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

SAMSUNG DISPLAY CO., LTD.,	
Petitioner,	Case No. IPR2024-01093
vs.	
PICTIVA DISPLAYS INTERNATIONAL LTD.,	Patent No. 8,723,164
Patent Owner.	

REMOTE DEPOSITION OF RUSSELL J. HOLMES, PH.D.

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Reporter, Notary

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Exhibit 1016	Holmes et al., Efficient, deep-blue organic electrophosphorescence by guest charge trapping, 83 Appl. Phys. Lett. 3818-3820 (2003)	297
Exhibit 1017	Yang & Neher, Polymer electrosphosphorescence devices with high power conversion efficiencies, Appl. Phys. Lett. 84, 2476-248 (2004)	150
Exhibit 1018	Choulis et al., The effect of interfacial layer on the performance of organic light-emitting diodes, Appl. Phys. Lett. 87, 113503 (2005)	215
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Exhibit 1023	Djobo, et al., PVK deposited by evaporation for light emitting diodes thin film structures Synthetic Metals 122 (2001) 131-133	156
Exhibit 1025	Kanno, et al, white Stacked Electrophosphorescent Organic Light-Emitting Devices Employing MoO3 as a Charge-Generating Layer Adv. Mater. 2006, 18, 339-342	303

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(*Exhibits attached to transcript.)

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P R O C E E D I N G S

WHEREUPON,

RUSSELL J. HOLMES, 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, Dr. Holmes. Can you please state your name for the record?

A My name is Russell Holmes.

Q And you have submitted a declaration in this proceeding?

A I have, yes.

(Deposition Exhibit Number 1003 was marked for identification.)

BY MS. ZHONG

Q Okay. And is that Exhibit 1003?

A Yes, it is.

Q Okay. What did you do to prepare the declaration?

A So I read the patent in question, which is the '164 patent, Exhibit 1001, and then I also

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read and analyzed a variety of prior art references, both patents and academic literature, and then also used my knowledge based on a person skilled in the art at the time of the patent.

(Deposition Exhibit Number 1001 was marked for identification.)

BY MS. ZHONG

Q How much time did you spend in drafting the -- the declaration?

A I can say that across the two patents that I've been involved with so far, I've spent more than 120 hours on both cases. I don't off the top of my head know how much was spent drafting the declaration versus revising, meeting, so, unfortunately, I can't answer that without any more specificity than what I've offered.

Q Do you know how much time you spent on drafting -- strike that.

Do you know how much time you spent on this declaration versus the other one?

A No. As I -- as I just said, I'd have

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to go back and look at my time sheets to know that explicitly.

Q You said it's more than 120 hours. Do you know -- is it more than 130 hours?

A Again, that's -- that's all I can offer, unfortunately. I didn't prepare to give a detailed accounting of my time on the various activities for this case and the associated case I'm working on.

I can say it was -- it was a significant amount of time, though, significant amount of effort.

(Deposition Exhibit Number 1004 was marked for identification.)

BY MS. ZHONG

Q So you relied on a number of references, and one of them is Exhibit 1004, Choulis or Choulis. I don't know how to pronounce it.

A I've been pronouncing this Choulis.

Q Choulis. Okay. Who located the Choulis patent?

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A Among the -- I'm sorry. What was the rest of your question?

Q Who located the Choulis patent or application?

A The Choulis patent, I think, was actually one that I was asked to consider, but, frankly, of the exhibits, it's challenging for me to remember which ones I located and which ones were offered to me as well.

(Deposition Exhibit Numbers 1005 and 1006 were marked for identification.)

BY MS. ZHONG

Q I assume 1005 and 1006, which is a Japanese patent, Sugiura, that one was provided to you for consideration?

A Yes, it was.

(Deposition Exhibit Number 1007 was marked for identification.)

BY MS. ZHONG

Q Okay. And what about Thompson, Exhibit 1007?

A Again, I don't have a good recollection

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of where each exhibit came from, but it's quite possible that one was also provided to me.

Q And I assume for Yong, Exhibit 1008, you did not locate it yourself, correct? It's the --

A Correct. Translated as Exhibit 1009?

Q 1008 and 1009.

A Yeah. My recollection is that one was provided to me.

(Deposition Exhibit Numbers 1008 and 1009 were marked for identification.)

BY MS. ZHONG

Q Okay. How long have you been working in the OLED field?

A So I've been working in the OLED field since I was a graduate student at Princeton. I started my Ph.D. in the year 2000 and began working in the OLED field, basically, almost immediately after that, so about 25 years.

Q Who was your thesis advisor?

A My thesis advisor at Princeton was Professor Steve Forrest, who was at that point a

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professor of Princeton and now is a professor at the University of Michigan.

Q What did you working on -- what did you work on when you were a graduate student?

A Sure. I worked on a variety of topics as a graduate student, but in the area of OLEDs, I worked primarily on blue electrophosphorescence and then made contributing contributions to white electrophosphorescence as well.

In the context of blue electrophosphorescence, my work was really trying to get to -- among the first efficient blue phosphorescent OLEDs and also trying to realize blue phosphorescent OLEDs with color purity that would actually be suitable for -- for high-end displays.

But in addition to that, I also worked on areas including organic photonics related to the behavior of materials in optical microcavities, as well as some -- some other contributing contributions in other areas, too. But those are some of the areas that I worked on

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as a graduate student.

Q When you say --

MR. GARR: Russ, I'm going to suggest that you speak -- make sure you're slow enough for the court reporter to hear you.

THE WITNESS: Slow down? Sure. Yeah. No problem. Apologies for that.

BY MS. ZHONG

Q When you mentioned that you worked on blue phosphorescent color purity, what do you mean by that?

A So when making a display -- and in the year, you know, 2001, 2002, 2003, this was still early in the development of OLEDs, but when making a display, it's important to satisfy a few different constraints, and one of the constraints is to make sure that each of the pixels that is making up the image, the red, green and blue pixels, has a sufficient, say, quality of red, green and blue light to reproduce all the different color mixtures that are required when -- when making, say, a display for a

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1 television, a cell phone, whatever the case may
2 be.
3 The way one can think about it is if
4 the emission spectrum of your material or of your
5 LED is too broad, right? Take the extreme case
6 if your emission spectrum covers red, green and
7 blue all at once. Then it can't function as
8 just, say, a red pixel, just a blue pixel, just a
9 green pixel as effectively without additional
10 modification.
11 So, with color purity, we were trying
12 to develop and demonstrate emitters that could
13 emit, essentially, a pure form of blue light,
14 more blue, if you like.
15 Q At the time of your graduate research,
16 there were already known blue emitters, correct?
17 A Just in general blue emitters or blue
18 phosphorescent emitters?
19 Q Blue emitters in general.
20 A Yes. At the time of my graduate
21 research, blue emitters were known.
22 Q Do those -- do those ones have -- let

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me take one step back.

When you say you want to have, like, color purity for the blue phosphorescent emitters, you mean you want to have an emitter whose emissions spectrum is pretty narrow and is centered around the blue, right?

A You know, the -- obviously, the term "pretty narrow" is - is vague, but the idea is that you would want to either have it be narrower or shifted further into the blue, right?

There's multiple ways you could get better color purity. One would be to narrow an existing blue emitter. The other would be to pull the whole spectrum just further into the blue, right, without necessarily narrowing it.

Q Okay. So for -- let's set aside the blue phosphorescent light.

For those existing fluorescent blue light, do those ones have good purity, or do they also have -- or did their emission spectrum also tailor into the non-blue region?

A When you say "those" emitters, are you

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talking about today, or are you talking about in 2002? Can you please give some additional detail on scope there?

Q In the early 2000s.

A Early 2000s. So the question is: Were there commercially-suitable blue emitters?

Q What's your definition of commercially-suitable blue emitters?

A So there's -- there's -- so I guess maybe can you rephrase the question that you -- that you'd like me to answer, and then I'm happy to answer it.

Q Why don't you answer my question. What do you mean by commercially-suitable blue emitters?

A Sure. So a commercially-suitable emitter would be one that leads to an OLED that at first pass would be able to give an efficient electroluminescence, suitable color purity to reproduce the color gamut required for the application, and then some specification on device lifetime that again would be associated

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with the application. Those would be your initial, at that point in time, requirements on -- on how you make a device and evaluate a device.

But in 2001, 2002, blue emission was still a challenge, and so even just getting the efficiency was still something that was a significant point of active research.

Q What about color purity?

A What about color -- can you again phrase that -- are you asking -- what specifically about color purity do you want to know?

Q How was the color purity? Do --

A For --

Q -- they provide a satisfactory color purity?

A For what kind of materials or what kind of devices?

Q Any of the blue emitters back then.

A Any blue emitter?

Q Yes.

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A So, fluorescent materials, at the time, a subset of them would have likely had reasonable color purity that would have been, you know, probably blue enough to realize a significant part of the gamut that would be needed for display application.

As I said in my research, phosphorescent blue OLEDs were -- were still improving in that regard.

Q So for those fluorescent blue emitters, did they have issues with efficiency in lifetime?

A At that point in time, the challenge with fluorescent emitters was mainly efficiency. Lifetime wasn't even something being -- the efficiency was the primary challenge, and so I would say lifetime, if it was a problem, was -- was secondary because efficiency was not there yet.

Q Okay. Now, let's go back to the '164 patent. The '164 patent discusses matrix materials, correct?

A Yes, it does.

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Q And it also mentions emitter materials, correct?

A The '164 patent does mention emitter materials, yes.

Q Are emitter materials the same as matrix materials in the context of the '164 patent?

A So are you asking, is an emitter material a matrix material in the context of the '164 patent?

Q Correct.

A It can be, but need not be. It depends on the circumstances.

Q Can you point me to the '164 patent where it indicates the emitter materials can be the matrix material?

A I'm not necessarily pointing to a particular location where it says that. What I'm pointing to is that the only requirement to be a matrix material is that a material is a component of the matrix and, again, has particular energy alignment for the '164 patent.

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Q I'm asking you --

A It's most succinctly noted in claim 1, for example.

Q I'm asking you where in the '164 it used emitter material and matrix material interchangeably.

MR. GARR: Object to form.

THE WITNESS: And what I'm responding is, as a person skilled in the art, the term "matrix material" is not one that's routinely used in the literature, and so, when interpreting that term, you have to look at how it's being utilized in the '164 patent.

BY MS. ZHONG

Q So I'm asking you in the concept of the '164 patent where it is said the emitter material is a matrix material.

A And my answer is that I'm not pointing to a particular passage where it's said in that way. What I'm saying is, as a person skilled in the art, looking at how a matrix material is defined in the '164, it only requires a matrix

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material to be part of a matrix and to have a particular energy alignment, and an emitter could absolutely satisfy that requirement. And so the definition of a matrix material in '164 is broad enough that it does not exclude an emitter.

Q Where is the definition for the matrix material in the '164 patent?

A So in the '164 patent -- so the first note of relevance is just in the abstract of '164, where it simply notes the organic functional layer comprises a first, a second and third matrix material, wherein the first matrix material has a larger band gap than the second and third matrix materials.

That is a very clear and straightforward definition of the fact that a matrix material merely is a component of an organic functional layer that has some particular energetic requirements on the gap and, as noted clearly in claim 1, the HOMO and LUMO. And so, again, there is nothing in the '164 that precludes an emissive material from taking on

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that role.

Q Why don't you go to column 1, lines 20 to 29, in particular, starting from line 22, "Emission layers thereby have a matrix material, which is doped with emitter molecules."

Do you see that?

A I do.

Q Are you saying the emitter molecule is a matrix material?

A Not necessarily. When I answered your question initially, I said it could be, but it need not be.

And so, for example, if you look in the language of a claim 1, for example, claim 1 clearly defines three matrix materials and then says that this layer is an emission layer that is also doped with one emitter material. In such a layer, there's four materials, and the three matrix materials that are required for the claim are being already met by three materials other than the emitter.

But a person skilled in the art would

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not read '164 and see any language that excludes an emitter from being a matrix material. It just need not be a matrix material. It depends on the device that's being examined.

Q The '164 patent repeatedly used dope in -- doping in relationship with the emitter materials, correct?

A It does.

Q Okay. One example is 3, 61 to -- column 3, line 61 to 63, correct, which reads --

A Hold on. Let me --

Q -- "the organic" --

A -- just find it. You said column 3, line 61, "the organic functional layer"?

Q Yes.

A Uh-huh. "Can be doped with at least one emitter material."

Q Yes. So it says, "The organic functional layer can be an emission layer and be doped with at least one emitter material," correct?

A I see that entry, yes.

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Q So, emitter material, the organic -- the emission layer is doped with the emitter material, correct?

A Yes. And I'll also draw your --

Q Does it ever say the emission layer is doped with a matrix material?

A Yes, it does.

Q Where does it say that?

A Column -- column 8, line 62.

"By doping an electron transport material, for example, BCP, the relative transport characteristics can be adjusted."

BCP is serving as the matrix material. It's the electron transport or the third --

Q Okay. It is --

A -- matrix material.

Q So it --

A So I'll just -- I'll just finish that -- that response.

And so, if you look through the '164, the term "doping" is actually used very much how it is in the broader literature, which simply

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means to add an impurity into the layer, and you'll see that in the other exhibits that -- that I cite. The term "dopant" does not necessarily mean emitter. It simply means that you're doping; you're adding an impurity into the layer.

Q I understand that. So let's go to that particular language. It does not say by doping BCP. It's doping in an electronic transport material, for example, BCP, right?

So the doping occurs in BCP, and BCP is not a dopant, correct?

A No, I would not say that's correct.

Q It says, by --

A You --

Q -- doping --

A You --

Q -- in an electronic transport material, for example --

A Right. You are --

Q -- BCP.

A You are doping it in to the matrix.

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Q Yes.

A Right. You are not --

Q So the --

A It -- it -- so it -- BCP is what is being doped into the matrix. The term "doping" is simply meaning to add an impurity, and so it's saying, by doping an electron transport material, right, by adding in an electron transport material, for example, BCP, the relative transport characteristics can be adjusted.

It is not talking about by doping in some unknown foreign additional material into BCP, the electron transport characteristics can be adjusted. It's saying, by doping in BCP, an electron transport material, you can further adjust the electron transport behavior of that functional emissive layer. So it's -- it's the verb of doping it in, doping in a material here, BCP.

Q So is BCP a matrix material?

A In this case, when BCP is added as an electron transporter, it would be a suitable

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third matrix material, potentially. Again, it all depends on what the relative alignment of the associated materials are, and claim 1 is -- is clear in describing what that alignment should be. But as an electron transport material that has potentially appropriate alignment, BCP could be matrix material 3.

Q Okay. And where in the '164 is the emitter material ever described as a matrix material?

A As I answered previously, I don't have a particular passage that I'm pointing to to make that assessment, and I'm also not saying that the emitter material is always a matrix material. It obviously depends on the different materials that are present in the layer which one is the matrix material and which one need not be a matrix material.

It's just there's nothing in the '164 that prevents the emitter from being a matrix material because all one has to have to be a matrix material is be a component of the matrix

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and have whatever the prescribed energy alignment is to satisfy the claims.

Q So your position is that a matrix material is just a component of a matrix?

A A matrix material is a component of a matrix, yes.

Q And so a dopant is a component of a matrix, and that's also commonly understood to be a matrix material?

A No. So, again, I'll first just highlight again what I said earlier, which is this term "matrix material" is not widely utilized in the literature, and so in the context of the '164, a matrix material is a component of the matrix.

And a guest emitter species -- and I don't want to use the term "dopant" because we've already talked about how that's not, you know, consistently defined necessarily. Doping is an action. The guest emitter species is also a component of the matrix and could be a matrix material, but in the '164, matrix material comes

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with additional energetic requirements, and so that's -- you know, that's why it's not always necessarily the case that it's going to be a matrix material.

MS. ZHONG: I have put Exhibit 2100 in Dropbox.

(Deposition Exhibit Number 2100 was marked for identification.)

BY MS. ZHONG

Q Exhibit 2100 is U.S. Patent No. 10,333,070 to Mark Thompson.

Do you --

A Did you just --

Q -- see it?

A Not yet. Did you just add it to Dropbox, or would it already have been there?

Q I just added to it. You may need to refresh the folder.

THE WITNESS: Okay. How do I -- what do I do here? How do I refresh the folder? I'm seeing 16 days ago.

MR. GARR: Just reload.

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THE WITNESS: Hit this and reload it?

MR. GARR: I guess.

THE WITNESS: 14 -- 14 hours ago. Okay. 2100?

MS. ZHONG: Yes.

THE WITNESS: Yes. I am opening it now. Okay. I can see it.

BY MS. ZHONG

Q Okay. Can you please go to column 8, lines 4 to 7?

A Line 4, you say?

Q Yeah.

A Okay. So the sentence starting "dopants"?

Q Correct.

A Okay. I see it.

Q So that sentence states, "Dopants can be present in the organic matrix material in an amount sufficient to increase conductivity relative to undoped organic matrix."

Do you see that?

A I see that.

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Q You see the use of "matrix materials" in this patent?

A I see the words "matrix material" in the sentence, yes.

Q And what is your understanding of organic matrix materials in this context?

MR. GARR: Object.

THE WITNESS: I -- there's no way I can render an opinion on the context of what matrix materials means in this patent only reading one sentence. I've never seen this patent before in my career.

BY MS. ZHONG

Q Okay. And here it -- it notes that dopants are present in the organic matrix materials, correct?

A It does say, "Dopants can be present in the organic matrix material," yes. That's a direct quote from line 4, correct.

Q Okay. So it contrasts the dopants from the matrix materials, correct?

A It -- you said it what? It --

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Q It contrasts the dopants and the matrix materials, correct?

A Again, I'm not going to render an opinion on what dopant or matrix material means in this context reading only one sentence. I -- I haven't analyzed this document, and so I'm not going to -- to provide an opinion on the fly for just -- for just a couple sentences from a -- from a patent.

Q Just from a pure grammatic point of view, are the dopants -- can the dopants be the same as the organic matrix materials?

A Well, again, if I'm looking at, for example, the '164, matrix materials are clearly being doped into a functional layer, and so that's a context where the word "doping" is being utilized for matrix materials.

I would have to read this patent to understand the context and the proper usage of those terms here in that patent. I don't know if it's being used in the same way or not.

Q Okay. And -- but you said organic

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matrix -- matrix material is not a term used --

A The term matrix -- the term "matrix material" is not one that is widely utilized.

Q Okay. But here is an example where matrix material is used, right, by Mark Thompson?

A The word "matrix material" is being used, but I don't know if it's being used with the same context. I'd have to --

Q Okay.

A -- read it --

Q And --

A -- in more detail.

Q -- Mark Thompson was a collaborator with Professor Stephen Forrest, correct?

A Yes.

Q And so Mark Thompson is at least a person of ordinary skill in the art, correct?

MR. GARR: Objection.

THE WITNESS: Mark Thompson would by the definition of what's going on in this case be a person of ordinary skill in the art.

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BY MS. ZHONG

Q Okay. And can you also go back to column 4, lines 4 to 10?

A In this Exhibit 2100?

Q Correct.

A Okay. You said column 4 --

Q The sentence --

A -- line --

Q Line 4 --

A -- which?

Q Lines 4 -- sorry. Lines 7 through 10. So the sentence starting with "the present invention" --

A I see the sentence.

Q -- "provides for" --

A Yes.

Q -- "inter alia, charge carrier transporting material containing an organic matrix (or host) material into which an organic or organometallic compound is doped."

Do you see that sentence?

A I see that sentence, yes.

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Q And in this sentence, Dr. Thompson is equating organic material -- strike that.

In this sentence, Dr. Mark Thompson is equating organic matrix with a host, right?

A Again, I'm not going to render an opinion on those terms, but parenthetically saying "or host" does appear that they're making a connection between matrix material and host.

Q Okay. So they're equating matrix material as a host material?

A So --

MR. GARR: Objection.

THE WITNESS: Again, I can't render an opinion that is that firm based on only one sentence. I can see that in this sentence, clearly, there is a parenthetical call-out to "or host," but to understand the full connection between those terms, I would need to certainly go over the whole patent and better understand exactly what they're getting at.

BY MS. ZHONG

Q In the sentence, they are linking the

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organic matrix material with the host material, correct?

A In this sentence, without rendering an opinion on the document, I agree that "or host" is being parenthetically cited after organic matrix. How tight the linkage between matrix and host is being applied in the whole document, I can't comment on because I haven't read this document.

Q Okay. So when you rendered the opinion regarding the plain and ordinary meaning of the organic matrix -- strike that.

When you rendered the opinion of matrix material, you did not really look at the literature of its usage; is --

MR. GARR: Objection.

BY MS. ZHONG

Q -- that fair?

MR. GARR: Objection.

THE WITNESS: You're asking, have I looked at the literature to consider the usage of matrix material?

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BY MS. ZHONG

Q Yeah, as a person of ordinary skill in the art would understand it.

A My -- my decisions and my opinions are absolutely based on my understanding of the literature and my experience in this field.

Q Okay.

A I did not --

Q Let's --

A I did not examine -- I did not examine this particular document, though.

Q Okay. And let's look at a few more documents.

(Deposition Exhibit Number 2101 was marked for identification.)

BY MS. ZHONG

Q Can you refresh Dropbox and see whether you have Exhibit 2101, which is U.S. Patent No. 8,679,647?

A Exhibit 2101?

Q Yes.

A Yes, I have, and I'm opening it now.

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Q Okay. And this is a document to Merck Patent GmbH, correct?

A Yes. The assignee is Merck Patent GmbH.

Q And Merck also makes --

MR. GARR: I'm still downloading --

BY MS. ZHONG

Q -- OLED materials --

MR. GARR: -- the document.

BY MS. ZHONG

Q -- correct?

MR. GARR: I just want to make sure I can get the document. What is it? 2101?

THE WITNESS: 2101.

MS. ZHONG: 2101.

MR. GARR: Yeah, I'm just downloading it. Just give me a second so I can pull it up.

MS. ZHONG: Let me know when you have it. Do you have it?

MR. GARR: Yes, I do. Okay. Go ahead.

BY MS. ZHONG

Q Okay. And Merck makes OLED materials,

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correct?

A I'm not familiar with what Merck is making these days. They have certainly been active in the past in OLEDs --

Q This --

A -- but, yeah.

Q This was back -- this patent was filed in 2009?

A So, clearly, at this point, they were researching OLED materials.

Q Okay. And those researchers would be considered persons of ordinary skill in the art, right?

A That I certainly can't comment on. I don't know these researchers, and I don't know their backgrounds.

Q You don't think that they have several years of experience in OLEDs?

A I don't know that for a fact, no.

Q And so you don't know -- think that the skill sets reflected by inventors in OLED fields reflected the skill sets of the persons of

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ordinary skill in the art?

A No. The question you asked was, would I consider these people persons of ordinary skill in the art, and to formally apply that definition as is noted in the documentation here, I need to know that they have three years of relevant experience beyond their bachelor's training. It's quite possible someone could have contributed to a patent and not had three years of relevant experience, so I'm applying that definition here.

So if I don't know what their background and training is, I can't with certainty say they're a person skilled in the art.

Q Okay. Do you -- is it your opinion that the -- that this patent document does not reflect the skill set of -- or understanding of a person of ordinary skill in the art?

A Can you rephrase your question?

Q Is it your opinion that Exhibit 2101 does not reflect the understanding of a person

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by -- strike that.

Is it your opinion that this document, Exhibit 2101, does not reflect the skill level or the understanding by a person of ordinary skill in the art?

MR. GARR: Objection. Form. Mischaracterizes.

THE WITNESS: No. My -- my opinion was based on the specific question of whether these individuals are persons of skill -- skill in the art at applying the definition of what a person skilled in the art is based on the document. I don't want to make any assumptions specifically for any of these individuals.

I can certainly say that Merck was working in this field at the time, but, again, if I don't know who these individuals are and don't have a good sense of their backgrounds, it's harder for me to say with certainty that they would meet the spec of a person skilled in the art.

Q Does this document reflect the

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understanding of a person of ordinary skill in the art?

A So, again, I've never seen this document or read it. That's hard for me to say.

Q Are patent documents supposed to reflect the understanding of a person of ordinary skill in the art at the time of the filing, at least?

A I don't know if there's a particular legal definition of -- of whether or not that necessarily would be the case. That's certainly an assumption one can make.

Q Okay. So why don't you go to column 89 and -- which is PDF page 47.

A All right. Column 89. Is there --

Q Yeah.

A -- a particular line?

Q Lines 50 to 52.

A So "all materials"?

Q It's actually the next sentence.

"The emission layer here always consists of a matrix material (host) and a

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dopant, which is admixed with the host by co-evaporation."

Do you see that sentence?

A I do.

Q And do you see that in the sentence after the matrix materials, there's a bracket, "host"?

A I see that.

Q Okay. So are the inventors linking the matrix materials with host in the sentence?

A In this sentence, the word "host" being parenthetically cited after matrix material potentially is being linked to matrix material, but, again, I haven't reviewed this document as a whole.

Q Okay. And are -- matrix materials and dopant in the sentence is again listed -- are listed separately, correct?

A They are listed separately in this sentence.

Q Okay. And that would convey to a person of ordinary skill in the art, they're

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referring to two different substances, correct?

A They would be referring to two different components of the film.

Q Okay. So here is another example where matrix material is used, correct?

A The word "matrix material" is present, yes.

Q Okay. And column 85 also mentions matrix material and dopant? For example, column -- column 85, lines 15 through 18.

MR. GARR: What lines?

THE WITNESS: 15 through 18. The sentence, "It is possible here," is that what you're referring to?

BY MS. ZHONG

Q "It is possible," yes. The sentence starting with "It is possible here."

A That sentence also lists the terms "matrix materials."

Q And dopants separately --

A And --

Q -- correct?

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A And -- and dopants.

(Deposition Exhibit Number 2102 was marked for identification.)

BY MS. ZHONG

Q Okay. Can you please refresh your Dropbox link and see whether you see an Exhibit 2102, which is U.S. Patent No. 10,586,926, assigned to Novaled GmbH?

A Yes, I see it.

Q Okay. And --

A Yeah. I have it open.

Q Okay. Do you know any of the inventors?

MR. GARR: Can you give me a second? It's still --

MS. ZHONG: Sure.

MR. GARR: -- loading on my computer. Okay. I have it.

THE WITNESS: Your question, do I know any of the inventors?

MS. ZHONG: Correct.

THE WITNESS: I don't think I know any

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of these inventors.

BY MS. ZHONG

Q Okay. You know of Novaled GmbH, correct?

A I am familiar with Novaled.

Q And they were -- at least back in 2008, they were heavily engaged in OLED development, correct?

A They were engaged in OLED development.

Q Okay. And can you read the abstract to yourself?

A I'm just going to read that again. It's written in a bit of an odd way.

Okay. I've read the abstract.

Q Okay. The abstract mentions organic semiconductor matrix material, correct?

A It does.

Q And it mentions doping this organic semiconductor matrix material with certain compounds, correct?

A It mentions using these listed compounds as a doping agent for doping an organic

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semiconductive matrix material.

Q So the doping agent and the semiconductive matrix materials are two distinct components, correct?

A There is an act of doping the semiconductor matrix material as defined here. Again, I'm -- all I have read is the abstract, so it's hard --

Q Okay.

A -- for me to render a more general opinion.

Q And in this context, the doping agent is not the semiconductive matrix material, correct?

A It doesn't say that it's not the semiconductive matrix material.

Q Well, you are using doping agent for doping the semiconductive matrix material, correct?

A That's correct. The doping agent is doping the semiconductor matrix material, but as I said earlier on in discussing the '164, the

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term "doping" can also merely mean the act of introducing an impurity, and so I'm not prepared to apply any additional limitations only reading the abstract of this document.

Q So the doping agent and the component that is being doped are distinct, correct?

A The sentence that you're pointing to is calling out the doping agent and the semiconductor matrix material.

Q Okay. And those are not the same, correct?

A That I can't conclude from the abstract. I would have to read the document and better understand the various ways in which doping agent is used and the various ways in matrix material are used.

And I think the example of why it's important to see that document is based on the discussion we've already had of the '164, where an emitter -- and, again, I prefer to use the term "emitter" rather than dopants since dopant can be vague -- where the emitter can be a matrix

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material depending on the energetic alignment that exists with the other materials in the film.

Q So is it your opinion that a doping agent that is used to dope the organic semiconductor matrix material is part of the semiconductor matrix material?

A I'm not offering any opinion on this abstract or this patent. I haven't examined it beyond what I just read in the abstract, so I'm not prepared to offer an opinion on this document or how it's using these terms.

Q Now, just applying your knowledge and common sense, is a doping agent the same as the organic semiconductor matrix that it is used to dope?

A Again, I can't provide an opinion just based on reading the abstract, and even applying just my knowledge or common sense just requires me to first examine the document and examine any associated documents that might be relevant.

Q Is there any circumstances in which -- under which the doping agent used to dope an

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organic semiconductor matrix material is the same as the organic semiconductor matrix material --

A In the context --

(Inaudible crosstalk.)

Q -- used to dope --

A In looking only at this sentence and only at those words, the doping agent is being used to dope the organic semiconductor matrix material.

Q So is the doping agent and the matrix material the same, or are they distinct entities?

A Again, I can't comment further on that without knowing what this document is actually professing to do.

Q Okay. What do you mean by doping a matrix material?

A So the --

Q Can you --

A -- act of dope -- so, again, I will -- I will define the term "doping" outside the context of a matrix material to avoid any confusion. But the act of doping a material in a

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film is the act of including an impurity in the film.

Q Okay.

A There is no need --

Q So the act --

A There is no need to attach the term "matrix material" to define the term "doping".

Q So the act of doping an organic semiconductor matrix material is to introduce into the semiconductor conductive matrix materials an impurity, correct?

A So, again, as I just said, I would prefer not to convolute the term "matrix material" into the definition of doping because it's not necessary to understand doping.

Q I'm talking --

A This --

Q -- about this particular sentence. It's talking -- it's talking about doping an organic semiconductive matrix material.

A So, again, without rendering an opinion on this document, doping agent for doping an

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organic semiconductor matrix material is suggesting -- the word "doping" is suggesting you're introducing an additional material into that film.

Q Okay. So the doping agent is an additional material to the semiconductive matrix material, correct?

A The way I would read that is the doping agent is an additional material into that film.

Q Okay.

A But the context of matrix material, especially in regards to the '164, which is most relevant here, is not prescriptive as to whether or not an emitter material is excluded from being a matrix material, and, in fact, it is inclusive provided it is a member of the matrix and also has the right energy alignment to meet claims.

Q Okay. Why don't we go to column 2, lines 20 to 24.

A All right. Same document?

Q This same document.

A Yeah. So starting with "the energetic"

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or "semiconductive"?

Q "The energetic positions of the HOMO of the matrix material and of the LUMO of the doping agent are decisive for the doping effect."

A Uh-huh.

Q Okay. So, again, the matrix material and the doping agent are two different substances in this sentence, right?

A The doping agent and the matrix material are two different molecular species. Again, I haven't read what the actual matrix materials and doping materials are, but I would interpret that they would be two different molecules.

(Deposition Exhibit Number 2103 was marked for identification.)

BY MS. ZHONG

Q Can you please refresh your folder and see whether you have Exhibit 2103 --

A Sure.

Q -- which is U.S. Patent No. 8,119,037?

A Yeah, I see the document.

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Q Okay. And this patent is again assigned to Novaled, correct?

MR. GARR: Yeah, so I'm just downloading it. Hold on a second, please.

Okay. I have it.

THE WITNESS: Your question was, is the assignee Novaled?

MS. ZHONG: Yes.

THE WITNESS: Yes, the assignee is Novaled.

BY MS. ZHONG

Q Okay. And do you know any of the inventors?

A No, I don't know these inventors.

Q Can you please go to column 3, lines 13 to 18. So it's the --

A An electronic --

Q -- i -- yeah, subpoint i.

A I see it. Would you like me to just read that passage or --

Q Yes.

A Okay. Okay. I've read the passage.

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Q Okay. So this passage, subpoint i, again mentions organic semiconductive matrix materials that is doped with at least one dopant in order to change the electrical -- electronic properties of the semiconductive matrix materials; is that correct?

A Yes, that's what the sentence reads.

Q Okay. And, again, in this context, the semiconductive matrix materials and the dopant are two different species, correct?

A So, again, I haven't read the whole document. I'm not familiar with the document. I don't know what species are listed for each, but it does imply that one material is being doped into the other, added as an impurity into the other.

Q And a dopant is the material that's added into the matrix material, correct?

A By virtue of being doped, the dopant is being added.

Q And so this is another document where matrix materials appears and is used, correct?

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A The word "matrix material" is here in this document, yes.

(Deposition Exhibit Number 2104 was marked for identification.)

BY MS. ZHONG

Q Okay. Can you refresh your folder to see whether you see Exhibit 2104, U.S. Patent 8,212,245?

A Yes, I see it.

Q And this is another document -- patent to Novaled, correct?

THE WITNESS: I'll just wait for counsel to pull it up as well.

MR. GARR: 2104?

THE WITNESS: Yes, 2104.

MR. GARR: It's downloading. Okay. I have it.

THE WITNESS: Your question was, again, is this a Novaled patent?

MS. ZHONG: Correct.

THE WITNESS: Yes. The assignee is Novaled.

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BY MS. ZHONG

Q And you don't know any of the inventors, correct?

A I don't know the inventors, no.

Q Okay. And can you please go to column 12 lines -- starting lines 41 to 45, the sentence that reads, "On the one hand, the electron-conductive layer of the organic semiconductor device can be made of matrix material and dopant precursors substantially homogeneously embedded therein."

Do you see that?

A I do.

Q Okay. So the matrix material and the dopant precursors are two different materials, right?

A Again, just as we've discussed several times, I don't know what materials are being called out here, per se, but here the dopant precursors would be added to the film --

Q Okay.

A -- the act of doping.

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Q And the dopant precursors are embedded in the matrix material, correct?

A They're -- they're -- again, they would be doped into the film, right, but without knowing more about matrix material and dopant, it's challenging for me to say anything further or render an opinion on this.

But this sentence would imply that the -- potentially that the dopant is being doped into the film, which contains the matrix material.

Q Okay. And the sentence says the dopant precursors substantially homogeneously embedded therein, and therein means that the dopant precursors are embedded in the matrix material, correct?

A You're asking, again, are the dopant precursors embedded in the matrix material?

Q Correct.

A So, in this sentence, again, not knowing what is being used as matrix material, not knowing how matrix material is being defined,

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this sentence implies that dopant precursors are being added homogeneously.

Q Okay. What does it mean by embedded therein?

A Embedded therein?

Q Uh-huh.

A So, again, I don't know if there's any particular language that's been added to these terms in the context of these patents or this patent. My opinion as a person skilled in the art would -- homogeneously embedded would mean uniformly distributed or somewhat uniformly distributed, but --

Q And what I mean is, when it says "embedded therein," what does therein refer to?

A So it -- within the film.

Q Within the matrix material film?

A Based on this sentence, that's really all I can conclude, but I'd have to go and look at the whole document to better understand --

Q When you say --

A -- what's --

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Q -- that's all you can conclude, what is the conclusion again?

A Well, this -- you're asking me to make a conclusion or -- or offer an opinion based on reading just one sentence here. And I don't know how matrix material has been defined in the previous paragraphs, nor do I know how dopant precursor has been defined.

So it's challenging to say anything definitive about how these terms are actually being used and what their relevance and connection would be to the '164, where things are -- are very well defined and discussed.

So I'm struggling to say more than I am because I don't know this document, and I don't know how these terms are being used.

Q So, in this sentence, is your understanding that the dopant precursors are embedded in the matrix material?

A If I read just this sentence in isolation without any context whatsoever, it implies that the dopant precursors are being

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homogeneously embedded within the film, which contains the matrix material. But to render anything more substantive or certain than that, I would need to read the full document and better understand the context.

Q Can you take a look at the -- your declaration, paragraph 97?

A Discussing Choulis Dependent Claim 2?

Q Correct.

A I see it.

Q And the last sentence in this paragraph is, "In other words, Choulis discloses PMMA can be used as the first matrix material, i.e., the host material."

Do you see that?

A I see that, yes.

Q So do you mean that "matrix material" means -- is used interchangeably with the term "host material"?

A No, that's not what I'm saying. What I'm saying is that because Choulis uses the term "host material" to define PVK and subsequently

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PMMA, we're equating the energetics of PVK and the energetics of PMMA to be the first matrix material. It doesn't matter whether it's called a host material or not in Choulis. All that matters is that it's a matrix material in that functional layer and has the appropriate energy alignment.

I included that comment just based on the fact that the reader would then say, okay, you're referring to what Choulis is calling a host as in PVK or PMMA, but the label of what is called here is -- is not what the issue is. It's what the energy levels actually are to satisfy the claim.

Q And so, in Choulis, you agree that Choulis calls PVK as a host material, correct?

A Choulis refers to a light-emitting layer that can include a host material and what embodiment that as PVK.

Q Okay. And it refers to TPD and PBD as organic moieties, correct?

A That's correct. TPD and PBD are

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organic moieties that Choulis adds to that host.

Q Okay. And Choulis does not refer to those two molecules as host materials, correct?

A TPD and PBD are referred to as moieties in Choulis.

Q Choulis also differentiates between the light-emitting material and the host and the organic moieties, correct, paragraph 32?

A In Choulis or in my declaration? Oh, okay.

Q Choulis --

A I mean --

Q -- exhibit -- yeah.

A Yeah. Let me just go to paragraph 32 to make sure I'm on the same page as you.

MR. GARR: Paragraph 32 of Choulis?

THE WITNESS: Yeah. Is there a particular line you're -- you're going for or a particular part of that paragraph? You had mentioned a passage that --

MS. ZHONG: Paragraph 32.

THE WITNESS: What was the --

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MS. ZHONG: Right-hand column, second sentence.

THE WITNESS: "When organic moieties"?

MS. ZHONG: Correct.

THE WITNESS: Okay. So can you ask your question again, then?

BY MS. ZHONG

Q Choulis differentiates among organic moieties, light-emitting material and host, correct?

A In that sentence, Choulis is calling out the organic moieties, the light-emitting material and the host, yes.

Q And those are three separate components, correct?

A It -- depending on the embodiment of Choulis, they might actually be four separate components.

Q Okay. What I'm saying is that they -- there are three categories of components, correct?

A Choulis is listing them separately in

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this sentence, three categories.

Q Okay. So in this sentence, in this paragraph 32, Choulis is treating organic moieties, light-emitting material and host as three different categories of components?

A Yeah. So, I guess, I want to make sure I understand. So when you say three different categories, Choulis is listing them differently here, but that need not exclude certain molecules from falling into multiple categories depending on their energy levels.

Q So, in this disclosure, Choulis is listing them as three separate categories?

A In this -- so in this sentence, Choulis is listing them as three separate categories and then when they call out examples, but, in general, a certain material, depending on the rest of the architecture and the rest of the light-emitting layer, could be one -- could fall into several categories depending on the architecture.

One could make different combinations

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with the same material appearing in different categories because, again, all of this depends on relative alignment of energy levels, so -- so it's important to just note that. There are three categories, but, you know, there could be some cross-talk depending on -- depending on the rest of the architecture and the materials chosen.

Q And in paragraph 44, the last sentence, Choulis is again treating host as a matrix, correct?

A Choulis doesn't use the term "matrix," so that --

Q It --

A Choulis has a host, but doesn't --

Q Okay.

A -- use the term "matrix."

Q It says --

A We're identifying Choulis' host as the first matrix material.

Q Okay. In some embodiments, the light emitting layer includes materials that are

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insulated matrices, that is" --

A I'm sorry. Hold on.

Q -- "the host does" --

A I just want to --

Q -- "not have transport properties."

Do you see that?

A Okay. So bottom of 44?

Q Correct. The last sentence of 44.

A "In some embodiments, the light emitting layer"?

Q Correct.

A I see that line. And what was your question?

Q And in that sentence, the host refers to the matrix material, correct?

A I don't see the --

Q Materials --

(Inaudible crosstalk.)

A Oh, I'm sorry. Yeah, I understand. The host does not have -- you're asking, does host there refer to matrix material?

Q Yes.

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A A person skilled in the art and looking at Choulis would interpret the host in this context as the first matrix material in '164.

Q So the host is referring to the material that are insulated matrices in this sentence, correct?

A Yeah. So this -- this is a different embodiment of Choulis, but, here, the host does not have transfer properties would be referring to the first matrix material of '164.

MS. ZHONG: I think we've been going for about an hour. Do you want to take a break?

THE WITNESS: Sure. That sounds great.

MS. ZHONG: Okay. Five minutes?

MR. GARR: Sure. Thank you.

THE WITNESS: That's fine with me. Thank you.

(Recess 10:14 a.m. to 10:20 a.m.)

BY MS. ZHONG

Q So, Dr. Holmes, it's your opinion that a matrix material is a component of a matrix, correct?

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A A matrix material is a component of a matrix, yes, that is my opinion.

Q Okay. What is a matrix?

A A matrix is a -- is a continuous film, effectively, is the way I would -- I would describe it.

Q Okay. And the first, second and third matrix materials, do they have to be of the same matrix, or can they be of different matrices?

A The first, second and third matrix materials, do they have to be in the same matrix? Is that your question?

Q Correct.

A Yes, they have to be in the same matrix. They're part of the same matrix.

Q They can be -- the three matrix materials need not to be applied simultaneously, correct?

A So a person reading the '164 and ultimately looking at claim 1 and the embodiments inside the '164 would interpret the fact that they're part of an emission layer and that they

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would be applied simultaneously.

So the '164, where it's noting that the three matrix materials wherein in the organic functional layers and emission layer is doped additionally with one emitter material, yes, what would be implied is those are all part of the same functional layer, which means they would be deposited at the same time or processed at the same time.

Q Now, element 13D specifically requires at least the first matrix material, the second matrix material and the third matrix materials as simultaneously applied, correct?

A You said element 13C?

Q 13D, D as in dog.

A Are we -- are we looking at claim 13?

Q Yes. Claim 13D. And I believe you have listed the claims on page 30 --

A I'm looking --

Q -- of your report.

A Yeah. I'm looking at claim 13 in the '164. I see A, B, C.

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Q So element 13D --

A Perhaps you're referring to my report where I discuss claim 13.

Is there a page of my report you're -- or my declaration you're referring to?

Q Page 66.

A Perfect. Thank you. I'll go to that page.

Sure. Yes. So I was confused by the fact that the claim itself only lists three steps. I broke out an additional step to treat simultaneously applied.

Q Okay. So, in this element, it requires the three materials to be simultaneously applied, correct?

A It does. Claim 13 does require them to be simultaneously applied.

Q So that means, inherently, they need not be simultaneously applied, correct?

A No, I wouldn't conclude that because of the fact that when one's talking about claim 1, it's very clear that this an organic functional

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layer and further is an emission layer, and the fact that it's a single layer that's being referred to, a person skilled in the art would recognize that as a matrix and as basically being simultaneously applied to contiguous film that contains those three matrix materials and the emitter.

Q So you are stating that the limitation simultaneously applied is superfluous because it has to be --

A I -- I am stating that a person skilled in the art looking at claim 1 and looking at the embodiments of -- embodiment of the '164 would see that as a single layer, which would be simultaneously applied.

Q So you didn't really -- you did not really answer my question.

A Oh, I'm sorry. What was your question?

Q So you -- you regard this requirement for simultaneously application to be superfluous?

A So, again, this is -- this is drifting into what would be superfluous for a claim or not

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in patent language. What do you mean by this claim would be superfluous? Superfluous in the context of 13?

I guess I wouldn't say it's superfluous because 13 is -- is a method claim, while one is a device claim. So, again, I'm not an attorney. I don't know the specifics of how a method claim should be constructed versus a device claim should be constructed, so it's challenging for me to comment on whether or not it's superfluous from a legal perspective.

Q Okay.

A My opinion is that a person skilled in the art would recognize that claim 1 is referring to a single film, referring to a matrix in which these matrix materials and the emitter are -- are included.

Q Okay. Claim 13 is for producing an electronic device according to Claim No. 1, correct?

A That's -- yes, that's correct.

Q And so, according to you, Claim No. 1

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refers to a device where the first, second and third matrix materials are applied simultaneously to form a single field, correct?

A No. What I'm saying is that claim 1 refers to a single film in which all of these matrix materials and the emitter are -- are included, and a person skilled in the art would read that as a film that's being applied simultaneously.

I'm not saying that's what claim 1 explicitly says, but that's the interpretation a person skilled in the art would -- would have, right, because any other interpretation, you know, outside of it being a single film would be inconsistent with what a person skilled in the art would see in claim 1.

Q So, under that interpretation, claim -- step number C need not be recited, correct?

A So, again, whether or not it needs to be recited wasn't part of my analysis. All I was looking at was: Does the prior art teach these claims as they're written? So I don't take an

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opinion on whether or not the -- the claims were properly written or most efficiently written. All I was looking at is: Does the prior art meet each claim?

Q So is it your opinion that first, second and third matrix materials have to be simultaneously applied?

A It's my opinion that in order to satisfy the claim language that the first, second and third matrix materials have to be within an organic functional layer and, more specifically, as is noted in claim 1, an emission layer.

So they have to be within that emission layer with the guest emitter. That's -- that's the only opinion I'm rendering here because that's the --

Q Okay.

A -- only opinion I have to render regarding claim 1.

Q And what is an emission layer?

A So an emission layer in an OLED is the layer from which light originates.

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Q And if light emits from an interfacial interface between two layers, does that interface -- is that interface included as part of the emission layer?

A So you're asking me to take an opinion on something I didn't -- I didn't think about in the context of this work. I didn't consider light emission from interfaces or situations where perhaps a device is poorly designed so that, you know, excitons leak out of the emissions layer.

Q Well, '164 mentions that the recombination can occur outside of the emission layer, correct?

A Can you point to a particular line where that's occurring?

Q Figure -- Figure 4.

A This is a simulation of electron hole densities in the device. What's your specific --

Q Correct.

A -- question on it?

Q Yeah. And the corresponding text in

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column 6, lines starting from -- column 6, line 57.

A Let me just refresh my memory on line 57. Okay. So, yes, it's a simulation in an OLED. What was your question related to that text?

Q As shown in Figure 4, the recombination can occur outside of the emission layer, correct?

A Again, where -- where are you seeing that in '164? Is there a particular line you're pointing to? I just want to make sure I'm on the same page as you.

Q Line -- starting from line 6.

A Six?

Q I'm sorry. Column 6, line 57.

A 57? So that's again this Figure 4 sentence?

Q Yes.

A So that -- so that describes that Figure 4 is showing a simulation. Is there a place where it's saying that recombination is --

Q So, for example, the last sentence,

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column line -- column 6, line 66 through 72.

A "This means," is that the sentence you're referring to?

Q Yes.

A Let me just read that.

Okay. I've read the sentence.

Q The sentence says that recombination in the adjacent layer 32 and 31 is reduced and it is shifted to the middle of the emission layer 30, correct?

A It does say that.

Q Okay. So the -- the adjacent layers 32 and 31 are not the emission layer 30, correct?

A I just want to note, first of all, that it doesn't say that there's light emission coming from 32 and 31. It just says there's recombination.

Q Okay. And if there are -- if there are emitter materials at the interface between layer 32 and 30 and layer 30 and 31, there can be emissions with recombination, correct?

A I'm sorry. Can you just rephrase that

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again for me, please? So you're saying where are the emitter layers or where is this emissive material?

Q So the -- if the emitter materials are located at the interface of emission layer 30 and emission layer 32 with a recombination taking place --

A I just --

Q -- near that interface, there can be emission there, correct?

A I just want to ask first: What layer was the emitter placed in in your hypothetical?

Q Emission --

A You said --

Q -- layer --

A You said at the --

Q -- 30, but --

A Yeah. Go ahead.

Q Go ahead.

A No, I just -- you said an emitter at the interface, but the emitter is included in one of those layers, so which layer was the emitter

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included in this hypothetical?

Q It's included in emission layer 30, but --

A Okay.

Q -- it can be at the interface of layer 30 and adjacent layers 32 and 31, correct?

A The emitter is included throughout the emission layer.

Q So it will be at the interface between the emission layer 30 and the hole transport layer 31 and at the interface between the emission layer 30 and the electron transport layer 32, correct?

A So --

MR. GARR: Object -- object to the form.

THE WITNESS: So the emitter is distributed throughout 30. That I would agree with.

BY MS. ZHONG

Q And it will be at the two interfaces, correct?

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MR. GARR: Object to the form.

THE WITNESS: So, again, I think I've made it clear if I -- if the emitter is throughout 30, then it's distributed throughout layer 30, and I think that's fairly clear.

BY MS. ZHONG

Q And it will be at the two interfaces, correct?

MR. GARR: Same objection.

THE WITNESS: Can you clearly say what you mean by it will be at the interfaces?

BY MS. ZHONG

Q The emitters will be at the interfaces.

A The emitters are distributed throughout layer 30, so they are --

Q What do you mean by -- sorry.

A The emitter molecules are distributed throughout layer 30. That's -- that's what I'm saying. That's -- that's all I have to say on that.

Q What do you mean by it's distributed throughout layer 30?

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A What I mean is that when that layer is made, the emitter molecules are distributed throughout layer 30. I want to make it clear that they are not necessarily distributed at an interface. They're distributed throughout the layer.

Q Yes. So they are distributed throughout the layer, including at the two interfaces, correct?

MR. GARR: Object.

THE WITNESS: The emitters are distributed throughout the layer. Whether or not they're -- again, if they're uniformly distributed throughout the layer, I think it's fairly clear where the emitters are.

BY MS. ZHONG

Q Okay. I don't understand why you are trying to avoid answering my question.

A I think --

Q The emitters --

A -- I answered.

Q -- are -- the emitters are distributed

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throughout the layer 30, including at the interface with the hole transport layer 31 and the electron transport layer 32; is that correct?

MR. GARR: Objection.

THE WITNESS: So if the emitters are distributed throughout 30, then there would be some emitter molecules throughout 30, and so some would be distributed at the top, some would be at the bottom, but they would be throughout that layer.

BY MS. ZHONG

Q Okay. And when you say some will be at the top and some will be at the bottom, what do you mean by the top?

A The top and bottom, I'm simply referring to the edges of layer 30.

Q Okay. So you are referring to the interface of layer 30 with adjacent layers?

MR. GARR: Object.

THE WITNESS: The --

MR. GARR: Mischaracterizes.

THE WITNESS: The top and bottom of the

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film would be the top surface and bottom surface of the film, for example, in -- in Figure 3. So --

BY MS. ZHONG

Q Okay. So the top of the film 30 is at the interface with layer 32, correct, in --

A Yes.

Q -- Figure 3?

A Yes.

Q And the bottom of film 30 is at the interface with layer 31, correct?

MR. GARR: Objection.

THE WITNESS: The bottom of the layer 30 is on top of 31. It's on the interface.

BY MS. ZHONG

Q On the interface. Okay.

So there will be -- so if the emitter is distributed uniformly throughout film 30, some will be at the interface with film 32 and some will be at the interface with film 31 in Figure 3, correct?

MR. GARR: Object to the form.

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THE WITNESS: Sorry. Are you asking, are some at each interface? Can you just rephrase --

MS. ZHONG: Correct.

THE WITNESS: -- your question? So can you just -- sorry -- rephrase it as a -- as a question so I'm clear on what you're asking for this point?

BY MS. ZHONG

Q So if the emitter is distributed uniformly through film 30, then in figure 30 -- Figure 3, some of the emitters will be at the interface with film 32, and some of the emitters will be at the interface with film 31; is that correct?

MR. GARR: Object to form.

THE WITNESS: So -- so, again, you're not asking me a question specifically. You're asking me to -- basically based on a statement.

Are you asking, will some emitter materials be on the top and bottom of film 30?

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BY MS. ZHONG

Q Correct. I think when I made a statement, I asked you, is that correct, and you probably did not hear that.

A Oh, okay. So the emitter, again, will be distributed throughout layer 30, so some emitter molecules will be at the top and bottom of the film.

Q And by the top and bottom film, you mean the interface with film 32 and the interface with film 31; is that correct?

MR. GARR: Object to the form of the question.

THE WITNESS: The top and bottom of the film would be in this context here -- again, it depends on the device architecture -- but would be the interface with the adjacent layers.

BY MS. ZHONG

Q Okay. And if -- and if there are recombinations in the adjacent layer 32 and 31, there will be light emission at the top and bottom of the film 30; is that correct?

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MR. GARR: Object to the form.

THE WITNESS: Can you rephrase your question?

BY MS. ZHONG

Q I'll put it this way: If there are emitter materials at the top and bottom of film 30, there will be light emission at those interfaces, correct?

A If there are emitters at the top and bottom of film 30 and those emitters are excited, those emitters within film 30 can emit light.

Q Okay. And do you see any reason why those emitters will not be excited?

A I -- is there a particular embodiment that you're referring to? What -- what active --

Q Figure 3 --

A -- materials, what emitter, what -- it depends on the materials chosen. The recombination -- recombination zone will vary depending on what materials are chosen and the composition of the film, so you can't --

Q Figure 3 -- sorry.

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A Pardon? I said -- sorry. The court reporter, I know, is going to warn us in a moment. You ask your question.

Q The Figure 3 embodiment.

A But Figure 3 doesn't -- I need to know more specifically what the materials are in order to know where the recombination zone will be. Figure 3 is just a layer structure.

Q Is it your position that Figure 3 and Figure 2 are two different embodiments?

A Is it my position that, what, Figure 3 and -- can you repeat that?

Q Is it your position that Figures 2 and 3 are two different embodiments?

A No, but even Figure 2 does not specifically call out materials, specific materials. It only calls out energy levels.

Q Well, Figure 2 provides -- what about the example in Figure 5?

A Figure 5 of '164?

Q Correct, which is in column 7, lines 21 --

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A I'm sorry. Figure 5 of '164 just shows the deposition apparatus.

Q Correct. The associated text is in column 7, line 21 through 60.

A Okay. And what -- and what is your specific question about this embodiment?

Q So, in this embodiment, are the emitters at the top and bottom of film 30?

MR. GARR: Objection.

THE WITNESS: I'm sorry. Can you repeat that?

BY MS. ZHONG

Q With this combination of the materials --

A Yes.

Q -- for film 30, is the emitter distributed uniformly throughout film 30?

A So in the example as described -- I just want to make sure everything is clear here -- the matrix materials are mCP, TCTA and TPBi, and the emitter is rubrene.

This is the embodiment you're referring

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to?

Q Correct.

A A person skilled in the art would read this paragraph and assume those materials have been uniformly distributed throughout the emissive layer.

Q Okay. And so will there be emission at the top and the bottom of the film?

A I don't know where the recombination zone will be for this particular device.

Q And according to -- if the recombination zone is similar to that simulated for Figure 4, do you think that there's emission at the top and bottom of the edge -- bottom of -- top and bottom of the film?

A So I don't know the inputs into Figure 4 or the model even being used here, so it's not possible for me to draw an opinion on what's accounted for and what wasn't accounted for in the context of a recombination zone calculation. So I really can't say a lot about where the recombination zone is going to be just based on

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this simulation because it depends on a lot of different things.

So I would say, from this diagram, no, I can't conclude where the recombination zone is.

Q Now, if the recombination zone does occur in adjacent layers 32 and 31 and if they are emitted materials at the top and bottom edge of 30, will there be light emission in the top and bottom of the film?

MR. GARR: Object to the hypothetical.

THE WITNESS: So, again, this is -- this is totally hypothetical because I haven't actually studied that particular aspect of this, but when recombination occurs outside the emissive zone of the structure, it can be non-radiative. So this is the challenge with Figure 4. Recombination need not mean light emission. You could have recombination that's not radiative --

MS. ZHONG: What if it's --

THE WITNESS: -- in which case it's a loss.

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BY MS. ZHONG

Q What if the recombination is at the edge where there are emitter materials?

A Are you asking if the recombination is at the edge of the emissive layer?

Q Correct.

A Then the recombination and the light emission is originating from the emissive layer.

Is that -- are you asking whether or not that's the case? Because it's still within the emissive layer.

Q Okay. Even though, at the interface, there are also materials from the adjacent layers, correct?

A Sorry. What was the question?

Q So, at the interface, basically, it's not purely emissive material -- layer material. You also have the materials from the layer 32 and layer 31, for example, correct?

A In a different layer.

Q So there are --

A You're saying there's a distinct second

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layer? Is that what you're asking?

Q So, like, in figure 31 -- in Figure 3 -- in the Figure 3 configuration --

A Yes.

Q -- you have a distinct layer 32 on top of layer 30 and a layer 31 at the bottom of layer 30, correct?

A Yes.

Q Okay. So, at those interfaces, it's not purely the emissive layer material, correct?

A No. At those interfaces, you have an abrupt junction between layers.

I don't understand the question. A person skilled in the art -- and, clearly, the inventors of the '164 are drawing this diagram with different layers. They are not drawing this as a diagram where there's some sort of non-distinct behavior between the layers. And so I -- I apologize. I don't understand the question.

Q So, at the interface, is there a transition, or it's a sharp --

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A There is a distinct change in layer at the interface.

Q Is there diffusion of the emitter layers -- emitter materials moving from one -- from film 30 to 32, for example?

A No, not via this method.

Q What do you mean by "not via this method"?

A So what is the question you're asking specifically?

Q Is your conclusion that there is no -- no diffusion possible for the emitter materials --

MR. GARR: Objection.

BY MS. ZHONG

Q -- to move -- to diffuse from one -- from film 30 into 32 at -- near the interface?

A So, again, I -- this is not something I thought at all about in the context of my declaration. Diffusion between layers was not something that came up in the '164 or in any of the prior art I had to worry about, so I'm not

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comfortable offering an opinion on whether or not I suspect materials might diffuse.

But a person skilled in the art would look at this and see distinct layers, as clearly do the inventors of the '164.

Q Now, can you please pull up Exhibit 100 -- 1006? And can you please go to PDF page No. 2?

A Yeah. Is there a particular claim you want me to look at?

Q Do you see the diagram on page 2 --

A Oh, I'm sorry. I was --

Q -- on the --

A I was on document page 2. Yeah, I see the cartoon.

Q So, in this cartoon, what is a matrix in this cartoon?

A Again, I -- this is a cartoon. I'm not going to interpret what a matrix is in the context of just a cartoon. I think you have to read the document and take it as a whole.

Q What is a matrix for this embodiment?

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A In the context of Sugiura in general beyond this cartoon?

Q This cartoon is part of the embodiment, correct?

A Right. But are you asking what a matrix material is in Sugiura as a whole?

Q I'm asking you, what is a matrix of which the three matrix materials are components of?

A So, in Sugiura, the matrix is the light-emitting layer in which one has polymer, the charge transporting material, the light-emitting material and the other charge transporting material.

Q What is a continuous phase?

A Can you provide additional context? Are you asking in general? In the context of Sugiura? What's your --

Q Your position is that a matrix is a continuous phase of materials, correct?

A My position is a matrix is a continuous phase of materials. Yes.

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Q So what is a continuous phase?
A A continuous phase would be a film, a distinct film, that has some distinct function in this case.
Q In this film, as drawn here in this cartoon, 3C and 3B are not continuous, correct?
A That's because they're matrix materials, not a matrix themselves.
Q So they are discontinuous, correct?
A Well, in this cartoon, they are drawn as discontinuous. I would emphasize that this has been highly simplified to provide a graphic to go with the patent. I don't take the position that this is a correct representation of how to think about the distribution of the two charge transporting materials in the film.
Q As drawn here, they are shown as discreet particles, correct?
A In this diagram, the cartoon representation of the charge transporting material is shown as a circle.
Q And each of the circles are not

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connected to any of the other circles, correct?

A For the context of simply describing this cartoon, the circles are not connected.

Q Okay. Do you know -- for Sugiura in particular, you're relying on Exhibit No. 8 materials, right -- Example 8 materials that's described in paragraph 62, correct?

A Well, let me just go to that cite.

Q PDF page 8, last paragraph on the right-hand side.

A I just want to make sure I'm on the same page. So that's document page 7, Example --

Q On page --

A -- 8?

Q -- 8, I believe.

A Sorry. When I say "document," I mean the page number in the document.

MR. GARR: There's different page --

MS. ZHONG: On the top.

THE WITNESS: Oh, pardon me. I'm looking at the original page number. Yeah. So example --

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MS. ZHONG: Okay.

THE WITNESS: Example 8, paragraph 62?

MS. ZHONG: Correct.

THE WITNESS: Yes, that is an embodiment that we are using in this respect.

BY MS. ZHONG

Q Okay. And do you know whether TPD and aluminum Q3 form exciplexes?

A I don't know whether Alq3 and TPD form exciplexes. It's not something I had to consider in the context of this work.

Q And if they form exciplexes, would that be -- would that affect the efficiency and the luminescence of the resulting film?

A So, again, you're asking me to speculate on something I haven't thought about, especially with these specific materials. So is there a particular part of my declaration or something that I can build off that you're pointing to?

Whether they form exciplexes wasn't relevant for a showing that this embodiment

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ultimately meets the requirements of the claims.

Q Would it be true that the dispersion of TPD and aluminum Q3 in the cartoon we just saw was intentional to prevent them forming exciplexes?

A So, again, I hesitate to spend too much time on the cartoon, but in my opinion, the cartoon does not accurately represent what's actually being described in Sugiura.

Q You're not answering my question.

You did not consider whether TPD and aluminum Q3 might form exciplexes, correct?

A I did answer that. I said I don't know if Alq3 and TPD would form an exciplex. That's not something I've studied in detail --

Q Okay. And if --

A -- for this work.

Q Sorry. And if TPD and aluminum Q3 does -- do form exciplexes, would a person of ordinary skill in the art do something trying to keep them apart so they won't form exciplexes?

A So whether or not they form exciplexes

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is -- it's not certain whether or not that would hurt the device because of the fact that you also have an emitter, and so Alq3 and TPD could form an exciplex and then you could still potentially pump the emitter, but I don't know the specifics of how that would look here. It's a pure hypothetical.

Q Okay.

A But, no, it --

Q So --

A -- need not -- it need not necessarily hurt the device, but exciplexes often can hurt the device. So answering your question requires more knowledge of the materials and the specifics of the -- the photophysics of each of them.

Q Okay. So you mentioned that exciplexes can often hurt devices, correct?

A They can, but they don't necessarily have to hurt devices, and it sometimes could be beneficial. It depends on the system.

Q Okay. And do you know if --

A But nowhere -- nowhere in the text here

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is there a discussion of utilizing an exciplex or avoiding an exciplex between TPD and Alq3.

Q And do you know, a priori, will exciplexes be beneficial or detrimental?

A In this -- is there a particular system you're asking me about?

Q Any system in general.

A So in any OLED system, could exciplexes be potentially beneficial?

Q Or do you know a priori whether the -- an exciplex would be --

A I --

Q -- beneficial or detrimental?

A I don't think I can comment or offer an opinion on that on the fly. That's -- that's far too expansive a scope to think about, so --

Q Okay.

A -- I would -- I would need to think about that more.

Q But -- but, often, exciplexes can hurt OLED devices, correct? That's what you said?

A I would say that exciplexes can hurt

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efficiency. It could also be beneficial. It depends on the context. It depends how the device is designed and what the materials are.

Q Okay. And you did not consider whether TPD with aluminum Q3, if they form exciplexes, whether they will be beneficial or detrimental, correct, in this context?

A I did not consider anything about exciplexes in the context of Alq and TPD.

Q Okay. And if an exciplex is detrimental to an OLED device, would a person of ordinary skill in the art try to do something to prevent the exciplex from forming?

A So I'll just highlight again that I did not consider the question of exciplexes in the context of my declaration, my opinions, and I don't think it's a relevant feature in terms of deciding whether the prior art meets the claims of the '164.

Q I'm not asking that question. I'm asking you --

A I understand --

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Q -- if --

A -- but you're asking me to make an opinion on something that I haven't thought deeply about in the context of this particular discussion, which is not something I generally am comfortable doing.

Q And so you have no opinion -- you offer no opinion on whether a person of ordinary skill in the art would avoid forming exciplexes if the exciplex hurts the performance of an OLED device, correct?

A I think that is too hypothetical a question for me to offer an opinion on here.

Q Okay. So, in particular, you did not consider whether a person of ordinary skill in the art would try to avoid forming an exciplex between TPD and aluminum Q3, correct?

A I did not consider the question of exciplexes between Alq3 and TPD.

Q Okay. And you did not do any investigation as to whether TPD and Alq3 exciplex would be detrimental to the OLED performance,

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correct?

A I think I've already answered that. I haven't -- I didn't look into exciplexes between Alq3 and TPD in my evaluation of Sugiura.

Q Okay. And do you have an opinion as to whether a person of ordinary skill in the art would avoid forming exciplexes if the resulting exciplex between TPD and aluminum Q3 would hurt the OLED performance?

A So, again, this is purely hypothetical, and so I am -- I'm not -- I'm not going to offer an opinion on -- on what someone would do in that regard. I haven't thought about exciplexes between Alq and TPD.

Q Okay. And you say, like, exciplexes often can hurt OLED device performance. In which respect would --

A I didn't --

Q -- they hurt --

A -- say -- I don't think I said often. I think I said they can hurt or are potentially useful depending on the context and depending on

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the materials involved. It's a fairly broad literature.

Q Okay. And when can exciplexes hurt the performance of OLED?

A So, again, this is something that's hypothetical that I haven't needed to consider in the preparation of my declaration, but an exciplex would be hurtful if it provided a separate recombination channel.

Q And when you say it provided a separate recombination channel, what do you mean?

A So if -- if it competed with the emissive material.

Q Aluminum Q3 is a green emitter, right?

A Alq3 is known as a green emitter.

Q Okay. So if there is recombination happening on Alq3, that will be competing with Nile Red for emission, right?

A So you're asking something different. Can you phrase your question again, please?

Q So if there is recombination on the Alq3 molecule, that will be competing for

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emission -- strike that.

So if -- if there is recombination happening on the Alq3 molecule, will Alq3 emit green light?

A So, in general, when a molecule of Alq3 is excited, it will emit green light.

Q Okay. And so, if Alq3 and TPD are close to each other and the hole recombines with the electron that's being transported on Alq3, will that result in green emission?

A Why would you suppose it's green emission? I don't know that for a fact.

Q Alq3 emits green light, right?

A When you excite a molecule of Alq, it emits green light. That's not what you're describing.

Q So if the hole -- and the hole from the TPD and the electron on the Alq3 forms an exciton, that --

A I --

Q -- will cause light emission from the Alq3, right?

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A Well, first note, I'm not going to render an opinion on that because it's not something I've thought about, but that is not an exciton.

Q What is an exciton?

A An exciton as understood by a person skilled in the art is a molecular excited state on a single molecule, not two molecules.

Q So if the hole -- okay.

So if the hole and the electron recombines on Alq3, that forms an exciton, correct?

A If the hole and electron both reside on Alq3, that forms an exciton.

Q And that will cause green light emission, correct?

A If that's where the energy stays until relaxation occurs, then it would cause green light emission.

Q Okay. And the probability for the hole and the electron to recombine on Alq3 increases if the distance between the TPD and Alq3 reduces;

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is that correct?

A Well, that -- again, that's very hypothetical and depends on a lot of factors, including the molecular orientation, you know, how -- how the Alq and TPD face each other. I don't think I can speculate on that. But in the Sugiura architecture, holes are not going to find their way onto Alq.

Q Why not?

A It's -- it's -- the design -- the device is designed so that holes are on the hole transport material of TPD and relax to the emitter material of Nile Red.

Q As drawn in the cartoon, that partly is achieved by keeping the TPD and the Alq3 apart from each other, right?

A No. As drawn in Figure 8, it's achieved via energy level alignment.

Q And --

A In Figure 8, holes are injected into TPD, the hole transporting material. Electrons are injected into Alq3, the electron transporting

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material. Moving a hole from TPD to the HOMO of Alq is energetically costly, and so a hole will reside on TPD or relax to Nile Red.

You will not be able to form an exciton on Alq in this architecture with any kind of ease.

Q Okay. And Exhibit 8 has a configuration as shown in Figure 4, correct?

A Sorry. Exhibit 8, remind me which exhibit you're --

Q Example 8.

A Oh, Example 8. Pardon me.

Q Look at Exhibit 62, the first paragraph.

A Yeah. Right. Yeah, this -- this is the same situation we've been referring to. And so you're asking, it has a configuration shown in Figure 4?

Q That's what is said here --

A That's --

Q -- right?

A Yeah. That's the simplified layer

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structure, and then the energy diagram associated with that configuration is shown in Figure 8.

Q Okay. And Figure 4 is supposedly to be the OLED device that's fabricated, evaluated, for example, No. 8, correct?

A Figure 4 is the -- yeah, is the layer structure that Figure 8 would then describe the emissive layer energetics for, the layer energetics for.

Q Okay. And in Figure 4, 3D and 3E are shown as non-connected discreet circles, correct?

A If you're asking if, in Figure 4, 3D and 3E are shown as circles, they are shown as circles.

Q Okay. Not connected to each other?

A Well, I -- I'm not sure how to think of the word "connected."

What -- is there a particular threshold you have in mind, a separation? Connectivity is subjective on its own.

Q As shown here, they are shown as discrete particles, right?

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A As shown here, they are shown as separate circles for the purposes of illustrating that the layer contains multiple molecular species.

Q Okay.

A But it's quite clear in Sugiura that hole transport is occurring along TPD and electron transport is occurring along Alq in the embodiment we're talking about.

Q And they don't show any of the 3D and 3E circles to be touching each other in Figure 4, correct?

A I think we've covered that. The circles in Figure 3D and 3E are circles, and they aren't touching.

Q Okay.

A But as a person skilled in the art, Figure 4 is a highly simplified illustration of the invention.

Q So the Nile Red is embedded in 3A, but not in either 3D or 3E, correct?

A Is there a particular line you're

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pulling that statement from?

Q I'm just asking you in Example 8.

A Okay. Can you just ask me again the question?

Q Let's just focus on Figure 4.

In Figure 4, the Nile Red, which is those small circles, they are embedded in the 3A matrix, but not in 3D or 3E; is that correct?

A No, that's incorrect. That's an incorrect reading of the -- of the patent.

Q I'm asking --

A If you --

Q -- about Figure 4.

A And I'm responding with the correct context. If -- if you read at the bottom of the description of Example 8 on to the top of the next page, it says clearly how the light-emitting layer was formed, and Nile Red would be uniformly distributed throughout that layer. There's no reason Nile Red would avoid mixing with some materials and not others, as is shown in Figure 4. Figure 4 is a cartoon.

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Q Is -- is your position that Figure 4 is embedded in TPD as well as Alq3?

A Can you ask that again?

Q Is your position that a Nile Red is embedded in aluminum Q3 as well as TPD?

A My position is that element 3 of Figure 4 describes a light-emitting layer in which all of the components are uniformly distributed, which is consistent with how that layer is being prepared, where everything is being dissolved into a solution and then spun-cast.

Q My question is: Is Nile Red embedded in TPD?

A So, TPD is a molecule. It's not -- saying Nile Red is embedded in TPD -- TPD just represents a single molecule.

So the way to think about it would be that that layer, right, that light-emitting layer has all of the components uniformly dispersed. You can't answer if it's just embedded in TPD because that's just a molecule.

Q Have you made a film to ensure --

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sorry.

You did not make a film as described in Example No. 8 of Sugiura, correct?

A I did not make a film described in Example 8.

Q Okay. And you did not follow the deposition -- the solution-based deposition process performed by Sugiura, correct?

A And are you referring specifically to the one I just called out at the top of the following page?

Q Example No. 8.

A As I just noted, I didn't make a film as part of my work on this -- this particular claim or this particular patent, I should say.

Q Okay. And you did not characterize the film to see whether there is non-heterogeneity, local heterogeneity, or whether there is segregation of the molecules, for example?

A As I said, I did not carry out any experimental characterization of any sample for my work on -- on this particular patent.

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Q And do you know the solubility of PVK versus Alq3 versus TPD?

A I don't know the solubility of those materials and relative terms to each other.

Q Okay. And so you don't know as the solvent is removed whether there is going to be aggregation?

A I did not think about any questions of aggregation in analyzing Sugiura.

Q Okay. Have you made similar films for the composition as shown in Example No. 8?

A Isn't that the example we were just talking about?

Q Yeah. I'm asking you --

A So you're asking --

Q -- have you made --

A -- me to --

Q -- films similar to this composition in your research?

A Can you specify which active materials when you say "similar"? What -- what counts as similar in this regard?

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Q Well, have you made films composed of PVK, aluminum Q3 and TPD?

A I have not made films of PVK, Alq3 and TPD.

Q Have you used any of these materials in your research?

A I have used PVK, Alq3 and derivatives of TPD in my research.

Q Okay. And have you used them together in a film?

A I don't think I have used them together in a film.

Q Have you used the PVK and TPD together in a film?

A I don't think so.

Q What about PVK and aluminum Q3 in a film?

A I don't think so.

Q Have you used solution-based process to deposit these materials?

A I have used solution-based processing to deposit PVK, but not in this combination.

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Q Is it in the one-to-one solvent of toluene and chloroform?

A I don't recall what solvent I used to process PVK.

Q Okay. So sufficient to say that you don't really have any experience as to the solution-based process for these materials in combination --

MR. GARR: Objection.

BY MS. ZHONG

Q -- correct?

MR. GARR: Objection.

THE WITNESS: What I would say I have experience in is understanding what it would take for the device to work efficiently and to realize success, and realizing --

MS. ZHONG: Okay.

THE WITNESS: -- large-scale aggregation and phase separation would not be beneficial for OLED performance.

BY MS. ZHONG

Q But you don't really know with any

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local heterogeneity, correct?

A Again, that's not something I thought about in the context of this work, but the word "local" is subjective.

Q And you did not investigate what the resulting film will actually look like, correct?

MR. GARR: Objection.

THE WITNESS: I think I've already answered that I didn't perform any experiments in the context of this embodiment of Sugiura.

BY MS. ZHONG

Q Sugiura didn't really provide any performance data for its devices, did it?

A Table 1 is where Sugiura shows all of their current efficiency and power efficiency results, so they actually provide fairly extensive at least numerical values for their device performance.

Q Okay. So they -- are you referring to the table on top of page 8?

A I -- yeah, I am. It's -- it's, I think, labeled "Table 1" in the end of the

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previous page, but, yes, that is the table I'm referring to.

Q And is the driving voltage between 7.6 and 10 considered an acceptable driving voltage, or it's too high?

A Again, that -- that depends on a lot of things. Is there a particular application you're looking for?

What -- can you be more specific when you say "too high"? What is the criterion we're worrying about here?

Q For OLED applications.

A Again, what -- the objective in this work is not to, you know, build, say, for instance, a final product. The objective here is to show improvement.

And if you look at the comparative examples of voltages versus the examples relevant to the art, the voltage goes down, which is the important result for someone skilled in the art to see, so...

Q So, in Example No. 8, aluminum Q3 as

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the electron transport material has the lowest weight ratio, correct?

A Is there a particular line you're pointing to? Is this still 62?

Q Yes.

A Alq3 has the second lowest weight ratio. The emitter is the lowest.

Q And both PVK and TPD are hole transport materials, correct?

A Both -- TPD is certainly a hole transport material, and PVK can transport holes.

Q So why is the amount of Alq3 so much lower than the TPD and the PVK added together?

A So, again, I'll first just note that this isn't something I needed to draw an opinion on in the context of considering the '164, and so I'm uncomfortable speculating on right now why this particular composition works.

Is there a particular aspect of my declaration that this relates to that you want to point me towards?

Q You did not consider that, right?

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A Well, in terms of the specifics of why Alq3 might be at 60 and TPD is 80 and whether that really is a meaningful reduction, no, certainly, I didn't have to consider that. I can certainly speculate, but I don't see any benefit to doing that.

Q The goal of adding Alq3 is to improve the electron transport; is that correct?

A Alq3 exists in this device to carry electrons.

Q Okay. And since the materials PVK and TPD are already predominantly hole transporting, why wouldn't you increase the amount of Alq3?

A You're asking hypothetically or --

Q I'm asking the question.

A Okay. So, again, I didn't consider the compositional dependence of performance on Alq to TPD ratio in this device, and so any answer I give would be just speculating.

But there's no -- there's no data, for instance, in this paper on the relative transport behavior that's detailed enough for PVK -- PVK,

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Alq and TPD and Nile Red, for that matter.

Q Okay.

A So I really can't speculate on why the inventors chose that composition. It's just clear that that composition works for their purposes.

Q So for charge transport properties, HOMO and LUMO ratios alone are not sufficient. You also need to know the charge carrier mobility in the media; is that correct?

A So the charge transport property of a material is really referring to a material itself. A carrier inside that material, how effectively does it move through the material? The contribution of a material to charge transport in the device reflects energetic alignment and then also mobility.

Q Okay. So the -- the conductivity or the transport properties of a hole transport material or an electron transport material include at least two factors. One is the intrinsic charge carrier mobility, and the other

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is the energetic alliance, which is the HOMO and LUMO --

A So --

Q -- level --

A So -- so, again, I --

Q -- which --

(Inaudible crosstalk.)

A -- I would -- what I said was slightly different than how you rephrased that. So the charge transport property, right, refers to a materials property, right? That's actually now looking at how mobile an electron or a hole is in a given material.

When thinking about an OLED, whether or not a material contributes to charge transport relies also on energetic alignment with other materials, right? There's relative property versus a materials property as well.

Q Why is the energetic alignment important?

A In the context of an OLED, deciding what material actually -- or -- or figuring out

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what material actually contributes to charge transport in the OLED relies on being able to actively excite that material with an electron or a hole.

Q And is it also important for you to be able to inject the holes or electrons into the material?

A Important in what sense?

Q Well, you cannot be a very good hole transporter or electron transporter if you don't have -- you don't receive any electrons or holes. You won't be able to transport them, right?

A That's what I just outlined, that in an OLED, your contribution of a given material to the overall charge transport depends on the injection, the excitation of the material with an electron hole as well.

Q When you say "excitation," what exactly do you mean? I guess that's where I was a little bit confused.

A Okay. Essentially populating the HOMO with a hole or the LUMO with an electron.

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Q Okay. Basically hole injection and electron injection?

A Injection into the HOMO or LUMO.

Q Okay. I thought you were talking about exciplex formation or exciton formation.

A No.

Q And this -- this Exhibit 106 doesn't really mention HOMO and LUMO, correct?

A This is still Sugiura?

Q Correct.

A It does not explicitly mention HOMO and LUMO, but Figure 8 being the stated energy diagram for the device is very clear to a person skilled in the art that this is the energy diagram for the OLED, as is also shown in the caption for the figure.

Q Okay.

A So a person skilled in the art would look at that diagram and understand immediately that what's being implied are molecular energy levels of the various materials in the device and the work functions of the electrodes.

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Q And is ionization potential exactly the same as HOMO?

A Ionization potential generally can be thought to correspond to the HOMO.

Q But valuewise and not one-to-one correspondence, correct?

A Valuewise, what you typically find in the literature is that the HOMO is the -- taken as the ionization potential when it's measured, but there can certainly be some variations.

Q Okay. The same with electron affinity and LUMO, correct?

A Electron affinity and LUMO correspond.

Q But the values, they can differ as well, correct?

A They could differ. But that's something that a person skilled in the art understands and would not prevent any impediment to applying ionization and electron affinity for HOMO or LUMO.

Q So, for example, in Figure 8, the energy diagram can be referring to the ionization

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potential and electron affinity, correct?

A In Figure 8?

Q Uh-huh.

A Yes. The caption for the diagram is just this is the -- essentially the energy levels of the device.

Q So the energy levels can be in terms of ionization potential and electron affinity, correct?

A So the text of Sugiura speaks in terms of ionization potential and electron affinity.

I'll just note, though, paragraph 42 of Thompson clearly states that, "As would be understood by one skilled in the art, a material has a lower HOMO level as compared with another material is one that has a higher ionization potential as compared with the IP of the other material. Similarly, also as would be understood by one skilled in the art, a material that has a higher LUMO level as compared to another material is one that has a lower electron affinity."

This is paragraph 42 in Thompson just

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further supporting that those skilled in the art would understand that these terms can be used interchangeably in interpreting an energy level diagram for an OLED.

Q Okay. But as you said, the HOMO and LUMO levels do not -- the values do not align precisely, correct?

A The value -- the values for HOMO and LUMO in terms of the HOMO being related to the ionization potential, the community generally takes the ionization potential as the HOMO.

The LUMO, the electron affinity, I would say there's relative alignment, but there can be some deviation.

Q Okay. You did not offer an independent value for Alq3 for its HOMO and LUMO level, correct?

A No. I relied on -- let me just refresh my memory here.

Sugiura states Alq is HOMO and LUMO. I didn't explicitly call them out in my report because I felt that Figure 8 was very clear in

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illustrating the intended energetic alignment of their device. But paragraph 53 actually clearly notes ionization potential of Alqs 5, 7, and the electron affinities 3 and O.

Q Okay. So you used the ionization potential and electron affinity?

A No. As I said, I used Figure 8. I didn't see a need to actually pull out specific material energy levels in the context of Sugiura because their -- their energy level diagram is so clear to a person skilled in the art.

Q Just to be clear, Sugiura never used the word "HOMO" and "LUMO." He used the word "ionization potential" and "electron affinity," correct?

A Sugiura speaks in terms of ionization potential and electron affinity.

Q Okay. And it is your opinion that HOMO corresponds to ionization potential, and LUMO corresponds to electron affinity, correct?

A That's my opinion and the position of the general community.

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Q Okay. Let me ask you a question. For both Choulis and Sugiura, at least for claim number 1, do you contend any limitation is missing?

A No. I -- I contend that Sugiura and Choulis both teach claim 1.

Q So you -- your position is that Choulis and Sugiura anticipates claim 1?

A Yes. I'm just going -- let me just go back to my disclosure.

Yeah. So looking at, for example, for Choulis, claim -- claim 1 is disclosed fully by Choulis.

Q Okay. What about claim number 2?

A Claim 2 is -- is -- so Choulis -- claim 2 is -- is anticipated, but if not anticipated, it's also obvious.

Q So, for Claim No. 2, are you relying on the same embodiment as Claim No. 1, or are you relying on a combination of two different embodiments?

A So, Choulis gives significant

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flexibility in the active materials used for the different matrix materials and emitter material in the light-emitting layer.

And Choulis specifically calls out that polymethyl methacrylate, PMMA, as we've discussed before, can also be used as a matrix material and is an insulator. And so, to meet claim 2, I am using the fact that Choulis calls out and teaches PMMA as a matrix material to satisfy the requirements of claim 2.

Q So you are proceeding under anticipation or obviousness?

A I'm proceeding under anticipation initially, but also consider in paragraph 100 that even if Choulis didn't disclose this that it would be obvious to a person skilled in the art to use a matrix material that has a wide energy gap. So, essentially, I'm anticipating, but then also making an obviousness argument as well.

Q And what is a reason that a POSITA would use PMMA instead of PVK?

A So the advantage to using PMMA allows

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all of the transport to be pushed to the hole and electron transporting moieties of Choulis, which would make it easier to optimize transport in the emissive layer of the device.

And then I also call out the fact that wide gap hosts trying to accomplish this with -- with phosphorescent emitters had been known at the time, trying to push, essentially, transport to a guest rather than rely on the host, and so a person skilled in the art seeing that literature would have -- would have thought to apply the same approach using the materials suggested by Choulis.

Q Have you ever used a solution-based process for PMMA, TPD and PBD?

A No. I haven't performed that experiment myself.

Q Have you ever used PMMA as a matrix material for emission layer in your research?

A I don't think I have.

Q Do you know its solution processability?

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A I know PMMA is very solution processible as a person skilled in the art because it's often used as a resist in other applications, so it certainly can be processed out of solution.

Q And do you know the miscibility of TPD, PBD and PMMA in solution process?

A That's -- in general solution processing, based on Sugiura, there -- and Choulis, there's -- based on Choulis, there's certainly good solution processability for PBD and TPD in general.

Q The three mixed together, do you know whether they can form --

A Which -- which three --

Q -- a film --

A -- materials are you referring to?

Q The TPD, PBD and PMMA.

A Do I know if those materials mixed will form a film?

Q Do you know whether they will form a film, a homogenous film, as you were assuming?

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A I -- I didn't -- I didn't make any further assessment of homogeneity for those materials.

Q Okay. And you did not assess whether use of PMMA instead of PVK is going to afford the level of doping that was possible in PVK; is that correct?

MR. GARR: Objection to form.

THE WITNESS: Can you rephrase that? I just want to make sure I'm clear on what you're -- what you're looking for.

BY MS. ZHONG

Q So what will be the -- if you use PMMA, what will be the composition of the -- the different components?

A I can't know that off the top of my head. I don't know what the specific composition would be, but it would be routine optimization for a person skilled in the art to adjust the composition of PBD and TPD to re-optimize the device.

Q And do you know whether after

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optimization you will be able to obtain a suitable device?

A I don't know that a priori, but I would have a likelihood of success given that I could now better adjust my electron hole transport without worrying about transport on the -- on the first matrix material on PVK.

Q Are you aware of any PMMA-based film that contains PMMA, TPD, PBD and the iridium emitter?

A Are you asking if I'm aware through this literature showing that precise combination?

Q Correct.

A I did not look for such a piece of literature in this -- in my work on this particular patent.

Q And in your line of work, you have never made such a film, correct?

A I have not previously combined PMMA, TPD, PBD and the stated iridium emitter in a solution process film.

Q Okay. Have you ever combined PMMA

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with TPD?

A In my own work, I have not combined PMMA with TPD.

Q What about PMMA with PBD?

A In my own work, I haven't combined PMMA with PBD.

Q PMMA with the iridium emitter?

A I have not made that combination in my own work.

Q Okay. Have you ever tried to use evaporation process to make the PMMA? Sorry.

Have you ever tried to use evaporative process to deposit a PMMA film?

A I haven't -- I haven't previously worked with the PMMA film that you're describing.

Q Sorry. I didn't hear your answer.

A Can you clarify your question?

Q Have you ever used evaporative process to deposit a PMMA film?

A I have not previously used an evaporative process to deposit a PMMA film.

Q Have you ever used an evaporative

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process to process a PVK film?

A In my own work, I have not previously evaporated PVK films.

Q So, in your previous work, you used solution-based process to deposit PVK films?

A I did, because the additional material we were using was also requiring solution processing.

Q What was the additional material it was using?

A Nanocrystals of silicon.

Q So they can't be deposited through evaporative process?

A Nanocrystals of silicon? Not -- not at standard thermal evaporation process. They require plasma-based processing. They're a very different material system.

Q Okay. And have you tried to make a NEAT PVK film through evaporative process?

A I've never had to attempt making a NEAT PVK film through an evaporative process, so, no, I haven't done that.

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Q Now, for claim number 3, are you proceeding under anticipation or obviousness?

A Regarding Choulis?

Q Correct.

A I'm arguing that in claim 3, Choulis actually discloses this claim.

Q So you're proceeding under anticipation for claim number 3?

A I am.

Q Okay. What about claim number 4?

A Claim number 4, I'm taking again an approach where -- arguing that I -- that Choulis anticipates this, but, at a minimum, renders it obvious.

Q Do you know what PMMA's transport -- the mobility for -- in PMMA for electron or holes?

A I know that PMMA is an insulator. I know that being a person skilled in the art, and I also know that because Choulis describes it as such.

Q Okay. Is PVK an insulator?

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A PVK in Choulis is recognized as a hole transport material.

Q Okay. And PMMA is an insulator because it's -- no holes or electrons can be injected into it?

A No. I'm referring to paragraph 44 in Choulis. "In some embodiments, the light-emitting layer includes materials that are insulated matrices. The host does not have transport properties."

And so my read of that is that the material itself is an insulator, that it is actually an insulating material that would have low mobility and low -- low transport property. So, because Choulis does not describe this as relative to some injection, I'm applying the definition accordingly.

Q So you read the transport as synonymous to mobility?

A No. I'm reading here that this is an insulated matrix -- insulated matrices, and by calling it that, right, I think Choulis is

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intending to refer to it as a material that actually is a poor transporter of charge, not just a material that has, you know, challenges in accepting charge.

Q If it has challenges in accepting charge, that would also make it an insulated matrix, correct?

A If it has challenges accepting charge, then I think one would also -- that that would also make it a poor charge transport in the context of an OLED, but, here, because Choulis doesn't actually say that due to injection, I interpret this as being more a transport property of the material.

Q Okay. But Choulis also -- Choulis makes all these disclosures in the context of an OLED device, correct?

A Well, here, I -- in paragraph 44, I don't think that's what he's doing. He's saying that the material does not have transport properties.

If it's in the context of an OLED

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device, one would have to be offering some relative energetic alignment because it depends then on where the charge is originating to.

Q Choulis is describing the manufacturing or fabrication of an OLED device and describes the materials that can be used in that device, correct?

A That's correct.

Q Okay. By the way, in paragraph 105, do you see that you were trying to cross-reference --

A Yes.

Q -- certain --

A And I can --

Q -- sections --

A Yeah. I apologize for that. Those were meant to refer to section VIII.A.5 and VIII.A.6, the two subsequent sections regarding the one electron --

Q Which sections?

A The subsequent section. So that first missing call-out should be section VIII.A.5,

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basically --

Q Eight --

A -- on the next page.

Q Eight five --

A Yeah, eight --

Q So like paragraph 107 and 108?

A Correct. Paragraph -- yeah, that section VIII.A.5.

And then the second missing reference should be calling out to the subsequent section VI.

Q So paragraphs 109, 110?

A Paragraph 109. And since we're talking about this, there's one other errata item I can call out now as well on page 115.

Q 115?

A 115, paragraph 256.

Q Hold on.

A Yeah.

Q 256. Okay.

A Second to last line of the document, "does not function as a charge carrying

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material," that should be calling out paragraph 44 of Thompson for that final quote.

Q Okay. Now let's go back to your Choulis --

A Okay.

Q -- analysis.

A Sure.

Q For claim number 5, is it again you contend that it's anticipation?

A Claim 5, I am intending it is fully disclosed, and that's because Choulis discloses, basically, TPD as a -- as a hole transporting material.

Q Okay. And same with claim 6; you contend that's anticipation?

A Claim 6 is also anticipation, as PBD is a material that performs electron transport.

Q And same with claim 7?

A Yes. Because claim -- claim 7 is also anticipated because Choulis is building a light-emitting layer, which is one of the allowed functional layers of dependent claim 7.

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Q So for claims -- let me put it -- so for claims 3, 4, 5, 6 and 7, you are not offering any obviousness opinions or why -- for example, you don't offer any opinion --

A No, in claim 4 --

Q -- on modification, correct?

A Claim 4, I do argue that -- or I do opine that Choulis discloses this claim or, at a minium, renders it obvious.

The other claims you listed are pure anticipation out of Choulis.

Q Okay. And claim number 8, is that pure anticipation again?

A Claim number 8 is also, yeah, disclosed by Choulis. That's anticipation because the doping concentration is 6 percent for Choulis' light-emitting guest.

Q Okay. And for claim number 9, is it anticipation or anticipation and obviousness?

A So claim 9 is anticipation and obviousness.

Q Okay. You understand that Choulis --

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strike that.

In Choulis, they are focusing on two interfacing layers, correct?

A I do understand that.

Q Okay. And they want the interfacing layers to have certain energetic alignment with the emitter materials, correct?

A With the light-emitting layer.

Q Yeah.

A I understand that.

Q So for -- so, for example, it wants the LUMO of the emitter to be within 0.2 eV of the interfacing materials on the cathode side, correct?

A Is there a particular line of Choulis you just want to point me to there to make sure that I'm following that same text?

Q I believe 0015, paragraph 15, is part of the general concept.

A Okay. Yeah. Middle of the paragraph, first interfacial layer. Is that where --

Q Yeah.

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A -- you're looking?
Q Uh-huh. Do you see --
A Yeah, that --
Q I have not really counted the number. The first --
A No, is it --
Q -- interfacial --
A Is it --
Q -- layer can --
A Yeah, that --
Q -- have a LUMO level --
(Reporter clarification.)
BY MS. ZHONG
Q So paragraph 15.
A I see it.
Q Okay. And do you see that in the middle it says, "The first interfacial layer can have a LUMO level that is within 0.2 eV, such as within 0.1 eV, of a LUMO level or triplet energy level of the phosphorescent organic material"?
A Yes, I see that sentence.
Q Okay. And for Figure 4 that you relied

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on, the first interfacial material is PBD, correct?

A Let me just go to -- I'm just going to go to Figure 4.

All right. Can you ask your question again now that I'm looking at Figure 4?

Q Yeah. So the first interfacial material is PBD, correct?

A No. In figure -- in Figure 4, the first interfacial material, I think, is TFB.

Q And that's a LUMO matching layer, right?

A Yeah.

Q The LUMO matching layer, I believe, is the interfacial material, the first interfacial material.

A Yeah. Aren't you asking about the first interfacial material?

Q Yeah. That's a LUMO matching material, correct?

A Oh, so are you asking about layer 360 or layer 380?

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Q Why don't we just do the -- the LUMO matching material.

A So layer 380 in Figure 4?

Q Yes.

A Okay.

Q And the LUMO matching material is designed to have a LUMO level that's within 0.2 eV of the LUMO of the iridium complex, right?

A That's what's noted in paragraph 15.

Q Okay. And so if you replace the iridium complex with rubrene, then the LUMO of the LUMO matching layer will be about 0.75 eV higher than the rubrene eV; is that correct?

A Yeah. I think that's shown in my figure on page 61 of my declaration as well.

Q Okay. So that's way higher than the 0.2 eV that's disclosed in paragraph 0015, correct?

A It's higher. It is higher.

Q It's about 0.5 eV higher than the desired range, correct?

A Okay.

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Q Did you consider that when you make the argument to replace iridium with rubrene?

A I did not consider that because my concern was not of the interfacial layers. What I was looking at was a person skilled in the art seeing this architecture of Choulis and their light-emitting layer and then extending that or emission at other colors with other emitters.

Q The Iridium(mppy)3, what color is that? I thought it's red.

A Is there a particular spectrum you're pointing to.

Q Iridium(mppy)3, is that a red emitter?

A Actually, I'm not sure I know the exact emission spectrum of Ir(mppy)3, so I don't think I can comment on that.

Q Okay.

A Actually, pardon me. Let me just actually examine another exhibit here.

Yeah, pardon me. No, it's a green emitter.

Q It's a green emitter?

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A Uh-huh.

Q Okay.

A If you look at Exhibit 1017, Figure 2(b).

(Deposition Exhibit Number 1017 was marked for identification.)

BY MS. ZHONG

Q Now, for Choulis Figure 4, that is an embodiment that includes both the HOMO matching layer and the LUMO matching layer, correct?

A No. In -- all I'm worrying about in Figure 4 on Choulis -- oh, you're asking Figure 4 on Choulis, not my figure in 61?

Q Correct.

A Figure 4 in Choulis is a full device with the matching layers.

Q Okay. And all you are proposing to replace is the emitter, nothing else, correct?

A That's all I propose to replace.

Q Okay. So the two LUMO matching layer and the -- strike that.

So the LUMO matching layer and the HOMO

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matching layer in Figure 4 of Choulis will remain there in your proposed modification, correct?

A I didn't -- I didn't make an opinion on what the matching layers would have to -- would have to be changed to or not. My emphasis was on the composition of the light-emitting layer in Choulis.

Q Okay. That's what I'm trying to get.

Your proposed modification is only with reference to the emitter material, correct?

A With reference to the emitter material?

Q Yeah.

A I don't specifically comment on the light-emitting layer, and so I am changing the emitter material.

Q Okay.

A Pardon me. I don't specifically comment on the matching layers. I am changing the emitter material.

Q Okay. And you did not propose to change the matching layers, correct?

A I didn't propose to change the matching

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layers.

Q Okay.

A But, if necessary, that would be something that -- that could be done by a person skilled in the art.

Q Well, I'm just talking about what you did propose. You did not --

A I --

Q -- propose making any of those changes, correct?

A No. I proposed to change the iridium complex for rubrene.

Q That's the only change you proposed?

A That's the only change I'm proposing.

Q Okay.

A I'll also note that I proposed other possible emitters as well regarding --

(Inaudible crosstalk.)

Q Understood. We'll go to there. Another emitter that you propose is PQ iridium, correct?

A Yes, PQIr.

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Q And according to you, the LUMO level for the PQIr is 2.7 eV or minus 2.7 eV?

A Yes. That's from the literature, not just according to me.

Q Okay. And that's about 0.3 eV away from the LUMO of the LUMO matching layer 380 in Figure 4 of Choulis, correct?

A Let me just go back to that figure. So, again, looking at Figure 4 and PBD as the LUMO matching layer, is that -- is that what you're asking?

Q As shown in Figure 4 of Choulis.

A Figure 4, yeah. Yes, it is also -- the difference between those two numbers is .3, yes.

Q 0.3 eV. Okay. Then let's look at another --

A Pardon me. I just want to make sure I heard you correctly. .3 eV. I thought --

Q Yeah.

A -- you might have said 3.3. Okay.

Q Yeah. So the difference -- let's just -- just --

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A The difference --

Q Just in case that the court reporter didn't get it, what you meant is that the difference in the LUMO levels between the PQIr and the LUMO matching layer is 0.3 eV, correct?

A The difference between those two levels is 0.3 eV.

Q Okay. And then let's look at another proposed emitter, DCM2, in your -- on your page 61.

A Yes.

Q Okay. And the LUMO level you listed here is minus 3.11 eV, correct?

A That's correct.

Q And so the LUMO level difference between DCM2 and the LUMO matching layer in Figure 4 of Choulis will be about 0.7 eV; is that correct?

A That's the difference between 2.4 and 3.11.

Q Okay. Now let's go to claim 11.

And for dependent claim 11, are you

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also proceeding only under anticipation?

A Yes, I'm proceeding under anticipation. Choulis discloses this.

Q Okay. Same for claim number 12?

A Yes. Choulis discloses this as well.

Q And same for claim 13?

A Yeah. Choulis also anticipates this claim as well.

Q Okay. And you are not -- are you proceeding under obviousness for claim 13?

A For claim?

Q 13.

A Pardon me. I thought you just asked me about claim 13. Claim 13 is -- is -- I'm arguing that it's anticipated in claim 13.

Q Okay.

A Well, pardon me. With the exception of simultaneous application, it's anticipated or, at a minimum, is obvious for that portion of claim 13.

Q Okay. And let's look at paragraph 134 of your declaration. You said it would have been

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obvious to a POSITA to apply the first matrix material using evaporative coating.

A Uh-huh.

Q Is that correct?

A Yes. That's -- that's what I've written in 134.

Q Okay. Are you aware of anyone actually using evaporative process to deposit PVK?

A Exhibit 1023 is the reference I cite to support that --

Q And --

A -- that conclusion.

(Deposition Exhibit Number 1023 was marked for identification.)

BY MS. ZHONG

Q Okay. In Exhibit 1023 --

A Yes.

Q -- it shows that there is decomposition of PVK when you deposit it through evaporation, correct?

A It does.

Q Is that desirable?

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A It depends what the decomposition products ultimately are. What's important about this exhibit is that the OLED that's actually manufactured does work, and so the device that's constructed from vapor process PVK and then an Alq3 emissive layer/electron transport layer does -- does emit light and does still carry holes, which would imply that whatever vinylcarbazole is created is still acting as a hole transport material.

Q And that process does not include TPD, PBD or the iridium complex, correct?

A No.

Q Okay. Do you know of anyone who has done evaporative process to process all these four materials?

A Can you just list those materials again for me?

Q TPD, PBD, PVK and an emitter material.

A I'm not aware of a work where all of those specifically are processed from vacuum.

Q And do you know a priori whether

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evaporation with -- of these materials together will provide you with an OLED device that operates satisfactorily?

A Can you define what you mean by satisfactorily?

Q A device that will meet Choulis' operation goal.

A So I think based on the fact that Exhibit 1023 shows that the hole transporting capability of -- of PVK despite degradation is preserved in the purpose of making an OLED, a person skilled in the art would expect that adding TPD and PBD and the iridium phosphor to the evaporated PVK film would have a likelihood of success.

Q Will it perform the same as when they did the solution?

A I can't know whether or not it performed the same without --

Q Would it have --

A -- doing the experiment.

Q Sorry. Would it perform better?

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A Again, I -- I can't know that, whether it performs the same or better. The goal would be: Would a person expect success? I think, based on the prior art, they would expect success in processing PVK from the vapor phase to make this OLED.

Q So your obviousness is examining whether there is a likelihood of success, correct?

A For the obvious -- obviousness side of the argument.

Q But you don't know whether evaporative process is going to improve performance, correct?

A I don't know that.

Q Okay.

A But the obviousness argument for 13D is on top of the anticipation argument that Choulis is already showing simultaneous application in the solution process approach as well.

Q Do you know whether the evaporative process would lead to higher yield than Choulis' solution-based process?

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A I know that in general there are advantages to evaporative processing in terms of control over layer thickness, control over composition and manufacturability, and that would be part of the reason that a person skilled in the art would be interested in trying to use an evaporative process to process PVK.

Q And the evaporative processes are usually used with small molecules instead of polymers, correct?

A In the context of OLEDs, correct.

Q Okay. Are you aware of any commercial process where polymer materials are evaporated for OLEDs?

A That's not something I had to draw an opinion on as part of this work --

Q Okay.

A -- so I don't want to speculate on the variety of commercial processes that exist.

Q And other than Exhibit 1023, have you seen any other articles where PVK is deposited through evaporative process?

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A I didn't look for any other articles for evaporative processing of PVK.

Q And do you know whether after 2001 anyone knowing this article even tried to use PVK -- to deposit PVK through evaporative processes?

A I didn't do any further tracking of evaporative application of PVK.

Q And if PVK decomposes during evaporation, is that an increase in the control of the composition?

A So you're asking -- can you ask again? Composition of what -- what component, what parameter?

Q So if PVK depositions through evaporation results in decomposition of the materials, does that mean you also -- you have increased the control over film composition?

A The general increase in control over a film composition and film uniformity in vapor processing is inherent to the vapor process itself and the fact that you don't have to rely

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on curing and solution processing to form film. So that's inherent to vapor processing.

Q But, generally, when you use vapor processing, it's with small molecules and you make sure that they don't decompose, correct?

A That's correct.

Q Okay. And so one of the kind of design principles for evaporative process for the OLED when you use vapor process is to make sure that the materials don't -- don't decompose when you evaporate them, correct?

A The criteria that a person skilled in the art might use in deciding on vapor processing versus solution processing could be quite broad, but decomposition would be one of the things that a person would consider.

Q Okay. And let me ask you -- just follow up to clarify.

So, Djobo, or Exhibit 1023, is the only instance you're aware of evaporative process of PVK; is that correct?

A That is the only reference that I -- I

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went and looked for. I didn't perform a broader exhaustive search. I found Djobo and felt that it was strong on its own.

Q Okay. You -- you know the -- you know -- you have been working in the OLED industry for about 20 years, right?

A Uh-huh. Oh, academia research, not industry.

Q Academia. As part of the academic research, you know what's going on in other academic groups, correct?

A Yes.

Q Okay. Are you aware of any instance of those other academic research groups that use evaporation to process PVKs?

A As I said earlier, I'm not aware of any other literature on the vapor processing of PVK.

Q Not just literature, but just through your general experience and knowledge of what other groups, research groups --

A Well, my --

Q -- are doing --

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A -- knowledge of what other research groups are doing is through the literature, so that -- that's how I'm informed with what's happening in the community. So, when I say "the literature," that's -- that's how I stay in tune with what other groups are doing.

Q I see. So are there collaboration between you and some of the other groups?

A I'm sorry. I missed part of your question.

Q So do you have collaborative projects or like joint research projects with other research groups?

A In my research group, I have collaborations with other groups.

Q Okay. Do those other groups use evaporation to process PVK?

A Those -- those other groups aren't even currently using PVK.

Q Have they used PVK in the past?

A I -- I don't know. Possibly. I've never looked at their full publication history to

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1 look only for if they used PVK.
2 Q But were you aware of them ever using
3 evaporation to process PVK?
4 A So I think I answered that earlier,
5 where I said that I'm not aware of other
6 literature on the vapor processing of PVK.
7 Q Okay.
8 THE REPORTER: Would it be possible to
9 take a restroom break soon?
10 MS. ZHONG: Sure. We can take a break.
11 (Recess 12:10 p.m. to 12:18 p.m.)
12 BY MS. ZHONG
13 Q So we were discussing claim number 13
14 just now.
15 And for claim number 14, Choulis
16 ground, is it again both anticipation and
17 obviousness?
18 A Yes. And on -- yes.
19 Q Okay. What about for claim 15 and 16?
20 A So I will add something on claim 14.
21 The obviousness is also the fact that Choulis
22 allows small molecules to entirely replace PVK,

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and you can just use small molecules entirely in the -- in the device for 14 as well.

Q Okay. And for the small molecules, did you propose any specific small molecules?

A I did not propose a specific small molecule.

Q And so you did not propose any specific small molecules or their respective HOMO and LUMO levels, right?

A I did not.

Q Okay. And for claim 15 and 16?

A For claim 15, it's anticipated. And then 16 is also anticipated.

Q Okay. And so let me just summarize for this particular ground.

So, for ground number 1, you believe it's anticipated? No, for claim number 1, it's anticipation only?

A Can you go through that again?

Q Okay.

A Just give --

Q So we're on number 1.

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A Just -- just give me a moment.
Q Okay.
A Yeah. Ground number 1 or claim -- claim 1 is fully disclosed by Choulis.
Q Okay. So for ground 1, claim number 1, you only proceed on anticipation under Choulis, correct?
A That's right. I am only arguing anticipation.
Q Okay. And for claim number 2, it's anticipation or obviousness, correct?
A Yeah. Or, at a minimum, renders it obvious, yes.
Q Okay. And claim number 3, only anticipation?
A Claim number 3 is only anticipation for Choulis, yes.
Q Okay. Claim 4, anticipation or obviousness, correct?
A That's correct.
Q And 5, 6, 7, 8, anticipation only, correct?

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A That's correct.

Q Claim No. 10 is anticipation or obviousness, correct?

A That's correct.

Q 11, 12, anticipation only?

A That's correct.

Q 13 and 14, anticipation or obviousness, correct?

A Yes. For 13 and 14, correct.

Q And 15 and 16 tracks claims 2 and 4, correct?

A 15 and -- 15 and 16 are anticipated.

Q Okay. Then, for claim number 9, it's only obviousness?

A Claim number 9 is obvious in light of Choulis and Yong.

Q Okay. We will come back to that.

Then let's go to ground number 3, which is Sugiura.

A Okay.

Q For Sugiura claim number 1, is it anticipation only?

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A Let me double-check my report. Yes.
Q Same for claims 3, 5, 6?
A Yes, they are --
Q So --
A -- anticipated --
Q Sorry.
A -- and disclosed by Sugiura.
Q Okay. So you only proceed on anticipation for claims 3, 5, 6, 7 and 8 as well?
A Sorry. I thought we already talked about 3. 3 was anticipation. 5 was --
Q Right.
A -- anticipation. Yes.
Q Is claim 5 anticipation only, too?
A Yes.
Q And claim 6 is anticipation only under Sugiura?
A Yes.
Q Okay. And claim 7, anticipation only?
A Yes.
Q Claim 8, anticipation only?
A Yes.

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Q What about claim number 10?
A Anticipation.
Q Claim 11 and 12, anticipation?
A Claim 11, in my opinion, yeah, anticipation. Claim 12, anticipation.
Q Okay. And what about claim 13?
A Yes, anticipation.
Q Claim 14 -- you -- you don't --
A I don't assert --
Q -- assert that --
A No.
Q Nothing about claim 14, correct?
A I don't assert Sugiura for any other claims.
Q Okay. And ground number 4, Thompson, it's only asserted against claims 15 and 16, correct?
A That's correct.
Q And is it anticipation or obviousness?
A Anticipation or, at a minimum, obvious.
Q Okay. So, for claim number 15, which element are you proposing to modify?

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A Let me just look at my report here. Pardon me. Claim 15 is anticipated.

Q Okay. What about claim 16?

A Claim 16 is anticipated or, at a minimum, obvious.

Q And for obviousness, what is the proposed modification?

A Pardon me. I'm trying to -- I don't think there is a modification in claim 16.

Q Sorry. I didn't catch your --

A Yeah, I'm --

Q -- answer.

A I'm just looking again. I want to make sure I'm clear.

Q Okay.

A Yeah, actually, claim 16 is anticipation, and so both 15 and 16 are anticipated.

Q Okay. So let's go back to claim number 9, ground number 2.

A Claim 9?

Q Where is it? Page 75, paragraph 160.

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A Yeah, I'm there.

Q Yong uses an evaporative process, correct?

A That's correct.

Q You are not contending that a solution-based process will yield a concentration gradient of the emitter material; is that right?

A No. I'm using Yong with evaporation.

Q Okay. So you are proposing to modify Choulis' solution-based process first to change it to --

A Well, I'm --

Q -- evaporation?

A I am using the fact that Choulis allows for evaporative small molecules as part of their discussion.

Q Okay. Choulis specifically allows for evaporation of the small molecules, correct?

A Yes. Choulis -- Choulis discloses the small molecules to be used and also several techniques, evaporation, sublimation and solution processing.

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Q Okay. And Choulis does not propose using evaporative process with polymers, correct?

A Choulis does not explicitly propose that. That's what I argued previously in the context of the Djobo reference.

Q Okay. And PVK is a polymer material, right?

A PVK is a polymer material, yes.

Q PVK is not considered to be a small molecule material, right?

A No. It's a polymer material.

Q Okay. And when you say Choulis specifically allows for evaporation of small molecule materials, you are not proposing to substitute PVK with a small molecule material for claim 9; is that correct?

A Let me just make sure I get my testimony correct here. I don't exclude the possibility of using evaporative PVK for -- for claim 9.

Q Did you propose to use evaporative process for PVK expressly in your discussion of

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claim number 9?

A My emphasis in claim number 9 was on just using evaporative processing. I didn't specifically call out evaporative processing of PVK again.

Q Okay. Did you propose for claim number 9 of replacing PVK with a small molecule?

A Again, I didn't propose a specific material for -- for PVK in claim 9.

Q Can you point me to where you propose to replace PVK with a small molecule?

A In claim 9?

Q For claim number 9, yeah.

A I didn't say that I did.

Q Oh, okay. In claim 9, relying on evaporative processing being a method that could be used to create Choulis.

Q Okay. Now, in Yong, they used a gradient because there is a charging balance from the ETL to the HTL layers, right?

A Yong is trying to correct a charging balance in the OLED.

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Q Okay. In particular in the emission layer?

A Yes. That's what charging -- that's the only place charging balance is generally considered.

Q Okay. But in Choulis, by using the electron transport materials and the hole transport materials, they actually create a film where the charge is balanced, correct?

A They propose an approach to improve charge balance. I don't think there's evidence to suggest that it's perfectly balanced.

Q And is there -- do you know what the resulting charge distribution is in Choulis' film?

A No. I don't know the spatial distribution of charge in Choulis' device.

Q Okay. So is it locally balanced but microscopically balanced or it's -- as in Yong, there is kind of a gradient of imbalance, a kind of gradient of the charge distribution?

A I'm not sure I follow the question.

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Could you please rephrase that?

Q Okay. So, in Yong, you know that the charge -- where the -- the charge distribution really is, right? There is more of a concentration of holes near the hole transport layer and less so near the electron transport layer.

But do you know what the charge distribution really is in Choulis?

A I -- I don't know a priori where the charge distribution really is in Choulis.

Q Okay. And you don't really know whether the charging balance is actually random within the film or there is actually a kind of gradiant, right?

A I don't think I understand your -- the use of your terminology, the charging balance being random. I'm not familiar with that terminology and its use for recombinations on a charge balance. So can maybe you phrase things differently?

Q So, in Yong, they -- they noted that

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there's kind of a gradient of the electrons and the holes throughout the --

A That's a carrier concentration gradient. I don't -- the term "charging balance gradient," I don't think is something that I've -- I've come across before, but there is --

Q Okay.

A -- carrier concentration profile in Yong, yes.

Q So, in Yong, there is a carrier -- from the ETL edge to the HTL edge, there is a hole concentration gradient and there is a hole concentration gradient, correct?

A Can you restate that?

Q So, in Yong, from the electron transport layer edge to the hole transport layer edge, there is a concentration gradient for the holes and there's a concentration gradient for the electrons, correct?

A I didn't necessarily, you know, make an assessment as to the specific charge profile in Yong, but in an OLED, there can be electron and

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hole concentration gradients in the emissive layer.

Q And Yong is trying to address that concentration gradient for its doping solution, correct?

A Yong's objective is to improve charge balance in the emissive layer of the device.

Q And it's trying to specifically address the observation that there's a charge carrier concentration gradient through the emission layer, correct?

A Yong's stated goal is to better match the emitter concentration to the carrier profile.

Q Okay. And do you know what the carrier profile is in Choulis?

A No, not a priori.

Q Okay. Do you know whether there is even a gradient throughout the film in Choulis?

A I'd only be able to speculate. I don't know for a fact what the carrier profile looks like in Choulis.

Q Okay. And was Choulis' attempt to have

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the interfacial layer -- strike that.

Was Choulis' invention that included the LUMO and HOMO matching layers as well as the electron transport materials and hole transport materials the -- the goal for Choulis is trying to eliminate the carrier concentration gradient; is that correct?

A The goal in Choulis is to improve charge balance.

Q So that there is not going to be a carrier concentration gradient from one --

A I --

Q -- edge to the other?

A I wouldn't add that. No, I wouldn't add that. No, the goal is to improve charge balance in Choulis, which is going to improve efficiency.

Q Okay. And that's the same goal as in Yong, correct? It's also trying to achieve some kind of charge?

A Yong is also trying to improve charge balance.

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Q Okay. So Yong's concentration gradient of the emitter is trying to create a charge balance system, correct?

A Trying to create a charge balance -- what was the last word?

Q System.

A Yong's invention is trying to improve charge balance in the emissive layer.

Q The same goal as Choulis?

A Same general goal.

Q And you don't know the resulting charge balance in Choulis, correct?

A Choulis does not explicitly give any sort of measure of their -- their charge balance of the device.

Q Choulis gives some results in Figure 5 of his -- of the -- of the patent application, correct?

A Yes. Choulis does disclose results in Figure 5.

Q Does that provide any information as regarding the charge balance?

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A I did not analyze these in details, but efficiency on its own is not sufficient to tell you what charge balance is.

Q But you also don't know whether Choulis has charging balance in its film, correct?

A Based on the -- I don't know for a fact if Choulis has charging balance in the film.

Q Okay. And you don't know -- I think you already said you don't know what the charge concentration profile is in Choulis, correct?

A Choulis doesn't report that.

Q So you don't know whether Choulis wants to have a doping concentration of the dye gradually increases or decreases along the direction from the anode layer to the cathode layer, correct?

A Choulis does not disclose a gradient, but a person skilled in the art would see introducing a gradient as an additional means to improve the device.

Q If Choulis already achieves charge balance, would there still be a need for

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gradient?

A There could be, just because of the fact that even if one achieves perfect charge balance, there still might be questions related to where the recombination zone is in the device as it relates to, say, stability and other considerations one still might want to pursue for introducing a graded composition profile.

Q Do you know what the recombination zone is in Choulis?

A I don't know what the recombination zone is in Choulis. It's not disclosed.

Q Do you know -- for Figure 4 embodiment in particular, do you know what -- where the recombination zone might be?

A I think that's the question you just asked me. It's not --

Q Yeah.

A -- disclosed in Choulis.

Q So your position is that Choulis did not disclose that information for any of its embodiment?

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A Not sufficiently to answer the question that you're -- that you're asking.

Q Okay. Now, if Choulis -- if you introduce a gradient in Choulis' device, will that improve Choulis' device's luminescence efficiency and stability?

A Again, that's speculation. A person skilled in the art would see Yong and the graded approach as another approach to engineer charge balance in Choulis and potentially further improve efficiency and stability and other parameters of interest.

I can't say a priori whether or not the efficiency and stability would go up or by how much.

Q And in Yong -- strike that.

Yong's device does not have the electron transport materials or the hole transport materials as in Choulis, correct?

A Is there a particular embodiment of Yong you're making that assessment on?

Q I'm just asking you in general in Yong.

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A Oh, I did not pull up the embodiments.
So if you consider, for example, document page 23, table 2 of Yong, there's several embodiments listed with graded emissive layers that do have hole and electron transport layers.
Q I mean in the -- in the emission layer.
A Oh, Yong's emission layer is a DCB host and a FIrpic phosphorescent guest.
Q Okay. So Yong's emissive layer doesn't have the hole transport materials or electron transport materials in them, correct?
A Not as additional moieties, no.
Q So Yong's emissive layer does not have the added components as in Choulis, correct?
A Does not have which components?
Q The added components as in Choulis, correct?
A The added components being --
Q The -- the charge carrier materials.
A Yong's device only contains DCB and FIrpic in the emissive layer, if we look at, say,

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embodiment 1. But if you're -- yeah, I think that's as specific as I can be.

Embodiment 2, it's CBP and Ir(ppy). Their emissive layers consist of a host and a guest.

Q What is DCB?

A DCB is the host of that device. Its structure is shown on page -- or document page 14 of Yong, Table 1.

Q So is it an inert matrix, or it has hole or electron transport properties?

A DCB likely has transport properties, but I don't know the relative mobilities or energy levels of DCB.

Q So, since it's a carbazole, does that mean it probably has hole transport properties?

A Again, I didn't say the transport properties of DCB. Not all carbazoles only have hole transport properties.

Q So you don't know the charge carrier transport properties of DCB?

A I don't know specifically the charge

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carrier properties of DCB, but as a carbazole, I suspect it is participating in charge transport.

Q Do you -- you don't know whether it can transport both holes and electrons or whether it can only transport one type of the charge carrier, correct?

A Again, I'm -- I'm going to look back in Yong and make sure I'm not missing a declaration regarding DCB. I didn't worry extensively about the ambipolar character of DCB when thinking about my report.

I would be speculating to say much more about DCB's transport properties, so I don't want to further comment on how good a transporter it is in the emissive layer.

Q Yong also doesn't have the LUMO and HOMO matching layers, correct?

A Yong has hole and electron transport layers, and, again, they're -- they're included in the stack, but they don't make a point of emphasis of what the energetic alignment is of those layers with the emissive material.

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Q And you did not look into that, either, correct?

A No.

Q Okay. And do you think that the energetic alignment will affect the concentration gradient of the charge carriers?

A I could speculate on what the energetic alignment would do in terms of the concentration gradient, but I didn't consider that question deeply in considering the usefulness of Yong in concert with Choulis to address the claim in question.

Q Okay. So the concentration gradient will be a function of both the energy alignment as well as the -- the charge carrier mobilities of the material itself, correct?

A Those are two of the factors that could impact the concentration profile.

Q And what other factors will affect the concentration profile of the charge carriers in the emissive layer?

A The specific composition of the

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emissive layer.

Q And how would the specific composition of the emissive layer affect the concentration gradient?

A The concentration gradient could be impacted by the concentration of the various components of the emissive layer.

Q And can you elaborate on that?

A In what way?

Q How can it be affected by the various composition of the materials in the emissive layer?

A I think that's illustrated well in Choulis, where depending on the amount of the organic moieties I include, hole transport material, electron transport material, one could vary the associated ability of electrons and holes to travel across the layer.

Q Okay. So the concentration gradient in Choulis is likely to be very different than the concentration gradient of the charge carriers in Yong, correct?

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A I didn't say that, and I didn't actually say that I'm aware of what the concentration gradient in Choulis looks like. That's not clearly identified in Choulis, so I can't speculate on how it might compare between multiple devices.

Q Did you try to do any analysis -- strike that.

Did you try to do any comparison of the concentration gradients in the two systems?

A I didn't do any analysis on the concentration gradients in the two systems.

Q You just thought, like, if Yong does it, then someone would do it in Choulis as well, correct?

A No, that's not correct. My argument was that a person skilled in the art realizing that optimizing charge balance is a significant challenge in OLEDs would understand that the skills taught in Yong give you another opportunity to tailor charge balance in the device and would see that Choulis and Yong, both

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recognizing the same problem, combining those solutions would give you additional flexibility in realizing an ideal output for the OLED.

Q Okay. But if there is no concentration gradient of the charge carriers in the emissive layer, would you still do the -- what Yong does?

A Again, I -- the concentration -- concentration gradient of charges in the emissive layer of an OLED is something that can almost always be counted on, just because of the fact that you're injecting holes from one side and injecting electrons from the other. So you can always expect there will be a concentration gradient because holes are coming in and flowing across the layer.

So my concern wasn't that there might not be any concentration gradient in Choulis. All I was concerned with was seeing another approach trying to go after the same problem and having an expectation of success in combining them as a person skilled in the art.

Q So are you saying there is always going

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to be more electrons towards the cathode side and more holes towards the anode side?

A I'm just saying that in an OLED, concentration gradients are -- are not a unique feature because one has hole injection from one side and electron injection from the other. I'm not --

Q So in that --

A -- making any -- I'm not -- I'm not making any further assessment of what the final profile looks like.

Q Okay. So, in that case, how would you -- how would you change the gradient of the concentration of the iridium given that -- given the --

A In --

Q -- concentration --

A In what --

Q -- of the --

A In what case? Can you phrase that as a --

Q In Choulis.

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MR. GARR: Careful about crosstalk.

THE WITNESS: Sorry. I'm not sure precisely how to -- what the specific graded profile would look like in Choulis. I think that would be a point of optimization combining these two approaches.

BY MS. ZHONG

Q Do you even know that there can be a workable gradient given the concentration profile of the charge carriers?

A As I've said a few times, the concentration profile of the charge carriers in Choulis is not known or is not disclosed, at least, in Choulis.

As a person skilled in the art, I would have an expectation for success by modifying the emission -- the concentration profile of the emitter in Choulis.

Q And --

A The fact -- the fact that Choulis already works as a reasonable device would allow me to further optimize that concentration profile

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of emitter using the techniques taught in Yong.

Q Have you ever done a concentration gradient when you were a graduate student?

MR. GARR: Object to form.

THE WITNESS: Can you be more specific? Have I ever -- what does that mean, done a concentration gradient?

BY MS. ZHONG

Q Have you ever done something similar to Yong when you were a graduate student?

A Not as a grad student, but in my independent research in my group, yes.

Q When did you first do that?

A If you look in my publication list, there's papers on graded heterojunction OLEDs where we grade not the emitter, but the hole electron transport layers in the device to improve charge balance.

Q And when was that?

A I don't know. Let's look at my CV. The first time we worked on an OLED with a graded composition was in 2010. We further made solar

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cells with graded compositions in 2010, further solar sells later in 2010. We have additional work on graded OLEDs in 2011.

So, if you're on the list, it would be publication number 22, 23, 25, 32, 34, possibly 39, though I'd have to go back and look at that paper. So 44 --

Q And --

A We've -- we've looked extensively at graded structures, not precisely the same, but certainly similar -- similar architectures.

Q And you said you studied your graduate school in 2000?

A Yes.

Q So ten years after you got your bachelor's degree?

A That was when I chose to start working on that in my own independent research group.

Q Okay. And so about ten years after you started research in OLEDs?

A That was when we published the first paper on gradients that my students in Minnesota

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did. It is not a suggestion that I needed that level of expertise to make a graded OLED.

Q Okay. You didn't think of making a gradient OLED in your graduate studies, correct?

A I don't think that is a full, accurate representation of what I was thinking as a graduate student, because what a graduate student thinks about and what they ultimately work on are sometimes two different things. A graduate student's work is directed in part by their advisor.

Q Did you ever propose to make a gradient OLED as a graduate student?

A In what context? I --

Q As a graduate student.

A I don't have any papers on graded OLEDs as a graduate student.

Q Okay. I mean, not having papers doesn't mean you didn't do work on it, right? It could be because the work didn't yield some spectacular results that warrants publication.

A Memory serves me as to the things I

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worked on -- or memory fails me as to the things I worked on and didn't necessarily publish, so that's why I tend to rely on my publications as the -- as the best record of what I published.

Maybe along these lines, it's worth looking on page 9 of Yong, where Yong does a very nice job outlining the prior use of gradients even to their own work in both solution-processed and vapor-processed devices, just to offer further context for the use of gradients. And these prior works are the year 2000, 2002 and so on, so there's pretty ample prior work on gradients even before Yong.

Q Do you know whether anyone did gradient (inaudible) in Choulis' system?

A Sorry. I don't think I got the whole question.

Q Do you know whether --

A Can you --

Q -- anyone even attempted to do a gradient -- strike that.

For Choulis or similar systems --

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A I'm not --

Q -- what --

A Sorry. I'm not aware of a demonstration of a gradient for Choulis' system. The system referenced regarding Friend on page 8, though, is solution processed.

Q What about same composition, but evaporation process? Are you aware of any attempt to do that?

A When you say "same composition," can you be more specific?

Q The same composition as Choulis' system.

A Again, so PVK as -- as the first matrix? Like four components? Three components? What are the -- PVK as the first matrix? What -- what specifically --

Q Yes.

A -- are you talking about? Yeah?

No, I'm not aware of an evaporated version of Choulis' system using a gradient.

Q Okay. And for the system where you had

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the gradient, what other components in the emissive layer?

A When you say the system I had, what are you referring to?

Q You said you made gradient -- gradient --

A In my own research. It depends on the paper, but the emissive layer generally consisted of a hole transporting material, an electron transporting material, and an iridium phosphor.

Q And is it charge balanced?

A It led to higher efficiency upon grading, but in those devices, the hole and electron transport material were graded. The emitter we tried to keep constant throughout the emissive layer.

Q So the -- the gradation is for the hole and transport materials; it's not for the emitter?

A That's correct, in my prior work. I mentioned that earlier.

Q Okay. I was asking whether you have

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done any work where the emitter materials had a gradient of concentration throughout the emissive layer.

A I don't think I have specifically published anything on a graded emitter composition.

Q Okay. And other than Yong, did you find another paper that actually taught using concentration gradient for the emitter materials?

A Well, the references on page 8 that grade NPD and Alq3, Alq3 is the emitter material. It's also the electron transport layer, so if you look at third full paragraph, where the architecture is -- let me find the beginning sentence.

"In the light-emitting layer of this device, the mass concentration ratio," that sentence, it's a gradient of NPD and Alq, and Alq is the light-emitting layer.

Q But the Alq is also the electron transport material, right?

A It is. It's serving two purposes in

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that device.

Q Okay. What about systems where you have separate electron transport materials, hole transport materials and emitter materials?

A I'm not aware of another -- another publication where the emitter is graded in that way.

Q Okay. And do you know why people don't do it that way?

A Pardon me. I should say I'm not aware of another publication that's prior art. I'm aware of some now.

Q When were those art published?

A I'd have to go back and look specifically.

Q Was it after 2020, or it's between 2010 and --

A Again, I'd have to go back and look. I don't want to guess at the date for something that I -- I wasn't prepared to defend.

Q Okay. Why didn't you do a concentration gradient for the emitter materials

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in your research?

A Why didn't I pursue a concentration gradient for the emitter materials in my research?

Q Correct.

A There -- there's a variety of reasons. I'm not sure how that's relevant.

Is there a specific question related to that that you're looking for?

Q What are the reasons?

A Our interest at the time was in trying to better understand if we could realize charge balance by just grading the hole and electron transport material. That was the main motivation that we had.

We weren't trying to grade the emitter material. Our -- our question was: Can we improve charge balance by grading the composition of the hole and electron transport material? That was quite simply what the question was that we were scientifically trying to answer.

Q Okay. So if your goal is trying to

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balance the charge balance -- the charge carrier balance in the emissive layer, wouldn't it occur to you to do it through the gradation of the emitter materials?

A Certainly, it was a consideration, but at the time we wanted to focus the number of variables we were changing in our OLED.

Again, absolutely, one could still broadly apply the idea, and, again, that -- that's something certainly that we considered as well, but at the time we wanted to consider just the question of the hole and electron transport materials.

Q And did you ever attempt to do the grade -- the emitter --

A In my own research, I -- we didn't expand that work to consider the emitter.

Q Okay. And are you aware of any other research group that attempted to do that?

A To grade the emitter concentration?

Q Yes.

A That's not -- that is prior art or

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isn't prior art?

I've already alluded to the fact that there are papers that have done it since. I just don't have specific call-outs because I didn't use them in preparing for my -- or preparing my declaration.

Q I understand that. So for those researchers, do they have both electron transport materials and hole transport materials --

A I'd have to go back --

Q -- in the --

(Inaudible crosstalk.)

A -- and look. Again, those aren't publications I've reviewed specifically for this -- for this deposition, so I -- you know, I'd have to go back and make sure I'm not mischaracterizing their prior work.

Q Do you know which group that is?

A I'm sorry?

Q Do you know which research group that is?

A The Forrest Research Group has done

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work in this area.

Q So those papers were from the Forrest Research Groups?

A At least one of them that I'm aware of.

MS. ZHONG: Okay. Okay. I see that it's about 1:00 p.m. your time. So do you want to take your lunch break now?

MR. GARR: Sounds good.

THE WITNESS: Sounds good.

(Whereupon, at 1:05 p.m., a luncheon recess was taken.)

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A F T E R N O O N S E S S I O N

(1:53 p.m.)

WHEREUPON,

RUSSELL J. HOLMES, PH.D.

was called for continued examination, and having been previously duly sworn, was examined and testified further as follows:

EXAMINATION BY COUNSEL FOR PATENT OWNER CONTINUED

BY MS. ZHONG

Q Exhibit 1004, do you have that?

A Exhibit -- which -- I missed what you said.

Q Exhibit 1004, Choulis.

A Choulis. Yes, I have it.

Q Okay. Can you please go to paragraph 54 of Choulis?

A Yes, I'm at paragraph 54.

Q Okay. Do you see that there is a specific example for the composition for the control device?

A Yes, I do.

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Q Okay. And then they also made a device 440 with a matching layer. Do you see that?

A Yes, further in the paragraph. I see that.

Q Yes. And do you see that they have -- the light-emitting layer includes 61 percent PVK, 24 percent PBD, 9 percent TPD and 6 percent Ir(mppy)3?

A Yes, I see that.

(Deposition Exhibit Number 1022 was marked for identification.)

BY MS. ZHONG

Q Okay. And can you please pull up Exhibit 1022?

A Yes, I'm looking at 1022.

Q Okay. Do you see that for Exhibit 1022, page -- PDF page number 3 and the original page 203502-2. I'm not really sure how to find the -- PDF page number 3, anyways.

A I'm looking at it as a hard copy, so just the third page of the --

Q Yeah.

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A -- document? Would you prefer for me to look at it digitally?

Q Either way is fine.

A Okay.

Q So, page 3 and first full paragraph on the left-hand side, the paragraph starting with "The device architectures studied are described as follows."

A Okay. So the second page of the document, the second page of the actual publication, 203502-2?

Q Yes.

A Okay. Yeah. I see the paragraph.

Q Do you see that for that particular -- this device, the LEP layer or the light-emitting polymer layer, it also contains 61 percent PVK, 24 percent PBD, 9 percent TPD and 16 percent -- 6 percent Ir(mppy)3?

A Yes.

Q Do you see that?

A I see that composition listed.

Q Okay. So -- and do you see that in

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Figure 2, there were some plots?

Actually, Figure 3, on the next page, there were some plots.

A Yes, I see the plots in Figure 3.

Q Okay. There is a plot for the control device, and there is a plot for PBD interfacial layer only, and there is another plot with PBD and TFB interface layers.

Do you see that?

A Yes. I see the three data sets in the figure.

Q Okay. And is the LEP device composition the same as the example -- in the example in paragraph 54 of the Choulis Exhibit 1004?

A Can you point to the composition you'd like me to compare to Choulis?

Q Paragraph 54, there is one composition for the light-emitting layer, right?

A Yeah. No, I meant in the -- in the paper. You're referring --

Q In the paper -- the one that we just

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discussed.

A Yes. That's the same as Choulis.

Q Okay. And can you take a look at Figure 5 of Choulis?

A Yes.

Q And compared to Figure 3 of Choulis, Exhibit 1 -- 1022.

A Yes, I can compare them.

Q Okay. Does -- so there is a control device 430 in Figure 5 of Choulis Exhibit 1004, correct?

A Yes.

Q And is that the same as the control device in Figure 3 of Choulis 1022?

A Is the device data the same?

Q Does it appear to be the same?

A I haven't compared them closely.

Q Can you compare them?

A At initial glance, they look very similar.

Q Okay. And does the curve for the device 440 appear to be the same as the -- the

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one for the PBD and TFB interfacial layers, the device with PBD and TFB interfacial layers?

A Let me just look at them briefly.

At initial glance, they do look similar.

Q Can you compare the performance data that's described in 54 to the one described on paper number -- page number 2 of the paper, so the -- that's described in the last two lines of the left-hand column to -- the paragraph that's bridging the left-hand column and the right-hand column on page 2?

A Can you maybe -- can you maybe just rephrase that with a little more specificity on where you want to look and the two references you're comparing?

Q Okay. Do you see that page 2 of Exhibit 1022?

A Yes.

Q There is a paragraph starting with "Figure 3" that bridges the left-hand column and the right-hand column?

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MR. GARR: So it's PDF page 3.

THE WITNESS: Yeah. So bottom of the --

MR. GARR: Yeah.

THE WITNESS: -- first column of paper page 2, "Figure 3 upper plot shows"?

MS. ZHONG: Correct.

THE WITNESS: I see it.

BY MS. ZHONG

Q And it provides certain performance data for the devices, correct?

A It does.

Q Okay. And paragraph 54 of Choulis also provides certain performance data for the example device, correct?

A Yes, it does.

Q Okay. And according to 54 of Choulis Exhibit 1004, it states that the peak luminance efficacy power of the control device 430 is 29 lumens per watt and luminance efficiency reaches 40 cd per area.

Do you see that?

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A I see that line.
Q Do you see that?
A Yes, I see that line. Yes.
Q Okay. And that's the same number that's reported in Exhibit 1022, correct?
A Yes.
Q For the control device?
A Yes. I would agree those are the same numbers, at least for the peak efficiency.
Q Okay. And paragraph 54 of Exhibit 1004 mentions that the matching layer device 440 had a peak luminance efficacy of about 50 lumens per watt and luminescence efficiency reaching about 55 candelas per area.
Do you see that?
A Yes, reaching about 55 candelas per atom. I see that.
Q Okay. And that is the same performance number luminance efficacy and efficiency reported for the PBD and TFB interfacial layer devices, correct, in --
A And where are you --

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Q -- Exhibit 1022?

A -- pointing me there?

Q Pardon?

A Whereabouts do you want me to look there? Do you want me to look at the graph or the text?

Q At the text. Exhibit 1022.

A Yeah. I see those efficiencies called out in the text as well.

Q Yeah. And those are for the device with both PBD and TFB interfacial layers, correct?

A That's correct, yes.

Q So does that -- did those numbers in the graphs indicate that the devices that's described in Exhibit 1022 is the example device in 54?

A Can you be more specific? Are you asking is it the same structure or the exact same data?

Q Does it appear to be the exact data?

A It's the same structure. The data is

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similar, but without, you know, digitally analyzing the data, I can't say with absolute certainty that it's identical. But I would say --

Q So they --

A -- it looks very similar.

Q So they look similar, correct?

A Yes. I would agree with that.

Q And the reported peak luminescence efficacy and the efficiency are the same, correct?

A As we've just discussed, paragraph 54 and the paper cite the same peak efficiencies.

Q Okay. And on that same page, there is a Figure 1 in Exhibit 1022, correct?

A Again, this is from Exhibit 1022? Yes, I see Figure 1.

Q Yeah. And is that the same figure as Figure 3 of Exhibit 10 -- Exhibit 1004?

A With the exception of the molecule missing and some energy levels not labeled, it's certainly very similar.

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Q For the LEP composition, they reference Paper 6 and 10, correct?

A Yes. I see where they reference Paper 6 and 10.

Q Okay. And Paper 6 is a paper by Yang, correct?

A Correct.

Q And 10 is another paper by Choulis published in 2005, correct?

A Those are reference 6 and 10, yes.

Q Okay. And Paper 6 is Exhibit 1017, correct?

A Yes, that's correct.

(Deposition Exhibit Number 1018 was marked for identification.)

BY MS. ZHONG

Q And Paper 10 is Exhibit 1018, correct?

A That's also correct.

Q Okay. So why don't we take a look at Exhibit 1017?

A Okay. I've got 1017 open in front of me.

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Q Okay. Paper 17 concerns a system where the green-emitting iridium complex in a polymer host is co-doped with an electron transporting and hole transporting material, correct?

A That's stated in the abstract. That's correct.

Q Okay. And in particular, the dopants are TPD and PBD, correct?

A That's correct.

Q Okay.

A I'll just -- I'll just note, though, for completeness that they're only -- they're dopants because they're being doped into PVK in this case, not applying --

Q Okay.

A -- any other functional definition to the word "dopant" here.

Q And if we go to page 2478, which is the last page of the article.

A Okay. I've got it handy.

Q According to Yang, the TPD concentration -- when the TPD concentration

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exceeds 13 weight percent, the luminescence efficiency begins to decrease, correct?

A Can you point me to a specific line you're pointing at?

Q The left-hand column, the last sentence of the first half, like a partial paragraph.

A "Moreover, the luminous efficiency"? That's --

Q Yeah.

A -- the sentence?

Q Yeah.

A That's what Yang says, begins to decrease for concentrations greater than 13 percent.

Q Okay. And so their theory is that when the TPD concentration exceeds 13 weight percent, TPD begins to disturb the balance of a carrier injection and transport; is that correct?

A That's a correct reading of the following -- the sentence that follows the passage you just read or mentioned.

Q Okay. Does that mean when you have too

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much of the TPD, you are going to upset the balance of hole and electron, the holes --

A It's a reflection --

Q -- and electrons?

A It's a reflection of the fact that for any -- whether it's the hole or electron transporting moiety, there's going to be an optimum concentration. That's all it's --

Q Okay.

A -- effectively saying.

Q So, according to Yang, given the particular concentration of the -- the PBD, you don't want to have too much TPD, correct?

A Can you describe what "too much" means?

Q According to Yang, the TPD concentration should not exceed 13 weight percent because, otherwise, the charge balance will be upset.

A Yang reports that beyond 13 percent, the efficiency will start to suffer.

Q And that is not a good thing, correct?

A Not good? Is that what you said?

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Q Yes.

A Well, efficiency is one consideration. If you look at Table 1, look at the driving voltage column, you can see the voltage continues to fall even as you go beyond 13 percent, and so, certainly, efficiency is one consideration that one would worry about, but voltage and brightness are also considerations, too. But Yang clearly is discussing only efficiency in the sentence that you called out.

Q The voltage -- the driving voltage really doesn't change much going from 9 percent to 19 percent, correct?

A What does "doesn't change much" mean?

Q Did you see that Yang says for the -- okay.

A I'm looking at Table 1, 9 percent, the driving voltage for 100 candelas per meters squared is 4.3 volts. Driving voltage for 10,000 candelas per meters squared is 8.6 volts. And if we go to the extreme of 19 percent, it falls to 4.1 and 8.2. And the brightness is substantially

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increased at 10 volts if you look in the last column.

So I'm not sure how to interpret "not much," but voltage is an important parameter in thinking about an OLED, as is brightness, and so improvements are meaningful.

Q So, in Yang, what -- do you see the sentence bridging pages 3 and 4?

It says, In fact, in a series of devices with an Ir(mppy)3 concentration of about 6 weight percent and different amounts of TPD (Table 1), the peak luminescence efficiency increases largely when adding around -- about 6 weight percent of TPD, but further addition of TPD affects the driving voltages and peak efficiencies only slightly.

A I see that line, and I'm -- I'm just observing that only slightly is relative and that while efficiency is important, voltage and brightness also matter, just highlighting that. But a blanket -- a blanket statement saying that higher TPD is poor only because the efficiency

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falls doesn't necessarily encapsulate everything someone might be concerned with when building an OLED. But I see the entry you're describing in Yang.

Q Okay. And the Choulis Group chose the 9 weight percent formulation. They didn't go for the 12.5 or the 19 percent, correct?

A That's correct. Choulis uses a TPD loading of 9 percent.

Q Yang's conclusion in this paper is that they "expect that co-doping with hole-transporting moieties such as TPD may be a general scheme to improve the efficiency of PVK:PBD based devices," correct?

A That's correct. That's just the line at the bottom of the next paragraph.

Q Okay. So their conclusion is very specific to matrices containing PVK and PBD, correct?

A I would argue -- or I would -- in my opinion, I wouldn't say it's that specific. It's certainly specific in terms of the data, but a

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person skilled in the art would understand the approach, which is engineering hole and electron transporting moieties to improve charge balance and would see that that's a generally applicable approach.

And that's consistent with what I talk about in my declaration about prior work on mixed OLEDs combining hole and electron transporting materials that well predates the '164. This idea of balancing hole and electron transport in an emissive layer with two different transporting species was -- was already very well known and applied at the time of the '164.

So I think that statement that you just read is -- is just reflecting the fact that they're being conservative, but a person skilled in the art would not read it as limiting.

Q They don't have any data here to indicate that the electron transport -- the hole transport -- adding hole transport moieties to other systems, correct?

A They only study one system.

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Q Okay. And they don't draw the conclusion that their approach can be applied to other systems, correct?

A Well, aside from the passage that you just recited, they don't more generally say it, but I'm telling you what a person skilled in the art -- how they would read it.

Q So a person with ordinary skill in the art would believe that adding hole transport materials to any other device is going to increase the efficiency lifetime or driving voltages?

A No. What I'm saying is that a person skilled in the art would see the general approach of taking a fine balance of the hole and electron transport material as a means to optimize electron and hole transport through the emissive layer on OLED and apply that to their own system to improve their own device.

Q Do you know when the mixed host system was first commercialized?

A I don't have any knowledge of when

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things were commercialized regarding mixed hosts.

Q What is a multilayer device?

A Can you be more specific? Just a multilayer electronic device? What -- what are you --

Q Well --

A -- actually curious about understanding?

Q Yang mentions, We would like to note that co-doping TPD was shown to improve the efficiency of multilayer devices --

A Can you point to --

Q -- based on --

A -- the entry --

Q -- europium complex --

A -- you're --

Q -- doped into a PVK:PBD host.

A Can you point to the entry you're referring to?

Q The last page, second to last sentence.

A The previous sentence? So I haven't examined the associated reference 30. I could

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speculate on what they meant, but I'm not -- I'm not prepared to because I don't think that's relevant to what I had to discuss in my declaration for the '164.

Q What is a multilayer device?

A A multilayer device is a device that would contain multiple layers.

Q So is Yang's device a single-layer device?

A Which architecture of Yang are you asking about?

Q Any of the architecture.

A Can you be more specific in what you're wanting me to point to, then?

Q For the Table 1 architecture, what is -- what's the architecture?

A Yang refers to their device as a single-layer device in Table 1.

Q What is a single-layer device?

MR. GARR: Object.

THE WITNESS: So, in -- in the context of Yang, a single-layer device is PVK, PBD,

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Ir(ppy) device with TPD added as well between electrodes. Or the electrodes could include and then likely do -- I'd have to double-check -- actually, I'm -- I'm just going to leave it at that. It's a single organic layer.

BY MS. ZHONG

Q So a single-layer device means it doesn't have hole injection layers, hole transport layers, electron transport layers and electron injection layers; is that right?

A Yeah, that --

MR. GARR: Object to form.

THE WITNESS: I just want to reread one passage out of Yang here.

So the definition of a single-layer device, there's some ambiguity to that. A single-layer device could be as simple as a single layer between two electrodes.

BY MS. ZHONG

Q And according to Yang, the TPD and the PBD can form exciplexes, correct?

A Can you point to me where you're seeing

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that?

Q Right above Table 1.

A Yes, they can form an exciplex.

Q An exciplex is not favored, correct?

A As I said this morning, it depends on the context. An exciplex might be beneficial. It may not be beneficial. It's the goal of what the rest of the device looks like.

Q And in the context of Yang or Choulis, is it a good thing to form TPD and PBD?

A In the context of Yang and Choulis, you wouldn't want to have the exciplex showing appreciable light emission, which Yang corrects in Figure 2(b). Yang clearly shows that even if the exciplex forms, it's being quenched by the iridium dopant so that you only get emission from the iridium dopant.

So the exciplex, whether or not it forms in the context of Yang doesn't lead to any problem with emission and potentially not even efficiency, because all of that energy is ending up on the iridium phosphor.

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Q And the exciplex is quenched by adding at least 4 weight percent of the iridium complexes, correct?

A Are you looking at Figure 2(b) or the text for that conclusion?

Q Both.

A In my opinion, in Figure 2(b), even at 2-and-a-half percent, you've likely quenched it, but, yes, certainly at 4 and 6, you've quenched it fully.

Q And that is for a TPD concentration of about 10 weight percent, correct?

A In (b), the devices have a TPD concentration of 10 weight percent, yes.

Q Okay. And what if the concentration of TPD increases? Do you have to increase the iridium concentration in order to quench those emissions?

A Again, that's not something that Yang discusses and not something I considered in detail in my declaration or as part of my consideration of the '164. And, a priori, it's

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something that would be difficult to know. You'd have to perform the experiment.

Q Okay. Could that be a reason why Yang doesn't go -- could that be a reason why the Choulis Group does not go beyond 9 weight percent of TPD?

A In my opinion, the Choulis Group is using 9 percent to realize peak efficiency.

Q Okay. Do you know what would be the lifespan for higher TPD concentrations?

A I'm sorry. I missed the beginning of your question. Can you repeat it, please?

Q Sure. So for devices with -- made with higher TPD concentration, like 13 weight percent and 19 weight percent, do you know what their lifespan would be?

A Yang doesn't report anything related to lifetime of those devices, and I'm not sure what the lifetime would be.

Q Is the higher the brightness the better?

A Can you provide any other conditions on

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that statement?

Q No.

A A higher brightness display can have advantages.

Q And what would be the disadvantages?

A Of running a display at high brightness? Can you ask a fully formed question regarding brightness? I'm happy to try and answer.

Q Is it always better to have a display with higher brightness?

Or let me put it this way: For Table 1 devices, is a 19 weight percent one more desirable or offers better performance than a 9 weight percent one?

A Again, there's several things to consider. The higher brightness, 19 percent, is just a reflection of the fact that it has lower voltage.

Again, Yang and Choulis are not trying to make a display. If one was going to make a display, the brightness spec is set by the usage,

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right, so whatever the end application would set the brightness. One wouldn't necessarily just run it at maximum -- maximum pixel brightness.

Q So for the Yang application, the peak luminescence efficiency is more important to them?

A I think for the Yang -- for Yang's paper, they're reporting all of these parameters, and efficiency is a -- is a good metric of overall performance. But voltage is also an important metric of overall performance, and so that's why they're -- they're reporting them. But, clearly, their emphasis is on efficiency based on some of the other passages that you pulled out of their paper.

Q And the Choulis Group picked the 9 weight percent one as the performance, correct? Sorry.

The -- the Choulis Group picked the one that's shown in Figure 3 for their experiments, correct?

A The Choulis Group uses the same

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composition device as the device that's being measured in Figure 3 in Yang.

Q Do you know why no performance data was reported for the 19 weight percent and the 13 weight percent one for Figure 3?

A No. This isn't my publication, so I -- I have no idea why they chose to report this data and --

Q How do --

A -- not others.

Q How do the researchers decide what data to include when they publish papers?

A Well, there's a variety of factors. Sometimes it might be related to the allowed length of the -- of the journal article. This is Applied Physics Letters. At this point in time, you were limited to three pages, so you could not show every piece of data you might show.

And so I suspect what they decided to show was their peak efficiency since at the time there was emphasis in trying to improve efficiency, but I think, importantly, they, you

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1 know, address their inability to show everything
2 through Table 1, so -- but, again, I'm -- I don't
3 know what their logic is, but those are some of
4 the factors that one might consider, but here I
5 suspect it's page length is what they're limited
6 by.
7 Q Okay.
8 A I will note, though, that in the
9 abstract, they do call out not only efficiency
10 but the concern to have acceptable operating
11 voltages, so, clearly, they were thinking about
12 voltage as well as efficiency in looking at --
13 Q But as far as --
14 A -- their analysis.
15 Q But as far as they're concerned, once
16 the TPD concentration exceeds 6 weight percent,
17 according to them, the addition of TPD affects
18 the driving voltages and the peak efficiencies
19 only slightly, correct?
20 A That's the sentence that -- that, yes,
21 you've already pointed me to.
22 Q Okay. And do you know the tendency to

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form exciplexes as the concentration of TPD increases?

A I don't specifically know the functional dependence of exciplex formation versus TPD and PBD composition.

Q Does it make them more likely to form exciplexes as the concentrations of the two increase?

A Exciplexes require contact between the materials, so if you have a lot of material in contact, then, potentially, they can form.

Q So the high concentrations make the contact easier or more likely, correct?

A Not necessarily, because if you had, say, 90 percent of one material high concentration, 10 percent of the other, you might not expect exciplexes to form because there just isn't very much interface.

Q Why wouldn't there be a lot of interfaces?

A Why would there or why wouldn't there?

Q Why wouldn't there?

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A Because the amount of interface area is dictated by how much each amount of material is in contact, right? If your film is mostly one component, then you're minimizing just the area of the interface between the two types of material.

Q But the 10 weight percent one will be surrounded by mostly the other material, right, so --

A That's true, but the intensity depends on the absolute amount of area as well. So if I -- like, if I only have 10 percent and 90, I don't have a large absolute area between these two phases of material, which is why, in Yang, when they show the exciplex, they're doing 40 percent 40 percent for TPD and PBD.

Q So, in Yang, if they increase the relative concentration of PBD, that means there is a decrease in the relative concentration of TPD, correct?

A In which -- which architecture?

Q The single device architecture.

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A This is back to Figure 3?

Q Or Table 1. Doesn't matter.

A Or Table 1. Well, Table 1 has several different compositions.

Q So, as the composition of the TPD increases, that means the PBD concentration decreases, right?

A Not necessarily. The PVK composition could also be decreasing.

MR. GARR: Counsel, can I ask you to check your microphone? It's a little hard to hear.

MS. ZHONG: Is this better?

MR. GARR: Yes, it is. It just seems like every so often, it goes in and out.

MS. ZHONG: Okay. It's probably because the way I'm turning.

MR. GARR: Thank you.

BY MS. ZHONG

Q So, in Table 1, basically, they have a fixed ratio of PVK and PBD, correct?

A I don't see that noted in Table 1.

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Q It says, "Performances of PVK:PBD based single-layer devices," right?

A It does, but I don't see the word "fixed."

Q Which -- and they gave you the final concentration of the Ir(mppy) and TPD, correct?

A They do provide the concentration of iridium and TPD, yes.

Q Which means the remaining percentage will be taken up by PVK and PBD, correct?

A I agree the remaining percentage is taken up by PVK and PBD, but your initial statement wasn't that. Your initial statement was the ratio of PVK to PBD is fixed.

Q And isn't it the case usually if you don't report the relative ratios of PVK and PBD for different concentrations, you assume that there is a fixed ratio for that base material?

A I don't think I would assume that.

Q Okay.

A Certainly, it doesn't -- it doesn't say that in the -- in the table or the text.

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Q So your conclusion is, you don't know the effects of higher concentration of TPD on the likelihood of forming exciplexes, correct?

A In my opinion, the precise behavior of the exciplex population, emission intensity, is not possible to know a priori without doing the experiment as a function of concentration.

Q So it could be the case that at a higher concentration with TPD, there will be more exciplexes forming, and you need to have more iridium materials in order to quench it; is that correct?

A In my opinion, that's unlikely. In my opinion, the amount of iridium that you have at 6 percent is going to be sufficient to quench any exciplex that you'd have in that layer, I suspect.

Q Why are they going to choose 6 percent when 4 weight percent is already sufficient to quench the exciplex formation with 10 percent TPD?

MR. GARR: Objection.

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THE WITNESS: Again, I don't have any knowledge of what they were thinking and why they chose 6 percent. I'd be speculating. It's not something I considered in writing my declaration.

BY MS. ZHONG

Q Putting the other 6 weight percent is to make sure that at 19 weight percent there is no exciplex forming?

A They don't show any spectral data for a 19 percent device, so I don't think the data is there to support any conclusion.

Q Okay. You did not look into this, right?

A No, because, clearly, in Figure 2(b), Yang shows that the exciplex is not a concern because they get pure emission from the iridium phosphor, and so a person skilled in the art would realize that the exciplex is not a concern in this device. You could get emission from the phosphor.

Q But that requires a certain concentration of the phosphor, correct?

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A It requires a certain concentration of the phosphor, but you'd be -- 6 percent is a typical if not even slightly lower concentration than one typically finds in OLEDs, so it's not any sort of, you know, extreme value of the concentration that would give you pause.

Q What's the typical weight -- strike that.

What's the typical concentration of the emitter materials?

A It depends on the emitter. But anything in the range of, you know, 7 percent to 15 percent would be typical, perhaps 10 percent being a common number one might see. But it again depends on a variety of different factors that one's trying to accomplish in OLED and also the associated materials that are present in the same emissive layer.

Q And is it weight percent, mole percent or volume percent?

A Those sorts of -- well, again, that -- that depends on the system being considered, and

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when you -- so when you're saying "is it," can you just tell me exactly what you're referring to?

Q Well, you gave me a range of the percentage. And are those percentages weight percent, volume percent or mole percent?

A So those percentages would -- depending on how the device is made, if it's being made via evaporation, it's probably volume percent. If it's being made via solution processing, in the literature, you'd probably find weight percent.

Q Okay. Are the terms "host" and "matrix" generally used interchangeably?

A I'm -- again, the use -- the word "host" is used in the literature very commonly. The word "matrix," I would say, is not.

So, no, I would argue that -- or I would -- in my opinion, those are not interchangeable words. They depend on more context than simply just the words themselves.

Q What is a host?

A A host is frequently a material into

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which an impurity or a second material is -- is added.

For example, Yang uses that term as a polymer host into which these additional materials are added to form the light-emitting layer.

Q And can you pull up Sugiura, Exhibit 1006?

A Is there a particular --

Q And the abstract.

Are you there?

A Yeah, I see the abstract.

Q Okay. And for the figure in the abstract, is -- does the charge transporting material, 3B shown there, form a matrix?

A Charge transporting material 3B is part of a matrix.

Q Does it form a matrix by its own?

A No. In the -- using these terms in the context of the '164, charge transporting material 3B is a matrix material.

Q But does it form a matrix?

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A It's -- it's part of the matrix. No, it does not form a matrix on its own.

Q Okay. And is 3A the polymer forming a matrix?

A 3A is also part of the matrix. None of these components on their own are a matrix. It's the collection of all of them that creates a matrix.

Q If you have a multilayer device, does it have more than one matrix?

A Can you describe more specifically what you mean by a multilayer device? What's the --

Q Having more than one --

A -- composition?

Q -- organic layer.

A Again, can you be more specific? What do these different layers do? What is their composition?

Q Does it matter?

A It would be helpful to consider. Multilayer device is a very general term.

Q Does a multilayer device have an

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emissive layer?

A A multilayer device could have an emissive layer.

Q Does an OLED multilayer device have an emissive layer?

A An OLED by definition should have an emissive layer.

Q Okay. And what will be a layer adjacent to the emissive layer in a multilayer device?

MR. GARR: I'll lodge an objection based on form and scope to this line of questions.

THE WITNESS: So, again, is there a specific question regarding multilayer device you're looking at?

MS. ZHONG: Counsel, again, reminding you of the proper objections in PTAB's proceeding, and your speaking objection just now amounts to coaching the witness. So I remind you to confine your objections to hearsay, form or privilege. If you are not sure what kind of

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proper objections are, please take a look at the Trial Practice Guide.

MR. GARR: I believe I'm acting consistently with the Trial Practice Guide.

MS. ZHONG: You're not. It's a speaking objection.

BY MS. ZHONG

Q So for the emissive layer, in a multilayer structure, what will be some of the examples of an adjacent layer to the emissive layer?

MR. GARR: Same objections.

THE WITNESS: Again, I could define an infinite number of multilayer stacks.

BY MS. ZHONG

Q Give me an example.

(Reporter clarification.)

BY MS. ZHONG

Q So, in a multilayer OLED device, what will be some of the examples of an organic layer adjacent to an emissive layer?

MR. GARR: Same objection. Scope as to

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this line of questions.

THE WITNESS: So to answer that question, I direct you to page 13 of my declaration --

MS. ZHONG: Okay.

THE WITNESS: -- where I provide an example of an OLED with multiple layers and clearly describe exemplary layers that might exist in that stack. So looking at --

MS. ZHONG: Okay.

THE WITNESS: -- looking at the figure at the top of page 13, this particular device has three organic layers, a hole transport layer, an emissive layer, an electron transport layer.

BY MS. ZHONG

Q So how many matrices are there in this device?

A So each of those layers would be a matrix.

Q Because they are deposited differently?

A Because they're separate layers that each have a particular function.

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Q So for the emissive layer, if the host and the dopant are deposited separately, is that considered to be two matrix materials or -- let me put it this way: If you have a mixed host system in the emissive layer and the two components are deposited sequentially rather than at the same time, does that mean there are two different matrices?

MR. GARR: Object to form. Outside of the scope of the direct testimony.

THE WITNESS: So the architecture you're describing is not one that I have thought about. Can you describe the layer structure again that you have in mind?

BY MS. ZHONG

Q We can use the same structure as you have, but --

A Okay.

Q -- for the emissive layer, the components are deposited sequentially rather than at the same time.

A So that there's a separate layer?

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Q I don't know whether that's considered a separate layer or the same layer.

A Well, I'm -- I'm just trying to understand the device architecture that you're proposing.

Q For the emissive layer, the --

A Okay.

Q -- the host materials are deposited sequentially rather than at the same time.

A So if the host materials are deposited sequentially, then there would be multiple emissive layers in the device.

Q Even if there is only a single emitter?

A Yes.

Q And so you consider each layer to be a matrix?

A I consider if you have two adjacent deposited emissive layers where each of them has, say, a different host, as your device architecture does, those are different emissive layers. In fact, that architecture is well described in the architecture and is called a

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double emissive layer OLED. So a person skilled in the art would understand that device has two separate emissive layers.

Q Okay. So let's take the -- Choulis' -- Choulis' architecture on the material composition.

Do you have that in mind?

A Sure. I can go back to Choulis.

Q Sure.

A Okay. I'm looking at paragraph 54.

Q Okay. So for Choulis materials, if PVK and PBD are deposited first, then TPD is deposited, is that considered to be a single matrix or two different matrices?

MR. GARR: Object to form.

THE WITNESS: I didn't consider that kind of configuration. I need to understand the layer structure again.

Can you please say that again and also tell me where the emitter is?

BY MS. ZHONG

Q The emitter is in the PVK and PBD host,

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and TPD is then deposited sequentially after that. Is that considered to be two matrices, a single matrix?

MR. GARR: Object to form. Incomplete hypothetical.

THE WITNESS: So to make sure I'm clear, the first layer is PVK, PBD and Ir(mppy), and the next layer is TPD? Is that --

MS. ZHONG: Yes.

THE WITNESS: -- what you're proposing?

BY MS. ZHONG

Q Then you can add --

A No, I'm asking, is that the device you're proposing?

Q I've not quite finished it. And then you --

A Okay.

Q -- add PVK and PBD -- PBD again and with iridium dopant in there.

A All right. So, again, I'll just first note that is certainly not an architecture that I've thought about and am not comfortable

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rendering an opinion based on such a structure. That said, this device now has two emissive layers separated by TPD.

Q So your interpretation is that if they're deposited at different times, then they're considered to be different layers and different matrices?

A It's not my interpretation. They are different layers.

Q Why?

A Because you've just described them as such. You -- you first process a film that has PVK, PBD and Ir(mppy). You're now going to go deposit a film of TPD, and then you're now going to go on top of that deposit PVK, PBD and Ir(mppy). Those are three different layers of an OLED stack.

Q Why would it be three layers?

A I don't understand how it isn't three layers.

Q I mean, it depends on, like, how much TPD you deposit. The first and third layers can

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be a single layer -- the first and third deposit films can be considered a single layer, right?

A No, that's incorrect. Even if you were to put down only a few nanometers of TPD, a person skilled in the art would view those as three layers.

Q Okay. What if I don't deposit the TPD, but PVK and -- let's just say PVK and PBD first. Then deposit them again a second time.

Is that considered to be a single film or two films?

A Again, this is a very hypothetical architecture now that I did not consider in the context of my declaration.

Q What if you deposit PVK and PBD first, then the emitter materials, then PVK and TPD?

Is that a single matrix material or two, three different layers, or what is it?

MR. GARR: Object. Out of scope.

THE WITNESS: I guess what I'll -- what I'll note is that the distinction of what are matrix materials and what are not in the

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incarnations you're talking about, I think becomes less important because these are now random arrangements of materials.

Some of the devices you're describing wouldn't function properly, and so I'm not sure how to respond to thinking about, you know, what these materials might be called in an OLED when we're really not talking about making an OLED anymore.

BY MS. ZHONG

Q So what is -- I'm trying to understand what you consider to be a matrix.

A Again, I think what I've said in -- regarding a matrix is that it's a continuous -- essentially, it's a film. It's a continuous collection of matrix materials, has a particular function.

The best definition is in, again, claim 1 of the '164 patent. It's very clear what the intent is. It's a functional layer, emissive layer, contains these materials. The matrix is that collection. The matrix materials are the

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components.

Q Claim number 1 doesn't say a single matrix, correct?

A Claim -- claim number 1 is describing a functional layer and an emissive layer without -- I'm telling you how a person would then interpret the term "matrix" on top of that.

Q The term "matrix" does not appear independent of matrix materials, correct?

A Not in claim 1.

Q Okay. And --

A I'd have to go back -- I'd have to go back and look at the patent again to make certain that it doesn't appear anywhere else, but it doesn't appear in claim 1. That I can be certain of.

Q Okay. I think you have a collection of the claims from page 27 to 20 -- actually, 32 of your declaration.

Can you take a look to see whether the term "matrix" appears independently of matrix materials?

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A Again, where would you like me to -- would you like me to read all the claims?

Q You can take a look at it.

A Okay.

Q Or if you can -- if you want, you can search it digitally.

A No, I have a hard copy, so I'll just skim them myself.

Okay. I've skimmed them again.

Q Do you see a reference to matrix independent of matrix materials?

A No. I think that's what I responded before as well.

Q So the claim itself does not impose the number of matrices that may be in the at least one organic functional layer, correct?

MR. GARR: Object.

THE WITNESS: So I'm applying, essentially, a plain reading of these terms as a person skilled in the art, and when I read claim 1, it reads to me that this is a matrix and these materials are in the matrix, and that matrix has

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a particular function as a layer.

BY MS. ZHONG

Q Okay. So you read the at least one organic functional layer as limited to a single matrix; is that correct?

A I'll -- I'll restate what I just said, which is that a film with particular functions, particular organic functional layer, particular materials, matrix 1, 2, 3 and the emitter, would be a matrix.

Q And in your mind, each individual organic functional layer is a single matrix; is that correct?

MR. GARR: Object to form.

THE WITNESS: In my opinion, organic functional -- the other organic functional layers might be a different matrix.

BY MS. ZHONG

Q So each organic functional layer in an OLED device constitutes a different matrix; is that correct?

A As it relates -- so, as it relates to

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claim 1, if you have another functional layer that also has three matrix materials, then that would also constitute a different matrix. So if there's multiple layers in the device that have a collection of matrix materials, different matrix materials, performing a different function, then, in my opinion, that would also be a matrix, but a different one.

Q Okay. And is it your opinion that each separately deposited layer is a different matrix?

A I didn't consider explicitly how the process of deposition impacts matrix, but in my opinion, a layer would be a matrix.

Q Does it matter whether that layer is deposited sequentially or simultaneously?

A Well, sequentially deposited layers are no longer the same layer.

Q Do you understand there's sequential scanning when you deposit the material from different sources?

A Can you describe more explicitly what you're referring to?

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Q When a layer has multiple materials, they are deposited from different sources, correct?

A They can be.

Q They often are, correct?

A Again, I said they can be.

Q Okay. And when they're deposited from different sources and the source is positioned such that source number 1 is deposited, then source number 2, then source number 2, then source number 1, is that a single layer, multiple layers, or --

A So, not being intimately familiar with the process that you're referring to, it's challenging for me to make an assessment because it's going to depend on a variety of factors.

Q Such as?

A Well, for example, if you're growing a very thick layer from source 1 and then a very thick layer from source 2, then those would be separate layers in the device.

Q What if they're thin layers?

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A What is a thin layer? I think, again, it would really depend on the specific architecture.

Q And what do you consider to be a thick layer?

A I'd have to consider -- again, I don't see the value in putting a number to that. I think it's related more to the intent.

When you're growing a thick layer, that layer is essentially meant to be single material. If you're growing a single material from your source 2 and you want it to behave as a layer that has essentially properties only of the material in source 2, then that -- that would strike me as a layer.

Q So it depends on the final functionality or the intended use of the layer?

A Again, I haven't reflected on this in detail in the context of the '164, but I think that -- I think, certainly, that the intent is important to consider.

Q And is your opinion that if it is

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intended to be a mixture, then you would consider that to be a single matrix material?

A If the emission layer -- can you clarify what it is?

Q Let's start with the emission layer.

A So tell -- please tell me what the composition is of the hypothetical emission layer, just so I know what it is. How many materials? What are -- what do we have here?

Q Let's start with two, the host materials and the dopant.

A And the question was?

Q If they are deposited sequentially, do you still consider them to be a single matrix material?

A In the example you're citing, if the host and dopant are being deposited sequentially, the device would no longer have an emission layer that's properly functioning unless that sequential deposition was really a co-deposition.

Q When you say -- how can the sequential deposition be a co-deposition?

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A When, effectively, the molecules are -- are continually being mixed across the film.

Q Can that be done?

A I'm -- I'm not aware of what can be done at industry in the production of displays. Again, this is not something I concerned myself with for the -- for the '164. I'm not an expert in the industrial processing of -- of OLEDs and deposition sources.

Q What about in your research?

A In my research, can what be done? Please restate the question.

Q Can sequential deposition lead to co-deposition?

A In my research, if the goal was to make a emissive layer that had a host and guest, then we would do a co-deposition.

Q And when you say "co-deposition," is it from two different sources or you premix them or --

A It's from --

Q -- what do you mean by that?

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A It's from two different sources with overlapping vapor plumes.

Q And what do you mean by overlapping vapor plumes?

A When one deposits any organic thin film, you start with a solid powder, heat that -- if you're using evaporative processing, as is done in industry, heat that solid powder, and then that solid powder will form a vapor. And then that vapor has some spatial extent. That's -- that's the vapor plume from the source.

And at least at a lab scale, when one wants to realize a host-guest-type emissive layer, one uses two different deposition sources and just overlaps the spatial extent of the two vapor plumes, in which case you get one mixed vapor plume.

Q So if you have the overlapping vapor plume, do you consider that to be a single matrix? Do you consider the films obtained as a single matrix?

A Again, I -- with a host-guest film as

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we're talking about, a simple emissive layer, this type of terminology doesn't come up. The terminology of matrix, I think, is most relevant when thinking about the '164 in the context of these multiple matrix materials and how they form a matrix.

Q I don't get what you're saying. Can you elaborate?

A So I can restate what I said, which is that the term of whether or not something is a matrix in organic light-emitting devices is not something that comes up. There isn't -- there isn't a need to apply this moniker to the components of an OLED.

What's more generally thought of is a film, because the film is actually the unit that carries out a particular prescribed function with a particular set of materials in the OLED.

The term "matrix" I think, is more relevant and more meaningful in thinking about claim 1 and the embodiments of the '164, where you're thinking about this collection of matrix

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materials forming a matrix. So it's not something that generally is -- you know, something's even described.

Q Can you pull up Exhibit 1007, Thompson?

A Sure.

Q Paragraph 6 of Thompson mentions both matrix materials and phosphorescent dopant material, correct?

A Yes.

Q Okay. And paragraph 23 mentions a host matrix, correct?

A Yes.

Q What is a matrix in this context?

A When you say "in this context," do you mean in Thompson now?

Q Yeah. In Thompson, what is a matrix?

A I'm going to reread paragraph 23.

So there's two different contexts that are being applied in paragraph 23 in my opinion. The word "matrix" is appearing twice, first in the context of a host matrix, which is similar to the application of matrix material 1 in the

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context of Choulis. I'm referring to PVK, for example, as a -- as a host for the additional organic moieties.

And then the second context in paragraph 23 that I think is relevant is the sentence that starts "This means that the dopants are capable of trapping holes and transporting them through the matrix." That is now referring to the collection of that host and guest as the matrix.

Q So the matrix is the host materials plus the dopant?

A In the context of paragraph 23 and the statement that "this means that the dopants are capable of trapping holes and transporting them through the matrix," Thompson's usage here is of the film being the matrix, the film being made up of the host and the guest in this case.

Q Okay. Is that the same for paragraph 24?

A Is there a particular line you want me to look at? Just the whole thing?

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Q There is a reference to host matrix, correct?

A Yeah. Let me just read paragraph 24.

So, in paragraph 24, again Thompson is using the term "host matrix" when referring to the host component of the film and -- and of the matrix, and so I don't think that's inconsistent with -- with what I just described from paragraph 23.

Q Okay. What about in paragraph 25? What does the matrix refer to here?

A I'm going to read that again.

So I think the usage is still consistent. I think Thompson is using the term "host matrix" as we would use the term "matrix material" in our --

Q What about the --

A -- discussion.

Q Sorry. What about the term "inert matrix"? What does the matrix refer to?

A Can you restate your question? What does that inert matrix refer to, or what does an

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inert --

Q Okay. So in paragraph 25 --

A Yeah.

Q -- do you see there's reference to an inert matrix?

A Yes.

Q And what does the matrix refer to in that context?

A So I think there this is -- an inert matrix is essentially an inert matrix material. So this is referring to a host that is not going to participate largely in charge transport.

Q Okay.

A And I'll just note that I think it's important to make sure that these terms are not read as -- the word "matrix" happens to appear in 25. I think it's very important to consider Thompson's patent and all of these exhibits as a whole.

Q Thompson uses matrix throughout this -- this document, correct?

A Again, I missed the beginning of your

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question. Can you just ask it again?

Q Okay. Thompson mentions matrix throughout Exhibit 1007, correct?

A Yes. He uses the term "matrix" throughout the exhibit.

Q Okay. So matrix is not a term that's rarely used, correct?

A No, I would argue that -- or I would -- I would opine in this case that it is still a term that is not as widely used in context related to the word, say, "host", for example.

The other challenge, I think, with the word "matrix," especially just looking at these various exhibits, is that it's not a word that has as common a usage in terms of what's being implied.

Q We have seen that Thompson uses matrix, not only here, but in another patent that we discussed earlier today, correct?

A Thompson does have the word "matrix" in this patent, yes.

Q And also in 2100, right, Exhibit 2100?

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A Again, I haven't examined 2100 in detail, but the word "matrix" may appear in there.

Q And so let's go to Exhibit 2100.

A Okay. I have it opened again.

Q Okay. And column 2, the first paragraph under "Summary of the Invention."

A Talking about dopants or enhanced conductivity?

Q Do you see that it mentions "The present invention provides charge transporting materials comprising an organic matrix and organometallic dopant"?

A I see that sentence, yes.

Q And, again, Thompson uses a term "matrix," correct?

A In this work?

Q In this work, correct.

A Yes. Thompson is using the term "matrix," yes.

Q And what does the matrix refer to here?

A As -- as I mentioned this morning the

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first time we looked at this patent, I haven't read this patent, so I can't speculate on how matrix is being used or even if it's consistent with Thompson's other uses.

Q Okay. And the organic matrix doesn't include the dopant in this context, correct?

A In the context of 2100?

Q Correct.

A I'm not going to speculate on what 2100 includes again. I've never read it.

Q Well, it says, "comprising an organic matrix and an organometallic dopant," correct?

A Yes, that's what the sentence reads.

Q So they are two different species, correct?

A Again, I would have to review the document and see the actual materials that are being discussed and understand the context of how they're being used to know whether or not they can or can't be the same material.

Q So is it your position that the organic matrix is a collection of the components that

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includes the organometallic dopant?

A I'm not taking any position on Exhibit 2100.

Q Okay. So you are not taking any position as to whether the organic matrix materials there refer only to the host materials or not, correct?

A Are we still talking about 2100?

Q Correct.

A I don't even see the word "host" listed in that citation.

Q I'm just asking you, are you taking the position one way or the other?

A Again, as I've said clearly, I'm not taking any position on Exhibit 2100 because I haven't examined that document.

Q And, similarly, you're not taking any position on the usage of the term "matrix" in Exhibit 2101 through Exhibit 2104, correct?

A Would you like to look at those again so that I can actually see the passages you're referring to or --

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Q Are you taking any position? I'm just asking you.

A If you could point me to particular passages, I could look again, but in general, I'm not going to take a position on something that I haven't had the chance to read and think about in full.

Q And I'm not going to waste my time.

(Deposition Exhibit Number 1013 was marked for identification.)

BY MS. ZHONG

Q Now, can you please pull up Exhibit 1013?

A Yes, I have it.

Q And can you please go to Figure 9H?

A Yes, I see it.

Q In Figure 9H, where is the matrix?

A Again, I'm -- I'm not -- not needing to applying the term "matrix" to this layer. This is a very specific and highly discontinuous device, where each of these subregions, discontinuous 1, 2, 3, are designed to have a

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1 particular spatial extent, and so very much these
2 are broken layers in a device.
3 And for something to be a matrix, it
4 should have continuous character, not be
5 discontinuous in this way, and so the distinction
6 of, you know, how to classify this, I would say
7 this is not a matrix, and I'm not sure how to
8 classify the discontinuous layers of Forrest.
9 Q So it's your position that 953a, b, c,
10 d don't belong to a matrix?
11 A So those are different processing steps
12 for the same architecture, so is there an end
13 point you just want me to look at? Oh, 953, the
14 different components?
15 Q Yeah. There is 9 -- discontinuous 1,
16 discontinuous 2, discontinuous 3, discontinuous
17 4. Do you see that?
18 A Yes, I see that. Yes, and then the
19 acceptor.
20 Q And is it your position that those four
21 components don't belong to a matrix?
22 A To be a matrix, the matrix needs to be

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continuous, and so the fact that these are highly discontinuous, I think, makes that distinction more challenging to make or makes that conclusion challenging to make. So I have to think more. I haven't thought as much about how exactly to classify whether this is a matrix or not.

Q What about -- what if you have like acceptor 154 that is being used as almost a binder of these ones, these different layers?

A I would disagree -- so I'll first note, I didn't consider the detailed, you know, layer structure and operation of this solar cell in the context of analyzing the predominantly OLED-related claims in '164, but I would disagree with the classification of the acceptor as a binder. I think it's more a layer that's being deposited on top.

Q Okay. So your view is that 953a, b, c, d, being discontinuous, they don't belong to a matrix?

A I would say that I wouldn't --

MR. GARR: Objection.

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THE WITNESS: I would have to think more about the Forrest reference and perhaps make sure it's clear exactly how they're describing their discontinuous layers before making a conclusion on matrix.

In my mind, a matrix, and as described in the -- in the claims of the '164 and really interpreting the definition of matrix material in '164, is that a matrix is a collection continuously of these different materials, different matrix materials within the matrix. And the discontinuity yet not discontinuity at a fine scale in Forrest bothers me as a way of calling that a continuous matrix.

BY MS. ZHONG

Q Okay. Does it matter that there is vertical continuance in Forrest?

A When you say "does it matter," can you be more specific?

Q So, in Forrest, 935b, for example, is contacting donor layer 152 and provides a continuous conductive path from one end to the

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other.

Does that make a difference?

A I want to make sure I understand your question. From one end to the other of what? What are the --

Q From anode to cathode. It's not providing a path from anode to cathode. There's still an acceptor layer and a blocking layer that -- there's no continuous path of 953b from anode to cathode. There's additional layers on top.

Q Why don't you go to -- okay. Why don't you go to paragraph 81?

A Okay. Whereabouts?

Q Paragraphs 81 and 82. Why don't you read it first?

A Okay. I'll reread them, then.

All right. So you had commented that it provides a continuous path from anode to cathode. 81 and 82 don't say that.

Q Okay. Do you see 81 says, "Most of the nanocrystals of the donor material shown in the

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cross-section directly contact the continuous donor layer 152, providing electrically conductive pathways for disassociated holes from layer 953c to the anode 120 in the finished device"?

A Yes, I see that line.

Q So does the fact that it provides an electrically conductive pathway from 953c to the anode change your opinion as to whether that is a matrix material or there is a matrix?

A No, that doesn't change my opinion.

So I'll first note that that is not stating a connective pathway between the cathode and anode. All that is saying is that one can pass holes through the nanocrystal parts of the layers to the anode.

And the second thing I'll note is that if all one had to have was conductive pathways to the anode to have a single matrix, then, in principle, the entire OLED could become a single matrix, which would be completely inconsistent with a person of skill in the art in their

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impression of the '164 and how the claims are written. So, no, it does not change my opinion.

Q So, because of the discontinuity exhibited by layers 953a to d, you are uncomfortable calling them to be -- to belong -- as belonging to a single matrix or to call them matrix materials; is that correct?

MR. GARR: Object to form.

THE WITNESS: So can you ask specifically if you're asking about matrix materials or matrix?

BY MS. ZHONG

Q So, because of the discontinuity of layers 953a through d, you are uncomfortable calling them as matrix materials; is that correct?

A The discontinuity of these layers is what makes me uncomfortable referring to this as a single matrix. Again, what I describe -- what I -- my interpretation of a matrix based on the '164, you think about claim 1. I think it's very clear you have a layer that has a particular

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function.

And, in fact, in claim 1, the function is limited right away to an emissive layer because of the inclusion of the guest. And so a person skilled in the art sees that claim, sees the appropriate embodiment in '164 and understands, okay, this is a layer that's been designed to efficiently emit light. I'm going to have a distribution of matrix material 1, 2, 3 within this overall matrix. I'm going to add in a guest now to see light emission from this layer.

That's the most straightforward way to think about the spirit of what the inventors in the '164 were proposing and what a person skilled in the art would see when they're looking at '164. Back applying the terminology of the '164 to a very different, you know, not even light-emitting device here is something that, again, I have not thought a lot about, but the discontinuity, I think, is problematic.

Q Okay. So, in your opinion, the figure

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in 9H does not show a single matrix; is that correct?

I'll put it another way. 953a, b, c don't belong to a single matrix. Is that your opinion?

A Without knowing more about the specific function of a, b and c, I am uncomfortable taking an opinion on that matrix. I don't --

(Inaudible crosstalk.)

Q So the --

A -- discontinuity of the layers as a means to describe a matrix.

Q So the functionality of 953a, b, c is described in paragraphs 81 and 82, correct?

A Yes. They are electron donor layers, but in terms of the scale of this discontinuity in 9H and knowing what an electron donor does, the scale of that discontinuity is going to be substantial. It's not going to be mixing at a molecular scale as one would have, say, in the emissive layer of an OLED. This is going to be a very coarse, discontinuous layer by design, and

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so I'm not comfortable thinking about this in the context -- the same context as I would all of the other exhibits that we've talked about today and applied to the claims of the '164.

Q So you're uncomfortable in this context to call them as belonging to the single matrix or call each individual component of 953a, b, c as a matrix material; is that correct?

A Again, my -- my definition or my interpretation of what a matrix material and a matrix are are informed by the '164 and what a person skilled in the art would say looking at the '164.

This is a very different architecture that has a very different intended function, and so the discontinuity gives me pause at simply assigning terms like matrix and matrix materials to these different components of the donor layer.

Q And let's just be clear. You don't believe that 953a, b, c, d belong to a single matrix, correct?

A Again, I -- I'm not willing to take an

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opinion on that because I think the discontinuity prevents a straightforward opinion from being taken regarding 953a, b and c. What I have said is that a matrix has to be continuous, right? So we're talking again about a functional layer with a particular intent.

These look like three broken layers or three potentially adjacent layers, and a matrix should not consist of several functional layers.

Q Does the fact that those three layers collectively seem to form some kind of continuous path change your opinion?

A No. Again, I think we've already covered that. The fact that they're discontinuous, I've already said, is what -- what prevents me from making a clear conclusion here. I think, again, the discontinuity is a problem, especially at the scale that looks to be implied in Figure 9H.

Q Okay. And you consider 953a, b, c to be three different layers?

A They're three discontinuous

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depositions. Again, generally, the term "layer" is applied to a continuous layer. When you have something that's discontinuous, you might sometimes refer to it as islands. You know, it's -- the term "layer" usually comes with the connotation that this is a continuous layer, so this is clearly highlighting that by calling them out as being discontinuous. So I wouldn't think of these as layers in the same way we're talking about OLEDs. This is, again, a solar cell, not an OLED.

MS. ZHONG: Why don't we take a break.

MR. GARR: Okay.

(Recess 3:38 p.m. to 4:48 p.m.)

BY MS. ZHONG

Q Okay. So I just want to confirm some of your understanding.

In your opinion, the matrix material is a component of the matrix regardless of the amount that's present?

A Yeah. Yes, that's how I'm applying the term "matrix material," that it is a component of

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the matrix, and the '164 is silent on what any kind of threshold might be for a material to be a matrix material in terms of concentration.

Q Okay. Now, in terms of the '164 patent and its invention, the -- one of the materials is electron transporting material, correct?

A That's correct.

Q Okay. It needs to be present in sufficient quantity in order for it to perform as an electron transporter, correct?

A I would agree with that.

Q Okay. The same with the second matrix material, which is the hole transport materials, correct?

A Yes, I agree with that, too.

Q So it needs to exceed a certain threshold before it can perform as an electron transport functionality or perform as a material that actually transports electrons -- transports holes, correct?

A Sorry. Can you just restate that?

Q Sorry. So the second matrix materials,

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which is described as a hole transport material in the '164, correct?

A The second matrix material and the third matrix material have to be able to participate in hole and electron transport.

Q Okay. So both of those materials have to be present in sufficient amounts in order for them to perform that functionality, correct?

A Well, the '164 is silent on what those amounts are.

Q But they need to meet certain thresholds?

A Well, they need -- they need to be participating in hole and electron transport, but in terms of what that threshold would be, assigning a number to it is arbitrary based on what's in the '164.

Q There is no absolute numbers assigned to it, but there's a functional threshold for the amount that needs to be present, correct?

A So there -- there would be a limit for which the second or third matrix materials would

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alone participate in charge transport, but even at low concentration, the second and third matrix materials, if present, would play a role in charge transport.

Q If they're present in 0.01 percent, will they be transporting charges or they will be trapping charges?

A Well, so, again, that's -- even -- even a species that traps charge is playing a role in hole or electron transport, and so my point is is that the second and third matrix materials, there will be a threshold at which they cease to become the only pathway for hole or electron transport, but that they would always participate to some degree in charge transport. But what that threshold is is something that's not articulated in the '164.

Q Do you believe there needs to be a threshold for claim number 1 to be met?

A No. I don't think there -- at least not -- not how the '164 is -- is written. Claim number 1, in fact, only argues on the -- or only

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1 describes the energy level alignment of -- of the
2 three materials, in fact, and so, in claim number
3 1, we're not even talking about hole and electron
4 transportability yet.
5 Q So, in your mind, a minor impurity that
6 meets the energy alignment requirement is going
7 to anticipate or fall within the scope of claim
8 number 1; is that right?
9 A My opinion is not -- is not a minor
10 impurity meeting claim 1. The materials have to
11 be added with intent to perform some function.
12 It's clear it's an organic functional layer
13 that's consisting of these materials.
14 All I'm saying is that the '164 is
15 silent on what that composition has to be for the
16 matrix material, and so, as a result, it's not --
17 it's not clear. And so if the -- if the
18 materials within the matrix, the three matrix
19 materials, satisfy this energy alignment in an
20 organic functional layer, then they're satisfying
21 the letter of what's -- what's in claim 1.
22 Q So, in your mind, they do not need to

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form a continuous path for electron transport or hole transport; is that correct?

A So, again, as we talked about earlier, a continuous path is -- is subjective. A continuous path need not be necessarily a molecule in contact with only its neighbors, for example, and so the continuous path is -- is something that if the material is serving as a hole or electron transporter, then capable it's carrying the hole and electron current, but saying that it has to be in a continuous path with some threshold is -- again, it's assigning -- assigning additional numbers and specifics that aren't in the '164.

Q In the '164, the materials participating in hole or electron transport needs to be in sufficient quantities so that the charge carriers can jump or hop from one of the molecules to the other, correct?

MR. GARR: Object to form.

THE WITNESS: The materials in the '164 need to be there in sufficient quantities to

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carry out the function of hole and electron transport. Hopping is, you know, certainly part of charge transport, but it's not only about the space in between the molecules.

BY MS. ZHONG

Q What other factors do you have to consider about charge transport?

A Well, one might have to consider, for example, the relative orientation of the two molecules as well. Organic molecules have, you know, fairly heterogenous molecular orbitals, and depending on whether or not those orbitals are actually in contact or not, you may or may not have the same level of charge transport between the two molecules.

Q And if the molecules do not exist in sufficient quantities to carry out the charge transport function, is that still a matrix material?

A In the context of claim 1, provided it meets the energetic alignment, then, yes, because claim 1 does not require any of the matrix

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materials to be hole or electron transporters. That comes later on. And so, provided the material has the appropriate relative energy alignment, which is really what claim 1 is all about, then, yes, it would meet the specification.

Q What about claims 5 and -- claims -- I believe it's 5 and 6.

A So you're asking about 5 and 6, just to be clear, 5, where the second matrix material now is hole transport material, and 6, where the third matrix material is now an electron transport material? That's what you're --

Q Correct.

A So, in those cases now, the materials you're using to meet the relative alignment in claim 1 would have to be hole or electron transport materials, so, at that point, the invention becomes more specific.

Q Do they have to exist in sufficient quantities --

A Again --

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Q -- for them to carry out the hole transport or electron transport functionality?

A So, again, claim 5 and 6, as well as the text of the '164, is silent on what such a threshold or concentration would be. The fact that they would carry out those functions is -- is sufficient, and the fact that they are carrying out the electron transport function or hole transport function would be sufficient.

Q So, again, it's your opinion that even for claims 5 and 6, you can have a minuscule amount such that the electrons will not jump from one molecule to another to form an electron transport pathway that will still meet the requirement of claims 1 and 6 or claims 1 and 5; is that right?

A So, again, I think you're mischaracterizing what I'm saying. I, first of all, don't know what a minuscule amount corresponds to in the context of the discussion. What I am simply saying is that if you first look just at claim 1, claim 1 does not require there

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to be a particular stated concentration.

And then, if you look at claim 5 and 6, really all that needs to happen there is that those functions just need to be carried out. Are we using an electron transport material that can carry electrons and a hole transport material that can carry holes? What potential threshold concentration is required is going to vary depending on the material and, potentially, even the matrix material 1 that you're -- you're doping these materials into.

So -- so, again, my position is just that the patent is silent on a lower threshold, and I'm not going to go back and, you know, add language to this in the patent to try and reinterpret what the inventors had in mind. All the inventors have in mind that there needs to be electron hole transport so that you can make an emission layer.

Q So the hole transport material or the electron transport materials need to exist in sufficient quantities in order for them to

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perform the function of hole transport and electron transport --

A So --

Q -- correct?

A -- in claim 5 and 6, in fact, no. In my opinion, the hole transport material simply means that the second matrix material is a hole transport material, is a known hole transport material, and 6, that the third matrix material is an electron transport material, and that's the -- that's the way I've applied those claims in -- in my declaration.

The context of whether or not they actually can transport charge, I think, just relates again to the function of the layer. And if you're including, as you say, you know, a trace level impurity, it's probably not offering any meaningful function. You're probably not getting an emissive layer anymore if it can't actually participate in the -- in the function of the device.

Q And in that situation, do you still

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consider them to be a matrix material?

A Do I consider a dilute impurity to be a matrix material?

Q Not even dilute impurity, but something that's added in such low quantities that they don't effectively participate or like they contribute almost nothing to the charge carrier transport?

A So, again, I think there's a lot of subjective language there that is trying to be tacked on to a claim 1 that it's actually pretty clear in what's required.

And so, in claim 1, if one has created a functional layer, it consists of three matrix materials that have this relative energy alignment, right, then -- then you've -- you've hit the requirements for each of the matrix materials to be -- to be present. And so I think going any further and saying, well, this is minuscule, might be 2 percent, 4 percent, 12 percent, whatever, I think is missing what's actually written in the claim, and so I'm not

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1 going to take an opinion on what the lower level
2 should be.
3 I think the material that's being
4 included should be included with intent, so,
5 again, not some dilute fragment that happens to
6 appear in the source material, but I'm not going
7 to take a position on what that lower
8 concentration threshold should be because the
9 inventors didn't.
10 Q So, as long as the material is added
11 intentionally, you would consider them to be a
12 matrix material?
13 MR. GARR: Objection.
14 THE WITNESS: So, in considering claim
15 1, again, if a functional layer running three
16 particular matrix materials with a prescribed
17 relative energy alignment, right, again, making
18 an emission layer that allows the guest to emit
19 light, if we're satisfying those constraints,
20 then we're satisfying the language of claim 1.
21 BY MS. ZHONG
22 Q So it doesn't really matter what the

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relative or absolute percentage of the minor components are, correct?

A Again, claim -- claim 1 and the '164 are silent on -- on that.

Q And so it does not matter whether you have a continuous path or you don't have a -- strike that.

So it doesn't really matter whether you have a continuous electron transport path or hole transport path, correct?

A Well, presumably, if you don't have a continuous electron transport or a hole transport path, then your emission layer may no longer function as an emission layer.

But in claim 1, there is, again, no stipulation on mobility and transport. Those are -- those are dependent claims later on.

Q Well, PVK itself will provide a hole transport path, right?

A PVK itself will compete with TPD for hole transport, and so, again, just going back to the paper we already discussed in detail in Yang

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and Neher, by looking at that Table 1 again, it's pretty clear that TPD is playing a role in hole transport because TPD is actually allowing the voltage to fall, and that's happening right away even at 6 percent loading.

And that's a conclusion that -- that I also make in exhibit -- let me find it here -- in Exhibit 1016 as well, in the context of making blue OLEDs using ultra wide-gap hosts, where even at 5 percent, a guest is essentially playing the role of charge transport. So I bring these up only to note that, you know, putting a lower bound on this is -- is in contrast with how the OLED literature looks at charge transport.

So I -- I agree that at some point a hole transporter, fractions of a fraction of a percent is now truly becoming an impurity, but I can't ascribe some -- some threshold that isn't present in the '164. Certainly, I didn't apply one in looking at how the prior art relates to the '164.

(Deposition Exhibit Number 1016 was

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marked for identification.)

BY MS. ZHONG

Q Okay. And you have not found any disclosure by '164 expressly that describes an emitter material as one of the matrix materials, correct?

A A disclosure by -- so, again, sorry. Can you please ask that question again?

Q So the '164 patent, you have reviewed several times, correct?

A Yes.

Q Has it ever described an emitter material as a matrix material expressly?

A To my recollection, it does not ascribe an emitter material as a matrix material, but it also doesn't say that a matrix material can't be an emitter material.

Q In fact, it always distinguishes emitter material from matrix materials, correct?

A In the embodiment that is shown in the '164, there's a distinction between the matrix materials used and the emitter material.

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Q Okay. Is the iridium complex described in column 8, lines 56 to 65 -- is that iridium complex -- can that iridium complex transport holes or electrons?

A So, just so I'm clear, this is column 8, line 56 in the '164?

Q Correct.

A So, again, this particular iridium phosphor, I'm not certain whether it's going to carry electrons and holes equally well or what its HOMO and LUMO levels are, so I'm not sure how effectively it would compete for holes with -- with another material.

Q Do you know whether it transports holes at all -- transported holes or electrons at all?

A The '164 doesn't give any details on the transport properties of this particular compound, and I don't know the specific transport properties of this particular compound.

Q What about Ir(ppy)3?

A So Ir(ppy)3 will transport holes and can participate in hole transport, but it depends

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on what else is present in the -- in the emissive layer of the device.

Q Okay. What about Ir(ppy)2(acac)?

A Ir(ppy)2(acac) will also likely participate in hole transport as well, but it depends on what else is present in the -- in the layer.

Q What about F-I-R-P-I-C?

A Can you restate the full question?

Q Is F-I-R-P-I-C -- strike that.

Is F-I-R-P-I-C considered to be a charge carrier transporter?

A Sorry. I just want to make sure I got that chemical correct. F-I-R-P-I-C or F-I --

Q Yes.

A -- P-I-C?

Q If you look at column 8 --

A Yeah.

Q -- line 32.

A Okay.

Q 32 --

A Perfect.

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Q -- and 33.

A Perfect. I don't know the specific transport properties of FIrpic. Its -- its energetics are a little different than the other molecules you've mentioned.

Q What about the Ir(piq)3, line 35, column 8?

A Again, I don't -- I'm not sure what the specific transfer properties are of -- of Ir(piq)3, and I don't know its HOMO and LUMO off the top of my head.

Q Okay. And so, even though Ir(ppy)3 and Ir(ppy)2(acac) have hole transport properties, it's listed as the emitter material, correct?

A So I'll just first make sure that my testimony was clear. I said my recollection is that they could carry holes, but it will depend what else is -- is present in the system.

And, yes, they are listed as the emitter material because their primary function in the device or in the layer is to emit light, and so the matrix materials and the -- the three

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matrix materials are there only to service as matrix materials in that particular embodiment, but that doesn't prevent an embodiment where Ir(ppy) or Ir(ppy)2(acac) could serve as a matrix material. It just depends on the relative energetic alignment and the function of the device, but in this embodiment, you know, Ir(ppy) would presumably be the emitter.

Q Was it known at the time of the invention that Ir(ppy)3 and Ir(ppy)2(acac) had the capability to transport holes?

A At the time of this invention, the HOMO levels would have been known of these materials, and I think it would have been known that they -- they can -- they certainly can have hole transport character. They also can probably have some electron transport character as well just based off the fact that you can make very good devices out of them.

Q So the inventors did not list either of them as a possible hole transport material, correct?

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A No. Those molecules are not listed as second or third matrix materials. They're listed as possible emitter materials.

(Deposition Exhibit Number 1025 was marked for identification.)

BY MS. ZHONG

Q Can you pull up Exhibit 1025, which is a journal article by Kanno?

A It will be just a moment. I have it.

Q Do you have the --

A Yes, I have it. I have it ready. Yeah, where do you want me to look?

Q Can you please go to -- I think it's page 2, Figure 2.

A Yes.

Q Do you see the energy diagrams on page 2?

A I see the energy diagrams in Figure 2.

Q Okay. I'm a little bit confused about the relative energy for Ir(ppy)3 and PQIr in CBP.

Do you see that in the caption for Figure 2, it says, "The HOMO and LUMO energies of

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Ir(ppy)3 and PQIr are (5.1 eV, 2.6 eV) and (5.0 eV and 2.7 eV)"?

Do you see that?

A Yes, I see that.

Q So if you look at the LUMO level for both the Ir(ppy)3 and PQIr, they are both higher than the 3.0 LUMO level that's listed -- that's illustrated for CBP, correct?

A Yes, I see that.

Q So why would the lines be between the CBP rather than, you know, the LUMO being above the 3.0 level?

Do you know what I mean?

A I do know what you mean. Let me reread the caption.

Q Okay.

A Yeah, it is unusual.

Q So if you are going to draw those energy levels, will they be above 3.0, or can you draw them as in the box of the CBP?

A So if you are trying to draw the relative energy alignment between the HOMO and

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LUMO energies of Ir(ppy) and PQIr as stated in the caption, the two HOMO levels, if, in fact, that's what's being represented on the chart, would be inside of the box for CBP, and the two LUMO levels on this scale would be just above the box for CBP.

So it's not clear to me what is -- what is intended with those bars. And I suspect, though, again, I -- you know, I was an author on this paper, I don't remember drawing this figure. I suspect that the Ir(ppy) and PQIr lines are meant to be schematic because the energy diagram is already very crowded and that's why the actual levels are given in the -- in the caption.

Q Okay.

A That's all --

Q But if you --

A -- I --

Q Sorry. If you are going to draw properly the LUMO levels for the Ir(ppy)3 and PQIr should be just outside of the box above it; is that --

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A If --

Q -- correct?

A Yeah. If, in fact, you are going to consistently show the LUMO levels and that the broken lines currently labeled as Ir(ppy) and PQIr were those LUMO levels, then they would be just above that 3.0 on CBP.

Q Okay. That's all I need to know.

A Okay.

Q Do you use the same host materials for phosphorescent emitters and fluorescent emitters?

A It depends on the host and depends on the emitter. Are there any specifics -- further specifics you can offer?

Q If they are both blue emitters, can you just interchange the host?

A So it depends on the host. There's -- there's different -- there's some different considerations, and the question would be if the host you're already using for the fluorescent blue also meets those considerations for the -- for the phosphorescent blue.

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Q Can you elaborate on that?

A Sure. So when you emit from a fluorescent material -- so when you have an organic semiconductor and you create a molecular excited state or an exciton, those excitons can come in two varieties, singlet and triplet excitons. Singlet excitons have a higher energy than triplet excitons. Singlet excitons have a spin equal to zero, while triplet excitons have a spin equal to one, and so, in a classic fluorescent material, what that means is that one can only emit from the singlet state.

So you'll -- under electrical excitation, you'll form singlets and triplets, but a fluorescent material, you only emit from the singlet state, which means that when you're thinking about trying to get that emission, you want to make sure that your singlet excitons stay on the molecule that you're intending to have emission from. You don't want those excitons to leak, say, back to the host or anywhere else where you might lose them and lose efficiency.

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The same general principle holds when designing the emissive layer for a phosphorescent blue OLED as well. It's just that now you're -- you're also emitting from the triplet state, and you need to make sure that none of your materials, including the host, have any low-lying triplet levels that might quench the triplet state of the phosphorescent material.

In the case of the fluorescent material, you don't really have a problem if your triplets get quenched because they weren't going to emit light anyway. In a phosphorescent material, you're trying to emit light out of a triplet state, and so you don't want them to non-radiatively recombine.

And so what I meant by my statement was that if you're using a host for your fluorescent emitter, it already has a sufficiently large singlet and triplet energy level to confine the triplet exciton to in the blue phosphorescent device, then you can use the same host. If you were using a host that would quench your triplet

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on the blue phosphorescent guest, then you'd have to move to a wider energy gap host so that you could confine it to the guest.

Q Is it concern only with the emissive layer host? What about the hole transport layers or electron transport layers that's adjacent to it?

A And, again, can you just specify what you mean by "is it concern"?

What specifically?

Q Is triplet energy levels of the ETL and HTL adjacent to the emissive layer a concern for phosphorescent OLED?

A So the singlet and triplet energy levels are always a concern for the adjacent levels, too. It's not just for phosphorescence, because you don't want to lose the fluorescent singlets, either, right?

If you take a blue-emitting fluorescent emissive layer and surround it by nothing but narrow gap transport layers, then you'll lose your blue fluorescent excitons just as well as

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you'll lose your blue phosphorescent excitons, and so it's a general concern in OLEDs to make sure that you confine charges and excitons to the emissive layer.

And the materials you might choose could vary, but there is a lot of commonality, and so a lot of the transport materials and blocking materials used in fluorescent materials are now used in phosphorescent materials, too, so there's -- there's actually a lot of overlap.

Q And do you have to worry about the triplet energies of the hole blocking layers or -- or whatever -- like the material that's adjacent to the emissive layer for phosphorescent energy?

A So, again, this is a general concern, not just for phosphorescence, but you always want to make sure that you're confining excitons into the emissive layer. When you're designing an OLED, you'd like to confine the excitons -- well, I should say -- I should be careful. You want to confine the excitons for the desired function,

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and so that means usually confining it to the guest and the emissive layer. And so if you're talking about adjacent blocking layers, then, if it's a fluorescent device, you'd want to make sure you're not losing singlet excitons outside the emissive layer. If it's a phosphorescent device, then you'd want to make sure you're not losing singlets or triplets outside the emissive layer. But, again --

Q And when you -- sorry.

A But, again, many of the blocking and transport layers used in fluorescent OLEDs also work in phosphorescent OLEDs, too.

Q And when you say it confines it, does it mean the triplet energy, for example, for the phosphorescent needs to be higher than the emitters?

A So whenever talking about exciton confinement in general -- and, again, I want to make sure it's clear. It's not just for triplets. What you're saying is that the -- the emissive -- the emissive guest in the simple

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device architecture I'm describing would have the lowest gap, so that, yes, either -- if it's a fluorescent material, it would have the lowest singlet energy. If it's phosphorescent material, you'd want it to have lowest triplet energy.

Q And so, in Figure 2 of Exhibit 1025, you have -- it seems that you have an electron transport layer with lithium doping, correct?

A Oh, so back to Figure 2 of Kanno?

Q Yeah.

A Okay. And please state your question again.

Q So, in that particular configuration, he used an electron transport layer with lithium doping, correct?

A Yes. In this work, there is an electron transport -- well, I should be careful here, so -- because the diagram isn't entirely clear. But there is -- there is an electron -- actually, let me just refresh myself on the layer structure as described. I want to make sure I recall how this worked.

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Yes. So there is a layer in this device that's -- that's exploiting lithium doping. That's right.

Q And is lithium diffusing -- diffusion -- sorry.

Is lithium diffusion a concern in these device structures?

A So, again, I'll just -- I'll just note that this is not something I've thought in detail about in the context of the '164, just because these sorts of doping of transport layers is really not something that came up in considering '164 or the related exhibits that I -- that I've shown here. So, again, I haven't -- I haven't thought about this enough to prepare any sort of opinion.

So what was your question regarding lithium doping of BPhen?

Q Is lithium diffusion a concern?

A I see. Lithium diffusion can be a concern in BPhen.

Q Is -- why is lithium diffusion a

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concern?

A So, in the literature, when lithium diffusion is discussed, lithium is a fairly small atom, and as a result, it might have some mobility and ability to actually move through -- through BPhen.

Q If it moves through BPhen and into the emissive layer, what problem would it cause?

A I'll just note, first of all, that that's not happening in this device because of the fact that, as described in the experimental section, there's a separate blocking layer of BPhen that's undoped.

And, generally, when one applies these sorts of doped structures in -- in an OLED, especially a phosphorescent OLED like this or ones trying to get very high efficiency, you make the appropriate adjustments to the device to prevent any sort of issues related to diffusing the quenching. So the BPhen layer that's neat there that's pure is -- is basically there to prevent that -- that issue, and so that's acting

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as a buffer against the lithium diffusion should there be any out of the BPhen lithium layer. So there's two distinct layers there.

Q Okay. So when you say lithium diffusion especially -- is problematic especially for phosphorescent OLEDs, why do you say that?

MR. GARR: Objection. Form. Mischaracterizes.

THE WITNESS: So, again, what I had said was, in devices where you're trying to get very high efficiency, which is what you're doing in a phosphorescent OLED, and so, when people make phosphorescent OLEDs in the community, these are the most efficient devices that we know how to make. And so, as a result, you're trying to move every possible loss in order to get that high efficiency.

Fluorescent OLEDs frequently are already plagued by low efficiency because they can't emit out of the triplet state and the triplet state's a loss, which means there's already several factors that are preventing high

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efficiency before you start to consider these finer details.

BY MS. ZHONG

Q So why would lithium diffusion, if it happens, reduce the efficiency?

A So, if lithium diffusion were to occur, why could it reduce OLED efficiency?

Q Yeah. Why would it reduce OLED efficiency?

A So, again, I'll just note this is -- this is pretty significantly outside the scope of the '164 and anything I discuss in my declaration. I don't think doping comes up at all in my declaration or in the '164 in any kind of detail.

But lithium could potentially act as a source for, basically, excitons to transfer their energy to, and that energy is released non-radiatively, so they're quenching sites.

Q Does it happen for lithium cation or for lithium atom?

MR. GARR: Objection. Scope.

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BY MS. ZHONG

Q When the exciton --

A And I'm -- and, again, I'm --

Q -- energy transfer --

A I'm not prepared to discuss the finer details of -- of that quenching.

I'm aware of the -- the mechanistic issue that is prevented in the literature through an additional undoped blocking layer, but in terms of what the -- what the exact state of lithium is that might be involved in that hypothetical quenching event, I'm not prepared to give an opinion on that.

Q Do you have knowledge of that?

A I have -- I have knowledge that the quenching could potentially occur, but I'm -- I'm not prepared to offer any opinion on the mechanistic details, and I also fail to see how that connects to the current proceedings.

Q Do you have knowledge of the mechanism in which the quenching occurs?

A I think --

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MR. GARR: Same objection.

THE WITNESS: I think I just answered that question. My answer's still the same, that I'm not going to offer an opinion on the mechanism for exciton quenching via lithium.

BY MS. ZHONG

Q Well, I'm not asking you whether you have offered an opinion or not. I'm asking you, do you have any knowledge as to how the quenching of the exciton occurs?

MR. GARR: Same objection.

THE WITNESS: Again, I have knowledge related to the behavior of excitons in organic semiconductors and related devices, and, you know, that's -- that's as far as I can extend my answer.

BY MS. ZHONG

Q Okay. So, as an expert in the OLED device -- OLED field, can you explain to me how the exciton quenching occurs when there is lithium diffusion?

MR. GARR: Objection. Form. Scope.

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THE WITNESS: And I'll -- I'll just answer that in the same way I already did. I already mentioned that lithium diffuses and acts as a sink for excitons in the emissive layer, and then the energy is shed non-radiatively by the lithium. So that -- that is the mechanism.

In terms of whether it's lithium or lithium (inaudible), that's not something I'm prepared to comment on.

BY MS. ZHONG

Q Do you have any knowledge of that?

MR. GARR: Same objections.

THE WITNESS: Again, I'm not sure how to interpret the question, do I have knowledge of that.

BY MS. ZHONG

Q Do you know whether the quenching occurs with lithium cation or lithium atom --

A I --

MR. GARR: Objection. Form.

BY MS. ZHONG

Q -- or both?

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THE WITNESS: Again --

MR. GARR: Incomplete hypothetical.

THE WITNESS: Again, I'm not going to offer any additional testimony on the quenching side. I think I've explained how the quenching works in terms of the specific chemistry involved and what state lithium's in. I don't have anything further to add to that.

BY MS. ZHONG

Q When you say you don't have anything further to add, it's because you're unwilling to or you're unable to?

MR. GARR: Objection.

THE WITNESS: When I say I don't have anything further to add to that, it's because I haven't specifically prepared to offer an opinion on that question, and I'm here to offer specific opinions related to my declaration regarding the '164. If you can point to a particular place in the '164 or the declaration where this is relevant, I'd be happy to look further.

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BY MS. ZHONG

Q It doesn't really matter what you think is relevant. I'm asking a question and need your answer. If your counsel believes it's irrelevant, they can move to strike.

Do you understand that?

A I --

MR. GARR: Objection.

THE WITNESS: I understand exactly what you're saying, and I think I've answered your question to the best of my abilities right now.

BY MS. ZHONG

Q Okay. So, as an expert in the field, you cannot testify right now whether quenching -- the exciton quenching occurs with respect to lithium cation or lithium atom; is that correct?

MR. GARR: Objection. Mischaracterizes. Scope. Form.

THE WITNESS: So I'll say the same answer I already did, which is that I've given you a mechanistic, simple picture of why lithium quenching would occur related to diffusion and

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related to the interaction with an exciton in the emissive layer. Anything further than that I'm not prepared to offer an opinion on.

BY MS. ZHONG

Q Okay. And lithium quenching is a specific -- is particularly concerning for phosphorescent OLEDs because of the efficiency, correct?

A What I said previously is that mitigating issues related to quenching by lithium but really in general are especially significant only because of the fact that phosphorescent OLEDs are devices that can be very efficient, and so the more efficient a device gets, the closer it gets to, say, the intrinsic maximum efficiency of the device, the more you have to worry about every detail of the device being perfect to continue to increase efficiency.

My contrast was to fluorescent devices, where, right away, you're losing 75 percent of your internal efficiency just to the triplets, and so while quenching might still be problem

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there, the -- the excitonics are already such a significant issue that it's not as big an issue because you're already losing so much efficiency to the excitons.

MS. ZHONG: Can we take a break?

MR. GARR: Yeah.

THE WITNESS: Sure.

(Recess 4:36 p.m. to 4:43 p.m.)

BY MS. ZHONG

Q So, Dr. Russell, I just want to confirm that it is your view that a matrix material differs from a host material, correct?

A A matrix material differs from a host material. It's my view that the term "host material," at least as we think about it in -- certainly how Choulis is using it, you know, can -- can be matrix material, matrix material 1.

I don't know -- are you asking to draw a direct parallel between host and matrix material? Can you give me a better description of what you're asking?

Q I just want to know your view as to

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whether --

A I --

Q -- host materials and matrix materials are synonymous or they mean two different things.

MR. GARR: Object to form.

THE WITNESS: So, based on what we've already discussed, a host material can be a matrix material, and so -- and, again, I wouldn't say that they're necessarily synonymous. It's going to depend on, ultimately, the energy level alignment when we're talking about the context of '164, but a host material can be a matrix material.

BY MS. ZHONG

Q But a matrix material is not necessarily a host material?

A So, again, the term "matrix material" has very specific meaning in the context of the '164.

The term "host material" is -- is used without such specific meaning in the literature, and so that's where I'm trying to make sure that

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we're clear on what the '164 defines as a matrix material, because the '164 applies particular energy alignment to matrix materials. And so, again, a host could be a matrix material, and many of the exhibits that -- that I discuss in my declaration were identifying the host is a matrix material, but, you know, we've also shown that materials defined as organic moieties or even emitter materials could also be matrix materials, and so that's really the fact -- there's -- there's a little bit more nuance than simply making a one-to-one correlation between a matrix material and a host.

Q You said that the matrix materials have to have certain energy alignment.

Those are not the necessary properties of the matrix materials, correct? Those are just additional requirements that the matrix materials have to meet in order to fall under claim number 1, for example, correct?

A The matrix materials have to -- so, in the '164, the matrix materials are components of

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the organic functional layer, and then, in claim 1, there's additional energetic requirements for the matrix materials.

Q Okay. So, in your mind, the matrix materials need not be the host materials; it can be a dopant, for example?

A Again, those terms are being -- those terms are not well defined in the context of the '164. I am reading the specific language of the '164 as a person skilled in the art, and so the '164, when thinking about a matrix material, what -- what constitutes the host in those embodiments? There are only matrix materials in the context of the '164, so that's why I go back to thinking about: What are the components of the matrix and then are they matrix materials?

An emitter certainly could be a matrix material. The term "dopant," I think, is less well defined in -- in the '164, as I -- as I pointed out this morning in the context of BCP. So -- so asking, is the dopant matrix material, again, you have to be a little bit more explicit

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with what we're pointing at, because the moieties in Choulis are also dopants and they're also matrix materials, so...

Q So you agree that the -- the components -- the TPD in Choulis is a dopant?

A Choulis refers to -- I'll just go back to Choulis so we're clear.

So, again, I don't want to take the time to reread Choulis, but Choulis or Yang -- and I'll pull up Yang as well -- refers to the act of doping PVK with the organic moieties. So, in that context, those materials are being co-doped.

So, again, it's in Yang in the abstract that a polymer host is co-doped with electron and hole transporting molecules and so this activity of doping. And so the term "dopant" can mean, you know, just that something has been included as an impurity in an additional material, right, included as an additional component of the film.

So that's why this -- this idea of saying, well, is a dopant a matrix material, is a

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dopant not a matrix material, well, the term "dopant" does not necessarily imply emitter, right? The term "dopant" implies something being added.

Q Now, in the paragraph you pointed to in column 8, lines 56 to 65 --

A In which exhibit?

Q Exhibit 1001.

A What paragraph? I wasn't pointing to 1001 just now.

Q The '164 --

A I was talking about --

Q -- patent --

A -- Yang.

Q The '164 patent.

A Yeah, I was just referring to Yang and Neher, not -- not the '164.

Q Exhibit 1001 --

A Oh, I'm sorry. You mean --

Q The '164 patent.

A You mean in the context of BCP, not in the context of the organic moieties being

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dopants, because that's what I was just talking about.

Q Hold on. I'm just saying like -- you mentioned -- you pointed out the paragraph in column 8, lines 56 to 65, with the -- you pointed this one out this morning --

A This morning.

Q -- correct?

A Yes, I did.

Q Okay. And in this particular paragraph, does it mention first matrix materials, second matrix materials and third matrix materials?

A Let me just reread the paragraph.

No, it doesn't list explicitly the various matrix materials.

Q And it also says -- mentions the NPB matrix is the one compatible with the iridium bis(2-methyldibenzo[f,h]quinoxaline)(acac), right?

A Yeah, it's -- I agree that sentence is there. It seems --

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Q Okay.

A -- to be a spelling mistake as well, but, yes.

Q Okay. Then it says, "If on the anode side, there is also another emitter layer, then this is not sufficiently supplied with electrons," correct?

A It does say that.

Q Okay. So it implies there are two emitter layers in this example?

A It's not clear to me what the embodiment is here. Let me just read this paragraph again, please.

Yeah, I'm not sure how to interpret that, that comment.

Q Okay. So do you know whether the doping is into the -- the NPB matrix or into the other emitter layer?

A It's still not clear to me on balance if there -- what another emitter layer is here just because that really hasn't been described anywhere else.

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My interpretation is that BCP is being used as an electron transport material in a matrix as the third matrix material to increase electron -- basically, electron transport through the -- through the emissive layer.

Q Your interpretation is that BCP is mixed in with NPB as well as UGH4?

A Yeah, I'm just -- again, I just want to read this carefully again.

Yes, that's what I'm arguing. I think -- I think the -- or that's my opinion. I think the intent in the paragraph is to say that if there were another emitter layer, then the challenge of having an NPB host would mean that -- or NPB, I guess, second matrix material would be that you might prevent electrons passing through the rest of the device, and so BCP is used as a third matrix material in order to allow electrons to pass through that emissive layer.

And then I think that's fairly clear with the following sentence that says, "The fine coordination of the transfer characteristics

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takes place in UGH4," suggesting that the balancing of hole and electron transport among these matrix materials then takes place in UGH4.

So I think in this particular paragraph it's -- it's NPB, BCP and UGH4 that would be your materials.

Q And what is BCP doped in -- doped into?

A BCP is a matrix material, and so it's -- it's being doped into the matrix that is the film.

Q The film that used to consist only of NPB matrix?

A No, that's not really the correct way to think about it because you're not doping BCP into a film that only consists of NPB and the -- and the phosphor, right? You're preparing these as a -- you're preparing these as a -- as a mixed film. So it's being doped into the film, into the -- into the sum of all of these components, the matrix.

I think that's consistent with the previous paragraph as well, where it's

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1 considering the first, second and third matrix
2 material for the matrix, suggesting that the
3 matrix is distinct from the first, second and
4 third matrix materials and that the first, second
5 and third matrix materials themselves are the
6 matrix.
7 Q Do you understand what the '164 -- the
8 inventors were saying when they say, "The matrix
9 cannot be selected arbitrarily for phosphorescent
10 emitters because of chemical compatibility"?
11 A I can only speculate. That's -- that's
12 a bit of an unusual way to write that because
13 these molecules are not undergoing any sort of
14 chemical reaction in the film. So, at best, I
15 can speculate on what chemical compatibility
16 might mean.
17 Q What's your understanding?
18 A My understanding might be that it could
19 mean, again, quenching, making sure that the
20 matrix materials are being selected to allow the
21 triplet on the iridium compound to actually emit.
22 And that would -- that would be

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reasonably consistent, I think, with the literature at the time, where there was more consideration to thinking about hosts and associated partner materials in a film and thinking, as we talked about before, the triplet energy and making sure that you didn't sink the triplet from the guest back to the host because, in that case, the device efficiency would suffer.

That -- that would be my speculation on what that means, but it's an unusual way to -- to describe such a phenomenon.

Q Okay. And the next sentence basically says the red -- the particular red emitter is only efficient in an NPB matrix, correct?

A Yes. That's what the sentence says, correcting for the obvious misspelling of the acronym, yes.

Q And that was a common understanding at the time?

A I don't know that that specific comment was a common understanding at the time, at least I'm not aware that this -- this particular

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molecule and NPB were viewed as only one pairing that could work with this molecule.

I suspect that's probably not a general statement. There's probably other hosts that could be utilized with that guest. But the idea that triplet quenching should be avoided, if, in fact, that's how chemical compatibility should be taken, was a general understanding at the time.

Q So the particular red iridium emitter should usually be disbursed in a hole transport material?

A I don't think the '164 is teaching that there.

Q I'm just saying the understanding at the time.

A No, I wouldn't characterize the understanding necessarily as that. I don't see a need for it to have to be disbursed in a hole transport material.

Q Is it -- does it happen to be the way that the Ir(acac) compound is generally disbursed a matrix material that's having -- that has hole

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transport property just because of how the energy levels aligned?

A So -- so, again, that -- that would be a consideration, but I'm not aware that that was a general concern for this particular dopant, and, certainly, there's -- there's phosphorescent devices in general at the time that were disbursed in hole or electron transporting hosts.

So I'm not aware that this was a particular special case that this guest had to be disbursed only in NPB, and then the secondary comment you made regarding the fact that it had to be disbursed in a hole transporter, I'm not aware of that being a general issue.

And I think my earlier comment regarding chemical compatibility was regarding the triplet energies, not regarding the transport behavior, which is a different -- which are two different things.

Q I understand it's two different things. I'm just saying that -- does the energy level alignment -- because of the energy alignment, it

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so happens that the materials that's most compatible with the iridium complex turns out to be hole transporters for that particular one?

A And I -- and I understand your comment, and in my opinion, I don't see why that would have to be the case with this particular emitter. I don't have any knowledge that would suggest this particular emitter only works well when it's present in a -- in a hole transporting material. I'm not aware of that, and I can't see a reason why that would necessarily be the case. But the HOMO and LUMO of this molecule, I don't think are provided.

Q Are you aware of any other materials that's compatible with the -- that Ir(acac) at the time?

A So, if I look at the other materials listed as possible transport layers in -- in the '164, again, I -- I don't know for a fact, but I would speculate that many of them are -- certainly molecules like TCTA -- again, CBP is spelled incorrectly, but CBP probably would as

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well, and then even some of the electron transport materials, like TAZ, triazole. There were very efficient phosphorescent OLEDs made earlier than this based on disbursing molecules like Ir(ppy)2(acac) into TAZ, and it's an electron transporting host.

And so, again, I don't -- I don't have any reason to think that this particular molecule would only work in a hole transporting material, but -- but, certainly, the other materials I've listed would -- would satisfy the triplet energy requirements actually even better than NPB. So I don't see -- I don't -- I don't see why that would be a general concern.

Q In this case, Ir(mppy)3 is a green emitter, not a red emitter?

A So we -- we can go look at the spectrum for Ir(mppy)3 because it's given in Yang and Neher. So if you want to go to Exhibit 1017, Figure 2(b), Ir(mppy)3 is a green emitter.

Q Okay. So it's not a red emitter, right?

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A Yeah. I don't recall saying it is a red emitter.

Q Okay. So the red emitters and green emitters may have different energy levels, and so the matrix materials may have different hole transport versus electron transport properties, right?

MR. GARR: Object to form.

THE WITNESS: Can you be more specific in terms of whether you're talking about fluorescence, phosphorescence? What -- what kind of emitter molecules are you referring to?

BY MS. ZHONG

Q So, for example, the Ir(mppy), which is a green emitter, it may be more compatible with electron transport materials or like host versus an Ir(acac), which may be a red emitter, which tend to be more compatible, or like the triplet energy is more compatible with hole transport materials?

A So I'll answer your question in just a second, but I'll just first note that

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Ir(ppy)2(acac) is a green emitter and as is Ir(ppy)3.

Maybe I'll refer to Kanno in Exhibit 1025 in the energy diagram where the energy levels in the caption again are -- are compared between Ir(ppy) and PQIr. And so Ir(ppy) is a green emitter, probably the most archetypical green emitter that exists for OLEDs. PQIr is a red emitter. And you can see that based on Figure 3, and you can see their HOMO and LUMO levels are actually very similar.

So, in this case, to make a device based on Ir(ppy) or to make a device based on PQIr, a green phosphorescent emitter versus a red phosphorescent emitter wouldn't necessitate a change in host based on energy levels.

MS. ZHONG: Can we take a five-minute break?

MR. GARR: Sure.

THE WITNESS: Sounds good.

(Recess 5:08 p.m. to 5:18 p.m.)

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BY MS. ZHONG

Q So, Dr. Russell, to confirm, it is your opinion that a matrix material can be a dopant or it can be a host material; is that correct?

MR. GARR: Objection.

THE WITNESS: So, as I stated previously, a matrix material can be the emitter. As I already said before, I don't like the term "dopant", but a material can be doped in and serve as a matrix material.

BY MS. ZHONG

Q So the matrix material can be a host --

MR. GARR: Objection.

BY MS. ZHONG

Q -- into which other materials are added, or it can be the additional material that's added to the host?

MR. GARR: Object to form.

THE WITNESS: No, the matrix material -- again, I'll use the example of Yang Neher. The matrix material in Yang Neher is a polymer host that has additional materials

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co-doped in, namely, the organic moieties, and so, in that case, the host is going to serve as matrix material 1. The moieties are matrix material 2 and matrix material 3.

In terms of the idea of whether or not a matrix material could be a dopant, I think we've covered in the '164 that the material BCP, which serves as an electron transporter, and matrix material 3 is doped into the matrix and adds as a matrix material.

So I would make the distinction again not on the term "dopant", but thinking instead about what are the different matrix materials and where is the emissive guest.

BY MS. ZHONG

Q So any of the materials in the matrix is a matrix material, correct?

A Potentially. The guest emitter could also be a matrix material, but in the context of the '164, it need not be for claim 1. But, yes, they're all part of the matrix.

Q So for claims 15 and 16, an emitter

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material can be a matrix material?

A In claims 15 and 16, in -- in exhibit -- the Thompson patent we've been speaking about all day, that's precisely how we're meeting claims 15 and 16, where one of the matrix materials is also the emitter. So this is back in Exhibit 1007.

Q Okay.

A And so, certainly, one of the matrix materials can also serve as the emitter.

Q Okay. I understand that's how you're mapping it.

And we also agree that '164 does not contain any express disclosure of using an emitter material as a matrix material, correct?

A '164 does not, but it also does not preclude the emitter material from being the matrix material.

Q And it consistently describes emitter material as being doped into the matrix, correct?

A It --

Q Or -- go ahead.

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A It consistently describes the emissive guest as being doped into the -- into the overall matrix, the overall film.

Q In column 1 on lines 22 -- column 1, lines 22 and 23 -- to 23 of '164 talks about a matrix material being doped with emitter molecules, correct?

A Sorry. What were the call-outs again?

Q Column 1, lines 22 to 23.

A In the background?

Q Correct.

A I see the line.

Q It talks about the matrix material being doped with emitter material -- material -- molecules, correct?

A It says that the emission layers there might have a matrix material which is doped with emitter molecules, yes.

Q Okay. And the "which" refers to the matrix material, correct?

A In the context of this sentence, this appears to be referring to perhaps a single

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emission layer, saying, organic light-emitting devices [sic] consisting of a sequence of several functional organic layers. Emission layers thereby have a matrix material, which is doped with emitter molecules.

In such a simple case, there's only two components in the matrix. So the layer is being doped, but you only have two components.

Q And the matrix material is doped with the emitter molecules, correct --

A In the --

Q -- in that sentence?

A In that sentence, it says, "Emission layers thereby have a matrix material, which is doped with emitter molecules," yes.

MS. ZHONG: Okay. I don't have any further questions.

MR. GARR: No questions from us.

MS. ZHONG: You can sign off.

Can I get a rough today?

THE REPORTER: Sure, no problem.

MS. ZHONG: Okay. Thank you.

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THE REPORTER: Mr. Garr, do you need a rough?

MR. GARR: Yes, a rough would be lovely.

(Whereupon, at 5:25 p.m., the deposition of RUSSELL J. HOLMES, PH.D. was concluded.)

* * * * *

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CERTIFICATE OF NOTARY PUBLIC

I, ERICK M. THACKER, the officer before whom the foregoing deposition was taken, do hereby certify that the witness whose testimony appears in the foregoing deposition was duly sworn by me; that the testimony of said witness was taken by me in stenotype and thereafter reduced to typewriting under my direction; that said deposition is a true record of the testimony given by said witness; that I am neither counsel for, related to, nor employed by any of the parties to the action in which this deposition was taken; and, further, that I am not a relative or employee of any counsel or attorney employed by the parties hereto, nor financially or otherwise interested in the outcome of this action.

ERICK M. THACKER
Notary Public in and for the
Commonwealth of Virginia

My commission expires:
August 31, 2028
Notary Registration No.: 7184488

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