know, tens of centimeters.

Q. Okay. So there is not enough

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information in Ma as to the evaporative configuration?

A. We know that Ma tells us the deposition rate of each source was maintained, which means throughout the deposition at .5, plus or minus two angstroms per second, for the organic material. In the case of the ETL, the two organic materials are BPhen and lithium Q, and those were co-deposited on the EML, which is on, already on the substrate.

And so, we know, we know that this layer is formed through co-deposition of those two being on at the same time, fluxing to the same substrate.

Q. But you don't know whether -- okay.

You don't know, for example, whether they hit at the same spot? What I want to know is like you don't know whether there is, whether the two streams of vapor mix in the vapor phase before they -- not even that.

Do you know whether there is like a premixing, mixing -- strike that.

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Do you know whether there is a premixing of the two vapor phases before the molecules from the two sources hits the substrate?

A. We know that these two sources are independently sent, so there is some point in volume in that vacuum chamber where the plumes are separate. We know that. They told us there are two independent quartz sensors. And we also know that they make a mixed film of BPhen and lithium quinolate, which indicates that those two plumes will intersect the substrate holder.

Q. But you don't know whether they, when they intersect the substrate, whether they stay separate and it becomes a mixture because you rotate the substrate so eventually it will be uniform; right?

A. As far as I can -- as far as I can tell from my reading of the experiment section two in Ma, they don't mention rotation.

Q. But typically the substrate holders are rotated, isn't it?

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A. Typically that's a good way to ensure uniform and homogenous deposits, yes.

Q. That's what a POSITA would do when they performed those deposition experiments, whether it's single source or multiple source; right?

A. In my experience it's common.

Q. Okay. So the two streams need not intersect in the vapor phase, they could be deposited on different parts of the substrate and through rotation eventually will become mixed and become a uniform film?

A. If you want to ensure a uniform film, as your question states, then given the deposition rates of .5 angstroms per second for the organic materials, meaning when summed up, that's one angstrom per second, so for a 50-nanometer fixed film, you're talking about 500 angstroms, therefore 500 seconds. Relatively fast. That's less than ten minutes.

Then in order to ensure a uniform film, you would need to have those two plumes

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intersect, else you would require a substrate rotation that is a probably dangerous in order to do that. It would mean it would have to be revolving so fast that it would not be warranted or safe practice.

So I think we have to assume that if you want a uniform deposit, you are going to have these two plumes intersect before reaching the substrate plane.

Q. But how far before, you don't know that; right?

A. How far before? You mean in terms of --

Q. Like how much intersection there is?

A. We have to assume there is intersection between the two plumes, the two organic vapors.

Q. How much of an intersection?

A. A sufficient intersection to ensure that the deposit is uniform, at least across the substrate. And usually you put the substrate in a position where you know those two plumes can

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intersect well. I'm sorry. When I say you, I mean a POSA.

Q. And does lithium Q coordinate to the BPhen in a vapor phase or does that occur through diffusion?

A. What do you mean by diffusion? I understand diffusion to be a process where something goes from a place of high concentration to low concentration.

Q. So when lithium Q gets deposited on the substrate, is it your opinion that it stays there or there is going to be some diffusion of the molecule?

A. Oh. Surface diffusion of the molecule. Now I understand. It depends.

Q. So if there is any coordination between BPhen and lithium Q, when does that happen?

A. It could happen at various stages of the deposition process. So taking the deposition process as described by Ma, we have two independent sources, and you end up making a

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uniform film mixture of BPhen and lithium quinolate; it could happen in the vapor phase before landing on the substrate, and then the two or more land as a coordinated composite onto the substrate.

It could happen on the substrate when one, either of those molecules, lands on the substrate and coordinates to the other type that might be in some configuration already settled and deposited on the substrate. And the amount of interaction on the substrate would depend upon the flux. If you have a very rapid flux of molecules, another molecule could come down and coordinate to one that hasn't maybe fully settled and formed some complex that way and probably halt any motion basically because it becomes much heavier.

And if the flux is very small, you'll have more opportunity for molecules to diffuse, move around, find a place to settle. If the temperature of the substrate is elevated --

Q. In the Ma deposition condition.

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A. They talk about measurements being carried out at room temperature. They don't talk about the conditions for deposition. I think we can assume that it's probably a room-temperature substrate so it doesn't have a lot of energy, and so molecules probably aren't going to diffuse too far on landing on the substrate. They will coordinate with molecules close by where they absorb.

Q. So near the surface?

A. Near the growing surface of that substrate, yes. Not going to penetrate deep into the surface of the film.

Q. Do you know whether any coordination occurs in the vapor phase?

A. I do not know if coordination occurs in the vapor phase, but I did state that it is an option.

Q. Did you do any investigation to see whether it occurs in the vapor phase?

A. I did not do any investigation to try to determine exactly when the coordination

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occurs.

Q. And you did not determine whether the coordination involved lithium nitrogen bonding; correct?

A. Correct. We've already established this previously.

Q. And you don't know whether the coordination involved the lithium Pi bonding; correct? Or whether the Pi bonding is through the two ligands, through the ligands?

A. I didn't limit myself to the requirement of a specific type of coordination between types of bonds or types of atoms.

Q. So, for example, when you said there is coordination, you did not determine that there is lithium and -- strike that.

You did not determine that there is bonding between lithium and the BPhen Pi system, for example?

A. I considered that there was coordination between the two molecular compounds.

Q. Okay. But the complexation could be

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through the ligand and the BPhen?

A. By the ligand, you mean the ligand of the lithium quinolate?

Q. Correct.

A. Again, I didn't limit my understanding to a specific type of coordination. I only considered coordination between the two compounds. In this case the two we're discussing are quinolate and BPhen.

Q. Do you whether Pi complexes are formed at the center of the lithium atom?

A. I don't know that specifically.

Q. So in your opinion, if there is Van Der Waals attraction between two molecules, does that mean the two molecules are coordinated to each other?

A. Van Der Waals interactions are very weak, typically weaker than the coordination. They can influence coordination, but what a Van Der Waals interaction indicates in the case of aromatic molecules is that when there is an oscillation of the Pi electrons, that will

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trigger corresponding oscillation in a neighboring molecule, and these oscillations, when out of phase, will have an attractive force to them.

Q. Will that cause some kind of charge transfer?

A. Again, it's possible that it could influence positively or negatively the process of charge transfer, but not the same thing.

Q. So shortening the distance between two molecules, that's increasing the Van Der Waals interaction; right?

A. It depends on the type of molecule and the distance between which parts of the molecule.

Q. BPhen and lithium Q?

A. Again, it depends on, you know, the parts of the molecule, whether they're more Pi electrons density or less. But in general when two molecules become closer, the chances of interaction, Van Der Waals interaction become larger and stronger.

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Q. And when Ma talks about like electron copying, that's really talking about a distance between two molecules; right? Talking from one molecule to the other; correct? On page 813.

A. I'm not sure if they are equating it to distance, but hopping indicates a close range interaction, just like a Van Der Waals interaction. And so a shorter distance would indicate a stronger hopping exchange.

Q. And what does hopping have to do with LUMO overlap?

A. Electron conduction -- step back. Charge carrier, which can be either an electron or a hole, charge carrier conduction in the conjugated aromatic organic thin film or solid, generally solid, requires either charge carriers, electrons or holes, to hop from one molecule to another, because between them is free space.

They are not bonded covalently or ionically to each other. They have free space between them. And that free space in between

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needs to be spanned by a hop of a charge carrier.

So if you can increase the interaction of LUMOs, the lowest unoccupied molecular orbital, then the electron which transports on the LUMO of the molecule will experience less resistance to such transfer.

Q. So when we are talking about bonding interaction, you are not limiting to the HOMO/LUMO interaction? You are including the LUMO/LUMO interactions as well; right?

A. I'm not limiting myself to HOMO/LUMO interactions, which would be sort of akin to like a donor/acceptor interaction. I'm also including LUMO/LUMO as pertains primarily to ETL.

Q. So in the context of '223, when they talk about the bonding interaction, is that a HOMO/LUMO interaction?

A. Can you refer me to the specific part of '223 that you are referring to?

Q. Just in general.

A. I'll have to reference this in general. Can you repeat your question so I can

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better focus my search?

Q. In the context of '223 patent, does a, is a coordination related or associated with HOMO/LUMO interaction or it involves LUMO/LUMO interactions as well?

A. Again, I didn't limit myself to one particular definition of coordination, and so I wouldn't limit myself in my response here to say it's one or the other.

Q. You are familiar with ditungsten tetra (hpp); correct?

A. I am.

Q. That's known as a molecular donor; correct? Electron donor?

A. Yes. Tungsten2(hpp)4 is known as an electron donor.

Q. And its interaction with acceptors is through HOMO/LUMO interactions; correct?

A. Insofar as its function as an electron donor is concerned, then it would be the electrons in the HOMO of the tungsten2(hpp)4 interacting with the free space in the LUMO of

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the acceptor.

Q. What is the free space?

A. Empty. Sorry. Thank you for correcting me.

Q. Do you consider ditungsten tetra (hpp) as an n-dopant?

A. I considers tungsten2(hpp)4 to be a very strong electron donor, and part of n-doping is donation of electrons. And so in that respect tungsten2(hpp)4 would be regarded as an n-dopant.

Q. Does the n-doping mechanism by ditungsten tetra (hpp) -- strike that.

Is the n-doping mechanism of ditungsten tetra (hpp) the same as that by lithium Q?

MR. GARR: Objection. Form.

A. I'm not sure what you mean by the same as, in the two different molecular compounds and two different molecular systems and pairs. So it's a little hard to be very matter of fact to say it's the same without considering all the options.

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Q. Does lithium Q donate electrons from HOMO?

A. To what?

Q. To MPTL material, electron transport material?

A. Any electron transport material?

Q. So you said -- okay. Let's take one step back. You said you believe that lithium Q acts as an n-dopant to BPhen; correct?

A. Yes.

Q. And lithium Q acts as an -- strike that.

So how does it donate its electron to BPhen?

A. The coordination of lithium quinolate and BPhen results in a partial charge transfer between the two compounds, which provides freer electron density in the combination, which results in the higher conductivity.

Q. And does that electron come from lithium Q's HOMO?

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A. It comes from -- I mean electrons in ground state molecules are in the HOMO and deeper, but we only care about the molecules at the HOMO level, the ones with the highest occupied molecular -- so yes. Those, that electron density comes from the HOMO of lithium quinolate interacting with BPhen.

Q. And you don't believe that it's due to the atomization of lithium Q to the free lithium cation or lithium atom that's contributing to the n-doping mechanism?

A. I don't restrict myself to the requirement that the lithium quinolate compound gets dissociated to release free lithium, no.

Q. Does lithium quinolate dissociate to release free lithium atom or cation?

A. It depends.

Q. Depends on what?

A. On the conditions under which you're stressing the lithium quinolate compound.

Q. In the Ma deposition conditions.

A. It's hard to know for sure, but I

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don't consider it necessary to understand the changes in conductivity observed by Ma to require dissociation of lithium quinolate into either lithium zero or lithium flux cations.

Q. What is electron injection?

A. Electron injection refers to the act of inserting an electron from typically a metal to, relevant to this case, an organic semiconductor.

Q. Does lithium Q inject electrons into BPhen?

A. Again it depends. If you have a BPhen layer and then a lithium quinolate layer and then a metal able to inject electrons onto lithium quinolate, then in that sequence lithium quinolate would inject electrons onto the BPhen.

Q. And in the case of Ma, does lithium Q also act as an electron injector?

A. I would say it acts as an electron transporter alongside BPhen. So this layer in combination, this mixture of compounds in combination in that layer acts as an electron

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transporting layer. I wouldn't restrict myself to saying that lithium quinolate injects electrons onto BPhen or vice versa.

Q. Does lithium quinolate -- strike that. Can lithium quinolate act as an electron injector?

A. Again it depends on what it's in contact with.

Q. In Ma. Especially for the electron-only system.

A. So in those cases, I'm just going to review it to be sure.

Q. On page 811 I believe it's BPhen in que, then aluminum cathode is deposited directly on it.

A. And also, importantly, lithium quinolate is never used by itself. There is a control, which is BPhen by itself, but it never goes up to lithium quinolate by itself. It always goes up to -- it only goes up to 50 weight percent.

And so in this device, again it's

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always forming when lithium quinolate is included, which is in devices E2, E3 and E4, it's always a mixture with BPhen.

Q. And lithium Q is always in contact with aluminum; correct?

A. Well, the mixture is in contact with aluminum.

Q. So is lithium Q in contact with aluminum?

A. Lithium quinolate is part of that mixture, but you can't necessarily separate the two.

Q. So at least some of the lithium Q is in contact with the aluminum; correct?

A. The mixture which contains lithium Q is in contact with aluminum.

Q. So when aluminum is deposited or is operated onto lithium Q, can it energize or activate lithium Q to release lithium atoms or lithium cations and inject electrons that way?

A. I don't know, because those data are not included in Ma. It's never aluminum directly

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on top of lithium Q. And I haven't considered that in my interpretation because it's not included in this paper.

Q. Is electron injection layer different from electron transport layer?

A. It depends on the device. Sometimes they might be one and the same, sometimes you might have two separate layers for those two independent purposes.

Q. So in the case of Ma, for the electron-only device, is the BPhen/lithium Q layer acting both as injection layer and a transport layer or only as the electron transport layer?

A. You are saying the electron-only devices?

Q. Correct.

A. The BPhen/lithium Q in the electron-only devices, that mixture is the sole electron transport layer that is changing in the experiment. That's the scenario? So it's only that layer that's being probed.

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Q. So is it -- does that layer act both as an electron injection layer and transport layer or solely as an electron transfer layer?

A. The electrons had to be injected from aluminum into that layer, so it's a little hard to separate the processes. Once in that layer, they will transport through it. And so that interface is injecting electrons.

Q. So as opposed to electron injection in the transport layer?

A. Again, in this context, because it's an electron-only device, it's transporting electrons through it and they are being injected from aluminum. But to try to, try to say the entirety of the layer is doing both one at the same time is challenging.

Q. But at least at the interface with the aluminum it's acting as electron injection layer?

A. We know that the aluminum to lithium quinolate mix, BPhen mixture accepts electrons. That's as far as I think we can take it with

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defining the role.

Q. Can you have an OLED without an electron injection layer?

A. You need to inject electrons into the emissive layer so that excitons can be formed so that eventually light can be produced. It's possible to have an OLED with fewer layers where let's say you wouldn't necessarily define a single layer which is an electron transport layer and a single layer which is an electron injection layer. You only know that electrons get through that layer onto the emissive layer.

Q. So is the emissive layer electrically conductively connected to the cathode?

A. Via the layers in between. Maybe not directly.

Q. Okay. And in your opinion is the electron transport layer electrically conductively connected to the cathode?

A. In which device?

Q. The OLED structure.

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A. The electron transport layer, or ETL, will be typically closer to the cathode than the emissive layer. But whether there aren't other layers in between, it's hard to say without looking at a specific device structure.

Q. But is it electrically conductively connected?

A. Via potentially other layers, yes.

Q. So directory or indirectly it's electrically conductively connected to the cathode?

MR. GARR: Objection.

BY MS. ZHONG:

Q. So electron transport layer in an OLED device, directly or indirectly is electrically connected to the cathode; correct?

A. In order for current to flow through any device the circuit has to be closed. It can't be open. So there has to be some pathway throughout that device and the wires that connect it so that current can flow.

Q. So is the answer yes?

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A. There is a conductive path that exists between the two electrodes of the OLED which comprises numerous layers.

Q. Okay. So the answer to my question is yes. In an OLED device --

MR. GARR: Objection.

Q. -- the electron transport layer is conductively connected to the cathode?

A. There is a path where the cathode is usually a metal, a metal oxide, a conducting metal oxide, is in the same series connected circuit path as the ETL, the electron transport layer.

Q. Do you consider that to be electrically connected.

MR. GARR: Objection. Form.

Q. Electrically conductively connected?

A. I rarely use the phrase "electrically conductively connected", and I think a POSA as well. But yes, I would consider that to be connected electrically to the entirety of the device, which is sort of all in theory.

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Q. The same for the emissive layer; correct?

A. Same for the emissive layer. It's all connected in the same device structure.

Q. How do you delineate emissive layer from, for example, the buffer layer or the hole-blocking layer that's adjacent to the emissive layer if the light, the recombination is at the surface of the emissive layer and the adjacent layers?

A. The emissive layer serves the purpose of containing molecules that are able to act as recombination centers via excitons to produce light. If light exits the device that has the signature of that emissive compound, then it has to have originated from the molecule, the emissive molecule in the emissive layer.

Q. So if the dopant or the emitter exists at the interface of the emissive layer, what you call the emissive layer and the hole-blocking layer or the electron-blocking layer -- the H-O-L-E blocking layer and

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electron-blocking layer, so would you -- can you consider the hole-blocking layer and the electron-blocking layer to be part of the emission layer?

A. No. I would consider them to be in contact with or adjacent to the emissive layer, but not part of the emissive layer.

Q. What about at least the interface part? Would you consider at least the interface part to be part of the emissive layer?

MR. GARR: Objection.

A. The interfaces in the devices discussed here in my declaration are discrete, they are distinct. And so if you are on one side of the interface, you are on, in the emissive layer. If you are on the other side of the interface, you are in the transport layer or buffer layer, however you want to call it. And the roles of those two layers are, much like the layers, distinct from one another.

Q. So you consider that to be black and white?

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MR. GARR: Objection.

BY MS. ZHONG:

Q. Going from emissive layer to blocking layer, buffer layer or electron transport layer?

A. If you are asking me if the interface is molecularly flat, then no, it is not. But I do consider the two layers to be discrete in their imperative, their operations to be distinct.

Q. So when you say the interface is not molecularly flat, what do you mean?

A. I mean if you have, if you have put yourself onto the landscape of a molecular film, typical molecule is on the order of nanometer size, which distances between molecules the same order of magnitude; and so what I mean by molecularly flat is within a nanometer scale.

If I'm looking at that lens, it probably would look rougher than that. But if we zoom out to macroscopic scale, it's going to look very distinct, the two layers.

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Q. So at the interface, like, for example, within one nanometer or so between the two layers, the role, what's happening there? There could be emission going on there as well; right?

MR. GARR: Objection. Scope.

A. It's possible that there can be an emitting molecule at that surface, yes.

Q. And you would still consider, if that molecule happens to be -- so wherever that molecule lands, that would be part of the emission -- emissive layer?

A. Which molecule?

MR. GARR: Same objection.

BY MS. ZHONG:

Q. The emitter molecule.

A. Can you repeat the question?

Q. Okay. So if the emitter material is at the interface between what you call the emission layer and the, and adjacent layer, would a POSITA consider at least the interfacial region to be part of the emissive layer?

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MR. GARR: Objection. Outside the scope.

A. If there is a possibility that a photon could emerge from that emitter molecule at the interface, then you would consider that to be part of the emissive layer.

Q. So for an OLED device, you can pick and choose any suitable host materials for the emission layer, for the electron transport layer, for the hole transport layer; right?

A. A person designing the OLED device, and presumably also fabricating it and testing it, needs to take a lot into consideration in the selection of compounds for the device and the roles that they each play.

Q. What considerations do they have to take into account?

MR. GARR: Objection. Scope.

A. I just want to preface my response with saying that there are so many, that I am likely to exclude some.

Q. Okay.

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A. But it depends upon the color of the OLED that you are trying to make, whether it's blue, green or red or near infrared or UV. It depends upon the orientation of the layers, whether you have the electron transport layer first in the sequence or last in the sequence.

It depends on whether you are depositing the layers exclusively with vapor deposition versus perhaps with solution deposition. It depends on whether the device is so-called substrate-emitting through the substrate or whether it emits out the top of the device, and whether your substrate is rigid or flexible, which could determine the type of temperature it can withstand.

So there are lots of things that need to be considered. And like I said, I don't think my list is exhaustive, because this is coming, I'm trying to come up with that off the top of my head. But there are lots of things that need to be considered in selecting compounds for a particular OLED device.

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Q. Have you ever made an OLED device that contains the ditungsten tetra (hpp)4?

A. I have never made an OLED that contained tungsten2, ditungsten2(hpp)4. But I have made many OLEDs that contain doped ETL.

Q. Electron transport layer, ETL.

A. Just never that dopant specifically.

Q. Are you aware of any OLEDs being made with ditungsten tetra (hpp)?

A. Can you be a little more specific by being aware of what is being made? Like in what context.

Q. Any context.

A. Yes, I am well aware of OLEDs having been made that use that compound.

Q. By whom?

A. The center of mass for OLEDs with n-doped layers in the time scale, the time range of 2008 to 2009 would be Dresden, Germany. The lab at TU Dresden as well as a company called Noveled would be the two most likely labs that have produced OLEDs that utilize W2(hpp)4.

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Q. What is the organic compound?
A. Can you be a little more specific? Which organic compound?
Q. What's the organic compound used -- strike that. So what is the organic compound that's doped with W2(hpp)4?
MR. GARR: Objection.
A. Again there are many.
Q. What was it?
A. Numerous compounds. Host matrices have been doped with tungsten2(hpp)4.
Q. Give me examples.
A. Fullerene C60, carbon60.
Q. C60. Anything else?
A. ZincPc. ZnPc.
Q. Anything else?
A. That I can think of with data in my head, no, but I'm sure there are others.
Q. Is fullerene -- strike that. Is fullerene C60 an organic compound with heteroaromatic ring?
A. It is not.

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Q. What about zincPc, does it contain a heteroaromatic ring that's conjugated with an aromatic ring through a CC single bond?

A. Can I refer to an image of the zincPc molecular structure?

Q. Sure.

A. Can I do that here?

Q. Yes.

A. It's likely in one of these exhibits.

Q. I think it's probably in the Werner exhibit.

A. If it's not, it's in Walzer.

Q. Here is the Werner.

A. I don't know if the molecular structure is in here.

Q. And let me -- I think one of the exhibits I have already put in.

A. I'll pretty sure Walzer has it, the chemical review paper.

(SDC Exhibit Number 2002 was marked for identification.)

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Q. If you look at Exhibit 2002, I'm pretty sure on page 8 of that.

A. Yes.

Q. I don't remember which page. Okay. Go to PDF page 12.

A. Yes. I see it on page 5.

Q. Yes.

A. If you want me to go to page 12, I will do that.

Q. That's fine. Page 12, Figure 14.

A. Page 12, Figure 14.

Q. PDF page 12.

A. Yeah. So there is no carbon/carbon single bond in that zincPC compound.

Q. Okay. And the fluorine and the zincPC both have much lower LUMOs than BPhen; correct?

A. The fullerene and the zincPC have lower LUMOs. In this plot in Figure 14 of the Exhibit 2002, they refer to LUMO as electron affinity, but those are the same energy.

Q. So as shown in Figure 14 of the

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Walzer paper, zincPC and C60 both have lower LUMOs than BPhen?

A. Yes. As shown in this figure, zincPC and C60 both have lower, also sometimes called deeper LUMOs, or electron affinity, than BPhen.

Q. And do you know the authors of this Chem Review paper?

A. I do know some of the authors of this Chem Review paper.

Q. Do you believe that they are reliable authors?

A. Definitely.

Q. So they try to make their information as accurate as possible?

A. I believe that was their intention, yes.

Q. And would fluorine and zincPC used in OLED or they're only used in the zinc film transistor?

A. Are you ready? ZincPc and C60 are not often used in OLEDs. They are sometimes used

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in OLEDs, particularly zincPc, to support hole injection. C60 more rarely. Their use in 2008, 2009 would be most common in a solar cell.

Q. But not for OLEDs?

A. Less common for OLED.

Q. And you said zincPc is often used for hole injection, not for electron injection?

A. That's correct. Given its property as being an electron donor, then yes. It's usually used as a hole injection layer. It's relatively easy to get a hole on it.

Q. What about C60, since its HOMO is even very deep?

A. C60's HOMO is very deep. It's challenging to get a hole on C60.

Q. Okay. So C60 is used more as, for electron transport?

A. C60 is, its role is often invoked in transporting electrons, yes.

Q. And you said C60 is rarely used for OLED?

A. Yes.

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Q. Are you aware of any OLED devices using C60?

A. Before 2008 or since?

Q. Before 2008.

A. I'm unaware before 2008.

Q. Okay. When was the first C60-based OLED you are aware of?

A. Hard to say, but after 2008.

Q. After 2009?

A. Probably.

Q. Are you aware of tungsten -- strike that. Are you aware of ditungsten tetra (hpp)4 complex used in conjunction with BPhen outside of the '223 patent?

MR. GARR: Objection.

A. The combination of tungsten2(hpp)4 with BPhen is described in the Werner patent.

Q. Specifically that combination?

A. Those two compounds are invoked as dopant, metal-containing dopant and host, and so yes. In my read of Werner, it includes discussion of those two used in combination.

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Q. I'm asking slightly different question. I'm asking you would anybody have made an OLED device using those two components?

Where are you looking?

A. I'm looking in Werner at their, the section starting on page 6, the application example.

Q. Okay.

A. To see what, to remind myself the examples that they provide.

Q. I think the specific example given is on page 61.

A. I was close.

Q. Are you looking for examples one, two, three?

A. I am. That's what I'm looking at. Can you remind me of the question now that I've reminded myself?

Q. Yes. I was just asking you are you aware of any group that has actually made an OLED device that combines BPhen with ditungsten tetra (hpp) other than the Ozlan group?

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A. Again, Werner in this patent describes the co-evaporation of tungsten2(hpp)4 with matrix materials that include BPhen.

Q. Does Werner actually make a device that combined those two components?

A. I can't say that with certainty because I wasn't in the labs with Werner and co-inventors. But it's contained within the scope of metal complexes and matrix materials that are described in Werner.

Q. Were you aware of any such devices being made?

A. I'm only aware of what's contained in the contents here. I'm not privy to other information.

Q. Just generally?

A. Yes. Generally. Not to my knowledge. I'm not aware of an OLED that used the specific combination of tungsten2(hpp)4 and BPhen as an ETL.

Q. And since you are already on the experiments section, can you take a look at

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example number three?

A. Sure.

Q. Is example three an example of co-deposition or joint evaporation of a matrix material and a metal complex?

A. No. Fullerene and cobaltocene were separately processed in the process described here, example three.

Q. Okay. And can you please go to page 59, original page 56? There is a page number at the lower right bottom and a page number on the top.

A. Which one do you refer to?

Q. 56 or 59. Whichever.

A. At the top?

Q. And 59 at the bottom.

A. I'm on that page.

Q. So you don't consider -- go to the section called Implementation of Doping. Is method B joint evaporation?

MR. GARR: Objection.

Q. Or does method B involve joint

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evaporation of two complexes?

A. Method B involves the sequential deposition, so one after the other.

Q. So you don't consider that to be joint evaporation?

A. I consider that to be one after the other subsequently as the name suggests. Joint evaporation I would equate with co-evaporation, as mentioned in A.

Q. Okay. Does method C involve joint evaporation?

A. No, it does not.

Q. What about method D?

A. Method D is similar to B, but I think broader in scope.

Q. What about E?

A. Also no.

MS. ZHONG: We can take a break.

(Recessed at 1:06 p.m.)

(Reconvened at 2:03 p.m.)

BY MS. ZHONG:

Q. Back on the record. What is the

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relation between HOMO energy level and ionization energy?

A. As it pertains to a molecule?

Q. Yes.

A. The energy of the HOMO is the ionization energy of that molecule. Meaning the amount of energy it takes to promote an electron past the HOMO energy to the vacuum.

Q. And is there a difference between gas-based ionization energy and ionization energy as is?

A. And ionization energy what?

Q. As is?

A. What do you mean by as is?

Q. So is there a difference between gas-based ionization energy and ionization energy?

A. The ionization energy of a molecule in the gas does not necessarily need to be the same as the ionization energy of a molecule in a different state of matter, say a solid or a liquid.

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Q. And what's the relationship between the gas-based ionization energy and the ionization energy, the solid phase ionization energy?

A. It depends.

Q. Is that for tungsten -- what about for ditungsten tetra (hpp)?

A. Again, it depends.

Q. Do you know what's the relative value?

A. I'm unable to provide a relative value because it depends on a lot of conditions.

Q. What conditions?

A. The environment.

Q. What environment?

A. Well, the gas or solid environment doesn't specify what it's surrounded by.

Q. So the ionization energy of a molecule changes if it's, if it is in a mixture versus if it is evaporated by itself?

A. Please rephrase and I'll try to understand.

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Q. Okay. So if you -- for example, for the ditungsten tetra (hpp), does its gas phase ionization energy change depending on whether it's in a mixture with an organic material versus if it is by itself?

A. In both cases it's in the gas phase?

Q. Yes.

A. Then it would depend upon whether in the mixture it's sufficiently isolated such that its energy levels closely resemble the isolated compound.

Q. If it acts as a dopant, what would be -- how would that affect its ionization energy?

A. What's it?

Q. If the ditungsten tetra (hpp) is used as a dopant, how would that affect its ionization energy?

MR. GARR: Objection.

A. If W2(hpp)4 has participated in a charge transfer reaction, its ionization energy will be influenced by such interaction.

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Q. If it does not, how would the ionization energy change?

A. If it does not what?

Q. If it does not participate in charge transfer?

A. If the W2(hpp)4 molecule hasn't interacted with any other molecule and it's remaining in its gas phase, then it would be as if its energy levels are unperturbed from the isolated molecule.

Q. If the ionization energy of W2(hpp)4 is 3.51 EV by itself, do you expect that it will dope a material with a LUMO level of 3 EV?

A. Based upon the teaching in Werner, it certainly would.

Q. What's the teaching in Werner?

A. I'm referring to Exhibit 1005.

(SDC Exhibit Number 1005 was marked for identification.)

Q. I understand. Which part of Werner?

A. Well, even if I just quote the abstract, the aim of the invention is to provide

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n-doped organic semiconductors for matrix material that have little reduction potential while achieving high conductivity.

Q. So you believe that any of the materials mentioned in Werner is going, will be able to act as effective n-dopant for any of the matrix materials mentioned in Werner?

A. I don't want to make a statement that says any, but I would expect it to work for even those compounds that are foreseen as matrix materials and still possess relatively little, as they put it, reduction potential, which refers to a matrix material with a high lying LUMO.

Q. Now, before the authoring of '223 patent, you are not aware of anyone actually reacting tungsten2(hpp)4 with BPhen; correct?

A. I'm aware of Werner's teaching that if one combined a dinuclear complex, of which W2(hpp)4 is one, with a shallow or material with little reduction potential like BPhen, there might be a reasonable expectation of success.

Q. You are not answering my question.

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My question is are you aware of anyone actually combining tungsten2(hpp)4 with BPhen before the '223 patent?

A. Again, given that Werner comes some years before the '223 patent and includes within its scope the combination of W2(hpp)4 and BPhen in its teaching, that matrix materials with little reduction potential can still achieve high conductivity, I think a POSA would have a reasonable expectation of success that combining those two molecules would result in an n-doped highly conductive layer.

Q. Isn't it the case that even Werner didn't provide an example of actually combining W2(hpp)4 with BPhen?

A. If you are referring to the three examples toward the end of the spec, page 61, 62 and 63, there are three examples. It's not one of those three examples.

Q. And W2(hpp)4 is not in any of those three examples either; correct?

A. W2(hpp)4 is not, but chromium2(hpp)4

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is. And given a POSA's knowledge, chromium being higher up in the same group as tungsten, a POSA would expect that to be a weaker electron donor. You are nodding that you agree with that. And so using W2(hpp)4 in place of chromium, a POSA would only expect it to work.

Q. Okay. BPhen has a high-lying LUMO than ZincPc and C60 used in those examples; correct?

A. BPhen has a higher lying LUMO than C60 without question. Its LUMO level with respect to zincPc is within experimental error with the ability to measure electron affinity, which is the LUMO energy.

Q. But according to the Walzer paper, there is a 0.5 EV difference; correct?

A. That's right. There is a 0.5 EV difference in the Walzer paper when it, when, with respect to BPhen. I'm trying to find it again.

MR. GARR: Is it working?

THE WITNESS: It's working.

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MS. ZHONG: Page 12.

THE WITNESS: Thank you. I went too far. I'm getting a blue square.

MR. GARR: I think you may be able to download it and open it up through Adobe.

A. It's loading now. While we are still with this one, I think I'm okay. It does show zincPc having a deeper LUMO than BPhen by .5 EV. This value is the normally quoted error bar for measuring LUMO value, and so one could say that zincPc and BPhen have a similar electron affinity within experimental error.

Q. But normally BPhen is considered to be having a higher LUMO than zincPc; correct?

A. BPhen has a higher LUMO than C60, but I would say BPhen's LUMO with respect to a zincPc is within a typical experimental error and so I can't say with assurance.

Q. And BPhen's typically quoted value is around 3 EV weight for LUMO; correct?

A. 3 EV for BPhen LUMO is what is given here in Exhibit 2002. But as is typical with

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these values that have a substantial amount of error as I mentioned, you are likely to be able to find or a POSA is likely to be able to find values that are different from these.

Q. Did you investigate the relative LUMO levels and HOMO levels for the tungsten2(hpp)4 and the BPhen?

A. I did not.

Q. And is it fair to say that any of its metal complexes will act as effective n-dopant for any of the matrix materials it mentions?

A. My apologies. There are a lot of claims in Werner. Claim 25 in Werner refers to organic semiconducting materials that contain at least one organic matrix compound and an N-dopant.

Q. Okay. So any one of them is going to work?

A. It claims the utility of them.

Q. And for any one of the n-dopant is, is going to effectively dope the organic matrix

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material?

A. It depends on what you mean by effectively. But Werner limits itself to claiming the material that contains this organic matrix compound and an n-dopant.

Q. And Werner specifically says a matrix material preferably consists entirely of a phthalocyanine complex, in particular zincPc, a porphyrin complex, or a Buckminster fullerene, in particular fullerene C60; correct?

A. Which claim are you referring to?

Q. Page 55?

A. Oh. Page 55. It says that after it talks about phenanthrolines, which can also be used as matrix material.

Q. But it specifically says preferably the matrix material is phenanthroline complex, in particular zincPc, a porphyrin complex, or a Buckminster fullerene, in particular fullerene C60; correct?

A. I just want to correct you. You said phenanthroline instead of phthalocyanine.

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So yes, the page 55, lines 18 through 20, that is what it says.

Q. Okay. How many different types -- let me put it this way. How many different matrix materials did Werner disclose? Hundreds? Thousands? Hundreds of thousands?

A. Werner discloses a lot of matrix material.

Q. How many?

A. It's hard to count.

Q. Can you give me an order of magnitude?

A. I can't give you an order of magnitude estimate that's going to have any accuracy.

Q. Is it going to be more than a thousand?

A. It will be more than one thousand.

Q. More than ten thousand?

A. Again, I don't want to be too specific about my estimate.

Q. Is it going to be more than ten

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thousand?

A. It's hard to say without me spending some time to try to determine that number more accurately.

Q. But you are comfortable saying that it's going to be more than a thousand?

A. Yes.

Q. Okay. What about how many metal complexes did Werner disclose? More than a thousand?

A. A lot of these dinuclear complexes, metal complexes were disclosed.

Q. Okay. How many are there?

A. Again it's hard to give an exact count.

Q. Give me an order of magnitude.

A. Building on, you know, page 71, paragraph 22, claim, it's going to be in the order of a hundred in that claim.

Q. Which claim are you referring to?

A. Claim 22.

Q. Claim 22. The M2(Carboxylate) alone

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is going to be more than one hundred; right?

A. I'm just taking a single Carboxylate ligand in my interpretation.

Q. Okay. But the Carboxylate ligand is unlimited; correct?

A. I'm uncomfortable describing it as unlimited as an infinite number.

Q. Okay. There are hundreds of Carboxylates; correct?

A. I would need to do some research on that, but there are certainly numerous Carboxylates.

Q. More than a hundred?

A. Again I would like to do, think about that, do a little research before I provided an absolute figure on that.

Q. How many Carboxylates do you know?

A. I'm uncomfortable providing a list of Carboxylates right now.

Q. Just give me an order of magnitude. More than ten?

A. Again this is something that I

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haven't considered in my declaration or in the, in my read of Werner and, thus, I'm uncomfortable providing a figure.

Q. How many Carboxylates have you worked with?

A. I'm unsure.

Q. More than five?

A. Probably.

Q. Okay. More than ten?

A. It's not a compound that's used a lot in my research, so it's really hard for me to give a figure.

Q. And the Carboxylate4, there can be different Carboxylates; right?

A. The Carboxylate what?

Q. The M2(Carboxylate)4, they don't all have to be the same Carboxylate; correct?

A. It's unlikely that it would be four different Carboxylates. I'm not a synthetic chemist, but it sounds like that would be a difficult thing to do. But I suppose it could be more than one type of Carboxylate.

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Q. So you have used more than five Carboxylates before; right?

A. Again, I can't give you a definitive. So I'll just say probably.

Q. And there are nine different metals and let's just say all the Carboxylates are the same; that's 45 combinations right there; right?

A. Yes.

Q. And M2(Carboxylate)4 doesn't exclude mixed metal complexing either; right? You said chromium and molybdenum or chromium and tungsten; right?

A. So on page 12 of Werner it has a paragraph in particular starting on line nine where they say in particular molybdenum and tungsten, wherein preferably all central atoms of the neutral metal complex are identical. But at the end they say both metal atoms M can be the same or different from each other. It allows for them being different as well, but it's not a preferred embodiment.

Q. But claim 22 does not exclude mixed

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metal complexes; correct? M2(Carboxylate)?

A. No, it doesn't exclude that because it uses the "or".

Q. Okay. So if M is the same, Carboxylate is the same, we already have 45, at least 45 combinations. And if you include the mixed possibilities, that number is going to increase pretty rapidly; correct?

A. Sorry. 45 is because you assumed 5 Carboxylate ligands; right?

Q. The 5 Carboxylate.

A. I guess it increases by a factor of 50 or so.

Q. 72 times five?

A. Right.

Q. At least? So then we have how many? Nine times eight, 72 times five, 360, plus the 45. That's almost 400? Let's just say 400?

A. Okay.

Q. Let's go to -- then there is M2(AlkylCOO)4. Then fluoride.

A. M2(AlkylCOO)4 fluoride, yes.

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Q. With Alkyl being identical or different with C1 to C10; right?

A. Correct.

Q. How many combinations are there, including the different isomers when you get above C3?

A. For example isopropyl?

Q. Isopropyl, then n-propyl?

A. Yep.

Q. What about C10; how many different isomers are there?

A. More.

Q. How many?

A. I don't know off the top of my head, but more.

Q. 20, 30 at least? So it's reasonable to say the AlkylCOO was C1 to C10, you are probably looking at a couple of hundred possible isomers?

A. I think it's fair to say that, yes.

Q. Okay. So you have about 200 different possible ligands for the AlkylCOO and

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how many different metal? One, two, three, four -- nine?

A. Just say nine.

Q. So nine times 200; 1,800?

A. Okay.

Q. So just between the M2(Carboxylate), M2(AlkylCOO)4, we are talking about over 2,000 already; right? And we haven't really counted the CT complexes, the M2(hpp)4 possibilities? Right? So fair to say there's going to be a few thousand possibilities? At least a few thousand possibilities in claim 22; right?

A. Fair to say that there is over a thousand.

Q. Over 2,000 actually?

A. Over 2,000. Sure. I will agree with that.

Q. Over 2,000 preferred metal complexes and we said there are a thousand matrix materials. So we are looking at how many? A few million combinations already?

A. You mentioned preferred in your

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question, and then I just want to --

Q. Okay. Claim 22, it's preferred; right? That's what the patent claims? So its trying to narrow the scope?

A. It's very clear to me that Werner and co-inventors recognize that there were a lot of ligands that were capable of holding a dinuclear metal complex into a low-oxidation state and they wanted to very clearly protect that new knowledge because they saw value in it.

Q. Okay.

A. And I think this claim reflects that learning.

Q. Okay. But there are over 2,000 possibilities here?

A. Yes. We went through that. I think I agree with your interpretation that there are a lot of options here.

Q. And that over 1,000 matrix materials?

A. We didn't have the same discussion with the number of matrix materials, but they

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disclose numerous matrix materials with specific emphasis on matrix materials which have little potential for reduction.

Q. Okay. And those disclosures, which span page 5234 through the end of page 5610; you believe that it's going to -- there are going to be more than a thousand possibilities; right?

A. I would need to work through it, and so I don't want to be too specific about the number. But again, much like they recognized how many ligands were capable of holding a dinuclear metal complex into a low-oxidation state such that it was a strong reducing agent, they recognize that if you had such a strong reducing agent, there were a great many matrix materials that would be receptive to being reduced, because they are such strong reducing agents. So again there is a lot of learning here that they wanted to protect.

Q. I understand they want to protect. So would a person of ordinary skill in the art walk away to say that any of the metal complex

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that Werner listed is going to work with any of the matrix materials?

A. I don't think any person of ordinary skill in the art would claim that something will or will not work. But I think upon reading this, they would have a reasonable expectation of success for a great many combinations of dinuclear metal complexes and matrix material hosts.

Q. How many of those millions of combinations would they have a reason for expectation of success?

A. Again I can't quantify like a percent value of that because it is very much dependent upon so many factors that go into making an organic electronic device and OLED is one of them, but there are numerous organic electronic devices, numerous criteria that one wants to consider for the processing of that material, for the device application, for the operating condition, that I can't give an exact figure on the percent of combinations that might

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reasonably lead to success because it will be very much dependent on the constraints of the condition of a person of ordinary skill in the art.

Q. Can you take a look on page 53, lines 5 to 19 I believe?

A. The paragraph starting "the matrix material"?

Q. Correct.

A. Okay. Okay.

Q. For an oligomer, so for an oligomer with a hundred to 500 monomer units, would you consider that to be a polymer?

A. Where one draws a line between an oligomer and polymer is, as far as I understand it, my area of expertise is not polymer science. That's mostly an expertise in the chemical engineering domain. But in my knowledge it is, there is no exact value that draws a line between an oligomer with a countable number of units well-defined and a polymer where that number is less well-defined. It's just a little vaguer.

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Q. My question is if you have an oligomer or polymer with more than 50 monomeric units, are they usually suitable for evaporation? Or put it another way. Is evaporation a suitable deposition method for an organic material where 50 to one -- more than 50 monomeric units?

A. It depends. I would say it's less common to use an evaporative technique for a high molecular weight compound and an oligomer with more than 50 repeat units is likely to have a relatively high molecular weight. It does not make it outside the realm of possibility to use a vacuum evaporation type technique to deposit, but it's certainly more common to use a method based upon an ink or a solution, a solvent, for example.

Q. And why is that?

A. Why is what?

Q. Why is it more common to use a solution-based process instead of evaporation process?

A. Thank you for clarifying. As a

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molecular weight gets larger and larger, then the energy required to fully vaporize that compound often competes with the energy needed to decompose that material. And, therefore, one needs to be very careful with evaporative techniques when you get a large number of repeat units. Like I said, it's not impossibly. There are those that do it but it is less common.

Q. So is it fair to say for a POSITA, if they observe that when you do an evaporative process with a large molecule and there is decomposition, they will not use evaporative process to form an OLED for example?

A. It's unclear how the POSITA would determine whether a molecule has decomposed and it hasn't successfully made its way to a substrate.

Q. Don't you do BSC, TEG type of analysis beforehand to see when the decomposition temperature, what is the decomposition temperature?

A. You could do that, but those

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techniques are not carried out in the same conditions as thermal evaporation, which is usually at a higher vacuum, which will really change thermal properties. So again it's a little hard to put myself in the position of a POSITA attempting something for the first time and I don't know exactly what the molecule is and what the conditions were.

Q. If they had made a device and afterwards the analysis indicated there was decomposition of the polymer, would they continue to use evaporation process?

A. They might. But they would refine the way they are doing it. They probably wouldn't go about it the same way because that didn't lead to success. So it depends. Depends how that POSITA would -- if they were really inclined to use evaporation, they would probably consider how to do it without degradation. Decomposition. Sorry. Not degradation.

Q. So it's important to make sure that the process condition does not degrade or

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decompose the material you want to deposit; is that correct?

A. From a practical point of view, it's best not to decompose your material in large quantities because that's going to be a yield issue. But in principle it's hypothetically possible to both the evaporating a material and degrading a material simultaneously. Some of the successful evaporated material would find its way to a substrate. Some of the material in the source could be degraded. But I would say it's not ideal.

Q. I'm asking is that something that a POSITA would do?

A. Again I think it very much depends on the nature of the experiments and the condition under which they want to prepare a film.

Q. If there are ways to prepare a film without degrading it and there are ways to prepare a film that will lead to degradation, will a POSITA choose the processing condition

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that does not degrade the film?

A. If it's the only processing condition that's available, because maybe they are not able to identify a suitable carrier solvent for the material. Maybe it's not soluble period. Or maybe the solvent that they do identify damages their substrate or underlying layers. So I think it very much depends on the condition of the experiment and the nature of the structure being prepared.

Q. If the solution, those types of process are available, which one would you choose?

A. If I have a choice between a solution process that degraded nothing and a vapor deposition process that degraded some of it, and both would result in the same film in the end of the day, then I think it would be a judgment call based upon other factors, equipment issues, et cetera.

Also, a solution process in the lab is typically the most common one for depositing a

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film in thin coating. It's a very poor yield of material starting in a solution to getting onto your film.

And so again if that value, if the yield of material from my solution to my film was similar to the yield of material from the source, the thermal source to the film, it's very hard to say.

Q. Have you used a PVK before?

A. By PVK are you referring to the polymer polyvinylcarbazole?

Q. Correct.

A. I have used PVK before.

Q. How do you process that?

A. Can you be more specific about which PVK? Because there are numerous options. Polyvinylcarbazole only refers to the core unit.

Q. What kind of PVK have used in the past?

A. I think I would need to look up my papers specifically.

Q. Do you use different process

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conditions for them?

A. The only way in my lab that we have deposited films or layers of PVK, which either could be NEAT films of PVK or host guest films, mixtures containing PVK would be from inks from solution. Typically organic film.

Q. You worked at Forrester's lab before; correct?

A. Are you referring to Steve Forrest?

Q. Yes.

A. I conducted my Ph.D. working with Steve Forrest as my thesis advisor, yes.

Q. Did his lab use PVK?

A. I myself never worked with PVK, to my recollection, while I worked in the labs of Steve Forrest. Whether PVK has been used in his lab, I'm unable to recall.

Q. How many years have you used PVK?

A. Pretty common material.

Q. How many years? Over a decade?

A. Maybe.

Q. Have you seen PVK being vapor

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deposited?

A. There is a community of researchers that study vapor deposition of polymers. I myself am not one of them. So it's a little hard for me to comment on vapor deposition of PVK specifically because it's not my core area of expertise.

Q. Did you study chemistry?

A. I have a minor in chemistry, yes.

Q. What chemistry classes did you take?

A. General chemistry, physical chemistry, photo chemistry, quantum chemistry, analytical chemistry, and then a lot of chemistry that I've learned along the way of doing research that wasn't necessarily in a class environment, and I may have missed one or two classes.

Q. So you did not take organic chemistry, for example?

A. I never took an organic chemistry class.

Q. What about organometallic?

A. I never took an organometallic

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chemistry class.

Q. In the 2008 time period do they teach OLED in undergrad chemistry class?

A. I do believe that they did. Yes.

Q. In general chemistry?

A. It may have come up as an example of general chemistry, but I don't recall it being in the general chemistry course I took.

Q. So when you say that they teach OLED in undergrad classes, chemistry classes, which class are you referring to?

A. It would be taught in the context of a photo chemistry class.

Q. In the context of photo chemistry class, what do they teach regarding the OLEDs?

A. They teach the basis of molecular excited state or excitons and various applications of molecular excited states of which an OLED is one.

Q. Do they teach the materials used for OLEDs in those classes?

A. They would show examples of

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photoluminescence, photoluminescent molecules, electro-luminescent molecules, fluorescent molecules and phosphorescent molecules, which would invariably include discussion of those types of molecular structures.

Q. Do they teach the type of materials suitable for phosphorescent SOLEDs versus fluorescent OLED?

A. Yes.

Q. And are the materials different for those two?

A. They are.

Q. How do they differ?

A. A phosphorescent compound emitting complex will have an ability to have intersystem crossing such that initially generated triplet excitons -- triplet -- are cape -- are capable of intersystem crossing and then flipping so that they can emit radiatively to the ground state, which is a singlet state.

Q. What about the organic matrix materials used to host those fluorescent or

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phosphorescent emitters?

A. What about them?

Q. Are they the same? Are they different?

A. They would typically be different from the emitting molecules.

Q. I'm saying the matrix materials for the fluorescent emitters versus the matrix materials for the phosphorescent materials?

A. In general the host materials for the emitting layer consider the energy levels of the relevant excited state of the emitting compound. And, you know, a blue emitter, whether it's fluorescent or phosphorescent, is going to have a similar emitting energy with respect to either the singlet or triplet, emitting from the triplet state or the singlet state, and so the considerations are similar.

The exact choice will be dictated by the value that is that energy. And so I don't want to just say a blue phosphorescent OLED is going to feature the exact same host as a blue

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fluorescent OLED, because the energies might be slightly different.

Q. What about the electron transmitting layers, the host transport layers, injection layers, are they all interchangeable with a fluorescent and the phosphorescent systems?

A. I wouldn't use a concrete term like all interchangeable, but it's certainly possible to use similar compounds in a fluorescent OLED and a phosphorescent OLED for ETL, and same true of the HTL. And it will depend upon the ability to inject electrons or holes into the emissive material host and it will depend upon the ability to block electrons and holes in the host to going onto the transport layer.

Q. Do you think a tungsten2(hpp)4 would be suitable for both systems?

A. When you say both systems, you mean a fluorescent OLED and a phosphorescent OLED?

Q. Correct.

A. I think it's possible that W2(hpp)4 can be used as a dopant in an electron

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transporting layer that could be used either in a fluorescent OLED or a phosphorescent OLED.

Q. Would they have been used in either, would it have been used in either system?

A. In what context?

Q. In OLED.

A. I don't see why they wouldn't be.

MS. ZHONG: Let's take a break.

(Recessed at 3:04 p.m.)

(Reconvened at 3:11 p.m.)

BY MS. ZHONG:

Q. Back on the record. We talked a little bit about matrix material. What is a matrix material?

A. A matrix material is a material that you are co-depositing with another material, and usually, but not always, it's the one that's, has a higher molar concentration. And again usually it has a larger energy gap than the guest, less molar concentration.

Q. So in the case where you dope W2(hpp)4 into an organic matrix material, would

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you consider W2(hpp)4 to be a matrix material as well?

A. It could be in the right conditions, again depending on what you wanted as the properties of the final layer. I wouldn't exclude its capability of being a matrix material.

Q. So for the emissive layer, would you consider both a dopant or the emitter as well as the host material to be matrix material?

A. In the emitting layer, especially in a phosphorescent OLED, I would consider the emitter to be, to not be the matrix.

Q. Do the matrix material have to be in a continuous phase?

A. Can you explain what you mean by continuous phase?

Q. For example, if in the mixture for a particular layer one of the mixture is more like island in the sea. Do you have that picture? But you have a --

A. The sea is the matrix, the island is

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the --

Q. So that you have a major component that forms the sea.

A. Most of?

Q. Yeah. And then you have another material that's kind of discontinued, like island in the sea.

A. I understand your picture. Can you go back to your original question?

Q. In that type of mixture would you consider the minor component that's the island in the sea to be a matrix material?

MR. GARR: Objection. Form. Out of scope.

A. I'm not really sure how to answer the question. I will still don't fully understand it. Can you repeat it or rephrase it?

Q. So if you have a mixture in the layer.

A. And one is much more predominant than another? They are in larger quantity.

Q. And one forms a continuous phase,

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the other one is distributed within that phase.

MR. GARR: Same objection.

A. The other one is there and it is perturbing the host in some sense, but the host is more or less defining the phase of the overall system.

Q. Okay. So would you call the minor component to be a matrix material?

MR. GARR: Objection.

Q. Or a matrix material is more synonym to a host material?

MR. GARR: And out of scope.

A. And in this example we only have two compounds?

Q. Let's start with two.

A. I must admit in my research and I don't often use the term "matrix". I usually use the term "host". So it's a little hard to put myself --

Q. The Germans seem to like the word.

A. -- in the position of a German -- I didn't want to say that -- but tend to use the

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term "matrix". But it's probably just a direct translation from the German word.

But I would, if a German colleague was talking about a matrix, I would tend to associate in my mind with what I, the vernacular I would use would be a host.

Q. So in a scenario that we have just discussed, would you consider the minor component to be the host?

MR. GARR: Same objection.

A. As I mentioned in my original answer to your question, this line of questioning, usually the host or matrix is there in larger quantity. Not always, but usually.

Q. That's how you usually interpret the term "host"?

A. Unless it has been very specifically stated that that material is there in larger quantity.

Q. What if you have a three-component system and one of them form a continuous phase, the other two are distributed in there, and

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neither form a continuous phase?

MR. GARR: Objection. Form. Scope. Incomplete hypothetical.

A. In the case that you have more than two materials, which does happen often in OLED, so-called mixed hosts with another material in there, usually the mixture of those two predominant forms are there in relatively large quantity because both of their merits are required for the application. And it's typical that you'll have two in relatively large quantity and one in lesser quantity.

Q. What if they are in the ratio of 60/20/20?

MR. GARR: Same objection. Incomplete hypothetical. Out of scope. Form.

A. Are you referring to molar?

Q. Volume.

A. Of course it will depend upon the density of the different material. If I had a volume ratio of 60 to 20 to 20, in an OLED?

Q. Uh-huh.

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A. Probably have to do with a layer that is emitting multiple colors. Which again is very possible for OLED where maybe you don't want color purity, but your intention is perhaps more for broad spectral coverage. An example of that is a white illumination device.

Q. So would you consider all of them to be matrix materials?

MR. GARR: Counsel I'm going to object to the lack of scope or this line of questions being out of scope. Is there some relevance to the materials in his declaration that you are getting at? If not, I'm going to --

MS. ZHONG: I'm sorry. You have stated your objection and he has to answer it.

MR. GARR: At a certain point I would like to go off the record to discuss how to proceed.

MS. ZHONG: He can answer the question. If you have a question, then you can file a motion to strike.

MR. GARR: After this question can

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we go off the record?

THE WITNESS: Can you repeat the question?

BY MS. ZHONG:

Q. So if you have a composition that's 60/20/20 in volume with the minor component to be in discontinuous phase, the first in the major component, would you consider those two minor components to be host materials?

A. Again it will very much depend on the volume that each of these molecules occupy in the solid and I think there is no way to answer your question absolutely, unfortunately. And that's because the two 20 and 20, that's 40 percent of the system, which is a lot.

So I mean they are all there in relatively high quantity, and without a little more information about specific molecules, the intended purpose, I'm not able to answer this question in absolute terms.

MR. GARR: Can we go off the record?

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BY MS. ZHONG:

Q. You have no opinion?

A. I don't lack an opinion. I just don't think I have enough information to properly answer the question.

Q. What more information --

MR. GARR: At this point I'm going to direct the witness to stop answering questions until we go off the record so I can discuss with you.

MS. ZHONG: Okay. We can go off the record, but you cannot direct him not to answer the question. I have had similar situations occurred before. You have to answer the question. You cannot -- the only way you can instruct him --

MR. GARR: If you want him to go out of the room, he can, but if you can explain to me some way how these are relevant to the issues in this IPR, I'm open to hearing it. If not, at a certain point I will say this is out of scope and the witness should stop answering the question.

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You are welcome to tell me now or with the witness out of the room, but there must be some explanation as to relevance to this proceeding, and if not, I don't understand why --

MS. ZHONG: I don't have to tell you what's in my mind. That's work product. And as I said, if you have issue with it, go ahead and try to file a motion to strike.

MR. GARR: Okay. Let's take a 20-minute break.

(Recessed at 3:25 p.m.)

(Reconvened at 3:44 p.m.)

BY MS. ZHONG:

Q. Let's go back on the record. Okay. Can you turn to page 53 of the Werner Exhibit 1005?

A. Yes. I'm there.

Q. Werner, Exhibit 1005 contemplates a mixture of matrix materials; correct?

A. I'm referring to lines 16 and 17, which refer to block or mixed polymers of the mentioned oligomers or that the matrix can also

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be a mixture of oligomers with different chain lengths, as is typical for conventional polymer.

Q. Look at the next paragraph.

A. The paragraph starting, "the matrix"? Page 53. Yes. It mentions matrix material can also be present in combination with each other.

Q. Okay. So when you have a mixture of matrix materials, when does a matrix material stop being a matrix material and become a dopant? When does a matrix material stop being a matrix material and become a dopant?

A. I would say it very much depends on what the end goal is for the properties of the mixture.

Insofar as it concerns Werner, they are using matrix materials to refer to compounds and then they are then adopting that language to refer to the matrix material as it pertains to, in this case, combinations of, for example, triarylamine and a spirobifluorene compound.

Q. Fullerenes, F-U-L-L-E-R-E-N-E-S,

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fullerenes are mentioned as both examples of a matrix material as well as suitable ligands for metal complexes; correct?

A. Can you refer me to the part that you are discussing when fullerene is used as a ligand?

Q. Page 51.

A. Let me back up a little bit to see. Out of context, that section is a bit odd to me. The section is synthesis of ligands and their precursors. Page 39.

Q. Uh-huh.

A. Then it gives numerous examples of synthesis of various ligands that Werner and co-inventors thought were important to disclose, perhaps because they never had been disclosed before.

It refers to the approach being similar to that used with cyclopentadienyl ligands, but not limited to it, and then they provide reference as an example, a paper from 2004.

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Q. Okay. So fullerene can be part of the metal complex or it can be used as matrix material; right?

MR. GARR: Counsel, I'm just seeing that the issue that we were discussing on a break has been raised with the Board, and I think that if there is an interest in having the Board's resolution to this issue, we should stop the deposition until that's received.

There is a number that can be called to obtain immediate resolution of disputes during depositions, so you can either withdraw that email or we can call the Board's hotline now if you want it resolved.

MS. ZHONG: There is a question pending.

A. Werner describes through reference to an example synthesis of fullerene-bearing ligands, with also reference to the section on page 47 on pi-perimeter compounds and specifically cyclopentadienyl.

MR. GARR: At this point I think the

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deposition needs to take a break until this is resolved.

MS. ZHONG: So you are going to stop the deposition?

MR. GARR: Well, there is -- if there is an issue that requires resolution during a deposition, there is a phone number that can be called for it.

MS. ZHONG: We can call the number.

MR. GARR: We can't?

MS. ZHONG: We can take a break and call the phone number.

MR. GARR: Let's do that.

(Recessed at 3:52 p.m.)

(Reconvened at 4:09 p.m.)

MS. ZHONG: Back on the record.

MR. GARR: We discussed during the break I'm going to, given that we weren't able to reach the PTAB on the phone and in the interests of expediency, I'm going to for now withdraw my instruction that we hold the deposition pending resolution of the issue. You can continue your

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questions, but I note my objection.

BY MS. ZHONG:

Q. Now, before the break we were talking about fullerenes that can be used both as part of a metal complex as well as a matrix material. Do you recall that discussion?

A. I do.

Q. So in a mixture containing a metal complex with fullerene and fullerene as a matrix material say, when does fullerene stop being a matrix material and become a dopant?

MR. GARR: Objection. Lack of scope. Out of scope. This matter pertains to interpretation of a claim term in a different patent that this witness has not offered opinions on. I object to the line of questions based on this issue.

MS. ZHONG: Counsel, you can only have limited objections, which is form, scope, privilege, hearsay.

MR. GARR: Objection as to the scope.

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MS. ZHONG: And speaking objections are not allowed.

A. With reference to Werner, page 51, the section on fullerenes, makes reference to cyclopentadienyl ligands; the section on page 47 that discusses those makes reference to seven papers; and the section about fullerenes also makes references to another paper, one from 2004.

None of the papers in either the cyclopentadienyl section or the one in the fullerene section I have had a look at. And so it's unclear to me what these metal complexes, what their specific molecular structure are, so it's a little hard for me to comment on exactly how they will interact with a matrix that is fullerene.

Q. So whether a material is a matrix material or not depends on its interaction with the other components of the mixture?

MR. GARR: Same objections to this line of questions.

A. I didn't say that. But I would say

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that the matrix material is dependent on context about what the purpose of the mixed layer is inside whatever type of device it is, would allow one, a POSA, to make a definition of matrix material in that context, which is not being provided here.

Q. You have reviewed Werner; right?

A. That is correct.

Q. Okay. But you did not review the papers cited by Werner?

A. I did not review all of the papers cited by Werner.

Q. What's in the matrix?

MR. GARR: Same objection.

A. Again it very much depends on context. The matrix, what is the other material or other materials? What is the device? Where is it in this device? It's very hard to give a singular answer to the question.

Q. Do all the materials in an emissive layer belong to a single matrix?

A. How many materials are in the

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emissive layer?

Q. There is at least a host and dopant; right?

A. Okay. And the dopant is the emitter?

Q. Uh-huh.

A. When the emitter that is there in typically lower quantities, I would say often ten percent or less molar ratio, you would consider the one that's there in 90 percent or more to be the matrix or host in that context.

Q. So in a mixed host system, let's say the molar percentage of the two matrix material is 70/30 and then you also have an emitter. Is that a single matrix, two different matrixes?

MR. GARR: Object to form, foundation, out of scope.

A. When you said the matrix materials are there, the two are 70/30, that's a hundred percent already.

Q. For the host system?

A. I see. Just for that. And then

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there is presumably a smaller amount of the emitter molecule. One would normally, a POSA would normally consider that mixture to be disordered, but relatively homogeneous.

Q. What if they are two difference phases for the two components of the mixture?

MR. GARR: Same objection. Form, foundation, out of scope of the witness' testimony.

A. What do you mean by phases?

Q. Have you heard of phase separation?

A. I have, yes.

Q. So in a solar cell application there tends to be space separation of the materials; right?

A. There does.

Q. Okay. So in that situation do you consider to be a single matrix, two different matrixes?

MR. GARR: Objection. Form, foundation, out of scope of the testimony in this particular IPR matter.

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A. It would be very dependent upon the molecular structure and electronic structure of the two materials, which, and thermal properties, which will dictate the degree of phase separation of two compounds in a mixture. They could be homogeneous, they could be biphasic, three-phase, four-phase. The list goes on. So it's completely dependent on the specific nature of the two compounds under consideration.

Q. So if they're biphasic, how many matrixes do you think there are?

MR. GARR: Objection. Form, foundation, out of scope. Again the objection pertains to the whole line of questions about what is or is not a matrix material.

MS. ZHONG: Counsel, no speaking objections.

A. So you certainly have molecule A and molecule B and we have a biphasic system. Then there is still multiple options. We could have a biphasic system composed of regions that are pure molecule A and pure molecule B, there could be

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regions where in a different manifestation you have pure molecule A and a mixture of molecule A and B in a specific mixing ratio. And the list goes on.

So there are lots of options even in a biphasic system with two molecules. It's very hard to give one answer.

Q. Okay. So if it's the situation, the first situation you mentioned, pure A and a pure B, how many matrices are there?

A. Well, then there are two; the layer is composed of parts that are completely A and parts that are completely B.

Q. What about a second situation when you have pure A, then a mixture of A and B; how many matrices do you consider there to be?

MR. GARR: Same objection.

A. It depends on whether that mixed phase is always homogeneously mixed. It could be infinite numbers within that or it could be smallest value two; pure phase of A and a phase of some specific stoechiometry mixture of A and

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B.

Q. So you consider that to be two different matrices?

MR. GARR: Same objections.

A. In the case where the two molecules go into this biphasic system as discussed; pure A and then one specific mixture of A and B, I consider that composite film to be composed of two matrices.

Q. Okay. What if you have -- what if you have a heterogeneous mixture? So in bulk it may appear to be homogeneous, but if you look into each of the regions microscopically, the mixture, the ratios are different; do you consider that to be an infinite number of phases or do you consider to be one single phase?

MR. GARR: Same objections.

A. I think it would depend on the context. If your POSA was interested in the thermal properties of said composite film and they all behaved homogeneously, despite other knowledge that some aspects of it might be

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heterogeneous, that POSA might not be concerned about that heterogeneity.

Electronically speaking, if that mixture behaves homogeneously in a way that didn't disrupt the intended application, despite again knowledge that there was some heterogeneity there, that POSA for the purposes of their investigations and their application might not be concerned about that heterogeneity.

Q. So in that case the POSA would consider that to be a single matrix?

MR. GARR: Same objection.

Q. Multiple matrices?

MR. GARR: Same objections.

A. So in the example I gave, they would, that person had knowledge that it was heterogenous, but they chose to exclude that as being important for their intended purpose, but I think that person would still accept that it's heterogenous.

Q. So would that be considered to be a single matrix material?

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MR. GARR: Objection. Outside of the scope.

Q. A single matrix system?

MR. GARR: Outside the scope.

A. Again, I think as long as it reached the intended goal, the additional knowledge, which is always good, probably wouldn't put them into a black and white description of whether something is a single matrix or a combination of matrices. They would accept that the system works to produce the desired outcome.

Q. What is a chain structure, chain-like structure?

THE WITNESS: Can you open that?

MR. GARR: The witnesses' laptop needs to be refreshed. It's back.

A. I'm opening the '233 patent. You asked about a chain; is that correct?

Q. Chain. Uh-huh.

A. Chain is defined in the '223 patent, is an organic compound coordinating to more than two metal complexes.

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Q. Where are you reading from?

A. I'm reading that from column seven, line 52 and three. So at least three molecules.

Q. Is it limited to two three molecules?

A. It's at least three molecules; an organic compound and two metal complexes.

Q. So if you take a look at compound number 12 on this page, on the '223 page. Do you see that?

A. I see it.

Q. Okay. And so if you have lithium Q coordinating to the phenanthroline ring on one end and another lithium Q molecule coordinating to the nitrogen atoms on the other end, is that a chain structure?

A. I'm sorry. I don't understand the question, because on molecule 12, if I'm looking at the right molecule, I do not see a phenanthroline. I see bipyridyl.

Q. Sorry. So for molecule number 12, if you have a lithium Q complex coordinating to

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the nitrogen on one end, another lithium Q molecule coordinating to the nitrogen on the other end of the molecule, is that a chain structure?

A. You are saying the outer-most nitrogens of the two bipyridyl --

Q. Doesn't have to be.

A. -- of molecule 12?

Q. It doesn't have to be.

A. No. But you were being very specific, so I just want to be clear that's what you were referring to.

Q. Yes.

A. Okay. So a lithium quinolate on either end?

Q. Uh-huh.

A. So lithium quinolate has the lithium atom and a pendent to it. Lithium prefers tetrahedral coordination. So I see no reason why lithium couldn't tetrahedrally coordinate to one side of this and a different lithium and a different lithium quinolate molecule coordinating

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to the nitrogen on the other side of this --

Q. So would you --

A. -- to form a chain.

Q. So would you consider that to be a chain?

A. I would.

Q. What if it's only the lithium molecule -- so what if that's the total length of the chain, so like there is no more growth from that end; do you still consider that to be a chain?

MR. GARR: Object to form.

A. My conclusion wouldn't be changed. It doesn't affect my conclusion.

Q. And if a third lithium Q molecule coordinates to another part of molecule 12, do you consider that to be a network-like structure then?

A. First, let me go to the definition of network. So with reference to the '223 patent, column 10, line 64, 63 and 64, a network is when the organic compound coordinates to more

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than two metal complexes; thus, at least four molecules are required to form a network.

Q. Okay.

A. And now that I've internalized that definition, can you repeat your question?

Q. So for compound number 12, assuming that three lithium Q molecules coordinating to three different nitrogens in the molecule, is that a network structure?

MR. GARR: Object to form.

A. That fits the description of a network structure as defined in the '233 patent.

Q. Now, let's go to your declaration, pages 34 to 37.

A. Okay.

Q. Are you trying to draw an analogy between the trifluoroacetate, the Rh2 trifluoroacetate reported by Cotton and the W2(hpp)4?

A. You said 34 to 37?

Q. Correct.

A. Okay.

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MR. GARR: The pages are -- page 34 or paragraph?

MS. ZHONG: Page 34.

THE WITNESS: That's what I'm reading. I think you might need to direct me a little more specifically, because I'm not catching this analogy that you are referring to with Cotton.

Q. You were saying like Rh2 trifluoroacetate in Cotton in 1999.

A. I think I'm on a different -- I'm on page 34.

Q. Yes. The last sentence on that page.

MR. GARR: What document are you looking at?

MS. ZHONG: Oh. Sorry.

BY MS. ZHONG:

Q. Okay. Go to page 39 of your declaration, then to 43.

A. The Cotton example is two rhodium complexes coordinating with a central hexamethyl

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benzene organic compound. Yes?

Q. Correct.

A. So what is your -- sorry. I'm a little confused in the shift now. Can you repeat your question?

Q. Are you trying to draw an analogy between the trifluoroacetate rhodium complex and the W2(hpp)4 complex?

A. In a way I guess I am drawing an analogy in that rhodium, this dirhodium metal complex and rhodium, they are different from lithium and will prefer octahedral coordination, and this is an example showing that rhodium in crystal form -- that's what's being made here -- will eventually trend toward octahedral coordination with, in this case, a purely Pi system lacking a hetero atom, which in a sense is an analogy to the ditungsten compound, which also would prefer octahedral coordination in solid form.

Q. What's the electron density on the rhodium complex versus the tungsten complex?

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A. I'm not prepared to offer my opinions on that. Because it's a little bit outside what I've considered in preparing my declaration.

Q. So you have no opinion on the electron density on the rhodium complex versus tungsten complex; correct?

A. Not without doing further research.

Q. So you did not consider that?

A. Doesn't mean that I never will or would or could. It's just that I do not at this moment.

Q. And do you know the electron density -- strike that.

MR. GARR: She thought you said Siri. My phone started talking.

BY MS. ZHONG:

Q. What about the electron density of BPhen versus hexamethyl benzene?

A. Again I'm unable to offer my opinion on that because it's going to be very dependent on factors that I didn't consider in preparing my

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declaration.

Q. Do you think that instead of hexamethyl, if you have hexafluorobenzene, is it going to coordinate to the rhodium complex?

A. A perfluorinated benzene compound electronically would be substantially different than the hexamethyl benzene, but I'm not prepared to offer my opinion on exactly how the coordination would be affected when you replace this compound with a perfluorinated benzene compound.

Q. Do you think that it will even form a coordinated complex?

A. Again, without doing further research and consideration, I'm not able to offer an opinion on that at this moment.

Q. Do you think that it's going to form a complex with BPhen?

A. What would form a complex with BPhen?

Q. The rhodium, the dirhodium complex of Cotton, is it going to form a coordinate --

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strike that.

So instead of the hexamethyl benzene, can the dirhodium complex form a similar structure with BPhen?

A. Define similar. Are these two prepared under similar conditions? Because the complexes produced by Cotton '99 and in this figure that's on page 40 of my declaration were prepared in a very different way from the manner of preparation for the layers in the '223 patent.

Q. Under any conditions do you think it will form a similar complex?

A. The nature of the analogy that was made, though admittedly not explicitly, more implicitly, is to show that if these rhodium complexes with dinuclear cores, much like the dinuclear core of a ditungsten complex, can coordinate to a molecule such as hexamethyl benzene, then it would seem there is a chance of success that it would coordinate to a compound like BPhen, which not only possesses phenyl ring constituents, but also the phenanthroline unit,

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which has hetero atoms.

Q. Have you ever tried that?

A. Have I ever tried what?

Q. Have you ever tried to make a complex?

A. Between what and what?

Q. Dirhodium and BPhen.

A. Have I ever tried preparing a complex between this specific dirhodium compound and BPhen?

Q. Correct.

A. No, I have not.

Q. Have you ever made a complex between tungsten2(hpp)4 and BPhen and determined that it has a structure you have drawn on page 43?

A. This illustration that I produced and which is in part of my declaration is an example of a way that BPhen can bridge two dinuclear tungsten complexes in a way similar, let's say inspired by the teachings of Cotton, in a layer that one would make for an OLED where you are co-depositing tungsten2(hpp)4 with BPhen.

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You are going to form a very disordered system. The nature of interactions between the two compounds, whether in chain-like or network-like fashion that involve multiple, more than three, three or more I should say molecules, will take on numerous different orientations and coordin-, not coordinate -- different structures. And the important point of the illustration is that many of them will feature interaction between the tungsten, one of the two tungsten atoms and some part of the BPhen molecule.

Q. This is the only structure you illustrated, correct, in your declaration?

A. This is not the only structure that's illustrated in my declaration.

Q. What other structure did you illustrate?

A. There are numerous molecular structures in my declaration.

Q. For the tungsten/BPhen interaction.

A. So when it comes to exactly the

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tungsten complex and BPhen, yes, this is the only illustration that's in the declaration.

Q. Okay. And in this illustration you are intending to show there is a Pi interaction between the tungsten and the BPhen; correct?

A. My intention was to show an example of an interaction without being specific, without being limiting to the option of others, nor limiting that it has to be a Pi interaction.

Q. What is shown on page 43? What kind of interaction is shown there?

A. As I mentioned with respect to rhodium, but it applies here to tungsten, tungsten is, it's a relatively large atom and it valent electrons are relatively far from its core. It is being held in the oxidation state of two by four coordinating very strong anionic ligands, and it prefers octahedral coordination.

It is a quadruple bond, it has a signal bond, two Pi bonds and a delta bond. The delta bond is a very de-localized bond. But I wasn't being prescriptive on exactly how it's

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going to coordinate, and so that's why I'm really uncomfortable labeling it a Pi bond interaction, and just to call it a coordination and forming a chain, which is what a POSA would anticipate happening given the teachings of Werner and Ma and language from '223.

Q. Is it a dative bond interaction?

A. I don't want to label the interaction a specific type. I think there is danger in that, given the heterogeneity of interactions in a very disordered landscape of these molecule.

Q. So you are unwilling to call it this is either a Pi interaction or a dative bond objection?

MR. GARR: Objection.

A. I'm unwilling to label it as one or the other. That is correct.

Q. Or something else? Doesn't have to be dative, Pi; it could be something else?

A. That's correct.

Q. But you are just not willing to

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characterize the type of interaction?

MR. GARR: Objection. Form.

A. Because the film that is formed from each of these compounds is going to be so disordered and so complex, I am uncomfortable as a scientist stipulating it has to be one over another. Because this is an illustration of an interaction. Whereas, for example, the analogy of Cotton, to use your words, from 1999 and the figure on page 40 involving the dirhodium complex and hexamethyl benzene, is a structure that has been informed from careful creation of a single crystal and analysis of the structure of such a crystal, Which is very different from the systems being considered in '223 or in Ma or in Werner.

Q. Okay. So have you done any kind of characterization of the interactions between, possible interactions between BPhen and W2(hpp)4?

A. Yes.

Q. What experiments did you do?

A. Going back you said -- could you repeat the previous question, reporter?

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- - -

(Whereupon the following portion of the testimony was repeated by the Court Reporter:

QUESTION: Okay. So have you done any kind of characterization of the interactions between, possible interactions between BPhen and W2(hpp)4?)

- - -

A. The characterization doesn't have to be an experiment.

Q. So you did a simulation?

A. Characterization does not have to be a simulation.

Q. Did you conduct any calculation or experiment to determine the type of interaction between W2(hpp)4 and BPhen?

A. I have not conducted any experiment to determine the nature of the interaction between BPhen and W2(hpp)4.

Q. And the type of interaction -- strike that. Will the type of interactions, if any, depend, depend on the processing conditions?

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A. Absolutely.

Q. So there may be no interaction and some process conditions and there may be not interactions in some other, under some other process conditions; right?

A. Yes.

Q. Okay. And what is the process condition that Werner used to combine the two?

A. Werner discloses numerous options when it comes to carrying out, making a combination of the two materials, specifically described five options, A through E, which we went through a few hours ago.

Q. Okay. What is the joint vaporization conditions he used?

A. That's described in more detail, but on page 56, line 17A, talks about co-evaporation in a vacuum with a source for the matrix material and one source for the dopant.

Q. Does that necessarily result in interaction between the two materials? Any vaporization conditions are going to result in

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interactions between the BPhen and W2(hpp)4?

A. It depends.

Q. And does Werner talk about the specific conditions that he used for that?

A. They go into Werner, go into a little more detail about the ways in which one would carry out joint vaporization.

Q. Where?

A. I draw attention to that, on page 56, the building of the respective matrix material can be carried out by one or a combination of the following methods, one of which, A, includes co-evaporation. And then in the paragraph below the A through E list, includes evaporating the dopant in various scenarios.

Q. Okay.

A. And then in example two on page 62 explains that a compound, in this case zinc phthalocyanine, was doped with the metal complex chromium2(hpp)4, which we've already discussed this one, and that that one was produced by

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co-evaporation of the zincPc matrix and the dopant, the two materials in, quote, high vacuum, so in a vacuum environment.

Q. Okay. Example two doesn't include either BPhen or W2(hpp)4; right?

A. It does not include either BPhen or W2(hpp)4, but zincPc can be evaporated just like BPhen can be, and chromium2(hpp)4 can be evaporated just like W2(hpp)4 can be. So I think that's why it's included as an example and not a limiting embodiment.

Q. And depending on the specific compound that's involved in the evaporation and the evaporation condition, the degree of the interaction will vary, including no interaction at all; correct?

A. Can you repeat that, please?

Q. Depending on which, what -- so depending on the dopant and the matrix material and the exact process condition?

A. Which includes the ratio of the two?

Q. Yeah.

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A. Uh-huh.

Q. And the, the resulting film -- in the resulting film the dopant and the matrix material can have no interaction or a lot of interaction; correct?

A. I don't want to isolate to no or a lot, but I would say that depending on these conditions that you laid out, like the ratio of the two compounds, there could be other processing conditions of making this film, that it would influence the degree of interaction in the film.

Q. Okay. And the specific examples of processing conditions include sequential deposition; correct?

A. On page 56 in the B section, that includes sequential deposition and that is also one of the examples later on; example 3 on page 62, yes.

Q. And is zinc phthalocyanine, phthalocyanine or zincPc, is that an organic compound?

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A. It is.

Q. Even though it has zinc in it?

A. Organic compounds must have carbon/carbon bond.

Q. So you don't consider organic compound to be limited to the non-metal compounds? ZincPc is also a metal complex; correct?

A. ZincPc is also a metal complex, yes.

Q. And do you think that if you have a -- so zincPc can both be an organic complex and a metal complex?

A. Molecules can be classified in numerous ways. It's difficult to define a molecule as only have a singular, belonging to a singular group.

Q. Have you used a zincPc for electron transport layers for OLEDs?

A. Have I personally myself?

Q. Uh-huh.

A. I personally myself have not used zincPc as an electron transport layer for an

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OLED.

Q. Are you aware of it being used as part of the electron transport layer?

A. Yes. It is described as such in the Werner patent.

Q. For OLED?

A. Perhaps not for OLED, but zincPc is described in the Werner patent, example two, as being able to be doped n-type, therefore transport electrons with conductivities that went from -- it doesn't give the original conductivity, but it gives the conductivity of the doped medium and it's relatively high.

Q. Do you know whether that's the conductivity for electrons or for hosts? It just says conductivity.

A. Directing attention to the abstract of Werner, the invention relates to the use of a metal complex as an n-dopant for doping an organic semiconducting matrix material for modifying the electrical properties of the same; to provide n-doped organic semiconductors for

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matrix materials that have little reduction potential while achieving high conductivity.

Given the context of the abstract and the knowledge of a POSA that understands that chromium2(hpp)4 is an n-dopant, would have to presume, but admittedly its not explicit, that the conductivity that's being referred to is electron conductivity.

MS. ZHONG: We can take a break.

(Recessed at 5:10 p.m.)

(Reconvened at 5:23 p.m.)

BY MS. ZHONG:

Q. Back on the record.

Would a POSITA use low-vacuum condition to process W2(hpp)4 and a BPhen?

A. They certainly could.

Q. Would they? Not a question could, but would?

A. It would depend upon the aim of the experiment and layer that you wanted to be prepared.

Q. For Werner's application?

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A. For Werner's application, that is processing the materials at a lower vacuum is certainly a possibility.

Q. It's a possibility, but is it something that a POSITA would do?

A. So when I think about what a POSA would do, I think about whether one can expect a reasonable likelihood of success, and that depends upon the type of layer I want to make. If you are telling me from the layers made in Werner, then I would expect a reasonable likelihood of success for processing W2(hpp)4 and BPhen in a lower vacuum.

Q. Okay. So if BPhen coordinate to a single lithium2 compound, is that a chain-like structure or a network-like structure?

A. So you have a single BPhen and a single W2(hpp)4?

Q. Uh-huh.

A. Within with the definition of the '223 patent, that does not qualify as either a chain or a network.

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Q. Will lithium Q form a type of complex similar to the Cotton complex?

A. Will lithium Q and what?

Q. Will lithium Q and a BPhen form a structure similar to what Cotton reported for the dirhodium complex?

A. The Cotton '99 image?

Q. Yes.

A. Again it depends. If you are talking about the result of joint vaporization, just like tungsten2(hpp)4 with BPhen is unlikely to make this exact singular complex, but rather the heterogenous landscape of a bunch of different complexes, then I would give a very similar response to the formation of interactions between the lithium quinolate and BPhen.

Q. Okay. How likely is it, how likely is it for a two lithium Q complex to coordinate to the two nitrogen of BPhen?

A. How likely is it for two lithium quinolates to coordinate to the same two nitrogens on a single BPhen? Is that what you

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are asking?

Q. Correct.

A. I don't want to opine on likelihood, but I am willing to offer that again lithium would like to prefer tetrahedral coordination, and if that means two lithium quinolate compounds can satisfy such a situation through coordination to a single BPhen molecule, again in a very disordered landscape of molecules, I can't opine again on how likely, but I wouldn't exclude that as a possibility.

Q. So you don't know whether it's more than 50 percent likely, the likelihood is one in a billion, one in a million, one in a hundred, one in a thousand; correct?

A. Again I'm not going to opine on the likelihood. But I would draw your attention to the molecular density of something like 10 to the 19 molecules per cubic centimeter. It's many billions. 10 to the 16th is, or 10 to the 19th is so extraordinarily large.

Q. What, what BPhen reacts with

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lithium? What's the usual coordination? Does the lithium coordinate to both BPhen, both nitrogens on the BPhen or it tends to coordinate to two different nitrogens?

A. I think it would depend. Also, I'm not sure. Are you talking about lithium atoms, neutral, cations?

Q. Cations. Lithium Q.

A. Oh. Lithium Q. I see. Again I think there is going to be a very -- not I think, I know there is a very disordered landscape in the layers which will lead to many interactions between molecules. It is difficult to assert the relative weight of one over another in that mixture.

Q. What would a POSITA expect, the type of interaction that will predominate?

A. The POSITA would extract learning from Ma whereby the mixture of lithium quinolate and BPhen results in a more conductive layer and explanations that they provide to, which are consistent with those experimental observations,

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to form an opinion that, as Ma mentions, disorder invoked in the paragraph that you turned my attention to earlier in the day, and that the nature of the interactions are going to be broad and diverse, but lead to the formation of conducting paths, usually chains or networks, added conductivity that boosts the prospects of using the combination of lithium quinolate and BPhen in electron transport layer to convey electrons to the emissive layer and lead to a brighter and higher performing OLED.

Q. Okay. What about chemical bonds? What kind of chemical bonds would form in that interaction, if any?

A. There would be a donor/acceptor type charge transfer that could in some manifestations, not all, because there is a lot of disorder, occur between BPhen, which is the more, which is, you know, the one that's there at least initially in higher quantity and lithium quinolate.

Q. Would there be chemical bonds formed

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between nitrogen and lithium necessarily?

A. Again it's hard to specify the exact atoms within the compounds because these do contain delocalized orbitals, and I'm only offering that the orbitals will interact. Specific atoms is hard to provide an opinion.

Q. And when you say the atoms, the atoms can be the ligand and the organic compound; correct?

A. When I say atoms, I mean any of the atoms in either of the compounds. But I'm not comfortable being specific about the exact nature of the interaction in, between those two compounds.

Q. Are there cross-linking in the film formed by BPhen and lithium Q?

A. So adopting the definition of cross-linking in the '223 patent, which equates cross-linking -- I'm referring to column 13, line 65 to 67, that draws analogy between the degree of cross-linking and the formation of network-like or chain-like structures. So to the

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extent that lithium quinolate/BPhen mixtures form chain-like or network-like structures, then the degree of, meaning the concentration of such structures, does indicate a degree of cross-linking.

Q. And is the degree of that -- and is the degree of the interaction a function of the dopant to matrix material ratio?

A. It depends. But if we use the example of Ma, lithium quinolate and BPhen, and return ourselves to Figure 5 in Ma, Exhibit 1007, we can see that the ratio between lithium quinolate and BPhen is important in the overall conductivity of that layer. And as so far as conductivity requires conducting paths and conducting paths require some sort of network or chain formation, then, yes, the degree of cross-linking can be affected by the ratio of the two compounds.

Q. Does the conducting path depend on chain or network formation?

A. In some sense. You used the word

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yourself "percolation" earlier today, which invokes at least an image in what I think is POSA's mind of some collection of structures. We can say chain, we can say a network of perhaps linear chains, disordered though, that when dense enough and percolated will form conducting paths that bridge the ends of the film.

Q. And that path does not necessarily include the involvement -- but that path does not necessarily include coordination to the lithium compound itself, the lithium metal then to itself; correct?

A. The lithium compound's role in this is important. And as Ma shows, you can use lithium quinolate and BPhen to influence the conductivity of that mixture. So while I'm still hesitant to assign it to a specific atom, atom interaction of the molecule, the role of lithium quinolate in forming networks is provided through the teachings of Ma.

Q. And that interaction could be through the interaction of the BPhen with the

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quinolate part of the metal complex; correct?

A. Again, I don't want to assign a specific ligand or atom to the coordination compound. Because as I mentioned, these systems are very disordered. They might feature nearly as many interactions as there are molecules per cubic centimeter, and in such a landscape it's very hard to be strict about which segment or atom in a molecule's interacting with a segment or atom in a neighboring molecule.

Q. Did you do any study to see what type of interactions could exist or would exist?

A. Can you be a little more specific? I study a lot of things about interactions.

Q. Did you do any calculation or do an experiment trying to characterize the exact type of interactions between BPhen and lithium Q?

A. I have not myself carried out any experiments or simulations or calculations that get to the question of the exact nature of the interactions between BPhen and lithium quinolate.

Q. And instead of using lithium

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quinolate, if you used aluminumQ3, would you expect to see offering improvement in conductivity of the BPhen?

A. So you are saying if I did an experiment much like that in Figure 5, but instead of lithium quinolate, used Alq3 and ETL?

Q. Correct.

A. It's challenging to say a priori what that interaction is going to do, and so I'm not able to offer an opinion on that without conducting it myself.

What I can offer is that aluminum quinolate 3, Alq3, the aluminum atom is surrounded on all sides by quinolate ligands, which would limit interactions of that atom with the BPhen molecule. Now that doesn't preclude other interactions between Alq3 and BPhen.

Also, one needs to take into account that Alq3 is a better electron transporting material natively than either lithium quinolate or BPhen. Thus, I think the answer, there would be something that would happen. It's hard for me

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to offer an opinion on exactly what that result would be for the following rationale that I described.

Q. And you don't know the exact form that lithium Q exists in vapor phase or in a solid phase; correct?

MR. GARR: Object to form.

A. We know that when it's in the vapor phase it's gas; when it's in the solid phase, solid.

Q. What I mean is you don't know whether it's a dimer of the lithium Q, trimer of lithium Q, or monomer; correct?

A. I suppose there is no way to know for sure if this molecule forms dimers or trimers without further inquiry.

Q. So if it forms a dimer or trimer, would that limit its ability to coordinate to BPhen, limit the metal's ability to coordinate to BPhen?

A. I don't like using the word "limit", but I would say that if we have dimers or trimers

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of lithium quinolate, it would certainly influence the interaction that those clusters of molecule have with neighboring BPhen molecules compared to just considering the pair-wise interaction of a single lithium quinolate with a single BPhen molecule.

Q. But you did not study that as part of your declaration; correct?

A. No, I did not.

Q. What is an electron conducting layer in an OLED?

A. Can you give me a little bit more context?

Q. Claim number one of '223 recites electron conducting layer; correct?

A. It does. It refers to an electron conducting layer in an organic electronic component, of which an OLED is one type of organic electronic component.

Q. So in OLED, which layers are considered to be electron conducting layers?

A. Any that have an appreciable

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electron density while the device is in operation.

Q. So is in emissive layer, is the emissive layer an electron conducting layer?

A. An emissive layer does conduct electrons so that they are able to form excitons and eventually be emissive.

Q. So you consider that to be an electron conducting layer?

A. I would consider it to be a layer that conducts electrons. I'm not sure I would assign it a singular title, electron conducting layer.

Q. Do you consider electron transport layer to be an electron conducting layer?

A. The role of an electron transport layer is to convey electrons from a contact to either a blocking layer or the emissive layer itself, and as such the electron transport layer is an example of an electron conducting layer, yes.

Q. What is a central metal atom?

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A. Can you be a little more specific?

Q. Claim number one recites a metal complex which comprises a central metal atom; correct?

A. It does.

Q. So what is a central metal atom?

A. It's a metal complex that comprises a central metal atom.

Q. So what is a central metal atom?

A. It's the at least one atom inside that metal complex that is metallic.

Q. So your understanding of the central metal atom or a POSITA's understanding of a central metal atom in the context of '223 is any metal atom in a metal complex? Is that correct?

MR. GARR: Objection.

A. Again I wouldn't take such an extreme stance and say that it has to refer to any. And let me return to the '223 patent when they are describing in more detail the metal complex.

So in column two, the paragraph that

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starts the coordination of lines 19 to 27, expresses that the central metal atom should be any atom in the metal complex, but is one that has some coordination to ligands, but also able to accept further additional ligand.

Q. So under that understanding, is the lithium in lithium Q a central metal atom?

MR. GARR: Objection. Scope.

A. I have been informed by counsel that the patent owner, the patent owner of '223 has asserted that lithium quinolate is a metal complex which comprises a central metal atom and I have approached my declaration and all of the research I have done relevant to this case assuming this assertion is true.

Q. Do you have any reason to disagree with the assertion?

MR. GARR: Objection. Scope.

A. I have assumed that the assertion is true and I have never made any objections to that assertion.

Q. Do you have any objections to the

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assertion?

MR. GARR: Objection. Scope.

A. I have never offered any objections to that assertion that lithium quinolate is a metal complex. I have accepted that.

Q. And do you think that's a correct assumption -- or assertion?

MR. GARR: Same objection.

A. It is the one I made, because I was asked to, because the patent owner asserted it.

Q. Would you have made it if you were not asked to?

A. I would need to think about that. Because I did make that assumption, it wasn't something I devoted thought to and so I would have to do some research to properly answer that question.

Q. Based on your understanding as a person of ordinary skill in the art, would you consider lithium Q to be a metal complex comprising a central metal?

MR. GARR: Object. Scope.

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A. Again I was asked to assume that and so that is the way -- that is the only perspective to my consideration of lithium quinolate as a metal complex, is that it does contain a central metal atom.

Q. You can make the assumption, but you can disagree with it. Do you agree with that assumption or you find that assumption to be objectionable?

MR. GARR: Object. Scope.

A. Again I have never offered my opinion on whether or not lithium quinolate is a metal complex which comprises a central metal atoms because I was told that it -- I was informed by counsel the patent owner asserts that it is so, and so I assumed it is so.

Q. Well, you are a person of ordinary skill in the art. When you hear that assertion, do you find it to be a reasonable assertion?

MR. GARR: Scope.

A. I don't have any reason to assume otherwise.

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Q. When you say assume otherwise, what do you mean?

A. To assume that it's not reasonable.

Q. Okay. So you consider that to be a reasonable assertion?

MR. GARR: Object to form. Scope.

A. I accept the assertion that lithium quinolate is a metal complex which comprises a central metal atom.

Q. And you never said that you disagree with that assertion; correct?

A. I never gave it much thought.

Q. If it's unreasonable, you would have pointed that out; correct?

A. I like to think that I'm someone that will offer their opinion when asked.

Q. So you never disagreed with the position that lithium Q is a metal complex comprising a central metal atom; is that correct?

MR. GARR: Same objection.

A. To my knowledge I have not made such a disagreement. I accepted the patent owner's

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assertion that lithium quinolate is a metal complex comprising a central metal atom.

Q. And you did not look into the structure of the lithium Q; correct? You just assumed it's a monomer?

A. I did look at the structure of lithium quinolate and, in fact, I have it in my declaration, which would indicate that I have looked at the structure of lithium quinolate.

Q. You assumed it's a monomer; correct?

A. I assumed this is a molecule of lithium quinolate. I didn't make any assumptions regarding monomeric, dimeric, trimeric or oligomeric form.

Q. And you have no opinion on the percentage of the lithium Q material that exists in the monomer form versus trimer, dimer, tetramer or hexamer form; correct?

A. I do not have any opinions on the relative amounts of each of those forms in nature.

Q. Okay. And so it could be one

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molecule out of one molar of molecule?

A. Which is what? What about one molecule out of one mole?

Q. So, for example, you did not determine whether the monomer exists as one molecule out of the, like out of a one molar of the lithium Q, that you evaporate one molecule out of that molar exist monomer form or what percentage of the molecules exist in monomer form versus the other forms; right?

MR. GARR: Object to form.

A. I didn't give much consideration to the exact form of lithium quinolate.

Q. Okay. If you -- if the evaporation chamber has other gases besides BPhen and lithium Q, does that increase the collision frequency between BPhen and lithium Q?

A. It depends. What are these other molecules?

Q. Inert molecules. Argon, nitrogen.

A. A POSA would understand that having a fraction of inert small molecules like nitrogen

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or argon in the vacuum environment would aid collision in general and would slow down the path from evaporation source to substrate substantially, therefore offering more opportunities for collision of all types, which could include lithium quinolate and BPhen if those were two molecules that were also suspended in this vacuum containing lots of other inert tiny molecules like nitrogen and argon.

Q. And those collisions can be nonproductive collisions because they never reach the substrate; right?

A. Could be. Some of them could be, sure.

Q. And do you know the percentage in that -- do you know the percentage of those collisions that will reach the substrate versus let's say nonproductive collisions that just deposit elsewhere?

A. It's difficult to offer an opinion on the percentage of productive versus nonproductive collision in this environment.

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Q. So compared to a high-vacuum system with minimal amount of other gaseous species versus an environment where you purposefully added inert molecules, how does that affect the actual number of productive collisions between BPhen and lithium Q, for example?

A. It provides -- the gaseous species around provide very short free paths of the molecules between collisions, whether productive or unproductive. Whereas, if you have a high-vacuum environment devoid of any other gaseous species, those molecules are effectively taking a ballistic path from source to substrate, because it lacks lots of molecules around to potentially collide with.

Thus, the transit time from source to substrate -- strike that. The effective rate at which, because I don't know anything about the distance between the source and substrate, the rate at which molecules traverse the gap between source and substrate would be slowed by such collisions and those molecules would be provided

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substantial additional opportunities to collide whether productive or not. And again it's hard to offer an opinion on the percentage of productive versus nonproductive.

Q. And how would the resulting film quality differ?

A. It would depend upon the processing conditions used for those two very distinct methods of forming a film.

Q. Can you come to the conclusion that one is better than the other?

A. I'm unable to offer a conclusion for a given or generic set of compounds that one is necessarily better than the other. Better depends the molecules under consideration. I acknowledge I think we are going to say with lithium quinolate/BPhen. And will also depend upon the parameters for the device that one is, a POSA is trying to make and the thickness of the film one is trying to achieve, the efficiency with which one wants to convey organic matter from source to substrate. It depends on so many

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different factors that it's hard to give a straight up better or worse type of --

Q. For Ma's device.

A. For Ma's device I believe one could use either method to achieve a film that provided a result similar to that which Ma disseminated.

Q. You believe it -- did you do any -- what did you do to determine what is going to happen or not and which one would be a preferred method?

A. If I were someone approaching this, a POSA approaching making lithium quinolate and BPhen mixtures as a film, and I had both methods available to me, whether it's with a substantial background, gas, inert gas or whether it can be in a system devoid of molecules in a vacuum, high-vacuum environment, and I didn't know a priori which one would lead to a good outcome, I might be encouraged to attempt both to see when I try to make those films, if they result in a good outcome for my intended purpose.

Q. And can Ma's equipment do both?

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A. In Ma I don't know the particulars of the equipment that was used. What we do know is that it was fabricated by so-called conventional thermal evaporation in a high vacuum chamber with a base pressure of one times ten to the minus five torr.

Q. So can you do the low-vacuum evaporation?

A. Again I don't know the specifics of the equipment used by Ma, so it's difficult for me to offer an opinion on that.

Q. So you are saying that the high-vacuum evaporator doesn't necessarily lend itself to doing the low-vacuum deposition condition?

A. Yes. Systems should be configured in such a way so as to lend themselves to one processing condition or another and you can't say necessarily one piece of equipment can achieve both methods.

Q. In your experience can one piece of equipment achieve both?

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A. I'm not sure. I have to think about it a little more. It wasn't an aspect I gave a substantial amount of thought to, whether one could have a piece of equipment that readily, not something that could be done easily, could be converted from one to the other.

Q. And would a person of ordinary skill in the art evaporate BPhen and lithium Q from the same crucible?

A. It depends. If your intention was to prepare like Ma a sequence of films with different loading of BPhen and lithium quinolate, a POSA would not be encouraged to premix those compounds, but rather use a system that allows to deposit two materials together.

If one didn't have access to such a piece of equipment and the only option was an evaporator with a single source and they wanted to make mixtures that were co-evaporated simultaneously, they might be encouraged to use such an approach.

Q. Is there an advantage of using a

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single crucible rather than two different sources?

A. I think it depends on the nature of the investigation. There could be advantages or disadvantages.

Q. Ma's investigation.

A. Science is full of trade-offs. That's kind of the nature of what is done. That's the nature of engineering for sure. So I think it would just depend upon a lot of different conditions.

Q. In the context of Ma?

A. So again in the context of Ma, one of their intentions -- this is a paper with multiple things that have been displayed. But when it comes to the intention of producing Figure 5, and the knowledge that Ma has, an evaporator with independently controlled sources, two independent quartz sensors, then if someone had the exact same equipment set, the simplest method to provide, to produce the film, to measure similar data, would be to use the method

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of Ma.

Q. Okay. And you mentioned that you don't know the exact considerations Ma's evaporator; correct?

A. That's correct. I'm not informed on the exact measurements, specifications, types of sources, types of pump, volume of the chamber. I don't have an entire knowledge of the system that was used to produce the films in Ma.

Q. Okay. And you don't know the degree of mixing of the two sources in the vapor phase; correct?

A. Can you be a little bit more specific? The degree of mixing of the two sources in the vapor phase?

Q. You are going to have two streams?

A. Right. Now I understand. Okay. Can you continue?

Q. And you don't know the degree of mixing of those two streams; correct?

A. I think the word "mixing" is a little ambiguous, but I don't know the degree of

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overlap of those two plumes of vapor in Ma's chamber. What we know is that the chamber is configured in such a way that you have independent control of at least two sources and you have at least two independent quarts sensors that can monitor the deposition rate of each of those sources and maintain them at .5, plus or minus 2 angstroms per second.

And a POSA would know that the film that they state to be 50 nanometers thick was able to be so-called tooled, meaning provide a correspondence between the rate measured at the sensor and the thickness given the film, and because these films involve co-deposition, when the sensor, when you make a 50 nanometer thick film with BPhen and then you make a 50 nanometer thick film with BPhen with 33 weight percent loading of lithium quinolate, that those two films have very different amounts of BPhen. And yet the film is 50 nanometer thick.

So we have to know that there is some degree of mixing that went into preparing a

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film always 50 nanometer thick regardless of the stoichiometry, the mixing ratio between those two compounds.

Q. So how does a quartz sensor determine the thickness of the film?

A. It's really interesting old tech. So you have a piece of quartz, which is a crystal, and you prepare it as effectively a disk. You put gold electrodes on either side, which you can put a frequency, a voltage frequency on, alternating current and AC signal, and it resonates the quartz crystal in tune with its natural resonance.

When you load it, meaning when material deposits on it, because you are adding mass to it, you shift the resonance. And these things are unbelievably sensitive measures of how much mass is loading the sensor.

Q. So when you have two independently controlled quartz sensors, is one measuring the loading of lithium Q and the other one is measuring the loading of BPhen?

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A. Since you are asking the questions in very rapid succession, I just want to say I would like to pause after answering, because I haven't gotten an opportunity and I need to change my train.

Q. Okay.

A. Because it's less than an hour away and I do not want to be stuck. So after I provide this answer.

When you have two independent sensors, that means one sensor is only seeing, only sensitive to the flux of one source. And the other sensor is only seeing or sensitive to the flux of the other source.

So, for example, lithium quinolate and BPhen, one sensor is measuring the flux of lithium quinolate, the other sensor is measuring the flux of BPhen. But in order to calibrate the flux at the sensor to the flux at the substrate, you have to provide what's known as a tooling factor, which it's a ratio of how much matter lands here to how much matter lands here, meaning

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the quartz crystal monitor, to how much matter lands at the substrate.

And once that has been done, the POSA is able to deposit a film of whatever composition or flux or thickness of those two materials that the POSA would like.

I would like to take a break.

- - -

(There was a pause in the proceedings.)

- - -

BY MS. ZHONG:

Q. So when tooling it, so when they are tooling to make sure that the composition corresponds to what's registered by the quartz sensors, right; are they looking at the bulk property? Are they looking at the microscopic properties?

A. The way that it's normally carried out in my lab, which I think is typical of many labs and thus a POSA would do, is to look at the bulk property. You are assessing the total thickness of the film. You are not zooming in to

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the molecular level to make an assessment of the total thickness.

Q. Okay. So you are looking at the bulk composition of the lithium Q versus the BPhen when you were doing the tooling?

A. Yes. Additionally, you could look at the mixture to make sure it's 50 nanometers thick, which may be what they did. It's hard to say.

Q. We don't have enough information as to how they did it?

A. We do not.

Q. And if you have a 50 nanometer thick film with, I wouldn't say alternating layers of BPhen and lithium quinolate, but one does not deposit it at the same time, the bulk composition will be the same; right?

A. I'm not sure I understand. Can you rephrase?

Q. Okay. So the two plumes can hit the substrate at the same time, or they can hit substrate at different times, and when you end up

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with a 50 nanometer thick film, the bulk composition will be the same? You can't really tell?

A. You mean if the layer is deposited through co-evaporation versus sequential deposition?

Q. I wouldn't say sequential deposition, but even if sequential deposition, it wouldn't be able to tell the bulk property of the composition; right?

A. By eye probably not. But maybe even still because the materials are anion-tropic, they have different optical properties. Light is a very effective means of characterizing material. So I wouldn't go so far as to say you can't. I think if a POSA was so determine, I feel like it probably could determine both differences at the molecular level.

Q. But the composition-wise it will be the same; right? The relative amount of lithium Q versus BPhen?

A. The total amount of lithium Q versus

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total amount of BPhen would follow the knowledge of the quartz monitor. So that's not to say that, you know, locally microscopically it would have to be the same.

Q. And when they did the Figure 5, they are looking at the bulk, they are not really looking at the microscopic properties; right? And they're not looking at, for example, the optical properties of the material either?

A. There is no assessment of the optical properties of BPhen/lithium quinolate ETLs in Ma. The measurements in Figure 5 is a so-called electrical test measurement. They are measuring current versus voltage. They have knowledge of the cross-sectional area of their device. It's stated, as a good paper should do.

It's five millimeters by five millimeters. That's on page 811 in the experiment Section. So they can plot not just current versus voltage, which is the measurement they must conduct, but they can plot current density by dividing the current value by the

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area. Five by five millimeters or 25 millimeters squared, to determine the current density here listed in milli-amps per square centimeter and for 50 nanometer thick BPhen/lithium quinolate film in this electron-only device.

Q. There is no luminescence properties reported; right?

A. In Figure 5?

Q. In Ma's film in general? In the Ma paper in general?

A. I don't agree with that. There are luminescence properties that are measured here. We have, for example, Figure 3, which describes power efficiency in lumens per watt versus current density. The Y axis unit lumen is a measure of optical power. And so there is certainly a measurement of an optical property in this paper.

Q. With respect to the bulk percentage of lithium Q in that film; correct?

A. Can you repeat that?

Q. It is the different curves are based

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on the doping in the bulk material; correct?

A. So Figure 3 features combined optical and electrical measurements on five different devices; one that indeed doesn't have doping and the others that have different degrees of doping in them.

Q. And the doping level is for the bulk film; right?

A. Well, it's interesting because the doping is actually for two different layers. Ma goes beyond ETL, they also talk about HTLs, hole transport layers, and they use m-MTDATA, methylMTdata, and F4-TCNQ is the dopant.

And so in this figure they are fixing --they have either an un-doped device or the lithium quinolate loading in BPhen is 33 weight percent, which corresponds to the most highly conductive lithium quinolate/BPhen composite, as shown in Figure 5.

Then they are changing the F4-TCNQ doping and showing how that influences the response of the OLED. The reason it's

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interesting is that the loading of that 4-TCNQ is considerably lower in the MTDATA host compared to the loading of lithium quinolate in BPhen.

F4-TCNQ is used in only very small quantities. Whereas, lithium quinolate is used in higher, almost stoichiometric quantities. And the reason is that F4-TCNQ features so-called integer charge transfer.

When a charge is transferred from a very strong molecular oxidant or acceptor that is F4-TCNQ from MTDATA, P-doping ensues and it's a very efficient process.

In lithium quinolate and BPhen the doping process doesn't feature this integer charge transfer modality. But a POSA would know it isn't the only way to improve conductivity.

And so while one uses a very small amount of dopant, the other one a large amount, the two when used in unison operate best when each of those layers conveys a similar amount of charge carriers to the emissive layer as they show in Figure 6. Where they show that, they

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explain the performance of Figure 3 by showing that when the hole-only device current matches the electron current of the electron-only device, their device performance is optimized. It is a really nice example of something known as charge balance in OLED and its shown here very well.

Q. Okay. And the doping level is for the bulk layer; correct?

A. So again they are doping two different layers.

Q. Yes. The 0.3 weight percent, for example, is for the HTL, hole transport layer? I'll call it injection layer.

A. So are you referring to bulk doping of the MTDATA layer?

Q. Correct.

A. So the MTDATA layer with dopant, which is F4-TCNQ, is distributed throughout, because again this was a co-evaporated combination of MTDATA and F4-TCNQ.

Q. But the reported weight percent is for the bulk film; right?

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A. It's for the entirety of the film in weight percent, yes.

Q. The same as 17 weight percent, 33 weight percent for lithium Q? That's for the entirety of the ETL film; correct?

A. Both of those legends are referring to comparable things, yes. The overall in the film, this is the weight percentage of dopant in host.

MS. ZHONG: So thank you very much, Dr. Rand. I know it's a long day. This concludes the cross-examination. I don't know whether your counsel has redirect or you are free to go.

MR. GARR: Counsel agrees that it's been a long day and yet has a few questions. That being said, I will try to keep it brief.

BY MR. GARR:

Q. So counsel asked you various questions about LUMO energy levels. Do you remember that?

A. I do remember that.

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Q. And you were asked specifically about LUMO levels with respect to BPhen?

A. Yes.

Q. You testified that BPhen has a higher lying LUMO level than C60?

A. Yes.

Q. And you noted that at least in the Walzer paper BPhen has been identified as having a level around I think one half EV higher than VNPC?

A. Yes.

Q. Would the possibility that BPhen may have a higher lying LUMO level than either of these materials give you reason to modify your conclusion as to the obviousness of combining BPhen with W2(hpp)4?

A. It would not.

Q. Why not?

A. Because a POSA would know that there are substantial error in the determination of a LUMO energy, and when you have such substantial error, a POSA would still be inclined to attempt

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to see if there is success in the combination of W2(hpp)4 with BPhen.

In addition, given that a complete charge transfer event is not required to improve conductivity, if a POSA was inclined and willing to accept the use of more W2(hpp)4 in a mixture with BPhen, they would have a reasonable expectation of success to improve the conductivity of such a mixture.

Q. What's the reason why -- you mentioned -- strike that.

You mentioned complete charge transfer; right? How does complete charge transfer differ from other types of charge transfer?

A. Complete or integer charge transfer, that means that a complete charge has transferred from an electron donor to an electron acceptor. In the case of W2(hpp)4 and a host matrix, W2(hpp)4 is almost always going to be in the position of electron donor. And so complete or integer charge transfer would mean that W2(hpp)4

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becomes ionized, has lost an electron and it has given an electron to the acceptor, which becomes also ionized and anion.

So you have the cation of W2(hpp)4 and the anion of the other molecule and this leads to increasing conductivity for each of those integer charge transfer events in the medium. That's what I mean by integer or complete charge transfer.

Q. And what do you mean by partial charge transfer?

A. So with partial charge transfer, this involves the language of coordination where it's not a complete event of ionizing the molecules, but there is still a ground state interaction.

So instead of producing an ion pair or a salt, you produce something sort of in between whereby you still activated electrons in the compounds, therefore improving conductivity, but the amount of conductivity increase per loading of the dopant would be expected to be

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less compared to the integer charge transfer arrangement.

Q. How do these mechanisms with charge transfer err on the obviousness of combining BPhen and W2(hpp)4?

A. They don't change the obviousness of attempting their combination. But they might instruct the POSA to be open to attempting numerous combinations, stoichiometries, mixing ratios of the two compounds to explore that parameter space completely.

Q. How do they bear on the reasonable expectation of success, if any, with that combination of BPhen and W2(hpp)4?

A. It wouldn't change a POSA's reasonable expectation of success.

MR. GARR: Okay.

BY MS. ZHONG:

Q. Okay. Counsel asked you regarding the reasonable expectation of success of combining W2(hpp)4 and BPhen just now; correct?

A. Correct.

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Q. And do you know what is the loading of the W2(hpp)4 in BPhen before you can no longer get an acceptable film?

A. I am unaware of that loading threshold.

Q. Okay. And do you know is a loading -- do you know what is a -- do you know what is a loading needed for W2(hpp)4 for there to be appreciable charge, partial or complete charge transfer from W2(hpp)4 to BPhen?

A. A POSA would not necessarily be aware of where exactly that transition point might lie.

Q. Okay. And do you know whether the loading at which there is appreciable partial charge transfer from W2(hpp)4 to the BPhen at that loading, what kind of film quality you are going to get?

A. Again the films, I don't know what you mean exactly by quality, but these films are very disordered. But that shouldn't necessarily indicate to you that they are rough or riddled

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with holes or porous or something like that. They are certainly disordered and they might be any of those other things. I just can't say a priori.

Q. For example, you don't know how that loading is going to --

So you don't know what's the expected adhesion of the film to the adjacent layers at a loading where appreciable charge transfer is going to occur; correct?

A. I was not asked to opine on adhesive properties between organic film and that's an area of expertise that falls squarely within I would say the mechanical engineering discipline, which I don't have that knowledge base.

Q. Okay. When you make a device based upon your knowledge as a POSITA, is the adhesion between adjacent layers important?

A. It depends.

Q. For OLEDs in your experience?

A. It could. If you are making an OLED that is meant to be stretched or flexed, adhesive

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properties are certainly important.

Q. Okay. And if there is the adhesion is not good, there can be delamination upon heating during operation; correct? So there could be delamination, increase the stress?

A. Temperature is a stress factor when it comes to delamination, probably because of differences of coefficients of thermal expansion. Again, not my area, so I --

Q. So you did not --

A. I'm not able to give much insight in this line of questioning as a POSA with knowledge in that. That's not me.

Q. Okay. So it's not something you considered, for example?

A. No.

MS. ZHONG: Okay. No more questions.

MR. GARR: We are done.

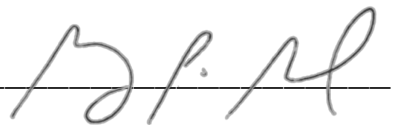
(Whereupon, at 6:47 p.m., the deposition of BARRY P. RAND, Ph.D. was concluded.)

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A C K N O W L E D G M E N T O F D E P O N E N T

I, BARRY P. RAND, Ph.D., do hereby acknowledge I have read and examined the foregoing pages of testimony, and the same is a true, correct and complete transcription of the testimony given by me, and any changes or corrections, if any, appear in the attached errata sheet signed by me.

5/1/2025
Date



BARRY P. RAND, Ph.D.

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UNITED STATES OF AMERICA)

ss:

DISTRICT OF COLUMBIA)

I, ROBERT M. JAKUPCIAK, an RPR and Notary Public within and for the District of Columbia do hereby certify:

That the witness whose deposition is hereinbefore set forth, was duly sworn and that the within transcript is a true record of the testimony given by such witness.

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

IN WITNESS WHEREOF, I have hereunto set my hand this April 16, 2025.



My Commission Expires:

February 28, 2029

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DAVID A. GARR

dgarr@cov.com

April 16, 2025

RE: Samsung Display Co., LTD. v. Pictiva Displays International

4/3/2025, Barry P. Rand, Ph.D., (#7280412).

The above-referenced transcript has been completed by Veritext Legal Solutions and review of the transcript is being handled as follows:

__ Per CA State Code (CCP 2025.520 (a)-(e)) – Contact Veritext to schedule a time to review the original transcript at a Veritext office.

_XX_ Per CA State Code (CCP 2025.520 (a)-(e)) – Locked .PDF Transcript - The witness should review the transcript and make any necessary corrections on the errata pages included below, notating the page and line number of the corrections. The witness should then sign and date the errata and penalty of perjury pages and return the completed pages to all appearing counsel within the period of time determined at the deposition or provided by the Code of Civil Procedure. Contact Veritext when the sealed original is required.

__ Waiving the CA Code of Civil Procedure per Stipulation of Counsel - Original transcript to be released for signature as determined at the deposition.

__ Signature Waived – Reading & Signature was waived at the time of the deposition.

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__ Federal R&S Requested (FRCP 30(e)(1)(B)) – Locked .PDF Transcript - The witness should review the transcript and make any necessary corrections on the errata pages included below, notating the page and line number of the corrections. The witness should then sign and date the errata and penalty of perjury pages and return the completed pages to all appearing counsel within the period of time determined at the deposition or provided by the Federal Rules.

__ Federal R&S Not Requested - Reading & Signature was not requested before the completion of the deposition.

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Barry P. Rand, Ph.D. (#7280412)

E R R A T A S H E E T

PAGE 32 LINE 9 CHANGE

change "N" to "n"

REASON transcriptional error

PAGE 32 LINE 11 CHANGE

change "PU" to "p"

REASON transcriptional error

PAGE 32 LINE 13 CHANGE

change "cell" to "solid"

REASON transcriptional error

PAGE 32 LINE 21 CHANGE

change "with" to "like"

REASON transcriptional error

PAGE 37 LINE 5 CHANGE

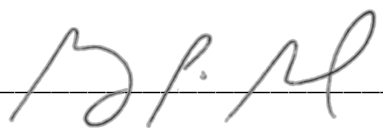
change "with quinolate" to "with lithium quinolate"

REASON transcriptional error

PAGE 49 LINE 1 CHANGE

change "gas" to "guest"

REASON transcriptional error



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(Barry P. Rand, Ph.D.) Date

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E R R A T A S H E E T

PAGE 56 LINE 20 CHANGE

change "pie" to "pi"

REASON transcriptional error

PAGE 65 LINE 18 CHANGE

change "includes" to "include"

REASON transcriptional error

PAGE 68 LINE 6 CHANGE change "specific of a type of form of bonding" to "specific type or form of bonding"

REASON transcriptional error

PAGE 72 LINE 22 CHANGE

change "very dated sense" to "very basic sense"

REASON transcriptional error

PAGE 92 LINE 9 CHANGE

change "absorb" to "adsorb"

REASON transcriptional error

PAGE 94 LINE 9 CHANGE

change "are quinolate" to "are lithium quinolate"

REASON transcriptional error



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E R R A T A S H E E T

PAGE 95 LINE 18-19 CHANGE

change “they're more Pi electrons” to “there is more Pi electron”

REASON transcriptional error

PAGE 102 LINE 4 CHANGE

change “flux” to “plus”

REASON transcriptional error

PAGE 112 LINE 16 CHANGE

change “which” to “with”

REASON transcriptional error

PAGE 116 LINE 21 CHANGE

change “Noveled” to “Novaled”

REASON transcriptional error

PAGE 120 LINE 21 CHANGE

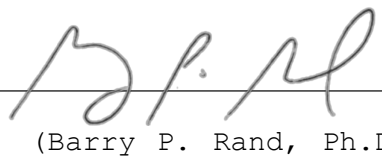
delete “Are you ready”

REASON transcriptional error

PAGE 134 LINE 16 CHANGE

delete “a”

REASON transcriptional error



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E R R A T A S H E E T

PAGE 152 LINE 7 CHANGE

change "the" to "be"

REASON transcriptional error

PAGE 181 LINE 22 CHANGE

change "stoichiometry" to "stoichiometric"

REASON transcriptional error

PAGE 184 LINE 17 CHANGE

change "233" to "223"

REASON transcriptional error

PAGE 188 LINE 12 CHANGE

change "233" to "223"

REASON transcriptional error

PAGE 196 LINE 14-15 CHANGE

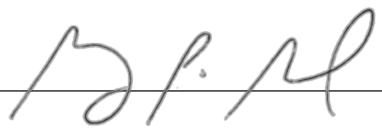
change "it valent" to "its valence"

REASON transcriptional error

PAGE 197 LINE 12 CHANGE

change "molecule" to "molecules"

REASON transcriptional error



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E R R A T A S H E E T

PAGE 214 LINE 17 CHANGE

change "atom, atom" to "atom-atom"

REASON transcriptional error

PAGE 214 LINE 18 CHANGE

change "molecule" to "molecules"

REASON transcriptional error

PAGE 235 LINE 5 CHANGE

change "quarts" to "quartz"

REASON transcriptional error

PAGE 235 LINE 8 CHANGE

change "2" to "0.2"

REASON transcriptional error

PAGE 240 LINE 12 CHANGE

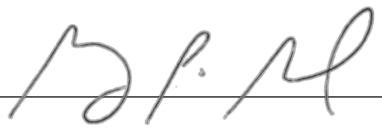
change "anion-tropic" to "anisotropic"

REASON transcriptional error

PAGE 240 LINE 16 CHANGE

change "determine" to "determined"

REASON transcriptional error



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E R R A T A S H E E T

PAGE 243 LINE 13 CHANGE

change "methylMTdata" to "methyl-MTDATA"

REASON transcriptional error

PAGE 233 LINE 1 CHANGE

change "4-TCNQ" to "F4-TCNQ"

REASON transcriptional error

PAGE 247 LINE 9 CHANGE

change "EV" to "eV"

REASON transcriptional error

PAGE 247 LINE 10 CHANGE

change "VNPC" to "ZnPc"

REASON transcriptional error

PAGE LINE CHANGE

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REASON

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Federal Rules of Civil Procedure

Rule 30

(e) Review By the Witness; Changes.

(1) Review; Statement of Changes. On request by the deponent or a party before the deposition is completed, the deponent must be allowed 30 days after being notified by the officer that the transcript or recording is available in which:

(A) to review the transcript or recording; and

(B) if there are changes in form or substance, to sign a statement listing the changes and the reasons for making them.

(2) Changes Indicated in the Officer's Certificate. The officer must note in the certificate prescribed by Rule 30(f)(1) whether a review was requested and, if so, must attach any changes the deponent makes during the 30-day period.

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