UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG DISPLAY CO., LTD.,

Petitioner,

v.

PICTIVA DISPLAYS INTERNATIONAL LTD.,

Patent Owner.

Case No. IPR2024-01094

Patent No. 8,558,223 B2

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* CONFIDENTIAL *

VIDEO-RECORDED VIDEOCONFERENCE DEPOSITION OF BARRY P. RAND, Ph.D.

Ogunquit, Maine

Tuesday, August 26, 2025

Volume 1

Reported by:

LESLIE JOHNSON

RPR, CCRR, CSR No. 11451

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PAGES 1 - 231

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

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Patent No. 8,558,223 B2

VIDEO-RECORDED VIDEOCONFERENCE DEPOSITION OF BARRY P. RAND, Ph.D., Volume 1, taken on behalf of Patent Owner, at Ogunquit, Maine, beginning at 9:00 a.m. and ending at 4:52 p.m., on Tuesday, August 26, 2025, before LESLIE JOHNSON, Certified Shorthand Reporter No. 11451.

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

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Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

I N D E X

WITNESS	EXAMINATION
BARRY P. RAND, Ph.D.	
Volume 1	
BY MS. ZHONG	6, 217
BY MS. HANSEN	211

EXHIBITS REFERRED TO
BARRY P. RAND, Ph.D.

NUMBER	PAGE
1003	7
1005	14
1007	25
1015	84
1020	7
1021	62
1022	183
1026	172
1034	37
2008	182
2009	115
2041	161
2044	13
2051	71
2052	71
2105	63
2106	153

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

Ogunquit, Maine; Tuesday, August 26, 2025

9:00 a.m.

THE VIDEOGRAPHER: Good morning. We are on the record at 9:00 a.m. on August 26, 2025. 09:00:33

Please note that this deposition is being conducted virtually. The quality of the recording depends on the quality of camera and internet connection of participants. What is seen from the witness and heard on screen is what will be 09:00:49 recorded. Audio and video recording will continue to take place unless all parties agree to go off the record.

This is Media No. 1 of the recorded deposition of Dr. Barry P. Rand in the matter of 09:01:01 "Samsung Display Company, Ltd. versus Pictiva Displays International, Ltd." filed in the United States Patent and Trademark Office before the Patent Trial and Appeal Board, Case No. IPR2024-01094.

This deposition is being conducted 09:01:26 remotely use, virtual technology. My name is JoAnn Yager, representing Veritext Legal Solutions, and I am the videographer. I am not related to any party in this action nor am I financially interested in the outcome. If there are any objections to 09:01:42

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

proceeding, please state them at the time of your appearance. 09:01:45

Counsel and all present will now state their appearances and affiliations for the record, beginning with the noticing attorney. 09:01:52

MS. ZHONG: Anita Zhong with Irell & Manella representing the patent owner.

MS. HANSEN: Alexa Hansen from Covington & Burling -- with me is Kiersten Choi -- on behalf of the petitioner and the witness. 09:02:05

THE VIDEOGRAPHER: Will the court reporter please introduce yourself and administer the oath to the witness, and then counsel may begin.

THE REPORTER: Good morning. Leslie Johnson, License No. 11451. 09:02:13

BARRY P. RAND, Ph.D.,

having been administered an oath, was examined and testified as follows:

09:02:34

EXAMINATION

BY MS. ZHONG:

Q Good morning, sir.

A Good morning.

Q Could you please state your name for the 09:02:38

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

record. 09:02:40

A Yes. It's Barry Rand.

Q You have submitted two declarations for this proceeding; is that correct?

A That is correct, a first declaration and then a reply declaration more recently. 09:02:50

Q Okay. So they're respectively Exhibit 1003 and Exhibit 1020; is that correct?

A Give me one moment to look.

Q Do you have access to them? 09:03:08

A I do. 1003 is my initial declaration and the reply declaration is Exhibit 1020, 1020. Yes, you're correct.

Q Is the reply declaration -- strike that.

Is the reply declaration necessary to establish obviousness of the challenged claims? 09:03:29

MS. HANSEN: Objection to form. Calls for a legal conclusion.

THE WITNESS: The purposes of both the first declaration and the reply declaration were to lay down my opinions that speak to the obviousness of a certain number of the claims in the exhibit 1001, the '223 patent. 09:03:43

BY MS. ZHONG:

Q Do you need the second declaration in 09:04:00

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

order to make the case of obviousness? 09:04:02

MS. HANSEN: Objection. Calls for a legal conclusion.

THE WITNESS: I viewed the second declaration or the reply declaration as an 09:04:11 opportunity to strengthen some of my opinions and arguments in favor of my assessment of the '223 patent.

BY MS. ZHONG:

Q You're not trying to advance new 09:04:28 combinations or new theories in the reply, are you?

MS. HANSEN: Objection. Calls for a legal conclusion.

MS. ZHONG: Counsel, I caution you not to -- strike that. 09:04:40

Counsel, you may want to review what kind of objections are proper.

MS. HANSEN: I'll keep that in mind, Counsel.

BY MS. ZHONG: 09:04:50

Q Do you want me to repeat the question?

A Yes, please.

Q You're not trying to advance new theories on your combinations in your reply declaration, are you? 09:05:00

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

MS. HANSEN: Objection. Calls for a legal conclusion. 09:05:01

MS. ZHONG: Counsel, if you continue that, we'll have to call the Board.

MS. HANSEN: Sounds great. Let's go for it. 09:05:09

MS. ZHONG: Okay.

BY MS. ZHONG:

Q Can you answer the question?

A Sure. The reply declaration is very consistent with the arguments in the original declaration. 09:05:14

Q Are you trying to advance new theories and new combinations in your reply declaration?

MS. HANSEN: Same objection. 09:05:32

THE WITNESS: Did you use the word "combinations"?

BY MS. ZHONG:

Q "Combinations," correct?

A Can you explain what you mean by that term? 09:05:41

Q Well, your ground of invalidity is obviousness, correct?

A That's correct.

MS. HANSEN: Objection. Form. 09:05:55

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

BY MS. ZHONG: 09:05:55

Q And you are combining -- you are proposing different combinations of a metal complex and organic compounds, correct?

A I'm not sure I understand the question when you say "different combinations of the compounds." And different from what exactly? 09:06:18

Q So for '223, claim No. 1, what are the organic compounds you specifically analyzed in your open -- in your opening declaration? 09:06:39

A Give me a moment to open the '223 patent to refer to claim 1's specific language.

Q I'm talking about in your opening declaration. Which compounds did you analyze?

MS. HANSEN: Object to form. 09:07:01
Mischaracterizes the document.

THE WITNESS: So, in the claim 1 of the '223 patent, it talks about a metal complex comprising a central metal atom and also an organic compound wherein that organic compound comprises a heteroaromatic compound, which is conjugated with an aromatic compound via a carbon-carbon single bond. 09:07:20

BY MS. ZHONG:

Q And which specific organic compounds did you analyze in your opening declaration? 09:07:36

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

A When I approached either declaration, both declarations, I adopted the conventions that were taught to me by the '223 patent, which is a metal complex comprising a central metal atom and an organic compound which has some component with a heteroaromatic part conjugated to an aromatic compound with a carbon-carbon single bond. So I didn't necessarily limit myself because the claim 1 of the '223 patent didn't limit itself. 09:07:39 09:08:02

Q Okay. Why don't we take a look at Exhibit 1003, paragraph 71 to 73. 09:08:21

A I'm opening -- you're referring to my first declaration?

Q Correct.

A Paragraph 70? 09:08:40

Q 71 to 73. And original pages 31 to 33.

A Okay. I've just reviewed those three paragraphs from my original declaration.

Q Those three paragraphs discussed two compounds, correct? 09:09:36

A Those three paragraphs do note the claim 1 language, which is very general, but specifically call out two compounds, yes.

Q And specifically only call out two compounds, correct? 09:09:53

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

A It specifically calls out two compounds from claim 6, which is containing more than two compounds. But in those three paragraphs, we talk about two of those specifically, which is BPhen, bathophenanthroline, a phenanthroline compound with two phenyl groups, and another compound, which is more commonly known as TAZ, which has a triazole core to it. 09:10:05 09:10:23

Q Those were the only two compounds you analyzed in those three paragraphs, correct? 09:10:40

MS. HANSEN: Objection to form.

THE WITNESS: Those were the two compounds from claim 6, again, from the '223 patent, which contains more than two, that we specifically referred to. 09:10:56

BY MS. ZHONG:

Q You didn't analyze the other ones, did you?

MS. HANSEN: Objection to form.

THE WITNESS: In those three paragraphs, no, but that doesn't mean I didn't consider the other compounds that were referred to in claim 6 of the '223 patent. 09:11:03

BY MS. ZHONG:

Q The compound you specifically discussed in 09:11:29

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

those three paragraphs are BPhen and TAZ; is that correct? 09:11:30

A That's correct. As I said, I think two questions ago, those are the two compounds that we called out specifically in those three paragraphs, yes. 09:11:48

Q You did not discuss Exhibit 2044 or compounds Ia through Ie of Exhibit 2044; is that correct?

MS. HANSEN: Objection to form. 09:12:14

THE WITNESS: So Exhibit 2044 is?

BY MS. ZHONG:

Q The '541 patent.

A The '541 patent from Novaled.

Let me scroll down to the table. I believe this is Table 2? 09:12:26

Q Correct.

A Okay. So Table 2 contains phenanthroline derivatives.

And so, yes, none of those is TAZ because that's not a phenanthroline derivative. And also, none of these is BPhen because there are none that only contain the two phenyl constituents. 09:12:46

So, correct, these are other phenanthroline derivatives, none of which are BPhen. 09:13:05

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

Q Okay. And this Exhibit 2044 is by the same inventors as the Werner reference; is that correct? 09:13:10

A Sorry. I need to open also the Werner reference. 09:13:36

Q It's Exhibit 1005.

A Can I open two at once?

Q I think so.

A Okay. Yeah. I just do it as a new tab. Okay. I'm sorry. I'm learning this as I go along. 09:13:47 So I can at least have them open on two tabs. And then 2044 is the '501.

So the assignee is the same for both. They're both from Novaled, a company based in Germany. Werner, Lux, Salbeck are the inventors on 09:14:22 the '541. Werner is one of the inventors on the Exhibit 1005, the Werner document. None of the other inventors are common. But --

Q What about Andrea Lux?

A You're right. Sorry. I didn't realize 09:14:49 there was a second column there that it was spilling over to. Yes. Lux and Werner are common inventors on both patents. Not all of the inventors are the same for either.

Q So the two, Exhibit 1005 and Exhibit 2044, 09:15:08

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

share inventors, correct? 09:15:12

A That's correct.

Q And they have the same first named inventor, correct?

A Ansgar Werner. Ansgar Werner. Andrea 09:15:24
Lux. Andrea Lux. Yes, they have both the same first and surnames.

Q Do you know Mr. Werner or Dr. Werner?

A You mean outside of knowing his name from 09:15:48
reading these documents?

Q Correct.

A No, I do not.

Q What about Andrea Lux?

A No, I do not know Andrea Lux.

Q What about Josef Salbeck? 09:15:58

A No, I do not know Josef Salbeck.

Q Have you done an experiments yourself with tungsten 2(hpp)4 and BPhen?

A Can you specify whether "myself" means 09:16:28
have I ever done that evaporation myself or done a measurement on one of those or been a part of a team that's been -- that's used that compound? Can you be a little more specific, please?

Q Be part of the team?

A Then yes, I've been part of a team that 09:16:45

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

has used both of those materials. 09:16:48

Q Have you been part of the team that used both of these materials simultaneously?

A No.

Q What kind of metal complexes have you been -- strike that. 09:17:09

For BPhen, have you ever tried to dope BPhen?

A Yes.

Q What kind of dopants have you tried to use with BPhen? 09:17:21

MS. HANSEN: Objection to form.

THE WITNESS: I've tried cesium, cesium carbonate, and ytterbium.

BY MS. ZHONG: 09:17:45

Q What about lithium quinolate?

A No.

Q What about any of the paddlewheel complexes?

A I've been on a team that has used extensively the paddlewheel complexes, but not with BPhen with its very close molecular cousin, BCP, the one with two methyl groups. 09:18:08

Q Okay.

A Which is, I think, compound 5 from the 09:18:25

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

'233 patent, if I'm not mistaken. 09:18:28

Q So which paddlewheel complex did you use?

A The tungsten2(hpp)4.

Q And when was the experiment with BCP?

A It was at a time when I worked in a 09:18:44
research center in Belgium in Europe. We were part of a collaboration that included a team from Dresden. Not Novaled, but another team that was in that same city. And as part of that collaboration, we used the tungsten2(hpp)4 with BCP to make 09:19:10
conductive electron transport layers.

Q What was the resulting conductivity?

A Oof. I'm sorry. I can't recall the number.

Q And when was that? 09:19:31

A This would have been certainly after 2010 but before 2013.

Q And when -- how did you measure conductivity when you were working in Dresden?

MS. HANSEN: Objection to form. 09:19:54

THE WITNESS: I never worked in Dresden.

BY MS. ZHONG:

Q Sorry.

How were you measuring connectivity when you were working in that Belgium center? 09:20:09

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

A So we had two different methods of doing that. Both consisted of two metal contacts. But one in one embodiment we would use a so-called vertical structure where you sandwich a semiconductor layer between two contacts. And another one is a lateral structure, so where you have two relatively distant -- they have a pretty long distance, many, many microns, and this doped semiconductor film in between. 09:20:12 09:20:34

Q Okay. So Exhibit 2044 also reported conductivity measurement, correct? 09:20:52

A That's correct.

Q How did they measure their conductivity?

I'll give you a clue. Go to column 3 and look for "2-point method." 09:21:28

A Okay. Sorry. I'm going to lean in here a little bit.

Q The second full paragraph, "The conductivity of a thin layer sample is measured using the 2-point method." 09:21:42

A Uh-huh.

Q Starting in line 31.

A Yes.

Q That paragraph.

A Okay. I've just read it. 09:22:24

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

Q You've read this document back to back, correct? 09:22:28

MS. HANSEN: Objection to form.

THE WITNESS: Sorry. I read this document back to back? What do you mean? 09:22:34

BY MS. ZHONG:

Q Did you review this patent in its entirety?

A Yes. I reviewed this document in its entirety. 09:22:44

Q How many times?

A In its entirety? Twice.

Q Okay. And did you focus on certain paragraphs?

A I read the overall part twice, but I did focus on certain sections more than twice, yes. 09:22:58

Q Which sections did you focus on?

A I focused on the sections that discussed the examples more toward the end of the document, just before the claims, as well as the section that described, you know, around Table 1. So the part about Table 1 and just thereafter where they describe it. 09:23:20

Q Okay. So let's go back to the Exhibit 2044's conductivity measurement. 09:23:37

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

A Okay. 09:23:41

Q Is that the method that you call "using the lateral structure"?

A This is -- yes, absolutely. They are being even more specific about it. They're saying 09:23:50 that the metal contacts are deposited first, and then this thin layer is deposited on top of it.

I'll admit that when I did this in -- not this exact thing, but when I did some lateral conductivity measurements in Belgium, we did the 09:24:09 opposite. We deposited the organic layer first followed by the metal contacts on top.

But in principle, as long as you are ensuring a sufficiently small contact resistance, and, as they say, properly, that the supply lines 09:24:24 and the contact resistance is a minute part of the overall resistance, that you can get a very accurate conductivity measurement from this, which is correct. And it doesn't matter whether those contacts are on the bottom or the top. 09:24:42

Q So when you use a lateral method, are you measuring the conductivity of the bulk film?

A The resistance that you measure, because you ultimately are applying a voltage and you're sensing a current -- and then you need to calculate 09:25:05

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

the conductivity through an understanding of the cross-section of which current over which current is flowing. And then, from that, you can contact -- you can determine the resistivity. And then the inverse of the resistivity is the conductivity. 09:25:08 09:25:24

So it's relatively straightforward to back out the assumed bulk resistivity or conductivity of the material. You are assuming that it's flowing evenly through the bulk when you make that calculation. That's the underlying assumption. 09:25:44

Q So when you are doing the conductivity measurement using the lateral structure, basically, the contact resistivity or resistance is trying to be kept as a minimum compared to the bulk resistance or resistivity; is that right? 09:26:04

A I don't want to confuse resistance with resistivity, so I'll just -- because you sort of used both. But you want to ensure that the resistance of the thing you want to quantify is much larger than the resistance of the other stuff so that your metal contacts, your wiring, and the resistance between the metal and the semiconductor that you're probing the resistance of. 09:26:25

Q You also mentioned there is a second method to measure conductivity which is using a 09:26:44

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

vertical structure, correct? 09:26:48

A That's correct.

Q Okay. And in those vertical structures, are the films that you're trying to measure relatively thin? 09:27:01

A Relatively with respect to the lateral one? Absolutely. The lateral one is going to be many microns. And then vertically, you're usually not probing a layer much more than a few hundred nanometers thick at most. So it will be at least 09:27:19 one, if not more than one, order of magnitude less material that you're transporting charge over that distance.

Q And when you're measuring the conductivity in the vertical direction using a vertical 09:27:38 structure, do you worry more about the contact resistance or resistance at the interfaces of the film?

MS. HANSEN: Objection to form.

THE WITNESS: Has -- it depends. 09:27:59

BY MS. ZHONG:

Q Okay. Depends on what?

A It depends on whether the layer has been doped or not. And by "doping" I mean by controlling the charge carrier population, some thing you put in 09:28:15

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

the material, some guest that you put in the material to change the conductivity and change the number of free charges that are around. 09:28:18

Q Uh-huh.

A If you have a doped layer, then you worry much less about contact resistance. It's a lot easier to make a so-called ohmic contact to a doped layer than it is to an undoped layer. And then you -- so that's why I say it depends. 09:28:29

Q Okay. So when you make an electron only device and do the current voltage measurement, is it more akin to trying to measure the conductivity using a vertical structure than in a lateral structure? 09:28:47

A Sorry. Could you repeat the question? 09:29:15

Q When you make an electron only device --

A Yes.

Q -- and conduct experiments such as trying to construct a current density versus voltage curve, is that more akin to trying to measure conductivity using the vertical structure versus the lateral structure? 09:29:32

A I'm still not really sure I'm quite getting it. So I would say that, when you calculate current density, you are, of course, measuring -- 09:29:56

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

you're applying a voltage between two contacts and you're measuring the current. And when you calculate current density, you in the vertical case divide by the area of that device, which is usually defined by the overlap area of the two contacts you're putting voltage between. 09:29:59 09:30:13

In a lateral device, your current density, you would first, again, put voltage between two contacts. And then to define the current density, you would take the current that you measured and divide by the cross-sectional area of the device. And so that, in this case, the cross-sectional area is defined by the thickness of the film times the width over which you're measuring between the two contacts. 09:30:32 09:30:52

In both cases, you can pretty accurately define an area and, therefore, pretty accurately define a current density. So I'm not sure I'm fully grasping your question.

Q So when you are working with an electron only device, are you measuring the conductivity or current density in the vertical direction or in the lateral direction? 09:31:06

A It depends on whether you made a lateral device or a vertical device. 09:31:26

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

Q In the case of the Ma reference. 09:31:29

A Let me go to the Ma reference.

This is Exhibit 1007.

Q Correct.

A Yeah. So they say in page 2, which is of 09:32:17 the manuscript -- in the journal page 811, where they have the section 2 on the experiments, they describe the hole-only and electron-only devices. The electron-only is what you're asking about. And they say that they use the same methods as above. 09:32:40

And when I go to above, there's a paragraph that opens "In the devices." And then sort of toward the end of that paragraph, they say "The active area of the devices." They describe the subsequent layering of different materials, one on 09:32:56 top of another. And then they say at the end the active area, which is relevant for the definition and calculation of current density -- the active area of the device is defined by the overlap of the ITO. That's one of the electrodes, indium-doped tin 09:33:14 oxide, and the aluminum electrode. And it's, in this case, about 5-by-5 millimeters, so 25 millimeters squared.

And so, in this case, what they are describing is a so-called vertical geometry. 09:33:31

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

Q Okay. In this vertical geometry, do they have to worry about the interfacial resistance at the film and -- strike that. 09:33:39

In this vertical structure, are there interfacial resistivity at the interface of the film and the cathode as well as at the interface of the anode and the film? 09:33:53

A There's a finite resistance to absolutely everything along the chain that connects the two terminals. So from the voltage meter on one pole to the voltage meter on the other pole, there's a finite non-zero resistance for every single link in that chain. So yes. 09:34:19

Q And do you know what's the relative value of the interfacial resistivity compared to the bulk resistivity through the film in the vertical direction? 09:34:37

A I do not know that, no.

Q Do you have a guess as to the relative magnitude? 09:35:02

A I'm unable to offer that guess with the information that I've, you know, taken from Ma, my many readings of it.

Q Okay. What about based on your experience working with semiconductor materials and devices? 09:35:21

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

A Well, based on my experience working with these devices and, you know, if I was trying to determine conductivity, the value absolutely, I would -- I would certainly look to use a lateral device, because it's a lot easier to make the guarantees that were made in the Werner reference. 09:35:27 09:35:48

But if I was looking to find a sort of relative change to the amount of current that was flowing in a vertical device, which is very akin to the organic electronic component that is the OLED, then I would be encouraged to use a vertical device to probe those changes. And I think there is probably a reason why neither Ma nor I would give an absolute value of conductivity of that layer. 09:36:02

Q So can you estimate the conductivity through the BPhen layer based on Figure 5 of Ma? 09:36:29

A So Figure 5 of Ma is displaying electron-only devices. And go to the experiments. This is ITO/BCP -- a very thin layer of BCP -- and then -- 09:37:08

Q You mean BPhen?

A No. There's a 5-nanometer thick layer of BCP between ITO and BPhen. And then there's a 5-nanometer thick layer of BPhen that's either been doped with various loadings of lithium quinolate, 09:37:24

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

Liq, or undoped, and then followed by an aluminum contact. 09:37:28

And you'll notice that they only show current density to one bias region, not both -- not in reverse -- not in so-called reverse bias, but only where they've applied a bias to inject electrons from the aluminum. So they are assuming aluminum is a good electron injecting layer, which is a reasonable assumption because it's the same contact that's used in an OLED. And so I think, 09:37:47 09:38:04

again, that's why you would do that.

But it would be -- it would be challenging to, I think, give an absolute value of conductivity in this device because, again, you have that 5-nanometer thick layer of BCP. Who knows what 09:38:19 that's going to do.

But the idea here was to assess relative changes as they added lithium quinolate to the matrix or host that is BPhen.

Q Given the interfacial resistivity through the different interfaces, how can you determine the change in the bulk conductivity from this curve in Figure 5 -- from the curves in Figure 5. 09:38:44

A So much like in a lateral device where you have to make the assumption that current is being 09:39:23

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

passed uniformly throughout that width and throughout that thickness, you are relying on an assumption here that the injection of electrons into this layer, that resistance is staying relatively constant. And as I change the BPhen layer, I add more lithium quinolate or Liq into it. 09:39:27 09:39:45

And one way that you can sort of give a little confidence into that is by looking at the current versus voltage curve, which are displayed in Figure 5, and noting that their general trends are preserved, which is the case here, if you look at the -- the sort of the way that they -- the current versus voltage curve increases with voltage, it is staying consistent through, in this case, the four different curves. And that gives you some confidence that you can make the assumption that the injection of, like, ability of electrons from aluminum into this layer is not the thing that's dominating the changes; that the thing that's dominating the changes is the change to the conductivity of the layer that I'm altering. 09:40:05 09:40:27 09:40:42

Q Understood.

So let's say the resistivity -- all the other resistivity stays constant through the doping process. And let's say the total resistivity of 09:41:00

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

those non-BPhen film-related resistivity is R. And let's assume for the undoped film, the resistivity is also R. Right? And then let's assume that when at the 33 percent doping level the bulk resistivity drops by a factor -- drops by two orders of magnitude. So basically, the bulk resistivity for the doped BPhen is much smaller than the remaining resistivity through the front anode to the cathode. 09:41:05 09:41:30

Does that mean the observed conductivity would then only be a factor of 2 increase instead of 100 times increase? 09:42:01

MS. HANSEN: Objection to form.

THE WITNESS: I think I'm going to need to see a diagram of this that you're describing. So you're describing two resistors, and you called them both R, which is what makes is really confusing. 09:42:23

BY MS. ZHONG:

Q Yeah, it should be resistivity.

A If you can maybe say like "R1" or "R2" or something like that. 09:42:32

Q Okay. Let's say --

A Can you maybe repeat it --

Q Yeah, sure, sure.

A -- with not using "R" for both, because that definitely confused me. 09:42:38

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

Q Okay. For resistivity, do you also use "R," or you use some other symbol? 09:42:41

A R is okay. I don't mind using R for resistivity. Usually it's rho, but it doesn't matter. 09:42:52

Q Okay. Let's just say the resistivity for all the other resist- -- in Ma's EOD device, there is a resistivity through the bulk BPhen film?

A In Ma's what? EOD? Is that what you said? 09:43:08

Q Electron-only device.

A Okay. Got it.

Q So, in Ma's electron-only device, or EOD device, there is going to be resistivity through the BPhen film, correct? 09:43:20

A Among other things, yes. Through everything in that stack, there is going to be some resistivity.

Q Okay. So let's call the resistivity through that film as "rho 1." 09:43:30

A Okay.

Q And let's say the resistivity through all the other layers and interfaces to be "rho 2"?

A Okay.

Q And let's say, assuming for the undoped 09:43:43

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Samsung v Pictiva
IPR2024-01094

device, rho 1 is approximately the same as rho 2? 09:43:48

A Okay.

Q You got that?

Okay?

Then, as you dope the BPhen layer, the 09:43:58
resistivity of rho 1 is going to drop. Let's assume that happens.

A Uh-huh.

Q And let's assume that after doping the rho 1 prime, since it's a new rho 1, is much smaller 09:44:18
than rho 2.

A And I think you said a hundred times smaller.

Q Yeah. Basically, just you can ignore it compared to rho 2. 09:44:29

A Yes. Okay.

Q So what would be the observed conductivity for the doped device versus the undoped device?

MS. HANSEN: Objection to form.

THE WITNESS: So now -- thank you for the 09:44:48
clarification. I now understand the question. It's basically a question in introductory circuits, which, thankfully, I've taught as a professor.

And so your observation would be you have something that has a total resistivity, which is 09:44:58

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Samsung v Pictiva
IPR2024-01094

basically two rho 1 and then it goes to effectively rho 1 or rho 2. And so it would go down by approximately half -- 09:45:02

BY MS. ZHONG:

Q Okay. 09:45:15

A -- resistivity. So the conductivity would go up by approximately 2 because conductivity is the reverse of resistivity.

Q Okay. So observed conductivity for the electron-only device goes up by a factor of 2 even though the bulk conductivity for the BPhen film went up by 100, correct? 09:45:24

MS. HANSEN: Objection to form.

THE WITNESS: In the scenario that you are displaying where initially the BPhen layer and the rest of the system were approximately of equal resistivity and then you dropped by a factor of a lot, the resistivity of the BPhen layer, yes, in that scenario, which I'm unwilling to assert is the scenario in Ma, but in the scenario that you described hypothetically, yes, it would -- the current at a specific voltage would go up by a factor of 2 -- 09:45:43 09:46:06

BY MS. ZHONG:

Q Okay. 09:46:17

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Samsung v Pictiva
IPR2024-01094

A -- despite 100 times change in conductivity of that one layer. 09:46:18

Q But you don't really know what's the relative ratio of rho 1 versus rho 2 for the undoped film in Ma, right? 09:46:29

MS. HANSEN: Objection to form.

THE WITNESS: I do not know that. It's not provided -- those measurements are not provided here. And that's largely because the measurements here were intended to inform on a layer that is in a very similar context as the layer in the OLED. 09:46:45

BY MS. ZHONG:

Q Okay. And so when you did your vertical versus the lateral structure conductivity measurement -- strike that. 09:47:16

So when you did your vertical structure conductivity measurement, what was the relative resistivity of the bulk film versus the contact resistance?

MS. HANSEN: Objection to form. 09:47:47

THE WITNESS: When the team I was a part of was looking at doped electron transport layers, we were looking at it in the context of another device that Dresden has looked at quite often, which is a so-called multijunction or tandem organic solar 09:48:08

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Samsung v Pictiva
IPR2024-01094

cell where your intention is to try to use a doped highly conductive spacer layer, which doesn't absorb a lot of light, to put the absorbers in the exact right location within the device to absorb a maximal amount of incident radiation, which is sort of the end goal a solar cell. And you want to do that with as minimal voltage drop as possible. 09:48:15 09:48:32

So, in our context, what mattered was operating near the current density that we knew our device could produce under 1 sun illumination and evaluate what the voltage drop was. And so all we really needed to do was look at how much voltage is dropped to achieve this current. 09:48:51

And so we were not looking at the system from the standpoint of determining the conductivity of a layer, but by looking at from the standpoint of how much voltage does it take for me to get to this current density in this layer. And so that's the context we were looking at under. And I didn't -- it wasn't necessary to quantify the conductivity, and so I did not. 09:49:07 09:49:21

BY MS. ZHONG:

Q Then in Ma's structure, thank you for pointing out there is a 5-nanometer BCP between the BPhen layer and the ITO. 09:49:36

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Samsung v Pictiva
IPR2024-01094

What is the bulk resistivity of BCP versus BPhen. 09:49:42

MS. HANSEN: Objection to form.

THE WITNESS: Let me just open up the '541 again. I can't recall. 09:50:07

BY MS. ZHONG:

Q It's not the '541.

A It's not in the '541.

Q Exhibit 1004. In Ma.

A I know Ma doesn't go into the bulk conductivity of BPhen, but I was wondering if it might have been in '541. I couldn't recall off the top. 09:50:16

Q I don't think so.

A No. I don't think it is. It's Alq. It's -- Table 1 is Alq, BAlq and BPhen. 09:50:35

In my experience, because I've worked a lot with BCP, a lot, and I've worked much less with BPhen. There's a good reason for that.

Q Okay. 09:50:55

A BCP and BPhen are effectively isoelectronic in their amorphous state. They have nearly the same LUMO and nearly the same conductivity. And the benefit of BCP and the disadvantage of BPhen is that it crystallizes 09:51:11

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Samsung v Pictiva
IPR2024-01094

readily; whereas, BPhen, those two methyl groups help to hinder the crystallization. 09:51:15

And so, if you ever want to do an experiment and do a comparison to the pristine film, like, you know, a pure BCP or pure BPhen, it is much in your favor to use BCP over BPhen because BPhen is like a ticking time bomb of crystallization; whereas, BCP is not. You have days, easily days to work with it. Whereas, with BPhen you don't have that luxury of time. And it's just a little bit annoying, to be honest, as a scientist, because I like doing careful experiments and careful controls. BPhen is tough to do controls with, in my experience. 09:51:26 09:51:43

The -- but that being said, BCP and BPhen, in my experience, which is pretty deep with these phenanthroline derivatives have initially the same electronic properties. 09:51:56

Q Can you pull up Exhibit 1034?

Do you have access to that? 09:52:16

A Maybe I need to refresh the Veritext site. I don't see Exhibit 1034.

Q Okay. So you don't have independent access to the exhibits, do you?

A I'm not sure what that means. 09:52:45

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Samsung v Pictiva
IPR2024-01094

Q It means, other than the Exhibit Share, do you have access to the exhibits that's already been submitted? 09:52:47

A I have access to Exhibit 1034 that I received from counsel. 09:53:03

Q That's fine.

A I have marked it, though.

Q Oh.

A So I'd rather have a clean copy.

Q Okay. I can -- hold on. Refresh the Exhibit Share again. 09:53:15

A Yes. I see Exhibit 1034.

Q You've reviewed this document, right?

A Yes, I have reviewed this document. A reference from the publication the "Journal of Applied Physics" in 2006. 09:53:45

Q Can you please go to PDF page 4, original page 094506-3?

A I am there.

Q And can you scroll to near the bottom of column -- the left-hand column -- 09:54:05

A Yes.

Q -- and look for a sentence starting with "Clearly, both the BCP and the BPhen films have relatively low absorption coefficients as compared 09:54:19

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Samsung v Pictiva
IPR2024-01094

to those of the photoactive CuPc and C60 films." 09:54:22

A Yes.

Q And read the next sentence to yourself.

A "While" -- oh, to myself? Okay.

Q You can read it into the record too, if you want to. 09:54:36

A "While BCP and BPhen have similar optical transparency, and HOMO and LUMO energy levels, electron mobility in BPhen" -- citing to reference 20 -- "at an electric field of 3.6 times 10 to the 5th volts per centimeter is two orders of magnitude higher than that in BCP," citing to reference 17. 09:54:52

Q Are you surprised by the two orders of magnitude difference in the electron mobility?

A I mean, I don't really like to use the word "surprised" when it comes to science. 09:55:10

Q Okay.

A Just like I don't like to use the word "belief." Just so you know.

Q Okay. 09:55:24

A I just tend to avoid those terms.

But you know, I haven't had an -- while I reviewed this reference, I didn't refer -- I didn't review either reference 20 or reference 17 from which those values sourced, and so I can't -- I 09:55:33

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Samsung v Pictiva
IPR2024-01094

can't say whether those measurements were conducted in this -- you know, with the same -- in the same group, with the same methods, with the same, you know, source material purities, same substrates. It's very -- it would be very challenging for me to weigh in on whether something is surprising when they come from two different references. 09:55:36 09:55:52

Q Okay. Do you expect the electron mobility to be similar for those two compounds?

A If they're both amorphous thin films and both measured by the same team with the same exact ancillary materials and equipment in the same atmosphere, I would expect those two materials to have similar electron mobilities. 09:56:13

Q But BPhen tends to be more crystalline than BCP, correct? 09:56:32

MS. HANSEN: Objection to form.

THE WITNESS: I mean, it depends. If you let that film sit for three days, then yes, it will definitely be more crystalline than BCP. 09:56:45

BY MS. ZHONG:

Q And do crystalline films tend to be -- to have a higher conductivity?

A Crystalline films tend to have higher conductivities because the mobility tends to go up, 09:57:04

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

not necessarily the free charge population. 09:57:08

Q And why is that?

A That is because the crystal is a higher density packing motif than the amorphous solid, which is sort of a kinetically trapped disordered 09:57:25 landscape. And especially if you're, you know, transporting over the crystalline access or crystal plane that has a good amount of pi-pi orbital overlap, your charge carry will experience a lower mobility -- sorry, a higher mobility and lower 09:57:51 resistivity between two contacts.

Q So, basically, shorter hopping distances in a more crystalline structure than an amorphous structure?

A Again, with the asterisk like that this is 09:58:09 potentially very crystal-orientation dependent. There might be certain crystal axes over which the hopping distance might be actually farther than in the amorphous film. The amorphous film will be very isotropic. Transport in all directions should be 09:58:29 very similar.

Whereas, in the crystal, at least over certain crystallographic directions, I would expect mobility to be substantially higher than in the amorphous film. 09:58:40

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Samsung v Pictiva
IPR2024-01094

Q Exhibit 2044. Do you have a theory as to why there is a two orders of magnitude difference in the conductivity for compounds Ia through Ie? 09:59:28

MS. HANSEN: Objection to form.

THE WITNESS: This is the '541 patent? 09:59:49

BY MS. ZHONG:

Q Correct.

A I think you're referring to Table 2.

Q Correct.

A And you're asking me to provide an opinion on what exactly? 10:00:14

Q You see that in Table 2, the reported conductivity spans over two orders of magnitude, correct?

A I do see that, yes. It spans over two orders of magnitude. 10:00:26

Q Do you have a theory as to why that might be happening?

MS. HANSEN: Objection to form.

THE WITNESS: So this is a series of five different compounds. Roman numeral Ia to Roman numeral Ie, all phenanthroline derivatives doped with W -- excuse me, W2(hpp)4, compound IVa, at 5-mole percent. And they're all measured as established earlier with a lateral device geometry 10:00:44 10:01:15

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Samsung v Pictiva
IPR2024-01094

that is suitable for, you know, extracting of conductivity. So conductivity is, you know, a measure of both, in this case, electron mobility as well as electron concentration. And so, you know, the only explanation I can give here is one that is scientific in nature, which is that if there's more than two orders of magnitude difference in these five compounds that there is a more than two orders of magnitude somewhere in the product of electron concentration times electron mobility. Which one is dominating or whether they're both contributing evenly, it's very difficult to say. But these compounds, even though they share a phenanthroline core, they're quite different. I mean, they have very different molecular weights, very different thermal properties. As mentioned here, they have different -- column 2 talks about their glass transition temperature, which changes by 63 degrees C, which is substantial; sublimation temperature, which changes by nearly 60 degrees C, which is substantial. So that's going to lead to differences in the, you know, sort of local environment when they condense out of the vapor phase to the solid.

Yeah. It's a little hard to say. But I can take the data at face value and just say

10:01:19 10:01:49 10:02:07 10:02:28 10:02:45 10:03:02

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

those -- some combination of electron concentration and electron mobility are changing by two orders or magnitude. 10:03:06

BY MS. ZHONG:

Q They have pretty similar LUMO, correct? 10:03:15

A According to Table 2, their LUMOs are all quite similar.

Q So shouldn't the electron density be pretty similar when doped by the same compound?

A I'm not sure I would instantaneously move to that conclusion. 10:03:43

Q Okay. And how reliable is a LUMO level as determined by cyclovoltammetry -- cyclic voltammetry?

A I'm a pretty careful scientist. And I know that might seem like a weird way to start my answer. And I do a lot of electrochemistry. Cyclic voltammetry is an electrochemical measurement. That's, like, sort of the core measurement to an electrochemist. 10:04:18 10:04:37

Now, while I'm not an electrochemist by training, I'm an electrical engineer by training, I am very well -- I've done a lot of research in this area. And that has sort of, I think, bolstered my knowledge base in this area. 10:04:51

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Samsung v Pictiva
IPR2024-01094

And when you conduct a cyclic voltammogram, which is this process of changing the voltage usually from sweeping from one way to another and then back to check for hysteresis, if it's not totally reversible, that's a potentially unreliable cyclic voltammogram. Right? If you don't get the exact same thing multiple times and if a reductive event isn't mated with a corresponding oxidative event as you push to the opposite voltage regime, that's a flag for me. And so I don't -- I haven't seen any of these cyclic voltammograms. But I am always very cautious approaching any materials characterization technique unless I see the data and read an experimental details here, which I'm not privy to. Right? It's not provided in the '541 patent. 10:04:53 10:05:11 10:05:31 10:05:54

And so my answer to you -- my long answer to you about the reliability of a CV measurement is that it depends. And it depends on what I see in the data, which I don't see here, unfortunately. So it's a little hard for me to give, you know, an answer on these data for sure, which I know wasn't your question. Your question was more general. But I would just say that the general answer is that it depends on the underlying data and the way it was 10:06:09 10:06:21

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

conducted.

And the same is true of absorption measurements, a photoluminescence measurement, an XPS, X-ray photoemission spectroscopy. All of these things have pitfalls. And if you do the measurement so as to fall into one of those pitfalls, either -- you know, perhaps unknowingly -- I'm not saying it's done on purpose -- then you can get an erroneous result. 10:06:23 10:06:36

Q And you have not examined the underlying data that's conducted by Werner to obtain those LUMO levels, correct? 10:06:50

A No. I have not. It's not provided.

I am using the data provided in Table 2 as my knowledge base for the source of these LUMOs. 10:07:10

I can say that -- you know, I can just offer my opinions -- is that they have the similar electron, you know, core here, this heteroaromatic core. I would expect that to dominate the lowest unoccupied molecular orbital or LUMO. 10:07:31

And so maybe it take makes sense to me that these LUMOs are rather similar. But I'm just accepting that on the basis of the table without seeing the underlying data.

Q But in your opinion, despite the similar 10:07:45

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IPR2024-01094

core and similarly reported LUMO levels, you don't expect the electron density doped by the same amount of tungsten2(hpp)4 to be the same, do you? 10:07:51

MS. HANSEN: Objection to form.

THE WITNESS: Each of these molecules contains phenanthroline. Now, some have additional phenanthrol R substituents. One example is compound Ie that has two additional phenanthrol substituents at the R1 and R8 positions. 10:08:15

But the question about electron density is different from a LUMO, a molecular orbital, and its energy. That's the energy that an electron sitting on that molecule sits at. Right? That's -- that's a different question. The total electron density passing through a solid that determines its conductivity when you apply a voltage is -- you know, is not exactly the same thing as what the energy of a LUMO is. So I'm uncomfortable giving a direct comparison between the two. 10:08:40 10:09:02

BY MS. ZHONG: 10:09:17

Q I understand conductivity is a multiple of the mobility as well as the free electrons.

So is the number of free electrons when doped by a molecular doping, such as tungsten2(hpp)4, dominated by the difference in 10:09:35

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Samsung v Pictiva
IPR2024-01094

their HOMO and LUMO energy gap? 10:09:39

MS. HANSEN: Objection to form.

THE WITNESS: The difference of what HOMO and LUMO energy gap?

BY MS. ZHONG: 10:09:53

Q I'm sorry.

So for phenanthroline derivatives, with similar reported LUMO levels, are the number of free electrons when doped by the same molecular amount of tungsten2(hpp)4 determined by the energy gap between 10:10:23 the LUMO of the phenanthrolines and the HOMO of the tungsten2(hpp)4?

MS. HANSEN: Objection to form.

THE WITNESS: That energy difference is one aspect among numerous that will determine the 10:10:48 ultimate electron density of the film composed of those two materials, assuming it only has those two materials.

BY MS. ZHONG:

Q What about some of the other 10:11:02 considerations that would determine the free electrons?

MS. HANSEN: Objection to form.

THE WITNESS: The structure of the overall film. You know, sort of the -- the -- you know, the 10:11:21

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

way that multiple material -- multiple molecules orient themselves compared to one another, like neighbors, nearest neighbor interactions, will also play a big role. So there's a structural role to be played, not exclusively an energetic role to be played. The background permittivity of the material, the dielectric constant of the material will determine how free those molecular orbitals are, how much they extend, which will play a big role. The temperature that you're at will play a role. So there are lots of factors -- and I'm sure I'm missing a lot -- right? -- that will determine the sort of overall electron density of the material. 10:11:26 10:11:45 10:12:04

BY MS. ZHONG: 10:12:28

Q Okay. Can you predict what the overall density of the material would be?

MS. HANSEN: Objection to form.

THE WITNESS: Can you be a little bit more specific of what you mean by "density"? 10:12:41

BY MS. ZHONG:

Q So you mentioned electron density?

A Okay. Okay.

Because it -- you know, there is also density like -- 10:12:53

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Samsung v Pictiva
IPR2024-01094

Q Yeah. Sorry. I understand. 10:12:54

A So can you repeat the question now, now that I know what you mean by --

Q Sure. Can you predict a priori what the electron density would be in the film? 10:13:08

A And the film is here comprised of a mixture of a phenanthroline host or matrix with the W2(hpp)4 guest?

Q Correct.

A I would say it would be very challenging 10:13:34 to give an absolute value. You can bound it. Because you can sort of say, if I have some mole percent of W2(hpp)4 and if I assume every single one of those resulted in a free electron in the system, then I could give an upper bound. But I wouldn't be 10:13:51 able to do better than that.

Q What about the relative conductivity or electron density for different phenanthroline compounds with the same amount of tungsten2(hpp)4?

MS. HANSEN: Objection to form. 10:14:14

THE WITNESS: It would depend very much on how much other information I had. If I knew that the efficiency of the W2(hpp)4 dopant was -- had already been determined to be equivalent for all of these five phenanthroline hosts, that would give me 10:14:40

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

an additional piece of information. 10:14:45

If I knew how each of these hosts behave on their own, that would give me an additional piece of information.

I would need additional information. With your question as posed, I can't give you -- there's no way I can quantify it. 10:14:58

BY MS. ZHONG:

Q Were those information known in 2008, 2009? 10:15:11

MS. HANSEN: Objection to form.

THE WITNESS: They're not contained in the '541 patent for these five compounds. They do have it for BPhen, by the way, in Table 1. But it could have been known. The measurements were possible to have been done. I don't know if they were done. They're not reported here. 10:15:30

BY MS. ZHONG:

Q Okay.

A It wasn't unknowable is what I'm saying. 10:15:36

Q Do you have any evidence they were known?

A I don't have any evidence that they were or were not known.

Q Do you know why there is a two orders of magnitude difference in the reported conductivity 10:15:52

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

for BPhen when doped with the tungsten2(hpp)4 in Table 1 versus in comparative example No. 2? 10:15:54

A So you're referring to comparative example No. 2, which is BPhen with 4-mole percent W2(hpp)4, and they report a conductivity of 4 times 10 to the minus 7 siemens per centimeter. And in Table 1, I believe it's 5-mole percent of tungsten2(hpp)4 that -- actually, is it tungsten2(hpp)4 in Table 1? I assume it is. I assume it's W2(hpp)4. I don't absolutely know. 10:16:31 10:17:16

Q Well, it says "The results are shown in Table 1 below." And so why don't you read the surrounding paragraphs.

A Yeah. "The dopant having the structure IVa," which is indeed -- it says -- there's a typo there. Structure needs to the tungsten2(hpp)4, not tungsten(hpp)4. But the molecular structure is unambiguous. 10:17:31

So yes, it's 5-mole percent instead of 4-mole percent, which indicates to me that these were two different experiments. Given that there are multiple inventors, they even could have been conducted by two different people, whether the measurement or the making or the fabrication or both. And, yeah, the dope -- the conductivity is 4 10:17:46 10:18:02

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

times 10 to the minus 9 siemens per centimeter here in Table 1, clearly a different experiment than the comparative Example 2 with 4-mole percent where it's 4 times 10 to the minus 7. So there's a two orders of magnitude difference. 10:18:06 10:18:21

Again, the reasons are kind of unclear to me. Either they're just reporting an experiment that was not very reproducible or it's a typo. I don't -- it's hard for me to say with certainty what the reason is for the differences in the reporting. 10:18:44

Q Okay. Then can you go to column 9 and take a look at the reported conductivity in Table 2 for Ie versus the conductivity reported in Example 2 for Ie?

A Sure. So the conductivity reported for compound Ie doped with 5-mole percent is 2 times 10 to the minus 6. And the conductivity reported for 4-mole percent with Ie is 2 times 10 to the minus 6, the same value, but, again, two different doping concentrations. But there -- there you have the same value for those two. Again, must be separate samples because they have slightly different doping concentrations. 10:19:14 10:19:38

Q Okay. So for Ie, whether it's 5 percent or 4 percent, you get almost the same conductivity, 10:19:53

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

correct? 10:19:57

A According to the data in the '541 patent, yes, that's what it says, with either 4 percent or 5 percent you have identical 2 times 10 to the minus 6 siemens per centimeter conductivity. 10:20:09

Q Do you know what the undoped BPhens conductivity would be if it was measured in comparative example No. 2?

A I don't even know what the conductivity is for undoped BPhen in Table 1. It just reports it as 10:20:32 less than 1 times 10 to the minus 10 siemens per centimeter. And I can provide my opinion, not necessarily proof but an opinion on what that means.

When you're doing a lateral device across many microns and the layer is of insufficient 10:20:51 conductivity to measure any current, then you can't quantify it accurately, and you have to go on the basis of the accuracy of the measurement unit you're using to measure current. And you can say the best this current meter can do is to extract for me a 10:21:15 conductivity of 1 times 10 to the minus 10. So it has to be less than that. So I don't know what it is, but I know it has to be less than that.

In the comparative Example 2, they don't quantify the undoped conductivity, so I can't 10:21:30

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

provide a number. But I can say that it's probably less than 1 times 10 to the minus 10 because undoped BPhen in Table 1 was that way. So was undoped Alq3. So was undoped BAlq. 10:21:33

Q Okay. But for Table 1, the measured conductivity for the doped one is 4E times 10 to the minus 9, correct? 10:21:51

A Table 1. BPhen doped with 5-mole percent of W2(hpp)4, yes, it's 4 times 10 to the minus 9.

Q Okay. Do you expect that a 1-mole percent change in the doping concentration would bump the conductivity by two orders of magnitude? 10:22:08

A From 4 times 10 to the minus 9 to 4 times 10 to the minus 7 you're referring to?

Q Correct. 10:22:31

A It's hard to say. You know, I have here two sets of data with two very different values. I don't know what's underneath it, if it's a typo, if it's really a sort of device-to-device variation. It's very hard for me to say if that's the case. 10:22:52

Q Okay.

A I don't know the accuracy of their doping system. I don't -- there's a lot I don't know.

Q So you don't really know, for example, whether the 4E times 10 to the minus 7 siemens per 10:23:07

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

centimeter, whether there's a typo there or whether that number was -- whether the experiment was conducted correctly or not; is that correct? 10:23:13

MS. HANSEN: Objection to form.

THE WITNESS: It's hard for me to know because I'm not one of these inventors exactly what is behind the difference in Table 1 and comparative Example 2. 10:23:34

BY MS. ZHONG:

Q And you don't have an explanation for the two orders of magnitude difference? 10:23:48

MS. HANSEN: Objection to form.

BY MS. ZHONG:

Q Right?

A I -- like, as I -- as I've told you over the previous few answers and responses, there are various factors that could have contributed to it, different people, because there are numerous inventors; various device-to-device variation that it might just be underlying in the system, which I can't know about; factors in their experiments; or a simple typo. And it's hard to know. I can't assert one way or the other. 10:23:58 10:24:16

I wonder if we could take a brief break. Doesn't have to be right now. But it could be soon. 10:24:50

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

It's up to you. 10:24:53

Q Okay. Why don't we go for another five minutes and take a break. Is that okay?

A That is okay.

Q Why don't we go to Figure 3 of Exhibit 2044, which is PDF page 7. 10:25:01

A Figure 3. Okay.

Q And Figure 3 is showing the decay of luminance over time; is that correct?

A It is showing change in luminance over time. Most subsequent data points are down, which would be decay, but I wouldn't say exclusively. So I'd rather just say it's showing to me change of luminance with time. 10:25:34

Q Let's focus on the curves for BPhen. Okay? 10:25:52

A Okay.

Q And for S1 BPhen, that's a curve where the initial luminance is 1,000 candela per meter squared is that correct? Or candela per meter squared; is that correct? 10:26:16

A I'm just going to find the figure captions to be certain. Maybe you can direct me, Ms. Zhong, to where the figure captions are. There they are. Column 9. Now I see it. 10:26:45

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

Q Column 9. 10:26:50

So for Figure 3, if you look at the open squares, those are for the S1 BPhen; is that correct?

A Please permit me to just open two copies of this so I can look at the description side by side on a different tab as I look at the figure, because scrolling back and forth is challenging. 10:27:51

Okay. All of the open symbols, unfilled symbols, refer to OLEDs using BPhen. And all of the filled symbols or the asterisk refer to the one using compound Id as the electron-transporting layer rather than BPhen. And it has different initial brightnesses or luminances in candelas per meter squared starting around 1,000 and up to almost, if not 6,000, candelas per meter squared. And it's going over a period of time of BPhen devices up to about one hour and the Id compound up to about 20 to 25 hours. Let's call it one day. 10:28:56 10:29:24

So what is your question, now that I'm familiarized myself with this chart? 10:29:45

Q Okay. So let's start with the curve for BPhen with the initial brightness or luminance at 1,000 --

A Okay. 10:30:01

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

Q -- candela per meter squared. 10:30:02

What is it's T50, which is when it lost 50 percent of its initial brightness, according to Figure 3?

A Maybe about 20 minutes, something like .3 something hours. 10:30:27

Q Okay. What about for when the initial brightness is around 2,000 candela per meter squared?

A It's less. It's probably about 15 minutes. 10:30:51

Q Okay. And then when the initial brightness is around 3,500 candela per meter squared?

A It's less still. It's maybe about 8 minutes. 10:31:10

Q Okay. Then what about the fourth curve where the initial brightness is around 6,000 candela per meter squared?

A And unsurprisingly, it's even less. I would say it's about five or six minutes. 10:31:32

Q Okay. Are those OLED devices?

A It depends.

Q Do you think a five-minute -- strike that.

What's a typical T50 that people are 10:32:04

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

striving to obtain for an OLED device? 10:32:08

MS. HANSEN: Objection to form.

THE WITNESS: What type of OLED? What type of application? What color? At what time? What year? 10:32:24

BY MS. ZHONG:

Q In 2008, 2009.

A For what type of application?

Q For orange-red color.

A Again, the application matters a lot. 10:32:47

Q Can you think of an application that uses where the T50 is set as 5 minutes or so?

MS. HANSEN: Objection to form.

THE WITNESS: Well, you know, for an application, you don't usually set a T50. It's not an alarm clock that you're looking to use for that amount of time. So it's a little challenging to answer your question. 10:33:11

BY MS. ZHONG:

Q Is there an application with T50 of 5 minutes with a design specification? 10:33:25

MS. HANSEN: Objection.

THE WITNESS: Not to my knowledge. But, you know, I'm not working for any companies that commercializing OLEDs or attempting to. 10:33:40

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

BY MS. ZHONG: 10:33:45

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

A At least 20 years.

Q And you have done consulting for industry? 10:33:55

A Minimal.

Q Have you worked in industry?

A No.

MS. HANSEN: Counsel, we've been going for about 10 minutes beyond when Dr. Rand asked for a 10:34:23 break.

Could we take a break now?

MS. ZHONG: Sure.

THE VIDEOGRAPHER: Going off the record. The time is 10:34 a.m. 10:34:32

(Recess taken.)

THE VIDEOGRAPHER: Back on the record. The time is 10:44 a.m.

BY MS. ZHONG:

Q Welcome back, Doctor. 10:45:06

Did you speak with counsel during the break?

A Yes.

Q Did you speak with her regarding this proceeding? 10:45:15

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

A I mean, I spoke to basically a wall that didn't reply to me, but I just needed to talk about some stuff just to get it off. And then otherwise, we spoke about coffee machines. 10:45:22

Q What did you speak to the wall about? 10:45:59

A Oh, just about that I'm happy that I spent a lot of time preparing by reading Ma and Werner multiple times.

Q Okay. Now, did you review Dr. Schanze's transcript as part of your reply declaration? 10:46:29

A I assume you're talking about Exhibit 1021.

Q Correct.

A Yes, I did review that document in full in preparing my reply declaration. 10:46:44

Q Did you review the exhibits cited or referenced in that transcript?

A I reviewed the exhibits cited in that transcript that are part of my cited work in my declaration or reply declaration. 10:47:06

Q Okay. Is there any reason you did not review all the exhibits to that transcript?

A In preparing my reply declaration, I only considered those aspects that I found relevant to providing my opinion regarding the '223 patent. 10:47:31

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

Q Okay. Did you review the Fu reference? 10:47:37

MS. HANSEN: Objection to form.

THE WITNESS: What full reference?

BY MS. ZHONG:

Q The Fu reference. Did you review that 10:47:51
document? The JACS paper?

A Thank you for the chat.

I did not review the Fu JACS paper, which I did see in the transcript of Schanze, Exhibit 1021, but I did not review that document. 10:48:03

Q Is there any reason why you did not review that document?

A Because I instead focused on those documents that I thought were the only ones I needed to really rely upon to form my opinions regarding 10:48:25
'223 claims in the IPR case here.

Q Do you know whether the Fu reference mentioned tungsten2(hpp)4 anywhere?

A I'm not sure because I haven't reviewed it. 10:48:48

Q Why don't you open up Exhibit 2105, which was Exhibit 11 to Dr. Schanze's transcript.

A Exhibit 2105.

MS. HANSEN: I'm going to object to this entire line of questioning as beyond the scope. 10:49:11

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

THE WITNESS: I have Exhibit 2105, the Fu JACS paper reference, open. 10:49:14

BY MS. ZHONG:

Q And the Fu reference is a basis for the 2.5 eV HOMO level you cited in your report; is that correct? 10:49:25

MS. HANSEN: Objection to form.

THE WITNESS: Let me --

BY MS. ZHONG:

Q Why don't we go to Exhibit 2044, which is the '501 patent, column 4, lines 15 to 19. 10:49:49

A 2044. Column?

Q Four.

A Four. Okay. Sorry.

Q Lines, actually, 16 to 19. 10:50:06

A 15 to 19. "The gas phase ionization potential of the dopant" -- oh, I see what you're saying -- "is 3.6." "The corresponding ionization potential of the solid can be estimated according to Fu and is approximately 2.5." Okay. 10:50:26

Q Okay. You cited the 2.5 eV number in your declaration, paragraph 27, for example, correct?

A Let me open the reply declaration.

Which paragraph did you refer to? Sorry.

Q I believe it's 27, the first sentence in 10:50:56

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

paragraph 27. 10:51:16

A Yes, it says "The '541 patent discloses that the gas phase ionization potential of W2(hpp)4 as 3.6 eV while the solid-phase ionization potential is estimated to be approximately 2.5 eV," just like 10:51:27 was mentioned previously, and sources indeed from the '541 patent, lines 15 through 19.

Q Okay. And you didn't bother to take a look at the underlying paper where the 2.5 eV came from, correct? 10:51:48

A I wouldn't use the word "bother," but I didn't refer to it. I used the '541 patent as the source of the 2.5 eV ionization potential.

Q Okay. And I think that previously when we were discussing Exhibit 1034, you said you cannot 10:52:07 know whether those numbers are reliable because you did not review the underlying documents that's cited that provided those numbers for that, right?

A I'm sorry. You're going to have to direct me to -- and you had a double negative in there. 10:52:25

Q So remember our discussion of Exhibit 1034?

A Exhibit 1034.

Q The Chan paper.

A Exhibit 1034 I'm not finding in the 10:52:46

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

Veritext. 10:52:48

Q We discussed that. 1034. 1034.

A Exhibit 1034. Right. I don't have it in the Veritext --

Q It should be there. 10:53:01

A -- marked exhibits. Let me refresh it. Oh, yeah. It is there. Sorry.

Right. The JAP reference with the BPhen and BCP electromobilities that differed by two orders of magnitude. 10:53:27

Q And you said you don't know where those numbers come from because you did not review the reference that reported those numbers, correct?

A That's right. I referred to the fact that it was hard for me to speak to the reasons for those differences, I think was -- I think, if I'm dialing back 45 minutes, was your question, and that it was hard for me to provide you an exact reason for the differences without delving into the details of those two samples and two different references. 10:53:42 10:54:05

Q Okay. So it's important to go to the source material to understand where the numbers -- the reporting numbers came from, correct?

MS. HANSEN: Objection to form.

THE WITNESS: Can you repeat your 10:54:33

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

question? 10:54:34

BY MS. ZHONG:

Q So it is important for you to go to the source material to understand where the mobilities -- where -- strike that. 10:54:42

So it is important for you to go to the source material to understand how the mobilities were measured; is that correct?

MS. HANSEN: Objection to form.

THE WITNESS: This particular case, the 10:54:56 one from Chan, Exhibit 1034 is reporting -- is pulling two values of mobility from two different materials. So yes, I would like to ensure that those two are so-called apples-to-apples comparison, that they were conducted in exactly the same way so 10:55:17 that I knew that those numbers -- that comparison can be considered as reliable before I would provide more opinion on the matter as to the sources of the difference, yes.

BY MS. ZHONG: 10:55:38

Q And 2.5 eV is estimated according to Fu, correct?

A That's what the '541 patent stipulates, yes.

Q Okay. Don't you think that you should 10:55:50

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

read Fu to see whether the estimate is a reasonable one? 10:55:52

A I don't see why I would need to do that.

Q Does Fu even mention tungsten2(hpp)4?

A Again, I'm not sure. I didn't read Fu. 10:56:12

Q Why don't you review it for yourself.

A Let me -- it's still open on a tab. I just have to find it.

So I don't have time to review this in its entirety likely here because it's a relatively long JACS article. The title "Quantum-Chemical Predictions of Absolute Standard Redox Potentials of Diverse Organic Molecules and Free Radicals in Acetonitrile." 10:56:28

MS. HANSEN: Dr. Rand, make sure to take whatever time you need to understand the reference. 10:56:47

MS. ZHONG: Counsel, you know the instruction is improper, correct?

THE WITNESS: So what is your specific question about Fu? 10:57:24

BY MS. ZHONG:

Q Is tungsten2(hpp)4 mentioned here?

A It's hard for me to say without reviewing the document in its entirety as well as the supporting information, which is available for this 10:57:59

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

article and contains information on more than 270 compounds. So it's a little hard for me to say at this moment without reviewing this manuscript in detail. 10:58:03

What I can say about this paper is that what it's appearing to be able -- what it's claiming to be able to do is that they are making comparisons of density functional theory, or DFT, which is a quantum-chemical method, to determine -- as a basis for comparison of electrochemical measurements measured in acetonitriles. They're attempting to establish a way to estimate values -- redox potentials, which can include ionization potential in solution, electron affinity in solution, so the sort of oxidative and reductive peaks, with a quantum-chemical calculation. 10:58:16 10:58:47 10:59:07

And so what '541 did was use this as a way to estimate -- in their words, estimate -- the value of the ionization potential of the solid W2(hpp)4.

Q Do you see -- look at Table 1 and Table 2. Table 1. 10:59:35

A Yes. Table 1.

Q Are there any -- all the species listed here are pure organic compounds, correct?

A In Table 1. 11:00:10

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

Q What about in Table 2? 11:00:13

A Yeah. The species in Table 1 and Table 2 are all organic compounds.

Q Do you see any metal complexes in either table? 11:00:56

A None of the compounds in Table 1 or Table 2 contain a metal atom or ion.

Q You did not review this document as part of your reply declaration, correct?

A That's correct. 11:01:33

Q Okay. Did you -- do you know a gentleman by the name of Ioannis Kymissis?

A I do know Ioannis Kymissis from Columbia University, yes.

Q Did you speak to him about this case? 11:01:51

A I did not.

Q Did you review his deposition transcript or the excerpt of his expert report in this report case?

A I noticed that his name -- his surname I think only -- his surname came up maybe once or twice in my review of the deposition transcript Schanze, that's Exhibit 1021, but I did not review the Kymissis document that was being referred to in that transcript. 11:02:06 11:02:46

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

Q Do you know what his view is whether Ma, for example, discloses joint vaporization? 11:02:47

A Only to the extent that was -- that I read in the Schanze transcript, Exhibit 1021.

Q Do you know what his view is in relationship between simultaneous evaporation and joint vaporization? 11:03:12

A From the few lines in the deposition transcript, Exhibit 1021, I don't think I have full context to be able to say yes to that question, so I would say no. 11:03:34

Q Why don't you pull up Exhibit 2051 and Exhibit 2052. Actually, just open up Exhibit 2051 for the time being.

A Okay. Exhibit 2051. This is an expert report from Ioannis Kymissis regarding two patents, one of which I know well -- that's the '223 -- and one I know less well, the 164. 11:04:17

Q Okay. And why don't you read to yourself paragraphs 452 and 453 of Exhibit 2051. 11:04:49

A 452 and 453. Parts of these are highlighted. I just want to draw your attention to that. Is that correct?

Q Understood. Those are supposed -- those were paragraphs that Samsung believes are 11:05:07

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

confidential. 11:05:11

A I see. These two paragraphs in their entirety, not just the highlighted part?

Q Just the highlighted part.

A Just the highlighted part. Okay. 11:05:22

Okay. I've read those two paragraphs in their entirety.

Q So Dr. Kymissis' view is that he does not believe the joint vaporization in Ma constitutes joint vaporization; is that correct? 11:06:06

MS. HANSEN: Objection to form.

THE WITNESS: I'm uncomfortable making that assessment after reading two paragraphs of what is a -- you know, a longer document.

BY MS. ZHONG: 11:06:36

Q But Dr. Kymissis states that he does not agree that this process constitutes joint vaporization with "this process" refers to the Ma process, correct?

MS. HANSEN: Objection to form. 11:06:50

THE WITNESS: It states in paragraph 453, "I do not agree that this" -- it's highlighted, "I do not agree in this process constitutes joint vaporization." But then the next sentence says "I intend to offer more detailed opinions on this 11:07:17

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

topic." So it's a little hard again for me, without the full context, to say more than that one sentence. 11:07:19

BY MS. ZHONG:

Q But he does not agree that the Ma process constitutes joint vaporization, correct? 11:07:31

MS. HANSEN: Objection.

BY MS. ZHONG:

Q That's his conclusion?

MS. HANSEN: Objection to form. 11:07:41

THE WITNESS: That sentence says "I do not agree that this process constitutes joint vaporization."

BY MS. ZHONG:

Q Did you talk to him why he disagrees that this process constitutes joint vaporization? 11:07:50

A I did not.

Q Does lithium quinolate has a central metal compound. Strike that.

Does lithium quinolate have a central metal atom? 11:08:18

MS. HANSEN: Objection to form.

THE WITNESS: I was informed by counsel that Pictiva asserts that lithium quinolate is a complex with a central metal atom. 11:08:38

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

BY MS. ZHONG: 11:08:41

Q Do you agree?

A I --

MS. HANSEN: Objection to form.

THE WITNESS: I accepted that assertion. 11:08:45

BY MS. ZHONG:

Q I'm asking a different question.

And your answer was nonresponsive.

Do you agree that lithium quinolate has a central metal atom? 11:08:59

MS. HANSEN: Objection to form.

THE WITNESS: It's not a topic I've given a lot of thought on. And I also can't claim to be an expert on organometallic complexes in their -- you know, that field as a whole. 11:09:21

BY MS. ZHONG:

Q What is a central metal atom in the context of the '223 patent?

A In the context of '223, the patent owner has asserted that lithium quinolate is a metal complex with a central metal atom. That's the context of '223 that I accepted in thinking about lithium quinolate as a metal complex. 11:09:37

MS. ZHONG: Move to strike as nonresponsive. 11:09:53

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

BY MS. ZHONG: 11:09:54

Q In the context of the '223 patent, what is a central metal atom, in your opinion?

MS. HANSEN: Objection to form.

THE WITNESS: I'm opening that exhibit. 11:10:12

So this is Exhibit 1 to the '223 patent.

In the context of '223, I would say a metal complex -- the essential metal atom of that metal complex is one part of it that allows for coordination to the organic compound and the 11:11:54 formation of chains and networks.

BY MS. ZHONG:

Q Does it have to be centrally located in the molecule?

MS. HANSEN: Objection to form. 11:12:10

THE WITNESS: I hesitate to provide an answer on where its location is, just that it has to contain a metal atom which allows for coordination.

BY MS. ZHONG:

Q So, in your expert opinion, in the context 11:12:27 of '223 patent, the central metal atom just has to provide for the coordination of organic compounds or ligands; is that correct?

MS. HANSEN: Objection to form.

THE WITNESS: That's my reading on 11:12:53

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

column 2 is that the central metal atom is, you know, critical to the role of the metal complex in coordinating with the organic compound with the heteroaromatic segment and the other organic segment connected by a carbon-carbon single bond. 11:12:54 11:13:15

BY MS. ZHONG:

Q Does the central metal atom in the metal complex have to have the ability to provide free electrons?

MS. HANSEN: Counsel, can you please point where in Dr. Rand's declaration -- reply declaration this comes up such that this is relevant for this deposition? 11:14:05

MS. ZHONG: Counsel, you can state your objection, but stop coaching. 11:14:15

BY MS. ZHONG:

Q Dr. Rand, please answer the question.

MS. HANSEN: Objection as to this whole line as beyond the scope. And Counsel, we may need to call the Board on this. 11:14:30

MS. ZHONG: Okay. Go ahead.

THE WITNESS: So your question referred to the metal atom and free electrons? Is that correct? Can you rephrase it?

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Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

BY MS. ZHONG: 11:15:00

Q Yeah. So does the central metal atom have to have the ability to provide free electrons?

A And this is according to the '223 patent?

Q In the context of '223 patent. 11:15:12

A Can you direct me to a specific place where they talk about this free electron donation?

Q I'm asking you, in the context of the '223 patent, does a central metal atom in the metal complex have to have the ability to provide free 11:15:30 electrons?

MS. HANSEN: Objection to form.

THE WITNESS: So, in the context of '223, it's the coordination between the metal complex and the organic complex -- sorry, the metal complex and 11:15:52 the organic compound -- sorry. So the coordination between the metal complex and the organic compound that results in a material with more electrons, which is, therefore, better able to conduct charge.

BY MS. ZHONG: 11:16:22

Q So does the central metal atom in the metal complex have to have the ability to provide free electrons to the organic complex then?

MS. HANSEN: Objection.

/ / / /

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

BY MS. ZHONG: 11:16:37

Q The organic compound then?

MS. HANSEN: Objection to form.

THE WITNESS: The central metal atom is critical to having the metal complex. And then the 11:16:44
metal complex coordinating to the organic compound is critical to having more free electrons.

BY MS. ZHONG:

Q Does the central metal atom have to donate electrons to the organic compound? Is that what 11:17:01
you're saying?

MS. HANSEN: Objection to form.

THE WITNESS: I'm saying that the coordination between the metal complex and the organic compound either pair-wise or in a chain, 11:17:13
which is maybe at least three molecules or a network that's at least four molecules, that combination of more than one molecule has to result in extra electrons available for conduction in the system.

BY MS. ZHONG: 11:17:35

Q Where do those electrons come from?

MS. HANSEN: Objection to form.

THE WITNESS: They come from the coordination of the at least two to at least four molecules. 11:17:50

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

BY MS. ZHONG: 11:17:51

Q Does lithium quinolate provide that feature or benefit?

MS. HANSEN: Objection to form.

THE WITNESS: What benefit? Sorry. 11:18:03

BY MS. ZHONG:

Q The benefit you just -- to form the chain or, like, to provide the electrons?

A The combination of lithium quinolate and BPhen, as shown in Ma, is capable of yielding a 11:18:19 layer that can convey more charge --

Q And where does that charge come -- sorry.

Where does that charge come from? From the lithium atom?

MS. HANSEN: Objection to form. 11:18:38

THE WITNESS: It comes from the combination of the lithium quinolate and BPhen.

BY MS. ZHONG:

Q Is it coming from the lithium atom?

MS. HANSEN: Objection to form. 11:18:49

THE WITNESS: I never -- I wouldn't say that. I'd say it's coming from the combination of the two molecules, which contain many atoms. I mean, we're talking about tens -- many tens of atoms between the two to four molecules, even hundreds 11:19:07

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

between the four. 11:19:11

BY MS. ZHONG:

Q So where -- where do the free electrons come from originally then?

MS. HANSEN: Objection to form. 11:19:20

THE WITNESS: Well, every atom contains electrons.

BY MS. ZHONG:

Q Uh-huh.

A Some are held in, you know, pretty 11:19:28 strongly bonded kind of intersphere situations. Others free, like pi electrons, those are ones that can expand the framework of the bonds of the molecule. And these provide the whole field of organic electronics. 11:19:51

Q So does lithium quinolate contribute to -- strike that.

So does the metal center in lithium quinolate provide the electrons or provide any of the electrons? 11:20:11

MS. HANSEN: Objection to form.

THE WITNESS: So lithium quinolate is going to be very electronically distinct from the quinolate ligand on its own -- right? -- without lithium. Whether I can say that the electron came, 11:20:32

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

you know, explicitly from one or the other -- I can only take a molecule in its full aggregate form when I -- when I'm talking about, say, interactions between lithium quinolate and BPhen. 11:20:38

BY MS. ZHONG: 11:20:49

Q You mentioned several times the word "coordinate." What does coordinate mean in the context of the '223 patent?

A In the context of the '223 patent, the -- "coordinate" refers to interaction between the metal complex and the organic compound that results in, quoting '223, "good electron conductivity" -- I'm quoting column 11 -- "in electron-conducting layer." 11:21:14

So the coordination is that interaction between the metal complex and the organic compound that results in higher electron conductivity for the combination compared to, say, one of the molecules on its own. 11:21:52

Q In the context of the '223 patent, is coordination limited to dative bonds? 11:22:11

A Is coordination limited to dative bonds in the context of '223? Is that what your question was?

Q Correct.

A That wasn't something I considered in 11:22:43

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

forming my opinions for either of the declarations that I wrote. I was taking coordination by the way it's defined in the '223 patent, which is the combination of molecules, one being a metal complex, one being an organic compound, containing a heteroaromatic unit and another organic unit connected by a carbon-carbon single bond that formed an organic electronic component with better electron conductivity than the -- either of those molecules on their own. That's how I interpreted it. And I didn't limit to, you know, consideration of specific atoms or specific types of bonds. 11:22:45 11:23:05 11:23:23

Q And do you determine whether in either Werner reference or in the Ma reference there is a chemical bond formed between two atoms in which a shared pair has been supplied by one of the two atoms? 11:23:46

A Can you perhaps repeat that? When you talk about shared pairs, maybe you can give a little context and then repeat the question. 11:24:04

Q Well, I'm just reading a definition Samsung has provided in district court.

A This might be a document that I'm wholly unfamiliar with, by the way.

Q So you did not review the district court's 11:24:27

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

claim construction; is that correct? 11:24:29

A That's correct.

Q And you did not apply the district court's claim construction either, correct?

MS. HANSEN: Objection to form. 11:24:38

THE WITNESS: If I didn't read it, how could I have done that?

BY MS. ZHONG:

Q Well --

A I don't see how it's possible. 11:24:43

Q Did you read the claim construction order that came out before your reply declaration?

A I did not.

Q Were you provided it?

A I was not. 11:24:54

Q Okay. So you did not determine whether your -- whether the broad definition applied in this proceeding is consistent with the definition that Samsung provided in the district court; is that correct? 11:25:16

MS. HANSEN: Objection to form.

THE WITNESS: Well, I need to open Exhibit 1003, my original declaration. I just want to be sure to get -- to not get it wrong. Yeah. It's paragraph 2. So this was the approach I took: 11:25:42

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

"I have been asked to consider whether the references listed" -- in this case, this is for the original declaration -- "Exhibits 1005 to 1015 disclose and/or render obvious the limitations recited in claims 1 through 4, 6, and 8 through 14 of the '223 patent. I have been also been asked to consider the state of the art and the prior art available before the time of the alleged invention of the '223 patent." 11:25:47 11:25:59

That was how I approached the original declaration. And a very similar way to approach the reply declaration is to, you know, consider also the context of the '223 patent and the prior art. 11:26:12

BY MS. ZHONG:

Q So you apply the plain and ordinary meaning in light of the specification when you interpret the claims; is that correct? 11:26:26

A Can you define "plain and ordinary meaning" for me?

Q Do you have an understanding of what "plain and ordinary meaning" in the context of this proceeding is? 11:26:56

A Counsel informed me that, you know, a patent claim can be considered to be obvious to a POSA at the time the application was filed. Then 11:27:15

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

you know, that means that the claim is not patentable. If that's what you mean by "plain and ordinary meaning," then yes, I have applied that. 11:27:20

Q How did you interpret the terms in the claim? 11:27:41

MS. HANSEN: Objection to form.

THE WITNESS: I'm not sure I understand the question.

BY MS. ZHONG:

Q Why don't we take a look at paragraph 48 of Exhibit 1003. 11:27:57

A Paragraph 48. Okay. So "plain and ordinary" is the same as "ordinary and customary"?

Q Correct.

A Okay. Since I'm not a lawyer, I need to rely on counsel for these types of things. 11:28:19

So, yes, I applied that terminology. If "plain and ordinary" is the same as "ordinary and customary," it's to basically approach the claims like a POSA would, so understanding having, you know, a full view of the literature prior to that and make my opinions known and determined on what I -- what I think about those claims. 11:28:36

Q So is the ordinary customary meaning of the term "coordination" limited to dative bonds for 11:28:55

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

claim 2? 11:29:03

MS. HANSEN: Objection to form.

THE WITNESS: I didn't need to go into that level of detail because the '223 patent didn't invoke that term specifically. So I just took 11:29:14 coordination to be the way that the '223 patent defined it.

BY MS. ZHONG:

Q Okay. So is the ordinary and customary meaning of "coordination" in the context of claim 2 11:29:29 of the '223 patent limited to forming a chemical bond between two atoms in which a shared pair has been supplied by one of the two atoms?

MS. HANSEN: Objection to form.

THE WITNESS: Claim 2 of the '223. Is it 11:29:52 limited to what? I don't know. You read something that I didn't know -- I didn't --

BY MS. ZHONG:

Q Limited to a chemical bond between two atoms in which a shared pair has been supplied by 11:30:07 one of the two atoms.

MS. HANSEN: Objection to form.

THE WITNESS: Claim 2 is referring to coordination between a metal complex and an organic compound. It's not as specific as what you just 11:30:32

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

noted. 11:30:36

BY MS. ZHONG:

Q Okay. Is -- what is a dative bond?

MS. HANSEN: Objection to form.

THE WITNESS: What is a dative bond? 11:30:50

BY MS. ZHONG:

Q Correct.

A Where in my declaration or reply declaration did I talk about dative bonding?

Q Do you have an understanding of dative bonding? 11:31:00

MS. HANSEN: Objection to form.

THE WITNESS: Are you asking me a question regarding the '223 patent or my declaration or my, more specifically, reply declaration or just as a scientist? 11:31:12

BY MS. ZHONG:

Q Do you have an understanding of what a dative bond is?

MS. HANSEN: Objection to form. 11:31:20

THE WITNESS: As a scientist, I have an understanding of what a dative bond is, yes.

BY MS. ZHONG:

Q What is a dative bond?

MS. HANSEN: Objection. This whole line 11:31:28

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

of questioning goes beyond the scope. 11:31:29

THE WITNESS: Again, not talking with respect to my reply declaration or the '223 patent, my understanding of a dative bond is quite akin to a covalent bond, sharing of electrons. 11:31:43

BY MS. ZHONG:

Q So a chemical bond between two atoms in which a shared pair has been supplied by one of the two atoms?

MS. HANSEN: Objection to form. 11:31:54

THE WITNESS: Sounds like you're reading from a chemistry textbook, and so I don't want to go against that definition per se. But I would say, you know, a dative bond is something that -- where you have something akin to a covalent bond, which is a sharing of electrons between atoms. 11:32:09

BY MS. ZHONG:

Q Sharing of electrons between two atoms?

MS. HANSEN: Objection to form.

THE WITNESS: Between atoms, yes. 11:32:20

BY MS. ZHONG:

Q And the atoms is supplied by one of the two atoms that forms the covalent bond; is that correct?

MS. HANSEN: Objection to form. 11:32:39

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

THE WITNESS: Sorry. The atoms are provided by atoms? 11:32:39

BY MS. ZHONG:

Q Sorry. So the electron is provided by one of the two atoms that form the covalent bond; is that correct? 11:32:46

MS. HANSEN: Objection to form.

THE WITNESS: Sounds to me what you're describing is what I know is like from a metal ligand charge transfer, like a coordinate bond. But I'm not -- I fail to see how this line of questioning is relevant to my reply declaration. 11:33:14

BY MS. ZHONG:

Q So is a coordinate bond different from a covalent bond? 11:33:26

MS. HANSEN: Objection to form.

THE WITNESS: I'd say that is a type of covalent bond.

BY MS. ZHONG:

Q So when you did your analysis of the term "coordination," you did not restrict it to the formation of a bond between a metal atom and the -- a metal atom and one of the atoms on the organic compound; is that correct? 11:34:21

MS. HANSEN: Objection to form. 11:34:50

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

THE WITNESS: I used the '223 spec to inform how I should approach and interpret the form -- the term "coordination" and that, you know -- let me go back to it. I think it was column 11. There it is. And yes, you know, I'm using that column 11, looks like, you know, sort of the first two paragraphs at the top of column 11. This coordination is, you know, interaction. If you want to call that bonding, you can call that bonding. Bondings have many different types and many different strengths that -- where you have, you know, at least one metal complex and at least one organic compound forming a chain-like or network-like structure. That was how I approached the term "coordination." And certain molecules that, you know, were typical or embodiments of the '223 patent include molecules like bathophenanthroline, BPhen. 11:34:50 11:35:09 11:35:47 11:36:07

BY MS. ZHONG:

Q Does the interaction have to -- strike that. 11:36:22

Does the interaction needs to be between the metal atom and the organic complex?

MS. HANSEN: Objection to form.

THE WITNESS: The interaction, as I 11:36:38

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

interpret '223, has to be between the metal complex and the organic compound. 11:36:39

BY MS. ZHONG:

Q Does it needs to be between the metal atom of the metal complex and the organic compound? 11:36:47

MS. HANSEN: Objection to form.

THE WITNESS: No. In preparing my declaration and reply declaration, I didn't limit myself to that. I took the language in the '223 patent plus the knowledge that dinuclear compounds like W2(hpp)4 and BPhen were amongst the metal complex and organic compound that could result in -- what do they say in column 11? -- good electron conductivity for the electron conducting layer in presenting my opinions. 11:37:08 11:37:29

BY MS. ZHONG:

Q In presenting opinions, did you determine that there is interaction between the metal atom of the metal complex and the organic compound?

MS. HANSEN: Objection to form. 11:37:48

THE WITNESS: I didn't look at specific elements. I looked at whether a metal complex and an organic compound like the ones claimed in '223 already existed in the literature and, in my opinion, as laid out in my first and reply 11:38:12

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

declarations, Werner and Ma pretty clearly showed those things. 11:38:15

BY MS. ZHONG:

Q Did you determine whether the shared electron pair is supplied by one of the two atoms that forms the bonding interaction? 11:38:25

A Can you repeat that, please?

Q Did you determine whether the shared electron pair is supplied by one of the two atoms that forms the bonding interaction? 11:38:49

MS. HANSEN: Objection to form.

THE WITNESS: I determined that the combination of the metal complex and the organic compound, prior art had those merits that were claimed in '223, and they resulted in a layer of good electron conductivity. And that's what I have to say on the matter. 11:39:16

BY MS. ZHONG:

Q Well, that's nonresponsive.

Did you specifically determine whether the shared pair of electrons is supplied by one of the two atoms that forms the bonding interaction? 11:39:32

MS. HANSEN: Objection to form.

THE WITNESS: I'm not prepared to articulate whether that happened, but I didn't 11:40:02

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

consider it in forming my opinions for either the declaration or the reply declaration. 11:40:06

BY MS. ZHONG:

Q Exhibit 2044 mentions both the gas-phase ionization potential and the solid-phase ionization potential for tungsten2(hpp)4, correct? 11:40:28

A I believe you're referring to the text in the '541 patent, column 4, lines 15 through 19 where they talk about the gas-phase ionization potential of W2(hpp)4, as well as the estimate for its solid ionization potential? 11:40:54

Q Correct.

A Yes. Then it provides both the value for the gas-phase ionization potential as well as an estimate for the solid-phase ionization potential. 11:41:07

Q Do you know where the 3.6 eV for the gas-phase ionization potential came from?

A I'm not 100 percent sure where that value came from. I assume it's either from measurements in the labs of the inventors or from earlier measurements that either are -- were accepted at the time or not referenced. 11:41:52

Q You have worked with tungsten2(hpp)4 before, correct?

A Yes. Correct. I've worked with 11:42:09

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

tungsten2(hpp)4. 11:42:11

Q What do you -- do you use the gas-phase ionization potential in any of your work with that compound?

MS. HANSEN: Objection to form. 11:42:22

THE WITNESS: Did I -- can you repeat it? Did I use the --

BY MS. ZHONG:

Q Strike that.

Did you use the ionization potential of 11:42:28 tungsten2(hpp)4 in any of your work?

MS. HANSEN: Objection to form.

THE WITNESS: I used the knowledge that it has a very shallow HOMO level. It's a very -- it's a fantastic electron donation molecule. I used that 11:42:49 knowledge in using it.

BY MS. ZHONG:

Q Which value did you use?

MS. HANSEN: Objection to form.

THE WITNESS: I mean, it depends what 11:43:14 my -- what the goal of my experiment was. If the goal was to look at something in the gas phase, I would have used the gas phase number. If my goal was to consider what happens only in the solid state, I would have used the solid number. So it 11:43:30

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

just depends on the experiment. 11:43:33

BY MS. ZHONG:

Q So in the context of the '223 patent, which number would you use?

MS. HANSEN: Objection to form. 11:43:43

THE WITNESS: One could use either number. A POSA would use the gas-phase number if they were in the context of '223 looking to form a coordination in the gas phase.

But '223 is not limited to that. It also 11:43:59 allows for coordination in the solid phase. And so, if they were looking for coordination in the solid phase, they would use the solid-phase numbers. I certainly wouldn't advocate mixing them. That would be a bad idea, using the same one, the gas-phase 11:44:15 one, the solid-phase, because that's not apples to apples.

BY MS. ZHONG:

Q So the electron affinity measured by cyclic voltammetry, is that a gas-phase number or 11:44:28 it's a solid-state number?

A It's -- the cyclic voltammetry number is never gas phase. It's usually solution phase. Could be solid phase.

Q And how do you convert that solution-phase 11:44:55

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

number to the solid-phase number? 11:44:59

A There are numerous methods that have been developed over the years to establish trends between measurements that have been taken in the gas phase versus in liquid phase, CV and different solvents, 11:45:26 compared to solid phase in vacuum and trying to establish a trend between a measurement via -- using one method to a measurement using another method. Because you can't directly compare values with the different methods. 11:45:51

And to add to that now that you've shared with me the Fu reference, apparently attempts have been made also using quantum chemistry to add to the sort of toolbox of data that could be compared to establish relationships like that. 11:46:16

Q What about the ionization potential or the electron affinity measured by the EPS method?

MS. HANSEN: Objection to form.

THE WITNESS: Can you repeat that?

BY MS. ZHONG: 11:46:35

Q What are some of the other methods to measure ionization potential?

MS. HANSEN: Objection to form.

THE WITNESS: I think you changed the question. That wasn't repeat. 11:46:44

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

So what's the new question? Because I was comparing to the previous one, and I lost it because it was a different question. 11:46:48

So can you please repeat this one?

BY MS. ZHONG: 11:46:55

Q What are some of the other methods that can be used to measure the ionization potential?

MS. HANSEN: Objection to form.

THE WITNESS: So to establish the ionization potential of a molecule, you can use ultraviolet photo emission spectroscopy, which can be either -- which is -- which is always conducted in -- not always. I'll get to it. Which can be conducted in ultra high vacuum and which can be done either to a plume of molecules in the vapor phase -- 11:47:07 11:47:35

that's the gas phase ionization potential -- or you can conduct this measurement on a film or solid phase of the same material, which then is not looking at the isolated molecule but looking at the collection of molecules, which has a very different environment compared to the gas phase. 11:47:52

You can also do photoelectron spectroscopy in air to establish the ionization potential of a molecule. There you do have to be concerned about whether air is influencing the outcome. 11:48:10

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

You can also use cyclic voltammetry to look either at an electrode of a molecule, if you're doing it kind of in solid phase interacting with an electrolyte, or you can have the molecule suspended in the solution that is an electrolyte and try to gauge the ionization potential through oxidizing the molecule that way, or you can conduct a simulation, a calculation of where the ionization potential lies. 11:48:13 11:48:28

All of them are used commonly in the community. It's up to the scientists to try to make the best comparison they can using either previously established ways of shifting from one technique to the other or by conducting all of the measurements on their own via, you know, the same measurement to make comparison meaningful. 11:48:44 11:49:05

BY MS. ZHONG:

Q Have you heard of a method called DPV?

A DPV? Is that what you said?

Q Yeah. 11:49:23

A Can you define what that acronym means?

Q I think it's differential pulsed voltammetry. Have you heard of that method?

A Without getting a little more context, like, description of it, I'm not sure. Because 11:49:46

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

sometimes researchers provide names that maybe are similar but not exactly the same as one that I'm referring to. 11:49:49

Q Have you heard of a differential pulsed voltammetry? 11:50:02

MS. HANSEN: Objection to form.

THE WITNESS: Not to my knowledge in that exact phrase.

BY MS. ZHONG:

Q So does UPS or ultraviolet -- strike that. 11:50:20

So does UPS or ultraviolet photoelectron spectroscopy, does that provide you with a gas-phase ionization potential?

MS. HANSEN: Objection to form.

THE WITNESS: UPS can provide you with a gas-phase ionization potential if you're shining the UV light onto those molecules in the gas phase and then you're measuring, you know, the outcome from those gaseous molecules, or it can be used in solid phase from a film or a chunk of that material. 11:50:41 11:51:02

BY MS. ZHONG:

Q So UPS can measure either the gas-phase ionization potential or solid-phase ionization potential; is that correct?

MS. HANSEN: Objection to form. 11:51:13

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

THE WITNESS: That's correct. Though it's -- UPS can be used in either sense. 11:51:15

BY MS. ZHONG:

Q Do you know what would be the solid-phase electron affinity for BPhen? 11:51:39

MS. HANSEN: Objection to form.

THE WITNESS: So electron affinity now you're shifting to; is that correct?

BY MS. ZHONG:

Q Correct. 11:51:57

A Again, it depends on the form. If it's a crystal, if it's an amorphous solid, if it's a vapor, if it's a liquid. I can't give you, you know, one answer.

Q Do you have a sense where it lies? 11:52:12

A Again, it depends on the form of it.

Can you be a little more specific?

Q Do you know the range depends on the form it's in?

MS. HANSEN: Objection to form. 11:52:31

THE WITNESS: Sorry. So you're saying do I know what the range of BPhens LUMO might be if it were vapor phase versus solution versus solid?

BY MS. ZHONG:

Q Do you know what's the range of the -- 11:52:44

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

strike that.

Do you know what's the range of BPhen's electron affinity or LUMO energy level would be for the solid phase? 11:52:46

MS. HANSEN: Objection to form. 11:52:57

THE WITNESS: So, in the solid, the most common way to establish the electron affinity is to do a so-called inverse photoemission spectroscopy measurement, which, instead of shining UPS, it's shining U, the ultraviolet -- that's what the "U" stands for -- shining ultraviolet light into the solid and measuring the energy of electrons that come out of your photoemission. 11:53:21

And the inverse is I don't apply UV light. I apply electrons to the solid. And I measure the energy of light that emerges as a product of the loss of energy of the electron getting inserted onto the LUMO. 11:53:35

The UPS measurement typically has an error bar assigned to it of some plus or minus .1 electron volts. The error bar on the IPES measurement, the inverse photoemission measurement, usually has assigned to it an error bar of up to .5 -- plus or minus .5 eV. 11:53:55

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Samsung v Pictiva
IPR2024-01094

BY MS. ZHONG: 11:54:14

Q Okay. So do you know what the range of the reported solid-phase electron affinity is for BPhen?

MS. HANSEN: Objection to form. 11:54:28

THE WITNESS: I don't know it specifically for BPhen, but what I can say is that, you know, given that I know that IPES often has an error bar associated to of plus or minus .5 eV, I have to imagine that the reports for a molecule like BPhen 11:54:44 would be to the tune of plus or minus .5 eV.

BY MS. ZHONG:

Q Do you know what the nominal value is?

MS. HANSEN: Objection to form.

THE WITNESS: I don't know off the top of 11:55:08 my head the nominal value for BPhen, but I know that, you know, there are numerous references that provide values for it. And I would expect those values to reflect the typical error in the IPES measurement. 11:55:22

BY MS. ZHONG:

Q Do you know what's a typical error bar for the cyclic voltammetry for measuring the electron affinity on LUMO levels?

A That's for a molecule in the liquid phase 11:55:39

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

usually. There the error bar is typically provided in the plus or minus .1 eV range for either the oxidative or the reductive. 11:55:42

But to revisit as something I said earlier, I would be very cautious of any interpretation of a cyclic voltammogram that doesn't show a reversible oxidative and reductive side. 11:56:00

Q And we don't know whether the cyclic voltammetry -- strike that.

And we don't know whether the cyclic voltammetry for the phenanthroline compounds in Exhibit 2044 showed the reversible redox behavior, correct? 11:56:19

MS. HANSEN: Objection to form.

THE WITNESS: You're talking about the molecules Ia through Ie in Table 2? 11:56:38

BY MS. ZHONG:

Q As well as BPhen.

A As well as BPhen. Okay. Right. Reported LUMO. Reported in Table 1. Yes, it is. 11:56:47

We don't know. We only know that that was determined by cyclic voltammetry with ferrocene/ferrocenium. That's FC/FC+ is the internal standard, which is a very common reference electrode for cyclic voltammetry. So we don't have 11:57:05

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

that information. 11:57:08

Q What about for Alq3 and BAlq2?

A It's a similar situation.

MS. HANSEN: Objection to form.

THE WITNESS: Yeah. Similar situation for Alq3 and BAlq. We don't have knowledge of -- you know, the cyclic voltammograms for these molecules are not shown in the '541 patent. 11:57:21

BY MS. ZHONG:

Q Is aluminum Q3 a metal complex or organic compound? 11:57:37

MS. HANSEN: Objection to form.

THE WITNESS: Alq3 is a molecule that contains a metal atom, aluminum in this case, surrounded by three quinoline ligands. 11:57:51

BY MS. ZHONG:

Q So is it an organic compound or metal complex?

MS. HANSEN: Objection to form.

THE WITNESS: It's a metal complex. It's an organic compound. 11:58:04

BY MS. ZHONG:

Q So it's your opinion that a metal complex and organic compounds are not mutually exclusive?

MS. HANSEN: Objection to form. 11:58:24

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

THE WITNESS: If the metal complex has, you know, a substantial amount of organic ligands, I would say it could fall into both bins. But it's -- you know, it's a chemistry binning. 11:58:29

BY MS. ZHONG: 11:58:50

Q Do you have an opinion on it?

MS. HANSEN: Objection to form.

THE WITNESS: I just provided my opinion on it, that you can put things into multiple bins, multiple categories. 11:59:03

BY MS. ZHONG:

Q Were you aware of Exhibit 2044 before this proceeding?

A 22.

Q The '541 patent. 11:59:34

A Oh, 2044, the '541 patent. Got it.

Prior to this proceeding, I was not aware of that patent specifically. But as a researcher in organic electronics and as one that I like to consider myself pretty well informed on the progress 11:59:56 in the field, I was very well aware of the strides and discoveries being made in and around Dresden, Germany at that time, which, you know, reflects my knowledge of particularly n-doping, electron doping in organic electronic materials. 12:00:22

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

Q Exhibit 2044 only reported the lifetime -- strike that. 12:00:59

The Example 2 in Exhibit 2044, that's not really device testing. That's a testing on the film; is that correct? 12:01:19

A Example 2?

Q Correct.

A Can you repeat your question?

Q Take a look at Example 2.

A I am right now, yes. 12:01:36

Q The testing done on Example 2, that's only on the bulk film. That's not in the device. Is that correct?

A I mean, this might be a matter of opinion, and I'm happy to have a discussion about it. But I would definitely consider that to be a device measurement, to have two contacts that constitute ability to pass current in a film. I think that is kind of the definition of a device. I mean, here it's a quite simple one. You have two contacts and a single semiconductor film. But I would -- I would really say that's a device measurement. 12:01:57 12:02:14

Q Okay. Does that device emit light?

MS. HANSEN: Objection to form.

THE WITNESS: The device measured in 12:02:43

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

Example 2, which is a layer of compound I -- Roman numeral Ie doped with the W2(hpp)4 compound does not emit light when voltage is applied across it because it's designed to only pass one type of carrier, in this case, the electron. And in order to have light emitted, you need to have two carriers around both electrons and the counter charge the hole. 12:02:46 12:03:09

BY MS. ZHONG:

Q And the device in Example No. 2 does not have a cathode; is that correct? 12:03:36

A That's not correct. The cathode is the terminal that's at a lower potential from the anode. One of them is a cathode and one of them is an anode.

Q So the two points, you believe one is a cathode, the other is an anode? 12:03:57

A Absolutely. Yeah, the one that has the positive -- you know, the positive bias is the anode. The one with the negative bias is the cathode. You know, relatively speaking, right? One can be grounded. One has lower versus higher potential, cathode versus anode. 12:04:09

And if you're generally maybe a little confused, Ms. Zhong, if I may?

Q Sure. 12:04:47

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

A In an OLED, you typically have one contact you call the anode and one contact you call the cathode. I can say most commonly in literature, the anode is your transparent conducting layer, usually ITO, because that's the one that under forward bias operation, the typical operation of the LED is under positive bias. And the cathode, the top contact, prevailingly aluminum is lower potential. So maybe that's a reason for some confusion between the nomenclature. 12:04:49 12:05:03 12:05:24

Do you understand my point?

Q Yes.

A Okay.

Q But in Example No. 2, the so-called anode and cathodes are in the lateral positions, not in the vertical position; is that correct? 12:05:42

A That's correct. They're in a lateral position. And both of them are the same material. Here it says "contacts made of indium tin oxide." So they're both ITO. 12:05:57

And what determines which is the anode and which is the cathode is the bias that is applied, not the material that it's composed of.

Q Okay. Is Example No. 2 measuring the thermal stability of the film? 12:06:32

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

A In a sense, yes, it's measuring -- it's applying a bias between the two contacts. And then during that time, they heat the sample successively by increasing by 10 degrees C and then taking it back down. So they are -- they are doing some sort of temperature stressing here by constantly ticking it up to a higher temperature and measuring the conductivity. And its response goes back to room-temperature. 12:06:54 12:07:16

Q Do you know would compounds Ia to Ie behave in this -- under the same stress testing or temperature cycling conditions in Example 2? 12:07:35

MS. HANSEN: Objection to scope.

THE WITNESS: So they compare in Example 2 Ie. Only Ie. And so I can't speak to how all of Ia, Ib, Ic, Id and Ie would compare to one another under this type of stress. 12:08:11

BY MS. ZHONG:

Q Can you predict?

MS. HANSEN: Objection to form. 12:08:34

THE WITNESS: I can't predict that my prediction would be correct. But they provide glass transition temperatures, which is a thermal measurement. It's not the only thermal measurement that's relevant to the sort of test that's being 12:08:52

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

conducted here. We need to consider lots of different factors like adhesion, the coefficient of thermal expansion, the crystallization temperatures, none of which are provided. But if the inventors here determined, which they didn't tell us, but if they determined that the glass transition temperature was the most important factor in all of that, then and only then would I be able to levy a prediction that Ie with the highest glass transition temperature would be the molecular layer most able to withstand this test without an appreciable degradation. 12:08:54 12:09:08 12:09:25

BY MS. ZHONG:

Q Why is that?

A Because Ie has the highest glass transition temperature among the five molecules in Table 2. 12:09:38

But like I said, I don't know anything about the coefficient of thermal expansion, the adhesion, which is dependent on things like surface energy. I don't know about the crystallization temperatures, which, from my experience, are not, you know, necessarily informed by glass transition temperature. I'm just giving a statement based on if the inventors assert, like, have determined that 12:10:07 12:10:22

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this is the only important metric. That would be my prediction. 12:10:25

Q Can you predict the surface energy based on the molecular structure?

MS. HANSEN: Objection to form. 12:10:57

THE WITNESS: It's something that can be measured. Prediction is pretty challenging for any amorphous film. You could probably predict it reasonably accurately if you knew it was a single crystal. 12:11:19

BY MS. ZHONG:

Q Do you expect these to be amorphous films?

MS. HANSEN: Objection to form.

THE WITNESS: It's not stated in the document, but it would be my expectation that these molecules initially would be a very disordered film. 12:11:39

BY MS. ZHONG:

Q Do you expect them to crystallize all the time?

MS. HANSEN: Objection to form. 12:12:02

THE WITNESS: Crystal is a, you know, lower -- you know, it's trying to reduce its entropy. I don't know if I would expect. It just depends very much on the thermal properties of these media. It's hard. 12:12:18

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I know from experience BPhen, which is not one of those five compounds, will crystallize given time. But the thermodynamics are a little hard to predict for molecules where I don't see that information. 12:12:22 12:12:36

BY MS. ZHONG:

Q Which is BPhen is not a favored material to use in a lot of the organic electronic material devices, isn't it?

MS. HANSEN: Objection to form. 12:12:47

THE WITNESS: Could you repeat?

BY MS. ZHONG:

Q Given the fact that BPhen tends to crystallize and make it a less desirable material to use in a lot of the organic electronic device applications? 12:12:56

MS. HANSEN: Objection to form.

THE WITNESS: I would say it strongly depends. BPhen is a commercially available compound. If, you know, you're looking to do measurements on a commercially available compound and not rely on a synthetic partner or your ability to synthesize a specific compound, then you would use it to inform something. And that's how science works a lot of the time. BPhen is cheap. It's 12:13:14 12:13:35

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readily available. It's easy to purify. You can easily do experiments with it. 12:13:38

Would it be my go-to compound to use on its own in a free film for a thing I want to sell and make money with? Probably not. But there are also ways to stabilize a film by mixing it with other things, by capping it with layers that are very thermally stable. So I don't want to say it's impossible. But, you know, when you're doing an experiment to try to learn something and teach something, you can still find ways around its transient nature. 12:13:52 12:14:07

BY MS. ZHONG:

Q Would you have preferred BCP?

A BCP is another molecule which is readily commercially available. And so when I choose to do experiments that require the use of a phenanthroline compound and I need to choose between BCP and BPhen, I would choose for BCP. 12:14:21

Q Which film has better thermal stability? 12:14:44

MS. HANSEN: Objection to form.

THE WITNESS: Between what and what?

BY MS. ZHONG:

Q BCP and BPhen?

A I think is very much depends. But if 12:14:57

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we're talking about a free film on a substrate, no nothing in it, like a pure neat film sitting on a substrate, then BCP will have -- will preserve its initially deposited amorphous nature longer than BPhen will. 12:14:59 12:15:19

Q What about in an organic electronic device?

A Yeah. That --

MS. HANSEN: Objection to form.

THE WITNESS: That's a lot harder to say. 12:15:33

In an organic electronic device, you will be, you know, depositing another layer on top of BPhen or BCP. You might even be co-evaporating BPhen or BCP with another molecule. You might subject it to some kind of cold treatment or heat treatment or purposely evaporate a metal on there in some condition that allows those two media to kind of intermix in such a way that preserves their morphology. There are lots of things you could do to coax stability out of that film. And you know, depends the lengths one wants to go to or has available to them to, I think, determine what you would select. 12:15:54 12:16:10

BY MS. ZHONG:

Q Can you predict a priori? 12:16:24

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A Only for the -- as I said, only for, like, the neat film. A neat film of BCP sitting on a substrate and a neat film of BPhen sitting on the same substrate uncapped, exposed to the same conditions, a priori, I would expect the BCP film to last longer, meaning preserve that initially deposited amorphous state. But beyond that, there are so many -- so many conditions. 12:16:27 12:16:39

MS. HANSEN: We've been going for about an hour and a half. Is now a good time to break for lunch? 12:16:56

MS. ZHONG: Sure.

THE VIDEOGRAPHER: Going off the record. The time is 12:16 p.m.

(Recess taken.) 12:17:03

THE VIDEOGRAPHER: Back on the record. The time is 1:00 p.m.

BY MS. ZHONG:

Q Doctor, can you pull up Exhibit 2009?

A I think I'm going to have to refresh. 01:01:11

2009. Cotton.

Q You have reviewed this document before, correct?

A I have reviewed this document before, that's right. 01:01:27

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Q Can you please go to PDF page 2? 01:01:32

A Okay.

Q Middle column. The first full sentence, starting with "The helium I gas-phase photoelectron spectra." 01:01:53

Do you see that sentence?

A I do, yes.

Q What is the sentence describing?

MS. HANSEN: Objection to form.

THE WITNESS: It's describing the nature of the data being shown in Figure 2. 01:02:19

BY MS. ZHONG:

Q Figure 2.

Is it describing the gas-phase photoelectron spectra of the reaction of the M2(hpp)4 complexes or the gas-phase photo spectra of those compounds by themselves? 01:02:36

MS. HANSEN: Objection to form.

THE WITNESS: Give me a moment. I just want to look quickly at the references. 01:03:10

So that sentence is describing experimental matters with respect to Figure 2. Figure 2 is displaying three separate spectra for three different metal2(hpp)4 complexes where the metal is either chromium or molybdenum or tungsten. 01:04:53

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And they're showing that the chromium has a deeper ionization energy than molybdenum, which is deeper still than tungsten, which is expected following the convention of sort of electronegativity difference between moving up the periodic table from tungsten to molybdenum to chromium, that you would expect tungsten to have the shallowest ionization energy. 01:04:59 01:05:15

And they also refer to experimental details that have been, you know, shown previously in some of -- a few citations, one of which is a thesis from the University of Arizona and another one which talks about that these molecules were sublimed at different temperatures, the chromium2(hpp)4 at 200 to 230 C in the instrument, which is at 10 to the minus 4 torr vacuum, the molybdenum version, which is a little bit higher still, 220 to 250, and the tungsten one, which is higher still 250 to 280, which is also expected sort of following the molecular weight of those compounds getting larger, you sort of -- you know, this is what is customary to observe is the molecular weight and the sublimation temperature to usually be kind of proportional to one another. So they're showing that that's the case. 01:05:32 01:05:56 01:06:15

And yeah, that's my read of that sentence, 01:06:30

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what it is -- what it is saying. 01:06:34

BY MS. ZHONG:

Q So is Figure 2 showing reaction products of these M2(hpp)4 complexes, or they're showing the ionization -- the photoelectron spectra of the 01:06:50 compounds themselves?

MS. HANSEN: Objection to form.

THE WITNESS: There is an asterisk on the spectrum in the center, which is molybdenum2(hpp)4, which they refer to in the caption represents helium 01:07:08 self-ionization. So not -- the spectra is not necessarily exclusively, you know, the compound on its own. There are some other effects that the authors understand their origin.

The interpretation that the authors are 01:07:25 providing here is that it is the metal complex itself. Because they also mention in reference 16 that any free Hhpp, so basically the ligand on its own with a proton, goes away earlier. And so the spectra they're capturing here doesn't include that. 01:07:50

So I guess there may have been some reaction that happened, but they are at least asserting confidence that the spectra that are represented here are owing to the three compounds in isolation. 01:08:06

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BY MS. ZHONG: 01:08:07

Q Okay. So the Footnote No. 16 is not discussing reactions between the metal complexes and an organic complex; is that -- strike that.

So Footnote No. 16 is not discussing 01:08:23
reactions between one of the metal complexes and an organic compound; is that correct?

MS. HANSEN: Objection to form.

THE WITNESS: I would say it's a little hard to say. They describe that they are reactive. 01:08:45
Because they say that they needed to the handled using rigorous air sensitive techniques and that they have a half-life of the solid powders in air observed to be roughly on the order of a minute and longer. Air could contain some organic compound, so 01:09:05
I don't want to exclude anything. But, you know, they're saying there the powders are reactive in air. But they're not explicitly saying that they're reacting with another organic compound.

BY MS. ZHONG: 01:09:23

Q Okay. So the powders are air sensitive, which means that it reacts with oxygen -- correct? -- or moisture in the air?

MS. HANSEN: Objection to form.

THE WITNESS: The most likely reaction in 01:09:41

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air would be with oxygen. 01:09:42

BY MS. ZHONG:

Q Okay. And is oxygen an organic compound?

A The diatomic O2?

Q Uh-huh. 01:09:56

A No.

Q Footnote No. 16 is not mentioning any organic compound specifically, correct?

A It mentions the metal complexes, which, as we've discussed earlier, you know, could be binned 01:10:19 into an organic compound. But it doesn't mention anything other than those metal complexes, the metal (hpp)4 complexes. Well, it does mention Hhpp, which I guess is strictly an organic complex. So I guess it does. I take it back. The answer is yes. 01:10:39

Q So is it talking about reacting hpp with the metal complex?

MS. HANSEN: Objection to form.

THE WITNESS: It's describing release of Hhpp from the sample powder of synthesized 01:11:01 metal2(hpp)4 from the sample at temperatures below the ones that they are taking spectra from. Doesn't exclude that you can't have any of that free at those higher temperatures. But they do mention that the free Hhpp ionizations occur above 7 eV. And 01:11:25

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IPR2024-01094

they provide a reference for that. So that would indicate that, even if there was some of that, it should be outside of the spectra that they show, which goes from 5.5 eV to about 3.2 eV. 01:11:30

But I would say they don't exclude any reaction with an organic and a metal complex. 01:11:48

BY MS. ZHONG:

Q So is footnote -- strike that.

Is Footnote No. 16 -- strike that.

Does Footnote 16 describe a charge transfer reaction between the metal complex and an organic compound? 01:12:07

MS. HANSEN: Objection to form.

THE WITNESS: No. Reference 17 doesn't specifically describe any charge transfer reaction between a metal complex and an organic compound. 01:12:27

BY MS. ZHONG:

Q I meant note 16, not 17.

A Oh, sorry if I said "17."

Reference 17 doesn't describe any reaction between a metal complex and an organic compound. 01:12:41

Q You mean note 16 or note 17?

A I thought your question was about 16.

Q Yes. And your answer is 17.

A And then I corrected myself. 01:12:57

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Q And then you said 17 again. 01:13:00

A I meant 16, not reference 17.

Q Okay. Just wanted to make sure.

Do you know why doping of C60 fullerene is more efficient with chromium2(hpp)4 compared to 01:14:30 tungsten2(hpp)4?

MS. HANSEN: Objection to form.

THE WITNESS: Offhand, I'm not aware of a reference that describes the doping efficiency of -- the relative doping efficiency of fullerene -- I 01:14:54 assume you mean C60 fullerene -- with chromium2(hpp)4 versus tungsten2(hpp)4.

Is it possible to see a reference?

BY MS. ZHONG:

Q Before we do that, would you predict -- if 01:15:15 you have to predict, which one do you think will have a better doping efficiency?

MS. HANSEN: Objection to form. Outside the scope.

THE WITNESS: C60 is a very capable 01:15:32 electronic sector. As such, it's quite easy to N-dope. It's quite easy to put an electron on it. It's readily reduced. It's also spherical, so any way it interacts a neighboring molecule is effectively identical from its perspective. Not 01:16:01

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necessarily the pairing, but at least its perspective is the same because it's spherically symmetric. 01:16:04

Chromium and tungsten are both held in the two-plus oxidation state in this dinuclear metal complex. That's a tough spot to be in if you're a molecule that wants to get reduced, because, you know, they want to check out an electron. But it's -- you know, I would say -- I would have a reasonable expectation of success in both cases. So it's hard for me to say one way or the other. 01:16:23 01:16:44

BY MS. ZHONG:

Q I'm just asking you which one you would expect to be more efficient.

MS. HANSEN: Objection to form. 01:16:58

THE WITNESS: I'd expect them to be nearly equally efficient at doping, that about the same percentage of metal to (hpp)4 molecules would result in a successful doping reaction with C60. It's not to say the conductivity is necessarily the same because chromium -- the chromium bearing metal complex is going to be smaller than the tungsten bearing metal complex, which is going to change the sort of microscopic structural arrangement of the molecules, which might influence other things like 01:17:37 01:17:54

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mobility. And therefore, conductivity isn't necessarily the same as doping efficiency. 01:17:56

So if doping efficiency is being evaluated exclusively with now some sort of very sensitive work function measurement, then I would expect them to be about the same. 01:18:10

BY MS. ZHONG:

Q But you expect the mobility may be better with chromium doped film?

A I think it's possible because chromium is a smaller molecule, chromium 2(hpp)4, compared to tungsten2(hpp)4. So it might not disrupt the ability of those spherically symmetric fullerenes to sort of self-assemble. 01:18:28

Q But the compound, the molecule, are still relatively big, right? Because you don't really have free chromium or free tungsten, for that matter? 01:18:50

MS. HANSEN: Objection to form.

BY MS. ZHONG: 01:19:03

Q Is that right?

A You don't have elemental chromium or elemental tungsten, no.

Q Or cation for that matter, right?

A Or what for that matter? 01:19:12

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Q Cation. 01:19:12

A Well, you can't have free cation unless you have an anion with it. The anion here, maybe you're talking about fullerene minus or something like that? Possible. 01:19:26

Q I don't know.

A I don't know either.

Yeah. It's -- they're big. Right? They're really big compared to a fullerene molecule, which is about a nanometer diameter all taken 01:19:36 together with, like, free space and pi electrons.

Q So wouldn't you expect them both to be -- have pretty low diffusivity anyways?

MS. HANSEN: Objection to form. Beyond the scope. 01:19:52

THE WITNESS: Why are we moving to diffusivity?

BY MS. ZHONG:

Q I thought you said, like, the chromium has better diffusivity than tungsten. 01:20:03

MS. HANSEN: Objection to form. Beyond the scope.

THE WITNESS: I never said that. We can dial -- we can ask the reporter for what I exactly said, but I never uttered the word "diffusivity." 01:20:14

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BY MS. ZHONG: 01:20:17

Q Didn't you say, like, the tungsten is -- chromium is smaller?

A Yeah.

Q So it can move through the material better? 01:20:23

MS. HANSEN: Objection to form.

BY MS. ZHONG:

Q Is that diffusivity?

A I never said -- I never spoke about the ability of the atom or the molecule to move about the material, the solid material. 01:20:31

Q So what were you discussing? Maybe I was just misunderstanding what you said.

A Okay. 01:20:47

MS. HANSEN: Objection to form.

THE WITNESS: Let me try to reiterate with slightly different language.

What I was referring to was that the chromium2(hpp)4 molecule is overall going to be a little bit smaller than the tungsten2(hpp)4 molecule because chromium is a smaller atom than tungsten, and there are two of them, which just sort of exacerbates the issue. And inside a film, that's my understanding mostly C60 -- C60 is the probable 01:20:54 01:21:12

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matrix here, and the tungsten or chromium 2(hpp)4 is the guest, following the teachings of Werner -- sorry -- is it '541? I almost said 514. Following the teachings of the '514, probably in a relatively low molar ratio, maybe a few percent, 4 or 5 percent, that the presence of 4 or 5 molar weight percent -- molar percent of the metal complex, the smaller one would disrupt the packing of C60 less than the bigger one. 01:21:16 01:21:35

BY MS. ZHONG: 01:21:54

Q Oh, okay.

A I think 4 would maybe result in less of a mobility erosion of the C60 layer.

Does that make sense expressed that way?

Q A C60 has poor conductivity by itself, correct? 01:22:08

MS. HANSEN: Objection to form.

THE WITNESS: C60 has poor conductivity by itself related to what?

BY MS. ZHONG: 01:22:23

Q Is C60 a conductor?

A C60 is a semiconductor.

Q Can you pull up Exhibit 1005, which is a Werner reference, and go to page 65, original page 62, Exhibit 3. 01:22:43

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A 1005. Which page? I'm sorry. Repeat, please. 01:22:56

Q PDF page 65, original page 62.

A I'm on original page 62.

Q Do you see at the bottom of the page there is an Example 3? 01:23:18

A Yes, I do.

Q And do you see that Werner reported "A pure layer of the fullerene was produced by sublimation in high vacuum. This layer had a low conductivity of 1 times 10 to the minus 7 siemens per centimeter"? 01:23:30

A Yes.

Q Okay. And Werner described the pure C60 conductivity as low, correct? 01:23:54

MS. HANSEN: Objection to form.

THE WITNESS: On line 26, Werner, it says "This layer had a low conductivity of 1 times 10 to the minus 7 siemens per centimeter."

The word "low" is used. 01:24:11

BY MS. ZHONG:

Q Okay. And the conductivity referenced here is a bulk conductivity of the layer on the film; is that correct?

MS. HANSEN: Objection to form. 01:24:29

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THE WITNESS: I believe they're expressing the bulk conductivity value, yes. 01:24:46

BY MS. ZHONG:

Q And Werner considered a conductivity value on the order of 10 to the minus 7 siemens per centimeter to be low, correct? 01:24:58

MS. HANSEN: Objection to form.

THE WITNESS: They used the word "low," yes. Example 3, line 26.

BY MS. ZHONG: 01:25:32

Q Is the conductivity reported here for the fullerene in line with what you know?

MS. HANSEN: Objection to form.

THE WITNESS: Yeah. I think it seems reasonable. You know, when I think about electron transporting organic semiconductors, one with, you know, a relatively high conductivity, and I'm going to define what I mean by "relatively high." I mean, with respect to other electron transport layers, say BPhen or BCP or TAZ or TBBI, or the list goes on and on, POTTT, I know C60 to be a relatively high conductivity layer natively compared to those systems, which would have perhaps orders of magnitude lower conductivity, again, undoped natively, neat film. 01:25:54 01:26:16 01:26:38

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BY MS. ZHONG: 01:26:40

Q Now, tungsten2(hpp)4, as you mentioned earlier, has a lower ionization potential than chromium(hpp)4, correct?

A Can you repeat it? Sorry. 01:27:13

Q Tungsten2(hpp)4 has a lower ionization potential than chromium2(hpp)4, correct?

MS. HANSEN: Objection to form.

THE WITNESS: Tungsten2(hpp)4 has a smaller magnitude value. It's closer to the vacuum, 01:27:29 yes.

BY MS. ZHONG:

Q So it's a better oxidant than the chromium?

A Yes. 01:27:40

MS. HANSEN: Objection to form.

THE WITNESS: Wait. Reductant.

BY MS. ZHONG:

Q It has a better -- it's better at oxidizing other compounds than chromium? 01:27:52

MS. HANSEN: Objection to form.

THE WITNESS: These are very strong molecular reductants.

BY MS. ZHONG:

Q So reductants oxidize compounds, correct? 01:28:07

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A Reductants get oxidized in the process of reducing something else. 01:28:12

Q They oxidize the organic compounds they're reacting with, correct?

MS. HANSEN: Objection to form. 01:28:26

THE WITNESS: So you're saying, if I mix W2(hpp)4 with C60, C60 gets oxidized?

BY MS. ZHONG:

Q Sorry. The tungsten complex -- the metal complex gets oxidized and the organic gets reduced? 01:29:01

A Yes.

Q Okay. So the tungsten complex has -- is better if it's using organic compounds than the chromium complex and the same reaction condition; is that correct? 01:29:18

MS. HANSEN: Objection to form.

THE WITNESS: Yeah. That's basically the same as saying its oxidation potential is closer to vacuum. It's those electrons are sitting at higher potential. They have more reductive capability, 01:29:31 yes.

BY MS. ZHONG:

Q So you would expect that when the two compounds are reacting with the same organic complex, there will be more trash transfer from the 01:29:46

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tungsten complex than from the chromium complex, wouldn't there? 01:29:49

MS. HANSEN: Objection to form.

THE WITNESS: It depends on what the other complex is that's, you know, gaining electron density getting either partially or fully reduced. If it's a molecule like C60, which as I sort of preluded all that I was talking about with, is C60 is relatively easy molecule to reduce. And so that's why -- you know, I don't know -- I think 01:30:06 01:30:26 chromium or tungsten to (hpp)4 could do it well.

If we're talking about a molecule that's much more difficult to reduce, then, you know, I would place my bets on the tungsten2(hpp)4 to have more complete transfer interaction than chromium would. 01:30:44

BY MS. ZHONG:

Q Do you consider the BPhen to be a difficult molecule to reduce?

MS. HANSEN: Objection to form. 01:30:57

THE WITNESS: Given that BPhen has a substantially shallower LUMO than C60, you know, at least 1 eV shallower, if not more, then, yes, I would say it's more difficult to reduce BPhen than it is to reduce C60. 01:31:12

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BY MS. ZHONG: 01:31:14

Q What about ZnPc?

A ZnPc is more difficult to reduce than C60. Whether it's more difficult to reduce than BPhen is another scenario. But, you know, ZnPc is certainly harder to reduce than C60. 01:31:33

Q Do you expect that tungsten2(hpp)4 would have a better chance of reducing ZnPc than chromium2(hpp)4?

A Give me one moment to look at the Werner reference. 01:32:04

So, you know, Example 2 in Werner, which is the same page 62 as Exhibit 3, the prior example to the one that you brought up a few moments ago is the doping of ZnPc or zinc phthalocyanine with chromium2(hpp)4. They show that to be effective at producing a conductive layer, an N-doped layer. And so given that chromium2(hpp)4 is capable of interacting with ZnPc and forming a conductive film, I would certainly anticipate that tungsten 2 would be capable as well, if not more capable at, you know, interacting with ZnPc. 01:32:35 01:33:08

Now, ZnPc is a molecule that likes to crystallize on demand. It does not form an amorphous film. And so you are also playing with 01:33:24

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structural effects there, quite potent ones. 01:33:29
Because if you remove the structure of ZnPc, its mobility will certainly go down between crystalline and amorphous, as we've talked about. And so you are going to be sort of like trading off mobility 01:33:44
versus free charge density.

Q In Example No. 2, the conductivity actually increased when the doped layer is heated to 70 degrees, correct?

A Sure. Yeah. Absolutely. I would expect 01:34:04
nothing less. Because organic semiconductors feature something known as thermally activated charge transport. It's very different from silicon. Silicon does not.

By the way, N-doped silicon probably has a 01:34:21
similar connectivity as that N-doped C60. I don't study a lot of silicon, but I think it's around the same value. And so I would say pretty good. But that's an aside.

Thermally activated charged transport 01:34:32
means, as I raise temperature, conductivity goes up, because hopping gets more easy. That does not happen with silicon because it's -- features band-like charged transport. So actually, heat is the enemy. Heat makes things go -- makes mobility 01:34:51

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go down in a band-like system. Does not happen the same in organic hopping-type transport system. 01:34:53

Q So what would be the expected conductivity if you dope ZnPc with tungsten2(hpp)4?

MS. HANSEN: Objection to form. 01:35:19

THE WITNESS: The expectation would be that, you know, at least at relatively modest loadings -- this is modest -- 1.9-mole percent. It's a small loading of the dopant.

So at those relatively low loadings of the chromium 2(hpp)4 versus the tungsten2(hpp)4, I would expect a similar conductivity for the two doped layers of ZnPc. 01:35:37

BY MS. ZHONG:

Q What is the activation energy for conductivity that's mentioned in Example No. 2? 01:36:07

MS. HANSEN: Objection to form.

THE WITNESS: It's mentioned as .27 electron volts.

BY MS. ZHONG: 01:36:20

Q No. I'm asking what does "activation energy of conductivity" mean?

A Okay. I thought you asked what it was. I'm sorry. Like the value. Got it.

What that means is that you have a process 01:36:31

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that is going to change to the tune of an exponential function raised to the minus activation energy divided by the thermal energy KT, which T is the temperature. So K is a constant, a fundamental constant known as Boltzmann's constant. 01:36:41 01:37:02

And so what the activation energy does is tell you basically the slope, how strongly the conductivity will change as a function of increasing the temperature.

Q So, basically, araneous equation? 01:37:18

A It's exactly an araneous equation, yes.

The larger that number, the higher the slope.

Q So, in Werner, how many metal complexes are expressly mentioned in Exhibit 1005? 01:37:54

A There are a lot of different metal complexes that are mentioned in the document, especially those containing, you know, dinuclear complexes, but they are more generally into some multinuclear, and especially the sort of series of the column including chromium and tungsten, and specifically, they say especially the hpp ligand. But there are a lot of other compounds that are called out using those types of metals held in low-oxidation states that can be potent reducing 01:39:06 01:39:31

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

agents. 01:39:36

Q Can you go to page 47 of Werner?

A That's the internal or the PDF?

Q PDF 47. Internal, 44.

A Okay. 01:40:02

Yes. I am there.

Q Take a look at Example No. 5.

A Okay.

Q Example No. 5 is not tungsten2(hpp)4, correct? 01:40:19

A Is not tungsten2(hpp)4? Is that what you said?

Q Correct.

A Yes. That is not tungsten2(hpp)4.

Q What about Exhibit No. -- the next page, Example No. 6? 01:40:34

A That is also -- I assume it's the same question?

Q Yes. Is it -- is the structure shown in Example No. 6 of Werner on page -- original page 45 an (hpp)4 molecule complex? 01:40:51

A The molecule shown in Example 6 on internal page 45 of Werner is not W2(hpp)4.

Q You know what Terpy is -- right? -- or Terpyridine? 01:41:26

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Samsung v Pictiva
IPR2024-01094

MS. HANSEN: Objection. Form. 01:41:28

BY MS. ZHONG:

Q Terpyridine?

A Sorry. I didn't -- are you saying "teraline"? 01:41:31

Q Terpyridine, T-E-R-P-Y-R-I-D-I-N-E. Often shortened as "Terpy" or "TPY."

A TPY. I see. It's, you know, like hpp or like phenanthroline or like acac. It's a relatively common ligand in metal organic chemistry. It's 01:42:00 composed of three carbon-carbon single-bond pyridines. Is that correct? Remember, I'm --

Q I think it's a tridentate ligand. It's a tridentate ligand.

A Okay. So three pyridines linked together 01:42:17 by single bonds.

Q Okay. That's a specific structure, correct?

A Terpyridine is a specific molecular structure, yes. 01:42:31

Q What about guanidinate? Is that also a specific structure, common structure?

MS. HANSEN: Form.

THE WITNESS: It is just like Terpyridine, a class of ligands. 01:42:51

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Samsung v Pictiva
IPR2024-01094

MS. ZHONG: I put the spelling in the chat. 01:43:01

BY MS. ZHONG:

Q It's a common type of ligands, guanidinate? 01:43:09

MS. HANSEN: Objection to form.

THE WITNESS: Yeah. I mean, it's a common compound in the use of metal organic complexes.

BY MS. ZHONG:

Q Okay. What about formamidinate? 01:43:25

A So it's sort of younger, smaller cousin.

Q Yeah.

A Sure. It's probably a little less common in metal organic systems.

Q But it's a known structure? 01:43:41

A Sure.

Q And it's a defined structure?

A It is a defined class of compounds.

Q What about .eta.5-cyclopentadienyl or CP?

MS. HANSEN: Objection. Form. 01:44:02

THE WITNESS: You'd have to show it to me. I think I might need to see it. But it's most likely another compound that's commonly used as a ligand.

/ / / /

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Samsung v Pictiva
IPR2024-01094

BY MS. ZHONG: 01:44:33

Q Ever seen, like, the five-membered ring with an anion charge? So similar to benzidine with five-membered ring with an anion charge? Do you know that? 01:44:45

A "NI charge."

Q Negative charge.

A Oh, negative charge.

Q So anion.

A Anion. With 5-membered exclusively carbon ring? 01:44:54

Q Yeah. CP ring. Ever heard of that?

MS. HANSEN: Objection to form.

THE WITNESS: I believe I have.

Is it the one that's used in ferrocene? 01:45:15

BY MS. ZHONG:

Q Yeah.

A Okay. Yes, I have.

Q Okay. And those are defined structures -- right? -- the CP rings? 01:45:24

A It's a defined class of compounds. It has a lot of different, you know, manipulations and changes you can make to it via hard erms, but yes.

Q But the simplest CP ring, that's a defined structure that is known, right? 01:45:39

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

MS. HANSEN: Objection to form. 01:45:41

BY MS. ZHONG:

Q Now, the Werner reference provided at least -- let me see -- about 64 different ligand structures that can be used to complex metals; is 01:46:29 that correct?

MS. HANSEN: Objection to form.

THE WITNESS: I'd need to, you know, validate the number. But I can -- you know, I can at least offer that there are a lot of compounds 01:46:44 that were disclosed as satisfying what they thought was very important and powerful intellectual property. They learned a lot, and they wanted to protect the classes of compounds that could serve the roles that they thought that they could serve. 01:47:03

BY MS. ZHONG:

Q Okay. So why don't you go to original page 36, PDF page 39.

A Yes, I'm there.

Q And do you see that the numbering for the 01:47:28 compound for the ligand is up to 64.

A I see that. I see a molecular compound 64 there.

Q Go to page 10 -- original page 10, PDF page 13. 01:48:00

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

A I'm there. 01:48:02

Q So there are at least 11 compounds shown here that can all be used as a ligand to metal complexes, correct?

MS. HANSEN: Objection to form. 01:48:19

THE WITNESS: Yeah. They're talking about these compounds that one or more or all can be selected from the group with compound 5 in particular as a singly or doubly charged ion or cation, yes. 01:48:54

BY MS. ZHONG:

Q So all these are candidate ligand structures, correct?

A That's what the Werner patent is protecting and asserting, yes. 01:49:08

Q Then let's go to page 28, original page -- original page 28, PDF page 31.

A Okay.

Q And there are additional compounds on this page that can be used as candidate ligands for metal complexes, correct? 01:49:27

MS. HANSEN: Objection to form.

THE WITNESS: I believe No. 19 is the Terpyridine you asked me about.

/ / / /

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Samsung v Pictiva
IPR2024-01094

BY MS. ZHONG: 01:49:44

Q Correct. If it's all H, I think.

A I believe these fall under the category of pincer ligands mostly. Yeah, these are additional candidate ligands. 01:50:07

Q Okay. And then, actually, we need to go back to original page 23, PDF page 26.

A Okay.

Q And the sixth compound, compounds 11 through 16, are additional ligands that can be used to form metal complexes, correct? 01:50:28

MS. HANSEN: Objection to form.

THE WITNESS: Yeah. These are boryl ligands involving boron and all anions.

BY MS. ZHONG: 01:50:57

Q And then compound 18 on page 24, compound 17 on page 25, they're also potential structures that can be used as ligands, correct?

MS. HANSEN: Objection to form.

THE WITNESS: Yes. That's being said here. 01:51:28

BY MS. ZHONG:

Q Then we have discussed the structures shown on page 28, which is compounds 19 to 37, plus 27a and 28a, those are also candidates for metal 01:51:43

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

complexation, correct? 01:51:50

MS. HANSEN: Objection to form.

THE WITNESS: Yes. That's what Werner is protecting here.

BY MS. ZHONG: 01:52:01

Q Okay. Then let's go to original page 33, PDF page 36. And there are nine compounds, 38 to 46, which can also be used as ligands for metal complexes, correct?

MS. HANSEN: Objection to form. 01:52:26

THE WITNESS: Yes.

BY MS. ZHONG:

Q Okay. Then page 34, there are compounds 47 to 56, also candidate compounds -- also candidate ligands for metal complexes, correct? 01:52:47

MS. HANSEN: Objection to form.

THE WITNESS: Yes. Also candidate ligands.

BY MS. ZHONG:

Q And then page 36, PDF page 39, compounds 57 through 64, those are also potential ligands for metal complexes, correct? 01:53:00

MS. HANSEN: Objection to form.

THE WITNESS: Sorry. Just give me another moment. These are classified slightly differently. 01:53:50

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

BY MS. ZHONG: 01:53:54

Q Okay.

A But yes, yes, they're all compounds that can be candidate ligands, yes.

Q So Werner had disclosed 64 structures that can be used for metal complexes, correct? 01:54:08

MS. HANSEN: Objection to form.

THE WITNESS: Yeah. I would say there are these 64 classes of candidate ligands that can be used. 01:54:33

BY MS. ZHONG:

Q And Werner did not restrict the type of metal that can be used with each one of the class of ligands, correct?

MS. HANSEN: Objection to form. 01:54:50

THE WITNESS: Didn't -- didn't restrict it. He did restrict it somewhat, but, you know, preferentially kept returning to the group of chromium, lithium, and tungsten. But doesn't list, you know, absolutely every -- every metal. 01:55:10

BY MS. ZHONG:

Q So if we take a look at the group of metals that's listed on page 60 and PDF 63, those include, by my count, at least chromium, manganese, iron, cobalt, nickel, copper, zinc, molybdenum, and 01:55:33

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

tungsten, correct? 01:55:38

A So PDF page 60, the section "Application Examples"?

Q Correct.

A Okay. Can you repeat the metals that you've listed, because I wasn't here on this page? 01:55:51

Q Okay. Chromium, manganese, iron, cobalt, nickel, copper, zinc, molybdenum, tungsten.

A That's correct.

Q How many? One, two, three, four, five, six, seven, eight, nine. That's nine metals, correct? 01:56:27

MS. HANSEN: Objection to form.

THE WITNESS: There are nine metal atoms that are listed there as possible to incorporate in the metal complex. 01:56:53

BY MS. ZHONG:

Q Okay. And those nine complexes are repeated throughout this application example, correct? 01:57:09

MS. HANSEN: Objection to form.

THE WITNESS: You mean those list of nine metals are repeated?

BY MS. ZHONG:

Q Correct. 01:57:20

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

A Yes. Those list of nine metals are repeated numerous times on that internal page 60. 01:57:20

Q So you have 64 possible structures and nine preferred metal group.

How many combinations are there? 01:57:41

MS. HANSEN: Objection to form.

THE WITNESS: Combinations of what?

BY MS. ZHONG:

Q Combinations of the metal and the ligands.

A Depends. What am I making? Am I making a single metal and a single ligand? 01:58:12

Q In the simplest form.

MS. HANSEN: Objection to form.

THE WITNESS: I'm not sure what that means. 01:58:26

BY MS. ZHONG:

Q So the one-to-one combination of 64 possible ligand and nine metal complexes. That means there are 576 -- at least 576 possible combinations, correct? 01:58:41

MS. HANSEN: Objection to form.

THE WITNESS: If you have a metal atom, nine of them, and 64 different ligands, then you -- the product of 64 and 9 is -- yeah, something less than 600, more than 500. 576. I will take your 01:58:59

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

word for it. 01:59:05

BY MS. ZHONG:

Q How many organic compounds are expressly mentioned in Werner?

MS. HANSEN: Objection to form. 01:59:33

THE WITNESS: Without doing a careful analysis, it's hard to quantify.

BY MS. ZHONG:

Q Can you give an order of magnitude?

A No. 01:59:52

MS. HANSEN: Objection to form.

THE WITNESS: That would imply quantifying. Even order of magnitude is quantifying. It's difficult to do that.

BY MS. ZHONG: 02:00:01

Q Is it more than 10?

A I'm getting a strong sense of deja vu compared to my early April testimony, Counsel.

Do we need to revisit this? Because it wasn't put in my reply declaration. 02:00:15

Q I'm just asking you.

A It's more than 10.

Q Okay.

A We can -- I wish I could read to you the whole transcript and we could save a half an hour. 02:00:28

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

Q Okay. Do you think that -- you're not changing your testimony from April, are you? 02:00:31

A Why would I do that?

Q Just making sure.

A The answer is no. 02:00:45

Q Have you ever combined tungsten -- have you ever combined tungsten2(hpp)4 with any of the phenanthroline compounds mentioned in Exhibit 2044?

MS. HANSEN: Objection to form. Asked and answered. 02:01:20

THE WITNESS: So Exhibit 2044, the '541 patent, I do believe it doesn't -- the '541 patent, to my knowledge, does not contain BCP, bathocuproine, which is the compound that I mentioned I have combined W2(hpp)4 with. And so no, it doesn't -- you know, I've never combined W2(hpp)4 with any of the compounds mentioned in the '541 patent. 02:02:41

BY MS. ZHONG:

Q The work you did with tungsten2(hpp)4 and BCP, were those for OLED or for some other application? 02:02:55

MS. HANSEN: Objection to form.

THE WITNESS: Again, as I mentioned earlier, we were using them the context of an 02:03:10

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

organic solar cell, specifically a so-called tandem or multijunction organic solar cell where you have multiple solar cells in series in one device. And we were using it for that purpose, to space -- used as a spacer to space these apart. 02:03:12 02:03:29

So it was not for an OLED. It was for an organic solar cell purpose.

BY MS. ZHONG:

Q Have you ever tried to use tungsten2(hpp)4 in OLED applications? 02:03:42

MS. HANSEN: Objection to form.

THE WITNESS: Not to my knowledge. But I've used it in other organic electronic components. And I've used it in other N-dopants in OLEDs. But not that specific one. 02:04:13

BY MS. ZHONG:

Q Besides BCP, what other organic compound have you used the tungsten2(hpp)4 with?

MS. HANSEN: Objection to form.

THE WITNESS: I've only used BCP with tungsten2(hpp)4, as I just mentioned. 02:04:30

BY MS. ZHONG:

Q None of the other organics?

MS. HANSEN: Objection.

/ / / /

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

BY MS. ZHONG: 02:04:44

Q Other organics?

MS. HANSEN: Objection to form.

BY MS. ZHONG:

Q I'm not limiting to phenanthrolines. 02:04:47

A Right. You're limiting it to tungsten2(hpp)4, yes?

Q Correct.

A Yes. I've only used tungsten2(hpp)4 with BCP. It's the only one. But I've used other 02:05:00 N-dopants with BCP and other electron transporting organics.

Q The other dopants you have used, if I remember correctly, it's cesium, ytterbium -- and what's the other one? There is another one. 02:05:18

A Cesium, ytterbium, and Cesium carbonate. That's the context in which I've used BPhen.

Q BPhen. What about for BCP?

What other dopants have you used, n-dopants have you used? 02:05:31

MS. HANSEN: Objection to form.

THE WITNESS: I've used tungsten2(hpp)4. I've used lithium, cesium, cesium carbonate, ytterbium, and failed chances at aluminum and gold, which were part of the learning. And a ruthenium 02:05:50

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

dimer dopant. 02:05:56

BY MS. ZHONG:

Q Did you expect those to succeed? The ones that failed, when you went into it, did you expect them to succeed? 02:06:09

MS. HANSEN: Objection to form.

THE WITNESS: Aluminum was a bit of a curiosity. Gold was expected to fail because of its relatively high work function and electrons that sit not in a good place to reduce anything. But that's 02:06:26 all part of the scientific process is you have an hypothesis and you test it. And that's what we did with a series of pairs of compounds.

BY MS. ZHONG:

Q You did not review Dr. Kymissis' 02:07:06 transcript in the district court; is that correct?

MS. HANSEN: Objection to form.

THE WITNESS: That's correct, I did not review Dr. Kymissis' transcript.

BY MS. ZHONG: 02:07:20

Q Okay. And you read the part that's referenced in Dr. Schanze's deposition; is that correct?

MS. HANSEN: Objection to form.

THE WITNESS: Yes, I did. 02:07:39

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

BY MS. ZHONG: 02:07:41

Q And you said you don't really know what the context those discussions appear, correct?

A Right. Without being able to fully read the document, it's hard to understand the entire 02:07:54 context of that brief discussion during the redirect.

Q And you understand that the transcript was attached as an exhibit to the Schanze -- strike that. 02:08:14

You understand that Dr. Kymissis' transcript was introduced as an exhibit to Dr. Schanze's deposition, correct?

MS. HANSEN: Objection to form.

THE WITNESS: I don't know that for sure. 02:08:26 Of course, if it's being referenced, I can presume that.

BY MS. ZHONG:

Q And you did not ask to review the document to obtain the context of those discussions, correct? 02:08:41

MS. HANSEN: Objection to form.

THE WITNESS: That's correct.

BY MS. ZHONG:

Q So why don't you pull up Exhibit 2106, which I believe is Exhibit 13 to Dr. Schanze's 02:08:57

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

deposition transcript. 02:09:04

A 2106.

MS. HANSEN: Objection to form.

BY MS. ZHONG:

Q And this -- 02:09:12

MS. HANSEN: Beyond the scope.

BY MS. ZHONG:

MS. ZHONG: And Dr. Kymissis' transcript is designated as confidential, so it should be under seal. 02:09:22

MS. HANSEN: Meaning that this transcript needs to be under seal?

MS. ZHONG: Yes.

MS. HANSEN: Okay.

THE WITNESS: I have Exhibit 2106 open. 02:09:34

BY MS. ZHONG:

Q Do you -- let me see. Transcript page 103.

A Okay.

Q Do you see the question and answer 02:10:02 starting from line 12 to 16?

MS. HANSEN: Object to this whole line of questioning as beyond the scope. Lack of relevance.

THE WITNESS: I see lines 12 through 16 starting with "Is simultaneous vaporization the same 02:10:22

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

as joint vaporization?" 02:10:27

BY MS. ZHONG:

Q So Dr. Kymissis was asked "Is simultaneous vaporization the same as joint vaporization?"

And what was his answer? 02:10:35

MS. HANSEN: Objection to form. Relevance.

THE WITNESS: His answer was "No, not necessarily."

BY MS. ZHONG: 02:10:43

Q Okay. And when he was asked "What is broader?" what was his answer?

MS. HANSEN: Objection to form. Lack of relevance.

THE WITNESS: His answer was "Simultaneous vaporization would be broader." 02:10:54

BY MS. ZHONG:

Q Okay. So Dr. Kymissis does not consider simultaneous vaporization to be the same as joint vaporization, correct? 02:11:06

MS. HANSEN: Objection to form. Lack of relevance.

THE WITNESS: I mean, as I mentioned in saying I have a hesitancy to be able to respond to something without capturing the context, just 02:11:17

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

rereading these four lines doesn't capture the context. I need to be able to absorb this document in its entirety. And I haven't done that. 02:11:19

BY MS. ZHONG:

Q Well, you had the chance while you were drafting the reply declaration to review the document, right? 02:11:29

A Well, I didn't -- how could I have had that chance? I didn't have the document. This is the first time I'm seeing this document. 02:11:41

Q Well, it's part of the transcript -- right? -- Exhibit 1021. Why don't you pull that up?

A Okay. Okay.

Q And go to page 6.

Do you see that Exhibit 13, deposition transcript Ioaniss Kymissis, Ph.D. is referenced there? 02:12:04

A Wait. Page 6?

Q Yes. Exhibit 1021, page 6?

A The internal page 6? 02:12:21

Q Yeah. Internal page 6.

A I see. Yeah, yeah, yeah. Okay. I was on the wrong page.

Yes, I see that. Exhibit 13. Transcript of Ioaniss Kymissis, Ph.D. I see that's there. 02:12:33

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

Q So it's available if you want to review it, right? 02:12:43

MS. HANSEN: Objection to form. Lack of relevance.

THE WITNESS: I mean, it's not there. It's two lines. How is it there? 02:12:51

BY MS. ZHONG:

Q Did you ask -- if you want to review it, it's part of the transcript, correct?

MS. HANSEN: Objection to form. 02:13:05

THE WITNESS: It's not part of this transcript. It's just two lines that's referenced.

BY MS. ZHONG:

Q That's because your counsel did not provide it to you with all the exhibits, correct? 02:13:11

MS. HANSEN: Objection to form. Caution the witness not to reveal the contents of any privileged communications.

THE WITNESS: I'm not sure why I would be provided with something I didn't ask for. 02:13:30

BY MS. ZHONG:

Q So you don't think it's necessary for you to ask for all the exhibits that's discussed during the deposition?

MS. HANSEN: Objection to form. Lack of 02:13:42

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

relevance. 02:13:43

THE WITNESS: I think it's important for me to ask for the exhibits that are clear to me to be relevant to making a determination about the '223 patent. And this didn't seem to rise to that level 02:13:58 of necessity.

BY MS. ZHONG:

Q Okay. So you don't think that Samsung's expert's position on what constitutes joint vaporization and its relationship to simultaneous 02:14:17 evaporation or co-evaporation or co-deposition is relevant to opinions in this proceeding; is that correct?

MS. HANSEN: Objection to form.

THE WITNESS: I was asked to provide my 02:14:34 own interpretation as a POSA at the time of invention, not to reflect on things that have happened much more recently and after the time of invention.

BY MS. ZHONG: 02:14:50

Q Do you think it's proper for Petitioner's expert to take one position in the IPR and have another expert take a different position in the district court proceeding --

MS. HANSEN: Objection. 02:15:07

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

BY MS. ZHONG: 02:15:08

Q -- for purposes?

MS. HANSEN: Objection to form. Lack of relevance. Calls for a legal conclusion.

THE WITNESS: I'm not a lawyer, as I mentioned in my deposition -- sorry, my declaration and almost mentioned my deposition. And therefore, it's not really my ability to comment on that. I cannot provide you a fully informed answer. 02:15:20

BY MS. ZHONG: 02:15:39

Q And do you understand that a claim construction has to be the same for validity and infringement?

MS. HANSEN: Objection. Calls for a legal conclusion. 02:15:46

THE WITNESS: Because, you know, the context of my involvement in this case is only in the, you know, proceeding here, then, no, I'm unaware of the -- any of these legal needs because that's not my role. 02:16:05

BY MS. ZHONG:

Q So you think it's okay to take one position on claim interpretation in one proceeding and a totally different one in another proceeding and that's proper? 02:16:21

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

MS. HANSEN: Objection. Calls for a legal conclusion. Lack of relevance. 02:16:23

THE WITNESS: Again, I'm not changing my views on anything. My conclusions haven't been altered. I'm not stating one thing today and having stated another thing in early April. I'm maintaining consistency of interpretation of the '223 patent and the exhibits that I've presented and looked at. I can't offer any kind of position or opinion on how different experts will interpret things. 02:16:35 02:16:53

I can offer that, you know, scientists have differences of opinion according to their interpretations of, you know, input data. They're not always in perfect alignment. But I can't offer anything with respect to legal proceedings. 02:17:16

BY MS. ZHONG:

Q Okay. And Kymissis reviewed Ma, as you did, and concluded Ma did not -- he disagrees that month discloses joint vaporization, correct? 02:17:32

MS. HANSEN: Objection to form.

THE WITNESS: Again, without the full context of reading that document, I cannot -- I can't provide that type of answer because I just don't know. 02:17:45

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

BY MS. ZHONG: 02:17:45

Q We reviewed his declaration. He said he disagrees that the process is a joint vaporization process, right?

MS. HANSEN: Objection to form. 02:17:56

THE WITNESS: Well, you reviewed it. And you can provide your opinion. But you can't ask me to when it's not something that I've reviewed.

BY MS. ZHONG:

Q Did you review all the exhibits attached, 02:18:05 cited by Dr. Schanze in his declaration?

A I'd need to be reminded about what all of the exhibits were. I certainly reviewed some. I can't, without giving a comprehensive review of every exhibit in there, tell you whether I reviewed 02:18:31 all of them. If you would like me to go to the list of references, please point me to the exhibit, and I will do that.

Q Do you have Dr. Schanze's Exhibit 2041?

A I'm sure I do. I'm closing other tabs 02:18:52 right now. 241?

Q Uh-huh.

A I think I need to refresh this.

I don't actually see Exhibit 2041.

Q Can you refresh it again? 02:19:30

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

A Okay. There it is. Is there a list of references? 02:19:34

Q I don't think so.

A Like all in one place?

Q Do you see page 89, Footnote 11, with a reference to Kymissis' report? 02:20:12

A Internal page 89? Yes, I see that.

Yeah, I see there's a reference to Kymissis' rebuttal there.

Q Did you review that? 02:20:32

A I did not review.

So the answer to your previous question if I've reviewed all the references in the Schanze declaration, the answer is no.

Q Okay. A sequential deposition you discussed in your report are layers of -- basically, you have two to three layers, distinct layers, right? 02:20:42

A You have -- sorry, what?

Q Like, the sequential deposition you discussed in your report, what's the resulting structure in those? 02:21:29

MS. HANSEN: Objection to form.

THE WITNESS: So this is Exhibit 1020, my reply declaration? 02:21:41

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

BY MS. ZHONG: 02:21:45

Q Uh-huh.

A This is -- all right. The discussion around paragraphs 47 through 50, correct?

Q Yes. 02:22:30

A Okay. So sorry, can you repeat your question?

Q So the sequential depositions you discussed in your reply report, what are the resulting structures of the film? 02:22:43

A It's hard to say. I mean, there are a lot of different options being exercised here. We have layers of two different materials that are being repeated with different thicknesses. And the resulting structure of the film -- it's a little 02:23:14 hard to say. I mean, there's some -- there's characterization of the sort of macroscopic picture of what's happening from things like X-ray diffraction, which is a technique that tells you about the crystalline content of the film. But I 02:23:35 cannot tell you about the disordered content of the film. And it's relatively insensitive, speaking as a material scientist, because X rays aren't very well refracted and absorbed in solids.

So, I mean, it's hard. I can't give you a 02:23:55

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direct answer of what exactly the structure is like in that system. They have varying degrees of order. 02:24:00

Q So if you have a structure that's deposited, like, for example, one molecular layer of C60 and then one molecular layer of ZnPc, one molecular layer of C60, one molecular layer of ZnPc, would you still consider that to be sequential deposition, or that would be co-deposition, as a practical matter? 02:24:20

MS. HANSEN: Objection to form. 02:24:39

THE WITNESS: If you deposited one molecular layer average thickness, which let's say it's like 1 nanometer. So, if you did 1 nanometer of a material and then 1 nanometer of another material and then 1 nanometer of the first material that's in material A, and then you go AB, AB, AB, AB many times, would I say -- 02:24:54

BY MS. ZHONG:

Q Yeah.

A -- it would be the same as co-evaporating the two simultaneously -- 02:25:03

Q Uh-huh.

A -- at the same total thickness?

Q Uh-huh.

A I think that these two references, 02:25:11

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especially the Hang reference, which does look at the 1 nanometer thickness limit, teaches us it's not exactly the same because they compare to a mixture. And they do see that the outcome is slightly different. 02:25:14 02:25:31

Q It's 1 -- so Hang's structure is not really 1 nanometer. 1 nanometer is 1, 3, 2, 2, 3, 2 -- 3, 1, right? So it's still different.

MS. HANSEN: Objection to form.

THE WITNESS: You're right. It's still different. It's hard to make an exact control here. Challenging. 02:26:00

BY MS. ZHONG:

Q Uh-huh. So you don't really have an example where the deposition is one molecular layer, another molecular layer, one molecular layer, and another molecular layer, right? 02:26:16

MS. HANSEN: Objection to form.

THE WITNESS: It's impossible here because it's not like a -- let's take an example from III-V semiconductors, because it's the cleanest example as an analogy. So, in III-V semiconductors, you have the concept of epitaxial growth. And that's where you grow one crystalline layer atop another crystalline layer. And you can exactly define how 02:26:34 02:26:55

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many layers you put down. 02:26:58

And so, if I take, you know, in some miracle of science that gallium arsenide, aluminum arsenide, and Germanium all have the exact same crystal structures. It's an absolute miracle. And 02:27:09 then you can mix aluminum and gallium together and make different stoichiometries. It's one of the absolute amazements of III-V semiconductors. You can make, like, a 1 nanometer thick of aluminum arsenide sandwiched between 1 nanometer thick layers 02:27:25 of gallium arsenide. And that can be perfectly defined.

But in the landscape of disordered molecules, I can't do that because I don't make, you know, a perfectly molecularly flat epitaxial layer 02:27:37 atop another one. There's a lot of disorder there.

What Hang and Yang have been able to assert here is that -- especially Hang -- that the mixture, the co-evaporated layer, has different features from the sequentially deposited layers. 02:27:58 And if we believe that there is some structure property relationship, some -- some -- some -- that the structure imposes some change on the property of the medium that you're measuring, then we have to believe that this type of layering gives a 02:28:18

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structural outcome that's different from the mixture. 02:28:25

But whether I say it's exactly one molecular layer followed by exactly one molecular layer, it's really quite difficult, nearly, I would say, impossible. 02:28:34

BY MS. ZHONG:

Q Now, if you have a large substrate that's rotating and you are depositing -- let's say, like, there are section A and section B. 02:28:53

A Uh-huh.

Q So at time zero, one plume hits section A and one plume hits section B. And as it's rotating at slightly -- at T1, one plume -- like plume -- let's strike that. 02:29:21

So at T0, let's say plume 1 hits section A, plume 2 hits section B.

A Okay.

Q Then as the substrate is moving or rotating, at T1, plume A hits section B, plume B hits section A. Is that co-evaporation? I mean, both sources are continuously evaporating. 02:29:35

A Right.

Q They're just hitting different sections at different times. And both time the macroscopic 02:29:54

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composition will be the same. 02:29:59

MS. HANSEN: Objection to form.

THE WITNESS: So when scientists either design or make use of a thermal evaporation chamber or deposition chamber, it's, you know, pretty 02:30:16 important to ensure that the substrate is at a sufficiently large distance from the sources and that the sources have a plume which is broad such that these plumes are always interacting at the substrate. 02:30:40

I can tell you with 100 percent confidence that every chamber I've ever worked with sits in that relationship. That's the way it was designed. And whether I can say that every single chamber has been maintained to produce that and every user has 02:30:54 used a source that provides for a broad enough plume, I, you know, can't say. But if it's a good science, then there should be a sufficient distance to ensure that those plumes will always mix and use a source that ensures a relatively broad output beam 02:31:13 of, you know, plume of molecules. And usually only one of those is sufficient to make that assertion. But ideally, you want both to be the case to make that assertion. And I can say all the chambers I've used have both. But, you know, I'm not going to 02:31:32

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speak for all of science. 02:31:35

BY MS. ZHONG:

Q Are you familiar with the work Dr. Kymissis does?

MS. HANSEN: Objection to form. 02:32:23

THE WITNESS: Can you be a little bit more specific? Do you mean today? Do you mean 20 years ago?

BY MS. ZHONG:

Q His work in the OLED area or organic electronics. 02:32:35

MS. HANSEN: Objection to form.

THE WITNESS: Again, you're painting this very broadly. I'm therefore, going to answer very broadly. I am generally familiar with the type of work that Dr. Kymissis does. 02:32:49

BY MS. ZHONG:

Q Do you consider him to be a good scientist?

A I do consider Dr. Kymissis to be a good scientist. 02:32:57

THE WITNESS: No need for an objection, Alexa.

(Court reporter clarification.)

THE WITNESS: No. Sorry, the last 02:33:15

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IPR2024-01094

part . . . 02:33:15

(Court reporter clarification.)

THE WITNESS: I generally consider Dr. Kymissis to be a good scientist.

BY MS. ZHONG: 02:33:38

Q So when he designs experiments, you would assume that he would be -- he would at least take as much caution as a person of ordinary skill in the art, correct?

MS. HANSEN: Objection to form. 02:33:51

THE WITNESS: It's not common that any lab has sort of made their own deposition chamber. It's a very uncommon thing to do. Because it's a lot of parts and generally a better move to purchase a piece of deposition equipment from a manufacturer 02:34:13 that produces such equipment. And in my experience, all manufacturers -- and I've used probably four different companies of -- that have produced such equipment, they always design chambers to have the right geometry such that, if you want multiple 02:34:35 sources able to be heated and sublime or, you know, make vapors of materials simultaneously, that they will allow for it.

BY MS. ZHONG:

Q Okay. That's not the question I'm asking. 02:34:52

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I'm asking, you would consider -- strike that. 02:34:56

Based on your familiarity with Dr. Kymissis, you would expect that when he plans an experiment, he would take at least as much care as a person of ordinary skill in the art would; is that correct? 02:35:12

MS. HANSEN: Objection to form.

THE WITNESS: I would expect that he would use a system that was purchased to do its intended purpose and that it would do it well. 02:35:27

MS. HANSEN: Counsel, we've been going for about an hour and a half. Is now a good time for a break?

MS. ZHONG: Sure. 02:35:49

THE VIDEOGRAPHER: Going off the record. The time is 2:35 p.m.

(Recess taken.)

THE VIDEOGRAPHER: Back on the record. The time is 2:49 p.m. 02:49:58

BY MS. ZHONG:

Q Your reply declaration discussed the -- Dr. Schanze's German declaration; is that correct?

A That's correct.

Q In particular, you describe his 02:50:18

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IPR2024-01094

experiments with BTB lithium Q experiment, correct? 02:50:20

A Yes. In particular, the experimental details provided in that document with respect to how those layers were formed.

Q Okay. Dr. Schanze performed those experiments, correct? 02:50:39

MS. HANSEN: Object to form.

THE WITNESS: Which experiments?

BY MS. ZHONG:

Q The experiments you discussed in your declaration. 02:50:57

A He may have been part of a team that was supervising. But it also described experiments that were done at Rice University, which I know is not the same institution that he's a part of. So I just need a little more clarity. 02:51:13

Q So the deposition process was performed by him or his group, correct?

A Let me open the document.

This is Exhibit 1026? 02:51:36

Q Correct.

A Okay. It describes the methods used, the types of equipment that was used. But it doesn't give their exact locations nor who sort of turned the knobs to make it happen. So it's hard for me to 02:52:51

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IPR2024-01094

say. 02:52:56

Q Okay.

A But he was involved. The implication is he was involved.

Q Okay. He would know what the evaporator configuration, the position of the sources for the degree of intersection of the plumes, if he wanted to find out, correct? 02:53:01

MS. HANSEN: Objection to form.

BY MS. ZHONG: 02:53:20

Q Let me strike that and just ask you this:

He would be aware of what the evaporator configuration was using the deposition process, correct?

MS. HANSEN: Objection to form. 02:53:36

THE WITNESS: I mean, I can't pretend to know what someone else knows.

BY MS. ZHONG:

Q The evaporator configuration would be known to the people who performed the experiments, correct? 02:53:47

A The evaporator configuration could be known. Whether it was, like, again, I can't say what was known to someone and what was not. But if you're standing or sitting or, you know, presented 02:54:04

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IPR2024-01094

with an evaporator that you're using to deposit something, you're going to have to open a port to it at some point to be able to insert and introduce the materials you're going to evaporate and the substrates you're going to evaporate those materials on. And during that time, you should have sufficient ability to observe the configuration. 02:54:06 02:54:22

Q Okay. Whoever performed the experiment would know the position of the sources, correct?

MS. HANSEN: Objection to form. 02:54:43

THE WITNESS: They could know it because they're putting materials in there. What matters is their position with respect to the substrate, the distance, whether it's a central location, whether the boats or crucibles are positioned in a way that, you know, allows the material to form a plume that kind of fills the entirety of the substrate holder. 02:54:56

BY MS. ZHONG:

Q Those would be knowable to people who performed the experiment, correct? 02:55:16

MS. HANSEN: Objection to form.

THE WITNESS: Yeah. Those types of things would be knowable. You could see it with your own eyes.

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BY MS. ZHONG: 02:55:31

Q They could also -- people who perform the experiments could also determine the degree of intersection of the plumes, correct?

MS. HANSEN: Objection to form. 02:55:39

THE WITNESS: You could determine that, yes.

BY MS. ZHONG:

Q Your reference also mentioned a Ki supporting information of the Ki publication, 02:55:55 correct?

A Ki is K-I, yes?

Q K-I.

A Yes. In the reply declaration, we cite the Ki supporting information. 02:56:12

Q Is Ki's processing condition the same as in Ma?

A Let me go to my declaration.

Can you repeat your question with Ki and Ma? 02:56:58

Q Did Ki and Ma use the same deposition conditions?

A It is my opinion that Ki used the same materials and the same processing conditions as Ma, yes. 02:57:11

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Q Did they use the same reactor configuration? 02:57:11

A They both used a vacuum chamber and vacuum to deposit films that were mixtures of BPhen and lithium quinolate. 02:57:38

Q Okay. What was the distance -- what's the position of the source to the substrate in Ma?

A I don't know that.

Q What's the position of the source to the substrate in Ki? 02:57:54

A I also don't know that.

Q Okay. What's the degree of intersection of the plumes in Ki?

A I don't know that myself.

Q What about in Ma? 02:58:10

A I also don't know that.

Q And in Ki, the deposition rate is controlled by the sum of the deposition rate of the two materials, correct?

A That's right. So the -- Ki is making use of a single quartz crystal -- maybe two. We don't know. It's either one or two quartz crystal -- 02:58:26

Q Two.

A -- microbalances.

Is it two? 02:58:41

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Q Yeah. If you look at your declaration page -- 02:58:41

A Yeah. Two, right.

Q -- 33.

A I see it. Yeah. 02:58:46

So they're using two quartz crystal microbalances, one of which is sensitive to one of the plumes, because it's probably kept a close distance from that source. And the other one is fixed near the substrate holder, so it's sensitive 02:58:59 to everything. And so you can determine all you need to know from two quartz crystal microbalances when you're depositing two materials. You can -- one configuration is like Ki describes, one near the substrate, one near one of those sources. And then 02:59:18 the difference between the two is the flux of the other source. Or you could have two sources that are each sensitive only to either of the sources. And then you need to sum them to get the total. And so it depends. 02:59:33

In my chamber, for example, that me and my team use at Princeton University, we have quartz -- three quartz crystal microbalances that are sensitive to, you know, three different materials that could be deposited simultaneously. We do not 02:59:47

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have any sensors that are sensing the entirety -- right? -- what's near the substrate. 02:59:52

But you can work with either. Just again, when you know your chamber, sufficient distance between the sources, because you know it, you're a good scientist, you're a POSA that wants to make a homogeneously mixed film, you ensure that it's the case, and you monitor your rates, you know, the deposition rates, to provide the layer of your target -- you know, your target layer. 03:00:02 03:00:20

Q Ki's base pressure is 10 to minus 7 torr versus 10 to minus 5 torr for Ma; is that correct?

A That's what it states, yes.

Q How can Ma keep the deposition rate of the two organic compounds on a 0.5 plus/minus 0.2 angstroms per second when it is varying the percentage of lithium Q to BPhen? 03:00:45

MS. HANSEN: Objection to form.

THE WITNESS: I mean, so Ki says --

BY MS. ZHONG: 03:01:11

Q I'm talking about Ma. I'm sorry.

A I know. I'm just going to come to your answer.

The Ki that says -- I'm just doing it in the order that's presented in my reply declaration. 03:01:20

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The sum of deposition rates of the two materials was kept at approximately -- there's the two squiggly lines. That means approximately. Approximately 2 angstroms per second. They don't define an error. They don't define what the plus or minus is. They just say approximately 2 angstroms per second. 03:01:21 03:01:33

Whereas, Ma doesn't use "approximately" because they use the plus or minus. And they prescribe their ability of .5 plus or minus .2 angstroms per second, because evidently, there is some shifting of the rate in their configuration. 03:01:47

In Ki, we don't know what that shifting is because they say "approximately," but we know it's not exactly 2 angstroms per second over the entirety of the thing. 03:02:08

So what researchers will often do when making a host-guest film is you will try hard to maintain an accurate ratio between the two, even if some of them might shift a little bit. And then you will measure the -- you will -- sorry, not measure. You will record the total thickness that has been monitored from each quartz crystal microbalance during the time the deposition was active. And you can back-calculate the average ratio throughout the 03:02:24 03:02:42

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IPR2024-01094

mixture. And if it hasn't changed much, if the ratio hasn't changed much across, you know, the tens to hundreds of seconds that it takes to make a layer, then you can report the exact average ratio via those two very accurate total thicknesses. 03:02:48 03:03:05

Q So my question is, how can you get different ratios when each of the material is deposited at 0.5 angstroms per second?

MS. HANSEN: Objection to form.

THE WITNESS: It says the deposition rate was maintained at plus or minus -- sorry, .5 plus or minus .2 angstroms per second for the organic materials. That indicates to me that, you know, the sum is .5 angstroms per second. That's what they went for. That was their target rate for organic deposition total. And it's not saying -- because obviously if lithium quinolate and BPhen were evaporated at .5 angstroms per second each, that would result in a 1:1 by weight. Not by molar, but that would be a 1:1 by weight, you know, ratio, which is one of the ones that Ma reports, but it's not the only one. So I have to imagine that, you know, .5 angstroms plus or minus .2 angstroms per second means that's their total. Just like in Ki, you know, the sum is kept at 2 angstroms per second. 03:03:22 03:03:43 03:04:03 03:04:20

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BY MS. ZHONG: 03:04:23

Q Okay. Just to be clear, the 0.5 -- sorry. Strike that.

In Ma, the stated 0.5 plus/minus 0.2 angstroms per second, that's the total 03:04:32 deposition rate for all the organic materials?

A Right.

Q And it's not the deposition rate for each of the organic materials?

A That's right. 03:04:46

And you know, they're doing multiple organics. They have BPhen. They have lithium quinolate. They have NPB. They have Alq. They have F4TCNQ. They have MTDATA. If those all can't be exactly recorded, what I mean to say is, you 03:05:01 know, at least five or six different organic materials, but whenever they go to do an organic semiconductor deposition, their target total flux for that deposition is .5 angstroms per second.

Q So when C60 fullerene is reduced by 03:05:40 tungsten2(hpp)4, do you know what's the product of the reduction?

MS. HANSEN: Objection to form.

THE WITNESS: If tungsten2(hpp)4 has -- I mean, you need to be a little more exact. 03:06:07

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Is this a complete redox, reduction oxidation reaction? Is this, you know, a partial charge transfer situation? It's hard to say exactly what the outcome is. But, you know, if there is some kind of interaction between tungsten2(hpp)4, a strong molecular reductant, and C60, a pretty darn good molecular acceptor, then I would imagine that the C60 has gained electron density and the W2(hpp)4 has lost some. 03:06:09 03:06:27

BY MS. ZHONG: 03:06:46

Q Okay. What's a reaction product?

Let's take one step back.

So, in Cotton's paper, is it a complete charge transfer between C60 and tungsten2(hpp)4?

MS. HANSEN: Objection to form. 03:07:02

THE WITNESS: Can you point to where Cotton combines tungsten2(hpp)4 and C60, which reference you're referring to, which exhibit?

BY MS. ZHONG:

Q Exhibit 2008. Let me see. I don't know whether I uploaded it yet. 03:08:17

A I don't see it yet.

Q Sorry. I got logged out.

Okay. Try again.

Do you have Exhibit 2008, which is the 03:09:46

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Cotton paper in "Inorganic Chemistry Communications"? 03:09:48

A Yes. I'm opening it now.

Okay.

Q So, in Exhibit 2008 -- 03:11:29

A Yes.

Q -- is it a full charge transport between tungsten2(hpp)4 and the C60 fullerene?

A It's unfortunately in -- thank you for reminding me about the paper. I have read this, by the way. But it's a little -- it's left a little ambiguous. Because I think the authors here were limited to solution-phase measurements. And they mention that the product is rather insoluble. So the tungsten2(hpp)4 C60 combination, when those are mixed, it -- you know, it leads to a product that's insoluble, and that restricts their ability to do further analysis. 03:11:48 03:12:07

Q Okay. What about in Exhibit 1022. Let me see whether you have that. No, you do not. 03:12:27

You can refresh your Exhibit Share.

A Okay. You said 1022?

Q Yes.

A Okay. Torben Menke in APL 2012.

Yes. 03:13:19

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Q So, in this paper, is it a full charge transport or partial charge transport? 03:13:19

A Can you repeat your question?

I thought you said "charge transport."

Q Sorry. 03:14:11

In this Exhibit 1022, does the interaction between fullerene C60 and tungsten2(hpp)4 involve full charge transfer or partial charge transfer?

MS. HANSEN: Objection to form.

THE WITNESS: It's unclear to me that they would have done -- that they have done, you know, an analysis that allows them to draw a conclusion whether there is full or partial or a mixture of full and partial, complete or partial charge transfer in the mixtures of C60 with either of these metal 2(hpp)4 metal complexes. 03:14:49 03:15:05

BY MS. ZHONG:

Q And this paper was after the priority date of the '223 patent, correct?

A That's correct. Received 9 January 2012. Published 29 February 2012. 03:15:22

Q So, in 2018 -- strike that.

Between 2008 and 2009, did you publish in "Synthetic Metals"?

A Between 2008 and 2009, I did not publish 03:15:46

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IPR2024-01094

in the journal "Synthetic Metals" in that time period, no. 03:15:50

Q Before 2009, did you ever publish in "Synthetic Metals"?

A Before 2009, I did not publish in "Synthetic Metals." 03:16:02

Q Do you know the publication process for all Elsevier journals in the 2008 and 2009 time period?

A "Synthetic Metals" -- sorry. Elsevier is a large publishing house with many journals, so I can't assert that I understand the publishing process in all Elsevier journals either now or then. 03:16:54

Q Do you know when -- strike that.

In the 2008 to 2009 period, do you know when an online Elsevier article got indexed in either Web of Science database or Science Direct database? 03:17:41

A I'm unaware of those exact time periods.

I can say that I used Web of Science in that time period relatively frequently. Not all the time, but with relative frequency. Let's say at least weekly. And in my experience with its use, it was a pretty effect -- it was a pretty effective way of searching recent articles that had been 03:18:14 03:18:38

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published. 03:18:42

Q Okay. Do you know that Web of Science in 2008 to 2009 did not index articles published online but before hard copy publication?

MS. HANSEN: Objection to form. 03:19:08

THE WITNESS: Can you repeat that?

BY MS. ZHONG:

Q Okay. You state Ma was published on August 29, 2008 in your reply declaration, correct?

A Let me pull that up. 03:19:32

Let me close it. No, there it is. Okay.

Yeah. The version posted online was in August 2018. That's correct.

Q Do you know when that article was indexed by Web of Science? 03:20:23

A I mean, that's not contained here in the article info, so I'm not privy to that information.

Q You reviewed Dr. Schanze's declaration, correct?

A Yes. 03:20:40

Q And you're aware that Dr. Schanze mentioned that Web of Science did not index the article until December 2008 when Ma was published in hard copy, correct?

A I'm aware that some anecdotal evidence was 03:20:59

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IPR2024-01094

provided. I don't -- I didn't reply to it because I didn't have any way to verify that, because it appeared quite anecdotal. 03:21:05

Q Did you -- do you know that Dr. Schanze actually attached a page from Web of Science showing when the document was indexed? 03:21:18

A I'm not aware of that.

Q Sorry. Actually, did you review paragraph 150 of Dr. Schanze's declaration?

A You said paragraph 150? 03:22:56

Q Yes.

A I'm looking at that, and I see it says "Indexed 2008 December 1st." Yes, I don't know where this screenshot is coming from exactly.

Q Did you verify that from Web of Science? 03:24:03

MS. HANSEN: Objection to form.

THE WITNESS: I don't even know that this is coming from Web of Science, so how would I have done that? There would be no reason for me to do that. 03:24:19

What I can say is that, you know, the article will be published in its final form later in print. Then it will be available online. But it's fully available once it is published online. And oftentimes what is done is that the article will 03:24:40

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IPR2024-01094

have a kind of temporary ability to be cited before it is finally put in print with final page numberings. You know, the page numbers for Ma, for example, are 810 to 814 in the issue in which it was printed. But there is still availability to view and cite that work prior to it being published in print with the final numbers, which can only be known once you have the final volume published and the indexing. That's probably the ultimate time it was indexed, which is when the final issue and final numbers came out. But that does not reflect that it wasn't available before that. That just means this is when it was last updated, because that's when it had its final numbers. 03:24:44 03:25:06 03:25:25

BY MS. ZHONG: 03:25:41

Q You know that it was indexed between August 2008 and December 2008? Do you have any evidence for that?

A I have evidence that it was available online 20 August 2008. 03:25:55

Q Do you have evidence that Web of Science indexed the online journal before December 2008, as stated in the screenshot?

MS. HANSEN: Objection to form.

THE WITNESS: This is operating under a 03:26:17

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IPR2024-01094

presumption that Web of Science is the only way to identify literature for a POSA, which it's not. And so evidence is that a POSA would have been able to find this article from the time it was published online from a computer terminal in 29 August 2008. 03:26:19 03:26:34

I don't have any specific evidence that Web of Science, you know, reindexed or anything because I have never worked for that organization. I think it's ISI, the parent organization. So I can't say much about their processes then or now. 03:26:54

BY MS. ZHONG:

Q And what evidence do you have that a person of ordinary skill in the art interested in the article would be able to locate that article? Have you ever attempted to do that? 03:27:10

MS. HANSEN: Objection to form.

THE WITNESS: Absolutely. I --

BY MS. ZHONG:

Q You attempted to retrieve Ma in 2008?

A So I can tell you how I find articles the moment they come out, which includes in Elsevier journals even to this day, which is these journals maintain an RSS feed. And I subscribe to it. And it plops into a folder for, you know, journal -- journal X. And then I can see the title and decide 03:27:23 03:27:42

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Samsung v Pictiva
IPR2024-01094

to click on it. And it takes me to the website, which is the one that reflects the available online date. It's there right when it's available. So a POSA would have been able to do that. 03:27:46

Q And do you have an RSS feed for "Syn Metal"? 03:27:59

A I don't, at this time, have one.

Q Did you have one in 2008?

A I believe that I did for "Synthetic Metals" and "Organic Electronics," and "Thin Solid Films." I think all three of those Elsevier journals I had RSS feeds for at the time. 03:28:12

Q And did you -- was Ma included among them?

A It must have been. Because all of those -- every new paper pops into the RSS feed as it publishes online. 03:28:31

Q Did you include that information in your declaration?

A I did not.

Q Okay. Do you ever recall trying to retrieve Ma outside of this -- outside this proceeding? 03:28:43

A Okay. Because I was the person that found Ma during this proceeding. But I don't recall ever reading Ma prior to this proceeding. 03:29:23

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

Q Okay. So before 2024, you don't recall ever reading Ma? 03:29:27

A Prior to 2024, I don't recall ever reading Ma, but I have been exposed to scientific content that is similar to the scientific content contained in Ma, in other words, the influence of doping of transport layers on organic electronic components. 03:29:49

Q If you have two materials that are in the same chamber but in two different sources and they are being heated at the same time, is that joint evaporation? 03:30:47

A I don't have sufficient information to say one way or the other because, you know, you can't just heat something and, you know, have it necessarily be above a temperature where it's started to form vapor. 03:31:15

Q If you have two materials that are in the same evaporation chamber but in two different sources and they are heated and evaporated at the same time, is that joint evaporation? 03:31:31

MS. HANSEN: Objection to form.

THE WITNESS: If each of those sources are heated so that they're producing vapor of the constituent molecule and those two plumes are, you know, designed in such a way that they both land on 03:31:52

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

the substrate, then that would be considered joint evaporation. 03:31:57

BY MS. ZHONG:

Q If they hit different spots of the substrate, is that still joint evaporation? 03:32:06

MS. HANSEN: Objection to form.

THE WITNESS: The places where those two plumes overlap, assuming they're not 100 percent distinct, then yes, that's still considered joint evaporation. 03:32:25

BY MS. ZHONG:

Q But if there are no overlap, would that still be considered joint evaporation?

MS. HANSEN: Objection to form. Relevance. 03:32:35

THE WITNESS: I think I would need to know a little bit more about the intended experiment and where the substrate is sitting, how it's moving, et cetera.

BY MS. ZHONG: 03:33:06

Q Just because two materials are evaporated from the same chamber at the same time, you cannot conclude that it is necessarily joint evaporation; is that correct?

MS. HANSEN: Objection to form. 03:33:23

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

THE WITNESS: I'd say that the, you know, person conducting the experiment can say that their sample was co-deposited or jointly evaporated or jointly deposited or co-evaporated, whatever term you'd like to use, as long as you describe it properly, as long as that person has ensured that the vapor emanating from each of those crucibles is hitting the substrate at the same time. 03:33:31 03:33:47

BY MS. ZHONG:

Q At the same time at different spots? Is that joint evaporation? 03:34:05

A I don't see how something can be hitting something at the same time in different spots. That's sort of . . .

Q Different spots of the substrate. 03:34:17

MS. HANSEN: Objection to form.

THE WITNESS: I'm a little confused.

BY MS. ZHONG:

Q Are you saying that the two plumes have to hit the same spot at the same time? 03:34:33

A Yes.

Q So in order there to be joint evaporation, the two plumes have to hit the same spot on the substrate at the same time?

A That's what I'm saying. 03:34:56

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

Q And is there sufficient information for you to determine that's necessarily what happens in Ma and Ki? 03:35:00

A And in the Schanze German exhibit, I would say yes. Because the assumption is that, if a researcher is doing an experiment to try to understand the properties of a layer that is composed of a mixture of the two compounds, that they've ensured that their evaporator has configured in such a way that it will allow for depositing those two compounds simultaneously. 03:35:20 03:35:42

Q Is tungsten2(hpp)4 donating electrons to BPhen if the interaction is LUMO LUMO interaction rather than HOMO LUMO interaction?

MS. HANSEN: Objection to form. 03:37:06

THE WITNESS: So the LUMO, you know, is comprised of empty orbitals. But it has, you know, some electron density cloud that's affiliated with it. And you know, W2(hpp)4 has its LUMO electron cloud that determines that energy level where electrons can sit, which is very shallow. It's probably very hard to get an electron onto W2(hpp)4, the LUMO. And then BPhen will have a LUMO, that, you know, it's molecular orbital that describes the energy at which an electron can sit. And, you know, 03:37:43 03:38:01

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

it's difficult to say that, you know, you have an electron that's transferring from LUMO to LUMO. I don't think I would describe it like that unless it was some kind of photo-induced charge transfer that you promote an electron to a LUMO, and then you can have charge transfer. So I'm not sure I'm fully grasping the question. 03:38:07 03:38:22

BY MS. ZHONG:

Q What's a LUMO level for tungsten2(hpp)4?

A The LUMO level is going to be, you know, quite close to vacuum. It's -- 03:38:42

Q So zero?

A I don't know where it is exactly, but it's going to sit in some place that, you know, promoting an electron from the HOMO to the LUMO puts it in a relatively precarious position for -- talk about a strong reductant. 03:38:54

Q So the LUMO will be close to 0 EV?

A Yeah.

Q So about 3 EV higher than that for the BPhen? 03:39:11

MS. HANSEN: Objection.

BY MS. ZHONG:

Q 2 1/2 to 3 EV higher than BPhen?

A Sure. 03:39:22

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

MS. HANSEN: Objection to form. 03:39:22

BY MS. ZHONG:

Q Do you consider 2 1/2 to 3 EV to be a large energy gap for effective LUMO LUMO interactions? 03:39:36

MS. HANSEN: Objection to form.

THE WITNESS: I mean, it depends what I'm trying to do. For an effective charge transfer reaction, I would say, you know, it's probably pretty effective. That's pretty exothermic. 03:39:51

BY MS. ZHONG:

Q How much overlap would there be?

MS. HANSEN: Objection to form.

THE WITNESS: I'm not sure I understand what you mean by "overlap." 03:40:07

BY MS. ZHONG:

Q Does the LUMO of BPhen and the LUMO of tungsten2(hpp)4 have the right molecular orbital orientation and energy gap to interact effectively?

MS. HANSEN: Objection to form. 03:40:34

Relevance.

THE WITNESS: Again, I don't know what you mean by "effectively." We know that the mixture of W2(hpp)4 and BPhen results in an increase of conductivity, which, you know, according to '223 is 03:40:52

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

one of the sort of necessary outcomes of coordination. So I would say that there's an effective interaction between those two compounds. 03:40:55

BY MS. ZHONG:

Q Is this a LUMO LUMO interaction? 03:41:06

MS. HANSEN: Objection to form.

THE WITNESS: I'm not sure I ever considered that in forming my opinions.

BY MS. ZHONG:

Q Do you believe there is a LUMO LUMO transfer mechanism in interactions between tungsten2(hpp)4 and BPhen? 03:41:18

MS. HANSEN: Objection. Form. Relevance.

THE WITNESS: I -- you know, if those two molecules are an intimate mixture, close contact, I can imagine that there could be interaction between the LUMO of tungsten2(hpp)4 and the LUMO the BPhen. 03:41:44

BY MS. ZHONG:

Q So are there intimate interactions in Exhibit 2044, the operating conditions? 03:42:00

MS. HANSEN: Objection to form.

THE WITNESS: 2044. '541 patent.

Can you repeat your question?

BY MS. ZHONG:

Q In Exhibit 2044, is there a mechanism for 03:42:17

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

electron transfer for LUMO LUMO interactions for the tungsten2(hpp)4 and the BPhen film? 03:42:30

MS. HANSEN: Objection to form.

THE WITNESS: I mean, if there was, they don't describe it. And their -- 03:42:56

BY MS. ZHONG:

Q Go ahead.

A And they're not -- you know, they're not talking about anything photo-induced here. I guess UPS is. They do describe UPS. So that's photo 03:43:10 induced.

So I would say yes, there is scope to have LUMO LUMO interaction in the experiments that are contained within Exhibit 2044.

Q How effective is the LUMO LUMO 03:43:29 interaction?

MS. HANSEN: Objection to form. Relevance.

THE WITNESS: I mean, I'm not in any -- I don't have enough information to be able to provide 03:43:40 an opinion on that.

BY MS. ZHONG:

Q Do you know how much of the conductivity improvement is due to the LUMO LUMO interaction?

MS. HANSEN: Objection to form. 03:43:59

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

Relevance. 03:43:59

THE WITNESS: There's insufficient, you know, information contained in the 2044 exhibit to be able to give an answer to that question.

BY MS. ZHONG: 03:44:14

Q Did you attempt to make a determination?

MS. HANSEN: Objection to form. Relevance.

THE WITNESS: I didn't attempt because there is insufficient information to do so. 03:44:23

BY MS. ZHONG:

Q Now, when you do the UPS, you are not really combining BPhen with tungsten2(hpp)4. You measure each material separately, correct?

MS. HANSEN: Objection to form. 03:45:07

THE WITNESS: You can conduct UPS on films that are combinations of molecules. I believe one of the exhibits that you pointed me toward maybe 15 minutes ago was such an example. Exhibit 1022, I believe. They conducted photo emission spectroscopy 03:45:32 measurements on combinations of the metal 2(hpp)4 with -- yep, they did. Did they? Maybe they didn't. It's unclear. I need to read this a little more carefully. But you certainly can do UPS measurements on mixtures of layers. It's done all 03:46:03

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

the time. 03:46:06

BY MS. ZHONG:

Q Did the '541 patent or Exhibit 10 -- strike that.

Did the '541 patent or Exhibit 2044 mention UPS measurement on a mixture of tungsten2(hpp)4 and BPhen? 03:46:11

A Not to my knowledge, no. Neither of those references describes UPS measurements on mixtures.

Q So for gas-phase ionization potential, which is the relevant value, the onset or the peak value, or somewhere in between? 03:47:08

A Relevant for what?

Q Charge transfer.

A Relevant for charge transfer to another compound in the gas-phase, yes. 03:47:37

Q Sure. We can start there.

A So, if we're talking about the charge transfer to another compound in the gas-phase, then what matters is the onset energy because that's the one that determines where you start to have electron density. 03:47:51

Q Okay. So is the 3.6 EV reported by Exhibit 2044 the onset ionization potential in the gas-phase? 03:48:12

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

A 2044. 3.6. I'm going to open the Cotton reference where I think this comes from. Exhibit 2009. That looks to be approximately the onset of W2(hpp)4, yes, in the gas-phase. 03:48:15

Q How do you know the 3.6 EV is the onset? 03:49:17

A Well, I'm referring to the Cotton "Science" paper, the 2009, where they show the gas-phase photoelectron spectra of, among those, tungsten2(hpp)4. That's the relevant one. And it looks to onset at approximately 3.6 EV. So that's why -- that's how I extrapolated that I think the 3.6 EV value is the onset. 03:49:37

Q Can you take a look at Exhibit 2044, column 8, lines 62 to 67.

A 2044. So this is the '541 patent? 03:51:16

Q Uh-huh.

A Column 8. Lines what?

Q The last paragraph in column 8.

A "The matrix materials"?

Q Correct. 03:51:38

A Okay. Okay.

Q So is it true that the inventors are attributing the improved thermal stability of the compounds to the increased sublimation and the decompensation temperatures? 03:52:13

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

MS. HANSEN: Objection to form. 03:52:16

THE WITNESS: They're attributing the increased thermal stability of the matrix materials to, in particular -- not necessarily exclusively, but, in particular, the increased sublimation and 03:52:35 decompensation temperatures.

BY MS. ZHONG:

Q And in the context of those phenanthroline complexes --

A Uh-huh. 03:52:48

Q -- "sublimation temperature" is also referred to as "evaporation temperature"?

A Yeah. Whether something evaporates or sublimes is, you know, a tricky thing. It depends upon the vacuum level -- sorry, the degree of 03:53:05 vacuum. I don't mean the electronic vacuum level, but, like, say, the -- how high of a vacuum you have will determine the evaporation or sublimation temperature. And if you're observant, you can tell whether a material has evaporated, which means it 03:53:26 would have gone through a liquid -- you know, a solid to liquid to gas transition in the -- you know, in making that plume or whether it goes directly from a solid to a gas, which is the sublimation process. 03:53:41

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

And the way you can observe that is, after you perform the deposition, you can look at the material before and after. And if you've seen it sort of, like, flow and then resolidify, you have a pretty good guess that that material has evaporated rather than sublimed. 03:53:41 03:53:58

If the material looks kind of like in the very same state that it started, then you can assume that that was a sublimation process.

But what is relevant, I think, here is the temperature that is required to reach a certain flux of molecules, that's probably what's being compared in that T sub S, the sublimation temperature. 03:54:12

Q So does joint vaporization requires a solid material to go through the liquid phase? 03:54:31

A It does not. It only requires that you're able to form a vapor of the material, the starting compound.

Q So when the literature says the matrix has an evaporation temperature of 200 degrees, that could also refer to the sublimation temperature; is that correct? 03:54:44

A "Evaporation" and "sublimation" are often used interchangeably. What I think is being expressed here is the temperature to reach some flux 03:55:05

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

of material to a substrate. 03:55:09

Q Okay. So the sublimation temperature just means that the temperature at which some vapor phase of the material can be --

A That the temperature of the thermal couple that's connected to the source that's being heated to put the material into vapor phase to then condense on the substrate. That's what the -- I'm pretty sure that's what the temperature -- that's what I think a POSA -- how it would interpret it. 03:55:20 03:55:35

Q Okay. Why does increase the sublimation temperature help increase the thermal stability?

A So the flux is also like a thermally activated process. The higher you go, once you're, you know, beyond, say, the sublimation point or the evaporation point of some compound, the higher that flux rate can be. And -- but you can't just keep dialing the temperature up. At some point, a compound will decompose. And so the -- the sort of -- the higher the temperature you can take a compound to before it decomposing kind of determines the sort of thermal stability of that compound in those conditions, usually a vacuum. But it could also be measured with a so-called, like, TGA to determine the decomposition temperature. Although, 03:55:58 03:56:19 03:56:41

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

that's often not in vacuum. And so one has to be a little careful with the comparison. 03:56:44

Q But that would be the decomposition temperature. That's not really the sublimation temperature, right? 03:56:55

A Right. Here they're reporting the sublimation, the temperature at which they're subliming the compound.

Q I would have thought you would want to have a lower sublimation temperature so you can hit a higher flux at a lower temperature -- 03:57:07

MS. HANSEN: Objection to form.

BY MS. ZHONG:

Q -- further away from the decomposition temperature of the material. 03:57:18

A The decomposition temperatures are not reported here. So it's a little hard to say if that window -- right? -- that processing window is getting larger or not. So it's a little challenging. I see your point, but it's a little challenging to -- you know, for me to say one way or the other. 03:57:33

Q But why would a higher evaporation temperature be good for thermal stability? I can see why the higher decomposition temperature would 03:57:55

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

be good for thermal stability, but why would a good evaporation temperature be good for thermal stability? 03:57:59

MS. HANSEN: Objection to form. Relevance. 03:58:10

THE WITNESS: They do -- you know, I'll draw your attention back to the passage you initially put my attention into, which is that this you say "which can be attributed, in particular, to increased sublimation and decomposition temperatures." 03:58:22

So, apparently, somewhere along the lines of these inventors performing their experiments, they recognized that that was an important metric for material stability. It's hard for me to express exactly what the rationale is for that because they don't provide it. But they do provide the statement saying that this is their observation, among others, because of the "in particular." 03:58:36

BY MS. ZHONG: 03:58:55

Q What is a sublimation temperature for BPhen?

A Maybe you can help me if they provide it. I know it's not in either Table 1 or Table 2, but I'm not sure if it's noted somewhere else. I could 03:59:34

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

conduct a search, or you could draw my attention to the passage. 03:59:38

Q I don't think I found it in this document.

A Okay.

Q Do you know where roughly the temperature would be, based on your experience? 03:59:48

A Based on my experience, I would place it at a lower temperature than, you know, these larger molecular weight phenanthroline derivatives in Table 2. But it's a little hard for me to give an exact value. If I had to take a guess, I would say, because in column 8, lines 39 and 40, it says "preferably, the matrix material has an evaporation temperature of at least 200C," that my feeling is that BPhen has a sublimation temperature below 200C. 04:00:07 04:00:34 But more I can't really say.

MS. ZHONG: Why don't we take a break. 10 minutes.

THE WITNESS: Sure.

THE VIDEOGRAPHER: Going off the record. The time is 4:01 p.m. 04:01:04

(Recess taken.)

THE VIDEOGRAPHER: Back on the record. The time is 4:13 p.m.

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Samsung v Pictiva
IPR2024-01094

BY MS. ZHONG: 04:13:20

Q We discussed the Figure 3 of Exhibit 2044 this morning, correct?

A Yes, we did.

Q Do you know what's the reason that the BPhen films seems to give rise to much more rapid decrease in the brightness compared to 1d? 04:13:39

MS. HANSEN: Objection to form.

THE WITNESS: So this is a complete OLED. It's not just a BPhen film. So it has numerous layers in it. What the inventors here are doing in Figure 3 is they are comparing when that electron transport layer is either -- I think it's 1e -- is it? 04:14:08

BY MS. ZHONG: 04:14:33

Q 1d?

A 1d, sorry. 1d doped with 4 percent of W2(hpp)4. And it's 10 nanometers thick, so it's quite thin, versus BPhen. And they say BPhen was used instead of 1d. So I have to imagine that means it's also 10 nanometers thick, and it's also 4 percent doped. 04:14:57

Q 16 nanometers, right?

A Sorry. I was looking at the wrong line.

I was looking at the emitting layer. 04:15:11

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Samsung v Pictiva
IPR2024-01094

There's a pure -- there's a pure layer of the 1d that's 10 nanometers. And then there's a 16-nanometer doped layer. Okay. Now I see. 04:15:14

So I assume the BPhen 1 is also a 10-nanometer pure layer and a 16-nanometer doped layer with also 4 percent of the W2(hpp)4. And they're comparing the OLED at, you know, similar starting but not exact, but similar starting brightnesses. And regardless of the starting brightness, they observe that the BPhen device loses brightness, I assume, when pinned to the same voltage point as the starting a little more rapidly than the 1d layer. And you know, my -- you know, I do a lot of research on the evolution and degradation of thin film electronic and optoelectronic devices, and it's challenging to assert a specific mechanism responsible because you're making so many different -- you have so many different things going on here. 04:15:25 04:15:46 04:16:15

In the first case here, it's a red emitter, which means you're going to have to push it pretty hard to get to these brightnesses, which are -- even a thousand is high. You know, if you're talking about a display, those are normally operating at approximately 100 candelas per meter 04:16:34 04:16:54

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

squared. And so this is already starting life pushing. You're pushing. 04:16:58

And then if the BPhen layer is lower conductivity than the 1d layer, it's going to naturally drop more voltage. And so you're holding the voltage of the 1d layer at a higher voltage to achieve a similar brightness. 04:17:09

Let's assume the EQE is the same. So the current is the same. Again, it's an assumption, because we don't know all the data here. Then you're still pushing a lot more power into this device with BPhen because you have operating at a higher voltage. Because we know the conductivity is lower. And that's going to be a larger thermal burden on the device. And you know, I would expect it to degrade. If I had the 1d device held at the same voltage and current point as the BPhen device and I could compare one to one those data, I would be in a better position to give you more authoritative answers. 04:17:24 04:17:39 04:17:58

But, you know, the purpose of this long diatribe here was just to say I can't say exactly what the mechanism is responsible, but I -- you know, the first thing that jumps into my mind is, you know, they're probably holding that at a higher 04:18:09

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

voltage. Because we know from their data that the conductivity of the doped BPhen layer is lower than the conductivity of the doped 1d. 04:18:14

Q Does Exhibit 2044 provide for the processing conditions for the films? 04:18:28

A Exhibit 2044 appears not to limit to a specific mode of processing the films. It's devoted to, you know, the final film with this -- with these compositions.

MS. ZHONG: I pass the witness. 04:20:03

MS. HANSEN: Okay. Let's go off the record.

THE VIDEOGRAPHER: Going off the record. The time is 4:20 p.m.

(Recess taken.) 04:27:59

EXAMINATION

BY MS. HANSEN:

Q Dr. Rand, I have just a few questions for you.

Could you bring up Exhibit 1005, the Werner reference, please? 04:28:15

A Yes. I have that open.

Q Okay. If you go to page -- internal page 10, PDF page 13, please.

A Okay. I'm there. 04:28:33

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

Q Do you recall counsel asking you questions about Structures 1 through 10 on page 10? 04:28:34

A Yes, I do recall.

Q Let's take a look at structure 1.

Is structure 1 a specific single compound, or is it a class of compounds? 04:28:48

A Structure 1 is a class of compounds, made clear by the five R groups.

Q Now, for the rest of the compounds listed on page 10, are those individual compounds, or are those classes of compounds? 04:29:03

A For the same reasons, those are all classes of compounds.

Q Okay. Now, if we could turn to page 23 -- internal page 23, PDF page 25. 04:29:24

Now, for compounds 11 through 16 on page 23, are those each individual compounds, or are those classes of compounds?

A These are all classes of compounds.

Q And on page -- internal page 24, there's Compound 18. 04:29:49

Is that an individual compound, or is that a class of compounds?

A That's a class of compounds.

Q And on page -- internal page 25, 04:30:01

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

compound 17, is that an individual compound or a class of compounds? 04:30:05

A Again, that's a class of compounds.

Q And turning to internal page 28, where you have compounds 19 through 37, as well as 27a and 28a, are those each individual compounds or classes of compounds? 04:30:19

A Those are all classes of compounds.

Q If we turn to internal page 33, PDF page 35, where you have compounds 38 through 46, are those individual compounds, or are those classes of compounds? 04:30:44

A I think you mean PDF page 36, not 35.

Q You are correct, yes.

A So those are all classes of compounds. 04:31:01

Q Okay. And if we turn to the next page, internal page 34, which has compounds 47 through 56, as well as compounds 45a and 46a, are those each individual compounds, or are those classes of compounds? 04:31:22

A Those are all classes of compounds.

Q If you turn to internal page 36, PDF page 39, there are compounds 57 through 64.

Do you see those?

A Yes. 04:31:37

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

Q And are those individual compounds, or are those classes of compounds? 04:31:37

A Those are all classes of compounds.

Q Now, if we could turn back to internal page 13, PDF page 17 -- I think it's 17. Might be 16. Let me know when you're there. 04:32:02

A I'm there, yeah. Internal page 13.

Q Okay. Now if we look at line 20, there's a reference to hpp.

Do you see that? 04:32:26

A I do.

Q Is that an individual compound or a class of compounds?

A That is a specific compound, not a class of compounds. That's referring to one thing and one thing only. 04:32:38

Q Got it.

Now, if we look at line 21, it talks about the guanidinates.

Do you see that? 04:32:48

A Guanidinates.

Q Guanidinates. Sorry.

Is that an individual compound or a class of compounds?

A That's a class of compounds. 04:32:55

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

Q And starting at around line 23, it talks about, in particular, at least one ligand, and then it talks about a carboxylate. 04:32:58

Is that an individual compound or a class of compounds? 04:33:13

A That's a class of compounds.

Q And it talks about a formamidinate.

Is that an individual compound or a class of compounds?

A A formamidinate is a class of compounds. 04:33:24

Q And it then talks about a pyrimido-pyrimidine.

Do you see that?

A I do.

Q Is that an individual compound or a class of compounds? 04:33:36

A That's, again, a class of compounds.

Q Now it talks also about guanidine.

Do you see that in lines bridging over to 25? 04:33:49

A Yes.

Q Is that an individual compound or a class of compounds?

A That's referring to the compound guanidine. That's a specific compound. 04:33:58

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

Q Okay. Now, if we take a look at internal page 15, there's a compound there that's listed as type 65b. 04:34:00

Do you see that?

A Yes. 04:34:16

Q We talked a little bit earlier about hpp. How, if at all, do hpp and the generic structure of 65b relate?

A So hpp is the situation where E is nitrogen and a, c -- a, b, c, d, e, f are carbon. 04:34:37

Q So hpp is a specific species of the genus described here in type 65b?

A That's correct.

Q If we take a look at the bottom of that list, which is turning over to page 16. 04:34:57

A Okay.

Q At the bottom, before we get to "type 65c," what does it say about what the metal M is in 65?

A It says "Wherein the metal M is a transition metal and preferably tungsten or molybdenum." 04:35:14

MS. HANSEN: Okay. I have no further questions at this time. 04:36:20

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

FURTHER EXAMINATION 04:36:20

BY MS. ZHONG:

Q Dr. Rand, can you please turn to page 10 -- internal page 10 of Exhibit 1005.

A Yes. I'm there. 04:36:31

Q Okay. Compound No. 1, the simplest form is R equals H all around, correct?

MS. HANSEN: Objection to form.

THE WITNESS: I don't know what you mean by "simplest." 04:36:47

Do you mean the lowest molecular weight?

BY MS. ZHONG:

Q Sure.

A Sure. If you mean the lowest molecular weight, then yes, with all around H, that would be 04:36:54 the lowest molecular weight version of cyclopentadienyl.

Q So when you refer to cyclopentadienyl, that would be the 5-membered ring with hydrogens in all five positions, correct? 04:37:15

A Correct.

Q What's the simplest form of a guanidinate?

MS. HANSEN: Objection to form.

THE WITNESS: Again, what do you mean by "simplest"? Do you mean the smallest molecular 04:37:59

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

weight? 04:38:02

BY MS. ZHONG:

Q Sure.

A Then that would be guanidine.

Q Guanidine. And that's a specific 04:38:08
compound, correct?

A Guanidine is a specific compound, yes.

Q What's the lowest molecular weight of
formamidinate?

A That would be formamidine. 04:38:31

Q What's the structure of Terpy?

A That's the Terpyridine; is that correct?

Q Correct.

A It's three pyridine rings where those are
linked together by carbon-carbon single bonds. 04:38:54

Q And is that a specific compound or class
of compound?

A It's a specific compound. If you're
asking if there are maybe more than one isomer,
there are. 04:39:21

Q In Werner, they cite many papers
discussing how certain complexes are made, correct?

MS. HANSEN: Objection. Beyond the scope.

BY MS. ZHONG:

Q Take a look at internal page 38, PDF 41. 04:39:49

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

A Okay. I'm at 38. 04:40:02

Q So do you see that in lines 25 through 35 they mention certain papers for making paddlewheel complexes?

A I do see that, yes. 04:40:18

Q Based on your experience, in those journals, do they have specific examples of metal complexes?

MS. HANSEN: Objection to form.

THE WITNESS: So I -- this is a little 04:40:32 outside my area. I'm not a synthetic chemist, and I've never published a paper in any of these journals. So it's a little hard for me to say what the standards are for publication in these journals.

BY MS. ZHONG: 04:40:48

Q Did you investigate whether they disclose specific compounds or classes of compounds?

MS. HANSEN: Objection to form.

THE WITNESS: I didn't investigate the nature of the compounds that were being explored in 04:41:00 those series of papers -- one, two, three -- five of them, I think, in that paragraph.

BY MS. ZHONG:

Q And do you see that there is synthesis of ligands and their precursors in Examples 1 through 6 04:41:35

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

on pages 39 through 45? 04:41:40

A Yes. Six examples over those pages you noted. Yes, I see them.

Q Okay. Are those specific compounds or classes of compounds? 04:42:14

A These are all specific compounds.

Q You did not review any of the papers cited by Werner on the synthesis of various ligands and the metal complexes, correct?

MS. HANSEN: Objection to form. 04:43:10

THE WITNESS: I've looked at various Cotton papers, if you're referring back to the paragraph on page 38, but I -- it's hard for me to tell you right now if I looked at or didn't look at any of these. Because I did review a few Cotton 04:43:31 papers.

BY MS. ZHONG:

Q Did those papers involve specific compounds or classes of compounds?

MS. HANSEN: Objection to form. 04:43:43

THE WITNESS: Without looking at them, you know, one by one, it's a little hard for me to say.

BY MS. ZHONG:

Q Have you ever collaborated with a chemist?

A Many times, yes. 04:44:05

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

Q When they -- do you know, when they publish -- do they publish in a journal -- a peer-reviewed journal, do you know whether they publish specific compounds or classes of compounds? 04:44:07

MS. HANSEN: Objection to form. Well beyond the scope of redirect. 04:44:19

THE WITNESS: I mean, I can't speak for them when they publish. I can only speak for when I publish with them.

BY MS. ZHONG: 04:44:35

Q Okay. When you publish with them --

A Okay.

Q -- do you discuss specific compounds?

A When I publish with them, we discuss and disclose specific compounds, yes. That's the way that we know that we can enable a reader to reproduce our experiments. 04:44:43

Q Do you know whether that's a typical way of publishing research results in peer-reviewed journals? 04:45:05

MS. HANSEN: Objection to form. Beyond the scope.

THE WITNESS: Again, I can't speak for others. But I would say, in general, you'd want to use -- you know, provide sufficient information such 04:45:16

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

that a reader can replicate your experiments. 04:45:21

BY MS. ZHONG:

Q Okay. Do you know how many specific compounds are disclosed in the references cited by Werner? 04:45:37

MS. HANSEN: Objection to form. Beyond the scope.

THE WITNESS: In Exhibit 1005?

BY MS. ZHONG:

Q Uh-huh. Correct. 04:45:43

A I don't know off the top of my head how many compounds are disclosed in the references.

Q Can you take a look at Exhibit -- the same exhibit, page 44?

A Internal page 44? 04:46:04

Q Correct.

A Okay. I'm there.

Q Is Example 4 hpp or something else?

A That's something else. That's not hpp.

Q Have you ever used any of these compounds for charge transfer? 04:46:19

MS. HANSEN: Objection to form.

THE WITNESS: Can you be a little more clear, like, and specific about which compounds? Because we've already established that I have used 04:46:35

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

W2(hpp)4. 04:46:39

BY MS. ZHONG:

Q Oh. Examples 4 to 6.

A No. I've never used any of those three.

Q Do you know what's their capability of 04:46:52
doping BPhen?

MS. HANSEN: Objection to form. Beyond the scope.

THE WITNESS: Given that Werner discloses BPhen as one of the matrix materials to be used with 04:47:34
one of these doping materials for the reductants, then, you know, I would have to imagine that there is some reasonable expectation for success mixing one of those three specific compounds with BPhen.

BY MS. ZHONG: 04:47:55

Q What's the conductivity?

MS. HANSEN: Objection to form. Beyond the scope.

THE WITNESS: That's a little challenging to assert. 04:48:07

BY MS. ZHONG:

Q What would be the conductivity compared to tungsten2(hpp)4 and BPhen?

MS. HANSEN: Objection to form. Beyond the scope. 04:48:18

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

THE WITNESS: Also challenging to know without conducting the experiment. 04:48:20

BY MS. ZHONG:

Q Do you expect it to be higher or lower?

MS. HANSEN: Objection. Beyond the scope. 04:48:30

THE WITNESS: I really can't say.

BY MS. ZHONG:

Q Okay. Do you know what the lifetime will be if you try to build an organic electronic device using Exhibit -- using compounds in Examples 4 to 6 and BPhen? 04:48:46

MS. HANSEN: Objection to form. Beyond the scope.

THE WITNESS: It would be challenging to know that without providing a lot more information, like the type of OLED, the thickness, the layer, the driving voltage current, brightness, etc. There's so many temperature ambient condition. I can't -- there's no way I can say. 04:49:00

BY MS. ZHONG: 04:50:03

Q Now, for the 64 compounds that we discussed earlier, of them, the lowest molecular weight species will be the ones where the R is hydrogen; is that correct?

MS. HANSEN: Objection to form. 04:50:27

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

THE WITNESS: The 64 classes of compound, assuming R is an option to be able to be used in all of the R positions, then yes, given that hydrogen is the lightest element on the periodic table, using all of -- filling all of those R positions with hydrogen would yield the lowest molecular weight compound of each of those classes. 04:50:29 04:50:47

BY MS. ZHONG:

Q Would those 64 specific compounds be known to a POSITA? 04:51:02

MS. HANSEN: Objection to form. Beyond the scope.

THE WITNESS: Again, these are classes of compounds, not specific compounds. But it's -- as long as a POSITA had this document, which I think we've made the assumption that that person does, then it would be known to them. 04:51:12

BY MS. ZHONG:

Q So they would know at least 64 ligands, correct? 04:51:35

MS. HANSEN: Objection to form.

THE WITNESS: They would know at least 64 classes of compounds that could be used as ligands in these metal complexes.

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Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

BY MS. ZHONG: 04:51:47

Q And for each class of ligand, the simplest one will be the compound without substitution, correct?

MS. HANSEN: Objection to form. Asked and 04:52:04
answered. Mischaracterizes his testimony.

THE WITNESS: By "without substitution," you mean with hydrogen?

BY MS. ZHONG:

Q Correct. 04:52:12

A Then yes.

MS. ZHONG: Okay. I don't have any further questions. Thank you very much, Dr. Rand.

MS. HANSEN: Thank you, Dr. Rand, for your time. We can go off the record. 04:52:21

THE VIDEOGRAPHER: This completes today's deposition. We are going off the record. The time is 4:52 p.m.

(TIME NOTED: 4:52 P.M.)

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

DECLARATION UNDER PENALTY OF PERJURY

I, BARRY P. RAND, Ph.D., the witness herein, declare under penalty of perjury that I have read the foregoing in its entirety; and that the testimony contained therein, as corrected by me, is a true and accurate transcription of my testimony elicited at said time and place.

Executed this _____ day of _____ 2025, at _____, _____.

(City) (State)

_____

BARRY P. RAND, Ph.D.

JOB NO. 7557870

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

REPORTER'S CERTIFICATION

I, Leslie Johnson, a Certified Shorthand Reporter of the State of California, do hereby certify:

That the foregoing proceedings were taken before me at the time and place herein set forth; that any witnesses in the foregoing proceedings, prior to testifying, were administered an oath; that a record of the proceedings was made by me using machine shorthand which was thereafter transcribed under my direction; that the foregoing transcript is a true record of the testimony given.

Further, that if the foregoing pertains to the original transcript of a deposition in a Federal Case, before completion of the proceedings, review of the transcript [xx] was [ ] was not requested.

I further certify I am neither financially interested in the action nor a relative or employee of any attorney or any party to this action.

IN WITNESS WHEREOF, I have this date subscribed my name.

Dated: August 31, 2025



LESLIE JOHNSON

CSR No. 11451, RPR, CCRR

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

ALEXA R. HANSEN

ahansen@cov.com

September 2, 2025

RE: Samsung Display Co., LTD. v. Pictiva Displays International

8/26/2025, Barry P. Rand , Ph.D., (#7557870).

The above-referenced transcript has been completed by Veritext Legal Solutions and review of the transcript is being handled as follows:

__ Per CA State Code (CCP 2025.520 (a)-(e)) – Contact Veritext to schedule a time to review the original transcript at a Veritext office.

_XX_ Per CA State Code (CCP 2025.520 (a)-(e)) – Locked .PDF Transcript - The witness should review the transcript and make any necessary corrections on the errata pages included below, notating the page and line number of the corrections. The witness should then sign and date the errata and penalty of perjury pages and return the completed pages to all appearing counsel within the period of time determined at the deposition or provided by the Code of Civil Procedure. Contact Veritext when the sealed original is required.

__ Waiving the CA Code of Civil Procedure per Stipulation of Counsel - Original transcript to be released for signature as determined at the deposition.

__ Signature Waived – Reading & Signature was waived at the time of the deposition.

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

__ Federal R&S Requested (FRCP 30(e)(1)(B)) – Locked .PDF Transcript - The witness should review the transcript and make any necessary corrections on the errata pages included below, notating the page and line number of the corrections. The witness should then sign and date the errata and penalty of perjury pages and return the completed pages to all appearing counsel within the period of time determined at the deposition or provided by the Federal Rules.

__ Federal R&S Not Requested - Reading & Signature was not requested before the completion of the deposition.

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

Samsung Display Co., LTD. v. Pictiva Displays International LTD.

Barry P. Rand , Ph.D. (#7557870)

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(Barry P. Rand , Ph.D.) Date

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

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& 3:4,11 6:6,8 229:24 230:9

0

0 195:18
0.2 178:16 181:5
0.5 178:15 180:8 181:2,4
094506-3 38:18

1

1 1:19,24 2:18 4:4 5:14 10:8 10:17 11:8,21 19:21,22 31:20 32:1,6,10,10 33:1,2 34:4 35:10 36:16 51:14 52:2,6,8 52:12 53:2 54:10,11,21 55:2,3,5,8,10 56:7 69:20,21 69:22,25 70:2 70:6 75:6 84:5 101:20 103:2 103:20 128:11 128:18 132:23 164:13,13,14 164:15 165:2,6 165:7,7,7,8 166:9,10 167:16 206:24 209:4 212:2,4 212:5,7 217:6 219:25 230:1
1's 10:12
1,000 57:19 58:15,24
1.9 135:8
1/2 195:24 196:3
10 39:10 52:5 53:1,4,16,18 54:4,11,11,21 54:21 55:2,2,6 55:9,13,14,25 61:10 109:4 117:15 128:11 128:18 129:5 141:24,24 148:16,22 178:11,12 200:3 207:17 208:18,21 209:2,5 211:24 212:2,2,10 217:4,4
100 30:11 33:12 34:1 93:18 168:11 192:8 209:25
1001 7:23
1003 4:12 7:8 7:11 11:11 83:23 85:11
1004 36:9
1005 4:12 14:6 14:17,25 84:3 127:23 128:1 136:15 211:20 217:4 222:8
1007 4:13 25:3
1015 4:13 84:3
1020 4:14 7:8 7:12,12 162:24
1021 4:14 62:12 63:10 70:23 71:4,9 156:12,19
1022 4:15 183:19,22 184:6 199:19
1026 4:15 172:20
103 154:18
1034 4:16 37:19,22 38:4 38:12 65:15,22 65:23,25 66:2 66:2,3 67:11
10:34 61:15
10:44 61:18
11 63:22 81:13 90:5,6,7 91:13 142:2 143:9 162:5 212:16
11451 1:22 2:22 6:15 228:25
115 4:17
12 154:21,24
12:16 115:14
13 4:18 141:25 153:25 156:15 156:24 211:24 214:5,7
14 4:12 84:5
15 59:10 64:11 64:16 65:7 93:8 199:18 216:2
150 187:9,10
153 4:20
16 64:15 118:17 119:2,5 120:7 121:9,10 121:18,22,23 122:2 143:10 154:21,24 208:23 209:3,5 212:16 214:6 216:15
161 4:17
164 71:18
17 39:12,24 121:14,18,19 121:20,22,24 122:1,2 143:17 213:1 214:5,5
172 4:15
18 143:16 212:21
1800 3:6
182 4:16
183 4:15
19 64:11,15,16 65:7 93:8

142:23 143:24 213:5
1:00 115:17
1:1 180:19,20
1d 208:7,16,17 208:17,20 209:2,13 210:4 210:6,16 211:3
1e 208:13
1st 187:13

2

2 13:16,18 15:18 18:15,20 25:5,7 30:10 31:23 32:1,11 32:15 33:2,7 33:10,23 34:4 42:8,12 43:17 44:6 46:14 52:2,4 53:3,12 53:13,16,18 54:4,8,24 56:8 69:20 70:1,2,7 76:1 83:25 86:1,10,15,23 103:16 106:3,6 106:9,11 107:1 107:9 108:14 108:24 109:12 109:14 110:17 116:1,11,13,22 116:23 118:3 124:11 127:1 133:12,20 134:7 135:11 135:16 165:7,7 165:8 167:17 179:4,6,11,15 180:12,23,25 184:16 195:24 196:3 199:21 206:24 207:10 229:3
2,000 59:8
2.5 64:5,21 65:5,9,13 67:21
2.5. 64:20
20 39:10,24 58:18 59:5 61:4 169:7 188:20 214:8
200 117:14 203:20
2006 38:16
2008 4:16 51:9 60:7 182:20,25 183:5 184:23 184:25 185:8 185:15 186:3,9 186:23 187:13 188:17,17,20 188:22 189:5 189:19 190:8
2009 4:17 51:10 60:7 115:19,21 184:23,25 185:3,5,8,15 186:3 201:3,7
200c 207:14,15
2010 17:16
2012 183:24 184:20,21
2013 17:17
2018 184:22 186:13
2024 191:1,3
2025 1:18 2:20 5:1,5 227:9 228:22 229:3
2025.520 229:9 229:12
203-7183 3:8
2041 4:17 161:19,24
2044 4:18 13:7 13:8,11 14:1 14:12,25 18:10 42:1 57:6 64:10,12 93:4 103:12 105:12 105:16 106:1,3 149:8,11 197:20,22,25 198:14 199:3 200:5,24 201:1 201:13,15 208:2 211:4,6
2044's 19:25
2051 4:18 71:12,13,15,20
2052 4:19 71:13
21 214:18
2105 4:19 63:21,23 64:1
2106 4:20 153:24 154:2 154:15
211 4:7
217 4:6
22 105:14
220 117:17
223 7:23 8:7 10:8,11,18 11:3,9 12:13 12:23 62:25 63:16 71:17 74:18,19,22 75:2,6,7,21 77:4,5,8,13 81:8,9,12,19,22 82:3 84:6,9,13 86:4,6,11,15 87:14 88:3 90:1,17 91:1,9 91:23 92:15 95:3,8,10 158:4 160:8 184:19 196:25
23 143:7 212:14,15,17 215:1
230 117:14
231 1:24
233 17:1
24 143:16 212:20

241 161:21
25 4:13 25:23 58:19 143:17 212:15,25 215:20 219:2
250 117:17,18
26 1:18 2:20 5:1,5 128:17 129:9 143:7
27 64:22,25 65:1 135:18
270 69:1
27a 143:25 213:5
28 142:16,17 143:24 213:4
280 117:18
28a 143:25 213:6
29 184:21 186:9 189:5
2:35 171:17
2:49 171:20

3

3 18:14 57:5,7 57:8 58:2 59:4 59:5 127:25 128:6 129:9 133:13 165:7,7 165:8 195:20 195:24 196:3 208:2,12
3,500 59:13
3.2 121:4
3.6 39:10 65:4 93:16 200:23 201:5,10,12
3.6. 64:18 201:1
30 230:1
31 11:16 18:22 142:17 228:22
310 3:8
33 11:16 30:4 144:6 177:4 213:9
34 144:13 213:17
35 213:10,13 219:2
36 141:18 144:7,20 213:13,22
37 4:16 143:24 213:5
38 144:7 213:10 218:25 219:1 220:13
39 141:18 144:20 207:12 213:23 220:1

4

4 15:18 17:3,10 38:17 42:23 47:3,25 48:10 48:12 50:8,13 50:19,23 52:1 52:4,4,5,7,8,9 52:16,17,20,25 53:3,4,18,25 54:3 55:9,9,13 55:13 63:18 64:11 65:3 68:4,22 69:19 84:5 91:11 93:6,8,10,23 94:1,11 107:2 116:16,24 117:14,15 118:4,9 120:13 120:21 122:5,6 122:12,12 123:18 124:11 124:12 126:20 126:21 127:1,5 127:6,12 130:2 130:4,6,7,9 131:7 132:11 132:14 133:7,9 133:16,18 135:4,11,11 137:9,11,14,21 137:23 149:7 149:15,16,20 150:9,18,21 151:7,9,22 181:21,24 182:5,8,14,17 183:8,15 184:7 184:16 194:12 194:19,22 195:9 196:18 196:24 197:12 197:17 198:2 199:13,21 200:7 201:4,9 208:17,18,22 209:6,6 222:18 223:1,3,23 224:10
40 207:12
41 218:25
415 3:15,17
44 137:4 222:14,15
45 66:17 137:20,23 220:1
452 71:20,21
453 71:20,21 72:21
45a 213:18
46 144:8 213:10
46a 213:18
47 137:2,4 144:14 163:4 213:17
48 85:10,12
4:01 207:21
4:13 207:24
4:20 211:14
4:52 2:20 226:18,19
4e 55:6,25

5

5 16:25 25:22 25:22 27:16,17 27:22,24 28:15

28:23,23 29:10 35:24 42:24 52:7,19 53:16 53:24 54:4 55:8 60:12,21 101:23,24 102:9,11 127:5 127:6 137:7,9 140:10 142:8 178:12 179:10 180:11,14,18 180:23 181:19 217:19
5.5 121:4
50 59:3 163:4
500 147:25
501 14:12 64:11
514 127:3,4
5400 3:15
541 13:13,14 14:16 36:4,7,8 36:12 42:5 45:15 51:13 54:2 65:2,7,12 67:23 69:17 93:8 104:8 105:15,16 127:3 149:11 149:12,17 197:22 200:3,5 201:15
56 144:14 213:17
57 144:21 213:23
576 147:19,19 147:25
591-6000 3:17
5th 39:11

6

6 4:6 12:2,13 12:22 53:17,18 54:5 84:5 137:16,20,22 156:14,18,19 156:20,21 219:25 223:3 224:10
6,000 58:16 59:18
60 43:20 145:23 146:2 147:2
600 147:25
62 4:14 127:25 128:3,4 133:13 201:14
63 4:19 43:18 145:23
64 141:4,21,22 144:21 145:5,9 147:3,17,23,24 213:23 224:21 225:1,9,19,22
65 127:24 128:3 216:19
65b 216:3,8,12
65c 216:18
6637 228:24
67 201:14

7

7 4:12,14 52:6 53:4 55:14,25 57:6 120:25 128:11,19 129:5 178:11
70 11:15 134:9
71 4:18,19 11:11,16
73 11:11,16
7557870 1:23 227:23 229:5 231:2

8

8 59:15 84:5 201:14,17,18 207:12
8,558,223 1:11 2:11
8/26/2025 229:5
810 188:4
811 25:6
814 188:4
84 4:13
89 162:5,7

9

9 53:1,11 55:7 55:9,13 57:25 58:1 147:24 184:20
900 3:6
90067-4276 3:7
94105-2533 3:16
9:00 2:19 5:2,5

a

a.m. 2:19 5:2,5 61:15,18
ab 164:16,16 164:16,16
ability 29:17 76:8 77:3,10 77:22 106:18 112:22 124:13 126:11 159:8 174:7 179:10 183:17 188:1
able 50:16 69:6 69:7 71:10 77:19 110:8,10 153:4 155:24 156:2 166:17 170:21 174:3 189:3,14 190:4 198:20 199:4 203:17 225:2
above 25:10,11 120:25 191:15 229:6
absolute 27:14 28:13 50:11 68:12 166:5,8
absolutely 20:4 22:7 26:8 27:3 52:10 107:17

134:10 145:20 189:17
absorb 35:2,4 156:2
absorbed 163:24
absorbers 35:3
absorption 38:25 46:2
acac 138:9
accepted 74:5 74:22 93:21
accepting 46:23
acceptor 182:7
access 7:10 37:20,24 38:2 38:4 41:7
accuracy 54:18 55:22
accurate 20:17 179:19 180:5 227:6
accurately 24:16,17 54:17 111:9
acetonitrile 68:14
acetonitriles 69:11
achieve 35:13 210:7
acronym 98:21
action 5:24 228:18,19
activated 134:12,20 204:14
activation 135:15,21 136:2,6
active 25:14,17 25:18 179:24
actually 41:18 52:8 64:15 71:13 134:8,24 143:6 161:24 187:5,8
add 29:5 96:11 96:13
added 28:18
additional 47:6 47:8 51:1,3,5 142:19 143:4 143:10
adhesion 110:2 110:20
administer 6:12
administered 6:18 228:8
admit 20:8
adopted 11:2
advance 8:10 8:23 9:13
advocate 95:14
affiliated 194:18
affiliations 6:4
affinity 69:14 95:19 96:17 100:5,7 101:3 101:7 102:3,24
agents 137:1
aggregate 81:2
ago 13:4 133:14 169:8 199:19
agree 5:12 72:17,22,23 73:5,12 74:2,9
ahansen 3:18 229:2
ahead 76:21 198:7
air 97:23,25 119:12,13,15 119:18,21,23 120:1
akin 23:12,20 27:9 88:4,15
alarm 60:16
alexa 3:12 6:8 169:23 229:1
alignment 160:15
alleged 84:8
allow 170:23 194:10
allows 75:9,18 95:11 114:17 174:16 184:12
alq 36:15,16 181:13
alq3 55:3 104:2 104:6,13
altered 160:5
altering 29:21
aluminum 25:21 28:1,7,8 29:18 104:10 104:14 108:8 151:24 152:7 166:3,6,9
amazements 166:8
ambient 224:18
ambiguous 183:12
amorphous 36:22 40:10 41:4,13,19,19 41:25 100:12 111:8,12 114:4 115:7 133:25 134:4
amount 27:8 35:5 41:8 47:2 48:9 50:19 60:17 105:2
analogy 165:22
analysis 89:20 148:7 183:18 184:12
analyze 10:14 10:25 12:17
analyzed 10:9 12:10

ancillary 40:12
andrea 14:19 15:5,6,13,14
anecdotal 186:25 187:3
angeles 3:7
angstroms 178:16 179:4,6 179:11,15 180:8,12,14,18 180:23,23,25 181:5,19
anion 125:3,3 140:3,4,9,10
anions 143:14
anita 6:6
annita 3:5
annoying 37:11
anode 26:7 30:8 107:12,14 107:16,19,22 108:2,4,14,21
ansgar 15:5,5
answer 9:9 44:17 45:17,17 45:22,24 60:18 74:8 75:17 76:17 100:14 120:15 121:24 149:5 154:20 155:5,8,12,15 159:9 160:24 162:12,14 164:1 169:14 178:23 199:4
answered 149:10 226:6
answers 56:16 210:20
anticipate 133:20
anyways 125:13
apart 150:5
apl 183:24
apparently 96:12 206:12
appeal 1:2 2:2 5:19
appear 153:3
appearance 6:2
appearances 3:1 6:4
appeared 187:3
appearing 69:6 229:18 230:7
appears 211:6
apples 67:14,14 95:16,17
application 60:4,8,10,11,15 60:20 84:25 146:2,19 149:22
applications 112:16 150:10
applied 28:6 38:16 83:17 85:3,17 107:3 108:22
apply 47:16 83:3 84:15 101:14,15
applying 20:24 24:1 109:2
appreciable 110:11
approach 83:25 84:11 85:19 90:2
approached 11:1 84:10 90:14
approaching 45:12
approximately 32:1 33:3,7,16 64:20 65:5 179:2,3,4,6,8 179:14 201:3 201:10 209:25
april 148:18 149:2 160:6
araneous 136:10,11
area 24:4,5,11 24:12,17 25:14 25:17,19 44:24 44:25 169:10 219:11
arguments 8:7 9:11
arizona 117:11
aromatic 10:22 11:6
arrangement 123:24
arsenide 166:3 166:4,10,11
art 84:7,7,13 92:14 170:9 171:6 189:13
article 68:11 69:1 185:16 186:14,17,23 187:22,25 189:4,14,14
articles 185:25 186:3 189:20
articulate 92:25
aside 134:19
asked 61:10 84:1,6 135:23 142:24 149:9 155:3,11 158:15 226:5
asking 25:9 42:10 74:7 77:8 87:13 123:13 135:21 148:21 170:25 171:1 212:1 218:19
aspect 48:15
aspects 62:24
assemble 124:14
assert 33:19 56:22 110:25

166:18 185:12 209:17 223:20
asserted 74:20
asserting 118:23 142:15
assertion 74:5 168:22,24
asserts 73:24
assess 28:17
assessment 8:7 72:13
assigned 101:20,23
assignee 14:13
associated 102:9
assume 30:2,3 32:6,9 50:13 52:9,9 62:11 93:19 122:11 137:17 170:7 203:8 209:4,11 210:8
assumed 21:7
assuming 21:8 28:7 31:25 48:17 192:8 225:2
assumption 21:10 28:9,25 29:3,16 194:5 210:9 225:16
asterisk 41:15 58:11 118:8
atmosphere 40:13
atom 10:19 11:4 70:7 73:21,25 74:10 74:17,21 75:3 75:8,18,21 76:1,7,23 77:2 77:9,21 78:4,9 79:14,19 80:6 89:22,23 90:23 91:4,18 104:14 126:11,22 147:22
atoms 79:23,24 82:12,15,17 86:12,13,20,21 88:7,9,16,18,20 88:22,23 89:1 89:2,5,23 92:5 92:9,22 146:14
atop 165:24 166:16
attached 153:9 161:10 187:5
attempt 199:6 199:9
attempted 189:15,19
attempting 60:25 69:11
attempts 96:12
attention 71:22 206:7,8 207:1
attorney 6:5 228:18
attributed 206:9
attributing 201:23 202:2
audio 5:11
august 1:18 2:20 5:1,5 186:9,13 188:17,20 189:5 228:22
authoritative 210:20
authors 118:14 118:15 183:12
availability 188:5
available 68:25 78:19 84:8 112:19,21 113:1,16 114:22 157:1 187:23,24 188:12,19 190:2,3
avenue 3:6
average 164:12 179:25 180:4
avoid 39:21
aware 105:12 105:17,21 122:8 173:12 186:21,25 187:7
axes 41:17

b

b 167:10,13,17 167:20,20 216:10 230:1
b2 1:11 2:11
back 19:1,1,5,5 19:24 21:6 45:4 58:8 61:17,20 66:17 90:4 109:5,8 115:16 120:15 143:7 171:19 179:25 182:12 206:7 207:23 214:4 220:12
background 49:6
bad 95:15
balq 36:16 55:4 104:6
balq2 104:2
band 134:24 135:1
bar 101:20,21 101:23 102:8 102:22 103:1
barry 1:16 2:18 4:4,10 5:15 6:17 7:2 227:3 227:17 229:5 231:2,24
base 44:25 46:15 178:11

based 14:14 26:24 27:1,16 110:24 111:3 171:3 207:6,7 219:6
basically 21:12 30:6 32:14,22 33:1 41:12 62:1 85:19 118:18 131:17 136:7,10 162:16
basis 46:23 54:18 64:4 69:9
bathocuproine 149:14
bathophenant... 12:5 90:18
bcp 16:22 17:4 17:10 27:19,19 27:23 28:15 35:24 36:1,18 36:21,24 37:5 37:6,8,15 38:24 39:7,12 40:16,20 66:9 113:14,15,18 113:19,24 114:3,13,14 115:2,5 129:20 149:13,21 150:17,20 151:10,11,18
beam 168:20
bearing 123:21 123:23
beginning 2:19 6:5
behalf 2:18 6:9
behave 51:2 109:11
behavior 103:12
belgium 17:6 17:25 20:10
belief 39:19
believe 13:16 52:7 64:25 72:9 93:7 107:15 129:1 140:14 142:23 143:3 149:12 153:25 166:21 166:25 190:9 197:10 199:17 199:20
believes 71:25
benefit 36:24 79:3,5,7
benzidine 140:3
best 54:19 98:12
bets 132:14
better 50:16 77:19 82:8 113:20 122:17 124:8 125:20 126:6 130:13 130:19,19 131:13 133:8 170:14 210:19
beyond 61:10 63:25 76:19 88:1 115:7 125:14,21 154:6,23 204:15 218:23 221:6,21 222:6 223:7,17,24 224:5,12 225:11
bias 28:4,5,6 107:18,19 108:5,7,22 109:2
big 49:4,9 124:16 125:8,9
bigger 127:9
binned 120:10
binning 105:4
bins 105:3,9
bit 18:17 37:10 49:19 117:16 126:21 152:7 169:6 179:20 192:17 216:6
board 1:2 2:2 5:19 9:4 76:20
boats 174:15
bolstered 44:24
boltzmann's 136:5
bomb 37:7
bond 10:22 11:7 76:5 82:7 82:15 86:12,19 87:3,5,19,22,24 88:4,5,7,14,15 88:23 89:5,10 89:14,15,18,22 138:11
bonded 80:11
bonding 87:9 87:11 90:9,10 92:6,10,22
bondings 90:10
bonds 80:13 81:20,21 82:12 85:25 138:16 218:15
boron 143:14
boryl 143:13
bother 65:8,11
bottom 20:20 38:20 128:5 216:14,17
bound 50:11,15
bphen 12:4 13:1,22,25 15:18 16:7,8 16:11,22 27:16 27:21,23,24 28:19 29:5 30:1,7 31:8,15 32:5 33:11,15 33:18 35:25 36:2,11,16,19

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

36:21,25 37:1 37:5,6,6,9,13 37:15 38:24 39:7,9 40:15 51:14 52:1,4 54:10 55:3,8 57:15,18 58:3 58:10,13,17,23 66:8 79:10,17 81:4 90:18 91:11 100:5 102:4,7,10,16 103:18,19 112:1,7,13,19 112:25 113:18 113:24 114:5 114:13,14 115:3 129:20 132:18,21,24 133:4 151:17 151:18 176:4 178:17 180:17 181:12 194:13 194:23 195:21 195:24 196:17 196:24 197:12 197:17 198:2 199:13 200:7 206:22 207:15 208:6,10,19,19 209:4,10 210:3 210:12,17 211:2 223:6,10 223:14,23 224:11

bphen's 101:2
bphens 54:6 100:22
break 56:24 57:3 61:11,12 61:22 115:10 171:14 207:17
bridging 215:19
brief 56:24 153:6
brightness 58:23 59:3,8 59:13,18 208:7 209:10,11 210:7 224:17
brightnesses 58:14 209:9,22
bring 211:20
broad 83:17 168:8,16,20
broader 155:12 155:16
broadly 169:14 169:15
brought 133:14
btb 172:1
build 224:9
bulk 20:22 21:7 21:9,14 26:15 28:22 30:4,6 31:8 33:11 34:18 36:1,10 106:12 128:23 129:2
bump 55:11
burden 210:15
burling 3:11 6:9

c

c 43:19,20 109:4 117:14 216:10,10
c60 39:1 122:4 122:11,20 123:19 126:25 126:25 127:9 127:13,15,18 127:21,22 128:14 129:21 131:7,7 132:7 132:8,22,25 133:3,6 134:16 164:5,6 181:20 182:6,8,14,17 183:8,15 184:7 184:15
ca 229:9,12,21
calculate 20:25 23:24 24:3 179:25
calculation 21:10 25:18 69:16 98:8
california 3:7 3:16 228:4
call 9:4 11:23 11:24 20:2 31:19 58:19 76:20 90:9,9 108:2,2
called 13:5 18:3 23:7 25:25 28:5 30:15 34:25 67:14 98:18 101:8 108:14 136:24 150:1 204:24
calls 7:17 8:2 8:12 9:1 12:1 159:4,14 160:1
camera 5:8
candela 57:19 57:20 59:1,8 59:13,18
candelas 58:14 58:16 209:25
candidate 142:12,20 143:5 144:14 144:14,17 145:4,9
candidates 143:25
capability 131:20 223:5
capable 79:10 122:20 133:18 133:21,21
capping 113:7
caption 118:10
captions 57:22 57:24
capture 156:1

capturing 118:20 155:25
carbon 10:22 10:22 11:7,7 76:5,5 82:7,7 138:11,11 140:10 216:10 218:15,15
carbonate 16:14 151:16 151:23
carboxylate 215:3
care 171:5
careful 37:12 37:12 44:15 148:6 205:2
carefully 199:24
carrier 22:25 107:4
carriers 107:6
carry 41:9
case 1:10 2:10 5:19 8:1 24:3 24:12 25:1,22 25:24 29:11,14 43:3 55:20 63:16 67:10 70:15,19 84:2 104:14 107:5 117:24 159:17 168:23 178:8 209:20 228:15
cases 24:16 123:10
categories 105:10
category 143:3
cathode 26:6 30:8 107:10,11 107:13,16,20 107:22 108:3,7 108:22
cathodes 108:15
cation 124:24 125:1,2 142:10
caution 8:14 157:16 170:8
cautious 45:12 103:5
ccp 229:9,12
ccrr 1:22 228:25
cell 35:1,6 150:1,2,7
cells 150:3
center 17:6,25 80:18 118:9
centimeter 39:11 52:6 53:1 54:5,12 56:1 128:12,19 129:6
central 10:19 11:4 73:18,20 73:25 74:10,17 74:21 75:3,21 76:1,7 77:2,9 77:21 78:4,9 174:14
centrally 75:13
certain 7:22 19:13,16 41:17 41:23 57:23 90:15 203:11 218:22 219:3
certainly 17:16 27:4 95:14 133:5,20 134:3 161:13 199:24
certainty 53:9
certification 228:1
certified 2:21 228:3
certify 228:4,17
cesium 16:13 16:13 151:14 151:16,16,23 151:23
cetera 192:19
chain 26:9,13 78:15 79:7 90:13
chains 75:11
challenged 7:16
challenging 28:12 40:5 50:10 58:8 60:17 111:7 165:12 205:20 205:21 209:16 223:19 224:1 224:14
chamber 168:4 168:5,12,14 170:12 176:3 177:21 178:4 191:9,18 192:22
chambers 168:24 170:19
chan 65:24 67:11
chance 133:8 156:5,9
chances 151:24
change 23:2,2 27:8 28:22 29:5,20 34:1 55:11 57:10,13 123:23 136:1,8 166:23 231:4,7 231:10,13,16 231:19
changed 96:24 180:1,2
changes 27:12 28:18 29:19,20 43:18,20 140:23
changing 44:2 45:2 149:2 160:3
characterizati... 45:13 163:17

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

charge 22:12 22:25 41:1,9 77:19 79:11,12 79:13 89:10 107:7 121:10 121:15 134:6 134:13 140:3,4 140:6,7,8 182:3,14 183:7 184:1,2,4,8,8 184:14 195:4,6 196:8 200:14 200:15,18 222:21
charged 134:20 134:24 142:9
charges 23:3
chart 58:21
chat 63:7 139:2
cheap 112:25
check 45:4 123:8
chemical 68:11 69:9,16 82:15 86:11,19 88:7
chemist 219:11 220:24
chemistry 88:12 96:13 105:4 138:10 183:1
choi 3:13 6:9
choose 113:16 113:18,19
chromium 116:25 117:1,6 123:4,21,21 124:9,10,11,17 124:22 125:19 126:3,22 127:1 130:4,14,20 131:14 132:1 132:11,15 135:11 136:21 145:19,24 146:7
chromium2 117:14 122:5 122:12 126:20 130:7 133:9,16 133:18
chunk 99:20
circuits 32:22
citations 117:10
cite 175:14 188:6 218:21
cited 62:16,18 62:19 64:5,21 65:17 161:11 188:1 220:7 222:4
citing 39:9,12
city 17:9 227:11
civil 229:19,21
claim 10:8,12 10:17 11:8,21 12:2,13,22 74:13 83:1,4 83:11 84:24 85:1,5 86:1,10 86:15,23 159:11,23
claimed 91:23 92:15
claiming 69:6
claims 7:16,22 19:20 63:16 84:5,17 85:19 85:23
clarification 32:21 169:24 170:2
clarity 172:16
class 138:25 139:18 140:21 145:13 212:6,7 212:23,24 213:2,3 214:12 214:14,23,25 215:4,6,8,10,15 215:17,22 218:16 226:2
classes 141:14 145:9 212:11 212:13,18,19 213:6,8,11,15 213:19,21 214:2,3 219:17 220:5,19 221:4 225:1,7,13,23
classified 144:25
clean 38:9
cleanest 165:21
clear 158:3 181:2 212:8 222:24
clearly 38:24 53:2 92:1
click 190:1
clock 60:16
close 16:22 177:8 186:11 195:11,18 197:15
closer 130:10 131:18
closing 161:20
cloud 194:18 194:20
clue 18:14
coaching 76:15
coax 114:20
cobalt 145:25 146:7
code 229:9,12 229:19,21
coefficient 110:2,19
coefficients 38:25
coffee 62:4
cold 114:15
collaborated 220:24
collaboration 17:7,9

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

collection 97:20
color 60:4,9
columbia 70:13
column 14:21 18:14 38:21,21 43:17 53:11 57:25 58:1 64:11,12 76:1 81:13 90:5,6,7 91:13 93:8 116:3 136:21 201:14,17,18 207:12
combination 44:1 78:17 79:9,17,22 81:17 82:4 92:13 147:17 183:15
combinations 8:11,24 9:14 9:17,19 10:3,6 147:5,7,9,20 199:17,21
combined 149:6,7,15,16
combines 182:17
combining 10:2 199:13
come 40:7 66:12 78:21,23 79:12,13 80:4 101:13 178:22 189:21
comes 39:16 76:12 79:16 201:2
coming 79:19 79:22 187:14 187:18
comment 159:8
commercializ... 60:25
commercially 112:19,21 113:16
common 14:18 14:22 101:7 103:24 138:10 138:22 139:4,7 139:13 170:11
commonly 12:7 98:10 108:3 139:23
communicati... 157:18 183:2
community 98:11
companies 60:24 170:18
company 5:16 14:14
comparative 52:2,3 53:3 54:8,24 56:7
compare 96:9 109:14,16 165:3 210:18
compared 21:14 26:15 32:15 38:25 49:2 81:17 96:6,14 97:21 122:5 124:11 125:9 129:22 148:18 203:12 208:7 223:22
comparing 97:2 208:12 209:7
comparison 37:4 47:19 67:14,16 69:10 98:12,16 205:2
comparisons 69:7
complete 132:15 182:1 182:13 184:14 208:9
completed 229:7,17 230:6
completes 226:16
completion 228:15 230:10
complex 10:3 10:18 11:4 17:2 73:25 74:21,23 75:8 75:9 76:2,8 77:10,14,15,15 77:17,22,23 78:5,6,14 81:11,15 82:4 86:24 90:12,23 91:1,5,12,19,22 92:13 104:10 104:18,20,23 105:1 118:16 119:4 120:14 120:17 121:6 121:11,16,21 123:6,22,23 127:8 131:9,10 131:12,14,25 132:1,1,5 137:21 141:5 146:16
complexation 144:1
complexes 16:5 16:19,21 70:4 74:14 116:16 116:24 118:4 119:3,6 120:9 120:12,13 136:14,17,19 139:8 142:4,21 143:11 144:9 144:15,22 145:6 146:18 147:18 184:16 202:9 218:22 219:4,8 220:9 225:24
component 11:5 27:10

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

82:8
components
150:13 191:7
composed
48:16 108:23
138:11 194:8
composition
168:1
compositions
211:9
compound
10:20,20,21,22
11:5,7 12:5,6
12:25 15:22
16:25 42:23
44:9 47:7
53:16 58:12,18
73:19 75:10
76:3 77:16,17
78:2,6,10,15
81:11,15 82:5
86:25 89:24
90:13 91:2,5
91:12,19,23
92:14 94:4
104:11,17,21
107:1,2 112:20
112:21,23
113:3,18
118:12 119:7
119:15,19
120:3,8,11
121:12,16,21
124:15 139:8
139:23 141:21
141:22 142:8
143:9,16,17
149:14 150:17
200:16,19
203:18 204:16
204:19,21,22
205:8 212:5,21
212:22 213:1,1
214:12,14,23
215:4,8,15,22
215:24,25
216:2 217:6
218:6,7,16,17
218:18 225:1,7
226:3
compounds
10:4,7,9,14,24
11:20,23,25
12:1,3,9,12,22
13:4,8 40:9
42:3,21 43:8
43:13 50:19
51:13 69:2,24
70:3,6 75:22
91:10 103:11
104:24 109:10
112:2 116:17
117:19 118:6
118:24 130:20
130:25 131:3
131:13,24
136:23 139:18
140:21 141:10
141:14 142:2,7
142:19 143:9
143:24 144:7
144:13,14,20
145:3 148:3
149:8,17
152:13 178:15
194:8,11 197:3
201:24 212:6,7
212:9,10,11,13
212:16,17,18
212:19,23,24
213:2,3,5,6,7,8
213:10,11,12
213:15,17,18
213:19,20,21
213:23 214:1,2
214:3,13,15,24
214:25 215:5,6
215:9,10,16,17
215:23 219:17
219:17,20
220:4,5,6,19,19
221:4,4,13,15
222:4,12,20,24
223:14 224:10
224:21 225:9
225:14,14,23
comprehensive
161:14
comprised 50:6
194:17
comprises
10:20
comprising
10:19 11:4
computer
189:5
concentration
43:4,10 44:1
55:11
concentrations
53:20,23
concept 165:23
concerned
97:24
conclude
192:23
concluded
160:19
conclusion 7:18
8:3,13 9:2
44:11 73:9
159:4,15 160:2
184:12
conclusions
160:4
condense 43:23
204:8
condition
114:17 131:14
175:16 224:18
conditions
109:12 115:5,8
175:22,24
197:20 204:23
211:5
conduct 23:18
45:1 77:19
97:17 98:7
199:16 207:1

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

conducted 5:7 5:20 40:1 46:1 46:11 52:23 56:3 67:15 97:12,14 110:1 199:20
conducting 81:13 91:14 98:14 108:4 193:2 224:2
conduction 78:19
conductive 17:11 35:2 133:17,19
conductivities 40:25
conductivity 17:12,19 18:11 18:13,19 19:25 20:10,18,22 21:1,5,7,11,25 22:14 23:2,12 23:20 24:21 27:3,14,15 28:13,22 29:21 30:9 32:17 33:6,7,9,11 34:2,14,17 35:15,20 36:11 36:24 40:23 42:3,13 43:2,2 47:16,21 50:17 51:25 52:5,25 53:12,13,15,17 53:25 54:5,7,9 54:16,21,25 55:6,12 81:12 81:16 82:9 91:14 92:16 109:8 123:20 124:1 127:15 127:18 128:11 128:15,18,22 128:23 129:2,4 129:11,17,22 129:24 134:7 134:21 135:3 135:12,16,22 136:8 196:25 198:23 210:4 210:13 211:2,3 223:16,22
conductor 127:21
confidence 29:8,16 118:23 168:11
confidential 1:13 72:1 154:9
configuration 173:6,13,19,22 174:7 176:2 177:14 179:12
configured 194:9
confuse 21:16
confused 30:25 107:24 193:17
confusing 30:16
confusion 108:9
conjugated 10:21 11:6
connected 76:5 82:7 204:6
connection 5:9
connectivity 17:24 134:16
connects 26:9
consider 12:21 84:1,7,12 93:1 94:24 105:20 106:16 110:1 132:18 155:18 164:7 169:18 169:20 170:3 171:1 196:3
consideration 82:11
considerations 48:21
considered 62:24 67:17 81:25 84:24 129:4 192:1,9 192:13 197:8
consisted 18:2
consistency 160:7
consistent 9:11 29:14 83:18
constant 29:5 29:24 49:7 136:4,5,5
constantly 109:6
constituent 191:24
constituents 13:23
constitute 106:17
constitutes 72:9,17,23 73:6,12,16 158:9
construct 23:19
construction 83:1,4,11 159:12
consulting 61:5
contact 20:14 20:16 21:3,13 22:16 23:6,7 28:2,10 34:18 108:1,2,7 197:15 229:9 229:20
contacts 18:2,5 20:6,12,20 21:21 24:1,5,9 24:15 41:11 106:17,20 108:19 109:2
contain 13:23 70:7 75:18

79:23 119:15 149:13
contained 51:12 186:16 191:5 198:14 199:3 227:5
containing 12:2 82:5 136:18
contains 12:14 13:18 47:6 69:1 80:6 104:14
content 163:20 163:21 191:4,5
contents 157:17
context 34:11 34:23 35:8,19 71:10 73:2 74:18,19,22 75:2,7,20 77:5 77:8,13 81:8,9 81:19,22 82:20 84:13,21 86:10 95:3,8 98:24 149:25 151:17 153:3,6,20 155:25 156:2 159:17 160:23 202:8
continue 5:11 9:3
continuously 167:22
contribute 80:16
contributed 56:17
contributing 43:11
control 165:11
controlled 176:18
controlling 22:24
controls 37:12 37:13
convention 117:4
conventions 11:2
convert 95:25
convey 79:11
coordinate 81:7,7,10 89:10,14
coordinating 76:3 78:6
coordination 75:10,18,22 77:14,16 78:14 78:24 81:14,20 81:21 82:2 85:25 86:6,10 86:24 89:21 90:3,8,15 95:9 95:11,12 197:2
copies 58:5
copper 145:25 146:8
copy 38:9 186:4,24
core 12:8 43:14 44:19 46:18,19 47:1
correct 7:4,5,8 7:13 9:19,23 9:24 10:4 11:14,20,25 12:10 13:2,3,9 13:17,24 14:3 15:1,2,4,11 18:11,12 19:2 20:19 22:1,2 25:4 31:15 33:12 40:16 42:7,9,14 44:5 46:12 50:9 54:1 55:7,15 56:3 57:9,20 57:21 58:4 62:13 64:6,22 65:10 66:13,23 67:8,22 68:18 69:24 70:9,10 71:23 72:10,19 73:6 75:23 76:23 81:24 83:1,2,4,20 84:17 85:14 87:7 88:24 89:6,24 93:6 93:12,24,25 99:24 100:1,8 100:10 103:13 106:5,7,13 107:10,11 108:16,17 109:22 115:23 119:7,23 120:8 127:16 128:15 128:24 129:6 130:4,7,25 131:4,15 134:9 137:10,13 138:12,18 141:6 142:4,13 142:21 143:2 143:11,18 144:1,9,15,22 145:6,14 146:1 146:4,9,12,20 146:25 147:20 151:8 152:16 152:18,23 153:3,13,20,22 155:20 157:9 157:15 158:13 160:20 163:4 170:9 171:7,23 171:24 172:1,6 172:18,21 173:8,14,21 174:9,20 175:4 175:11 176:19 178:12 184:19 184:20 186:9 186:13,19,24

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

192:24 199:14 201:20 203:22 208:3 213:14 216:13 217:7 217:20,21 218:6,12,13,22 220:9 222:10 222:16 224:24 225:20 226:4 226:10
corrected 121:25 227:6
corrections 229:14,15 230:3,4
correctly 56:3 151:14
corresponding 45:8 64:18
cotton 115:21 182:17 183:1 201:1,6 220:12 220:15
cotton's 182:13
counsel 6:3,13 8:14,16,19 9:3 38:5 61:9,21 68:17 73:23 76:10,14,19 84:23 85:16 148:18 157:14 171:12 212:1 229:18,22 230:7
count 145:24
counter 107:7
couple 204:5
course 23:25 153:16
court 6:11 82:22 83:19 152:16 158:24 169:24 170:2
court's 82:25 83:3
cousin 16:22 139:11
cov.com 3:18 3:19 229:2
covalent 88:5 88:15,23 89:5 89:15,18
covington 3:11 6:8
cp 139:19 140:12,20,24
critical 76:2 78:5,7
cross 21:2 24:11,12
crucibles 174:15 193:7
crystal 41:3,7 41:16,17,22 100:12 111:10 111:21 166:5 176:21,22 177:6,12,23 179:23
crystalline 40:15,20,22,24 41:7,13 134:3 163:20 165:24 165:25
crystallization 37:2,7 110:3 110:21
crystallize 111:18 112:2 112:14 133:24
crystallizes 36:25
crystallograp... 41:23
csr 1:22 228:25
cupc 39:1
curiosity 152:8
current 20:25 21:2,2 23:11 23:19,25 24:2 24:3,7,9,10,18 24:22 25:18 27:8 28:4,25 29:9,12 33:22 35:9,13,18 54:16,19,20 106:18 210:9 210:17 224:17
curve 23:19 28:22 29:9,13 57:18 58:22 59:17
curves 28:23 29:15 57:15
customary 85:13,19,24 86:9 117:21
cv 45:18 96:5
cyclic 44:13,17 45:1,6,11 95:20,22 98:1 102:23 103:6,8 103:10,22,25 104:7
cycling 109:12
cyclopentadi... 139:19 217:17 217:18
cyclovoltam... 44:13

d

d 4:1 138:6 216:10
darn 182:6
data 43:25 45:13,20,22,25 46:11,14,24 54:2 55:17 57:11 96:14 116:11 160:14 210:10,18 211:1
database 185:17,18
date 184:18 190:3 228:20 229:16 230:5 231:24

dated 228:22
dative 81:20,21 85:25 87:3,5,9 87:10,19,22,24 88:4,14
day 58:19 189:22 227:9
days 37:8,8 40:19
decay 57:8,12
december 186:23 187:13 188:17,22
decide 189:25
declaration 7:5 7:6,11,12,14,15 7:20,20,25 8:5 8:5,24 9:10,12 9:14 10:10,14 10:25 11:1,13 11:18 62:10,15 62:20,20,23 64:22,23 70:9 76:11,11 83:12 83:23 84:3,11 84:12 87:8,9 87:14,15 88:3 89:12 91:8,8 93:2,2 148:20 156:6 159:6 161:2,11 162:14,25 171:22,23 172:11 175:14 175:18 177:1 178:25 186:9 186:18 187:9 190:18 227:1
declarations 7:3 11:2 82:1 92:1
declare 227:3
decompensat... 201:25 202:6
decompose 204:19
decomposing 204:21
decomposition 204:25 205:3 205:14,16,25 206:10
decrease 208:7
deep 37:16
deeper 117:1,2
define 24:9,17 24:18 84:18 98:21 129:18 165:25 179:5,5
defined 24:5,13 25:19 82:3 86:7 139:17,18 140:19,21,24 166:12
definitely 30:25 40:20 106:16
definition 25:17 82:21 83:17,18 88:13 106:19
degradation 110:12 209:15
degrade 210:16
degree 173:7 175:3 176:12 202:15
degrees 43:18 43:20 109:4 134:9 164:2 203:20
deja 148:17
delving 66:19
demand 133:24
density 23:19 23:25 24:3,7,9 24:18,22 25:18 28:4 35:9,18 41:4 44:8 47:2 47:10,14 48:16 49:13,17,20,22 49:25 50:5,18 69:8 132:6 134:6 182:8 194:18 200:22
depend 50:21
dependent 41:16 110:20
depends 5:8 22:20,22,23 23:9 24:24 40:18 45:19,19 45:25 59:23 94:20 95:1 100:11,16,18 111:24 112:19 113:25 114:21 132:4 147:10 177:20 196:7 202:14
deposit 174:1 176:4
deposited 20:6 20:7,11 114:4 115:7 164:4,11 166:20 177:25 180:8 193:3,4
depositing 114:12 167:9 177:13 194:10
deposition 1:15 2:17 5:6,15,20 70:17,22 71:8 76:13 152:22 153:13 154:1 156:15 157:24 158:11 159:6,7 162:15,20 164:8,8 165:15 168:5 170:12 170:15 172:17 173:13 175:21 176:17,18 178:9,14 179:1 179:24 180:10 180:16 181:6,8 181:18,19 203:2 226:17 228:14 229:19 229:23,25 230:8,10

depositions 163:8
derivative 13:21
derivatives 13:19,25 37:17 42:22 48:7 207:9
describe 19:23 25:8,14 119:10 121:10,15,20 171:25 193:5 195:3 198:5,10
described 19:21 33:21 128:14 172:13 216:12
describes 122:9 172:22 177:14 194:24 200:9
describing 25:25 30:14,15 89:9 116:8,10 116:14,21 120:19
description 58:6 98:25
design 60:21 168:4 170:19
designated 154:9
designed 107:4 168:13 191:25
designs 170:6
desirable 112:14
despite 34:1 46:25
detail 69:4 86:4
detailed 72:25
details 45:14 66:19 117:9 172:3
determination 158:4 199:6
determine 21:4 27:3 28:21 48:15,21 49:8 49:12 69:9 82:13 83:16 91:17 92:4,8 92:20 114:22 175:3,6 177:11 194:2 202:18 204:25
determined 44:13 48:10 50:24 85:22 92:12 103:22 110:5,6,25 229:18,23 230:7
determines 47:15 108:21 194:20 200:21 204:21
determining 35:15
developed 96:3
device 23:11,16 24:4,7,11,21,25 24:25 25:19 27:5,9,11 28:14,24 31:7 31:11,13,14 32:1,18,18 33:10 34:24 35:4,10 42:25 54:14 55:19,19 56:19,19 60:1 106:4,12,16,19 106:22,23,25 107:9 112:15 114:7,11 150:3 209:10 210:12 210:15,16,17 224:9
devices 25:8,12 25:14 26:25 27:2,18 58:17 59:22 112:9 209:16
devoted 211:7
dft 69:8
diagram 30:14
dial 125:24
dialing 66:16 204:18
diameter 125:10
diatomic 120:4
diatribe 210:22
dielectric 49:7
differed 66:9
difference 39:14 42:2 43:7 47:25 48:3,14 51:25 53:5 56:7,11 67:19 117:4 177:16
differences 43:21 53:10 66:16,19 160:13
different 10:3,6 10:7 18:1 25:15 28:21 29:15 40:7 42:21 43:14,15 43:15,17 47:11 47:14 50:18 52:21,23 53:2 53:19,22 55:17 56:18 58:7,13 66:20 67:12 74:7 89:14 90:10,11 96:5 96:10 97:3,20 110:2 116:24 117:13 126:18 134:13 136:16 140:22 141:4 147:23 158:23 159:24 160:10 163:12,13,14 165:5,8,11

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

166:7,19 167:1 167:24,25 170:18 177:24 180:7 181:16 191:9,18 192:4 193:10,13,15 209:18,19
differential 98:22 99:4
differently 144:25
difficult 43:12 132:13,19,24 133:3,4 148:14 167:5 195:1
diffraction 163:19
diffusivity 125:13,17,20 125:25 126:9
dimer 152:1
dinuclear 91:10 123:5 136:18
direct 47:19 57:23 65:19 77:6 164:1 185:17
direction 22:15 24:22,23 26:17 228:10
directions 41:20,23
directly 96:9 202:24
disadvantage 36:25
disagrees 73:15 160:19 161:3
disclose 84:4 219:16 221:15
disclosed 141:11 145:5 222:4,12
discloses 65:2 71:2 160:20 223:9
discoveries 105:22
discuss 13:7 221:13,14
discussed 11:19 12:25 19:18 66:2 120:10 143:23 157:23 162:16,21 163:9 171:22 172:10 208:2 224:22
discussing 65:15 119:3,5 126:13 218:22
discussion 65:21 106:15 153:6 163:3
discussions 153:3,20
disorder 166:16
disordered 41:5 111:16 163:21 166:13
display 1:4 2:4 5:16 209:24 229:4 231:1
displayed 29:9
displaying 27:17 33:15 116:23
displays 1:7 2:7 5:17 229:4 231:1
disrupt 124:12 127:8
distance 18:8 22:13 41:18 168:7,18 174:14 176:6 177:9 178:4
distances 41:12
distant 18:7
distinct 80:23 162:17 192:9
district 82:22 82:25 83:3,19 152:16 158:24
diverse 68:13
divide 24:4,11
divided 136:3
doctor 61:20 115:19
document 10:16 14:17 19:1,4,9,19 38:13,14 62:14 63:6,10,12 68:24 70:8,24 72:14 82:23 111:15 115:22 115:24 136:17 153:5,19 156:2 156:7,9,10 160:23 172:3 172:19 187:6 207:3 225:15
documents 15:10 63:14 65:17
doing 18:1 21:11 37:12 54:14 98:3 109:5 113:9 148:6 178:24 181:11 194:6 208:11
dominate 46:19
dominated 47:25
dominating 29:19,20 43:11
donate 78:9
donating 194:12
donation 77:7 94:15
dopant 50:23 52:14 64:17 135:9 152:1

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

[dopants - electron]

dopants 16:10 150:14 151:11 151:13,19,20
dope 16:7 32:5 52:25 122:22 135:4
doped 18:8 22:24 23:5,7 25:20 27:25 30:7 32:18 34:22 35:1 42:22 44:9 47:2,24 48:9 52:1 53:16 55:6,8 107:2 124:9 133:17 134:8,15,16 135:12 208:17 208:22 209:3,5 211:2,3
doping 22:24 29:24 30:4 32:9 47:24 53:19,22 55:11 55:22 105:24 105:24 122:4,9 122:10,17 123:17,19 124:2,3 133:15 191:6 223:6,11
double 65:20
doubly 142:9
dpv 98:18,19
dr 5:15 15:8 61:10 62:9 63:22 68:15 72:8,16 76:11 76:17 152:15 152:19,22 153:11,13,25 154:8 155:3,18 161:11,19 169:4,16,20 170:4 171:4,23 172:5 186:18 186:21 187:4,9 211:18 217:3 226:13,14
drafting 156:6
draw 71:22 184:12 206:7 207:1
dresden 17:8 17:19,21 34:24 105:22
driving 224:17
drop 32:6 35:7 35:11 210:5
dropped 33:17 35:13
drops 30:5,5
due 198:24

e

e 4:1 138:6,6 216:9,10 229:9 229:12 230:1 231:3,3,3
earlier 42:25 93:20 103:5 118:19 120:10 130:3 149:25 216:6 224:22
early 148:18 160:6
easier 23:7 27:5
easily 37:8 113:2
easy 113:1 122:21,22 132:9 134:22
effect 185:24
effective 133:16 185:24 196:4,8,10 197:3 198:15
effectively 33:1 36:21 122:25 196:19,23
effects 118:13 134:1
efficiency 50:23 122:9,10 122:17 124:2,3
efficient 122:5 123:14,17
eight 146:11
either 11:1 14:24 27:24 39:24 46:6 53:7 54:3 70:4 78:15 82:1,9 82:13 83:4 93:1,19,21 95:6 97:12,15 98:2,12 99:22 100:2 103:2 116:25 125:7 132:6 168:3 176:22 177:18 178:3 184:15 185:13,17 206:24 208:13
electric 39:10
electrical 44:22
electrochemi... 44:18 69:10
electrochemist 44:20,21
electrochemi... 44:17
electrode 25:21 98:2 103:25
electrodes 25:20
electrolyte 98:4 98:5
electromobili... 66:9
electron 17:11 23:10,16 24:20 25:8,9 27:18 28:8 31:11,13 33:10 34:22 39:9,14 40:8 40:14 43:3,4,9 43:10 44:1,2,8 46:18 47:2,10 47:12,14 48:16 49:13,22 50:5 50:14,18 58:12

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

69:14 77:7 80:25 81:12,13 81:16 82:8 89:4 91:13,14 92:5,9,16 94:15 95:19 96:17 100:5,7 101:3,7,17,20 102:3,23 105:24 107:5 122:22 123:8 129:15,19 132:5 135:19 151:11 182:8 194:18,19,22 194:25 195:2,5 195:15 198:1 200:21 208:12

electronegati... 117:4

electronic 27:10 37:18 82:8 105:25 112:8,15 114:6 114:11 122:21 150:13 191:7 202:16 209:15 224:9

electronically 80:23

electronics 80:15 105:19 169:11 190:10

electrons 28:7 29:3,17 47:22 47:23 48:9,22 76:9,23 77:3 77:11,18,23 78:7,10,19,21 79:8 80:3,7,12 80:19,20 88:5 88:16,18 92:21 101:12,15 107:7 125:11 131:19 152:9 194:12,21

element 225:4

elemental 124:22,23

elements 91:22

elicited 227:7

elsevier 185:8 185:10,13,16 189:21 190:11

emanating 193:7

embodiment 18:3

embodiments 90:16

emerges 101:16

emission 97:11 199:20

emit 106:23 107:3

emitted 107:6

emitter 209:21

emitting 208:25

employee 228:18

empty 194:17

enable 221:16

encouraged 27:11

enemy 134:25

energetic 49:5

energy 39:8 47:12,12,18 48:1,4,10,14 101:3,12,16,17 110:21 111:3 117:2,7 135:15 135:22 136:3,3 136:6 194:20 194:25 196:4 196:19 200:20

engineer 44:22

ensure 21:18 67:13 168:6,19 178:7

ensured 193:6 194:9

ensures 168:20

ensuring 20:14

entire 63:25 153:5

entirety 19:8 19:10,12 68:10 68:24 72:3,7 156:3 174:17 178:1 179:15 227:5

entropy 111:23

environment 43:22 97:21

eod 31:7,9,13

epitaxial 165:23 166:15

eps 96:17

eqe 210:8

equal 33:16

equally 123:17

equals 217:7

equation 136:10,11

equipment 40:12 170:15 170:16,19 172:23

equivalent 50:24

erms 140:23

erosion 127:13

errata 229:14 229:16 230:3,5

erroneous 46:8

error 101:19,21 101:23 102:8 102:19,22 103:1 179:5

especially 41:6 136:18,20,22 165:1 166:18

esq 3:5,12,13

essential 75:8

establish 7:16 69:12 96:3,7

96:15 97:9,23 101:7
established 42:25 98:13 222:25
estimate 27:15 68:1 69:12,18 69:18 93:10,15
estimated 64:19 65:5 67:21
et 192:19
eta.5 139:19
europe 17:6
ev 64:5,21 65:4 65:5,9,13 67:21 93:16 101:24 102:9 102:11 103:2 120:25 121:4,4 132:23 195:18 195:20,24 196:3 200:23 201:5,10,12
evaluate 35:11
evaluated 124:3
evaporate 114:16 174:4,5
evaporated 166:19 180:18 191:19 192:21 193:3,4 202:20 203:5
evaporates 202:13
evaporating 114:13 164:20 167:22
evaporation 15:20 71:6 158:11,11 167:21 168:4 191:11,18,20 192:2,5,10,13 192:24 193:11 193:22 202:12 202:18 203:20 203:23 204:16 205:23 206:2 207:13
evaporator 173:5,12,19,22 174:1 194:9
evenly 21:9 43:12
event 45:8,9
evidence 51:21 51:22 186:25 188:18,19,21 189:3,6,12
evidently 179:11
evolution 209:14
exacerbates 126:24
exact 20:9 35:3 40:11 45:7 66:18 99:8 165:11 166:4 172:24 180:4 181:25 185:19 207:11 209:8
exactly 10:7 42:11 47:17 56:6 67:15 99:2 125:24 136:11 164:1 165:3,25 167:3 167:4 179:15 181:15 182:3 187:14 195:13 206:16 210:22
examination 4:3 6:21 211:16 217:1
examined 6:18 46:10
example 47:7 52:2,3 53:3,13 54:8,24 55:24 56:8 64:22 71:2 106:3,6,9 106:11 107:1,9 108:14,24 109:12,14 128:6 129:9 133:12,13 134:7 135:16 137:7,9,16,20 137:22 146:19 164:4 165:15 165:20,21 177:21 188:4 199:19 222:18
examples 19:19 146:3 219:7,25 220:2 223:3 224:10
excerpt 70:18
exclude 119:16 120:23 121:5
exclusive 104:24
exclusively 49:5 57:12 118:12 124:4 140:10 202:4
excuse 42:23
executed 227:9
exercised 163:12
exhibit 7:8,8,12 7:22 11:11 13:7,8,11 14:1 14:6,17,25,25 18:10 19:24 25:3 36:9 37:19,22 38:1 38:4,11,12 42:1 57:6 62:12 63:10,21 63:22,23 64:1 64:10 65:15,22 65:23,25 66:3 67:11 70:23 71:4,9,12,13,13 71:15,20 75:5

75:6 83:23 85:11 93:4 103:12 105:12 106:1,3 115:19 127:23,25 133:13 136:15 137:15 149:8 149:11 153:9 153:12,24,25 154:15 156:12 156:15,19,24 161:15,17,19 161:24 162:24 172:20 182:18 182:20,25 183:5,19,21 184:6 194:4 197:20,25 198:14 199:3 199:19 200:3,5 200:24 201:3 201:13 208:2 211:4,6,20 217:4 222:8,13 222:14 224:10

exhibits 4:9 37:24 38:2 62:16,18,22 66:6 84:3 157:15,23 158:3 160:8 161:10,13 199:18

existed 91:24

exothermic 196:10

expand 80:13

expansion 110:3,19

expect 40:8,13 41:23 46:19 47:2 55:10 102:18 111:12 111:18,23 115:5 117:6 123:14,16 124:5,8 125:12 131:23 133:7 134:10 135:12 152:3,4 171:4 171:9 210:15 224:4

expectation 111:15 123:10 135:6 223:13

expected 117:3 117:18 135:3 152:8

experience 26:24 27:1 36:17 37:14,16 41:9 110:22 112:1 170:16 185:23 207:6,7 219:6

experiment 17:4 37:4 53:2 53:7 56:2 94:21 95:1 113:10 171:5 172:1 174:8,20 192:17 193:2 194:6 224:2

experimental 45:14 116:22 117:8 172:2

experiments 15:17 23:18 25:7 27:18 37:12 52:21 56:21 113:2,17 170:6 172:1,6 172:8,10,13 173:20 175:3 198:13 206:13 221:17 222:1

expert 70:18 71:15 74:14 75:20 158:22 158:23

expert's 158:9

experts 160:10

explain 9:20

explanation 43:5 56:10

explicitly 81:1 119:18

explored 219:20

exponential 136:2

exposed 115:4 191:4

express 206:15

expressed 127:14 203:25

expressing 129:1

expressly 136:15 148:3

extend 49:9

extensively 16:21

extent 71:3

extra 78:18

extract 54:20

extracting 43:1

extrapolated 201:11

eyes 174:24

f

f 216:10

f4tcnq 181:14

fabrication 52:24

face 43:25

fact 66:14 112:13

factor 30:5,10 33:10,17,23 110:7

factors 49:11 56:17,21 110:2

fail 89:11 152:8

failed 151:24 152:4

fall 46:6 105:3 143:3

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

[familiar - form]

familiar 169:3 169:15
familiarity 171:3
familiarized 58:21
fantastic 94:15
farther 41:18
favor 8:7 37:6
favored 112:7
fc 103:23,23
feature 79:3 134:12
features 134:23 166:20
february 184:21
federal 228:14 230:1,8,9
feed 189:23 190:5,15
feeds 190:12
feeling 207:14
ferrocene 103:23 140:15
ferrocenium 103:23
field 39:10 61:3 74:15 80:14 105:21
figure 27:16,17 28:23,23 29:10 57:5,7,8,22,24 58:2,7 59:4 116:11,13,22 116:23 118:3 208:2,12
filed 5:17 84:25
filled 58:11
filling 225:5
fills 174:17
film 18:9 20:22 22:18 24:13 26:3,5,7,16 30:1,2 31:8,15 31:20 33:11 34:5,18 37:4 40:19 41:19,19 41:25 48:16,25 50:5,6 97:17 99:20 106:5,12 106:18,21 108:25 111:8 111:16 113:4,6 113:20 114:1,2 114:20 115:2,2 115:3,5 124:9 126:24 128:24 129:25 133:19 133:25 163:10 163:15,20,22 178:7 179:18 198:2 208:10 209:15 211:8
films 22:4 38:24 39:1 40:10,22,24 111:12 176:4 190:11 199:16 208:6 211:5,7
final 187:22 188:2,7,8,10,10 188:14 211:8
finally 188:2
financially 5:24 228:17
find 27:7 57:22 68:8 113:11 173:8 189:4,20
finding 65:25
fine 38:6
finite 26:8,12
first 7:5,20 11:13 15:3,7 20:6,11 24:8 64:25 90:7 91:25 116:3 156:10 164:15 209:20 210:24
five 42:20 43:8 50:25 51:13 57:2 59:21,24 110:16 112:2 140:2,4 146:10 181:16 212:8 217:20 219:21
fixed 177:10
flag 45:10
flat 166:15
flow 203:4
flowing 21:3,8 27:9
flux 177:16 181:18 203:11 203:25 204:13 204:17 205:11
focus 19:13,16 19:17 57:15
focused 19:18 63:13
folder 189:24
followed 20:12 28:1 167:4
following 117:3 117:19 127:2,3
follows 6:19 229:8
footnote 119:2 119:5 120:7 121:8,9,10 162:5
foregoing 227:4 228:5,7 228:11,13
form 7:17 9:25 10:15 12:11,19 13:10 16:12 17:20 19:3 22:19 30:12 32:19 33:13 34:6,20 36:3 40:17 42:4,19 47:4 48:2,13 48:23 49:18 50:20 51:11 56:4,12 60:2 60:13 63:2,15 64:7 66:24 67:9 72:11,20 73:10,22 74:4

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

74:11 75:4,15
75:24 77:12
78:3,12,22
79:4,7,15,20
80:5,21 81:2
83:5,21 85:6
86:2,14,22
87:4,12,20
88:10,19,25
89:5,7,16,25
90:3,24 91:6
91:20 92:11,23
94:5,12,19
95:5,8 96:18
96:23 97:8
99:6,14,25
100:6,11,16,18
100:20 101:5
102:5,14
103:14 104:4
104:12,19,25
105:7 106:24
109:20 111:5
111:13,20
112:10,17
113:21 114:9
116:9,18 118:7
119:8,24
120:18 121:13
122:7,18
123:15 124:19
125:14,21
126:7,16
127:17 128:16
128:25 129:7
129:13 130:8
130:16,21
131:5,16 132:3
132:20 133:24
135:5,17 138:1
138:23 139:6
139:20 140:13
141:1,7 142:5
142:22 143:11
143:12,19
144:2,10,16,23
145:7,15
146:13,21
147:6,12,13,21
148:5,11 149:9
149:23 150:11
150:19 151:3
151:21 152:6
152:17,24
153:14,21
154:3 155:6,13
155:21 157:3
157:10,16,25
158:14 159:3
160:21 161:5
162:23 164:10
165:9,18 168:2
169:5,12
170:10 171:8
172:7 173:9,15
174:10,16,21
175:5 178:18
180:9 181:23
182:15 184:9
186:5 187:16
187:22 188:24
189:16 191:16
191:21 192:6
192:14,25
193:16 194:15
196:1,6,13,20
197:6,13,21
198:3,17,25
199:7,15 202:1
203:17 205:12
206:4 208:8
217:6,8,22,23
219:9,18
220:10,20
221:5,21 222:6
222:22 223:7
223:17,24
224:12,25
225:11,21
226:5
formamidinate 139:10 215:7 215:10 218:9
formamidine 218:10
formation 75:11 89:22
formed 82:7,15 172:4
forming 82:1 86:11 90:13 93:1 133:19 197:8
forms 88:23 92:6,10,22
forth 58:8 228:6
forward 108:5
found 62:24 190:23 207:3
four 29:14 64:13,14 78:17 78:24 79:25 80:1 146:10 156:1 170:17
fourth 59:17
framework 80:13
francisco 3:16
frcp 230:1
free 23:3 41:1 47:22,23 48:8 48:21 49:8 50:14 68:13 76:8,23 77:3,7 77:10,23 78:7 80:3,12 113:4 114:1 118:18 120:23,25 124:17,17 125:2,11 134:6
frequency 185:22
frequently 185:21
front 30:8
fu 63:1,5,8,17 64:1,4,20 67:21 68:1,4,5 68:20 96:12

full 18:18 62:14 63:3 71:9 73:2 81:2 85:21 116:3 160:22 183:7 184:1,8 184:13,14
fullerene 122:4 122:10,11 125:4,9 128:9 129:12 181:20 183:8 184:7
fullerenes 124:13
fully 24:18 132:6 153:4 159:9 187:24 195:6
function 124:5 136:2,8 152:9
functional 69:8
fundamental 136:4
further 183:18 205:14 216:23 217:1 226:13 228:13,17

g

gained 182:8
gaining 132:5
gallium 166:3,6 166:11
gap 48:1,4,10 196:4,19
gas 64:16 65:3 93:4,9,14,17 94:2,22,23 95:7,9,15,20,23 96:4 97:16,21 99:12,16,17,22 116:4,14,16 200:10,16,19 200:25 201:4,8 202:22,24
gaseous 99:19
gauge 98:6
general 11:22 29:10 45:23,24 221:24
generally 107:23 136:19 169:15 170:3 170:14
generic 216:7
gentleman 70:11
genus 216:11
geometry 25:25 26:1 42:25 170:20
german 171:23 194:4
germanium 166:4
germany 14:15 105:23
getting 23:24 98:24 101:17 117:20 132:6 148:17 205:19
give 7:9 10:11 18:14 27:13 28:13 29:7 43:5 45:21 50:11,15,25 51:3,6 82:19 100:13 116:19 133:10 144:24 148:9 163:25 172:24 199:4 207:10 208:6 210:19
given 28:20 52:21 74:12 102:8 112:2,13 132:21 133:18 223:9 225:3 228:12
gives 29:15 166:25
giving 47:18 110:24 161:14
glass 43:17 109:22 110:6,9 110:15,23
go 5:12 9:5 14:10 18:14 19:24 25:2,11 27:18 33:2,7 33:22 36:10 38:17 40:25 53:11 54:17 57:2,5 64:10 66:21 67:3,6 76:21 86:3 88:12 90:4 113:3 114:21 116:1 127:24 134:3,25 135:1 137:2 141:17 141:24 142:16 143:6 144:6 156:14 161:16 164:16 175:18 181:17 198:7 203:15 204:14 211:11,23 226:15
goal 35:6 94:21 94:22,23
goes 33:1,10 88:1 109:8 118:19 121:4 129:20 134:21 202:23
going 18:16 22:7 28:16 30:13 31:14,17 32:6 43:21 57:22 58:17 61:9,14 63:24 65:19 80:23 115:9,13,20 123:22,23 126:20 129:17 134:5 136:1 168:25 169:14 171:12,16 174:2,4,5 178:22 195:10

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

195:14 201:1 207:20 209:19 209:21 210:4 210:14 211:13 226:17
gold 151:24 152:8
good 5:4 6:14 6:23,24 28:8 36:19 41:8 81:12 91:13 92:16 115:10 134:18 152:10 168:17 169:18 169:20 170:4 171:13 178:6 182:7 203:5 205:24 206:1,1 206:2
grasping 24:19 195:7
great 9:5
ground 9:22
grounded 107:21
group 40:3 142:8 145:18 145:22 147:4 172:18
groups 12:6 16:23 37:1 212:8
grow 165:24
growth 165:23
guanidinate 138:21 139:5 217:22
guanidinates 214:19,21,22
guanidine 215:18,25 218:4,5,7
guarantees 27:6
guess 26:19,21 118:21 120:14 120:14 198:9 203:5 207:11
guest 23:1 50:8 127:2 179:18

h

h 3:5 143:2 217:7,15 231:3
half 33:3 115:10 119:13 148:25 171:13
hand 38:21
handled 119:11 229:8
hang 165:1 166:17,18
hang's 165:6
hansen 3:12 4:7 6:8,8 7:17 8:2,12,18 9:1,5 9:15,25 10:15 12:11,19 13:10 16:12 17:20 19:3 22:19 30:12 32:19 33:13 34:6,20 36:3 40:17 42:4,19 47:4 48:2,13,23 49:18 50:20 51:11 56:4,12 60:2,13,22 61:9 63:2,24 64:7 66:24 67:9 68:15 72:11,20 73:7 73:10,22 74:4 74:11 75:4,15 75:24 76:10,18 77:12,24 78:3 78:12,22 79:4 79:15,20 80:5 80:21 83:5,21 85:6 86:2,14 86:22 87:4,12 87:20,25 88:10 88:19,25 89:7 89:16,25 90:24 91:6,20 92:11 92:23 94:5,12 94:19 95:5 96:18,23 97:8 99:6,14,25 100:6,20 101:5 102:5,14 103:14 104:4 104:12,19,25 105:7 106:24 109:13,20 111:5,13,20 112:10,17 113:21 114:9 115:9 116:9,18 118:7 119:8,24 120:18 121:13 122:7,18 123:15 124:19 125:14,21 126:7,16 127:17 128:16 128:25 129:7 129:13 130:8 130:16,21 131:5,16 132:3 132:20 135:5 135:17 138:1 138:23 139:6 139:20 140:13 141:1,7 142:5 142:22 143:12 143:19 144:2 144:10,16,23 145:7,15 146:13,21 147:6,13,21 148:5,11 149:9 149:23 150:11 150:19,24 151:3,21 152:6 152:17,24 153:14,21 154:3,6,11,14 154:22 155:6 155:13,21

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

157:3,10,16,25
158:14,25
159:3,14 160:1
160:21 161:5
162:23 164:10
165:9,18 168:2
169:5,12
170:10 171:8
171:12 172:7
173:9,15
174:10,21
175:5 178:18
180:9 181:23
182:15 184:9
186:5 187:16
188:24 189:16
191:21 192:6
192:14,25
193:16 194:15
195:22 196:1,6
196:13,20
197:6,13,21
198:3,17,25
199:7,15 202:1
205:12 206:4
208:8 211:11
211:17 216:23
217:8,23
218:23 219:9
219:18 220:10
220:20 221:5
221:21 222:6
222:22 223:7
223:17,24
224:5,12,25
225:11,21
226:5,14 229:1

happen 134:23
135:1 172:25

happened
92:25 118:22
158:18

happening
42:18 163:18

happens 32:7
94:24 194:2

happy 62:6
106:15

hard 43:24
45:21 53:9
55:16,20 56:5
56:22 66:15,18
68:23 69:2
73:1 111:25
112:3 119:10
123:11 140:23
148:7 153:5
163:11,16,25
165:11 172:25
179:18 182:3
186:4,24
194:22 205:17
206:15 207:10
209:22 219:13
220:13,22

harder 114:10
133:6

head 102:16
222:11

heard 5:10
98:18,23 99:4
140:12

heat 109:3
114:15 134:24
134:25 191:14

heated 134:8
170:21 191:10
191:19,23
204:6

held 80:10
123:4 136:24
210:16

helium 116:4
118:10

help 37:2
204:12 206:23

hesitancy
155:24

hesitate 75:16

heteroaromatic
10:21 11:6
46:18 76:4
82:6

hhpp 118:18
120:13,20,25

high 97:14
128:10 129:17
129:18,21
152:9 202:17
209:23

higher 39:12
40:23,24 41:3
41:10,24 81:16
107:21 109:7
117:16,18
120:24 131:19
136:12 195:20
195:24 204:14
204:16,20
205:11,23,25
210:6,13,25
224:4

highest 110:9
110:15

highlighted
71:22 72:3,4,5
72:22

highly 35:2

hinder 37:2

hit 192:4
193:20,23
205:10

hits 167:12,13
167:16,17,20
167:21

hitting 167:24
193:8,12

hold 38:10

holder 174:17
177:10

holding 210:5
210:25

hole 25:8 107:7

homo 39:8 48:1
48:3,11 64:5
94:14 194:14
195:15

homogeneou...
178:7

honest 37:11
hopping 41:12 41:18 134:22 135:2
host 28:19 50:7 179:18
hosts 50:25 51:2
hour 58:18 115:10 148:25 171:13
hours 58:19 59:6
house 185:11
hpp 15:18 17:3 17:10 42:23 47:3,25 48:10 48:12 50:8,13 50:19,23 52:1 52:4,7,8,9,16 52:17 55:9 63:18 65:3 68:4,22 69:19 91:11 93:6,10 93:23 94:1,11 107:2 116:16 116:24 117:14 118:4,9 120:13 120:16,21 122:5,6,12,12 123:18 124:11 124:12 126:20 126:21 127:1 130:2,4,6,7,9 131:7 132:11 132:14 133:7,9 133:16,18 135:4,11,11 136:22 137:9 137:11,14,21 137:23 138:8 149:7,15,16,20 150:9,18,21 151:7,9,22 181:21,24 182:5,8,14,17 183:8,15 184:7 184:16 194:12 194:19,22 195:9 196:18 196:24 197:12 197:17 198:2 199:13,21 200:7 201:4,9 208:18 209:6 214:9 216:6,7 216:9,11 222:18,19 223:1,23
huh 18:21 23:4 32:8 80:9 120:5 161:22 163:2 164:22 164:24 165:14 167:11 201:16 202:10 222:10
hundred 22:9 32:12
hundreds 79:25 180:3
hydrogen 224:24 225:3,6 226:8
hydrogens 217:19
hypothesis 152:12
hypothetically 33:21
hysteresis 45:4
hzhong 3:9

i

ia 13:8 42:3,21 103:16 109:10 109:16
ib 109:16
ic 109:16
idea 28:17 95:15
ideally 168:23
identical 54:4 122:25
identify 189:2
ignore 32:14
iii 165:20,22 166:8
illumination 35:10
imagine 102:10 180:22 182:7 197:16 208:20 223:12
implication 173:3
imply 148:12
important 66:21 67:3,6 110:7 111:1 141:12 158:2 168:6 206:14
imposes 166:23
impossible 113:9 165:19 167:6
improper 68:18
improved 201:23
improvement 198:24
incident 35:5
include 69:13 90:17 118:20 145:24 190:17
included 17:7 190:13 229:14 230:3
includes 189:21
including 136:21
incorporate 146:15
increase 30:10 30:11 196:24 204:11,12
increased 134:8 201:24 202:3,5 206:10
increases 29:13

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

[increasing - interpreted]

increasing 109:4 136:8
independent 37:23
index 186:3,22
indexed 185:16 186:14 187:6 187:13 188:10 188:16,22
indexing 188:9
indicate 121:2
indicates 52:20 180:13
indium 25:20 108:19
individual 212:10,17,22 213:1,6,11,19 214:1,12,23 215:4,8,15,22
induced 195:4 198:9,11
industry 61:5,7
influence 123:25 191:6
influencing 97:25
info 186:17
inform 34:10 90:2 112:24
information 26:22 50:22 51:1,4,5,9 68:25 69:1 104:1 112:5 175:10,15 186:17 190:17 191:12 194:1 198:20 199:3 199:10 221:25 224:15
informed 73:23 84:23 105:20 110:23 159:9
infringement 159:13
initial 7:11 57:19 58:13,23 59:3,7,12,18
initially 33:15 37:17 111:16 114:4 115:6 206:8
inject 28:6
injecting 28:8
injection 29:3 29:17
inorganic 183:1
input 160:14
insensitive 163:22
insert 174:3
inserted 101:17
inside 126:24
insoluble 183:14,17
instantaneous... 44:10
institution 172:15
instruction 68:18
instrument 117:14
insufficient 54:15 199:2,10
intellectual 141:12
intend 72:25
intended 34:10 171:10 192:17
intention 35:1
interact 196:19
interacting 98:3 133:19,22 168:9
interaction 81:10,14 90:8 90:20,22,25 91:18 92:6,10 92:22 132:15 182:5 184:6 194:13,13,14 197:3,5,16 198:13,16,24
interactions 49:3 81:3 196:5 197:11 197:19 198:1
interacts 122:24
interchangea... 203:24
interested 5:24 189:13 228:17
interface 26:5,6
interfaces 22:17 28:21 31:23
interfacial 26:2 26:5,15 28:20
intermix 114:18
internal 103:24 137:3,4,23 147:2 156:20 156:21 162:7 211:23 212:15 212:20,25 213:4,9,17,22 214:4,7 216:1 217:4 218:25 222:15
international 1:7 2:7 5:17 229:4 231:1
internet 5:8
interpret 84:17 85:4 90:2 91:1 160:10 204:10
interpretation 103:6 118:15 158:16 159:23 160:7
interpretations 160:14
interpreted 82:10

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

intersection 173:7 175:4 176:12
intersphere 80:11
intimate 197:15,19
introduce 6:12 174:3
introduced 153:12
introductory 32:22
invalidity 9:22
invention 84:8 158:17,19
inventor 15:4
inventors 14:2 14:15,16,18,22 14:23 15:1 52:22 56:6,19 93:20 110:4,25 201:22 206:13 208:11
inverse 21:5 101:8,14,22
investigate 219:16,19
invoke 86:5
involve 184:7 220:18
involved 173:3 173:4
involvement 159:17
involving 143:14
ioaniss 156:16 156:25
ioannis 70:12 70:13 71:16
ion 70:7 142:9
ionization 64:16,18 65:3 65:4,13 69:13 69:19 93:5,5,9 93:11,14,15,17 94:3,10 96:16 96:22 97:7,10 97:16,23 98:6 98:8 99:13,16 99:23,23 117:2 117:7 118:5,11 130:3,6 200:10 200:24
ionizations 120:25
ipes 101:21 102:8,19
ipr 63:16 158:22
ipr2024-01094 1:10 2:10 5:19
irell 3:4 6:6
irell.com 3:9
iron 145:25 146:7
isi 189:9
isoelectronic 36:22
isolated 97:19
isolation 118:25
isomer 218:19
isotropic 41:20
issue 126:24 188:4,10
ito 25:20 27:19 27:23 35:25 108:5,20
iva 42:23 52:15

j

jacs 63:6,8 64:2 68:11
january 184:20
jap 66:8
joann 3:21 5:21
job 1:23 227:23
johnson 1:21 2:21 6:15 228:3,24
joint 71:2,7 72:9,10,17,23 73:6,12,16 155:1,4,19 158:9 160:20 161:3 191:10 191:20 192:1,5 192:9,13,23 193:11,22 203:14
jointly 193:3,4
josef 15:15,16
journal 25:6 38:15 185:1 188:22 189:24 189:25 221:2,3
journals 185:8 185:11,13 189:22,22 190:12 219:7 219:13,14 221:20
jumps 210:24

k

k 136:4 175:12 175:13
keep 8:18 178:14 204:17
kept 21:14 145:18 177:8 179:2 180:25
ki 175:9,10,12 175:15,19,21 175:23 176:10 176:13,17,20 177:14 178:19 178:24 179:13 180:24 194:3
ki's 175:16 178:11
kiersten 3:13 6:9
kind 8:16 16:5 16:10 53:6 80:11 98:3 106:19 114:15 114:17 117:22 160:9 174:17 182:5 188:1

195:4 203:7
204:21
kinetically 41:5
knew 35:9
50:22 51:2
67:16 111:9
knobs 172:25
know 15:8,14
15:16 19:21
26:14,18,22
27:2 34:3,7
36:10 37:5
39:19,22 40:2
40:4 41:6 43:1
43:2,4,22
44:16 45:21,22
46:7,16,18
47:17 48:25,25
49:24 50:3
51:16,24 52:10
54:6,9,22,23
55:16,18,22,23
55:24 56:5,21
56:22 60:14,24
63:17 65:16
66:11 68:17
70:11,13 71:1
71:5,17,18
72:14 74:15
76:2 80:10
81:1 82:11
84:12,23 85:1
85:21 86:16,17
88:14 89:9
90:4,5,6,8,12
90:16 93:16
98:15 99:18
100:4,14,18,22
100:25 101:2
102:2,6,7,8,13
102:15,16,17
102:22 103:8
103:10,21,21
104:7 105:2,4
105:23 107:18
107:20 109:10
110:18,21,23
111:21,22,23
112:1,20 113:9
114:12,20
117:9,20
118:12 119:16
120:10 122:4
123:8,9 125:6
125:7 129:12
129:15,17,21
132:5,10,10,13
132:22 133:5
133:12,22
135:7 136:18
137:24 138:8
140:5,22 141:8
141:9 145:17
145:20 149:16
153:2,15
159:16,18
160:12,14,25
166:2,15 168:5
168:17,21,25
170:21 172:14
173:5,17,25
174:9,11,16
176:8,11,14,16
176:22 177:12
177:24 178:4,5
178:8,10,22
179:13,14
180:2,13,20,23
180:25 181:11
181:16,21
182:2,4,20
183:16 184:11
185:7,14,15
186:2,14 187:4
187:13,17,21
188:3,16 189:7
189:24 191:13
191:14,25
192:16 193:1
194:16,17,19
194:24,25
195:1,10,13,14
196:9,22,23,25
197:14 198:8
198:23 199:3
201:5 202:14
202:21,23
204:15 205:21
206:6,24 207:5
207:8 208:5
209:7,13,13,23
210:10,13,15
210:21,24,25
211:1,8 214:6
217:9 220:22
221:1,3,16,18
221:25 222:3
222:11 223:5
223:12 224:1,8
224:15 225:19
225:22
knowable
174:19,23
knowing 15:9
knowledge
44:25 46:15
60:23 91:10
94:13,16 99:7
104:6 105:24
149:13 150:12
200:8
known 12:7
51:9,15,21,23
85:22 134:12
136:5 139:15
140:25 173:20
173:23,24
188:8 225:9,17
knows 28:15
173:17
kt 136:3
kymissis 70:12
70:13,24 71:16
72:8,16 152:15
152:19 153:11
154:8 155:3,18
156:16,25
160:18 162:6,9
169:4,16,20
170:4 171:4

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

l

lab 170:11
labs 93:20
lack 154:23 155:13,21 157:3,25 159:3 160:2
laid 91:25
land 191:25
landscape 41:6 166:13
language 10:12 11:22 91:9 126:18
large 167:8 168:7 185:11 196:4
largely 34:9
larger 21:20 117:20 136:12 205:19 207:8 210:14
lateral 18:6 20:3,9,21 21:12 22:6,7 23:13,21 24:7 24:23,24 27:4 28:24 34:14 42:25 54:14 108:15,17
lawyer 85:15 159:5
lay 7:21
layer 18:5,19 20:7,11 22:9 22:23 23:5,8,8 27:14,16,19,22 27:24 28:8,15 29:4,5,18,21 32:5 33:15,18 34:2,10,11 35:2,16,18,25 54:15 58:12 79:11 81:13 91:14 92:15 107:1 108:4 110:10 114:12 127:13 128:9 128:10,18,23 129:22 133:17 133:17 134:8 164:4,5,6,6,12 165:15,16,16 165:17,24,25 166:15,19 167:4,5 178:9 178:10 180:4 194:7 208:13 208:25 209:1,3 209:5,6,13 210:3,4,6 211:2 224:16
layering 25:15 166:25
layers 17:11 31:23 34:22 113:7 129:19 135:13 162:16 162:17,17 163:13 166:1 166:10,20 172:4 191:7 199:25 208:11
lead 43:21
leads 183:16
lean 18:16
learn 113:10
learned 141:13
learning 14:10 151:25
led 108:6
left 38:21 183:11
legal 5:22 7:18 8:2,12 9:1 159:4,14,19 160:1,16 229:7
lengths 114:21
leslie 1:21 2:21 6:14 228:3,24
level 30:4 44:12 64:5 86:4 94:14 101:3 158:5 194:20 195:9,10 202:15,16
levels 39:8 46:12 47:1 48:8 102:24
levy 110:8
license 6:15
lies 98:9 100:15
life 119:13 210:1
lifetime 106:1 224:8
ligand 80:24 89:10 118:18 136:22 138:10 138:13,14 139:24 141:4 141:21 142:3 142:12 147:11 147:18 215:2 226:2
ligands 75:23 104:15 105:2 138:25 139:4 142:20 143:4,5 143:10,14,18 144:8,15,18,21 145:4,9,14 147:9,23 219:25 220:8 225:19,23
light 35:3 84:16 99:17 101:11 101:14,16 106:23 107:3,5
lightest 225:4
likely 68:10 119:25 139:23
likes 133:23
limit 11:8,9 82:11 91:8 165:2 211:6
limitations 84:4

limited 81:20 81:21 85:25 86:11,16,19 95:10 183:13
limiting 151:5 151:6
line 18:22 63:25 76:19 87:25 89:11 128:17 129:9 129:12 154:21 154:22 208:24 214:8,18 215:1 229:15 230:4 231:4,7,10,13 231:16,19
lines 20:15 64:11,15 65:7 71:8 93:8 154:24 156:1 157:6,12 179:3 201:14,17 206:12 207:12 215:19 219:2
link 26:12
linked 138:15 218:15
liq 28:1 29:6
liquid 96:5 100:13 102:25 202:21,22 203:15
list 129:20 145:19 146:22 147:1 161:16 162:1 216:15
listed 69:23 84:2 145:23 146:6,15 212:9 216:2
literature 85:21 91:24 108:3 189:2 203:19
lithium 16:16 27:25 28:18 29:6 73:18,20 73:24 74:9,20 74:23 79:2,9 79:14,17,19 80:16,18,22,25 81:4 145:19 151:23 172:1 176:5 178:17 180:17 181:12
little 15:23 18:17 29:8 37:10 43:24 45:21 49:19 60:17 69:2 73:1 82:19 98:24 100:17 107:23 112:3 117:16 119:9 126:21 139:13 163:15 169:6 172:16 179:20 181:25 183:11 183:11 192:17 193:17 199:23 205:2,17,19,20 207:10 209:12 216:6 219:10 219:13 220:22 222:23 223:19
llp 3:4,11
loading 135:9
loadings 27:25 135:8,10
local 43:22
locate 189:14
located 75:13
location 35:4 75:17 174:14
locations 172:24
locked 229:12 230:1
logged 182:23
long 18:8 20:13 45:17 61:2 68:10 193:5,6 210:21 225:15
longer 72:14 114:4 115:6 119:15
look 7:9 11:10 18:15 27:4 29:11 35:12 38:23 53:12 58:2,6,7 65:9 69:20 85:10 91:21 94:22 98:2 106:9 116:20 133:10 137:7 145:22 165:1 177:1 201:13 203:2 212:4 214:8,18 216:1,14 218:25 220:14 222:13
looked 34:24 91:22 160:9 220:11,14
looking 27:7 29:8 34:22,23 35:14,16,19 60:16 95:8,12 97:19,19 112:20 187:12 208:24,25 220:21
looks 90:6 201:3,10 203:7
los 3:7
loses 209:10
loss 101:17
lost 59:2 97:2 182:9
lot 23:6 27:5 33:18 35:3 36:18,18 44:17 44:23 49:12 55:23 60:10 62:7 74:13 112:8,15,25 114:10 134:17 136:16,23 140:22 141:10

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

141:13 163:11 166:16 170:13 209:14 210:11 224:15
lots 49:11 110:1 114:19
low 38:25 125:13 127:5 128:10,15,18 128:20 129:6,8 135:10 136:25
lower 41:9,10 107:12,21 108:8 111:22 129:24 130:3,6 205:10,11 207:8 210:3,14 211:2 224:4
lowest 46:19 217:11,14,16 218:8 224:22 225:6
luminance 57:9 57:10,14,19 58:23
luminances 58:14
lumo 36:23 39:8 44:5,12 46:11,20 47:1 47:11,18 48:1 48:4,8,11 100:22 101:3 101:18 102:24 103:20 132:22 194:13,13,14 194:16,19,23 194:23 195:2,2 195:5,9,10,15 195:18 196:4,4 196:17,17 197:5,5,10,10 197:17,17 198:1,1,13,13 198:15,15,24 198:24
lumos 44:6 46:15,22
lunch 115:11
lux 14:15,19,22 15:6,6,13,14
luxury 37:10

m

m 216:18,20
m2 116:16 118:4
ma 25:1,2 26:22 27:13,16 27:17 33:20 34:5 36:9,10 62:7 71:1 72:9 72:18 73:5 79:10 82:14 92:1 160:18,19 175:17,20,21 175:24 176:7 176:15 178:12 178:14,21 179:8 180:21 181:4 186:8,23 188:3 189:19 190:13,21,24 190:25 191:2,4 191:6 194:3
ma's 31:7,9,13 35:23
machine 228:9
machines 62:4
macroscopic 163:17 167:25
made 24:24 27:6 96:13 105:22 108:19 170:12 212:7 218:22 225:16 228:9
magnitude 22:11 26:20 30:6 39:11,14 42:2,13,16 43:7,9 44:3 51:25 53:5 55:12 56:11 66:10 129:24 130:10 148:9 148:13
maine 1:17 2:19 5:1
maintain 179:19 189:23
maintained 168:15 180:11
maintaining 160:7
make 8:1 17:10 21:9 23:7,10 23:16 27:5 28:25 29:16 68:15 85:22 98:11,16 112:14 113:5 122:3 127:14 140:23 165:11 166:7,9,14 168:4,22,23 170:22 172:25 178:6 180:3 199:6 229:14 230:3
makes 30:16 46:21 134:25 134:25
making 52:24 69:7 72:12 147:10,10 149:4 158:4 176:20 179:18 202:23 209:18 219:3
manella 3:4 6:7
manganese 145:24 146:7
manipulations 140:22
manufacturer 170:15
manufacturers 170:17

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

[manuscript - measuring]

manuscript 25:6 69:3
marked 38:7 66:6
mated 45:8
material 21:8 22:12 23:1,2 40:4 49:1,7,7 49:14,17 66:22 67:4,7 77:18 97:18 99:20 108:18,23 112:7,8,14 126:5,12,12 163:23 164:14 164:15,15,16 174:16 180:7 199:14 202:20 203:3,5,7,15,17 204:1,4,7 205:15 206:15 207:13
materials 16:1 16:3 25:15 26:25 40:12,13 45:12 48:17,18 67:13 105:25 163:13 170:22 174:4,5,12 175:24 176:19 177:13,24 179:2 180:13 181:6,9,17 191:8,17 192:21 201:19 202:3 223:10 223:11
matrix 28:19 50:7 127:1 201:19 202:3 203:19 207:13 223:10
matter 5:15 20:19 31:5 67:18 92:17 106:14 124:18 124:24,25 164:9
mattered 35:8
matters 60:10 116:22 174:12 200:20
maximal 35:4
mean 9:20 12:21 15:9 19:5 22:24 27:21 30:9 39:15 40:18 43:14 49:20 50:3 62:1 79:24 81:7 85:2 94:20 106:14,19 121:22 122:11 129:18,18 135:22 139:7 146:22 155:23 157:5 163:11 163:16,25 167:21 169:7,7 173:16 178:19 181:15,25 186:16 196:7 196:15,23 198:4,19 202:16 213:13 217:9,11,14,24 217:25 221:7 226:8
meaning 84:16 84:19,21 85:3 85:24 86:10 115:6 154:11
meaningful 98:16
means 15:19 37:25 38:1 54:13 85:1 98:21 119:22 134:21 135:25 147:15,19 179:3 180:24 188:12 202:20 204:3 208:20 209:21
meant 121:18 122:2
measure 17:18 18:13 20:23 21:25 22:4 23:12,20 43:3 54:16,19 96:22 97:7 99:22 101:15 179:21 179:21 199:14
measured 18:19 24:10 40:11 42:24 54:7 55:5 67:8 69:11 95:19 96:17 106:25 111:7 204:24
measurement 15:21 18:11 19:25 20:18 21:12 23:11 34:15,17 44:18 44:19 45:18 46:3,5 52:24 54:18 96:7,8 97:17 98:15 101:9,19,21,22 102:20 106:17 106:22 109:24 109:24 124:5 200:6
measurements 20:10 34:8,9 40:1 46:3 51:15 69:10 93:19,21 96:4 98:14 112:21 183:13 199:21 199:25 200:9
measuring 17:24 20:22 22:14 23:25 24:2,14,21 99:18 101:12 102:23 108:24

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

109:1,7 166:24
mechanism 197:11,25 209:17 210:23
media 5:14 111:25 114:17
medium 166:24
membered 140:2,4,10 217:19
menke 183:24
mention 68:4 118:17 120:11 120:13,24 183:14 200:6 219:3
mentioned 21:24 43:16 49:22 63:18 65:6 68:22 81:6 130:2 135:16,18 136:15,17 148:4 149:8,15 149:17,24 150:21 155:23 159:6,7 175:9 186:22
mentioning 120:7
mentions 93:4 120:9
merits 92:14
metal 10:3,18 10:19 11:3,4 16:5 18:2 20:6 20:12 21:21,22 70:4,7 73:18 73:21,25 74:10 74:17,20,21,23 75:3,8,8,9,18 75:21 76:1,2,7 76:7,23 77:2,9 77:9,14,15,17 77:21,22 78:4 78:5,6,9,14 80:18 81:10,15 82:4 86:24 89:9,22,23 90:12,23 91:1 91:4,5,11,18,19 91:22 92:13 104:10,14,17 104:20,23 105:1 114:16 116:25 118:16 119:3,6 120:9 120:12,12,17 121:6,11,16,21 123:5,18,21,23 127:7 131:9 136:14,16 138:10 139:8 139:14 142:3 142:20 143:11 143:25 144:8 144:15,22 145:6,13,20 146:14,16 147:4,9,11,18 147:22 184:16 184:16 190:6 199:21 216:18 216:20,21 219:7 220:9 225:24
metal2 116:24 120:21
metals 136:24 141:5 145:23 146:5,11,23 147:1 184:24 185:1,4,6,10 190:10
meter 26:10,11 54:20 57:19,20 58:14,16 59:1 59:8,13,19 209:25
method 18:15 18:20 20:2,21 21:25 69:9 96:8,8,17 98:18,23
methods 18:1 25:10 40:3 96:2,10,21 97:6 172:22
methyl 16:23 37:1
metric 111:1 206:14
microbalance 179:23
microbalances 176:24 177:7 177:12,23
microns 18:8 22:8 54:15
microscopic 123:24
middle 116:3
millimeters 25:22,23
mind 8:18 31:3 210:24
minimal 35:7 61:6
minimum 21:14
minus 52:6 53:1,4,17,18 54:4,11,21 55:2,7,9,13,14 55:25 101:20 101:24 102:9 102:11 103:2 117:15 125:4 128:11,19 129:5 136:2 178:11,12,15 179:6,9,10 180:11,12,23 181:4
minute 20:16 59:24 119:14
minutes 57:3 59:5,11,16,21 60:12,21 61:10

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

66:17 199:19 207:18
miracle 166:3,5
mischaracteri... 10:16 226:6
missing 49:12
mission 3:15
mistaken 17:1
misunderstan... 126:14
mix 131:6 166:6 168:19
mixed 178:7 183:16
mixing 95:14 113:6 223:13
mixture 50:7 165:3 166:19 167:2 180:1 184:13 194:8 196:23 197:15 200:6
mixtures 176:4 184:15 199:25 200:9
mobilities 40:14 67:5,7
mobility 39:9 39:14 40:8,25 41:10,10,24 43:3,10 44:2 47:22 67:12 124:1,8 127:13 134:3,5,25
mode 211:7
modest 135:7,8
moisture 119:23
molar 127:5,6 127:7 180:19
mole 42:24 50:12 52:4,7 52:19,20 53:3 53:16,18 55:8 55:10 135:8
molecular 16:22 43:15 46:20 47:11,24 48:9 49:8 52:17 110:10 111:4 117:19 117:21 130:23 138:19 141:22 164:4,5,6,6,12 165:15,16,16 165:17 167:4,4 182:6,7 194:24 196:18 207:9 217:11,14,16 217:25 218:8 224:22 225:6
molecularly 166:15
molecule 47:13 75:14 78:18 80:14 81:2 94:15 97:10,19 97:24 98:2,4,7 102:10,25 104:13 113:15 114:14 122:24 123:7 124:11 124:15 125:9 126:11,20,21 132:7,9,12,19 133:23 137:21 137:22 191:24
molecules 47:5 49:1 68:13 78:16,17,25 79:23,25 81:17 82:4,9 90:15 90:17 97:15,20 99:17,19 103:16 104:7 110:16 111:16 112:4 117:12 123:18,25 166:14 168:21 197:15 199:17 203:12
molybdenum 116:25 117:2,6 117:16 145:25 146:8 216:22
molybdenum2 118:9
moment 7:9 10:11 69:3 116:19 133:10 144:25 189:21
moments 133:14
money 113:5
monitor 178:8
monitored 179:23
month 160:20
morning 5:4 6:14,23,24 208:3
morphology 114:19
motif 41:4
move 44:10 74:24 126:5,11 170:14
moving 117:5 125:16 167:19 192:18
mtdata 181:14
multijunction 34:25 150:2
multinuclear 136:20
multiple 45:7 47:21 49:1,1 52:22 62:8 105:9,10 150:3 170:20 181:11
mutually 104:24

n

n 4:1 105:24 122:22 133:17 134:15,16 138:6 150:14 151:11,20

name 5:21 6:25 15:9 70:12,20 228:21
named 15:3
names 99:1
nanometer 27:22,24 28:15 35:24 125:10 164:13,13,14 164:15 165:2,7 165:7 166:9,10 209:3,5,5
nanometers 22:10 208:18 208:21,23 209:2
natively 129:22 129:25
naturally 210:5
nature 43:6 113:12 114:4 116:10 219:20
near 35:9 38:20 177:10,14,15 178:2
nearest 49:3
nearly 36:23,23 43:20 123:16 167:5
neat 114:2 115:2,2,3 129:25
necessarily 11:8 41:1 54:13 110:23 118:12 123:1 123:20 124:2 155:9 191:15 192:23 194:2 202:4
necessary 7:15 35:20 157:22 197:1 229:14 230:3
necessity 158:6
need 7:25 14:4 20:25 30:13 37:21 51:5 68:3,16 76:19 83:22 85:15 86:3 107:6 110:1 113:18 139:22 141:8 143:6 148:19 156:2 161:12 161:23 169:22 172:16 177:12 177:19 181:25 192:16 199:23
needed 35:12 62:2 63:14 119:11
needs 52:16 90:22 91:4 154:12 159:19
negative 65:20 107:19 140:7,8
neighbor 49:3
neighboring 122:24
neighbors 49:3
neither 27:13 200:8 228:17
network 78:16 90:14
networks 75:11
never 17:21 79:21 95:23 125:23,25 126:10,10 149:16 189:8 219:12 223:4
new 8:10,11,23 9:13,14 14:9 32:10 97:1 190:15
ni 140:6
nickel 145:25 146:8
nine 144:7 146:11,11,14 146:18,22 147:1,4,18,23
nitrogen 216:10
nomenclature 108:10
nominal 102:13 102:16
non 26:12 30:1
nonresponsive 74:8,25 92:19
normally 209:24
notating 229:15 230:4
note 5:6 11:21 121:18,22,22
noted 87:1 206:25 220:3 226:19
notice 28:3
noticed 70:20
noticing 6:5
noting 29:10
novaled 13:14 14:14 17:8
npb 181:13
number 4:11 7:22 17:14 23:3 47:23 48:8 55:1 56:2 64:21 94:23,25 95:4,6,7,20,21 95:22 96:1,1 136:12 141:9 229:15 230:4
numbering 141:20
numberings 188:3
numbers 65:16 65:18 66:12,13 66:22,23 67:16 95:13 188:3,7 188:11,14
numeral 42:21 42:22 107:2

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

numerous
48:15 56:18
96:2 102:17
147:2 208:10

o

o2 120:4
oath 6:12,18
228:8
object 10:15
63:24 154:22
172:7
objection 7:17
8:2,12 9:1,15
9:25 12:11,19
13:10 16:12
17:20 19:3
22:19 30:12
32:19 33:13
34:6,20 36:3
40:17 42:4,19
47:4 48:2,13
48:23 49:18
50:20 51:11
56:4,12 60:2
60:13,22 63:2
64:7 66:24
67:9 72:11,20
73:7,10,22
74:4,11 75:4
75:15,24 76:15
76:18 77:12,24
78:3,12,22
79:4,15,20
80:5,21 83:5
83:21 85:6
86:2,14,22
87:4,12,20,25
88:10,19,25
89:7,16,25
90:24 91:6,20
92:11,23 94:5
94:12,19 95:5
96:18,23 97:8
99:6,14,25
100:6,20 101:5
102:5,14
103:14 104:4
104:12,19,25
105:7 106:24
109:13,20
111:5,13,20
112:10,17
113:21 114:9
116:9,18 118:7
119:8,24
120:18 121:13
122:7,18
123:15 124:19
125:14,21
126:7,16
127:17 128:16
128:25 129:7
129:13 130:8
130:16,21
131:5,16 132:3
132:20 135:5
135:17 138:1
139:6,20
140:13 141:1,7
142:5,22
143:12,19
144:2,10,16,23
145:7,15
146:13,21
147:6,13,21
148:5,11 149:9
149:23 150:11
150:19,24
151:3,21 152:6
152:17,24
153:14,21
154:3 155:6,13
155:21 157:3
157:10,16,25
158:14,25
159:3,14 160:1
160:21 161:5
162:23 164:10
165:9,18 168:2
169:5,12,22
170:10 171:8
173:9,15
174:10,21
175:5 178:18
180:9 181:23
182:15 184:9
186:5 187:16
188:24 189:16
191:21 192:6
192:14,25
193:16 194:15
195:22 196:1,6
196:13,20
197:6,13,21
198:3,17,25
199:7,15 202:1
205:12 206:4
208:8 217:8,23
218:23 219:9
219:18 220:10
220:20 221:5
221:21 222:6
222:22 223:7
223:17,24
224:5,12,25
225:11,21
226:5
objections 5:25
8:17
observant
202:19
observation
32:24 206:18
observe 117:21
174:7 203:1
209:10
observed 30:9
32:17 33:9
119:14
obtain 46:11
60:1 153:20
obvious 84:4
84:24
obviously
180:17
obviousness
7:16,21 8:1
9:23
occur 120:25

[offer - opinion]

offer 26:21 46:17 72:25 141:10 160:9 160:12,15
offhand 122:8
office 1:1 2:1 5:18 229:11
oftentimes 187:25
ogunquit 1:17 2:19 5:1
oh 38:8 39:4 62:6 64:17 66:7 105:16 121:19 127:11 140:8 223:3
ohmic 23:7
okay 7:7 9:7 11:10,17 13:18 14:1,9,10 16:24 18:10,16 18:25 19:13,24 20:1 22:3,22 23:10 26:1,24 30:21 31:1,3,6 31:12,19,21,24 32:2,4,16 33:5 33:9,25 34:13 36:20 37:23 38:10 39:4,17 39:20 40:8 44:12 49:16,23 49:23 51:19 53:11,24 55:5 55:10,21 57:2 57:3,4,7,16,17 58:9,22,25 59:7,12,17,22 62:9,21 63:1 64:14,20,21 65:8,14 66:21 67:25 70:11 71:15,19 72:5 72:6 76:21 83:16 85:12,15 86:9 87:3 102:2 103:19 106:23 108:13 108:24 116:2 119:2,21 120:3 122:3 126:15 127:11 128:14 128:22 131:12 135:23 137:5,8 138:15,17 139:10 140:18 140:19 141:17 142:18 143:6,8 144:6,13 145:2 146:5,7,18 148:23 149:1 152:21 154:14 154:19 155:11 155:18 156:13 156:13,22 158:8 159:22 160:18 162:1 162:15 163:6 167:18 170:25 172:5,22 173:2 173:5 174:8 176:6,12 181:2 182:11,24 183:4,19,22,24 186:2,8,11 190:20,23 191:1 200:23 201:21,21 204:2,11 207:4 209:3 211:11 211:23,25 212:14 213:16 214:8 216:1,16 216:23 217:6 219:1 220:4 221:11,12 222:3,17 224:8 226:12
oled 27:10 28:10 34:11 59:22 60:1,3 61:2 108:1 149:21 150:6 150:10 169:10 208:9 209:7 224:16
oleds 58:10 60:25 150:14
once 14:7 70:21 187:24 188:8 204:14
ones 12:17 63:14 80:12 91:23 120:22 134:1 152:3 180:21 224:23
online 185:16 186:3,12 187:23,24 188:20,22 189:5 190:2,16
onset 200:11,20 200:24 201:4,5 201:10,12
oof 17:13
open 10:10,11 14:4,7,11 36:4 58:2,5,9 63:21 64:2,23 68:7 71:13 83:22 154:15 172:19 174:2 201:1 211:22
opening 10:10 10:13,25 11:12 75:5 183:3
opens 25:12
operating 35:9 188:25 197:20 209:25 210:12
operation 108:6,6
opinion 42:10 46:25 54:12,13 62:25 67:18 75:3,20 91:25 104:23 105:6,8 106:14 160:10 160:13 161:7 175:23 198:21

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

opinions 7:21 8:6 46:17 63:15 72:25 82:1 85:22 91:15,17 93:1 158:12 197:8
opportunity 8:6
opposite 20:11 45:9
optical 39:7
option 225:2
options 163:12
optoelectronic 209:16
orange 60:9
orbital 41:8 46:20 47:11 194:24 196:18
orbitals 49:8 194:17
order 8:1 22:11 83:11 107:5 119:14 129:5 148:9,13 164:2 178:25 193:22
orders 30:5 39:11,13 42:2 42:13,16 43:7 43:8 44:2 51:24 53:4 55:12 56:11 66:10 129:23
ordinary 84:15 84:18,21 85:3 85:13,13,18,18 85:24 86:9 170:8 171:6 189:13
organic 10:4,9 10:19,20,24 11:5 20:11 27:10 34:25 68:13 69:24 70:3 75:10,22 76:3,4 77:15 77:16,17,23 78:2,6,10,15 80:15 81:11,15 82:5,6,8 86:24 89:23 90:13,23 91:2,5,12,19,23 92:13 104:10 104:17,21,24 105:2,19,25 112:8,15 114:6 114:11 119:4,7 119:15,19 120:3,8,11,14 121:6,12,16,21 129:16 131:3 131:10,13,24 134:11 135:2 138:10 139:8 139:14 148:3 150:1,2,7,13,17 169:10 178:15 180:12,15 181:6,9,16,17 190:10 191:7 224:9
organics 150:23 151:2 151:12 181:12
organization 189:8,9
organometallic 74:14
orient 49:2
orientation 41:16 196:19
origin 118:14
original 9:11 11:16,18 38:17 83:23 84:3,10 127:24 128:3,4 137:20 141:17 141:24 142:16 142:17 143:7 144:6 228:14 229:10,20,22
originally 80:4
outcome 5:25 97:25 99:18 165:4 167:1 182:4
outcomes 197:1
output 168:20
outside 15:9 121:3 122:18 190:21,21 219:11
overall 19:15 20:17 48:24 49:13,16 126:20
overlap 24:5 25:19 41:9 192:8,12 196:12,15
owing 118:24
own 51:3 80:24 81:18 82:10 98:15 113:4 118:13,19 158:16 170:12 174:23
owner 1:8 2:8 2:19 3:3 6:7 74:19
oxidant 130:13
oxidation 123:5 131:18 136:25 182:2
oxidative 45:9 69:15 103:3,7
oxide 25:21 108:19
oxidize 130:25 131:3
oxidized 131:1 131:7,10
oxidizing 98:6 130:20
oxygen 119:22 120:1,3

p

p 1:16 2:18 4:4 4:10 5:15 6:17 138:6 227:3,17

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

229:5 231:2,24
p.m. 2:20 115:14,17 171:17,20 207:21,24 211:14 226:18 226:19
packing 41:4 127:8
paddlewheel 16:18,21 17:2 219:3
page 4:11 25:5 25:6 38:17,18 57:6 116:1 127:24,25 128:1,3,3,4,5 133:13 137:2 137:15,20,20 137:23 141:18 141:18,24,24 141:25 142:16 142:16,17,17 142:20 143:7,7 143:16,17,24 144:6,7,13,20 144:20 145:23 146:2,6 147:2 154:17 156:14 156:18,19,20 156:21,23 162:5,7 177:2 187:5 188:2,3 211:23,24,24 212:2,10,14,15 212:15,17,20 212:20,25,25 213:4,9,10,13 213:16,17,22 213:23 214:5,5 214:7 216:2,15 217:3,4 218:25 220:13 222:14 222:15 229:15 230:4 231:4,7 231:10,13,16 231:19
pages 1:24 11:16 220:1,2 229:14,17,17 230:3,6,6
painting 169:13
pair 78:15 82:16 86:12,20 88:8 92:5,9,21
pairing 123:1
pairs 82:19 152:13
paper 63:6,8 64:2 65:9,24 69:5 182:13 183:1,10 184:1 184:18 190:15 201:7 219:12
papers 218:21 219:3,21 220:7 220:12,16,18
paragraph 11:11,15 18:18 18:24 25:12,13 64:22,24 65:1 72:21 83:25 85:10,12 187:9 187:10 201:18 219:22 220:13
paragraphs 11:18,19,21 12:3,10,20 13:1,5 19:14 52:13 71:20,25 72:2,6,13 90:7 163:4
parent 189:9
part 11:6 15:21 15:24,25 16:2 17:6,9 19:15 19:21 20:16 34:21 62:10,19 70:8 72:3,4,5 75:9 151:25 152:11,21 156:11 157:9 157:11 170:1 172:12,15
partial 182:2 184:2,8,13,14 184:14
partially 132:6
participants 5:9
particular 67:10 142:9 171:25 172:2 202:4,5 206:9 206:19 215:2
particularly 105:24
parties 5:12
partner 112:22
parts 71:21 170:14
party 5:23 228:19
pass 106:18 107:4 211:10
passage 206:7 207:2
passed 29:1
passing 47:15
patent 1:1,2,8 1:11 2:1,2,8,11 2:19 3:3 5:18 5:18 6:7 7:23 8:8 10:11,18 11:3,9 12:13 12:23 13:13,14 17:1 19:7 42:5 45:16 51:13 54:2 62:25 64:11 65:2,7 65:12 67:23 74:18,19 75:2 75:6,21 77:4,5 77:9 81:8,9,19 82:3 84:6,9,13 84:24 86:4,6 86:11 87:14 88:3 90:17 91:10 93:8

95:3 104:8 105:15,16,18 142:14 149:12 149:12,18 158:5 160:8 184:19 197:22 200:3,5 201:15
patentable 85:2
patents 14:23 71:16
pdf 38:17 57:6 116:1 128:3 137:3,4 141:18 141:24 142:17 143:7 144:7,20 145:23 146:2 211:24 212:15 213:9,13,22 214:5 218:25 229:12 230:1
peak 200:11
peaks 69:15
peer 221:3,19
penalty 227:1,4 229:16 230:5
people 52:23 56:18 59:25 173:20 174:19 175:2
percent 30:4 42:24 50:13 52:4,7,19,20 53:3,16,18,24 53:25 54:3,4 55:8,10 59:3 93:18 127:5,6 127:7,7 135:8 168:11 192:8 208:17,22 209:6
percentage 123:18 178:17
perfect 160:15
perfectly 166:11,15
perform 175:2 203:2
performed 172:5,17 173:20 174:8 174:20
performing 206:13
period 58:17 185:2,9,15,21 229:18 230:7
periodic 117:5 225:4
periods 185:19
perjury 227:1,4 229:17 230:6
permit 58:5
permittivity 49:6
person 170:8 171:6 189:13 190:23 193:2,6 225:16
perspective 122:25 123:2
pertains 228:13
petitioner 1:5 2:5 3:10 6:10
petitioner's 158:21
ph.d. 1:16 2:18 3:13 4:4,10 6:17 156:16,25 227:3,17 229:5 231:2,24
phase 43:23 64:16 65:3,4 93:4,5,9,14,15 93:17 94:2,22 94:23 95:7,9 95:11,13,13,15 95:16,20,23,23 95:24,25 96:1 96:4,5,6 97:15 97:16,18,21 98:3 99:12,16 99:17,20,22,23 100:4,23 101:4 102:3,25 116:4 116:14,16 183:13 200:10 200:16,19,25 201:4,8 203:15 204:3,7
phenanthrol 47:7,8
phenanthroline 12:5 13:18,21 13:25 37:17 42:22 43:13 47:6 48:7 50:7 50:18,25 103:11 113:17 138:9 149:8 202:8 207:9
phenanthroli... 48:11 151:5
phenyl 12:6 13:23
photo 97:11 116:16 195:4 198:9,10 199:20
photoactive 39:1
photoelectron 97:22 99:11 116:4,15 118:5 201:8
photoemission 46:4 101:8,13 101:22
photolumines... 46:3
phrase 99:8
phthalocyanine 133:15
physics 38:16
pi 41:8,8 80:12 125:11
pictiva 1:7 2:7 5:16 73:24 229:4 231:1
picture 163:17

piece 51:1,3 170:15
pincer 143:4
pinned 209:11
pitfalls 46:5,6
place 5:12 77:6 132:14 152:10 162:4 195:14 207:7 227:7 228:6
places 192:7
plain 84:15,18 84:21 85:2,12 85:18
plane 41:8
plans 171:4
play 49:4,9,10
played 49:5,6
playing 133:25
please 5:6 6:1 6:12,25 8:22 15:23 38:17 58:5 76:10,17 92:7 97:4 116:1 128:2 161:17 211:21 211:24 217:3
plops 189:24
plume 97:15 167:12,13,14 167:14,16,17 167:20,20 168:8,17,21 174:16 202:23
plumes 168:9 168:19 173:7 175:4 176:13 177:8 191:24 192:8 193:19 193:23
plus 91:10 101:20,23 102:9,11 103:2 123:5 143:24 178:15 179:5,9 179:10 180:11 180:11,23 181:4
point 18:15,20 76:10 108:11 161:17 174:3 182:16 204:15 204:16,18 205:20 209:12 210:17
pointed 199:18
pointing 35:24
points 57:11 107:15
pole 26:10,11
poor 127:15,18
pops 190:15
population 22:25 41:1
port 174:2
posa 84:25 85:20 95:7 158:16 178:6 189:2,3 190:4 204:10
posed 51:6
posita 225:10 225:15
position 108:16 108:18 158:9 158:22,23 159:23 160:9 173:6 174:9,13 176:7,9 195:16 210:19
positioned 174:15
positions 47:9 108:15 217:20 225:3,5
positive 107:18 107:18 108:7
possible 35:7 51:15 83:10 122:13 124:10 125:5 146:15 147:3,18,19
posted 186:12
potent 134:1 136:25
potential 64:17 64:19 65:3,4 65:13 69:13,19 93:5,6,9,11,14 93:15,17 94:3 94:10 96:16,22 97:7,10,16,23 98:6,8 99:13 99:16,23,24 107:12,22 108:8 130:3,7 131:18,20 143:17 144:21 200:10,24
potentially 41:16 45:5
potentials 68:12 69:13
pottt 129:21
powder 120:20
powders 119:13,17,21
power 210:11
powerful 141:12
practical 164:9
precarious 195:16
precursors 219:25
predict 49:16 50:4 109:19,21 111:3,8 112:4 114:25 122:15 122:16
prediction 109:22 110:9 111:2,7
predictions 68:12
preferably 207:13 216:21
preferentially 145:18

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

preferred 113:14 147:4
preluded 132:8
prepared 92:24
preparing 62:7 62:15,23 91:7
prescribe 179:10
presence 127:6
present 3:20 6:3
presented 160:8 173:25 178:25
presenting 91:15,17
preserve 114:3 115:6
preserved 29:11
preserves 114:18
pressure 178:11
presume 153:16
presumption 189:1
pretend 173:16
pretty 18:7 24:16,17 37:16 44:5,9,15 80:10 92:1 105:20 111:7 125:13 134:18 168:5 182:6 185:24,24 196:10,10 203:5 204:9 209:22
prevailingly 108:8
previous 56:16 97:2 162:12
previously 65:6 65:14 98:12 117:9
prime 32:10
princeton 177:22
principle 20:13
print 187:23 188:2,7
printed 188:5
prior 84:7,13 85:21 92:14 105:17 133:13 188:6 190:25 191:3 228:7
priori 50:4 114:25 115:5
priority 184:18
pristine 37:4
privileged 157:18
privy 45:15 186:17
probable 126:25
probably 27:13 55:1 59:10 111:8 113:5 127:4 134:15 139:13 170:17 177:8 188:9 194:22 196:9 203:12 210:25
probe 27:12
probing 21:23 22:9
procedure 229:19,21
proceeding 6:1 7:4 61:25 83:18 84:22 105:13,17 158:12,24 159:18,23,24 190:22,24,25
proceedings 160:16 228:5,7 228:9,15
process 29:25 45:2 72:17,18 72:19,23 73:5 73:12,16 131:1 135:25 152:11 161:3,4 172:17 173:13 185:7 185:13 202:25 203:9 204:14
processes 189:10
processing 175:16,24 205:18 211:5,7
produce 35:10 168:15
produced 128:9 170:18
produces 170:16
producing 133:17 191:23
product 43:9 101:16 147:24 181:21 182:11 183:14,16
products 118:3
professor 32:23
progress 105:20
promote 195:5
promoting 195:14
proof 54:13
proper 8:17 158:21 159:25
properly 20:15 193:6
properties 37:18 43:16 111:24 194:7
property 141:13 166:22 166:23
proportional 117:23

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

proposing 10:2
protect 141:14
protecting 142:15 144:4
proton 118:19
provide 42:10 54:12 55:1 66:18 67:17 75:16,22 76:8 77:3,10,22 79:2,8 80:14 80:19,19 99:1 99:12,15 102:18 109:22 121:1 157:15 158:15 159:9 160:24 161:7 178:9 198:20 206:17,17,23 211:4 221:25
provided 34:8 34:8 45:15 46:13,14 65:18 82:22 83:14,19 89:2,4 103:1 105:8 110:4 141:3 157:20 172:3 187:1 229:19 230:8
provides 93:13 168:16
providing 62:25 118:16 224:15
publication 38:15 175:10 185:7 186:4 219:14
publish 184:23 184:25 185:3,5 221:2,2,4,8,9 221:11,14
published 184:21 186:1,3 186:8,23 187:22,24 188:6,8 189:4 219:12
publishes 190:16
publishing 185:11,12 221:19
pull 37:19 71:12 115:19 127:23 153:24 156:12 186:10
pulling 67:12
pulsed 98:22 99:4
purchase 170:14
purchased 171:10
pure 37:5,5 69:24 114:2 128:9,14 209:1 209:1,5
purify 113:1
purities 40:4
purpose 46:8 150:4,7 171:11 210:21
purposely 114:16
purposes 7:19 159:2
push 45:9 209:21
pushing 210:2 210:2,11
put 22:25 23:1 24:8 35:3 105:9 122:22 139:1 148:20 166:1 188:2 204:7 206:8
puts 195:15
putting 24:6 174:12
pyridine 218:14
pyridines 138:12,15
pyrimidine 215:12
pyrimido 215:12

q

q3 104:10
quality 5:7,8
quantify 21:19 35:20 51:7 54:17,25 148:7
quantifying 148:13,14
quantum 68:11 69:9,16 96:13
quartz 176:21 176:22 177:6 177:12,22,23 179:23
question 8:21 9:9 10:5 23:15 24:19 32:21,22 45:23,23 47:10 47:14 50:2 51:6 58:20 60:18 66:17 67:1 68:20 71:10 74:7 76:17,22 81:22 82:20 85:8 87:13 96:25 97:1,3 106:8 121:23 137:18 154:20 162:12 163:7 170:25 175:19 180:6 184:3 195:7 197:23 199:4
questioning 63:25 88:1 89:12 154:23
questions 13:4 211:18 212:1 216:24 226:13

quickly 116:20
quinolate 16:16 27:25 28:18 29:6 73:18,20 73:24 74:9,20 74:23 79:2,9 79:17 80:16,19 80:22,24 81:4 176:5 180:17 181:13
quinoline 104:15
quite 23:23 34:24 43:14 44:7 88:4 106:20 122:21 122:22 134:1 167:5 187:3 195:11 208:19
quoting 81:12 81:13

r

r 3:12 30:1,3,16 30:24 31:2,3,3 47:7 138:6,6 212:8 217:7 224:23 225:2,3 225:5 229:1 231:3,3
r&s 230:1,9
r1 30:19 47:9
r2 30:19
r8 47:9
radiation 35:5
radicals 68:13
raise 134:21
raised 136:2
rand 1:16 2:18 4:4,10 5:15 6:17 7:2 61:10 68:15 76:17 211:18 217:3 226:13,14 227:3,17 229:5 231:2,24
rand's 76:11
range 100:18 100:22,25 101:2 102:2 103:2
rapid 208:6
rapidly 209:12
rate 176:17,18 178:14 179:12 180:10,15 181:6,8 204:17
rates 178:8,9 179:1
rather 38:9 46:22 57:13 58:13 183:14 194:14 203:6
ratio 34:4 127:5 179:19 179:25 180:2,4 180:20
rationale 206:16
ratios 180:7
ray 46:4 163:18
rays 163:23
reach 203:11 203:25
reacting 119:19 120:16 131:4 131:24
reaction 116:15 118:3,22 119:25 121:6 121:11,15,20 123:19 131:14 182:2,11 196:9
reactions 119:3 119:6
reactive 119:10 119:17
reactor 176:1
reacts 119:22
read 18:25 19:1 19:4,15 39:3,5 45:14 52:12 68:1,5 71:3,19 72:6 83:6,11 86:16 117:25 148:24 152:21 153:4 183:10 199:23 227:4
reader 221:16 222:1
readily 37:1 113:1,15 122:23
reading 15:10 62:7 72:13 75:25 82:21 88:11 160:23 190:25 191:2,3 229:24 230:9
readings 26:23
realize 14:20
really 23:23 30:16 34:3 35:12 39:15 55:19,24 63:15 106:4,22 124:16 125:9 153:2 159:8 165:7,14 167:5 199:13 205:4 207:16 224:6
reason 27:13 36:19 53:10 62:21 63:11 66:18 108:9 187:19 208:5 231:6,9,12,15 231:18,21
reasonable 28:9 68:1 123:10 129:15 223:13
reasonably 111:9
reasons 53:6 66:15 212:12
rebuttal 162:9

recall 17:13 36:5,12 190:20 190:24 191:1,3 212:1,3
received 38:5 184:20
recent 185:25
recently 7:6 158:18
recess 61:16 115:15 171:18 207:22 211:15
recited 84:5
recognized 206:14
record 5:5,13 6:4 7:1 39:5 61:14,17 115:13,16 171:16,19 179:22 207:20 207:23 211:12 211:13 226:15 226:17 228:8 228:11
recorded 1:15 2:17 5:11,14 181:15
recording 5:7 5:11
red 60:9 209:20
redirect 153:7 221:6
redox 68:12 69:12 103:12 182:1
reduce 111:22 132:9,13,19,24 132:25 133:3,4 133:6 152:10
reduced 122:23 123:7 131:10 132:6 181:20
reducing 131:2 133:8 136:25
reductant 130:17 182:6 195:17
reductants 130:23,25 131:1 223:11
reduction 181:22 182:1
reductive 45:8 69:15 103:3,7 131:20
refer 10:12 39:23 58:10,11 64:24 65:12 117:8 118:10 203:21 217:18
reference 14:2 14:5 25:1,2 27:6 38:15 39:9,12,23,24 39:24 63:1,3,5 63:17 64:2,4 66:8,13 68:16 82:14,14 96:12 103:24 118:17 121:1,14,20 122:2,9,13 127:24 133:11 141:3 162:6,8 165:1 175:9 182:18 201:2 211:21 214:9
referenced 62:17 93:22 128:22 152:22 153:16 156:16 157:12 229:6
references 40:7 66:20 84:2 102:17 116:20 161:17 162:2 162:13 164:25 200:9 222:4,12
referred 4:9 12:15,22 66:14 70:24 76:22 202:12
referring 11:12 42:8 52:3 55:14 86:23 93:7 99:3 126:19 182:18 201:6 214:15 215:24 220:12
refers 72:18 81:10
reflect 102:19 158:17 188:11
reflects 105:23 190:2
refracted 163:24
refresh 37:21 38:10 66:6 115:20 161:23 161:25 183:21
regarding 61:24 62:25 63:15 71:16 87:14
regardless 209:9
regime 45:10
region 28:4
reindexed 189:7
reiterate 126:17
relate 216:8
related 5:23 30:1 127:19
relationship 71:6 158:10 166:22 168:13
relationships 96:15
relative 26:14 26:19 27:8 28:17 34:4,17 50:17 122:10 185:22 228:18
relatively 18:7 21:6 22:5,6 29:4 38:25 68:10 107:20

124:16 127:4 129:17,18,21 132:9 135:7,10 138:9 152:9 163:22 168:20 185:21 195:16
release 120:19
released 229:22
relevance 154:23 155:7 155:14,22 157:4 158:1 159:4 160:2 192:15 196:21 197:13 198:18 199:1,8 206:5
relevant 25:17 62:24 76:12 89:12 109:25 158:4,12 200:11,13,15 201:9 203:10
reliability 45:18
reliable 44:12 65:16 67:17
rely 63:15 85:16 112:22
relying 29:2
remaining 30:7
remember 65:21 138:12 151:14
reminded 161:12
reminding 183:10
remotely 5:21
remove 134:2
render 84:4
repeat 8:21 23:15 30:22 50:2 66:25 82:18,20 92:7 94:6 96:19,25 97:4 106:8 112:11 128:1 130:5 146:5 163:6 175:19 184:3 186:6 197:23
repeated 146:19,23 147:2 163:14
rephrase 76:24
replicate 222:1
reply 7:6,12,14 7:15,20 8:5,11 8:24 9:10,14 62:2,10,15,20 62:23 64:23 70:9 76:11 83:12 84:12 87:8,15 88:3 89:12 91:8,25 93:2 148:20 156:6 162:25 163:9 171:22 175:14 178:25 186:9 187:1
report 52:5 64:5 70:18,18 71:16 162:6,16 162:21 163:9 180:4
reported 1:21 18:10 42:12 47:1 48:8 51:17,25 53:12 53:13,15,17 66:13 102:3 103:19,20 106:1 128:8 129:11 200:23 205:17
reporter 2:21 6:11,14 125:24 169:24 170:2 228:4
reporter's 228:1
reporting 53:7 53:10 66:23 67:11 205:6
reports 54:10 102:10 180:21
represented 118:24
representing 5:22 6:7
represents 118:10
reproduce 221:17
reproducible 53:8
requested 228:16 230:1,9 230:10
require 113:17
required 203:11 229:20
requires 203:14,16
rereading 156:1
research 17:6 44:23 209:14 221:19
researcher 105:18 194:6
researchers 99:1 179:17
resist 31:7
resistance 20:14,16,17,23 21:13,14,16,19 21:20,22,23 22:17,17 23:6 26:2,8,12 29:4 34:19
resistivity 21:4 21:5,7,13,15,17 26:5,15,16 28:20 29:23,24 29:25 30:1,2,4 30:6,8,18 31:1 31:4,6,8,14,18 31:19,22 32:6

32:25 33:6,8 33:17,18 34:18 36:1 41:11
resistors 30:15
resolidify 203:4
respect 22:6 88:3 116:22 129:19 160:16 172:3 174:13
respectively 7:7
respond 155:24
response 109:8
responses 56:16
responsible 209:17 210:23
rest 33:16 212:9
restrict 89:21 145:12,16,17
restricts 183:17
result 46:9 78:18 91:12 123:18 127:12 180:19
resulted 50:14 92:15
resulting 17:12 162:21 163:10 163:15
results 52:11 77:18 81:11,16 196:24 221:19
retrieve 189:19 190:21
return 229:17 230:6
returning 145:18
reveal 157:17
reverse 28:5,5 33:8
reversible 45:5 103:7,12
review 8:16 19:7 39:24 62:9,14,16,22 63:1,5,8,10,11 65:17 66:12 68:6,9 70:8,17 70:22,23 82:25 152:15,19 153:19 156:6 157:1,8 161:10 161:14 162:10 162:11 187:8 220:7,15 228:15 229:8 229:10,13 230:2
reviewed 11:17 19:9 38:13,14 39:23 62:18 63:19 115:22 115:24 160:18 161:2,6,8,13,15 162:13 186:18 221:3,19
reviewing 68:23 69:3
revisit 103:4 148:19
rho 31:4,20,23 32:1,1,6,10,10 32:11,15 33:1 33:2,2 34:4,4
rice 172:14
right 14:20 21:15 30:3 34:5 35:4 38:13 45:6,15 47:13 49:12 56:14,25 65:18 66:3,8,14 80:24 103:19 106:10 107:20 115:25 124:16 124:21,24 125:8 137:24 140:20,25 151:6 153:4 156:7,12 157:2 161:4,21 162:18 163:3 165:8,10,17 167:23 170:20 176:20 177:3 178:2 181:7,10 190:3 196:18 205:5,6,18 208:23 220:14
rigorous 119:12
ring 140:2,4,11 140:12,24 217:19
rings 140:20 218:14
rise 158:5 208:6
role 49:4,4,5,10 49:11 76:2 159:20
roles 141:15
roman 42:21 42:21 107:1
room 109:9
rotating 167:9 167:13,20
roughly 119:14 207:5
rpr 1:22 228:25
rss 189:23 190:5,12,15
rules 230:8
ruthenium 151:25

s

s 203:13 231:3
s1 57:18 58:3
salbeck 14:15 15:15,16
salesforce 3:14
sample 18:19 109:3 120:20 120:21 193:3
samples 53:22 66:20

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

[samsung - seems]

samsung 1:4 2:4 5:16 71:25 82:22 83:19 229:4 231:1
samsung's 158:8
san 3:16
sandwich 18:4
sandwiched 166:10
satisfying 141:11
save 148:25
saying 20:5 46:7 51:20 64:18 78:11,13 100:21 118:1 119:17,18 131:6,18 138:4 155:24 180:16 193:19,25 206:18
says 52:11,15 54:3 65:2 72:24 73:11 108:19 128:17 178:19,24 180:10 187:12 203:19 207:12 216:20
scenario 33:14 33:19,20,20 133:5
schanze 63:9 70:23 71:4 153:9 161:11 162:13 172:5 186:21 187:4 194:4
schanze's 62:9 63:22 152:22 153:13,25 161:19 171:23 186:18 187:9
schedule 229:10
science 39:16 112:24 166:3 168:18 169:1 185:17,17,20 186:2,15,22 187:5,15,18 188:21 189:1,7 201:7
scientific 43:6 152:11 191:4,5
scientist 37:11 44:15 87:16,21 163:23 169:19 169:21 170:4 178:6
scientists 98:11 160:12 168:3
scope 63:25 76:19 88:1 109:13 122:19 125:15,22 154:6,23 198:12 218:23 221:6,22 222:7 223:8,18,25 224:5,13 225:12
screen 5:10
screenshot 187:14 188:23
scroll 13:15 38:20
scrolling 58:8
se 88:13
seal 154:10,12
sealed 229:20
search 207:1
searching 185:25
second 7:25 8:4 14:21 18:18 21:24 178:16 179:4,7,11,15 180:8,12,14,18 180:24,25 181:5,19
seconds 180:3
section 19:20 21:2 25:7 146:2 167:10 167:10,12,13 167:17,17,20 167:21
sectional 24:11 24:12
sections 19:16 19:17,18 167:24
sector 122:21
see 30:14 37:22 38:12 42:12,15 45:13,19,20 57:25 63:9 64:17 68:1,3 69:20 70:4 72:2 83:10 89:11 112:4 116:6 122:13 128:5,8 138:8 139:22 141:4 141:20,22,22 154:17,20,24 156:15,22,24 156:25 161:24 162:5,7,8 165:4 174:23 177:5 182:20 182:22 183:20 187:12 189:25 193:12 205:20 205:25 209:3 213:24 214:10 214:20 215:13 215:19 216:4 219:2,5,24 220:3
seeing 46:24 156:10
seem 44:16 158:5
seems 129:14 208:6

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

[seen - single]

seen 5:9 45:11 140:2 203:3
segment 76:4,4
select 114:23
selected 142:8
self 118:11 124:14
sell 113:4
semiconductor 18:5,9 21:22 26:25 106:21 127:22 181:18
semiconduct... 129:16 134:11 165:21,22 166:8
sense 46:21 100:2,15 109:1 127:14 148:17
sensing 20:25 178:1
sensitive 119:12,21 124:4 177:7,10 177:18,24
sensors 178:1
sentence 38:23 39:3 64:25 72:24 73:3,11 116:3,6,8,21 117:25
separate 53:21 116:23
separately 199:14
september 229:3
sequential 162:15,20 163:8 164:7
sequentially 166:20
series 42:20 136:20 150:3 152:13 219:21
serve 141:14,15
set 60:12,15 228:6
sets 55:17
seven 146:11
several 81:6
shallow 94:14 194:21
shallower 132:22,23
shallowest 117:7
share 15:1 38:1 38:11 43:13 183:21
shared 82:16 82:19 86:12,20 88:8 92:4,8,21 96:11
sharing 88:5,16 88:18
shift 179:20
shifting 98:13 100:8 179:12 179:13
shining 99:16 101:9,10,11
shortened 138:7
shorter 41:12
shorthand 2:21 228:3,9
show 28:3 103:7 121:3 133:16 139:21 201:7
showed 92:1 103:12
showing 57:8 57:10,13 117:1 117:23 118:3,4 187:5
shown 52:11 79:10 104:8 116:11 117:9 137:19,22 142:2 143:24
side 58:6,7 103:7
siemens 52:6 53:1 54:5,11 55:25 128:11 128:19 129:5
sign 229:16 230:5
signature 228:24 229:22 229:24,24 230:9
silicon 134:13 134:14,15,17 134:23
similar 34:11 39:7 40:9,14 41:21 44:5,7,9 46:17,22,25 48:8 84:11 99:2 104:3,5 134:16 135:12 140:3 191:5 209:7,8 210:7
similarly 47:1
simple 56:22 106:20
simplest 140:24 147:12 217:6 217:10,22,25 226:2
simulation 98:7
simultaneous 71:6 154:25 155:3,15,19 158:10
simultaneously 16:3 164:21 170:22 177:25 194:11
single 10:22 11:7 26:12 50:13 76:5 82:7 106:21 111:9 138:11 138:16 147:11 147:11 168:14

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

[single - specific]

176:21 212:5 218:15
singly 142:9
sir 6:23
sit 40:19 152:9 194:21,25 195:14
site 37:21
sits 47:13 168:12
sitting 47:12 114:2 115:2,3 131:19 173:25 192:18
situation 104:3 104:5 182:3 216:9
situations 80:11
six 59:21 146:11 181:16 220:2
sixth 143:9
skill 170:8 171:6 189:13
slightly 53:22 126:18 144:25 165:4 167:14
slope 136:7,13
small 20:14 135:9
smaller 30:7 32:10,13 123:22 124:11 126:3,21,22 127:8 130:10 139:11
smallest 217:25
solar 34:25 35:6 150:1,2,3 150:7
solid 41:4 43:23 47:15 64:19 65:4 69:19 93:5,10 93:15 94:24,25 95:11,12,13,16 95:21,24 96:1 96:6 97:17 98:3 99:19,23 100:4,12,23 101:4,6,12,15 102:3 119:13 126:12 190:10 202:22,24 203:15
solids 163:24
solution 69:14 69:14 95:23,25 98:5 100:23 183:13
solutions 5:22 229:7
solvents 96:5
somewhat 145:17
soon 56:25
sorry 14:4,10 14:20 17:13,23 18:16 19:4 23:15 41:10 48:6 50:1 64:14,24 65:19 66:7 77:15,16 79:5,12 89:1,4 100:21 121:19 127:3 128:1 130:5 131:9 135:24 138:4 144:24 159:6 162:19 163:6 169:25 178:21 179:21 180:11 181:2 182:23 184:5 185:10 187:8 202:15 208:17,24 214:22
sort 21:17 25:13 27:7 29:7,12 35:5 41:5 43:22 44:19,24 48:25 49:13 50:12 55:19 69:15 90:6 96:14 109:5,25 117:4 117:18,20 123:24 124:4 124:14 126:23 132:7 134:5 136:20 139:11 163:17 170:12 172:24 193:14 197:1 203:4 204:19,22
sounds 9:5 88:11 89:8
source 40:4 46:15 65:13 66:22 67:4,7 168:16,20 176:7,9 177:9 177:17 204:6
sourced 39:25
sources 65:6 67:18 167:22 168:7,8 170:21 173:6 174:9 177:15,17,18 178:5 191:9,19 191:22
space 125:11 150:4,5
spacer 35:2 150:5
spans 42:13,15
speak 7:21 61:21,24 62:5 66:15 70:15 109:15 169:1 221:7,8,23
speaking 107:20 163:22
spec 90:1
species 69:23 70:2 216:11 224:23
specific 10:12 10:24 15:23

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

20:5 33:22 49:20 68:19 77:6 82:11,12 86:25 91:21 100:17 112:23 138:17,19,22 150:15 169:7 189:6 209:17 211:7 212:5 214:14 215:25 216:11 218:5,7 218:16,18 219:7,17 220:4 220:6,18 221:4 221:13,15 222:3,24 223:14 225:9 225:14
specifically 10:9 11:22,24 12:1,4,14,25 13:5 86:5 87:15 92:20 102:6 105:18 120:8 121:15 136:22 150:1
specification 60:21 84:16
specify 15:19
spectra 116:5 116:15,16,23 118:5,11,20,23 120:22 121:3 201:8
spectroscopy 46:4 97:11,22 99:12 101:8 199:20
spectrum 118:9
spelling 139:1
spent 62:6
spherical 122:23
spherically 123:2 124:13
spilling 14:21
spoke 62:1,4 126:10
spot 123:6 193:20,23
spots 192:4 193:10,13,15
squared 25:23 57:19,20 58:15 58:16 59:1,9 59:14,19 210:1
squares 58:3
squiggly 179:3
stability 108:25 113:20 114:20 201:23 202:3 204:12,22 205:24 206:1,3 206:15
stabilize 113:6
stable 113:8
stack 31:17
standard 68:12 103:24
standards 219:14
standing 173:25
standpoint 35:15,16
stands 101:11
stars 3:6
start 44:16 58:22 200:17 200:21
started 191:16 203:8
starting 18:22 38:23 58:15 116:4 154:21 154:25 203:17 209:8,8,9,12 210:1 215:1
state 6:1,3,25 36:22 76:14 84:7 94:25 95:21 115:7 123:5 186:8 203:8 227:11 228:4 229:9,12
stated 111:14 160:6 181:4 188:23
statement 110:24 206:17
states 1:1 2:1 5:18 72:16,21 136:25 178:13
stating 160:5
staying 29:4,14
stays 29:24
step 182:12
stipulates 67:23
stipulation 229:21
stoichiometries 166:7
stop 76:15
straightforward 21:6
street 3:15
strengthen 8:6
strengths 90:11
stress 109:11 109:17
stressing 109:6
strictly 120:14
strides 105:21
strike 7:14 8:15 16:6 26:3 34:15 59:24 67:5 73:19 74:24 80:17 90:20 94:9 99:10 101:1 103:9 106:2 119:4 121:8,9 153:9 167:15 171:1 173:11 181:3 184:22 185:14 200:4

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

striving 60:1
strong 130:22 148:17 182:6 195:17
strongly 80:11 112:18 136:7
structural 49:4 123:24 134:1 167:1
structure 18:4 18:6 20:3 21:12 22:1,16 23:13,14,21,22 26:4 34:14,16 35:23 41:13,14 48:24 52:14,16 52:17 90:14 111:4 134:2 137:19 138:17 138:20,22,22 139:15,17 140:25 162:22 163:15 164:1,3 165:6 166:21 166:23 212:4,5 212:7 216:7 218:11
structures 22:3 140:19 141:5 142:13 143:18 143:23 145:5 147:3 163:10 166:5 212:2
study 134:17
stuff 21:20 62:3
sub 203:13
subject 114:15
sublimation 43:19 117:22 128:10 201:24 202:5,11,18,25 203:9,13,21,23 204:2,11,15 205:4,7,10 206:10,21 207:15
sublime 170:21
sublimed 117:13 203:6
sublimes 202:14
subliming 205:8
submitted 7:3 38:3
subscribe 189:23
subscribed 228:21
subsequent 25:15 57:11
substantial 43:19,21 105:2
substantially 41:24 132:22
substituents 47:7,8
substitution 226:3,7
substrate 114:1 114:3 115:3,4 167:8,19 168:6 168:10 174:13 174:17 176:7 176:10 177:10 177:15 178:2 192:1,5,18 193:8,15,24 204:1,8
substrates 40:4 174:5
succeed 152:3,5
success 123:10 223:13
successful 123:19
successively 109:3
sufficient 168:18,22 174:7 178:4 191:12 194:1 221:25
sufficiently 20:14 168:7
suitable 43:1
suite 3:6,15
sum 176:18 177:19 179:1 180:14,25
sun 35:10
supervising 172:13
supplied 82:16 86:13,20 88:8 88:22 92:5,9 92:21
supply 20:15
supporting 68:25 175:10 175:15
supposed 71:24
sure 9:10 10:5 23:23 24:18 30:23,23 37:25 44:10 45:22 49:11 50:4 53:15 61:13 63:19 68:5,15 83:24 85:7 93:18 98:25 107:25 115:12 122:3 134:10 139:13,16 147:14 149:4 153:15 157:19 161:20 171:15 195:6,25 196:14 197:7 200:17 204:9 206:25 207:19 217:13,14 218:3
surface 110:20 111:3
surname 70:20 70:21

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

surnames 15:7
surprised 39:13,16
surprising 40:6
surrounded 104:15
surrounding 52:13
suspended 98:4
sweeping 45:3
symbol 31:2
symbols 58:9 58:10,11
symmetric 123:3 124:13
syn 190:5
synthesis 219:24 220:8
synthesize 112:23
synthesized 120:20
synthetic 112:22 184:24 185:1,4,6,10 190:9 219:11
system 33:16 35:14 50:14 55:23 56:20 78:19 135:1,2 164:2 171:10
systems 129:23 139:14

t

t 136:3 138:6 203:13 231:3,3
t0 167:16
t1 167:14,20
t50 59:2,25 60:12,15,20
tab 14:9 58:7 68:7
table 13:15,16 13:18 19:21,22 36:16 42:8,12 44:6 46:14,23 51:14 52:2,6,8 52:12 53:2,12 54:10 55:3,5,8 56:7 69:20,20 69:21,22,25 70:1,2,2,5,6,7 103:16,20 110:17 117:5 206:24,24 207:10 225:4
tabs 14:11 161:20
take 5:12 11:10 24:10 35:17 43:25 46:21 53:12 56:24 57:3 61:12 65:8 68:15 81:2 85:10 106:9 120:15 137:7 145:22 147:25 158:22 158:23 159:22 165:20 166:2 170:7 171:5 182:12 201:13 204:20 207:11 207:17 212:4 216:1,14 218:25 222:13
taken 2:18 26:22 61:16 96:4 115:15 125:10 171:18 207:22 211:15 228:5
takes 180:3 190:1
talk 12:3 62:2 73:15 77:7 82:19 87:9 93:9 195:16
talked 134:4 216:6
talking 10:13 62:11 79:24 81:3 88:2 103:15 114:1 120:16 125:4 132:8,12 142:6 178:21 198:9 200:18 209:24
talks 10:18 43:17 117:12 214:18 215:1,3 215:7,11,18
tandem 34:25 150:1
target 178:10 178:10 180:15 181:18
taught 11:3 32:23
taz 12:7 13:1 13:20 129:20
tbbi 129:20
teach 113:10
teaches 165:2
teachings 127:2 127:4
team 15:21,24 15:25 16:2,20 17:7,8 34:21 40:11 172:12 177:22
technique 45:13 98:13 163:19
techniques 119:12
technology 5:21
tell 110:5 136:7 161:15 163:21 168:11 189:20 202:19 220:14
tells 163:19
temperature 43:18,19 49:10 109:6,7,9,12 110:7,10,16,24

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

117:22 134:21 136:4,9 191:15 202:11,12,19 203:11,13,20 203:21,25 204:2,3,5,9,12 204:18,20,25 205:4,5,7,10,11 205:15,24,25 206:2,21 207:5 207:8,14,15 224:18
temperatures 109:23 110:3 110:22 117:13 120:21,24 201:25 202:6 205:16 206:11
temporary 188:1
tend 39:21 40:22,24
tends 40:15,25 112:13
tens 79:24,24 180:2
teraline 138:5
term 9:21 85:25 86:5 89:20 90:3,15 193:4
terminal 107:12 189:5
terminals 26:10
terminology 85:17
terms 39:21 85:4
terpy 137:24 138:7 218:11
terpyridine 137:25 138:3,6 138:19,24 142:24 218:12
test 109:25 110:11 152:12
testified 6:19
testifying 228:8
testimony 148:18 149:2 226:6 227:5,7 228:12
testing 106:4,4 106:11 109:11
text 93:7
textbook 88:12
tga 204:24
thank 32:20 35:23 63:7 183:9 226:13 226:14
thankfully 32:23
theories 8:11 8:23 9:13
theory 42:1,17 69:8
thermal 43:16 108:25 109:23 109:24 110:3 110:19 111:24 113:20 136:3 168:4 201:23 202:3 204:5,12 204:22 205:24 206:1,2 210:14
thermally 113:8 134:12 134:20 204:13
thermodyna... 112:3
thesis 117:11
thick 22:10 27:22,24 28:15 166:9,10 208:18,21
thickness 24:13 29:2 164:12,23 165:2 179:22 224:16
thicknesses 163:14 180:5
thin 18:19 20:7 22:5 27:19 40:10 190:10 208:19 209:15
thing 20:9 21:19 22:25 29:18,19 45:7 47:17 113:4 160:5,6 170:13 179:16 202:14 210:24 214:15 214:16
things 31:16 46:5 85:16 92:2 105:9 110:20 113:7 114:19 123:25 134:25 158:17 160:11 163:18 174:22 209:19
think 13:3 14:8 16:25 27:12 28:10,13 30:13 32:12 36:14,15 42:8 44:24 59:24 60:11 65:14 66:16,16 67:25 70:21 71:9 85:23 90:4 96:24 98:22 106:18 113:25 114:22 115:20 122:16 124:10 127:12 129:14,15 132:10 134:17 138:13 139:22 143:2 149:1 157:22 158:2,8 158:21 159:22 161:23 162:3 164:25 183:12 189:9 190:11 192:16 195:3 201:2,11 203:10,24 204:10 207:3

208:13 213:13 214:5 219:22 225:15
thinking 74:22
thought 63:14 74:13 121:23 125:19 135:23 141:11,15 184:4 205:9
thousand 209:23
three 11:17,19 11:21 12:3,10 12:20 13:1,5 40:19 78:16 104:15 116:23 116:24 118:24 138:11,15 146:10 162:17 177:23,24 190:11 218:14 219:21 223:4 223:14
ticking 37:7 109:6
time 6:1 17:5 37:7,10 57:9 57:11,14 58:17 60:4,17 61:15 61:18 62:7 68:9,16 71:14 84:8,25 93:22 105:23 109:3 111:19 112:3 112:25 115:10 115:14,17 156:10 158:16 158:18 167:12 167:25 171:13 171:17,20 174:6 179:24 185:1,8,19,21 185:22 188:9 189:4 190:7,12 191:10,20 192:22 193:8 193:10,13,20 193:24 200:1 207:21,24 211:14 216:24 226:15,17,19 227:7 228:6 229:10,18,25 230:7
times 19:11 24:13 30:11 32:12 34:1 39:10 43:10 45:7 52:5 53:1 53:4,16,18 54:4,11,21 55:2,6,9,13,13 55:25 62:8 81:6 128:11,18 147:2 164:17 167:25 220:25
tin 25:20 108:19
title 68:11 189:25
today 160:5 169:7
today's 226:16
together 125:11 138:15 166:6 218:15
told 56:15
took 83:25 86:5 91:9
toolbox 96:14
top 20:7,12,20 25:16 36:13 90:7 102:15 108:7 114:12 222:11
topic 73:1 74:12
torben 183:24
torr 117:15 178:11,12
total 29:25 32:25 47:14 164:23 177:19 179:22 180:5 180:16,24 181:5,18
totally 45:5 159:24
tough 37:13 123:6
toward 19:19 25:13 199:18
tower 3:14
tpy 138:7,8
trademark 1:1 2:1 5:18
trading 134:5
training 44:22 44:22
transcribed 228:10
transcript 62:10,17,19,22 63:9,22 70:17 70:22,25 71:4 71:9 148:25 152:16,19 153:8,12 154:1 154:8,11,17 156:11,16,24 157:9,12 228:11,14,16 229:6,8,10,13 229:13,22 230:2,2
transcription 227:6
transfer 89:10 121:11,15 131:25 132:15 182:3,14 184:8 184:8,15 195:4 195:6 196:8 197:11 198:1 200:14,15,19 222:21
transferring 195:2

transient 113:12
transition 43:18 109:23 110:6,9,16,23 202:22 216:21
transparency 39:8
transparent 108:4
transport 17:11 34:22 41:20 129:19 134:13,20,24 135:2 183:7 184:2,2,4 191:7 208:13
transporting 22:12 41:7 58:12 129:16 151:11
trapped 41:5
trash 131:25
treatment 114:15,16
trend 96:7
trends 29:10 96:3
trial 1:2 2:2 5:19
triazole 12:7
tricky 202:14
tridentate 138:13,14
tried 16:7,10 16:13 150:9
true 46:2 201:22 227:6 228:11
try 35:1 98:5 98:11 113:10 126:17 179:18 182:24 194:6 224:9
trying 8:10,23 9:13 21:13 22:4 23:12,18 23:20 27:2 96:6 111:22 190:20 196:8
tuesday 1:18 2:20 5:1
tune 102:11 136:1
tungsten 15:18 52:17 116:25 117:3,5,7,17 123:4,22 124:17,23 125:20 126:2 126:22 127:1 131:9,12 132:1 132:11 133:20 136:21 145:19 146:1,8 149:6 216:21
tungsten2 17:3 17:10 47:3,25 48:10,12 50:19 52:1,7,8,16 63:18 68:4,22 93:6,23 94:1 94:11 122:6,12 124:12 126:21 130:2,6,9 132:14 133:7 135:4,11 137:9 137:11,14 149:7,20 150:9 150:18,21 151:7,9,22 181:21,24 182:5,14,17 183:8,15 184:7 194:12 195:9 196:18 197:12 197:17 198:2 199:13 200:7 201:9 223:23
turn 212:14 213:9,16,22 214:4 217:3
turned 172:24
turning 213:4 216:15
twice 19:12,15 19:16 70:22
two 7:3 11:19 11:23,24 12:1 12:2,4,6,9,12 12:14 13:3,4 13:23 14:7,11 14:25 16:23 18:1,2,5,7 24:1 24:5,8,14 26:9 30:5,15 33:1 37:1 39:11,13 40:7,9,13 41:11 42:2,13 42:15 43:7,8 44:2 47:8,19 48:17,17 51:24 52:21,23 53:4 53:19,21 55:12 55:17,17 56:11 58:5 66:9,20 66:20 67:12,12 67:14 71:16 72:2,6,13 78:24 79:23,25 82:15,16 86:12 86:13,19,21 88:7,9,18,23 89:5 90:7 92:5 92:9,22 106:17 106:20 107:6 107:15 109:2 114:17 123:5 126:23 131:23 135:12 146:10 157:6,12 162:17 163:13 164:21,25 176:19,21,22 176:23,25 177:3,6,12,13 177:16,17 178:15 179:1,3 179:19 180:5

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

191:8,9,17,18 191:24 192:7 192:21 193:19 193:23 194:8 194:11 197:3 197:14 219:21
type 60:3,4,8 89:17 107:4 109:17 135:2 139:4 145:12 160:24 166:25 169:15 216:3 216:12,17 224:16
types 82:12 85:16 90:10 136:24 172:23 174:22
typical 59:25 90:16 102:19 102:22 108:6 221:18
typically 101:19 103:1 108:1
typo 52:15 53:8 55:18 56:1,22

u

u 101:10,10
uh 18:21 23:4 32:8 80:9 120:5 161:22 163:2 164:22 164:24 165:14 167:11 201:16 202:10 222:10
ultimate 48:16 188:9
ultimately 20:24
ultra 97:14
ultraviolet 97:11 99:10,11 101:10,11
unable 26:21
unambiguous 52:18
unaware 159:19 185:19
uncapped 115:4
unclear 53:6 184:10 199:23
uncomfortable 47:18 72:12
uncommon 170:13
under 35:10,19 108:5,6 109:11 109:17 143:3 154:9,12 188:25 227:1,4 228:10
underlying 21:10 45:25 46:10,24 56:20 65:9,17
underneath 55:18
understand 10:5 32:21 47:21 50:1 66:22 67:4,7 68:16 85:7 108:11 118:14 153:5,8,11 159:11 185:12 194:7 196:14
understanding 21:1 84:20 85:20 87:10,18 87:22 88:4 126:25
understood 29:22 71:24
undoped 23:8 28:1 30:2 31:25 32:18 34:4 54:6,10 54:25 55:2,3,4 129:24
unfamiliar 82:24
unfilled 58:9
unfortunately 45:20 183:9
uniformly 29:1
unit 54:18 82:6 82:6
united 1:1 2:1 5:17
university 70:14 117:11 172:14 177:22
unknowable 51:20
unknowingly 46:7
unoccupied 46:20
unreliable 45:6
unsurprisingly 59:20
unwilling 33:19
updated 188:13
uploaded 182:21
upper 50:15
ups 99:10,11,15 99:22 100:2 101:9,19 198:10,10 199:12,16,24 200:6,9
use 5:21 9:16 16:10 17:2 18:3 20:21 25:10 27:4,11 31:1,2 35:1 37:6 39:15,18 60:16 65:11 69:17 94:2,7 94:10,18 95:4 95:6,7,13 97:10 98:1 112:8,15,24 113:3,17 139:8 150:9 168:4,19 171:10 175:21

176:1,20 177:22 179:8,9 185:23 193:5 221:25
used 15:22 16:1 16:2,20 17:10 21:18 28:10 65:12 90:1 94:13,15,23,25 97:7 98:10 99:19 100:2 128:20 129:8 139:23 140:15 141:5 142:3,20 143:10,18 144:8 145:6,10 145:13 150:4 150:13,14,18 150:20 151:9 151:10,13,17 151:19,20,22 151:23 168:16 168:25 170:17 172:22,23 175:23 176:3 185:20 203:24 208:20 222:20 222:25 223:4 223:10 225:2 225:23
user 168:15
uses 60:11
using 18:20 20:2 21:12,25 22:15 23:13,21 30:24 31:3 46:14 54:19 58:10,12 90:6 94:16 95:15 96:7,8,13 98:12 119:12 131:13 136:24 149:25 150:4 173:13 174:1 177:6 224:10 224:10 225:4 228:9
usually 22:8 24:4 31:4 45:3 60:15 95:23 101:22 103:1 108:4 117:22 168:21 204:23
uttered 125:25
uv 99:17 101:14

v

v 1:6 2:6 165:20,22 166:8 229:4 231:1
vacuum 96:6 97:14 117:15 128:10 130:10 131:19 176:3,3 195:11 202:15 202:16,16,17 204:23 205:1
validate 141:9
validity 159:12
value 26:14 27:3,14 28:13 43:25 50:11 53:19,21 69:18 93:13,18 94:18 102:13,16 129:2,4 130:10 134:18 135:24 200:11,12 201:12 207:11
values 39:25 55:17 67:12 69:12 96:9 102:18,19
vapor 43:23 97:15 100:13 100:23 191:16 191:23 193:7 203:17 204:3,7
vaporization 71:2,7 72:9,10 72:18,24 73:6 73:13,16 154:25 155:1,4 155:4,16,19,20 158:10 160:20 161:3 203:14
vapors 170:22
variation 55:19 56:19
various 27:25 56:17,19 220:8 220:11
varying 164:2 178:16
verify 187:2,15
veritext 5:22 37:21 66:1,4 229:7,9,11,20
version 117:16 186:12 217:16
versus 5:16 23:19,21 29:9 29:13 32:18 34:4,14,18 36:1 52:2 53:13 96:5 100:23,23 107:21,22 122:12 134:6 135:11 178:12 208:19
vertical 18:4 22:1,3,15,15 23:13,21 24:3 24:22,25 25:25 26:1,4,16 27:9 27:11 34:13,16 108:16
vertically 22:8
video 1:15 2:17 5:11
videoconfere... 1:15 2:17
videographer 3:21 5:4,23 6:11 61:14,17 115:13,16

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

171:16,19 207:20,23 211:13 226:16
view 71:1,5 72:8 85:21 188:5
viewed 8:4
views 160:4
virtual 5:21
virtually 5:7
voltage 20:24 23:11,19 24:1 24:6,8 26:10 26:11 29:9,13 29:13 33:22 35:7,11,12,17 45:3,9 47:16 107:3 209:12 210:5,6,6,13,17 211:1 224:17
voltammetry 44:14,18 95:20 95:22 98:1,23 99:5 102:23 103:9,11,22,25
voltammogram 45:2,6 103:6
voltammogra... 45:11 104:7
volts 39:11 101:21 135:19
volume 1:19 2:18 4:4 188:8
vu 148:17

w

w 3:13 42:23
w2 42:23 50:8 50:13,23 52:4 52:9 55:9 65:3 69:19 91:11 93:10 107:2 131:7 137:23 149:15,16 182:8 194:19 194:22 196:24 201:4 208:18 209:6 223:1
wait 130:17 156:18
waived 229:24 229:24
waiving 229:21
wall 62:1,5
want 8:16,21 21:16,18,19 35:6 37:3 39:6 71:22 83:23 88:12 90:9 113:4,8 116:20 119:16 123:8 157:1,8 168:23 170:20 205:9 221:24
wanted 122:3 141:13 173:7
wants 114:21 123:7 178:6
way 29:7,12 44:16 45:3,25 49:1 51:7,14 55:3 56:23 67:15 69:12,17 82:2,24 84:11 86:6 98:7 101:7 114:18 122:24 123:11 127:14 134:15 168:13 174:15 183:11 185:24 187:2 189:1 191:13,25 194:10 203:1 205:21 221:15 221:18 224:19
ways 98:13 113:6,11
wchoi 3:19
we've 61:9 115:9 120:10 134:4 171:12 222:25 225:16
web 185:17,20 186:2,15,22 187:5,15,18 188:21 189:1,7
website 190:1
weekly 185:23
weigh 40:6
weight 117:19 117:21 127:7 180:19,20 207:9 217:11 217:15,16 218:1,8 224:23 225:6
weights 43:15
weird 44:16
welcome 61:20
went 33:11 152:4 180:15
werner 14:2,4 14:15,16,17,22 15:5,5,8,8 27:6 46:11 62:7 82:14 92:1 127:2,24 128:8 128:14,17 129:4 133:10 133:12 136:14 137:2,20,23 141:3 142:14 144:3 145:5,12 148:4 211:21 218:21 220:8 222:5 223:9
whereof 228:20
wholly 82:23
width 24:14 29:1
window 205:18 205:18
wiring 21:21
wise 78:15
wish 148:24
withstand 110:11
witness 4:3 5:10 6:10,13 7:19 8:4 9:16

10:17 12:12,20
13:11 16:13
17:21 19:4
22:20 30:13
32:20 33:14
34:7,21 36:4
40:18 42:5,20
47:5 48:3,14
48:24 49:19
50:21 51:12
56:5 60:3,14
60:23 63:3
64:1,8 66:25
67:10 68:19
72:12,21 73:11
73:23 74:5,12
75:5,16,25
76:22 77:13
78:4,13,23
79:5,16,21
80:6,22 83:6
83:22 85:7
86:3,15,23
87:5,13,21
88:2,11,20
89:1,8,17 90:1
90:25 91:7,21
92:12,24 94:6
94:13,20 95:6
96:19,24 97:9
99:7,15 100:1
100:7,21 101:6
102:6,15
103:15 104:5
104:13,20
105:1,8 106:25
109:14,21
111:6,14,21
112:11,18
113:22 114:10
116:10,19
118:8 119:9,25
120:19 121:14
122:8,20
123:16 125:16
125:23 126:17
127:18 128:17
129:1,8,14
130:9,17,22
131:6,17 132:4
132:21 135:6
135:18 138:24
139:7,21
140:14 141:8
142:6,23
143:13,20
144:3,11,17,24
145:8,16
146:14,22
147:7,14,22
148:6,12
149:11,24
150:12,20
151:22 152:7
152:18,25
153:15,22
154:15,24
155:8,15,23
157:5,11,17,19
158:2,15 159:5
159:16 160:3
160:22 161:6
162:24 164:11
165:10,19
168:3 169:6,13
169:22,25
170:3,11 171:9
172:8 173:16
174:11,22
175:6 178:19
180:10 181:24
182:16 184:10
186:6 187:17
188:25 189:17
191:22 192:7
192:16 193:1
193:17 194:16
196:7,14,22
197:7,14,22
198:4,19 199:2
199:9,16 202:2
206:6 207:19
208:9 211:10
217:9,24
219:10,19
220:11,21
221:7,23 222:8
222:23 223:9
223:19 224:1,6
224:14 225:1
225:13,22
226:7 227:3
228:20 229:13
229:16 230:2,5
witnesses 228:7
wonder 56:24
wondering 36:11
word 9:16 39:16,18 65:11 81:6 125:25 128:20 129:8 148:1
words 69:18 191:6
work 37:9 62:19 94:3,11 124:5 149:20 152:9 169:3,10 169:16 178:3 188:6
worked 17:5,21 36:17,18 61:7 93:23,25 168:12 189:8
working 17:19 17:25 24:20 26:25 27:1 60:24 61:2
works 112:25
worry 22:16 23:5 26:2
wrong 83:24 156:23 208:24
wrote 82:2

x

x 4:1 46:4 163:18,23 189:25

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

xps 46:4
xx 228:16 229:12

y

y 138:6
yager 3:21 5:22
yang 166:17
yeah 14:9 25:5 30:18,23 32:14 43:24 50:1 52:14,25 66:7 70:2 77:2 83:24 98:20 104:5 107:17 114:8 117:25 125:8 126:4 129:14 131:17 134:10 139:7 139:12 140:12 140:17 142:6 143:4,13 145:8 147:24 156:21 156:22,22,22 162:8 164:19 174:22 177:1,3 177:5 186:12 195:19 202:13 214:7
year 60:5
years 61:4 96:3 169:7
yep 199:22
yield 225:6
yielding 79:10
younger 139:11
ytterbium 16:14 151:14 151:16,24

z

zero 26:12 167:12 195:12
zhong 3:5 4:6 6:6,6,22 7:24 8:9,14,20 9:3,7 9:8,18 10:1,23 12:16,24 13:12 16:15 17:22 19:6 22:21 30:17 33:4,24 34:12 35:22 36:6 40:21 42:6 44:4 47:20 48:5,19 49:15,21 51:8 51:18 56:9,13 57:23 60:6,19 61:1,13,19 63:4 64:3,9 67:2,20 68:17 68:21 72:15 73:4,8,14 74:1 74:6,16,24 75:1,12,19 76:6,14,16,21 77:1,20 78:1,8 78:20 79:1,6 79:18 80:2,8 81:5 83:8 84:14 85:9 86:8,18 87:2,6 87:17,23 88:6 88:17,21 89:3 89:13,19 90:19 91:3,16 92:3 92:18 93:3 94:8,17 95:2 95:18 96:20 97:5 98:17 99:9,21 100:3 100:9,24 102:1 102:12,21 103:17 104:9 104:16,22 105:5,11 107:8 107:24 109:18 110:13 111:11 111:17 112:6 112:12 113:13 113:23 114:24 115:12,18 116:12 118:2 119:1,20 120:2 121:7,17 122:14 123:12 124:7,20 125:18 126:1,8 127:10,20 128:21 129:3 129:10 130:1 130:12,18,24 131:8,22 132:17 133:1 135:14,20 138:2 139:1,3 139:9 140:1,16 141:2,16 142:11 143:1 143:15,22 144:5,12,19 145:1,11,21 146:17,24 147:8,16 148:2 148:8,15 149:19 150:8 150:16,22 151:1,4 152:2 152:14,20 153:1,18,23 154:4,7,8,13,16 155:2,10,17 156:4 157:7,13 157:21 158:7 158:20 159:1 159:10,21 160:17 161:1,9 163:1 164:18 165:13 167:7 169:2,9,17 170:5,24 171:15,21 172:9 173:10 173:18 174:18 175:1,8 178:20 181:1 182:10 182:19 184:17 186:7 188:15 189:11,18 192:3,11,20 193:9,18 195:8

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

[zhong - znpc]

195:23 196:2
196:11,16
197:4,9,18,24
198:6,22 199:5
199:11 200:2
202:7 205:13
206:20 207:17
208:1,15
211:10 217:2
217:12 218:2
218:24 219:15
219:23 220:17
220:23 221:10
222:2,9 223:2
223:15,21
224:3,7,20
225:8,18 226:1
226:9,12
zinc 133:15
145:25 146:8
znpc 133:2,3,5
133:8,15,19,22
133:23 134:2
135:4,13 164:5
164:6

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

California Code of Civil Procedure

Article 5. Transcript or Recording

Section 2025.520

(a) If the deposition testimony is stenographically recorded, the deposition officer shall send written notice to the deponent and to all parties attending the deposition when the Original transcript of the testimony for each session of the deposition is available for reading, correcting, and signing, unless the deponent and the attending parties agree on the record that the reading, correcting, and signing of the transcript of the testimony will be waived or that the reading, correcting, and signing of a transcript of the testimony will take place after the entire deposition has been concluded or at some other specific time.

(b) For 30 days following each notice under subdivision (a), unless the attending parties and the deponent agree on the record or otherwise in writing to a longer or shorter time period, the deponent may change the form or the substance of the answer to a question, and may either approve the transcript of the deposition by signing it, or

refuse to approve the transcript by not signing it.

(c) Alternatively, within this same period, the deponent may change the form or the substance of the answer to any question and may approve or refuse to approve the transcript by means of a letter to the deposition officer signed by the deponent which is mailed by certified or registered mail with return receipt requested. A copy of that letter shall be sent by first-class mail to all parties attending the deposition.

(d) For good cause shown, the court may shorten the 30-day period for making changes, approving, or refusing to approve the transcript.

(e) The deposition officer shall indicate on the original of the transcript, if the deponent has not already done so at the office of the deposition officer, any action taken by the deponent and indicate on the original of the transcript, the deponent's approval of, or failure or refusal to approve, the transcript. The deposition officer shall also notify in writing the parties attending the deposition of any changes which the deponent timely made in person.

(f) If the deponent fails or refuses to approve the transcript within the allotted period, the

deposition shall be given the same effect as though it had been approved, subject to any changes timely made by the deponent.

(g) Notwithstanding subdivision (f), on a seasonable motion to suppress the deposition, accompanied by a meet and confer declaration under Section 2016.040, the court may determine that the reasons given for the failure or refusal to approve the transcript require rejection of the deposition in whole or in part.

(h) The court shall impose a monetary sanction under Chapter 7 (commencing with Section 2023.010) against any party, person, or attorney who unsuccessfully makes or opposes a motion to suppress a deposition under this section, unless the court finds that the one subject to the sanction acted with substantial justification or that other circumstances make the imposition of the sanction unjust.

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Samsung v Pictiva
IPR2024-01094

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Quantum-Chemical Predictions of Absolute Standard Redox Potentials of Diverse Organic Molecules and Free Radicals in Acetonitrile

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Abstract: A calibrated B3LYP/6-311++G(2df,2p)//B3LYP/6-31+G(d) method was found to be able to predict the gas-phase adiabatic ionization potentials of 160 structurally unrelated organic molecules with a precision of 0.14 eV. A PCM solvation model was benchmarked that could predict the pK_a's of 15 organic acids in acetonitrile with a precision of 1.0 pK_a unit. Combining the above two methods, we developed a generally applicable protocol that could successfully predict the standard redox potentials of 270 structurally unrelated organic molecules in acetonitrile. The standard deviation of the predictions was 0.17 V. The study demonstrated that computational electrochemistry could become a powerful tool for the organic chemical community. It also confirmed that the continuum solvation theory could correctly predict the solvation energies of organic radicals. Finally, with the help of the newly developed protocol we were able to establish a scale of standard redox potentials for diverse types of organic free radicals for the first time. Knowledge about these redox potentials should be of great value for understanding the numerous electron-transfer reactions in organic and bioorganic chemistry.

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1. Introduction

The propensity of an organic molecule to donate or accept an electron in solution is measured by its (one-electron) standard redox potential ($E°$).[1] A sound knowledge about standard redox potentials is fundamental to understanding the innumerable chemical and biological electron-transfer reactions. Thus chemists have developed, and are still developing, a variety of experimental methods to obtain the $E°$ data. At present, the most popular experimental method for measuring $E°$ is cyclic voltammetry.[2] The error of this method is usually as low as 0.01−0.02 V when the redox process is reversible. However, for nonreversible redox reactions the experimental situation is complicated, and accurate $E°$ values are available only via some sophisticated techniques such as pulse radiolysis.[2] Therefore, it is not always easy to obtain reliable experimental $E°$ data. Furthermore, for the species that are highly unstable (e.g., organic radicals), it can be very difficult to measure their standard redox potentials experimentally.

Recognizing the limitations of the experimental methods, some research groups recently tried to develop theoretical approaches to predict the standard redox potentials in solution. A general idea in these studies is to employ a certain theoretical method (i.e., AM1,[3] PM3,[4] DFT[5−9]) to compute the gas-phase ionization energies and then add the solvation energy terms calculated using either an explicit[6] or implicit[3−9] solvation model. The results from these pioneering studies are usually in reasonable agreement with the experiments. However, each of the above studies only considered the redox potentials of a fairly small group of closely related compounds. In some occasions, only the relative $E°$ values between a few structurally related compounds were obtained instead of the absolute values.[8] Thus, it still remains unclear whether one could develop a generally applicable protocol to accurately predict the absolute $E°$ values for a large number of structurally unrelated molecules.

(1) The standard redox potential refers to standard conditions (i.e., all reactants are 1.0 M or 1 atm pressure, 298 K). Also, in the present study we only considered the single-electron transfer redox potentials. Furthermore, people have defined both the oxidation potentials and reduction potentials by using different orders of half reactions. In the present study, we only considered the redox potential that corresponded to the oxidation of a species. For the reduction of a species, one just needs to consider the oxidation of the corresponding reduced form.

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We recently launched a program to systematically investigate how to utilize the modern quantum-chemical methods to gain useful, quantitative data for realistic, solution-phase organic chemistry. In the first step, we benchmarked a generally applicable protocol to calculate the pK_a values of diverse organic acids in dimethyl sulfoxide with a precision of 1.7−1.8 pK_a units.[10] Herein we wished to develop a first-principle protocol that could be used to predict the absolute standard redox potentials of diverse types of organic molecules. The significance of the study is twofold: (1) to benchmark a generally applicable theoretical tool that could predict the standard redox potentials with reasonable accuracy and (2) to comprehensively test the efficacy of quantum-chemical methods for electrochemistry, which represents one of the few remaining areas of chemistry that has not been successfully modeled by modern ab initio computations.

The focus of the present study was to establish a coherent, simple, and well-defined method to predict the standard redox potentials of diverse organic molecules of substantial size in organic solution. To accomplish this goal, we carefully calibrated the theoretical method for the gas-phase calculations and parametrized the solvation model for the solution-phase calculations. As to the solvent we chose acetonitrile, because acetonitrile is one of the most popular organic solvents for the measurement of redox potentials. To demonstrate that our protocol can be used for diverse types of organic molecules, we extensively searched the literature and compiled more than 270 experimental standard redox potentials.[11] By comparing the theoretical results with the experimental data, we would be able to confidently assess the performance of the theoretical protocol for the redox potential predictions.

Armed with the carefully benchmarked theoretical method, we next tried to establish a scale of standard redox potentials for various organic free radicals. Such a scale of data has been highly desirable for many years in organic and bioorganic chemistry,[12−22] because organic free radicals have been found to participate in a plethora of electron-transfer reactions. Information about the electrochemical properties of these radical reactants or intermediates in solution is of tremendous importance to understanding the reaction mechanisms and kinetics. Unfortunately, as free radicals are usually transient species, their redox potentials are very difficult to measure experimentally. Up to now the $E°$ values of only a few free radicals have been reported,[12−22] and not all of these data are free of flaws. It is truly valuable to have an extensive tabulation of the $E°$ values for organic free radicals. By supplying trustworthy and useful data that are difficult to obtain via the experiments, we also hoped to better demonstrate the value of computational electrochemistry.[6,9]

2. Developing a Reliable Protocol To Calculate Standard Redox Potentials

2.1. Calibrating the Gas-Phase Ionization Potentials. Before computing the standard redox potentials, it is indispensable to calculate the gas-phase adiabatic ionization potentials (IPs), defined as the enthalpy changes of the following reactions in the gas phase at 298 K, 1 atm.

$$\text{Reduced form (g)} \rightarrow \text{Oxidized form (g)} + e^- \text{(g)} \quad (1)$$

Although high-level theoretical methods such as G3 and CBS-Q can provide very accurate IPs, these methods are too demanding for general applications. The HF and MP2 methods are known to be inappropriate for the IP calculations.[23] Thus, the only choice is to use the density functional theory (DFT) methods to calculate the IPs.

Herein the popular B3LYP density functional was selected to calculate the gas-phase adiabatic ionization potentials. The standard 6-31+G(d) basis set was used for the geometry optimizations and frequency calculations, while the single-point energy calculations were performed with the 6-311++G(2df,2p) basis set. For the molecules that have more than one possible conformation, the conformation with the lowest electronic energy was singled out and used in the ensuing calculations. Each final optimized geometry was confirmed by the B3LYP/6-31+G(d) frequency calculation to be a real minimum on the potential energy surface without any imaginary frequencies. The enthalpy of each species was calculated using the B3LYP/6-311++G(2df,2p) electronic energy and the zero-point vibrational energy and thermal corrections (0 → 298 K) obtained at the B3LYP/6-31+G(d) level (unscaled).

The adiabatic IPs calculated using the above approach are compiled in the Supporting Information. Comparing these theoretical IPs with the available experimental data, we found that the B3LYP/6-311++G(2df,2p)//B3LYP/6-31+G(d) method systematically underestimated the adiabatic IPs (Figure 1. Pay attention to the $y = x$ line.). Similar underestimation behavior of the DFT methods in the IP calculations was noted previously by Jursic in his study on alkanes[23] and by Kollman et al. in their study on toluene derivatives.[24]

Despite the underestimation problem, it is found that the B3LYP IPs correlate well with the experimental data, that is:

$$\text{IP (Exptl)} = \text{IP (B3LYP)} + 0.28 \text{ eV} \quad (2)$$

For 160 structurally unrelated molecules, the correlation coefficient (r) of eq 2 is 0.989 and the standard deviation (sd)

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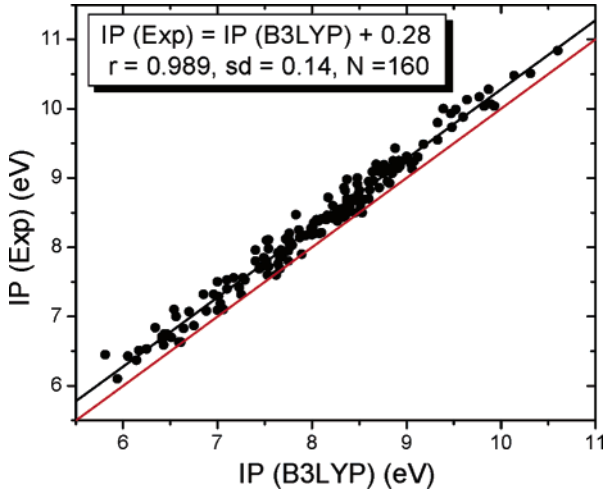


Figure 1. Correlation between the theoretical and experimental adiabatic IPs.

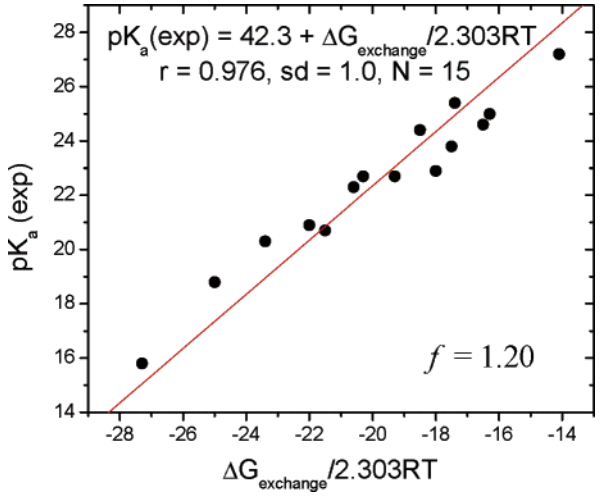


Figure 2. Correlation between the theoretical and experimental pK_a's in acetonitrile.

equals 0.14 eV (ca. 3 kcal/mol). It is worth noting that the experimental error for adiabatic IPs is usually 0.05−0.1 eV (i.e., 1−2 kcal/mol). Therefore, by adding 0.28 eV to the B3LYP results one can predict the adiabatic IPs reasonably well.

2.2. Calibrating the Solvation Model. With reliable theoretical gas-phase adiabatic IPs in hand, the next crucial step for the redox potential calculation is the computation of solvation free energies. In the present study, we used the polarized continuum model (PCM) developed by Tomasi and co-workers[25] to calculate the solvation free energies in acetonitrile.

A central idea in the PCM model is the construction of a solvent-inaccessible cavity in which the solute molecule resides.[26,27] In practice, this solvent-inaccessible cavity is built as a union of overlapping spheres centered on the nuclei of atoms or chemical groups. The sphere radii are usually proportional to the atomic radii with a scale factor (f). For aqueous solution, the f value was optimized to be 1.2,[25] while for dimethyl sulfoxide solution f was optimized to be 1.35.[10,28] Nonetheless, for many other solutions including acetonitrile, rigorous optimization of the f value has not been done because of the lack of experimental solvation free energies.

Without a careful optimization (or assessment) of the solvation model for acetonitrile, we were reluctant to blindly apply it to the redox potential calculations. Unfortunately, there are not enough experimental solvation free energies for us to evaluate the PCM model for acetonitrile.[29] At this point, we decided to use the experimental pK_a's of 15 organic acids in acetonitrile to assess the solvation model and to optimize the f value.[30] These 15 experimental pK_a values vary significantly from 15.8 to 27.2 (see the Supporting Information). Thus, it is sensible for us to assess and optimize the solvation model by attempting to calculate these pK_a's theoretically.

To calculate the pK_a's in acetonitrile, we considered the following proton-exchange reaction

$$AH + {}^{-}CH_2CN \rightarrow A^{-} + CH_3CN \qquad (3)$$

If the free energy change of the above reaction is defined as $\Delta G_{exchange}$, the pK_a of the acid AH can be calculated by eq 4.[10]

$$pK_a(HA) = pK_a(CH_3CN) + \frac{\Delta G_{exchange}}{2.303 \times RT} \qquad (4)$$

It is known from the previous studies that the gas-phase free energy change of eq 3 can be fairly accurately calculated.[10] Thus, whether the theory can reproduce the experimental pK_a's mainly relies on the quality of the solvation energy calculations.

Using the Bondi scale of radii,[31−32] we examined different f values (f = 1.10, 1.15, 1.20, 1.25, 1.30, 1.35. See the Supporting Information for details) for the PCM model in the calculation of pK_a's in acetonitrile. Because the pK_a value of CH_3CN in acetonitrile has not been accurately determined (pK_a(CH_3CN) > 33.3[33]), we could only plot the experimental pK_a's against the theoretical results for ($\Delta G_{exchange}$/2.303RT) at different f values. By fixing the regression slope at 1.00, we found that f = 1.20 gave the best fit with the highest correlation coefficient (r = 0.976) and lowest standard deviation (sd = 1.0 pK_a unit) (Figure 2). It is worth mentioning that the correlation results also suggest that pK_a(CH_3CN) = 42.3.

2.3. Computing Standard Redox Potentials in Acetonitrile. At this point we have established a theoretical protocol that can predict the gas-phase adiabatic IPs with an accuracy of 0.14 eV (ca. 3 kcal/mol). We have also optimized a solvation model that can predict the solution-phase pK_a's with an accuracy of

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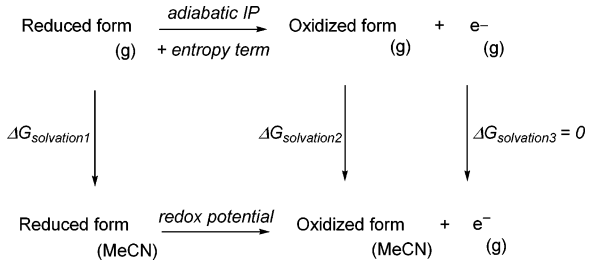


Figure 3. Free energy cycle for the redox reaction in acetonitrile.

1.0 pK_a unit (ca. 1.4 kcal/mol). Now it is time to see whether these theoretical methods can be combined to calculate the standard redox potentials in acetonitrile accurately.

It should be noted that by convention the standard redox potential is defined for half reactions written in the order:

$$E°: \quad \text{Reduced form} \rightarrow \text{Oxidized form} + e^- (g) \qquad (5)$$

The value of $E°$ is usually measured relative to a reference electrode, for instance, the normal hydrogen electrode (NHE). The NHE half reaction is $H^+(aq) + e^- (g) \rightarrow {}^1/_2H_2(g)$. Thus, the $E°$ value is connected to the standard free energy change of the reaction

$$\Delta G°: \quad \text{Reduced form} + H^+(aq) \rightarrow \text{Oxidized form} + {}^1/_2H_2(g) \qquad (6)$$

in the form of eq 7.

$$E° = \Delta G°/F \qquad (7)$$

where F is the Faraday constant equal to 23.06 kcal/mol·V.

From a free energy cycle as shown in Figure 3, one can relate the redox potentials with the gas-phase adiabatic IPs and solvation energies using the following equation:

$$E° \text{ (versus NHE)} = \text{IP} + \frac{1}{23.06}(-T\Delta S + \Delta G_{\text{solvation2}} - \Delta G_{\text{solvation1}}) - 4.44 \qquad (8)$$

In eq 8, IP is the gas-phase adiabatic ionization potential (unit: eV), which equals the gas-phase enthalpy change from the reduced form to the oxidized form plus e^- at 298 K. The second term, $-T\Delta S$ (unit: kcal/mol) is the gas-phase entropy term from the reduced form to the oxidized form plus e^- at 298 K.[33] The next terms, $\Delta G_{\text{solvation1}}$ and $\Delta G_{\text{solvation2}}$ (unit: kcal/mol), correspond to the solvation free energies of the reduced and oxidized forms. The last term, −4.44 (unit: eV), is the free energy change associated with the reference NHE half-reaction (i.e., $H^+(aq) + e^- (g) \rightarrow {}^1/_2H_2(g)$).[34]

Using eq 8 it is straightforward to compute the standard redox potential of any organic molecule in acetonitrile from the aforementioned theoretical gas-phase IP (corrected by adding 0.28 eV) and solvation energies (f = 1.20). To assess the performance of this protocol, we compiled all the literature experimental standard redox potentials for organic molecules containing no more than 12 non-hydrogen atoms (see the Supporting Information). This compilation provided more than 270 structurally unrelated compounds that included alkanes, alkenes, alkynes, aromatics, alcohols, amines, aldehydes, ketones, ethers, esters, nitro compounds, halogenated compounds, amides, thiols, sulfides, heterocycles, hydrazines, azoalkanes, silanes, and tetrazenes.[35]

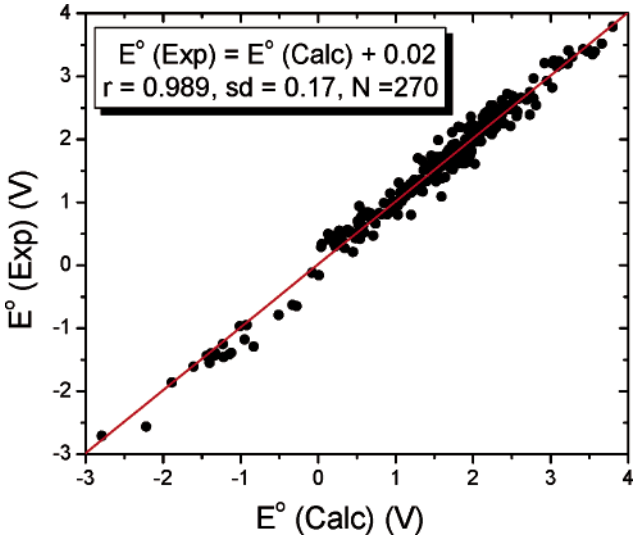


Figure 4. Correlation between the theoretical and experimental standard redox potentials in acetonitrile.

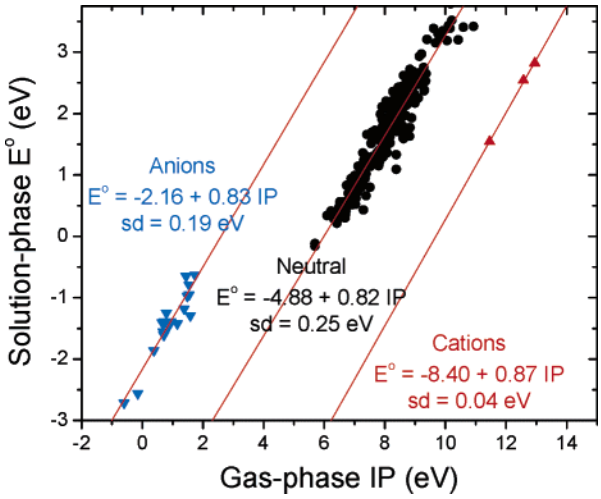


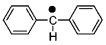
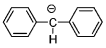
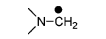
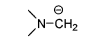
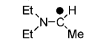
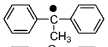
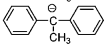
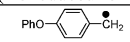
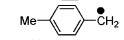
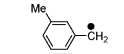
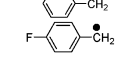
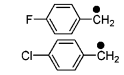
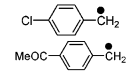
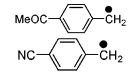
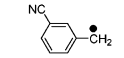
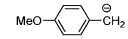
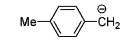
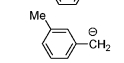
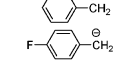
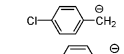
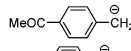
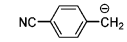
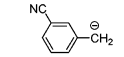
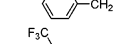
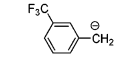
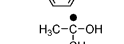
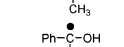
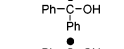
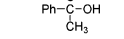
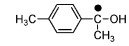
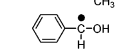
Figure 5. Correlation between the gas-phase adiabatic ionization potentials (theoretical values) and experimental standard redox potentials in acetonitrile.

The correlation between the experimental and theoretical standard redox potentials is shown in Figure 4. From Figure 4 it can be seen that the slope and intercept of the correlation are 1.00 and 0.02 V, respectively, indicating that there is almost no systematic error in the predictions. The correlation coefficient (r) is 0.989. The standard deviation between the experimental and theoretical standard redox potentials is 0.17 V (e.g., 4 kcal/mol) for 270 structurally unrelated compounds. Although this standard deviation is higher than the reported experimental error (0.01−0.02 V) of cyclic voltammetry, it is worth noting that not all of the experimental redox potentials were measured under rigorously reversible reaction conditions. In fact, for most cases the experimental errors are reported to be around 0.1 V.

(34) Trasatti, S. *Pure Appl. Chem.* **1986**, *58*, 955.
(35) Not all the redox potentials are reported relative to NHE. Nevertheless, it is not hard to convert one scale of redox potentials to the other by using the relative potentials of different electrodes. For instance, SCE versus NHE = +0.24 V and $Ag|Ag^+$ (0.1 M) versus NHE = +0.57 V.

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Table 1. Experimental and Theoretical Adiabatic Ionization Potentials (IPs, eV) and Standard Redox Potentials (E°, V) in Acetonitrile for Organic Free Radicals

Species (As reduced form)	IP (exp.)	IP (calc)[a]	E^0(exp) *vs.* NHE	E^0(calc) *vs.* NHE	Ref.
	7.24 ± 0.01	7.48	0.97	0.96	14a
	6.6	6.71	0.40	0.48	14c
	0.91 ± 0.01	1.16	-1.21	-1.31	14a
	0.79 ± 0.11	1.00	-1.49	-1.57	14c
	7.3 ± 0.1	6.74	0.59	0.63	14a
	1.36 ± 0.10	1.71	-0.90	-0.88	14a
	5.7	5.91	-0.79	-0.85	14b
	-	0.00	-1.76	-1.82	14c
	-	5.21	-0.88	-1.24	14b
	6.9	6.99	0.61	0.58	14c
	0.81 ± 0.13	1.05	-1.34	-1.31	14c
	-	6.49	0.47	0.43	14c
	-	1.51	-1.10	-1.16	14c
	6.70 ± 0.03	7.03	0.35	0.17	14c
	-	0.2	-1.76	-1.88	14c
	6.94	7.38	0.00	0.35	14c
	-0.02 ± 0.10	0.18	-1.06	-1.48	14c
	7.07	7.16	1.00	1.01	14c
	1.87 ± 0.01	2.07	-0.52	-0.48	14c
	-	6.45	-0.21	-0.23	14c
	-	6.53	-0.11	-0.25	14c
	-	6.74	0.16	-0.04	14c
	-	6.21	0.55	(-0.62)	14c
	-	7.10	-0.10	0.17	14c
	-	6.38	0.44	(-0.66)	14c
	-	5.95	-0.61	-0.46	14c
	-	0.50	-1.79	-1.71	14c
	6.8 ± 0.1	6.72	0.50	0.50	14e
	-	6.69	0.69	0.80	14e
	6.96 ± 0.02	7.13	0.75	0.85	14e
	7.12 ± 0.02	7.31	0.94	0.98	14e
	-	7.43	0.97	0.92	14e
	-	7.43	1.04	0.97	14e
	-	7.70	1.14	1.22	14e
	-	8.02	1.32	1.36	14e
	-	8.03	1.35	1.28	14e
	-	0.99	-1.51	-1.50	14d
	0.84 ± 0.14	1.07	-1.38	-1.42	14d
	0.88 ± 0.14	1.15	-1.26	-1.30	14d
	0.94 ± 0.01	1.19	-1.26	-1.34	14d
	-	1.42	-1.16	-1.29	14d
	-	2.03	-0.47	-0.75	14d
	-	2.11	-0.53	-0.78	14d
	-	1.82	-0.87	-1.05	14d
	-	1.64	-0.96	-0.92	17
	-	6.47	-0.37	-0.46	19b
	-	6.22	-0.01	0.10	19b
	-	6.34	0.00	0.01	19b
	-	6.13	-0.22	-0.13	19b
	-	6.65	-0.06	0.17	19b
	-	7.21	0.55	0.79	19b
	-	6.61	0.62	0.46	19b
	-	6.07	0.15	-0.20	19b
	1.10 ± 0.01	1.33	-0.29	-0.60	21

[a] Calculated by the B3LYP/6-311++G(2df,2p)//B3LYP/6-31+G(d) method and corrected by adding 0.28 eV to the DFT results. Experimental gas-phase adiabatic ionization potentials are taken from NIST Standard Reference Database 69, March 1998 Release: *NIST Chemistry WebBook* (data compiled by J. E. Bartmess).

Therefore, the theoretical protocol is modestly successful for predicting the standard redox potentials.

At this point, we need to mention that not all of the theoretical predictions are in reasonable agreement with the experiment. For propene, 2-methyl-propene, 1-butene, 2-butene, 1-pentene, 1-octene, and 2-octene, the experimental standard redox potentials[36] (versus NHE) are 3.21, 3.16, 3.17, 2.72, 3.25, 3.21, and 2.74 V, but the theoretical values are 2.73, 2.33, 2.82, 2.32, 2.81, 2.61, and 2.24 V, respectively. The deviation between the experiment and the theory is about 0.5−0.8 V (i.e., 11−18 kcal/mol). Furthermore, for propane-1-thiol and butane-1-thiol the experimental standard redox potentials are 1.71 and 1.91 V versus NHE,[37] but the theoretical predictions are 2.37 and 2.48 V, respectively. The cause of these dramatic deviations remains to be clarified.

2.4. Correlation between Ionization Potentials and Redox Potentials. No one has compiled as many standard redox potentials in acetonitrile previously. Therefore, we have a unique opportunity to reliably reinvestigate one important subject related to the redox potentials, i.e., the correlation between gas-phase ionization potentials and solution-phase standard redox potentials. This correlation has been proposed and used by many authors in either explaining the experimental data or predicting unknown redox potentials.[38,39] We were interested in this

(36) (a) Fleischmann, M.; Pletcher, D. *Tetrahedron Lett.* **1968**, *60*, 6255. (b) Clark, D. B.; Fleischmann, M.; Pletcher, D. *J. Electroanal. Chem. Interfacial Electrochem.* **1973**, *42*, 133.

(37) Loveland, J. W.; Dimeler, G. R. *Anal. Chem.* **1961**, *33*, 1196.

(38) Miller, L. L.; Nordblom, G. D.; Mayeda, E. A. *J. Org. Chem.* **1972**, *37*, 916.

(39) Recent examples: (a) Dhiman, A.; Becker, J. Y.; Minge, O.; Schmidbaur, H.; Muller, T. *Organometallics* **2004**, *23*, 1636. (b) Ue, M.; Murakami, A.; Nakamura, S. *J. Am. Chem. Soc.* **2002**, *149*, 1572.

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correlation because it could reveal some important information about the solvation effect on redox potentials. Thus we plotted the theoretical gas-phase adiabatic IPs against the experimental redox potentials in Figure 5.

From Figure 5 it is clear that the gas-phase IPs cannot have a unified correlation with the solution-phase redox potentials for all of the compounds. Nevertheless, after we separated the compounds into three groups, i.e., anions (20 members), neutral compounds (247 members), and cations (3 members), we obtained three nice correlation lines. Surprisingly, the slopes of these three lines (0.83, 0.82, and 0.87) are fairly close to each other, although their intercepts (−2.16, −4.88, and −8.40 V) are dramatically different. Therefore, in each group the standard redox potentials are correlated with the IPs, but molecules with different total charges cannot be put together for such a correlation.

It is obvious that the different intercepts (i.e., −2.16, −4.88, and −8.40 V) are caused by the different solvation effects experienced by the anions, neutral molecules, and cations in acetonitrile. Furthermore, the slopes (ca. 0.85) of the correlations indicate that about 15% of the gas-phase ionization potentials are offset by the solvation in the solution-phase redox processes. Both of the above two effects are nicely reproduced by the PCM solvation model. Thus the redox potentials of anions, neutral molecules, and cations can be successfully predicted by a single quantum-chemical method.

At this instant we should mention that, although the continuum solvation model has been shown to be successful for various types of closed-shell molecules, it has never been extensively tested for open-shell species (e.g., radicals) against solid experimental data in the past. Since the redox potential calculations require accurate computation of the solvation energies of the open-shell species, the results from the present study should represent one of the first confirmations for the validity of the continuum solvation model for open-shell species. Such a confirmation is important, because we expect steady growth in the application of computational methods to studies of the solution-phase chemistry of various open-shell speices.

3. Standard Redox Potentials of Organic Free Radicals in Acetonitrile

To test the usefulness of the above theoretical protocol, we utilized it to study the standard redox potentials of organic free radicals in acetonitrile.[40] These redox potential data are of particular importance in mechanistic organic chemistry because free radicals are the intermediates of a plethora of electron-transfer reactions. Although considerable efforts have been devoted to the determination of the redox potentials of free radicals, up to now chemists have only measured the standard redox potentials of a few relatively stable free radicals (e.g., benzyl radicals).[12−22]

3.1. Comparing the Predictions with Available Experimental Data. Before predicting the unknown redox potentials, we first utilized the theoretical protocol developed in section 2 to calculate the standard redox potentials of free radicals that had been experimentally measured. The results are summarized in Table 1. It is worth noting that both the oxidation from carbon anions to carbon radicals and the oxidation from carbon radicals to carbon cations were considered in the present work.

(40) Only the carbon-centered free radicals are considered in the present study.

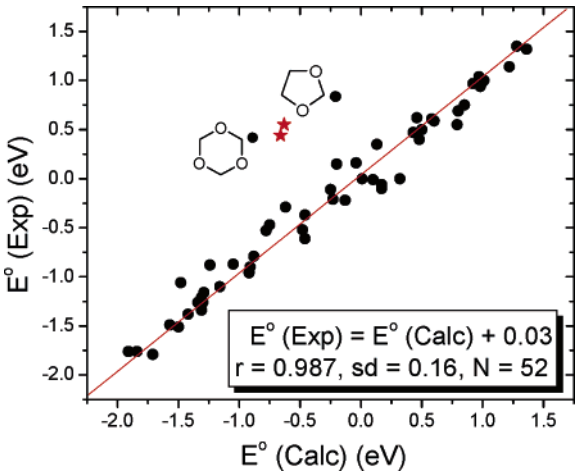


Figure 6. Correlation between the theoretical and experimental redox potentials in acetonitrile for organic free radicals.

Plotting the theoretical redox potentials against the experimental data, we obtained a nice correlation (Figure 6). The slope and intercept of the correlations are 1.00 and 0.03 V, respectively, indicating that there is almost no systematic error for the predictions. The correlation coefficient (r) is as high as 0.987, and the standard deviation for 52 redox couples is as low as 0.16 V. Thus the theoretical protocol is satisfactory for the calculation of standard redox potentials of organic free radicals. Nevertheless, there are two cases for which the theory does not agree with the experiment. They correspond to the oxidations of 1,3-dioxolane and 1,3,5-trioxane radicals to the corresponding cations (Figure 6).[14]

3.2. A Scale of Standard Redox Potentials for Organic Free Radicals. Having confirmed the reliability of the theoretical method for a number of free radicals, we next utilized the same method to calculate the standard redox potentials of various types of organic free radicals. These include the alkyl radicals, α-amino radicals, α-alkoxyl radicals, α-carbonyl radicals, captodative radicals, alkenyl radicals, alkynyl radicals, aromatic radicals, and carbonyl radicals. For each type, we selected a few representative examples. Both the oxidation of free radicals to carbon cations and the oxidation of carbon anions to free radicals were considered. The results are shown in Table 2.

To better illustrate the calculation results, we showed the predicted standard redox potentials graphically in Figure 7. From Figure 7 it can be seen that the aromatic carbon radicals have the highest standard redox potentials, around ∼+1.5 to +3.0 V (versus NHE). They are followed by alkynyl (ca. +2.4 V), alkyl (∼+0.5 to +2.5 V), and α-carbonyl radicals (∼+1.2 to +2.3 V). The standard redox potentials of alkenyl and captodative radicals are about 1.0 V. The standard redox potentials of carbonyl radicals are about 0.6 V. The standard redox potentials of α-alkoxyl radicals are about ∼−0.5 to +0.8 eV. The standard redox potentials of α-amino radicals are about ∼−1.5 to +0.5 V. Thus, depending on the substituents, the standard redox potentials of carbon-centered free radicals range from −1.5 to +3.0 V.

Compared to the radicals, the standard redox potentials for the carbon anions follow a different trend. The highest standard redox potentials are observed for the alkynyl anions (ca. +1.4

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IPR2024-01094

Table 2. Adiabatic Ionization Potentials (IP, eV) and Standard Redox Potentials (E°, V) of Organic Free Radicals in Acetonitrile Predicted by the Method Developed in the Present Study

Species (As reduced form)	IP	E^0 *vs.* NHE	Species (As reduced form)	IP	E^0 *vs.* NHE
Alkyl radicals					
CH_3^-	0.36	-0.98	$CH_3^\bullet$	10.23	2.54
$H_3C-CH_2^-$	0.06	-1.55	$H_3C-CH_2^\bullet$	8.49	1.23
$H_3C-CH^-(CH_3)$	0.06	-1.81	$H_3C-CH^\bullet(CH_3)$	7.65	0.65
$H_3C-C^-(CH_3)_2$	0.22	-1.88	$H_3C-C^\bullet(CH_3)_2$	7.03	0.17
CH_2^-–vinyl	0.79	-1.11	$CH_2^\bullet$–vinyl	8.42	1.42
CH_2^-–ethynyl	1.23	-0.64	$CH_2^\bullet$–ethynyl	9.00	2.00
CH_2^-–phenyl	1.16	-1.31	$CH_2^\bullet$–phenyl	7.48	0.96
$Ph-CH^-$	1.71	-0.88	$Ph-CH^\bullet$	6.74	0.63
$Ph-C^-(Ph)_2$	1.77	-0.99	$Ph-C^\bullet(Ph)_2$	6.32	0.45
cyclopropyl$^-$	0.62	-1.05	cyclopropyl$^\bullet$	7.05	0.05
cyclobutyl$^-$	0.20	-1.69	cyclobutyl$^\bullet$	7.78	0.83
cyclopentyl$^-$	0.11	-1.84	cyclopentyl$^\bullet$	7.41	0.57
cyclohexyl$^-$	0.32	-1.76	cyclohexyl$^\bullet$	7.30	0.63
α-Amino radicals					
$H_2N-CH_2^-$	-0.26	-1.80	$H_2N-CH_2^\bullet$	6.69	-0.66
$N-CH_2^-$	0.00	-1.82	$N-CH_2^\bullet$	5.91	-0.85
$N-C^-$	0.18	-1.86	$N-C^\bullet$	5.10	-1.47
$N-C^-(Ph)$	1.00	-1.53	$N-C^\bullet(Ph)$	5.40	-0.82
$H(O)C-N^-CH_2$	0.75	-1.45	$H(O)C-N^\bullet CH_2$	7.26	0.36
α-Alkoxyl radicals					
$HO-CH_2^-$	0.07	-1.55	$HO-CH_2^\bullet$	7.97	0.49
$HO-C^-$	0.13	-1.81	$HO-C^\bullet$	6.50	-0.42
$HO-C^-(Ph)$	0.87	-1.59	$HO-C^\bullet(Ph)$	6.45	0.02
$H_3CO-CH_2^-$	0.18	-1.48	$H_3CO-CH_2^\bullet$	7.38	0.35
$H_3CO-C^-H-OCH_3$	0.40	-1.37	$H_3CO-C^\bullet H-OCH_3$	6.07	-0.64
$O-CH_2^-$	0.86	-1.21	$O-CH_2^\bullet$	7.55	0.85
α-Carbonyl radicals					
$(O)C-CH_2^-$	2.04	0.04	$(O)C-CH_2^\bullet$	8.70	1.94
$(O)C-C^-$	1.59	-0.58	$(O)C-C^\bullet$	8.00	1.49
$H_3CO(O)C-CH_2^-$	1.96	0.01	$H_3CO(O)C-CH_2^\bullet$	8.87	2.09
$Me_2N(O)C-CH_2^-$	1.79	-0.34	$Me_2N(O)C-CH_2^\bullet$	7.55	1.17
α-Carbonyl radicals					
$H(O)C-C^-H-C(O)H$	3.09	0.76	$H(O)C-C^\bullet H-C(O)H$	8.84	2.18
$H_3CO(O)C-C^-H-C(O)OCH_3$	3.16	0.83	$H_3CO(O)C-C^\bullet H-C(O)OCH_3$	8.65	2.23
Captodative radicals					
$H_2N-C^-H-C(O)H$	1.19	-0.98	$H_2N-C^\bullet H-C(O)H$	7.44	0.54
$H_2N-C^-H-C(O)OCH_3$	1.12	-1.02	$H_2N-C^\bullet H-C(O)OCH_3$	7.23	0.37
$HO-C^-H-C(O)H$	1.54	-0.50	$HO-C^\bullet H-C(O)H$	8.47	1.46
$HO-C^-H-C(O)OCH_3$	1.36	-0.71	$HO-C^\bullet H-C(O)OCH_3$	8.27	1.37
Alkenyl radicals					
CH_2^-–vinyl	0.96	-0.61	$CH_2^\bullet$–vinyl	8.97	1.63
$CH_2^-C(CH_3)$	1.01	-0.77	$CH_2^\bullet C(CH_3)$	7.31	0.46
$CH^-CH(CH_3)$	0.79	-1.15	$CH^\bullet CH(CH_3)$	7.22	0.55
Alkynyl radicals					
CH_2^-–ethynyl	3.04	1.35	$CH_2^\bullet$–ethynyl	9.04	1.98
CH_2^-–phenylethynyl	3.34	1.38	$CH_2^\bullet$–phenylethynyl	9.33	2.60
Aromatic radicals					
phenyl$^-$	1.33	-0.60	phenyl$^\bullet$	8.51	1.80
2-furyl$^-$	2.13	0.33	2-furyl$^\bullet$	9.79	2.85
3-furyl$^-$	1.91	0.08	3-furyl$^\bullet$	9.90	2.99
2-pyrrolyl$^-$	1.86	0.01	2-pyrrolyl$^\bullet$	9.04	2.18
3-pyrrolyl$^-$	1.40	-0.29	3-pyrrolyl$^\bullet$	9.10	2.28
2-pyridyl$^-$	1.07	-0.75	2-pyridyl$^\bullet$	8.07	1.41
3-pyridyl$^-$	1.68	-0.32	3-pyridyl$^\bullet$	8.59	1.92
4-pyridyl$^-$	1.71	-0.35	4-pyridyl$^\bullet$	8.74	1.97
Carbonyl radicals					
$(O)C^-$	0.74	-1.07	$(O)C^\bullet$	7.41	0.24
$H_3CO(O)C^-$	1.66	-0.26	$H_3CO(O)C^\bullet$	7.79	0.79
$Me_2N(O)C^-$	0.93	-0.93	$Me_2N(O)C^\bullet$	7.03	0.29

V). They are followed by α-carbonyl (∼−0.6 to +0.7 V) and aromatic (∼−0.8 to +0.2 V) anions. Carbonyl anions and captodative anions have similar standard redox potentials (∼−1.0 to −0.5 V). The standard redox potentials of alkenyl anions are around −1.0 V. The standard redox potentials of α-alkoxyl and α-amino anions are about ∼−2.0 to −1.5 V. The standard redox potentials of alkyl anions range from −2.0 to −0.7 V.

4. Summary

The ability to accurately predict the standard redox potential for a given molecule in the solution phase is highly desirable.

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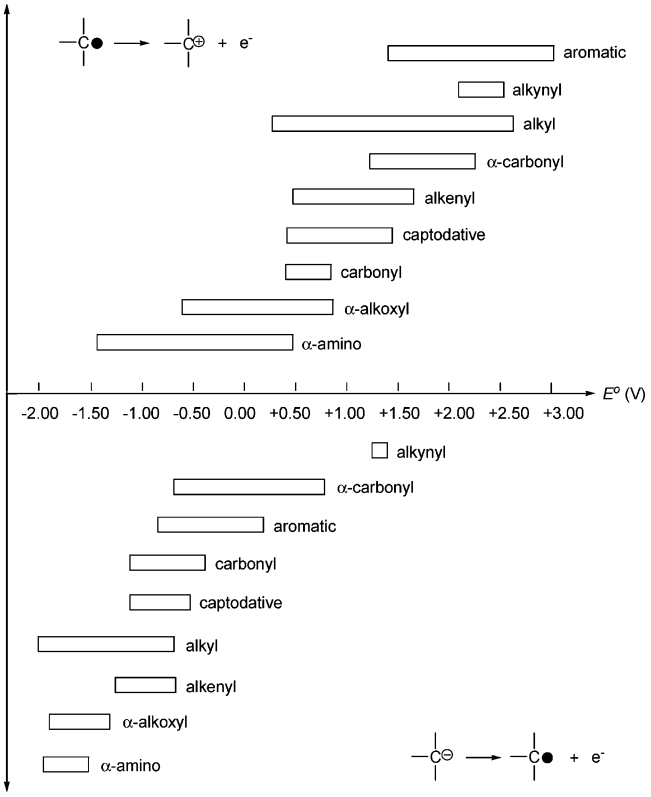


Figure 7. Standard redox potentials of various types of organic free radicals in acetonitrile.

Identifying key electronic features that dictate the redox potential on a molecular level is of substantial importance and might facilitate the derivation of rational strategies for tuning the redox properties of catalysts and provide a unique pathway to discovering novel redox-active systems with desired chemical behavior. In the present study, we carefully benchmarked a generally applicable theoretical protocol for the prediction of standard redox potentials in acetonitrile. This protocol was utilized to calculate the standard redox potentials of 270 structurally unrelated organic molecules, and it was demonstrated to have a precision of 0.17 V.

The primary value of the study is that it provides the chemical community a calibrated protocol for the prediction of standard redox potentials. Second, the study demonstrates that it is time for computational electrochemistry[6,9] to become a powerful tool for organic chemistry research. Furthermore, the study comprehensively tests the validity of the continuum solvation theory for the organic radical species. It demonstrates that this great theoretical model can successfully predict the solvation energies of organic radicals. Finally, with the help of the newly developed protocol we are able to establish a scale of standard redox potentials for diverse types of organic free radicals for the first time. Knowledge about these redox potentials is of great value for understanding the numerous electron-transfer reactions in organic and bioorganic chemistry.

5. Computational Methodology

All of the theoretical calculations were conducted using the Gaussian 98 and 03 programs.[41,42] The gas-phase calculations were conducted using the standard B3LYP/6-311++G(2df,2p)//B3LYP/6-31+G(d) method. The PCM solvation model was used in its original dielectric formulation (D-PCM) developed by Tomasi and co-workers[25,26] to calculate the solvation free energies in acetonitrile. The gas-phase geometry was utilized for all the solution-phase calculations, as it was demonstrated that the change of geometry by the solvation effect was usually not significant.[27] All the PCM calculations were performed at B3LYP/6-31+G(d,p) level (version = MATRIX INVERSION, cavity = PENTAKISDODECAHEDRA, Icomp = 4, TSNUM = 60, TSARE = 0.4, radii = bondi, alpha = ∼1.10−1.35).

Acknowledgment. This study was supported by the National Natural Science Foundation of China (No. 20332020 and No. 20472079). We also thank the USTC Supercomputer Center.

Supporting Information Available: Experimental and theoretical adiabatic ionization potentials and standard redox potentials for more than 270 compounds. Experimental and theoretical pK_a values for 15 organic acids. Complete citations for refs 41 and 42. This material is available free of charge via the Internet at http://pubs.acs.org.

JA0421856

(41) Frisch, M. J. et al. *Gaussian 98*, revision A.7; Gaussian, Inc.: Pittsburgh, PA, 1998.
(42) Frisch, M. J. et al. *Gaussian 03*, revision B.04; Gaussian, Inc.: Pittsburgh, PA, 2003.

Pictiva EX2056
Samsung v Pictiva
IPR2024-01094

UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

PICTIVA DISPLAYS INTERNATIONAL LTD., ET AL.,	)	
Plaintiffs,	)	Civil Action Nos. 2:23-cv-00945-JRG
vs.	)	2:24-cv-00532-JRG
SAMSUNG ELECTRONICS CO., LTD., SAMSUNG ELECTRONICS AMERICA, INC.,	)	
Defendants.	)	

** CONFIDENTIAL **
** ATTORNEYS' EYES ONLY PURSUANT TO PROTECTIVE ORDER **

REMOTE VIDEOTAPED DEPOSITION
OF
IOANNIS KYMISSIS, Ph.D.
Saturday, June 14, 2025
San Francisco, California

Reported by: B. Suzanne Hull, CSR No. 13495

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

Exhibit #
Schanze 13
07/21/25
exhibitsticker.com

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The Videographer:	Kim Smith

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

I N D E X

EXAMINATION BY	PAGE
MR. SHEASBY	13

E X H I B I T S

EXHIBIT	DESCRIPTION	PAGE
Exhibit 1	OLED document, September 22, 2022, Bates Stamp Numbers SDC_00071260 through SDC_00071284, twenty-five pages	23
Exhibit 3	PM Manual, October 11, 2023, Bates Stamp Numbers SDC_00070979 through SDC_00070995, seventeen pages	25
Exhibit 2	Transcript of Jihyung Seo, dated January 21, 2025, eighty-four pages	26
Exhibit A1	OLED, Bate Stamp Number SDC_00071266, one page	54

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

EXHIBITS (Continued)

EXHIBIT NO.	DESCRIPTION	PAGE
Exhibit A2	Microcacvity, Bates Stamp Number SDC_00071265, one page	54
Exhibit 7	Exhibit A to Humphrey's report, three hundred twenty-three pages	65
Exhibit 13	United States Patent, Schmid, et al., Patent Number US 8,558,223 B2, date of patent October 15, 2013, twenty-one pages	81
Exhibit 12	Transcript of Yonghun Jo, March 12, 2025, twenty-two pages	90
Exhibit 14	Novateq tear-down report, TOF-SIMS analysis - Stage III Samsung Galaxy S24 ultra red pixel, February 8, 2025, Bates Stamp Numbers PICTIVA00042502 through PICTIVA00042546, forty-five pages	108

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Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

EXHIBITS (Continued)

EXHIBIT NO.	DESCRIPTION	PAGE
Exhibit 16	Chemical Physics Letters, "Unraveling the complexation effect of electron transporting materials with Liq on the charge transport properties: A theoretical perspective," Sunwoo Kang, Sang Ho Jeon, Taekyung Kim, Bates Stamp Numbers PICTIVA00030235 through PICTIVA00030242, eight pages	113
Exhibit 18	iRiver Clix2 OLED characterization project report, Job Number V1QWL906, one hundred seventeen pages	120
Exhibit 19	synthetic Metals, "Organic light-emitting diodes based on new n-doped electron transport layer," J.W. Ma, Wei Xu, X.Y. Jiang, Z.L. Zhang, five pages	120

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Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

EXHIBITS (Continued)

EXHIBIT NO.	DESCRIPTION	PAGE
Exhibit 20	International application published under the Patent Cooperation Act (PCT), September 15, 2005, International Publication Number WO 2005/086251 A2, Bates Stamp Numbers PICTSAMSUNGEDTX013791 through PICTSAMSUNGEDTX013878, eighty-nine pages	120
Exhibit 21	PowerPoint slide deck, December 12, 2013, Bates Stamp Numbers SDC_00076984 through SDC_00077057, seventy-four pages	129
Exhibit 22	Excel spreadsheet, Bates Stamp Number SDC_00074321	137
Exhibit 26	August 5, 2014, Bates Stamp Numbers SDC_00074415 through SDC_00074452, thirty-eight pages	138

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Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

EXHIBITS (Continued)

EXHIBIT NO.	DESCRIPTION	PAGE
Exhibit 23	Samsung SDI, Dreamus, Bates Stamp Numbers DREAMUS_00000001 through DREAMUS_00000039, thirty-nine pages	154
Exhibit 24	Excel spreadsheet, Bates Stamp Number DREAMUS_00000040	155
Exhibit 25	ReignCom Limited, Bates Stamp Numbers DREAMUS_00000042 through DREAMUS_00000302, two hundred sixty-one pages	155
Exhibit 27	United States Patent, Schmid, et al., Patent Number US 8,723,164 B2, date of patent May 13, 2014, thirteen pages	159
Exhibit 4	Excel spreadsheet, Bates Stamp Number SDC_00045424	177

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Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

EXHIBITS (Continued)

EXHIBIT NO.	DESCRIPTION	PAGE
Exhibit 5	United States Patent, Schmid, et al., Patent Number US 8,723,174 B2, date of patent May 13, 2014, Bates Stamp Numbers PICTIVA00000160 through PICTIVA00000171, twelve pages	177
Exhibit 6	[redacted] Bates Stamp Numbers SDC_00072475 through SDC_00072537, sixty-three pages	177
Exhibit 8	Excel spreadsheet, LUMO_HOMO	177
Exhibit 9	Expert report of Ioannis Kymissis, Ph.D., regarding the validity of U.S. Patent Numbers 8,558,223 and 8,723,164, five hundred fifty-six pages	178

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Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

EXHIBITS (Continued)

EXHIBIT NO.	DESCRIPTION	PAGE
Exhibit 10	Expert report of Ioannis Kymissis, Ph.D., regarding the noninfringement of U.S. Patent Numbers 8,558,223 and 8,723,164, four hundred eighteen pages	178
Exhibit 15	Curriculum vitae of Kirk S. Schanze, Bates Stamp Numbers PICTIVA00041241 through PICTIVA00041487, two hundred forty-seven pages	178
Exhibit 17	E-mail, To: Michael Kim, From: EBay - cmoredeals4u, dated December 20, 2024, Re: Order #235648 from iRiver America shipped on October 3, 2007, Bates Stamp Numbers PICTSAMSUNGEDTX487530 through PICKSAMSUNGEDTX487532, three pages	178

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

QUESTIONS INSTRUCTED NOT TO ANSWER:

Page 115 Line 25
Page 142 Line 19
Page 163 Line 20

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

San Francisco, California

Saturday, June 14, 2025; 8:05 a.m.

THE VIDEOGRAPHER: Good morning.

We are going on the record on June 14, 2025, at 8:05 a.m. 08:05:50 08:05:56

Please note that this deposition is being conducted virtually. 08:05:58

Quality of recording depends on the quality of camera and Internet connection of participants.

What is seen from the witness and heard on screen is what will be recorded.

Audio and video recording will continue to take place unless all parties agree to go off the record. 08:06:12

This is media unit one of the video-recorded deposition of Dr. Ioannis Kymissis, taken by counsel for the plaintiffs in the matter of Pictiva Displays International, et al., versus Samsung Electronics Company, et al., filed in the United States District Court, for the Eastern District of Texas, Marshall Division, Case Number 2:24-cv-00532-JRG. 08:06:12 08:06:23 08:06:27 08:06:27 08:06:36 08:06:36 08:06:42

My name is Kim Smith, representing Veritext Legal Solutions, and I am the videographer. 08:06:46 08:06:50

I am not related to any party in this 08:06:53

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

action, nor am I financially interested in the outcome. 08:06:55 08:06:58

If there are any objections to proceeding, please state them at the time of your appearance. 08:06:58 08:07:01

Counsel will now state their appearances and affiliations for the record, beginning with the noticing attorney, and then the court reporter will introduce herself and the witness will be sworn. 08:07:03 08:07:06 08:07:09 08:07:12

MR. SHEASBY: Jason Sheasby, for plaintiffs. 08:07:15

MR. SNYDER: Gavin Snyder, with Quinn Emanuel, on behalf of the defendants. 08:07:17 08:07:19

And then also with me is Melissa Baily, from Quinn Emanuel. 08:07:21 08:07:25

THE REPORTER: My name is Suzanne Hull. I am a certified shorthand reporter representing Veritext Legal Services. My CSR number is 13495. 08:07:25 08:07:25 08:07:37

Raise your right hand, please, Dr. Kymissis. 08:07:37

Do you solemnly swear or affirm that the testimony you shall give shall be the truth, the whole truth, and nothing but the truth. 08:07:43 08:07:43 08:07:45

THE WITNESS: I do. 08:07:47

IOANNIS KYMISSIS, Ph.D.,

called as an expert witness by counsel for Plaintiffs, being first duly sworn, testified as

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

follows:

THE REPORTER: Thank you.

Mr. Sheasby.

EXAMINATION

BY MR. SHEASBY:

Q. Good morning, sir.

Can you state your full name for the record.

A. Good morning.

My name is Ioannis Kymissis.

Q. You have been retained by Samsung in this matter; is that correct?

A. That is correct.

Q. As an expert; is that correct?

A. That is correct.

Q. You have a preexisting relationship with Samsung; is that correct?

A. That is correct.

Q. You consult for Samsung; is that correct?

A. I have not had any consulting relationship with Samsung, but Samsung has sponsored research within my group through the university.

Q. How much -- since when has Samsung sponsored your work?

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

A. So I have had two projects with Samsung, and one of those projects was about five years ago, and another project started about a year ago. 08:08:34 08:08:38 08:08:43

Q. And you -- so you have an ongoing project with them? 08:08:45 08:08:50

A. There is a current project in my group which is with Samsung Electronics, yes. 08:08:51 08:08:54

Q. What was the value of the project that was five years ago? 08:08:56 08:08:58

A. That project was [redacted]. 08:08:59 08:09:05

Q. And the project that is ongoing right now? 08:09:07

A. That project is [redacted] 08:09:10 08:09:14

Q. For how -- and how long will that continue? 08:09:15

A. That project is -- [redacted]. 08:09:18 08:09:22

Q. And what is the total amount of grant funding your laboratory receives? 08:09:26 08:09:29

A. So at my time at Columbia I have raised about [redacted], and so those projects represent about [redacted] of the funding in my group. 08:09:31 08:09:34 08:09:38

Q. Not the question I asked. 08:09:41

On a yearly basis, what is the funding at your -- in your laboratory? 08:09:42 08:09:46

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

MR. SNYDER: Objection to form. 08:09:47
THE WITNESS: Yeah. 08:09:48
So I have seven Ph.D. students and one post doc right now; so, roughly speaking, you know, my group is somewhere around [redacted] of funding and expenditure. 08:09:48 08:09:53 08:09:57 08:10:02
BY MR. SHEASBY: 08:10:04
Q. Great. 08:10:05
Does Samsung contribute other funds to the school that you are a part of? I know that you are -- you -- you have a -- a deanship that relates in the engineering school. 08:10:05 08:10:12 08:10:14 08:10:23
MR. SNYDER: Objection to form. 08:10:24
THE WITNESS: I am not aware of any other -- I'm sorry. 08:10:25 08:10:27
Are you -- are you asking about research contributions or any unrestricted contributions or -- 08:10:28 08:10:30
BY MR. SHEASBY: 08:10:34
Q. Anything. Any money, any sort of income benefit provided to your laboratory by Samsung or to your school by Samsung? 08:10:34 08:10:39 08:10:43
MR. SNYDER: Objection to form. 08:10:44
THE WITNESS: Yeah. 08:10:45
So I am not sure I have a lot of visibility into the other research groups in my school or at the 08:10:45 08:10:48

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

university. Samsung supports research across all areas, and so there are certainly other faculty that have research projects with Samsung; so I'm not sure that I can answer that with specificity. But I'm not aware of any other either in kind or financial support that Samsung provides to the school separate from -- from research funding. 08:10:52 08:10:58 08:11:02 08:11:05 08:11:07 08:11:11 08:11:14

BY MR. SHEASBY: 08:11:16

Q. To the faculty? 08:11:16

A. To the -- I'm sorry. 08:11:18

Can you be clearer about that question? 08:11:21

Q. Research funding to the faculty. 08:11:23

A. Again, research funding flows first to the school, and then it is expended by the school; so that is not funding that comes directly to the faculty, if that makes sense. 08:11:26 08:11:28 08:11:32 08:11:35

Q. It does make sense. 08:11:37

In addition to -- do you have any business relationship with Samsung? 08:11:38 08:11:41

A. No. 08:11:42

I do not. 08:11:43

Q. Do you work for a company that was acquired by Samsung? 08:11:44 08:11:46

A. So I was the first employee at a company called QD Vision, and I worked there as a full-time 08:11:47 08:11:51

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

employee for one year and then as a consultant for a few years. And about twelve years after I left, that company was acquired by Samsung Electronics. 08:11:55 08:11:59 08:12:02

Q. And did you have any stock interest or obtain any economic advantage from that? 08:12:04 08:12:09

A. No. 08:12:11

I did not. My -- I had [redacted] 08:12:12

[redacted] 08:12:16

[redacted] 08:12:20

[redacted] 08:12:23

[redacted] 08:12:28

[redacted] 08:12:32

[redacted] 08:12:36

Q. That acquisition, was the company a commercial success? 08:12:38 08:12:43

A. That's a difficult question to answer. I'm sorry. If you could be more specific, I can try to answer it. 08:12:46 08:12:51 08:12:54

Q. Sure. 08:12:54

Was this company that Samsung acquired able to launch a commercial product? 08:12:54 08:12:57

MR. SNYDER: Objection to form. 08:13:00

THE WITNESS: The company did have several commercial products. They were able to release the first QD-enabled television in a collaboration with 08:13:00 08:13:03 08:13:08

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

Sony. There were also other products that were introduced by the company, and -- and the company's technology is the basis for what Samsung today and other companies as well call QD LED. 08:13:12 08:13:16 08:13:19 08:13:22

And so with respect to whether a commercial product was launched, yes. QD Vision did launch several commercial products both in the television space, and there were also several products in the lighting space. There was a high CRI -- light color-rendering index -- lamp that QD Vision developed, and that was also commercially sold. 08:13:26 08:13:31 08:13:34 08:13:37 08:13:39 08:13:42 08:13:48

BY MR. SHEASBY: 08:13:50

Q. And what was the acquisition price for QD Vision? 08:13:50 08:13:52

MR. SNYDER: Objection to form. 08:13:54

THE WITNESS: So my understanding is that the acquisition was for about $70 million. 08:13:54 08:13:58

BY MR. SHEASBY: 08:14:02

Q. And you said that this technology from QD Vision is the foundation for the quantum dot technology that is used by Samsung; is that correct? 08:14:06 08:14:11 08:14:15

MR. SNYDER: Object to the form. 08:14:18

THE WITNESS: So there are a number of quantum dot technologies that Samsung is pursuing; so I would not characterize my statement that way. I'm 08:14:19 08:14:23 08:14:28

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

sorry. 08:14:32

If you could ask the question again, I could try to answer more precisely. 08:14:32 08:14:35

BY MR. SHEASBY: 08:14:37

Q. Sure. 08:14:37

Are you the named inventor on any QD Vision patents? 08:14:38 08:14:42

A. Yes. 08:14:42

I am the named inventor on several patents that were issued to QD Vision. 08:14:42 08:14:46

Q. Have you done an element-by-element analysis to determine if Samsung's accused products in this case use any of those patents? 08:14:48 08:14:49 08:14:50

A. So I have not offered any opinion on whether any of my patents were involved in any of the accused products. 08:14:54 08:14:59 08:15:02

Q. Sure. 08:15:03

Have you identified -- have you done an element-by-element analysis to identify any third-party patent or Samsung patent that is used by any of the accused products? 08:15:03 08:15:06 08:15:09 08:15:13

A. So I have not offered an opinion on any patents, other than the patents that are at issue in this case. 08:15:14 08:15:18 08:15:20

Q. Okay. How many hours have you spent on this 08:15:20

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

project? 08:15:25

A. So if we count the background research 08:15:25
collection of references, writing the report, editing 08:15:32
the report, reviewing the report, and other 08:15:36
preparation, it is several hundred hours. 08:15:39

Q. You wrote the report yourself? 08:15:41

A. So the report contains my opinions. 08:15:44

Q. Did you write the report yourself? 08:15:47

A. So I generally don't do the typing for my 08:15:49
writing. You know, I produce about twenty papers 08:15:54
a year, for example, in my research; so I provided my 08:15:58
opinions and the structure that I recommended, but 08:16:02
I asked for assistance in the typing from the legal 08:16:06
team. 08:16:09

I, however, then also -- some of those were 08:16:10
delivered in writing, some in discussion, and then 08:16:14
I also reviewed and approved and edited the final 08:16:16
report document. But the actual typing I asked for 08:16:22
assistance with. 08:16:25

Q. What portion of the report did you actually 08:16:26
write yourself? 08:16:28

A. I can't say. I was involved in all of the 08:16:28
parts of the report, but it is difficult for me to 08:16:32
come up with specific sections or numbering. 08:16:35

Q. Did you write more than 5 percent of the 08:16:37

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

report yourself? 08:16:39

A. Again, I can't say specifically exactly what 08:16:40
percentage. 08:16:44

Q. How about more than 3 percent? 08:16:44

A. Again, I can't offer an opinion on the exact 08:16:47
percentage. 08:16:50

Q. Okay. So I have added a number of 08:16:50
documents. 08:16:55

By the way, do you have your reports in 08:16:55
front of you? 08:16:59

A. I have a paper copy, but it would be very 08:17:00
helpful if you could introduce the electronic reports 08:17:03
into the exhibits so I can do searches, which may 08:17:06
speed up some of our discussion. 08:17:08

Q. I am happy to do that. 08:17:09

Have you ever designed a commercial OLED? 08:18:26

A. So I was involved in designing a number of 08:18:49
organic light-emitting diodes while I was at 08:18:55
QD Vision, but I -- none of those went into 08:19:01
commercial production without further modifications. 08:19:04

Q. And since you have left -- so the answer 08:19:06
is -- have you ever designed a commercial OLED? 08:19:09

A. So I have not designed any unmodified 08:19:13
commercial organic light-emitting diodes. 08:19:17

Q. And since you have been a faculty member, 08:19:20

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

have you published any papers -- peer-reviewed papers on OLED design? 08:19:23 08:19:29

A. So I -- give me a second to think about it. I have published about 150 peer-reviewed papers, and so I -- I can't say whether I published any specifically out of OLED design. I have published a number on organic light-emitting diodes and particularly a number of transport and charge injection issues, but some of that is in the context of organic affordable tank devices, which have some similar and some different issues; so I'm not sure exactly how to answer that question. 08:19:31 08:19:37 08:19:42 08:19:50 08:19:53 08:19:58 08:20:01 08:20:05 08:20:10 08:20:14

Q. All right. I will -- let me try to be crisp. 08:20:15 08:20:19

Have you published any paper on an OLED design? 08:20:19 08:20:23

MR. SNYDER: Object to the form. 08:20:23

THE WITNESS: So I have not published any papers exclusively on the design of organic light-emitting diodes. 08:20:24 08:20:29 08:20:33

BY MR. SHEASBY: 08:20:34

Q. Okay. Why don't we -- I have now uploaded Exhibit 1 through 9 to the Exhibit Share. Just for the sake of good order and efficiency, why don't you go ahead and download all of those. 08:20:34 08:20:37 08:20:40 08:20:43

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

A. Okay. Great. 08:20:46
Q. One through ten, actually. 08:20:47
A. All right. I see ten now. It is 08:20:49
alphabetically. 08:20:52
Okay. I think I have them all downloaded. 08:20:54
Q. Great. 08:21:32
Let's turn to Exhibit -- Exhibit 1. 08:21:39
(Deposition Exhibit Number 1 08:21:39
was marked for identification.) 08:21:39
THE WITNESS: (Witness complies.) 08:22:00
BY MR. SHEASBY: 08:22:00
Q. Let's go ahead and open that up. 08:22:00
A. Okay. I'm at Exhibit 1 now. 08:22:11
Q. I'll put it on the screen, actually, and 08:22:13
we'll do this -- I will make a PowerPoint so we can 08:22:28
annotate it. 08:22:38
Great. 08:23:02
So I have marked a page from Exhibit A1, 08:23:02
just so we can work with it on the screen, but you 08:23:07
have the full .pdf of it. 08:23:09
Do you recognize this document? 08:23:12
A. Yes. 08:23:13
I recognize at least the figures in the 08:23:13
document. 08:23:15
Q. Uh-huh. 08:23:16

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

A. There were a lot of documents. I don't remember the structure exactly. 08:23:17 08:23:19

Q. And did you analyze this document before preparing your opinion? 08:23:22 08:23:25

A. I do remember seeing this document and so, yes. I offered some analysis based on the device stacks and this figure as well. 08:23:26 08:23:29 08:23:33

Q. And you see the reference to G EML and G prime? 08:23:35 08:23:45

A. Yes, I do. 08:23:47

Q. And the reference between R EML and R prime? 08:23:49

A. Yes, I do. 08:23:55

Q. What are those layers? 08:23:56

A. So the -- the G EML is the emissive layer or the green subpixel; so that is the region in which the holes are injected on one side, the electrodes are injected on the other. Those carriers then form an exciton, which gets transferred to the green lumiphore, and then that is the region that generates the light which is emitted. 08:23:58 08:24:05 08:24:09 08:24:13 08:24:17 08:24:22 08:24:24

Q. And do you see the Korean characters in red that are on the surface of the R EML, B EML, and G EML layer? 08:24:26 08:24:30 08:24:36

A. I do, but sorry. If I can just complete my explanation before of what the prime layer is. 08:24:37 08:24:42

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

Oh, sorry. You had asked what the EML and the prime layers are. 08:24:45 08:24:48

Q. Okay. Well, we'll get back to that. 08:24:50

Do you see the -- what box? 08:24:53

A. I do, yes. 08:24:59

Q. That is a Korean character; correct? 08:25:01

A. That is. 08:25:03

Q. Have you had that Korean character translated for you? 08:25:03 08:25:06

MR. SNYDER: Objection to form. 08:25:07

THE WITNESS: Yes, I have. 08:25:10

BY MR. SHEASBY: 08:25:11

Q. Who translated it for you? 08:25:13

A. I believe this came up in a discussion with Mr. Jo, in an interview with him. 08:25:15 08:25:21

Q. All right. Does Mr. Jo speak English? 08:25:24

A. That conversation was through a translator. 08:25:27

Q. The -- if you go to Exhibit 3, which is the Seo transcript. 08:25:32 08:25:46

(Deposition Exhibit Number 3 was marked for identification.) 08:25:46 08:25:51

THE WITNESS: Sorry. I think Exhibit 3 -- oh, sorry. 08:25:53 08:25:56

MR. SHEASBY: It is -- the Seo transcript will be Exhibit 2. 08:25:56 08:25:59

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

(Deposition Exhibit Number 2 was marked for identification.) 08:25:59 08:26:11

THE WITNESS: Okay. I have it open now. 08:26:11

BY MR. SHEASBY: 08:26:13

Q. And if you turn to 163-20 to 164-3. 08:26:15

A. (Witness complies.) 08:26:28

Okay. I see that section. 08:26:44

Q. And if we actually turn to 162-20 to 160- -- 162-22 to 163-1, you'll see that Mr. Seo, Samsung's corporate representative, testified that those three Korean characters transmit as light-emitting surface; correct? 08:26:46 08:26:59 08:27:11 08:27:14 08:27:16

MR. SNYDER: Objection to form. 08:27:17

THE WITNESS: I see that statement in the transcript. 08:27:20 08:27:22

BY MR. SHEASBY: 08:27:22

Q. And did you speak to Mr. Seo in preparing your opinions? 08:27:22 08:27:26

A. I actually can't remember if I interviewed Mr. Seo. I spoke with a number of Samsung employees, and I believe I did. Give me one second to just check because I made a list in my report. 08:27:26 08:27:35 08:27:39 08:27:43

I believe that I did. 08:28:08

Q. Did you access any experimental data that contradicts that [redacted] 08:28:11 08:28:27

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[redacted] 08:28:30

MR. SNYDER: Objection to form. 08:28:34

THE WITNESS: So sorry. I'm not exactly 08:28:38
sure what you are asking. 08:28:41

BY MR. SHEASBY: 08:28:43

Q. Well, if you are not sure what I am asking, 08:28:44
you should just say I am not sure what you are 08:28:46
asking, and I will reask the question. 08:28:49

A. Yeah. 08:28:50

I am not sure what you are asking. 08:28:51

Q. Okay. Did you look at any Samsung 08:28:52
experimental data that contradicts the statements on 08:28:54
this page of the document that [redacted] 08:29:08

MR. SNYDER: Objection to form. 08:29:08

THE WITNESS: So there are a number of 08:29:08
reasons -- and I discuss some of these in my 08:29:12
report -- [redacted] 08:29:37

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[redacted] 08:29:39

MR. SHEASBY: Objection to form. 08:29:41

BY MR. SHEASBY: 08:29:43

Q. I am asking you, did you see any 08:29:44

experimental data that contradicts [redacted] 08:29:51

MR. SNYDER: Objection to form. 08:29:54

THE WITNESS: So, again, the -- whether we 08:29:55

describe this as an experiment or not, you see the 08:29:58

spectrum of the light that is emitted from the 08:30:01

organic light-emitting diodes, and the spectrum of 08:30:05

that light is consistent with the emission of the 08:30:08

light only occurring within the emissive layer. 08:30:10

MR. SHEASBY: Objection to form. 08:30:16

BY MR. SHEASBY: 08:30:16

Q. I'm asking you can you identify any 08:30:17

experimental data generated at Samsung that [redacted] 08:30:25

MR. SNYDER: Objection to form. 08:30:27

THE WITNESS: So, again, the -- 08:30:28

BY MR. SHEASBY: 08:30:29

Q. Give me the name of the document. Give me 08:30:32

its Bates number. That is what I'm looking for. 08:30:33

MR. SNYDER: Objection to form. 08:30:36

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

THE WITNESS: If you give me a minute, we can look at the spectrum as an example of the emitted light from the organic light-emitting diode. I'll see if, for example, this exhibit has that spectrum. Just give me one moment. 08:30:37 08:30:42 08:30:44 08:30:47 08:30:52

So if we look, for example, on the page after this one in the document, you know, it has a spectrum of the -- of one of the emitted -- one -- one of the organic light-emitting diodes. 08:31:52 08:31:55 08:31:57 08:32:06

And, again, one of the pieces of evidence [redacted]. Now, in an organic light-emitting diode, the exciton, when it recombines, emits light corresponding to the energy of that HOMO-LUMO gap. And so if light was being emitted from the prime layers, we would see light escaping from the OLED with a shorter wavelength than the wavelength of the lumiphore, which is present in the EML. 08:32:10 08:32:24 08:32:27 08:32:32 08:32:35 08:32:39 08:32:42 08:32:48 08:32:51

And so although it is not an explicit experiment in which we attempt to create some different structure, [redacted] 08:32:52 08:32:57 08:33:03

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[redacted] 08:33:14

MR. SHEASBY: Objection. Form. 08:33:18

BY MR. SHEASBY: 08:33:19

Q. I'm actually asking you if there has been any -- would -- have you run any experiments that 08:33:19 08:33:22

contradict the assertion that [redacted] 08:33:29

MR. SNYDER: Objection to form. 08:33:33

THE WITNESS: So, again, [redacted] 08:33:40

MR. SHEASBY: Objection. 08:33:44

THE WITNESS: -- which is the emissive layer. 08:33:45 08:33:46

MR. SHEASBY: Objection to form. 08:33:47

BY MR. SHEASBY: 08:33:48

Q. I asked you if you have run any experiments to determine [redacted] 08:33:48 08:33:59

MR. SNYDER: Objection to form. 08:34:00

THE WITNESS: So, again, in every OLED the wavelength of light being emitted is measured. And that next page, actually in this very document, shows 08:34:02 08:34:07 08:34:10

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

the spectrum, for example, of one of the red OLEDs. 08:34:13

[redacted] 08:34:31

MR. SHEASBY: So objection. Form. 08:34:39

BY MR. SHEASBY: 08:34:40

Q. I asked you if you had run any experiments. 08:34:40

Did you or did you not? It is a yes-or-no 08:34:44

question. 08:34:47

MR. SNYDER: Objection to form. 08:34:47

THE WITNESS: I'm sorry. 08:34:50

Is your question whether I personally 08:34:51

conducted any experiments -- 08:34:53

BY MR. SHEASBY: 08:34:55

Q. That's correct. 08:34:56

A. -- or that I was viewing data? 08:34:56

Q. That's correct. 08:34:58

I asked you if you had run any experiments. 08:34:59

MR. SNYDER: Objection to form. 08:35:02

THE WITNESS: So to answer your question, 08:35:03

I am reviewing the data, which is provided by 08:35:05

Samsung, and I did not personally make any of the 08:35:08

devices or measure the graphs which are there; 08:35:12

however, your exhibit -- again, on the very next 08:35:16

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

page, if you would like to look at the spectrum, we can walk through its shape -- 08:35:19 08:35:22

MR. SHEASBY: Objection. Form. 08:35:24

THE WITNESS: -- and provide the evidence that I am using to answer your question. 08:35:26 08:35:27

MR. SHEASBY: Objection. Form. 08:35:29

BY MR. SHEASBY: 08:35:30

Q. I asked you if you had run any experiments, and the answer is either a yes or a no. 08:35:30 08:35:33

A. I don't -- 08:35:36

MR. SNYDER: Objection to form. 08:35:36

THE WITNESS: I did not personally make any of the devices which are described in that document. 08:35:37 08:35:39

BY MR. SHEASBY: 08:35:39

Q. Did you perform any simulations for any of the devices that are at issue in this case? 08:35:43 08:35:47

MR. SNYDER: Objection to form. 08:35:50

THE WITNESS: I did not personally simulate any of the devices that are at issue in this case. 08:35:51 08:35:54

BY MR. SHEASBY: 08:36:09

Q. Okay. Now -- so what is the -- so if we turn to the second page of the document we were looking at, which is Exhibit 1, you are referring to the bottom left-hand graph; is that correct? 08:36:09 08:36:38 08:36:41 08:36:45

A. I'm sorry. 08:36:52

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

Just so that we are clear, are you speaking about the page after this page or the second page of the document in its totality? 08:36:54 08:36:57 08:37:00

Q. The page after this page, which is SDC_00 -- 00007-1267. 08:37:02 08:37:08

A. That is correct. 08:37:13

So that would be then, just to be clear, that -- this page. 08:37:14 08:37:18

Q. And you believe that that bottom left-hand graph corresponds to the devices on the previous page? 08:37:19 08:37:23 08:37:27

A. [redacted] 08:37:36

Q. And you believe this corresponds to the red pixel that was from the previous page? 08:37:37 08:37:42

A. Yes. 08:37:46

That is -- that is my understanding. 08:37:47

Q. And did you get the document translated to have confidence in that? 08:37:49 08:37:52

A. The -- I did not have a certified translation of the document. 08:37:54 08:38:00

Q. Okay. Let me ask you this. 08:38:02

Does this generally reflect the design of the blue -- if we turn to this page of Exhibit 1, 08:38:04 08:38:07

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

does this generally reflect the design of the blue, green, and red pixels that are used in the accused devices? 08:38:10 08:38:13 08:38:17

MR. SNYDER: Objection to form. 08:38:18

THE WITNESS: This is the general design of the organic light-emitting diodes that are used by Samsung. 08:38:18 08:38:21 08:38:25

BY MR. SHEASBY: 08:38:26

Q. Okay. Let me ask you the next question, which is now if we go down, this is a shift from red to -- red to green in the -- what you think is the red pixel; is that correct? 08:38:26 08:38:28 08:38:33 08:38:40

A. So the red pixel is involved in that change that this is showing a difference in the spectrum as a function of the viewing angle. 08:38:42 08:38:47 08:38:50

Q. Okay. And now I want to dig into your -- you had some logic, and now that we have gotten it cleaned up, the red EML -- what is the wavelength of the red EML? 08:38:52 08:38:56 08:38:59 08:39:03

A. I'll have to check. If you just give me a second, there is additional documentation of the red peak wavelength. Sorry. I would have to check on that to give you an exact answer. 08:39:05 08:39:11 08:39:14 08:40:24

Q. Okay. Well -- 08:40:26

A. Is that -- yeah. 08:40:28

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

Q. So.... 08:40:29
A. There is possible weights of pixel, so.... 08:40:30
Q. I'm sorry. 08:40:34
Go ahead. Say that again. 08:40:34
A. No. 08:40:35
I'm sorry. Go ahead. 08:40:35
Q. Okay. So you -- what is your logical basis 08:40:36
for why the interface between EML and HTL is not 08:40:40
a light-emitting surface? 08:40:45
MR. SNYDER: Objection to form. 08:40:50
THE WITNESS: So if we look specifically at 08:40:51
a red pixel on -- or a green pixel, again, the 08:40:53
exciton is confined within the emissive layer. And 08:40:58
the light that we see from those subpixels is only 08:41:02
the light which is from the -- the lumiphores, which 08:41:05
are within the emissive layer. 08:41:10
BY MR. SHEASBY: 08:41:11
Q. Yes. 08:41:11
I understand you said that. 08:41:12
What is the experimental evidence that shows 08:41:13
that? 08:41:15
MR. SNYDER: Objection to form. 08:41:17
THE WITNESS: I didn't conduct any 08:41:19
experiments in order to determine that personally. 08:41:21
And, you know, we would need to review, again, the -- 08:41:24

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

the color quality and the wavelength of light coming out. That is only one of several pieces of evidence, however. 08:41:28 08:41:33 08:41:36

BY MR. SHEASBY: 08:41:36

Q. Okay. So let's dig into that one. 08:41:36

So what is the -- what is the experimental data that you can point to right now that supports the assertion you just made? 08:41:39 08:41:41 08:41:44

MR. SNYDER: I would just like to remind the witness, you can finish your answer. 08:41:46 08:41:49

THE WITNESS: Great. 08:41:51

There is other evidence as well in addition to experimental data. And, again, right now, at this moment, I don't have it in this exhibit. This document also contains other information. But if we have a little bit of time, I can look at other more detailed documents examining that since you were asking for a specific -- for a specific reference. 08:41:52 08:41:54 08:41:58 08:42:01 08:42:06 08:42:09 08:42:12

But in addition to the -- the spectrum of the light that is emitted from the single-color pixels, additional information that we can use is a simulation, which, again, I did not personally conduct but has been conducted by many others. 08:42:19 08:42:24 08:42:28 08:42:30 08:42:35

And it is also something that is well known from the -- a person of ordinary skill in the art, 08:42:39 08:42:42

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

specifically because the prime layers have a wider HOMO-LUMO gap and, as a consequence, again, if there was recombination happening in the prime layers, we would then see that in the spectrum of each of the individual pixels. 08:42:47 08:42:51 08:42:56 08:42:58 08:43:00

Now, this -- sorry. Go ahead. 08:43:01

BY MR. SHEASBY: 08:43:02

Q. Okay. So now let's dig in. 08:43:02

So the first reason you gave is because of the spectrum of light that is being emitted by the pixel; is that correct? 08:43:05 08:43:07 08:43:10

A. That is correct. 08:43:11

Q. Okay. 08:43:12

A. And the -- 08:43:13

Q. Let's just do it in pieces. I will give you an opportunity to speak about all three. 08:43:14 08:43:17

In your report, do you cite any -- any experimental data that indicates that the spectrum of light does not include the interface layer between the HTML and -- HTL and R EML layer? 08:43:20 08:43:22 08:43:26 08:43:28

MR. SNYDER: Objection to form. 08:43:35

THE WITNESS: So in my report I did not do any specific experimental analysis of the emission from the -- the prime layer. And, again, I see no evidence in any of the documentation that that 08:43:37 08:43:44 08:43:50 08:43:54

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

emission exists. 08:43:55

BY MR. SHEASBY: 08:43:56

Q. So I just asked you -- 08:43:57

MR. SHEASBY: Objection. Form. 08:44:00

BY MR. SHEASBY: 08:44:01

Q. -- in your report do you identify any 08:44:02

experimental evidence that [redacted] 08:44:18

MR. SNYDER: Objection to form. 08:44:20

THE WITNESS: [redacted] and 08:44:35

so I did not see any need to personally conduct any 08:44:38

experiments in order to support that -- that -- that 08:44:41

conclusion. 08:44:45

MR. SHEASBY: Objection. Form. 08:44:47

BY MR. SHEASBY: 08:44:47

Q. I asked you in your report do you cite any 08:44:48

evidence that [redacted] 08:44:57

MR. SNYDER: Objection to form. 08:44:59

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

THE WITNESS: [redacted]

[redacted], and I did not cite any specific experimental evidence examining that, given the -- again, the -- the reasons that I -- I had described earlier.

MR. SHEASBY: Objection. Form.

BY MR. SHEASBY:

Q. I asked you whether you cite any evidence about [redacted]

MR. SNYDER: Objection to form.

THE WITNESS: [redacted]

MR. SHEASBY: So objection. Form.

BY MR. SHEASBY:

Q. This document, you agree, is [redacted]

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[redacted] 08:46:12

A. I see that notation in this document, but 08:46:16

I disagree that this is a light-emitting surface, and 08:46:19

that light-emitting surface -- 08:46:22

MR. SHEASBY: Objection. 08:46:22

BY MR. SHEASBY: 08:46:23

Q. Go ahead. 08:46:24

A. [redacted]

[redacted] 08:46:36

MR. SHEASBY: Objection. Form. 08:46:38

BY MR. SHEASBY: 08:46:39

Q. We have this document that [redacted]

[redacted] correct? You see 08:46:45

this document? 08:46:50

A. I see this document, yes. 08:46:50

Q. Okay. In your report, do you cite any 08:46:51

experimental evidence to the contrary? 08:46:57

MR. SNYDER: Objection to form. 08:47:00

THE WITNESS: So, again, I disagree that 08:47:01

that surface is a light-emitting surface. [redacted]

[redacted] 08:47:12

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[redacted] 08:47:20

MR. SHEASBY: Objection. Form. 08:47:20

BY MR. SHEASBY: 08:47:21

Q. In your report do you cite any experimental 08:47:21

evidence contradicting this statement on this 08:47:24

document [redacted] 08:47:30

MR. SNYDER: Objection to form. 08:47:33

THE WITNESS: [redacted] 08:47:41

BY MR. SHEASBY: 08:47:43

Q. Right. 08:47:43

MR. SHEASBY: Let's take a break. I'm going 08:47:44

to suspend this, I think, and we're going to -- I'm 08:47:47

going to call the court on Monday morning. 08:47:49

THE VIDEOGRAPHER: Do we have an agreement 08:47:51

to go off the record? 08:47:53

MR. SHEASBY: We can go off. 08:47:55

MR. SNYDER: Yes. 08:47:55

We can go off the record. 08:47:55

THE VIDEOGRAPHER: This marks the end of 08:47:57

media number one. 08:47:59

The time is 8:47 a.m. 08:48:00

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

And we are off the record. 08:48:02

(Short recess taken.) 09:07:37

THE VIDEOGRAPHER: This marks the beginning of media unit number two. 09:07:37 09:07:38

The nine is -- time is the 9:07 a.m. 09:07:40

We are on the record. 09:07:42

BY MR. SHEASBY: 09:07:45

Q. What is the wavelength that is emitted at the interface between EML and HTL? 09:07:45 09:07:51

MR. SNYDER: Objection to form. 09:07:56

THE WITNESS: [redacted] 09:08:19

BY MR. SHEASBY: 09:08:21

Q. And what is the experimental evidence that you have cited in your report that supports that assertion? 09:08:21 09:08:23 09:08:26

A. So I do discuss this question of the interface in my report. If you go to my rebuttal report, Paragraph 246, I have some discussion of that. 09:08:29 09:08:31 09:08:37 09:08:42

MR. SHEASBY: Objection. Form. 09:08:54

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

BY MR. SHEASBY: 09:08:55

Q. What is the experimental evidence you cite 09:08:56

to support the assertion you just made? 09:08:58

MR. SNYDER: Objection to form. 09:09:01

THE WITNESS: So there -- there are a few -- 09:09:02

again, there are a few reasons that I cite. You 09:09:07

know, the first is, you know, that particular 09:09:13

document that was an interview with -- with a Samsung 09:09:19

engineer [redacted] And so that -- she agrees with me 09:09:29

there. 09:09:33

And, also, you know, Mr. Humphrey, 09:09:34

I understand, in his -- in his declarations, has 09:09:38

stated -- but, again, without any evidence on his 09:09:43

side or any scientific explanation -- how that light 09:09:47

could be -- could be generated. Now -- 09:09:51

MR. SHEASBY: Objection to form. 09:09:53

THE WITNESS: Okay. 09:09:55

BY MR. SHEASBY: 09:09:55

Q. Do you cite any experimental evidence for 09:09:56

your assertion that what is stated on this Samsung 09:09:58

document is incorrect? [redacted]?

09:10:23

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

MR. SNYDER: Objection to form. 09:10:24

THE WITNESS: So yeah. 09:10:25

[redacted] [redacted]

[redacted] [redacted]

[redacted] [redacted]

[redacted] [redacted]

[redacted] [redacted]

[redacted] [redacted] :49

BY MR. SHEASBY: 09:10:50

Q. What is the wavelength of those lumiphores? 09:10:51

A. I don't have it at my fingertips. 09:10:54

I would -- I would need to -- to look more closely at 09:10:57

those documents. It will -- 09:11:01

Q. [redacted] [redacted]

[redacted] [redacted] :07

A. [redacted] [redacted]

[redacted] 09:11:13

Q. And do you cite in your experimental 09:11:15

evidence that [redacted] [redacted]

[redacted] 09:11:23

MR. SNYDER: Objection to form. 09:11:27

THE WITNESS: [redacted] [redacted]

[redacted] [redacted]

[redacted] [redacted]

[redacted] [redacted] :40

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[redacted] 09:11:45

MR. SHEASBY: Objection. Form. 09:11:45

BY MR. SHEASBY: 09:11:47

Q. I said do you cite any evidence? 09:11:47

MR. SNYDER: Objection to form. 09:11:49

THE WITNESS: I'm sorry. If you could be a little clearer. 09:11:50 09:11:52

The OLEDs themselves are structured with these discrete layers. If you are asking if the -- I'm sorry. 09:11:53 09:12:00 09:12:05

If you could ask that question again. 09:12:05

BY MR. SHEASBY: 09:12:07

Q. Yes. 09:12:08

[redacted], and there is -- 09:12:10 09:12:16

A. That is correct. 09:12:17

[redacted] 09:12:22

Q. And I'm saying do you cite any evidence that [redacted] 09:12:24 09:12:31

MR. SNYDER: Objection to form. 09:12:32

BY MR. SHEASBY: 09:12:33

Q. Any experimental evidence. 09:12:33

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

A. Again, [redacted]

[redacted]and I have not done any experiments to examine that question specifically. 09:12:41 09:12:49

Q. Is there any simulations? 09:12:53

MR. SHEASBY: So objection to form. 09:12:55

BY MR. SHEASBY: 09:12:57

Q. Have you done any simulations to examine [redacted] 09:12:57 09:13:02

MR. SNYDER: Objection to form. 09:13:07

THE WITNESS: [redacted] 09:13:28

MR. SHEASBY: Objection. Form. 09:13:29

BY MR. SHEASBY: 09:13:30

Q. I asked you have you done any simulation to see [redacted] :40 09:13:31

MR. SNYDER: Objection to form. 09:13:42

THE WITNESS: So if your question is whether I, personally, have done any such simulation, I have 09:13:44 09:13:46

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

not. 09:13:49
BY MR. SHEASBY: 09:13:50
Q. Okay. Now -- so this is page two of 09:13:50
Exhibit A1, which is an excerpt from Exhibit 1, and 09:16:21
there is Korean characters between the EML and the 09:16:26
HTL layer. 09:16:30
Do you see those Korean characters? 09:16:32
A. I see those Korean characters, yes. 09:16:35
Q. And I will mark them with a black box. 09:16:37
Those Korean characters translate as 09:16:48
light-emitting surface. 09:16:52
Were you aware of that fact? 09:16:52
MR. SNYDER: Objection to form. 09:16:54
THE WITNESS: Yes. 09:16:55
I am aware of that fact, and I discuss this 09:17:00
in my report. 09:17:02
BY MR. SHEASBY: 09:17:04
Q. Okay. Let me ask you the next question, 09:17:04
which is what is the HTL layer? 09:17:06
A. So the HTL layer in -- in organic 09:17:11
light-emitting diode is the whole transport layer. 09:17:21
It is one of the layers in which the holes which are 09:17:24
injected from the anode travel towards the emissive 09:17:27
layer, and then the electrons from the other side 09:17:31
travel in, and they meet at the emissive layer. 09:17:35

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

Q. And so it is the point at which the holes in the electrons meet that the light transmission occurs -- light transmission occurs? 09:17:38 09:17:47 09:17:50

A. So it is a multistep process. The holes and the electrons both have to meet on an organic semiconductor and form an excited state. That excited state then diffuses some distance in order to find its lowest potential energy, which is generally structured to be on the light-emitting doping. And then when it combines, we get the HOMO-LUMO gap energy of that light emitter, and that is where the light is generated. 09:17:55 09:17:57 09:18:02 09:18:05 09:18:10 09:18:13 09:18:20 09:18:25 09:18:28

Q. And did you do any experimental studies as to whether photons and electrons meet at the interface between the EXR holes and electrons meet at the interface between the EML and HTL layer? 09:18:29 09:18:37 09:18:41 09:18:44

A. Sorry. 09:18:48

If your question is whether I, personally, went into the lab and did any experiments, I did not personally conduct any experiments. 09:18:49 09:18:51 09:18:56

Q. And did you do any simulations? 09:18:58

A. If you are asking if I, personally, did any simulations, I, personally, did not do any simulations. 09:19:02 09:19:05 09:19:08

Q. Okay. What is a functional layer? 09:19:09

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

MR. SNYDER: Objection to form. 09:19:19

THE WITNESS: So a functional layer is something which is discussed in the patents, and I also discuss this in my reports. Give me a second, and I will just use the exact language that I used, which is from the specification from the patent. 09:19:20 09:19:24 09:19:26 09:19:30 09:19:34

So the -- the functional layer is the layer of the device which has a discrete and specific function. 09:19:54 09:19:59 09:20:03

BY MR. SHEASBY: 09:20:04

Q. Can a layer be made up of sublayers? 09:20:50

A. I don't offer an opinion on whether a layer could be made up of sublayers. Each layer is a layer, as understood to a person of ordinary skill in the art, and, again, that can deliver that -- that function. 09:20:53 09:20:59 09:21:03 09:21:08 09:21:12

Q. Yeah. 09:21:12

But my question is can a layer be made up of sublayers? 09:21:13 09:21:17

MR. SNYDER: Objection to form. 09:21:18

THE WITNESS: So -- and I haven't offered an opinion on whether a layer can consist of sublayers. 09:21:21 09:21:23

BY MR. SHEASBY: 09:21:27

Q. Is there anything in the patent that excludes a layer from consisting of sublayers? 09:21:27 09:21:30

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

A. So if we look at the text of the patent, the -- the '164 patent, I'll -- I'll read the section which discusses this. And -- 09:21:33 09:21:42 09:21:47

Q. You don't need to read the section. You can just tell me the section you are referring to. 09:21:50 09:21:53

A. If we go to column three, line fifty-three. 09:21:55

THE REPORTER: What line, please? 09:22:04

THE WITNESS: Sorry. 09:22:06

It is line fifty-three in the '164 patent. 09:22:08

BY MR. SHEASBY: 09:22:23

Q. Yes. 09:22:23

Okay. So back to my question. 09:22:23

Can a functional layer be made up of sublayers? 09:22:26 09:22:30

MR. SNYDER: Objection to form. 09:22:31

THE WITNESS: So, again, each layer is a layer, and so I don't offer an opinion on whether it can be made from sublayers. But, again, each layer needs to be a layer which has a specific function. 09:22:34 09:22:37 09:22:45 09:22:48 09:22:51

BY MR. SHEASBY: 09:22:52

Q. And in layer means one or more layers in patentese; correct? 09:22:52 09:22:56

MR. SNYDER: Objection to form. 09:22:57

THE WITNESS: I'm not speaking as if I am 09:22:59

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

writing a patent. I'm answering the question as it would be viewed by a person of ordinary skill in the art. 09:23:01 09:23:05 09:23:09

BY MR. SHEASBY: 09:23:09

Q. I understand that. 09:23:09

But do you understand that the patent says at least one organic functional layer? Do you see that? 09:23:10 09:23:13 09:23:17

A. I do. And right after that it lists several possible examples, for example, an emissive layer, an electronic transport layer, and so on. And so the fact that it says an organic functional layer and then enumerates those layers tells us that the layer envisioned in the specification of the patent is one of those layers, such as the emissive layer or one of the transport layer. 09:23:18 09:23:23 09:23:29 09:23:33 09:23:39 09:23:42 09:23:45 09:23:49

Q. And is it known in the art that an emissive layer can, itself, be made up of sublayers? 09:23:50 09:23:54

MR. SNYDER: Objection to form. 09:23:58

THE WITNESS: Again, the -- I don't offer an opinion on whether there are sublayers. The emissive layer is a layer of the device, and -- and it is the layer which offers that specific function of being emitted. 09:23:59 09:24:01 09:24:05 09:24:08 09:24:13

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Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

BY MR. SHEASBY: 09:24:13

Q. I know. 09:24:15

I'm asking you in the art was it understood that an emissive layer to the -- can be made up of sublayers? 09:24:15 09:24:18 09:24:22

A. Yeah. 09:24:23

I'm sorry. I am not sure exactly how I can clarify my answer further. 09:24:25 09:24:28

Q. Sir, you purport to be a person of ordinary skill in the art at the time of the patent, at least. Persons of ordinary skill in the art understood that functional layers, like emission layers, could be made up of multiple layers. 09:24:31 09:24:35 09:24:35 09:24:37 09:24:39

MR. SNYDER: Objection to form. 09:24:41

THE WITNESS: So, again, I think we may be getting into somewhat of a semantic discussion. But the emissive functional layer is a layer, and if you have a specific context in which I can offer a more nuanced opinion, I would be happy to discuss that more. 09:24:42 09:24:46 09:24:49 09:24:55 09:25:01 09:25:05

BY MR. SHEASBY: 09:25:05

Q. Sure. 09:25:05

In the context of OLED, would it rec- -- was it recognized that emission -- emissive layers could be made up of multiple sublayers? 09:25:05 09:25:05 09:25:10

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

MR. SNYDER: Objection to form. 09:25:14

THE WITNESS: So, again, the -- the emissive layer is a layer of the device, and there is, again, a compositional structure to it that helps it function. And that -- that structure makes it, itself, a layer. 09:25:15 09:25:19 09:25:23 09:25:27 09:25:33

Now -- yeah. I'll -- I'll leave my answer there. 09:25:35 09:25:39

BY MR. SHEASBY: 09:25:39

Q. Okay. And can that emission layer be laid down in multiple steps? 09:25:39 09:25:42

A. The emissive layer can be laid out in multiple steps where, for example, we can have the deposition of components that make the emissive layer, and where they are deposited, say, in sequence or, you know in -- in the evaporator, in many cases for structural balance reasons, the first part, and a second part may be made in different chambers even if they have the same composition; so there could be multiple steps. 09:25:46 09:25:49 09:25:52 09:25:58 09:26:06 09:26:11 09:26:15 09:26:16 09:26:20

Q. And can the emissive layer have different composition of different depths? 09:26:21 09:26:25

A. So there can be some differences in the composition in different parts of the emissive layer. 09:26:27 09:26:30

Q. Okay. I'm going to ask you the next 09:26:34

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

question, which is a functional layer for light emission is a layer that emits light; is that correct? 09:26:36 09:26:41 09:26:44

MR. SNYDER: Objection to form. 09:26:44

You can finish your previous answer. 09:26:46

THE WITNESS: Well, I didn't get to finish my previous answer, but that's okay. I can answer the new question. 09:26:49 09:26:52 09:26:55

Oh, I'm sorry. Can you ask your question again? I lost my train of thought because I was thinking about the composition question. 09:26:57 09:26:59 09:27:02

BY MR. SHEASBY: 09:27:04

Q. Oh, sure. 09:27:04

So my question was -- well, let's actually have it -- I'll -- I'll withdraw it, and I'll reask it in a different way. That is probably the easiest way of doing it. 09:27:04 09:27:08 09:27:11 09:27:15

A. Okay. 09:27:16

MR. SHEASBY: And just for the good order, I'm going to go ahead and mark A1 and A2 as exhibits, just so we have them. 09:27:20 09:27:22 09:27:28

(Deposition Exhibit Number A1 was marked for identification.) 09:27:28 09:27:30

(Deposition Exhibit Number A2 was marked for identification.) 09:27:30 09:29:43

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

BY MR. SHEASBY: 09:29:43

Q. Okay. I have just added the PowerPoints A1 and A2 to the exhibit list. 09:29:43 09:29:46

So a light-emitting functional layer is the material that emits light in the pixel. 09:29:50 09:30:05

A. So the light-emitting functional layer, the EML, the emissive layer, is the layer in the device that emits light in an organic light-emitting diode. 09:30:10 09:30:14 09:30:18

Q. Different question. 09:30:22

The -- the -- the -- the functional layer that performs light emission -- so if a functional -- so a light emission functional layer, it would be a layer that emits light; correct? 09:30:23 09:30:26 09:30:29 09:30:35

MR. SNYDER: Objection to form. 09:30:38

THE WITNESS: I would not use those words to describe that layer, and a person of ordinary skill in the art would not use those words to describe it that way. 09:30:40 09:30:43 09:30:45 09:30:47

BY MR. SHEASBY: 09:30:47

Q. Okay. What is the function of a light emission layer? 09:30:48 09:30:51

MR. SNYDER: Objection to form. 09:30:53

THE WITNESS: Again, I -- the -- the -- that expression, light emission layer, is not a phrase that would normally be used by a person of ordinary 09:30:53 09:30:56 09:30:59

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

skill in the art; so, again, there -- I hesitate to offer an opinion. I really want to be precise in my description of where the light is generated and in the description of the layers using the standard terminology that is used in the organic light-emitting diode community. 09:31:02 09:31:07 09:31:13 09:31:16 09:31:20 09:31:27

BY MR. SHEASBY: 09:31:27

Q. And that is emission layer? 09:31:30

A. EML, the emissive layer specifically. 09:31:37

Q. Well, in the patent it says the organic functional layer can be an emission layer. That is at column three, line sixty through sixty-three. 09:31:40 09:31:40 09:31:44

Do you see that? 09:31:49

A. I -- I see that, yes. 09:31:49

And that is the EML, as I would describe it in -- in English that it is translated from German, so.... 09:31:51 09:31:55 09:31:59

Q. Well, the organic functional layer can be an emission layer and be doped with at least one emitted material. 09:31:59 09:31:59 09:32:05

Do you see that? 09:32:05

A. I see that, yes. 09:32:06

Q. And what is the function of the emission layer in that passage? 09:32:07 09:32:10

MR. SNYDER: Objection to form. 09:32:12

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

THE WITNESS: Again, I -- that layer is the emissive layer, the EML, which is doped with the light-emitting component, and that generates the light that is inside the organic light-emitting diode. 09:32:12 09:32:15 09:32:20 09:32:23 09:32:26

BY MR. SHEASBY: 09:32:26

Q. The organic functional layer can be an emission layer. 09:32:26 09:32:31

That is the layer that generates the light within the OLED? 09:32:32 09:32:34

A. So, again, I, personally, would not use that word. But the emissive layer, the EML, is the region of AMBI polar semiconductor in which the light is generated. 09:32:37 09:32:39 09:32:43 09:32:49

Q. Right. 09:32:49

In the patent it just says emission layer, though. 09:32:50 09:32:51

It doesn't say EML; right? 09:32:51

A. The patent uses the words emission layer. 09:32:54

Q. Yes. 09:32:56

And the purpose of the function emission layer is to emit light; is that correct? 09:32:56 09:33:00

MR. SNYDER: Objection to form. 09:33:03

THE WITNESS: So, again, as described specifically in the patent, it is the region which 09:33:03 09:33:05

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

I am describing as the EML, which is doped with the lumiphore, which is where the light is generated, as I mentioned. 09:33:08 09:33:12 09:33:16

BY MR. SHEASBY: 09:33:16

Q. All right. 09:33:16

MR. SHEASBY: Objection. Form. 09:33:18

BY MR. SHEASBY: 09:33:19

Q. The emission light emits light; correct? 09:33:19

A. So, again, I disagree with the use of that term emission layer. And, again, the patent describes the various layers in the device. And in my explanation, I am just describing that EML, which is that emissive layer, which is doped with the dopings, is, indeed, where the light is emitted. 09:33:24 09:33:27 09:33:32 09:33:35 09:33:40 09:33:44

Q. So the emission layer is where the light is emitted; correct? 09:33:47 09:33:50

A. So, again, I wouldn't use those words personally, but the patent is mapping to the EML, which is the region where the device is doped and where the excitons are then transferred to the lumiphores in order to shine out of the organic light-emitting diode. 09:33:51 09:33:54 09:33:58 09:34:02 09:34:07 09:34:18

Q. Right. 09:34:18

In other -- any excitons transferred to lumiphores at the interface between the R prime and 09:34:18 09:34:18

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

the EML layer? 09:34:20

A. So, yeah. 09:34:21

They are -- the dopings are inside the EML, 09:34:23
and so to the degree that the EML extends that 09:34:27
interface, of course, there can be -- of course, 09:34:30
there is nothing special about that interface, and 09:34:34
the -- the excitons have a relatively large diffusion 09:34:37
length, something like twenty nanometers within the 09:34:42
device, and so they are not intending to go to any 09:34:46
specific spot. They diffuse and recombine throughout 09:34:49
the volume of the emissive layer. 09:34:53

MR. SHEASBY: So objection to form. That is 09:34:57
not the question I asked. 09:34:59

THE WITNESS: If you could ask it again. 09:35:00

MR. SHEASBY: And I'll actually just say 09:35:02
objection to form. 09:35:07

BY MR. SHEASBY: 09:35:07

Q. The question I ask when lumiphores recombine 09:35:07
with excitons, you say there was a twenty nanometer 09:35:12
range in which they can be located; correct? 09:35:16

A. So yeah. 09:35:18

So just to rephrase that, the -- the 09:35:20
excitons are formed on the host typically, not 09:35:24
always. And then they diffuse and recombine on the 09:35:28
lumiphores. And so that -- there is a whole fostered 09:35:35

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

diffusion process that we can get into in which the excitons can move some distance within the organic light-emitting diode. But if that happens, it has to be energetically downhill; so that only happens within the EML, which is where those -- the dopings exist that give us the light from the organic light-emitting diode. 09:35:41 09:35:45 09:35:50 09:35:53 09:35:57 09:36:01 09:36:04

Q. And what if there is any dopings at the interface between 700 angstroms and 800 angstroms? 09:36:04 09:36:08

A. I'm sorry. 09:36:14

Are we speaking about wavelength or sometimes, like -- are -- you are talking about in the cross section of the device -- 09:36:16 09:36:22 09:36:24

Q. Yes. 09:36:26

A. -- specific? 09:36:26

Q. Yes. 09:36:28

A. So -- 09:36:29

MR. SNYDER: Objection to form. 09:36:30

THE WITNESS: -- if there are dopings within the diffusion length, then it is possible for the exciton to diffuse there as long as the energy of the doping is equal to or smaller than the energy of the parent exciton. 09:36:30 09:36:32 09:36:36 09:36:41 09:36:46

BY MR. SHEASBY: 09:36:46

Q. [redacted] 09:36:48

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

A. [redacted]

[redacted] 09:36:55

Q. [redacted]

[redacted] 09:36:59

A. So there is some discussion of this in my report, and, actually, we have some testimony. If you just give me a moment, I will bring it up. 09:37:03 09:37:05 09:37:09

So one of the discussions -- and I did not personally conduct this interview, [redacted] 09:38:54

[redacted] 09:39:11

And the -- the second testimony we have from -- from Samsung is with Mr. Noh, again, also from a deposition taken there. And so Mr. Noh never -- and, apparently, [redacted] 09:39:12 09:39:23 09:39:30

[redacted] And I described in my analysis of this in my report as well. 09:39:46 09:39:51

Q. Okay. So let's split it into pieces. 09:39:53

[redacted] 09:40:02

A. I don't believe that I personally brought up 09:40:03

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

that issue in any of my discussions with Samsung engineers. 09:40:06 09:40:10

Q. Okay. [redacted] 09:40:17

A. I did not think it was necessary, given the strength of the evidence, and so I did not request for any additional study to be performed. 09:40:18 09:40:24 09:40:26

MR. SHEASBY: Objection. Form. 09:40:28

BY MR. SHEASBY: 09:40:29

Q. I asked you if you had asked for any data that had been generated by Samsung [redacted] 09:40:29 09:40:36

MR. SNYDER: Objection to form. 09:40:38

THE WITNESS: I'm sorry. 09:40:40

I believe I already answered that question. But just to be clear, I did not believe it to be necessary and so I did not ask for any additional data beyond the testimony from the two employees and, again, some of the other evidence of that. 09:40:41 09:40:43 09:40:46 09:40:49 09:40:56

BY MR. SHEASBY: 09:40:56

Q. And did you ask -- you said that Ms. Seo testified [redacted]; is that correct? 09:40:56 09:41:07

A. That is correct. That was her testimony. 09:41:08

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

Q. You understand that [redacted]; correct? 09:41:10

MR. SNYDER: Objection to form. 09:41:13

THE WITNESS: [redacted] 09:41:33

BY MR. SHEASBY: 09:41:34

Q. Great. 09:41:35

So now here is the question: [redacted] 09:41:40

A. So I -- again, I did not think it to be necessary. I have made many OLEDs in my lifetime and have studied questions of doping placement and layer formation in -- in great detail. We can talk about those if you are interested. [redacted] 09:42:18

MR. SHEASBY: Objection. Form. 09:42:21

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Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

BY MR. SHEASBY: 09:42:22

Q. I asked you whether you requested any data from Samsung. That is all I asked. 09:42:22 09:42:25

A. Okay. I will repeat my answer, which is I did not think it to be necessary; so I did not request any additional data from Samsung on that point. 09:42:28 09:42:31 09:42:34 09:42:38

Q. Did you request any simulations from Samsung on that point? 09:42:38 09:42:42

A. Similarly, I did not believe it to be necessary; so I did not request any simulations from Samsung on that point of the diffusion specifically. 09:42:43 09:42:46 09:42:49

Q. Okay. Let's talk about did you measure the HOMO or LUMO levels of the materials that are present in the pixels in the light-emitting functional layers? 09:42:53 09:43:06 09:43:11 09:43:18

A. Sorry. 09:43:18

Can you be more specific? Are we speaking about my experience in general or about any specific devices that are at question in any of my report. 09:43:19 09:43:23 09:43:26

Q. Devices that are at issue in this case. 09:43:29

A. So for the specific devices accused at issue, I did not personally go in the laboratory and measure the HOMO or the LUMO levels of those semiconductor materials. 09:43:32 09:43:35 09:43:38 09:43:42

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

Q. Did you ask Samsung for the data they had in the HOMO or LUMO levels? 09:43:44 09:43:47

A. So Samsung provided extensive data and analysis regarding the HOMO and LUMO levels of the materials that I cite in my report, and so I was able to use that information as provided by Samsung. Any missing data I was at liberty to request. 09:43:50 09:43:57 09:44:01 09:44:04 09:44:10

Q. I asked you if you requested any data from Samsung on the subject. 09:44:13 09:44:17

A. I don't recall having to ask for any data beyond what was already supplied to me. I believe I had a complete set for the discussion and analysis that I have in my report. 09:44:20 09:44:25 09:44:28 09:44:32

MR. SHEASBY: Okay. I have marked the -- Humphrey's report Exhibit A. 09:44:34 09:44:59

(Deposition Exhibit Number 7 was marked for identification.) 09:44:59 09:45:03

BY MR. SHEASBY: 09:45:03

Q. Why don't you open that up. And that would be Exhibit A to the Humphrey's report, which would be Exhibit 7. 09:45:04 09:45:10 09:45:13

A. Seven. I will put it up. 09:45:20

Okay. I have the report open. 09:45:35

Q. Okay. And why don't we turn to Paragraph 189. 09:45:43 09:45:46

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

A. Okay. I am there now. 09:46:13

Q. The patents don't require actual LUMO and HOMO values. 09:46:15 09:46:26

They just require relative LUMO and HOMO -- LUMO-HOMO values in comparison to the first, second, and third matrix; correct? 09:46:28 09:46:31 09:46:33

A. That is correct. 09:46:35

The patent only requires relative positioning of the HOMO and LUMO values. 09:46:35 09:46:38

Q. And if we go to Paragraph 192, it talks about blue host, blue doping, and blue prime materials. 09:46:42 09:46:49 09:46:53

Do you see that? 09:46:54

A. I see that, yes. 09:46:55

Q. And what is a matrix material? 09:46:56

MR. SNYDER: Objection to form. 09:47:01

THE WITNESS: So -- matrix material is a disputed term; so give me one second just to bring up my discussion there. 09:47:02 09:47:12 09:47:17

So, you know, there is some dispute and -- you know, I understand that Pictiva and Samsung have different proposed constructions. And my understanding is also that there is not yet a claim construction order; so if that is issued, we probably need to follow that specifically. 09:48:10 09:48:12 09:48:17 09:48:20 09:48:24 09:48:29

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

Now, my understanding is Samsung has proposed the construction, a continuous phase of the mixture of matrix materials, which I agree with. And that Pictiva has proposed the construction plain and ordinary meaning, which they proclaimed as the phrase does not need to be construed. 09:48:31 09:48:34 09:48:39 09:48:43 09:48:47 09:48:53

BY MR. SHEASBY: 09:48:55

Q. And what is a continuous phase? 09:48:55

A. So a continuous phase would be, again, a block of material or a region of material which is -- which is continuous, which is not interrupted. 09:48:58 09:49:02 09:49:06

Q. What does it mean for material to be not interrupted? 09:49:10 09:49:19

A. So what -- I -- I don't want to invent a new term here, but it would mean that the material is in a single -- I want to use the word continuous, but that it is in a single region, and that -- that material is all a -- simply connected through -- through the layer of material. 09:49:20 09:49:31 09:49:34 09:49:42 09:49:46 09:49:52

Q. And let's go to Paragraph 205 in Humphrey Exhibit A. 09:49:54 09:50:31

A. (Witness complies.) 09:50:41

205, okay. I am there now. 09:50:56

Q. In the chart he lists the first matrix material, second matrix material, and a third matrix 09:50:59 09:51:04

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

material. 09:51:09

Do you see that? 09:51:09

A. I see that, yes. 09:51:10

Q. Are those matrix materials? 09:51:11

MR. SNYDER: Objection to form. 09:51:13

THE WITNESS: So, again, Humphrey describes them as matrix materials. Now, whether they are matrix materials in the meaning of the -- of the patent, I disagree that those are matrix materials because they are not all continuous in one layer. 09:51:15 09:51:20 09:51:27 09:51:33 09:51:37

BY MR. SHEASBY: 09:51:41

Q. Which ones -- you say they are not all continuous in one layer. 09:51:41 09:51:44

Is that what you said? 09:51:45

A. Yes. That is correct. 09:51:46

Q. Okay. Is the first matrix material he listed a matrix material? 09:51:47 09:51:50

A. [redacted] 09:52:28

Q. [redacted] 09:52:38

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

Is that what you are saying? 09:52:40

A. That is correct. 09:52:41

[redacted] 09:53:23

Q. So you consider a matrix in the layer to be -- mean the same thing? 09:53:25 09:53:28

MR. SNYDER: Objection to form. 09:53:31

THE WITNESS: So a matrix is that mixture of materials in a layer, and so I'm not sure that the reverse is necessarily true. But if we describe a matrix as I have described in my construction before, the proposed construction, it would be a mixture of the materials in a layer. 09:53:32 09:53:38 09:53:42 09:53:46 09:53:49 09:53:52

BY MR. SHEASBY: 09:53:54

Q. What is the -- let's go back to Exhibit 1 at .pdf page seven. 09:54:27 09:54:41

A. Give me a minute to bring it up. 09:54:42

Okay. I am there now. 09:55:04

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

Q. What is the HOMO and LUMO values in the ETL layer? 09:55:09 09:55:19

A. I don't have those in memory. I would have to see if they are present in another part of the document, but this -- this page does not tell us what the ETL HOMO and LUMO layers are. 09:55:20 09:55:29 09:55:31 09:55:36

Q. Did you ask Samsung's engineers if the HOMO-LUMO values in the ETL, EML, and HTL layers, respectively, satisfy the limitation of claim one that talks about a first matrix material, a second matrix material, and a third matrix material that have various comparative amounts of LUMO and HOMO? 09:55:39 09:55:42 09:55:48 09:55:53 09:55:57 09:56:01

MR. SNYDER: Objection to form. 09:56:06

THE WITNESS: So the EML and the ETL are different layers, and so I just -- I'm not sure I understand your question because the ETL and the EML are not part of the same matrix. 09:56:07 09:56:13 09:56:19 09:56:25

BY MR. SHEASBY: 09:56:27

Q. I understand that. 09:56:27

A. I'm not sure how one would consider those to then meet the requirements of -- of the -- patent claim. 09:56:28 09:56:33 09:56:38

Q. Is there a matrix within the ETL? 09:56:39

A. I would say yes. 09:56:44

Q. Okay. Is there a matrix within the EML? 09:56:45

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

A. Yes. 09:56:49

I would -- I would agree with that 09:56:49

statement. 09:56:51

Q. Is there a matrix within the HTL? 09:56:51

A. Yes. 09:56:55

I agree with that statement. 09:56:55

Q. What are the various HOMO-LUMO values of 09:56:56

those three matrices? 09:57:00

A. In looking separately, I don't have it 09:57:03

committed to memory. But, again, the -- you can look 09:57:07

up -- if you would like, I can pull up more 09:57:14

documentation. That analysis is available to us for 09:57:18

those layers separately. And then we can -- we can 09:57:21

find what those HOMO-LUMO levels are. 09:57:27

Q. And you -- 09:57:31

A. I don't have those memorized. I'm sorry. 09:57:32

Q. Did you put that in your report? 09:57:35

A. The HOMO and LUMO level specifically of all 09:57:37

the layers, I did not specifically enumerate those in 09:57:41

my report, no. 09:57:45

Q. Do you know if they satisfy the comparative 09:57:45

requirements of the claim limitation? 09:57:49

A. So, again, I -- I disagree that those layers 09:57:52

are all part of the same matrix, in which case I can 09:57:57

confidently say that they don't satisfy the claim 09:58:02

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

limitation, which requires all of those to be intermixed into a single layer. 09:58:05 09:58:09

Q. So you believe the claims require the first matrix, the second matrix, and the third matrix to be -- yeah. I understand what you are saying. 09:58:12 09:58:14 09:58:18

I am actually specifically asking is the matrix material in the ETL, what is its LUMO and HOMO relative to the matrix material in the EML and the HTL? 09:58:21 09:58:27 09:58:34 09:58:38

MR. SNYDER: Objection to form. 09:58:39

THE WITNESS: So that is knowable, and if you would like, we can -- unfortunately, this document doesn't have those details. I don't remember it from memory. But we -- we could certainly look separately and -- and enumerate what those layers are. Those are -- those are known values. I apologize. I just don't have them committed to memory. 09:58:40 09:58:43 09:58:47 09:58:50 09:58:54 09:58:57 09:59:00 09:59:03

MR. SHEASBY: All right. Let's take our break. 09:59:09 09:59:11

THE VIDEOGRAPHER: This marks the end of media unit number two. 09:59:13 09:59:15

The time is 9:59 a.m. 09:59:16

We are off the record. 09:59:18

(Short recess taken.) 10:03:59

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

THE VIDEOGRAPHER: This marks the beginning of media unit number three. 10:18:00 10:18:05

The time is 10:18 a.m. 10:18:08

We are on the record. 10:18:09

BY MR. SHEASBY: 10:18:10

Q. Looking back at Exhibit 1, and we're looking at the -- the EML layer. 10:18:11 10:18:14

Now, you said that for there to be emissions, there has to be a conduction of electrons in the transport of -- of holes; correct? 10:18:17 10:18:19 10:18:26

MR. SNYDER: Objection to form. 10:18:33

THE WITNESS: That is correct. 10:18:34

So for the emissive layer to do its work, both the hole and an electron have to meet on the semiconductor to form the excited state, and so both electrons and holes need to meet and be injected into one of the components of the EML. 10:18:38 10:18:42 10:18:45 10:18:50 10:18:56

BY MR. SHEASBY: 10:18:59

Q. There is no conduction of electrons in the EML layer; correct? 10:18:59 10:19:01

A. So I disagree with that characterization. The electrons do not flow all the way through the EML, but the electrons need to be able to access the EML in order to form the exciton. 10:19:05 10:19:09 10:19:12 10:19:16

Q. Sir, there is no conduction of electrons in 10:19:19

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

the EML layer; correct? 10:19:26

A. I disagree. 10:19:29

Q. The conduction of electrons is not required for the emission of light in the EML layer? 10:19:31 10:19:48

A. I disagree. I'm sorry. I'm not exactly sure what you are asking. 10:19:58 10:20:04

Q. Sure. 10:20:06

There is -- the EML layer emits light; correct? 10:20:06 10:20:10

A. That is correct. 10:20:12

The EML is the emissive layer of the -- of the -- of the OLED, and that is where the light is -- is generated and is emitted from that. 10:20:13 10:20:18 10:20:22

Q. And there is no conduction of electrons in the EML layer because that is not necessary for emission? 10:20:25 10:20:28 10:20:30

A. So electrons need to reach and enter the EML, and so I disagree with the statement that there is no conduction of electrons, as I mentioned before. 10:20:32 10:20:36 10:20:42

Q. Okay. Let me -- let me ask you another question, which is about the -- why don't we go to -- oooh, I'm going to have to mark some more exhibits. 10:20:47 10:20:50 10:21:01

Why don't we go back to SDC_000709. 10:21:04

Let's go back to some of the exhibits. Let's go to Exhibit 3. 10:21:10 10:23:06

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

A. (Witness complies.) 10:23:15

Okay. I'm there now. 10:23:19

Q. And let's turn to Page 70993. 10:23:20

A. (Witness complies.) 10:23:44

Q. [redacted] 10:24:09

MR. SNYDER: Objection to form. 10:24:10

THE WITNESS: [redacted] 10:24:26

BY MR. SHEASBY: 10:24:27

Q. And is -- are those forms of vaporization? 10:24:28

MR. SNYDER: Objection to form. 10:24:33

THE WITNESS: Yes. 10:24:34

[redacted] 10:24:42

BY MR. SHEASBY: 10:24:44

Q. And does that page depict the chambers in which that -- that occurs? 10:24:44 10:24:47

A. So this document shows some of the structure of the sources that are used, but -- but it does not show the whole chamber generally. 10:24:51 10:24:54 10:24:58

Q. And what do you mean, the structure of the 10:25:01

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

sources? 10:25:04

A. So the [redacted] -- 10:25:05

strictly speaking, evaporation is when the material 10:25:12

melts, and not all of it melts. But when that 10:25:17

process occurs, that happens out of a source out of 10:25:20

a small furnace, and sometimes it is linear, 10:25:24

sometimes it is circular. [redacted]

[redacted] 10:25:40

There is the rest of the chamber, and there 10:25:42

are other structures also inside the system, which is 10:25:45

why I say it is just a section where the source 10:25:49

materials are stored and the schematic description of 10:25:53

how they are configured. 10:25:58

Q. [redacted]

[redacted]? 10:26:01

MR. SNYDER: Object- -- 10:26:05

THE WITNESS: That is my understanding; [redacted]

[redacted] 10:26:20

BY MR. SHEASBY: 10:26:22

Q. And what materials are used in the METL 10:26:22

layer? 10:26:33

MR. SNYDER: Objection to form. 10:26:34

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

THE WITNESS: I'm not sure which ones are used in -- in the general case. The document describes what sources are loaded, but not all of them are used in every device, and that depends upon the recipe; so we have to look at the construction of each individual device in order to say what is in the ETL layer. 10:26:36 10:26:38 10:26:46 10:26:48 10:26:51 10:26:55 10:27:00

BY MR. SHEASBY: 10:27:01

Q. Are there any processes in which the E- -- in which the ETL layer is manufactured and which the materials that make up that ETL layer are not both evaporated in the same chamber? 10:27:02 10:27:05 10:27:09 10:27:12

A. So our -- I'm sorry. 10:27:17

Are you asking the question in general or are you asking about Samsung's process? 10:27:22 10:27:24

Q. The accused Samsung processes. 10:27:26

A. [redacted] 10:27:45

Q. [redacted] 10:27:47

MR. SNYDER: Objection to form. 10:27:50

THE WITNESS: [redacted] 10:27:52

[redacted] 10:27:54

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

BY MR. SHEASBY: 10:28:05

Q. How do you jointly vaporize materials within a chamber? 10:28:49 10:28:56

A. So the -- this question of joint vaporization is a -- is a complicated one, and so in -- one -- one way that material could be jointly vaporized would be, for example, to mix the material together into a single crucible and then evaporate it from that single crucible. 10:28:58 10:29:05 10:29:09 10:29:13 10:29:15 10:29:22

Q. What are the other ways of joint vaporization? 10:29:25 10:29:28

A. So I discussed this a little bit in my report. There are some other examples, for example, that are offered by -- in -- in Werner251. Let me just figure those out. But for sure that is one example where -- which has been discussed in the -- in the patent literature and in the literature. And, you know, I -- there -- there may be other ways as well. 10:29:28 10:29:31 10:29:36 10:29:45 10:29:47 10:29:50 10:29:54 10:29:57

Q. Have you ever performed joint vaporization in a chamber? 10:29:57 10:30:00

A. So I have done codeposition of materials, but I'm not certain that that would necessarily qualify as joint vaporization because of the types of systems that I was using. 10:30:02 10:30:10 10:30:13 10:30:17

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

Q. Why is codeposition not joint vaporization? 10:30:21
A. So joint vaporization -- if you just give me a second and let me just pull up the -- the language that I use. 10:30:27 10:30:32 10:30:35
Q. Let me ask it this way. 10:31:56
A. Sure. 10:31:58
Q. For the 2.- -- for the '223 patent, is there any description of simultaneous vaporization through comixing in the specification? 10:31:58 10:32:09 10:32:14
MR. SNYDER: Objection to form. 10:32:19
THE WITNESS: So the -- the '223 patent describes the -- the benefits of the patent as obtained by joint vaporization, and so it basically is describing a process where there is substantial mixing and coordination that occurs as part of that joint vaporization process. 10:32:20 10:32:25 10:32:28 10:32:36 10:32:39 10:32:44
BY MR. SHEASBY: 10:32:45
Q. Right. 10:32:45
And that is what I am asking you. 10:32:45
Where is that? Where does it say in the '223 patent that the -- the materials must be mixed in advance for there to be joint vaporization? 10:32:47 10:32:51 10:32:53
A. That is just an example of one way that one could consider creating a situation where there is joint vaporization. 10:32:56 10:33:01 10:33:03

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

MR. SHEASBY: Objection. Form. 10:33:05
BY MR. SHEASBY: 10:33:05
Q. Where does the patent talk about premixing 10:33:06
the materials are involved in joint vaporization? 10:33:09
A. Sorry. I was responding to your question 10:33:12
and example of how one could conduct joint 10:33:14
vaporization. 10:33:17
MR. SHEASBY: Objection. Form. 10:33:17
BY MR. SHEASBY: 10:33:18
Q. Where does the patent describe mixing in 10:33:19
advance the two materials that are involved in joint 10:33:21
vaporization? 10:33:25
MR. SNYDER: Objection to form. 10:33:25
THE WITNESS: So the -- the '223 patent does 10:33:26
not describe that mixing. That was -- 10:33:28
BY MR. SHEASBY: 10:33:31
Q. So let me ask the next question, which is 10:33:31
where does the '223 patent describe that the -- the 10:33:33
substances in the joint vaporization process must be 10:33:37
simultaneously deposited? 10:33:41
MR. SNYDER: Objection to form. 10:33:43
THE WITNESS: So, again, the -- the '223 10:33:44
patent discusses joint vaporization and describes 10:33:52
that joint vaporization as providing the complex 10:33:57
agent and the other coordination processes that are 10:34:03

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

the benefits of the patent. 10:34:05

MR. SHEASBY: Objection. Form. 10:34:07

BY MR. SHEASBY: 10:34:08

Q. Where does the '223 patent describe simultaneous deposition through vaporization? 10:34:08 10:34:11

MR. SNYDER: Objection to form. 10:34:14

THE WITNESS: So the -- give me a moment, and I'll -- I'll take a quick look at an example. 10:34:15 10:34:30

Sorry. Would it be -- I think the '223 patent is -- let's see. It is -- 10:35:06 10:35:32

BY MR. SHEASBY: 10:35:34

Q. It is not. 10:35:34

A. If you would like me to refer specifically to it, then it would be great if you could introduce that. 10:35:36 10:35:38 10:35:44

MR. SHEASBY: This will be marked as Exhibit 13. 10:36:32 10:36:34

(Deposition Exhibit Number 13 was marked for identification.) 10:36:34 10:36:53

BY MR. SHEASBY: 10:36:53

Q. Let me ask you a question. 10:36:53

If you evaporate something at the same time, is that -- will that result in joint vaporization? 10:36:55 10:36:58

A. Not necessarily. 10:37:00

Q. All right. 10:37:01

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

A. It really depends on the details of the deposition, the pressure, the reactivity of the two materials, the degree of intermixing. 10:37:02 10:37:04 10:37:08

Q. So what exactly -- what actually is required for joint vaporization? 10:37:11 10:37:13

A. So as described in the patent, joint vaporization is the -- the -- the -- the -- the final outcome is that coordination process that the patent describes. 10:37:15 10:37:21 10:37:26 10:37:31

MR. SHEASBY: Objection. Form. 10:37:34

BY MR. SHEASBY: 10:37:35

Q. What is joint vaporization? 10:37:36

MR. SNYDER: Objection to form. 10:37:38

THE WITNESS: The patent itself, again, doesn't describe the -- you know, there is no line specifically on what there is, but it is this formation of complexes the -- the general definition that the patent offers. 10:37:39 10:37:52 10:37:57 10:38:01 10:38:07

BY MR. SHEASBY: 10:38:09

Q. What is the common and ordinary meaning of joint vaporization? 10:38:09 10:38:11

MR. SNYDER: Objection to form. 10:38:13

THE WITNESS: So the -- again, I -- in my -- in my report I describe -- if you go to paragraph fifty-two in my noninfringement report, I provide 10:38:14 10:38:48 10:38:54

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

that, you know, at least a POSITA would understand that joint vaporization required that the metal compound and the organic compound could be coevaporated so that they are present together in the vapor phase. And so, again, it also depends on the pressure because that determines how much interaction the two materials will have in the vapor phase. If the pressure is very low, then the mean free path is long. If the pressure is high, they have more opportunity to interact. 10:39:02 10:39:04 10:39:07 10:39:07 10:39:10 10:39:15 10:39:19 10:39:22 10:39:25 10:39:29

But it also depends on the structure of the evaporation sources and whether the plumes are allowed to interact in a way that permits that reaction to occur in the vapor phase; so it is not a simple understanding, but that is generally what a person of ordinary skill in the art would recognize as joint vaporization. 10:39:30 10:39:32 10:39:35 10:39:39 10:39:42 10:39:47 10:39:50

BY MR. SHEASBY: 10:39:54

Q. Is any of that described in the patent? Does the patent say anything about immediately present in the same vapor phase? 10:39:54 10:39:59 10:40:01

A. So the -- the -- the patent states joint vaporization. It offers cotton, for example, as an example. It does not have a strict definition of what is or is not joint vaporization. 10:40:07 10:40:13 10:40:17 10:40:22

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

MR. SHEASBY: Objection. Form. 10:40:25
BY MR. SHEASBY: 10:40:26
Q. Does the patent describe that there must be coevaporation such that both the -- the meta complex and the organic compound are immediately present in the same vapor phase? 10:40:26 10:40:30 10:40:35 10:40:39
A. So I'm sorry. I think I have already answered that. The -- the -- the patent does not specifically describe what joint vaporization is or is not. 10:40:46 10:40:49 10:40:50 10:40:53
Q. It is not the question I asked. 10:40:53
MR. SHEASBY: Objection. Form. 10:40:55
BY MR. SHEASBY: 10:40:56
Q. Does the patent ever describe an embodiment in which there is coevaporation such that both the complex and the compound are immediately present in the same vapor phase? 10:40:56 10:40:59 10:41:03 10:41:06
MR. SNYDER: Objection to form. 10:41:08
THE WITNESS: I have to take a quick look one more time at the patent. Just give me a moment. 10:41:19 10:41:21
If we go to column fourteen, for example, in line fifteen it describes the situation that I described earlier as an example in which the two components are mixed together in one -- in one -- in one vessel, one crucible, and then are vaporized from 10:42:02 10:42:07 10:42:12 10:42:15 10:42:20

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

a joint vessel as one possible way to conduct that joint vaporization. 10:42:25 10:42:30

BY MR. SHEASBY: 10:42:31

Q. It also discusses joint vaporization by using two separate vessels; correct? 10:42:32 10:42:34

MR. SNYDER: Object to the form. 10:42:40

THE WITNESS: So there is a sentence before that except for with the phrase however. 10:42:40 10:42:46

BY MR. SHEASBY: 10:42:46

Q. Right. 10:42:51

A. So I -- that might be a counterexample -- 10:42:52

Q. Well -- 10:42:57

A. -- saying that that may or may not be joint vaporization. But there is a sentence there that also describes using two different vessels. Again, joint vaporization is a complicated issue, and it depends on the details of the interaction after the material was evaporated as well. 10:42:57 10:43:02 10:43:05 10:43:09 10:43:12 10:43:15

Q. So this describes two options in the patent, one in which the metal complex in the organic compound can be vaporized from two different vessels, which are stationed separated from each other. 10:43:17 10:43:20 10:43:24 10:43:28

Do you see that? 10:43:30

MR. SNYDER: Objection to form. 10:43:30

THE WITNESS: I see that. 10:43:31

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

It is also, however, followed by however, and then that describes another option, which is the joint vessel option. 10:43:32 10:43:36 10:43:41

BY MR. SHEASBY: 10:43:42

Q. Right. 10:43:42

So it describes separate vessels and joint vessels; correct? 10:43:42 10:43:45

MR. SNYDER: Objection to form. 10:43:46

THE WITNESS: Both of those options are -- are listed in that paragraph. 10:43:47 10:43:55

BY MR. SHEASBY: 10:43:56

Q. And are joint vessels required necessarily for joint vaporization? 10:43:56 10:43:59

A. So as I mentioned before, it is not a requirement that joint vessels be used for joint vaporization. 10:44:02 10:44:08 10:44:13

Q. Let me ask you the next question -- 10:44:13

A. I'm sorry. 10:44:15

Q. -- which is -- let me ask you another question. 10:44:15 10:44:17

Have you ever done joint vaporization? 10:44:18

A. Okay. 10:44:21

MR. SNYDER: You can finish your previous answer to the question. 10:44:22 10:44:24

THE WITNESS: Okay. 10:44:25

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

BY MR. SHEASBY: 10:44:25

Q. Have you ever done joint vaporization? 10:44:26

A. Can I finish my previous answer or at least make a note that I didn't get to finish? 10:44:27 10:44:31

Q. Sure. 10:44:33

Have you ever done joint vaporization? 10:44:34

A. So I will just say I didn't get to finish my previous answer. Sorry. 10:44:35 10:44:42

So I have performed joint vaporization using the method where we have mixed materials together and evaporated them together in an attempt to get them to react. But when making OLEDs, I -- generally, the type of equipment I have used personally, those codeposition in the way in which the vapor plumes do not overlap. 10:44:43 10:44:48 10:44:53 10:44:56 10:45:02 10:45:05 10:45:08

Q. Separate vessels? 10:45:09

A. So in those cases, yes. Those were separate vessels and separated by baffle, which prevents the material from redepositing. There are a number of functional reasons why you often don't want the plumes to overlap. 10:45:11 10:45:16 10:45:21 10:45:25 10:45:29

Q. And that is how you have done it for OLEDs? 10:45:30

A. That is -- that is correct. That is my usual approach in making OLEDs. 10:45:36 10:45:39

Q. Okay. [redacted] 10:45:42

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[redacted]

10:45:54

A. [redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted].

10:46:19

MR. SHEASBY: And so objection. Form. 10:46:21

BY MR. SHEASBY: 10:46:22

Q. [redacted]

[redacted]

[redacted]

[redacted]:35

MR. SNYDER: Objection to form. 10:46:37

THE WITNESS: [redacted]

[redacted]

10:46:42

BY MR. SHEASBY: 10:46:42

Q. [redacted]

[redacted]

10:46:49

MR. SNYDER: Objection to form. 10:46:50

THE WITNESS: [redacted]

[redacted]

[redacted]

10:46:57

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[redacted] 10:47:11

BY MR. SHEASBY: 10:47:14

Q. [redacted] 10:47:17

MR. SNYDER: Objection to form. 10:47:18

THE WITNESS: [redacted] :33

BY MR. SHEASBY: 10:47:35

Q. [redacted] 10:47:39

MR. SNYDER: Objection to form. 10:47:39

THE WITNESS: I disagree with that 10:47:40

characterization. 10:47:42

BY MR. SHEASBY: 10:47:42

Q. Okay. Why don't we go to -- [redacted] :56

MR. SNYDER: Objection to form. 10:47:57

THE WITNESS: Again, I disagree with that 10:47:58

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

statement. [redacted]

[redacted]

[redacted]

[redacted]. 10:48:09

BY MR. SHEASBY: 10:48:11

Q. Why don't we -- why don't you download 10:48:23

Exhibit 12. 10:48:26

(Deposition Exhibit Number 12 10:48:26

was marked for identification.) 10:49:00

THE WITNESS: (Witness complies.) 10:49:00

Okay. I have it downloaded. 10:49:01

BY MR. SHEASBY: 10:49:03

Q. This is the testimony of Mr. Jo; correct? 10:49:20

A. That is correct. 10:49:26

Q. He testifies: 10:49:27

[redacted]

[redacted] 10:50:10

[redacted] 10:50:11

[redacted]

[redacted] 10:50:18

MR. SNYDER: Objection to form. 10:50:19

THE WITNESS: Sorry. Let me pull up the 10:50:21

section that you are referring to. 10:50:24

I'm sorry. Could you ask your question 10:50:38

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

again? 10:50:41
BY MR. SHEASBY: 10:50:41
Q. Sure. 10:50:42
[redacted] [redacted]
[redacted] [redacted]
[redacted] [redacted]
[redacted] 50:51
MR. SNYDER: Objection to form. 10:50:53
THE WITNESS: So, again, I disagree with 10:50:54
that as the characterization. The question that was 10:50:57
asked by the -- the -- by Ms. Zhong, she is -- 10:51:02
BY MR. SHEASBY: 10:51:09
Q. Let me do it crisply. 10:51:09
He is testifying regarding the METL layer; 10:51:11
correct? 10:51:16
MR. SNYDER: Objection. 10:51:16
THE WITNESS: So sorry. 10:51:17
Are we asking about the -- the mixed ETL; 10:51:22
right? The METL? 10:51:27
BY MR. SHEASBY: 10:51:27
Q. Yeah. 10:51:28
I'm using the acronym, the METL. 10:51:28
A. The METL, great. 10:51:32
So -- because the next layer is metal. 10:51:34
Q. I understand. 10:51:37

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

A. No problem; so yes. 10:51:38

[redacted] 10:52:05

Q. All right. We'll do it in pieces. 10:52:08

Does the claim say simultaneous deposition? 10:52:10

A. So the claim says joint vaporization. 10:52:14

Q. Does it say simultaneous deposition? 10:52:17

A. So I do not believe that that phrase appears in the patent. 10:52:20 10:52:25

Q. Okay. And Mr. Jo testifies: 10:52:26

[redacted] 10:52:39

Do you see that testimony? 10:52:42

A. I see that testimony. 10:52:43

Q. And do you -- do you agree or disagree with that testimony? 10:52:45 10:52:48

A. So I disagree that it produces the result that you are describing. [redacted] 10:52:48 10:52:52

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[redacted] 10:53:03

Q. Not the question I asked. 10:53:05

The question I asked is evaporation is 10:53:06

a form of vaporization; correct? 10:53:09

A. That is correct. 10:53:11

Q. [redacted] 10:53:20

A. So, again, in different areas the materials 10:53:21

are being heated and the materials are being 10:53:24

evaporated, and that does happen in the same chamber 10:53:27

at the same time. 10:53:31

Q. Okay. Let me ask the next question, which 10:53:32

is [redacted] 10:54:00

MR. SNYDER: Objection to form. 10:54:03

THE WITNESS: Sure. 10:54:08

I just -- I just want to finish my 10:54:09

qualification of the previous answer, which is -- 10:54:11

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Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

BY MR. SHEASBY: 10:54:14

Q. So, sir -- sir, just -- sir -- 10:54:14

A. Okay. I just want to make it clear that I had a qualification to make to what I said before, and I -- 10:54:17 10:54:19 10:54:24

Q. Your witness is -- your -- your -- your attorney is just coaching you, and so I -- I don't agree with that, but that is -- that is for another day. 10:54:26 10:54:27 10:54:29 10:54:32

So if we go to the result -- what -- what is the result of joint vaporization? 10:54:32 10:54:40

MR. SNYDER: Objection to form. 10:54:43

THE WITNESS: So I'll -- again, I'll just -- I want to make it clear on the record that I had a further qualification to my statement in which I disagree that that evaporation at the same time is -- because it is happening temporally at the same time means that the evaporation is happening on the same parts of the substrate at the same time together. And that is very clear both from the -- from my report, as well as from Samsung documents and with the interview. 10:54:47 10:54:50 10:54:53 10:54:56 10:55:00 10:55:03 10:55:07 10:55:11 10:55:13 10:55:17

MR. SHEASBY: So objection. Form. Nonresponsive. 10:55:18 10:55:19

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Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

BY MR. SHEASBY: 10:55:19

Q. I'm merely asking whether you disagree or 10:55:19

agree with the testimony of Mr. Jo [redacted] [redacted]

[redacted] [redacted]

[redacted] 10:55:29

Correct or incorrect? 10:55:31

MR. SNYDER: Objection. 10:55:34

THE WITNESS: So, again, it -- there is 10:55:34

a lot of other testimony that is also here describing 10:55:36

the details of how that deposition happens. [redacted] [redacted]

[redacted] [redacted]

[redacted] [redacted] [redacted]

[redacted] [redacted]

[redacted] [redacted]

[redacted] [redacted]

[redacted] 10:56:02

MR. SHEASBY: Objection. Form. 10:56:06

BY MR. SHEASBY: 10:56:07

Q. Is what Mr. Jo says at page forty, lines 10:56:07

eighteen through twenty-two, correct or incorrect? 10:56:12

MR. SNYDER: Object to the form. 10:56:17

THE WITNESS: So, again, it is technically 10:56:17

correct that [redacted] [redacted]

[redacted]. But Mr. Jo -- there 10:56:25

is a lot of other testimony in which he qualifies 10:56:29

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

that and explains why -- 10:56:32

MR. SHEASBY: Objection. 10:56:35

THE WITNESS: Okay. 10:56:36

BY MR. SHEASBY: 10:56:36

Q. I'll ask it again. 10:56:36

[redacted] [redacted]

[redacted] [redacted]

[redacted] [redacted] :44

MR. SNYDER: Objection to form. 10:56:49

THE WITNESS: [redacted] [redacted]

[redacted] [redacted]

[redacted] 56:54

BY MR. SHEASBY: 10:56:59

Q. Okay. Then let me ask you the next 10:56:59

question, which is what is the end result of joint 10:57:02

vaporization, as described in the patent, in terms of 10:57:05

the layer that is created? 10:57:07

A. Okay. I just want it to be clear that I had 10:57:09

an initial qualification, but -- 10:57:12

Q. I don't know what you are talking about, 10:57:14

sir. 10:57:17

MR. SHEASBY: So objection. Form. 10:57:17

BY MR. SHEASBY: 10:57:19

Q. What is the end result of the joint 10:57:19

vaporization process that is described in the patent? 10:57:22

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

A. So the patent describes joint vaporization as delivering the benefit of coordination in the system. 10:57:24 10:57:27 10:57:31

Q. And what does coordination mean? 10:57:32

A. So coordination is another disputed term, and I don't -- 10:57:35 10:57:39

Q. Okay. That is fine. It is disputed. 10:57:46

What does it mean to -- for -- to you? 10:57:48

A. So just give me a second. I have an explanation that I just want to make sure I follow exactly. 10:57:51 10:57:57 10:58:00

So one of the -- so there were two -- again, there were two constructions that have been proposed, and, you know, there is a claim construction that comes down from the court, and I, of course, follow that. But one -- the construction that is proposed by Samsung is the formation of a dative bond in the structure, and the construction that is proposed by Pictiva is a bonding interaction. 10:59:03 10:59:06 10:59:10 10:59:13 10:59:16 10:59:20 10:59:24 10:59:28

Q. [redacted] 10:59:48

A. So no. 10:59:53

It is my opinion that [redacted] 10:59:54

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[redacted] 11:00:00

Could you ask the question again? 11:00:04

MR. SHEASBY: Objection. Form. 11:00:06

THE WITNESS: No problem. Yep. 11:00:07

BY MR. SHEASBY: 11:00:09

Q. [redacted] 11:00:18

A. So it is my opinion that, again, [redacted] 11:00:35

Q. Okay. Did you do any experimental studies to determine if there was any bonding interaction? 11:00:37 11:00:41

A. So as I describe in my report, I, personally, did not do any experiments, but I did rely on a number of both experiments and models that were performed by others, including the work that was done by Dr. Miller. There was some experiments performed by Professor Park, and we also had some information from the air down of the mixed two that provided some additional support and information. 11:00:45 11:00:50 11:00:53 11:00:56 11:01:00 11:01:06 11:01:10 11:01:13

Dr. Miller also did some modeling in order to support the -- the conclusions that formed part of 11:01:16 11:01:20

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

the basis of the conclusions I concluded as well. 11:01:23
MR. SHEASBY: Objection. Form. 11:01:26
BY MR. SHEASBY: 11:01:27
Q. I asked you if you had done any experiments 11:01:27
or simulations. 11:01:31
MR. SNYDER: Objection to form. 11:01:32
THE WITNESS: So I, personally, did not 11:01:33
conduct any experiments or simulation. I didn't see 11:01:34
it as necessary, given the -- the wealth of 11:01:38
information that was available to me. 11:01:40
MR. SHEASBY: Objection. Form. 11:01:41
BY MR. SHEASBY: 11:01:42
Q. I just asked you if you did any experiments 11:01:42
or simulations. I didn't ask you why. 11:01:45
Do you understand that? 11:01:47
MR. SNYDER: Objection to form. 11:01:48
THE WITNESS: I did not find it to be 11:01:49
necessary, and so I did not personally conduct any 11:01:54
experiments or simulations. 11:01:57
MR. SHEASBY: Objection. Form. 11:01:59
BY MR. SHEASBY: 11:02:00
Q. I did not ask you why. I just asked you if. 11:02:01
Do you understand that? 11:02:04
MR. SNYDER: Objection to form. 11:02:05
THE WITNESS: So I understand. I just want 11:02:06

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

to make sure I am giving the clearest and most accurate answer to your question. 11:02:08 11:02:10

BY MR. SHEASBY: 11:02:12

Q. So answer my question. 11:02:12

Did you do any experiments or simulations? Yes or no? 11:02:14 11:02:16

MR. SNYDER: Objection to form. 11:02:18

THE WITNESS: I, personally, did not conduct any experiments or simulation and, instead, relied on others and the work that they did. 11:02:18 11:02:21 11:02:25

BY MR. SHEASBY: 11:02:27

Q. Did you ask Samsung if it had any internal experiments or simulations on the subject? 11:02:27 11:02:31

A. I had a significant amount of data from Samsung, including some results they had performed based on XPS and other analysis, but I did not ask for any additional measurements to be taken by Samsung. 11:02:33 11:02:37 11:02:41 11:02:45 11:02:48

Q. Did you ask for any measurements to be taken by Samsung? 11:02:48 11:02:53

A. I did not ask Samsung specifically to take any measurements. 11:02:53 11:02:56

Q. Do the claims require a metal complex with a high disposition and ability to provide free electrons? 11:02:56 11:03:35 11:03:39

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

A. So the claims specifically do not offer that restriction. That is, however, one of the benefits that is described in the specification. And the specification is clear that the material that is being deposited needs to have that ability to coordinate. And having that in a high disposition, the ability to reconfigure the bonding, as well as the free electrons that can form the -- the -- the reaction that is needed for coordination is required by the patent in the light of the specification. 11:03:39 11:03:54 11:03:59 11:04:02 11:04:05 11:04:08 11:04:13 11:04:16 11:04:20 11:04:24

MR. SHEASBY: Objection. Form. 11:04:28

BY MR. SHEASBY: 11:04:28

Q. Do the claims require a high disposition and ability to provide free electrons for the metal complex? Yes or no? 11:04:29 11:04:33 11:04:37

MR. SNYDER: Objection to form. 11:04:38

THE WITNESS: Again, I'm just trying to give the clearest answer and the most complete answer. And so the claims are silent about the exact details of the material that is required for the doping. 11:04:39 11:04:41 11:04:44 11:04:47

BY MR. SHEASBY: 11:04:52

Q. Okay. Do the claims require that the central METL atom be able to coordinate with additional ligands? 11:04:52 11:05:10 11:05:16

A. So yeah. 11:05:19

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

The claims describe the metal complex with the central METL atom, and they require them to be able to coordinate, and so it depends on the exact situation that we're talking about. But that would be one of the criteria that one could use to establish whether that material can coordinate. 11:05:25 11:05:29 11:05:34 11:05:38 11:05:41 11:05:45

Q. Did the claims require being able to coordinate with additional ligands? 11:05:49 11:05:53

MR. SNYDER: Objection to form. 11:05:56

THE WITNESS: So the -- it requires -- claims require that there be a central METL atom that can coordinate, and so if it is not able to coordinate, then it would not satisfy the claim requirement. 11:05:57 11:06:03 11:06:07 11:06:11 11:06:16

BY MR. SHEASBY: 11:06:18

Q. Does claim two require that the coordination occur in the gas phase? 11:06:51 11:06:54

A. So claim two says that the coordination happens due to the joint vaporization, and so while claim two only uses the phrase joint vaporization, and it is understood by a person of ordinary skill in the art that while the molecules are in the gas phase is when they are the most reactive and, as a consequence, I would say that in general for the coordination to happen, claim two does -- does imply 11:07:05 11:07:08 11:07:11 11:07:15 11:07:18 11:07:22 11:07:25 11:07:30

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

that that is happening in the gas phase. 11:07:36

Q. Does -- claim eleven actually requires that 11:07:38

the coordination occur in the gas phase; correct? 11:07:42

A. So claim eleven uses a different term. It 11:07:45

uses the term simultaneous vaporization, and then it 11:07:50

says that that coordination happens in the gas phase. 11:07:54

My understanding of claim two comes from this phase 11:07:57

joint vaporization, which is defined earlier as being 11:08:00

a process which encourages that coordination 11:08:05

reaction, and that is the basis for my previous 11:08:08

answer. 11:08:12

Q. Is simultaneous vaporization the same as 11:08:12

joint vaporization? 11:08:16

A. No. Not necessarily. 11:08:16

Q. What is broader? 11:08:19

A. Simultaneous vaporization would be broader. 11:08:21

Q. And so you actually think there is -- in 11:08:25

a gas phase a limitation in claim two in place of it? 11:08:31

A. Again, I haven't offered a line on what is 11:08:36

or is not joint vaporization. But I do offer the 11:08:39

opinion earlier in my report that it is understood 11:08:42

that joint vaporization has that ability to react and 11:08:46

form whatever direction is associated with 11:08:52

coordination before condensation. And so, again, all 11:08:58

the examples that I discuss that involve vaporization 11:09:03

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

are -- are going to happen in that gas phase. 11:09:07

Q. So the claims -- claim two requires that the 11:09:12

coordination occur in the gas phase? 11:09:16

A. Again -- 11:09:19

MR. SNYDER: Objection to form. 11:09:20

THE WITNESS: Yeah. 11:09:21

Claim two says that it is due to joint 11:09:22

vaporization, and the details there are then -- 11:09:26

again, we need to understand the -- whether -- you 11:09:30

know, exactly how the deposition is happening when we 11:09:33

make that determination of whether or not joint 11:09:36

vaporization is occurring. 11:09:40

BY MR. SHEASBY: 11:09:41

Q. So it is your understanding that joint 11:09:51

vaporization requires coordination in the gas phase? 11:09:53

MR. SNYDER: Objection to form. 11:09:56

THE WITNESS: So joint vaporization requires 11:09:57

the formation of coordination. I had mentioned an 11:10:01

example before in which we could, for example, mix 11:10:05

the materials in the crucible. You can imagine if 11:10:08

the materials melt and react in the crucible and then 11:10:12

vaporize, the reaction can happen, in other words. 11:10:15

MR. SHEASBY: Objection. Form. 11:10:19

BY MR. SHEASBY: 11:10:21

Q. Does joint vaporization require coordination 11:10:21

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

in the gas phase? Yes or no? 11:10:23

MR. SNYDER: Objection to form. 11:10:25

THE WITNESS: It only requires coordination. 11:10:26

BY MR. SHEASBY: 11:10:26

Q. Okay. The -- what is a dative bond? 11:10:30

A. So a dative bond is a -- is a -- is a molecular bond where both of the electrons are donated by one of the atoms. 11:10:39 11:10:42 11:10:46

Q. In terms of your analysis of the technical benefits of the patents-in-suit, did you discuss the patents-in-suit with any Samsung engineers? 11:11:13 11:11:16 11:11:21

A. Yes. 11:11:23

I detailed in my report that I did have an interview with three Samsung engineers to confirm some points relating to the process of measurements. 11:11:29 11:11:33 11:11:36

Q. Not the question I asked. 11:11:39

Did you discuss the patents-in-suit with any Samsung engineers? 11:11:40 11:11:43

A. I'm sorry. 11:11:44

Are you asking if that is separate from my interviews which were conducted with counsel or outside of -- outside of the case? 11:11:45 11:11:48 11:11:51

Q. Did you show Samsung engineers the patents and discuss them with them? 11:11:53 11:11:56

A. I'm sorry. 11:11:58

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

I'm not sure I understand the question. 11:12:02
So all of the discussions I have had with 11:12:04
Samsung engineers related to these patents are only 11:12:07
those interviews that I -- that I disclosed in my 11:12:11
report. 11:12:13
Q. And did you actually discuss the patents 11:12:14
with them specifically, look at the claims with them? 11:12:16
A. No. 11:12:20
In general, those conversations were 11:12:20
discussions relating to some questions I had about, 11:12:23
you know, what certain documents meant, you know, 11:12:27
translation of some terms, and confirmation again of 11:12:32
certain issues that I wanted to clarify in the 11:12:36
documentation that was sent over. 11:12:38
Q. Did you ask these Samsung engineers their 11:12:41
views on the patents-in-suit? 11:12:44
A. I did not ask them for their opinions on the 11:12:47
patents. The discussions were technical discussions 11:12:53
relating to the document. 11:12:56
Q. What does it mean you deposit something as 11:12:59
a mixture? What is -- what is the result of that? 11:13:44
It requires that there be the exact same con- -- 11:13:47
con- -- concentration of both materials; correct? 11:13:51
MR. SNYDER: Objection to form. 11:13:55
THE WITNESS: I disagree. 11:13:55

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

BY MR. SHEASBY: 11:14:04

Q. So what does it mean for two substances to be deposited as a mixture? 11:14:39 11:14:43

A. So for -- to speak generally, for two substances to be a mixture, we have a concentration of one substance, concentration of the other, and the two are combined in a way that distributes the -- the composition between them. 11:14:49 11:14:54 11:14:58 11:15:01 11:15:05

Q. Equal amounts? 11:15:07

MR. SNYDER: Objection to form. 11:15:11

THE WITNESS: I disagree that it means equal amounts; so we have peanut butter and jelly. You can have a different concentration of one or the other, but there is nothing in the word mixture that requires that it be a 50/50 mix of the two materials. 11:15:12 11:15:15 11:15:21 11:15:24 11:15:27

BY MR. SHEASBY: 11:15:31

Q. Are the organic material and the metal complex in the METL present throughout the ETL? 11:15:31 11:15:36

MR. SNYDER: Objection to form. 11:15:45

THE WITNESS: So the METL, as the name implies, is mixed, and so there is -- both materials are present in the ETL throughout that layer. 11:15:47 11:15:53 11:15:57

BY MR. SHEASBY: 11:16:00

Q. Let me ask you the next question, which is -- hmmm. 11:16:00 11:16:02

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

Have you ever used Liq in making any OLEDs? 11:16:23
A. I, personally have not used the Liq 11:16:30
equivalent, no. 11:16:33
Q. Have you used any lithium-containing 11:16:33
compounds? 11:16:37
A. Yes. 11:16:38
I often use lithium fluoride as an electron 11:16:38
injection layer. That lithium fluoride is a -- is 11:16:43
a pretty inert salt, and so it is usually -- when 11:16:47
I use it, I put it at the very top layer on top of 11:16:51
the electron transport layer, and that is activated 11:16:55
by the deposition of aluminum, and that forms 11:16:58
aluminum fluoride and releases the lithium as a -- as 11:17:02
a doping at that interphase. 11:17:07
Q. Okay. Hmmm. 11:17:10
Let's go to Exhibit 13 -- sorry. 11:19:32
Exhibit 13? Yes. Go ahead and download that. 11:19:58
A. Okay. 11:20:08
Q. Sorry. Exhibit 14. 11:20:10
A. Exhibit 14? I was going to say Exhibit 13 11:20:13
is the patent. 11:20:19
(Deposition Exhibit Number 14 11:20:19
was marked for identification.) 11:20:32
THE WITNESS: Okay. I have it open. 11:20:32
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Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

BY MR. SHEASBY: 11:20:34

Q. Have you reviewed this document? 11:20:54

A. I have seen it before, yes. 11:20:56

Q. In your report, you don't indicate any disputes with this experimental methodology; is that correct? 11:20:58 11:21:03 11:21:08

MR. SNYDER: Objection to form. 11:21:08

THE WITNESS: I detail a number of objections I have to Dr. Schanze's analysis and work in my report; so I would disagree with that statement. 11:21:10 11:21:13 11:21:19 11:21:22

BY MR. SHEASBY: 11:21:22

Q. Now, Exhibit 14 is a report by Novateq. 11:21:23

A. Oh, okay. Sorry. I have Exhibit 15 opened, which also says export. 11:21:29 11:21:37

Q. Yeah. 11:21:39

It is a little bit confusing. 11:21:39

A. Let me clear all of my tabs and go back. Exhibit 14. 11:21:42 11:21:55

Okay. Great. Sorry. 11:22:41

If you could ask your question again. 11:22:44

BY MR. SHEASBY: 11:22:46

Q. Yes. 11:22:47

The question is you don't specify in your report any disputes with the methodology used by 11:22:47 11:22:50

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

Novateq in the analysis in Exhibit 14; correct? 11:22:54

MR. SNYDER: Objection to form. Sorry. 11:22:59

Objection to form. 11:23:00

THE WITNESS: So I object to the 11:23:02

interpretation of the results, but I have no 11:23:06

objection specifically to the measurements that were 11:23:10

taken by Novateq. 11:23:13

MR. SHEASBY: Objection. Form. 11:23:16

BY MR. SHEASBY: 11:23:17

Q. In your report you don't identify any 11:23:18

disputes or objections to the methodology used by 11:23:20

Novateq; correct? 11:23:24

MR. SNYDER: Objection to form. 11:23:26

THE WITNESS: So, again, the -- the work 11:23:28

that -- that Novateq did from the perspective of 11:23:31

taking measurements, I did not -- I had no objections 11:23:37

specifically to that analysis. 11:23:44

BY MR. SHEASBY: 11:23:48

Q. Let me ask the next question, which is if 11:23:48

you go to page forty-five of this report. 11:23:51

A. Okay. I just wanted to complete that the 11:23:54

interpretation and the order of the tests I do have 11:23:57

a number of objections to. 11:23:59

MR. SHEASBY: Objection. Form. 11:24:01

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Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

BY MR. SHEASBY: 11:24:02

Q. Do you have any dispute with the methodology used by Novateq? Yes or no? 11:24:02 11:24:04

MR. SNYDER: Objection to form. 11:24:07

THE WITNESS: I'm going to do yes or no. I'll say yes. 11:24:08 11:24:10

BY MR. SHEASBY: 11:24:10

Q. Great. 11:24:12

And so let's go to page forty-five. 11:24:12

A. (Witness complies.) 11:24:23

Okay. 11:24:25

Q. [redacted] 11:24:34

Q. [redacted] 11:25:50

MR. SNYDER: Objection. 11:25:52

THE WITNESS: So I -- following the description in the specification of the -- of the patent, no. It is not. 11:25:53 11:26:02 11:26:09

BY MR. SHEASBY: 11:26:10

Q. What do you mean, following the description? 11:26:10

A. [redacted] 11:26:25

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[redacted] 11:26:42

Q. Not the question I asked. 11:26:49

MR. SHEASBY: Objection to form. 11:26:52

BY MR. SHEASBY: 11:26:52

Q. [redacted] 11:26:56

MR. SNYDER: Objection to form. 11:26:58

THE WITNESS: [redacted] 11:27:11

BY MR. SHEASBY: 11:27:14

Q. Okay. Let's go to paragraph eighty-one of your report. And this is your rebuttal report. 11:27:14 11:27:17

A. (Witness complies.) 11:27:32

Okay. I am there now. 11:27:52

Q. Okay. In -- in this -- in this structure, [redacted]? 11:27:54 11:28:11

MR. SNYDER: Objection. 11:28:17

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

THE WITNESS: [redacted]

[redacted]. 11:28:25

MR. SHEASBY: Okay. I have marked a new 11:28:29
exhibit, Exhibit 16. 11:29:29
(Deposition Exhibit Number 16 11:29:29
was marked for identification.) 11:29:31
BY MR. SHEASBY: 11:29:31
Q. Go ahead and download it. 11:29:31
A. (Witness complies.) 11:29:49
Okay. Give me a second to take a look. 11:29:50
MR. SNYDER: Jason, I think we have been 11:29:54
going for over an hour; so if we could take a break 11:29:56
soon. 11:30:00
MR. SHEASBY: Yeah. 11:30:01
Why don't we just break for lunch after this 11:30:01
question -- after this -- this line of questioning. 11:30:04
THE WITNESS: Okay. Great. 11:30:07
I have the reference open. 11:30:10
BY MR. SHEASBY: 11:30:12
Q. Have you looked at this reference 11:30:12
previously? 11:30:14
A. Yes, I have. 11:30:14
Q. And did you have discussions regarding it 11:30:15
with Mr. Kang? 11:30:19

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

A. No. 11:30:21
I did not have any discussions with 11:30:22
Mr. Kang. 11:30:24
Q. This article concludes that ETL and Liq 11:30:25
interact through a coordination bond; correct? 11:30:53
A. I disagree under my understanding of the 11:30:57
coordination bond that this article shows that 11:31:00
conclusion. 11:31:03
Q. The article literally states ETL and Liq 11:31:04
interact through a coordination bond; correct? 11:31:09
A. The article uses those words, but I disagree 11:31:12
that the article shows the formation of 11:31:16
a coordination bond. 11:31:18
Q. Great. 11:31:19
So you disagree with Mr. Kang? 11:31:20
A. Again, I would not describe what he shows or 11:31:22
the net effect as a coordination bond. 11:31:26
Q. This is a peer-reviewed publication on 11:31:30
experiments involving Liq; correct? 11:31:34
A. This is a peer-reviewed publication, and 11:31:36
lithium quinolate is used in this publication. 11:31:40
Q. And you have never published on the use of 11:31:43
Liq. 11:31:46
In fact, you have never used Liq in your 11:31:46
entire career; right? 11:31:49

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

MR. SNYDER: Objection to form. 11:31:50

THE WITNESS: I have -- I have never 11:31:51
published on the use of Liq quinolate. 11:31:52

BY MR. SHEASBY: 11:31:56

Q. Have you ever used it in your entire career? 11:31:56

A. I don't believe that I have, although -- 11:32:00
yeah. I'll leave it at that. 11:32:04

Q. And you believe that Liq does not form 11:32:06
a coordination bond with ETL; correct? 11:32:11

A. That is correct. 11:32:15

Q. And looking at this article by Samsung 11:32:16
dis- -- Sam- -- from the Samsung display, Researcher 11:32:47
Sunwoo Kang in the peer-reviewed journal, why don't 11:32:54
you read out loud the sentence in blue highlighting? 11:32:55

A. Okay. And, again, this is the language of 11:33:01
the paper, not my position: 11:33:03

"It was found that ETL-Liq complex could 11:33:06
be formed from an attractive interaction 11:33:10
between ETL and Liq through a coordination 11:33:13
bond." 11:33:17

Q. Did you discuss this paper with any of the 11:33:18
Samsung engineers that you talked to? 11:33:20

A. I don't believe this came up in my 11:33:22
discussion with the Samsung engineer. 11:33:25

Q. Did you ask Samsung lawyers to allow you to 11:33:26

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

speak to Mr. Kang? 11:33:29
MR. SNYDER: Objection based on the wording 11:33:31
of that question -- 11:33:34
THE REPORTER: I can't hear you at all. 11:33:37
MR. SNYDER: Yes. 11:33:39
Based on the wording of that question, 11:33:40
I instruct the witness not to answer. 11:33:42
BY MR. SHEASBY: 11:33:45
Q. Who do you think knows more about Liq, you 11:33:45
or Mr. Kang? 11:33:50
A. So, again, the word coordination has 11:33:51
a specific meaning and construction, and my 11:33:55
interpretation and answers are based on that specific 11:33:58
meaning and construction. 11:34:01
MR. SHEASBY: Objection. Form. 11:34:03
BY MR. SHEASBY: 11:34:04
Q. I asked you who do you think knows more 11:34:04
about Liq, you or Mr. King? 11:34:08
MR. SNYDER: Objection to form. 11:34:10
THE WITNESS: I don't have an opinion on the 11:34:12
relative expertise that I and Mr. Kang have on the 11:34:13
specifics of lithium quinolate. 11:34:17
BY MR. SHEASBY: 11:34:21
Q. Well, we do know one thing, which is he has 11:34:21
published a peer-reviewed article on the subject; 11:34:24

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

correct? 11:34:27

A. He has. That is correct. 11:34:27

Q. You have not; correct? 11:34:28

A. I have not. 11:34:30

Q. And, in fact, you have never used Liq in your entire career, as far as you know; correct? 11:34:30 11:34:34

A. Again, I have not used Liq that I can recall in my career; that is correct. 11:34:36 11:34:41

MR. SHEASBY: Okay. Why don't we break for lunch. 11:34:43 11:34:45

THE VIDEOGRAPHER: Okay. This marks the end of media unit three. 11:34:46 11:34:48

The time is 11:34 a.m. 11:34:50

We are off the record. 11:34:52

(Luncheon recess taken.) 12:39:41

THE VIDEOGRAPHER: This marks the beginning of media unit number four. 12:39:41 12:39:49

The time is 12:39 p.m. 12:39:52

We are on the record. 12:39:54

BY MR. SHEASBY: 12:39:55

Q. Sir, joint vaporization doesn't require a mixture in the gas phase; correct? 12:39:55 12:39:58

A. So, again -- all right. Give me a second to just recalibrate on my report. 12:40:03 12:40:10

But, again, the -- the patent doesn't 12:40:13

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

specify where the -- sorry. Let me start again. 12:40:15

Joint vaporization is, again, that -- 12:40:23

that -- that evaporation or vapor- -- vaporization 12:40:27

which allows at least for the opportunity for the 12:40:31

materials to -- to interact. 12:40:34

Q. In a gaseous phase? 12:40:38

A. So, again, it is not a requirement for the 12:40:40

coordination to necessarily happen at a specific 12:40:43

spot, but I -- if you give me a second, I will pull 12:40:45

up my definition in my report. But certainly the gas 12:40:51

phase is one region where there is the opportunity 12:40:57

for interaction to occur. 12:41:01

So in my report -- if we go to paragraph 12:41:44

fifty-two of my noninfringement report, it has some 12:41:47

discussion about what is not joint vaporization. 12:41:54

Again, there is no, really -- it depends in many 12:41:57

cases on some of the details, like the reactivity of 12:42:02

the materials, the degree of interaction, the 12:42:06

pressure that occurs, the overlap of the gas plumes, 12:42:09

during vaporization, et cetera. 12:42:14

And so -- again, there is the opportunity 12:42:16

for that interaction, but it -- it -- whether the 12:42:20

reaction happens exactly in one spot or another is 12:42:29

not so specified. As I say, a POSITA would recognize 12:42:31

joint vaporization requires metal complex. And, 12:42:33

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

there again, the compound should be coevaporated so that they are immediately present in the same vapor phase. 12:42:38 12:42:38 12:42:41

Q. And what does it mean to be immediately present in the same vapor phase? 12:42:41 12:42:43

A. So that would mean that at least at some point they are colocated in space while they are in the vapor phase. 12:42:46 12:42:50 12:42:57

Q. What does it mean to be colocated in space? 12:42:58

A. So that would mean that they are in the same location in -- in -- in space in -- during the -- during the vaporization. 12:43:01 12:43:08 12:43:11

Q. What does it mean to be in the same location in space? 12:43:12 12:43:15

A. I'm sorry. 12:43:17

I'm not sure what you are asking, beyond the ordinary meaning of being in the same location. 12:43:18 12:43:21

Q. Yes. 12:43:24

That's what I am asking. 12:43:27

What does it mean to be in the same location? 12:43:28 12:43:30

A. So the -- the vaporization has a particular plume. And the molecules, while they are in space, if they are colocated, they are in the same place. That is -- that is the meaning of colocation. 12:43:31 12:43:38 12:43:41 12:43:46

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

Q. So the plumes would overlap? 12:43:48
A. The plumes overlapping is one way for there to be that colocation. 12:43:50 12:43:54
Q. What are the other ways for there to be that colocation? 12:43:56 12:43:59
A. So for -- I don't know that I have the list specifically. You know, I would -- I would say, you know, again, in the evaporation having the plumes overlap is one way that it is possible to have the colocated. 12:44:00 12:44:11 12:44:18 12:44:22 12:44:26
Q. Right. 12:44:26
And I am asking for what are the other ways of colocation that you are aware of? 12:44:27 12:44:29
A. Just thinking here right now, I can't think of any right off the top of my head. 12:44:32 12:44:35
Q. Okay. Why don't you go ahead and download Exhibits 18 through 20. 12:44:37 12:44:52
(Deposition Exhibit Number 18 was marked for identification.) 12:44:52 12:44:57
(Deposition Exhibit Number 19 was marked for identification.) 12:44:57 12:44:57
(Deposition Exhibit Number 20 was marked for identification.) 12:44:57 12:44:58
THE WITNESS: Okay. Okay. I have them downloaded. 12:44:58 12:45:21

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

BY MR. SHEASBY: 12:45:22

Q. Okay. So one of the prior arts -- prior references you rely on is the display in what you describe as the Clix2; is that correct? 12:45:22 12:45:24 12:45:27

A. Yes. 12:45:30

The Clix2, yes. 12:45:31

Q. And the Clix2 screen you claim is OLED -- an OLED; is that correct? 12:45:32 12:45:39

A. That is correct. 12:45:40

The Clix2 used an OLED display as its screen. 12:45:41 12:45:46

Q. Did you investigate whether there was a different Clix2 display using the United States versus the one outside the United States? 12:45:46 12:45:48 12:45:53

A. So there is substantial evidence, which I detail in my report, that the Clix2, and every model of the Clix2, used an organic light-emitting diode display. 12:45:56 12:45:58 12:46:01 12:46:06

Q. Not the question I asked. 12:46:06

I said did you investigate it? 12:46:08

MR. SNYDER: Objection to form. 12:46:10

THE WITNESS: So I reviewed the evidence, which I describe in my report. That is the extent of my investigation. 12:46:11 12:46:14 12:46:19

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Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

BY MR. SHEASBY: 12:46:20

Q. Did you speak to the individuals who 12:46:20

manufactured the Clix2? 12:46:22

A. So I, personally, did not -- well, I'm 12:46:25

sorry. 12:46:32

Are we asking about the screen or are we 12:46:33

asking about the finished unit? 12:46:36

Q. The finished? 12:46:39

A. So no. 12:46:41

I did not have an interview with anybody at 12:46:42

Dreamus. I just have their declaration, which is in 12:46:45

the report as well -- is cited in my report. 12:46:48

Q. Okay. So if we go to Exhibit 18 -- first 12:46:52

off, what process was used for the OLED screen in the 12:47:04

Clix2 product? 12:47:11

MR. SNYDER: Objection to form. 12:47:14

THE WITNESS: I'm sorry. 12:47:15

Are you asking about the code name for the 12:47:19

process or a different description? 12:47:22

BY MR. SHEASBY: 12:47:26

Q. What is the name of the process? 12:47:26

MR. SNYDER: Objection to form. 12:47:28

THE WITNESS: So Samsung described this as 12:47:29

[redacted] 12:47:43

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

BY MR. SHEASBY: 12:47:43

Q. [redacted]

[redacted] 12:47:53

Q. [redacted]

[redacted] 12:47:57

A. [redacted]

[redacted] 12:48:05

Q. Not the question I asked. 12:48:07

[redacted]

[redacted] 12:48:13

MR. SNYDER: Objection to form. 12:48:15

THE WITNESS: [redacted]

[redacted]

[redacted] 12:48:28

BY MR. SHEASBY: 12:48:29

Q. [redacted]

[redacted] 12:48:33

A. [redacted]

[redacted]

[redacted] 12:48:57

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[redacted]. 12:49:07

Q. So you cite a teardown by a company called Eurofins; correct? 12:49:08 12:49:37

A. That is correct. 12:49:40

Q. And if you go to Exhibit 18, did you supervise the experiments in Exhibit 18? 12:49:41 12:50:17

A. I'm not sure exactly what you mean by supervised. I was involved in helping to confirm the teardown structure and had some discussion with the engineers at Eurofins, but I did not, for example, fly to Europe in order to participate personally in any of the teardown. 12:50:20 12:50:25 12:50:30 12:50:33 12:50:38 12:50:42

Q. And did you tear down the product? 12:50:44

A. I was not personally involved in any of the disassembly or analysis of the product. 12:50:46 12:50:55

Q. Okay. If you turn to page twenty-four of the document, on the right-hand side it has a date of 01/09/2008. 12:50:58 12:51:10 12:51:16

Do you see that? 12:51:18

MR. SNYDER: Objection to form. 12:51:19

THE WITNESS: I do not see that, no. 12:51:22

BY MR. SHEASBY: 12:51:25

Q. Do you see .01.09? 12:51:26

A. So I see numbers on the circuit board, but I disagree that that is a date. 12:51:31 12:51:35

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

Q. Okay. What is it then? 12:51:37
A. There are a significant number of numbers 12:51:39
that are on the circuit board. And, again, I see no 12:51:43
reason to believe that that is a date. 12:51:47
Q. Did you ask the manufacturers if it was 12:51:49
a date? 12:51:52
A. I -- as I mentioned, I had no discussion 12:51:53
with the manufacturer. 12:51:58
Q. Did you do anything to confirm that this was 12:51:59
actually an iRiver Clix2 that was sold before the 12:52:02
date of the patents-in-suit in the United States? 12:52:07
This specific product. 12:52:11
MR. SNYDER: Objection to form. 12:52:15
THE WITNESS: So there is significant 12:52:17
evidence that this unit was sold before the priority 12:52:20
date of the patent in evidence. In particular, there 12:52:25
is the sale receipt of the product on its first sale, 12:52:28
which was provided, as well as documentation that the 12:52:33
product was released well before the priority date of 12:52:39
the patents-in-suit. 12:52:43
BY MR. SHEASBY: 12:52:44
Q. So Exhibit 17 is the -- this sale receipt 12:52:44
you are referring to? 12:52:49
A. That is one of the pieces of evidence that 12:52:50
is the sales receipt, yes. 12:52:52

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

Q. And who purchased this product? 12:52:54

A. So the product was purchased by -- I think it is on the next page. The -- oh, I guess I don't know. Again, I had no contact with the individual who purchased the product. 12:52:56 12:53:05 12:53:15 12:53:27

Q. Was that individual deposed? 12:53:28

A. I am not aware of that individual being deposed. 12:53:31 12:53:36

Q. Did they submit a declaration? 12:53:37

A. I am not aware of that individual having submitted a declaration. 12:53:42 12:53:45

Q. Do you know if anything was done to authenticate that this receipt related to the actual device that was shipped to Quinn Emanuel, Samsung's counsel? 12:53:45 12:53:48 12:53:52 12:53:57

MR. SNYDER: Objection to form. 12:54:03

THE WITNESS: So this is the customary receipt that one receives from eBay. And so, again, I am not aware of any further authentication that has been attempted. But this is consistent with what one receives when they purchase off eBay. I have done it many times, and this is the normal documentation one receives. 12:54:04 12:54:06 12:54:11 12:54:16 12:54:21 12:54:25 12:54:28

BY MR. SHEASBY: 12:54:28

Q. So the normal documentation is thank you for 12:54:28

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

shopping at iRiver America. We are happy to report that your Order Number 235648 shipped on 10/03/2007? 12:54:31 12:54:36

A. Oh, sorry. You are talking about the iRiver receipt, yeah. That is the receipt that the -- the seller received and that they forwarded. 12:54:42 12:54:44 12:54:46

Q. Yeah. 12:54:47

I know that is what the seller received and forwarded. 12:54:47 12:54:51

But what is the evidence that that receipt relates to the actual product that was shipped to Quinn Emanuel? 12:54:53 12:54:55 12:54:57

MR. SNYDER: Objection to form. 12:54:58

THE WITNESS: So, again, I am not aware of any further authentication that has been done. 12:54:59 12:55:02

BY MR. SHEASBY: 12:55:04

Q. Did you do anything to authenticate it? 12:55:04

A. I have no other interaction with the receipt specifically. 12:55:07 12:55:18

Q. [redacted] 12:55:48

A. [redacted] 12:56:04

Q. [redacted] 12:56:10

A. [redacted] 12:56:13

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[redacted] 56:17

Q. [redacted]

[redacted] 12:56:22

A. I did not conduct any experiments examining 12:56:25

the -- the plume. 12:56:29

Q. Did you know the shapes of the vessels that 12:56:31

were used in [redacted] 12:56:33

A. [redacted]

[redacted]

[redacted] 12:56:47

Q. [redacted]

[redacted]

[redacted]

[redacted]

[redacted] 12:56:59

Q. [redacted]

[redacted]

[redacted] 12:57:09

A. [redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted] :57:42

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[redacted] 12:57:46

Q. Yeah. 12:57:50

And so now I'm asking you did you do a simulation to establish that? 12:57:51 12:57:53

A. So I did not independently do any simulation of the plume shape in -- in the deposition process. 12:57:55 12:58:00

Q. For either [redacted] or the current process? 12:58:05

A. I have not, personally, done any simulation for [redacted] or the current process of the exact shape of the plume direction. 12:58:08 12:58:14 12:58:19

MR. SHEASBY: Okay. I'm marking Exhibit 21. 12:58:20

(Deposition Exhibit Number 21 was marked for identification.) 12:58:20 12:58:56

BY MR. SHEASBY: 12:58:56

Q. Let me know when you get it. 12:58:56

A. Okay. 12:58:58

Q. It may take a minute. 12:59:18

A. Okay. I have the document. 12:59:39

Q. Let's go to Page 77047. 12:59:41

A. (Witness complies.) 12:59:50

Okay. Okay. 13:00:09

Q. You agree that whether electron-conducting layers formed by joint vaporization depends, in part, on the configuration via evaporation chambers? 13:00:15 13:00:18 13:00:22

A. One of the components of considering joint 13:00:28

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

vaporization -- joint vaporization is the configuration of the evaporation chamber. 13:00:30 13:00:31

Q. And that would include chamber height, variable baffle height, placement of the shudder -- shudder, and lip length? 13:00:35 13:00:39 13:00:43

A. Yes. 13:00:44

Amongst other considerations, the -- the baffles, the shape of the emitter, and also the pressure in the chamber will also have an effect. 13:00:44 13:00:46 13:00:49

Q. And, in fact, if you go to page -- if you go to Exhibit 31 [sic] and look at 77047, [redacted] 13:00:52 13:01:09

MR. SNYDER: Objection to form. 13:01:11

THE WITNESS: So it shows that, yes. [redacted] 13:01:27

BY MR. SHEASBY: 13:01:28

Q. Did you say shadowing? 13:01:29

A. [redacted] 13:01:35

Q. Right. 13:01:41

And you used shadowing to describe that; correct? 13:01:43 13:01:48

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

A. That is one word that can be used to describe that effect. 13:01:49 13:01:51

Q. Okay. Let's turn to your open report at Page 147. 13:01:51 13:04:46

A. (Witness complies.) 13:04:47

This is the .pdf Page 147 or the marked Page 1- -- 13:04:58 13:05:02

Q. Marked Page 147; so it is -- it is -- it is Paragraph 294. 13:05:02 13:05:06

A. Okay. I'm there now. 13:05:08

Q. Where in this document that you cite on Page 147 does it show that the -- that [redacted] 13:05:12 13:05:57

A. So if we look there in that figure, the ETL layer was deposited in the system that is surrounded by the red box. And if you zoom in, you will see on the upper left the chamber, [redacted] is labeled METL. 13:06:05 13:06:16 13:06:21 13:06:29

Q. So you think only that chamber -- so only that chamber was used for METL. 13:06:32 13:06:38

You think that that annotation of METL is only associated [redacted]? 13:06:42 13:06:45

A. So that is my understanding of the structure that is in that top line. The -- as -- as you have seen in the other documentation, [redacted] 13:06:50 13:06:55 13:07:01

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[redacted] 13:07:21

But at least for that top line, it is my understanding [redacted] delivers the METL. In some of the more advanced lines in the future, the configuration may be slightly different. 13:07:23 13:07:25 13:07:30 13:07:35

Q. Right. 13:07:37

And so a couple issues. 13:07:37

That -- you think that your evidence that [redacted] is the chamber that delivers the METL is the fact that there is that word METL written above what you claim [redacted]; is that right? 13:07:42 13:07:45 13:07:50 13:07:52

A. That is one of the pieces of evidence. There is additional documentation in the -- in the -- in the data sheets and in the project breakdown that also discusses the chamber configurations. 13:07:57 13:08:00 13:08:03 13:08:08

Q. [redacted] 13:08:18

A. [redacted] 13:08:34

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

Q. Okay. So let's go -- go to the next document. 13:08:35 13:08:40

[redacted] 13:08:53

Q. Where are they? 13:08:57

A. [redacted] :37

THE REPORTER: Are the what? 13:09:42

THE WITNESS: I'm sorry. 13:09:44

Are the crucibles. 13:09:45

BY MR. SHEASBY: 13:09:46

Q. [redacted] 13:09:49

A. [redacted] 13:10:01 13:10:05

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

Q. Okay. Let's go to the next page, Paragraph 296. 13:10:05 13:10:11

A. (Witness complies.) 13:10:13

I'm okay. I am there now. 13:10:15

Q. What is the document in page -- on Paragraph 296 depicting? 13:10:18 13:10:23

A. [redacted] 13:10:41

Q. Does this show joint vaporization? 13:10:43

A. [redacted] 13:11:06

Q. And let's go to the next paragraph. It is Paragraph 297. 13:11:08 13:11:20

A. Uh-huh. 13:11:21

Q. This is a document for [redacted] is that correct? 13:11:22 13:11:27

A. That is correct. 13:11:27

Q. And it shows the chamber in which the -- in which -- by the way, what is alignment? 13:11:28 13:11:33

A. [redacted] 13:11:38

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[redacted]. 13:11:47

Q. And where it says 360, what is that column referring to? 13:11:50 13:11:54

A. I'm sorry. 13:11:56

Where are we pointing now? 13:11:57

Q. Paragraph 297, the red box. 13:11:59

A. 297, the red box. I'm sorry. I am just not clear. 13:12:03 13:12:18

Paragraph 297 says: 13:12:18

[redacted] 13:12:34

Q. Right. 13:12:35

[redacted] 13:12:35

A. [redacted] 13:12:43

Q. Okay. Does this document show that they are jointly vaporized? 13:12:43 13:12:48

A. [redacted] 13:12:59

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[redacted] 13:13:02

Q. Okay. [redacted]

[redacted]; correct? 13:13:08

A. That is what this document says, yes. 13:13:12

Q. And the document you cited previously for 13:13:14

the [redacted]process says the -- the -- the METL you claim 13:13:17

is in [redacted] 13:13:22

A. That is what that document shows; correct. 13:13:25

Q. Which one -- is the [redacted]the same as the [redacted] 13:13:28

line? 13:13:32

MR. SNYDER: Objection to form. 13:13:33

THE WITNESS: [redacted]

[redacted] 13:13:47

BY MR. SHEASBY: 13:13:51

Q. Right. 13:13:51

So that is what I'm asking you. 13:13:51

This [redacted]one, what is the date of this 13:13:53

document for this process? 13:13:57

A. I would need to check the original 13:13:58

reference, if you have that available. Cited as 13:14:05

citation in Footnote 235. 13:14:10

Q. I do think I have it. Just give me one 13:14:13

second. 13:14:16

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

A. Okay. 13:14:16

MR. SHEASBY: Okay. I have just marked it as a new exhibit. 13:15:04 13:15:08

(Deposition Exhibit Number 22 was marked for identification.) 13:15:08 13:15:16

THE REPORTER: What number? 13:15:16

MR. SHEASBY: It looks like it is twenty-two. 13:15:18 13:15:20

THE WITNESS: So I -- yeah. 13:16:02

So I don't know when the document was -- was first presented, yeah. I would have to -- I would have to check with -- I would have to check with others at Samsung to -- to translate it for me. 13:16:04 13:16:07 13:16:11 13:16:18

BY MR. SHEASBY: 13:16:21

Q. In your report, do you cite any evidence whatsoever that this [redacted] document existed at the time of the -- before the priority date of patents-in-suit? 13:16:22 13:16:24 13:16:28 13:16:32

A. So -- okay. In my report I discuss the review that I had of the process with several engineers at Samsung who worked on the -- the Clix2 product, and they confirmed that the process, as I understood it, was the process used for the Clix1, and that predates the -- the -- the start of the Clix1 production process, which is also then before 13:16:33 13:16:41 13:16:44 13:16:49 13:16:52 13:16:56 13:17:00

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

the priority date of the patents that are involved in the suit. 13:17:03 13:17:06

MR. SHEASBY: Objection. Form. 13:17:07

BY MR. SHEASBY: 13:17:08

Q. The document -- SDC_74321, do you cite any evidence whatsoever that that document existed before the priority date of the patents-in-suit? Yes or no? 13:17:08 13:17:16 13:17:19

MR. SNYDER: Objection to form. 13:17:23

THE WITNESS: So I do not cite any specific evidence relating to that document specifically. 13:17:24 13:17:27

BY MR. SHEASBY: 13:17:33

Q. Okay. Why don't you pull down Exhibit 26. 13:17:33

(Deposition Exhibit Number 26 was marked for identification.) 13:17:33 13:18:57

THE WITNESS: I don't see it yet. 13:18:57

BY MR. SHEASBY: 13:19:15

Q. Try it now. 13:19:16

A. Okay. I have the document. 13:19:33

Q. So this is -- this document, Exhibit 26, has a date of May 14th, 2008, on it. 13:19:36 13:20:14

Do you see that? 13:20:18

A. I see that on the cover page, yes. 13:20:19

Q. Yes. 13:20:25

And that is after the alleged date of the -- of the shipment of the -- the Clix2 in 2007 that we 13:20:26 13:20:30

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

saw in this e-mail. 13:20:36

Do you see that? 13:20:37

A. That is after that date. 13:20:39

Q. And did you investigation whether the 13:20:41

process -- the [redacted] process changed between 2007 and 13:20:43

2008 in 2009? 13:20:50

A. Yes. 13:20:54

In my report, I have -- if you go to 13:20:55

Paragraph 303 of my opening report, [redacted]

[redacted] 13:21:18

Q. Right. 13:21:21

You realize that is a hearsay document; 13:21:21

correct? 13:21:24

MR. SNYDER: Objection to form. 13:21:24

THE WITNESS: I'm not a lawyer, and so I -- 13:21:26

yeah. 13:21:29

BY MR. SHEASBY: 13:21:30

Q. So here is what I'm asking for. I'm asking 13:21:30

for a document [redacted]

[redacted] 13:22:00

A. I'm sorry. 13:22:18

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

Is there a question? 13:22:18

Q. Yes. 13:22:19

I just said that question. [redacted] [redacted]

[redacted] [redacted]

[redacted] 13:22:31

A. So the -- there is substantial documentation 13:22:38
of the process from Samsung. We have testimony 13:22:42
confirming that the process was stable between the 13:22:46
beginning and the end of the project that developed 13:22:50
those materials. And so the documents that we have 13:22:54
all describe the same process, again, as supported by 13:22:59
that testimony, as well as the analysis that we had 13:23:02
performed, which is consistent with that -- that 13:23:05
process, material stack, and process of -- the 13:23:10
teardown of the Clix2 confirmed all of the major 13:23:16
components of the composition and the stack, 13:23:20
confirming that, indeed, the product was made the way 13:23:24
that the documentation supports. 13:23:28

MR. SHEASBY: Objection. Form. 13:23:30

BY MR. SHEASBY: 13:23:31

Q. [redacted] [redacted]

[redacted] [redacted]

[redacted] Point to me the document. 13:23:39

MR. SNYDER: Objection to form. 13:23:43

THE WITNESS: So sitting here right now 13:23:44

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

during the deposition, unfortunately, I don't know the exact generation date of all of the documents that I cited, but, again, I am, for all the reasons I described, confident in the statement that the -- [redacted]. And given time to check the production date of all of the documents, I am confident again that there is documentation available that -- that would meet that criteria. But I did not -- 13:23:48 13:23:51 13:23:55 13:24:02 13:24:13 13:24:17 13:24:20 13:24:23 13:24:26

BY MR. SHEASBY: 13:24:27

Q. In -- in your report, point out to me the document you cite [redacted] and that -- 13:24:27 13:24:39

MR. SNYDER: Objection to form. 13:24:41

BY MR. SHEASBY: 13:24:41

Q. Point out to me the document. 13:24:41

A. So, again, sitting here today, I don't know the exact generation date of each of the documents that I relied on. That would require some additional investigation, and I would need to -- to -- to check and see when they were -- when they were provided. 13:24:44 13:24:47 13:24:50 13:24:55 13:24:59

Q. Okay. 13:25:03

A. My -- 13:25:03

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

Q. Let me ask you this. 13:25:04

Did you speak to the engineers and tell the 13:25:05

engineers -- say to the engineers at Samsung, [redacted] 13:25:15

Did you ask that of any of the engineers? 13:25:20

A. So, again, my discussion with the engineers 13:25:23

was understanding the stationary of the process, and 13:25:26

they confirmed that the process, after it was 13:25:33

established, remained the same throughout the 13:25:36

project, [redacted] And so that was, again, for 13:25:42

me, adequate to then understand the process and 13:25:46

define it. 13:25:50

I did not have a discussion with the 13:25:51

engineers beyond that -- those parameters. 13:25:53

MR. SHEASBY: Objection. Form. 13:25:57

BY MR. SHEASBY: 13:25:57

Q. Did you ask any Samsung engineer anywhere in 13:25:58

the world or any Samsung attorney anywhere in the 13:26:00

world to [redacted] 13:26:12

MR. SNYDER: I caution the witness not to 13:26:17

reveal the contents of any privileged communication. 13:26:20

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

And so on that basis I would instruct the witness not to answer the question without talking to the attorney. 13:26:24 13:26:28 13:26:28

But do not answer the question without talking first to me. 13:26:31 13:26:32

BY MR. SHEASBY: 13:26:32

Q. Did you ask any Samsung employee anywhere in the world [redacted] 13:26:33 13:26:43

MR. SNYDER: I repeat my previous instruction to the extent that Samsung employee also encompasses Samsung's counsel. 13:26:47 13:26:49 13:26:52

MR. SHEASBY: It doesn't. 13:26:55

BY MR. SHEASBY: 13:26:56

Q. You may answer the question. 13:26:56

A. So, again, I have a lot of documentation. And some of that may, indeed, predate that date. Unfortunately, sitting here today, I can't pick out the -- the drafting dates of each of the documents that I relied on. And so with that -- with that caveat, I did not make a specific request for the specific document with -- with that providence. 13:26:58 13:27:03 13:27:06 13:27:09 13:27:14 13:27:19 13:27:24

MR. SHEASBY: Objection. Form. 13:27:27

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Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

BY MR. SHEASBY: 13:27:28

Q. Did you ask a Samsung employee for [redacted] 13:27:29

[redacted] 13:27:36

MR. SNYDER: Objection to form. 13:27:41

THE WITNESS: So, again, with that restriction, I had a lot of documents already produced in my possession, and I was satisfied with their -- with their information; so I did not make that specific request of Samsung employees. 13:27:42 13:27:45 13:27:49 13:27:53 13:27:56

MR. SHEASBY: Objection to form. 13:27:59

BY MR. SHEASBY: 13:28:00

Q. Did you make a request for [redacted] Yes or no? 13:28:07

MR. SNYDER: Objection to form. 13:28:11

THE WITNESS: Yeah. 13:28:12

I'm sorry. I feel like I have already answered that question. 13:28:13 13:28:15

And is there a different way that you would -- 13:28:16 13:28:20

BY MR. SHEASBY: 13:28:20

Q. I'm not allowed to comment on your questioning, sir. That -- I'm not allowed to comment on it. 13:28:21 13:28:23 13:28:26

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

A. Okay. That -- that is fine. 13:28:26
Q. So if you can just answer the question. All 13:28:28
I can do is object to form. 13:28:31
A. Okay. I'm sorry. I feel like I have 13:28:35
answered the question. 13:28:38
Q. Okay. We'll try it one more time. It is 13:28:38
a yes-or-no question. 13:28:41
Did you ask any employee at Samsung for 13:28:42
[redacted] 13:28:48
MR. SNYDER: Objection to form. 13:28:53
THE WITNESS: So Samsung produced a large 13:28:54
number of documents, some of which I am confident 13:28:56
were produced before that date. But I did not make 13:28:59
that specific request of any Samsung employees. 13:29:01
MR. SHEASBY: Objection to form. 13:29:05
BY MR. SHEASBY: 13:29:07
Q. Did you ask any Samsung employee for 13:29:07
[redacted] 13:29:14
MR. SNYDER: Objection to form. 13:29:19
BY MR. SHEASBY: 13:29:20
Q. Yes or no? 13:29:21
A. Again, I don't feel this is a yes-or-no 13:29:21
question. I had a large number of documents in my 13:29:24

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

possession, and I -- and many of which for particular reasons I am confident predated that date. But I did not make a specific request for any additional documents with that particular date. 13:29:26 13:29:33 13:29:37 13:29:39

MR. SHEASBY: Objection. Form. 13:29:44

BY MR. SHEASBY: 13:29:47

Q. Did any of those documents [redacted] 13:29:54

A. So I show in my report documentation that was produced that details the process used for the -- for the Clix device, and that documentation shows [redacted] And, again, there is substantial documentation and witness testimony that that process was stationary [redacted]. 13:29:56 13:29:59 13:30:14 13:30:16 13:30:19

MR. SHEASBY: Objection. Form. 13:30:25

BY MR. SHEASBY: 13:30:26

Q. Did -- any of the documents you cited that are dated before September of 2008 that have information [redacted]? 13:30:27 13:30:30 13:30:33

A. So, again, sitting here right now, I am not sure which documents have exactly which date. Again, I have that evidence of the process based on the parameters that I had discussed. 13:30:38 13:30:42 13:30:46 13:30:49

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

Q. So on this spreadsheet you relied in Paragraph 297, [redacted] 13:30:50 13:30:54

What is [redacted] 13:31:00

A. Sorry. Let me pull that up again. This is in -- 13:31:03 13:31:06

Q. 297. 13:31:08

A. -- my report or are we -- I'm sorry. 13:31:10

Q. Yeah. 13:31:14

Paragraph 297 of your report. 13:31:14

A. 297 of my report. Give me a second to pull that up. 13:31:16 13:31:21

I'm sorry. Paragraph 297? 13:31:33

Q. In Paragraph 297 of your report, sir. 13:31:34

A. This is the opening report? 13:31:37

Q. Yes, sir. 13:31:38

A. Okay. I'm back there now. 13:31:53

Q. What is [redacted] 13:31:54

A. And so [redacted] 13:32:05

I'm sorry. Is -- hmmm. Yeah. I think so. Give me a second. Let me just double-check. 13:32:09 13:32:14

So [redacted] 13:32:45

Q. What is your evidence that it is the code name for the [redacted] 13:32:45 13:32:48

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

A. Sorry. Refresh my memory, it had it in Paragraph 302. But in terms of the evidence that was also something that I discussed with Mr. Jo during our conversation, and I specifically asked him about that issue just to confirm. 13:32:51 13:32:56 13:32:58 13:33:04 13:33:07

Q. What is the documentary evidence -- written documentary evidence that [redacted]? 13:33:09 13:33:17

A. Sitting here right now, I can't point specifically to it. But I know it is in other Samsung documentation amongst the process documents and material specs that I cited in my report. But I would need some time to review them in order to point to the specific document that confirms that fact. 13:33:21 13:33:26 13:33:29 13:33:32 13:33:36 13:33:39 13:33:41

Q. Do you cite any document in your report -- discuss any document in your report that defines [redacted]? 13:33:41 13:33:50

A. So I would need to check. I do cite Footnote 238 for the 321 document. But, again, I would need to check my -- 13:33:52 13:33:57 13:34:04

Q. I think I -- I have given you that document -- 13:34:06 13:34:08

A. Same document. 13:34:09

Q. -- so you can check it as much as you want. 13:34:10

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

MR. SNYDER: Objection to form. 13:34:14

THE WITNESS: Give me just a second to 13:34:15

check. There are a lot of citations, and so -- and 13:34:17

there were a lot of data sheets and other 13:34:19

documentation; so just give me a moment. 13:34:22

The document doesn't specify. 13:35:21

BY MR. SHEASBY: 13:35:23

Q. Okay. Well, let's dig in a little more. 13:35:23

A. Okay. 13:35:26

Q. Does chamber twelve have the capability of 13:35:26

joint vaporization? 13:35:30

MR. SNYDER: Objection to form. 13:35:32

THE WITNESS: So I don't have, again, the 13:35:33

exact details to understand if that might be 13:35:42

possible, but my understanding, [redacted] 13:36:09

BY MR. SHEASBY: 13:36:10

Q. Okay. Let's go to Werner251. And I believe 13:36:10

that should be -- 13:36:23

A. Exhibit 20? 13:36:31

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

Q. Yeah. 13:36:32

That sounds right. Well, yeah. That sounds right. 13:36:34 13:36:38

A. Okay. I'm there now. 13:36:50

Q. Has anyone in the world ever combined the -- a process like the [redacted] process with Werner251? 13:36:52 13:36:57

MR. SNYDER: Objection to form. 13:37:04

THE WITNESS: I -- I'm not sure exactly what you are asking. Werner251 describes a few possible processes and some doping; so I'm not sure what your question is. 13:37:05 13:37:08 13:37:12 13:37:23

BY MR. SHEASBY: 13:37:23

Q. Well, you specify in Paragraph 30 -- 365 you specify a modification that you would make to Clix2 based on Werner251. 13:37:24 13:37:30 13:37:35

A. I have to go there. 13:37:43

Okay. So -- sorry. 13:38:11

You are thinking of the combination of Clix2 and Werner251? 13:38:14 13:38:17

Q. Yes, sir. 13:38:19

I'm asking has anyone in the real world ever made the combination that you propose? 13:38:20 13:38:23

MR. SNYDER: Objection to form. 13:38:26

THE WITNESS: So I -- I can't say whether someone has or has not. 13:38:27 13:38:33

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

BY MR. SHEASBY: 13:38:35

Q. Okay. Next question. 13:38:35

Have you ever worked with those materials that you are proposing to swap out of -- of -- of Werner251 in the Clix2? 13:38:39 13:38:47 13:38:52

A. I'm sorry. 13:38:56

Or, more specifically, you are speaking about the paddle wheel-type complexes or -- 13:39:00 13:39:03

Q. Yeah. 13:39:06

The specific complexes that are -- that you are citing in Werner251 and -- 13:39:07 13:39:09

A. So I have not personally used the tungsten W2(hpp4) molecule. 13:39:14 13:39:25

Q. Okay. 13:39:26

MR. SHEASBY: Why don't we take a break while I organize myself. 13:40:44 13:40:46

THE WITNESS: Okay. 13:40:48

THE VIDEOGRAPHER: Okay. This marks the end of media unit number four. 13:40:49 13:40:51

The time is 1:40 p.m. 13:40:53

We are off the record. 13:40:54

(Short recess taken.) 13:57:08

THE VIDEOGRAPHER: This marks the beginning of media unit number five. 13:57:08 13:57:13

The time is 1:57 p.m. 13:57:15

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

We are on the record. 13:57:17

BY MR. SHEASBY: 13:57:18

Q. Did you do any analysis as to whether the -- 13:57:20

in your report, did you do analysis as to whether the 13:57:23

materials you proposed to swap in from Werner, how 13:57:26

they would interact with the layers adjacent to the 13:57:30

EML layer? 13:57:34

A. Okay. So we're speaking now about my -- 13:57:38

the -- the -- the Werner -- the Werner modification 13:57:41

that -- that I proposed? 13:57:50

Q. Yes, sir. 13:57:51

A. I did not do any specific analysis relating 13:57:52

to that interaction. 13:57:59

Q. Let me ask the next question. 13:58:00

Did you speak to any Samsung engineers to 13:58:02

see if the Werner materials that you proposed to 13:58:05

introduce would appropriately interact with the 13:58:09

surrounding layers? 13:58:12

A. So my argument is that it would be obvious 13:58:13

to a person of ordinary skill that is not based on 13:58:22

any interviews with Samsung. 13:58:25

MR. SHEASBY: Objection. Form. 13:58:27

BY MR. SHEASBY: 13:58:29

Q. I said did you ask any Samsung engineers 13:58:29

whether the materials you proposed to use from Werner 13:58:32

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

would be appropriate and work in a Clix2 process -- the [redacted] process. 13:58:35 13:58:38

A. And I apologize. I believe I have already answered that question, which is that -- that my proposal was based on what I considered to be obvious, and it was not based on any interview with Samsung employees. 13:58:40 13:58:43 13:58:47 13:58:50 13:58:53

MR. SHEASBY: Objection. Form. 13:58:54

BY MR. SHEASBY: 13:58:55

Q. I asked you did you speak to any Samsung employees about your proposal to swap out the Werner -- the -- [redacted] materials with the Werner materials to determine how they interact with other layers? 13:58:55 13:58:57 13:59:00 13:59:06 13:59:09

MR. SNYDER: Objection to form. 13:59:11

THE WITNESS: So, again, I will repeat that my opinion is based on my opinion that that combination is obvious, and it is not based on any interview with any Samsung employees. 13:59:12 13:59:14 13:59:19 13:59:22

MR. SHEASBY: Objection. Form. 13:59:24

BY MR. SHEASBY: 13:59:25

Q. Let's look at Exhibit 19. 13:59:59

A. (Witness complies.) 14:00:02

Q. Wait. Is it Exhibit 19? Yeah. It is Exhibit 19. 14:00:07 14:00:11

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

A. Okay. I have the paper up. 14:00:25
Q. Great. 14:00:27
Does Exhibit 19 disclose joint vaporization? 14:00:27
A. So I'm not sure. And there is some 14:00:36
discussion of the deposition, but it is not -- you 14:00:43
know, it is a relatively short paper; so I can't say 14:00:50
whether or not it represents joint vaporization. 14:00:54
Q. Does codeposition necessarily result in 14:00:57
joint vaporization or does joint vaporization -- does 14:01:02
this codeposition necessarily mean there was joint 14:01:06
vaporization? 14:01:09
MR. SNYDER: Objection to form. 14:01:11
THE WITNESS: So, again, not necessarily. 14:01:14
The -- the question of joint vaporization depends on 14:01:16
a number of factors, including the presence of the 14:01:19
materials together; also, their opportunity to 14:01:22
interact; some energetic and kinetic factors. And 14:01:26
so, again, we need to know more details in order to 14:01:33
reach any conclusion about joint vaporization in the 14:01:38
system. 14:01:38
BY MR. SHEASBY: 14:01:39
Q. Why don't you download twenty, twenty-one -- 14:02:05
sorry. Twenty-three, twenty-four, and twenty-five. 14:02:12
(Deposition Exhibit Number 23 14:02:12
was marked for identification.) 14:02:17

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

(Deposition Exhibit Number 24 was marked for identification.) 14:02:17

(Deposition Exhibit Number 25 was marked for identification.) 14:02:17

THE WITNESS: Twenty-five is taking a while. 14:02:52

Okay. I have them downloaded. 14:03:00

BY MR. SHEASBY: 14:03:03

Q. Let's pull up Exhibit 23. 14:03:26

A. (Witness complies.) 14:03:29

Okay. I have that up. 14:03:41

Q. So if you go to Exhibit 23, [redacted] 14:04:48

Do you see that? 14:04:55

MR. SNYDER: Objection to form. 14:04:56

THE WITNESS: [redacted] 14:05:08

BY MR. SHEASBY: 14:05:12

Q. Did you ask -- did you have that document translated? 14:05:12

A. I don't know if I did. But, again, the document -- if you are reading through the document, it very, very clearly describes the specification for organic light-emitting diode display. 14:05:14

Q. I understand that. 14:05:37

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[redacted] 14:05:38

A. I would have to check my references to see if this document was translated. But, again, I, even after reviewing this, did not conclude at any point that that statement [redacted] 14:05:44 14:05:46 14:05:52 14:06:01

Q. Did -- did Dreamus make available versions of its devices with LCD displays? 14:06:05 14:06:12

A. I'm sorry. 14:06:16

Are you asking Dreamus as the corporate entity generally? 14:06:19 14:06:23

Q. No. 14:06:24

For the Clix2 product. 14:06:26

A. So.... 14:06:29

MR. SNYDER: Objection to form. 14:06:30

THE WITNESS: So no. 14:06:33

The Clix2 product was only offered in an AMOLED format. 14:06:33 14:06:36

BY MR. SHEASBY: 14:06:37

Q. Okay. So if you go to the spreadsheet, which is Exhibit 24. 14:06:37 14:06:39

A. (Witness complies.) 14:06:42

Q. Go to the sheet one page. 14:07:05

A. (Witness complies.) 14:07:20

Okay. I'm on sheet one. 14:07:20

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

Q. Uh-huh. 14:07:25

Okay. Where can I find this? One second. 14:07:54

Hmmm. Let's go -- let's do it in a different way. 14:08:25

Let's go to Exhibit 18. 14:09:37

A. (Witness complies.) 14:09:49

Q. Let's turn to page eight. 14:10:00

A. (Witness complies.) 14:10:04

It is opening. Okay. Page eight. 14:10:09

Q. What are the three matrix materials in the 14:10:14

functional layer in -- in the Clix2 in [redacted] 14:10:18

process? 14:10:25

A. Okay. So I guess I disagree that there are 14:10:28

any matrix materials. Matrix materials, as I discuss 14:10:36

in my report, are only those materials where there 14:10:40

are three components, as defined by the patent. And 14:10:44

there are no layers in the device in which there are 14:10:51

three materials, let alone matrix materials, as -- as 14:10:55

I discuss in my report. 14:10:58

Q. Okay. Let me ask you the next question, 14:11:00

which is if you go to -- hmmm. 14:11:02

Can we go to Segura, which I think is in 14:11:21

paragraph -- what is the paragraph of your report 14:11:25

that has Segura in it? Do you remember? 14:11:27

A. Sorry. 14:11:32

Were you speaking about the combination 14:11:32

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

Segura? 14:11:35

Q. Yeah. 14:11:38

Hold on for one second. 14:11:39

MR. SHEASBY: Actually, give me five minutes. Sorry. 14:11:43 14:11:45

Let's go off the record. I have to deal with something. 14:11:46 14:11:49

THE VIDEOGRAPHER: This marks the end of media unit number five. 14:11:49 14:11:51

The time is 2:11 p.m. 14:11:52

We are off the record. 14:11:55

(Short recess taken.) 14:17:54

THE VIDEOGRAPHER: This marks the beginning of media unit number six. 14:17:54 14:17:58

The time is 2:18 p.m. 14:18:00

We are on the record. 14:18:03

BY MR. SHEASBY: 14:18:04

Q. Let's go to the '164 patent. 14:18:05

Do you have it handy? 14:18:13

A. Just give me a moment to bring it up. 14:18:16

Seven. 14:18:30

MR. SNYDER: And, Jason, I don't see that as an exhibit. 14:18:55 14:18:58

Do you have an exhibit number? 14:18:59

THE WITNESS: Yeah. 14:19:02

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

Is there an exhibit number? Sorry. 14:19:02

MR. SHEASBY: That will be Exhibit 27. 14:19:47

(Deposition Exhibit Number 27 14:19:47

was marked for identification.) 14:20:04

THE WITNESS: Okay. I have that open. 14:20:04

BY MR. SHEASBY: 14:20:05

Q. Okay. I want to look at claim one. 14:20:05

So it -- it requires an organic functional 14:20:13

layer that has at least three matrix materials; 14:20:18

correct? 14:20:26

A. So that is correct. 14:20:32

There are three matrix materials specified 14:20:36

in claim one. 14:20:39

Q. And those three matrix materials have to be 14:20:40

in a single organic functional layer? 14:20:43

A. That's right. 14:20:48

It specifies there should be one organic 14:20:49

functional layer, and those are the matrix materials 14:20:53

of that functional layer. 14:20:56

Q. And there can be more than those matrix 14:20:56

materials in an organic functional layer, but there 14:21:01

needs to be at least those three; correct? 14:21:02

A. Yes. 14:21:05

There is one layer, but there can be more 14:21:05

materials inside that layer. 14:21:08

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

Q. And the layer is defined by the function; is that correct? 14:21:11 14:21:18

MR. SNYDER: Objection to form. 14:21:18

THE WITNESS: Not exclusively. Again, if we look at the specification and the understanding of a person of ordinary skill in the art, there is also an understanding based on, especially the specification, what the layer is. But one of the determining factors is the function of the layer. 14:21:20 14:21:20 14:21:20 14:21:23 14:21:26 14:21:28

BY MR. SHEASBY: 14:21:31

Q. What are the other determining factors? 14:21:31

A. Again, the composition, the -- what the layer does beyond just the electrical function. In some cases the practical function, et cetera. 14:21:40 14:21:42 14:21:46

Q. And specific in this, the emission layer has to be -- in this claim it is an emission layer that has to have at least three matrix materials; correct? 14:21:48 14:21:55 14:21:59

A. So in -- the EML is the layer here, which is described by having these -- these components. 14:22:05 14:22:11

Q. No. 14:22:14

It literally says -- the claim literally says emission layer. It doesn't say EML. 14:22:14 14:22:18

It says emission layer; correct? 14:22:22

A. So that is the language which is in the patent. 14:22:25 14:22:26

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

Q. Okay. And so in the patent it specifies an emission layer that is an organic functional layer that has at least three matrix materials in it; correct? 14:22:26 14:22:28 14:22:32 14:22:34

A. The patent describes the organic functional layer with the three matrix materials, and that layer is responsible for the emission in it. 14:22:35 14:22:39 14:22:42

Q. Okay. Now, the -- those matrix materials, what makes a material a matrix material? 14:22:46 14:22:54

A. So, again, there are two possible interpretations here; right? 14:22:58 14:23:04

And I have answered most of your questions under the construction that Samsung has proposed, but I -- I understand also that Pictiva has a different construction. And I got into this a little bit in my report. 14:23:05 14:23:08 14:23:12 14:23:15 14:23:21

Q. I'm just asking for your opinion. 14:23:21

What makes something a matrix material? 14:23:22

A. So, again, there are two constructions, and so I just want to be really careful in my answer because, again -- I have, again, answered a lot of questions, and I want to be clear that there are two possible interpretations. 14:23:25 14:23:32 14:23:36 14:23:39 14:23:46

Q. You can do whatever you want. I am just asking for your interpretation. 14:23:47 14:23:49

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

A. Fantastic. 14:23:51
So.... 14:23:52
MR. SNYDER: Objection to form. 14:23:52
THE WITNESS: So give me -- give me one second just to -- just to collect myself for a moment. 14:23:53 14:24:00 14:24:05
Okay. Sorry. Just every time there is a claim construction dispute, I want to be very clear on which construction I am going to be doing an explanation. 14:26:00 14:26:03 14:26:06 14:26:09
So -- so in terms of the matrix material, you know, Samsung has proposed the construction. The first, second, and third matrix materials are different materials and part of the same matrix, and so -- and I agree with that as a general definition of matrix material. 14:26:10 14:26:20 14:26:23 14:26:26 14:26:29 14:26:32
But Pictiva has proposed a different construction, which is the plain and ordinary meaning, which is to say a material that forms a continuous phase. 14:26:34 14:26:36 14:26:39 14:26:42
Now, Samsung's proposal is a little bit more restrictive because it restricts everybody to a single layer. Under Pictiva's understanding, you know, for example, Mr. Humphrey and Dr. Schanze have some considerations which allow for a broader 14:26:44 14:26:47 14:26:50 14:26:54 14:26:59

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

definition of what could mean in a layer or within one of the matrix materials. And, again, if there is a claim construction offered by the court, then we'll have to abide by that. 14:27:03 14:27:07 14:27:10 14:27:13

BY MR. SHEASBY: 14:27:14

Q. And what does it mean to be part of the same matrix? 14:27:15 14:27:17

A. So part of the same matrix -- again, the matrix is another one of these disputed terms, and, you know -- and I agree with Samsung's construction as a general matter, which is that it is a continuous phase of the mixture of matrix materials. 14:27:19 14:27:27 14:27:33 14:27:35 14:27:38

But Pictiva has offered an alternative construction, which is to say that they believe it should not be construed and that that should be interpreted under the plain and ordinary meaning. 14:27:41 14:27:47 14:27:49 14:27:51

Q. Okay. 14:27:54

A. And we should examine examples like yours under both constructions just to be careful. 14:27:55 14:27:58

Q. Well, I'm not -- I am asking about your construction. I have said that three times now. 14:28:00 14:28:03

Do you understand that? 14:28:05

A. That's fine. 14:28:06

MR. SNYDER: Objection to form. 14:28:07

MR. SHEASBY: At a break will you instruct 14:28:09

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

him to just give the speech you gave about different constructions at the previous break? 14:28:11 14:28:12

MR. SNYDER: Objection to form. 14:28:13

THE WITNESS: So... 14:28:15

MR. SNYDER: And I instruct the witness not to answer on the basis of privilege. 14:28:17 14:28:19

BY MR. SHEASBY: 14:28:19

Q. Did you speak -- 14:28:19

THE REPORTER: On the basis of what? 14:28:19

MR. SNYDER: Privilege. 14:28:25

BY MR. SHEASBY: 14:28:25

Q. Did you speak about your deposition testimony at the last break with your counsel? 14:28:26 14:28:27

MR. SNYDER: I -- to answer that question -- 14:28:30

THE WITNESS: Yeah. No. 14:28:38

BY MR. SHEASBY: 14:28:40

Q. Okay. So what does it mean for the three materials to be part of a continuous phase? 14:28:41 14:28:44

A. So for three materials to be part of a continuous phase is to say that there are three materials that are in a layer that are intermixed. And, as we discussed before, when they are continuous, there is no interruption in the -- the general positioning of the material. 14:28:48 14:28:50 14:28:53 14:28:57 14:28:59 14:29:04

Q. And did -- do they have to be at the same 14:29:06

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

concentration at each location in the phase? 14:29:10

A. I think that has to be considered in the 14:29:13
context of a person of ordinary skill in the art, and 14:29:17
I think there can be some difference in the 14:29:21
concentration. But we have to evaluate whether or 14:29:24
not it is a continuous layer or not when we are 14:29:26
making that evaluation. 14:29:29

Q. Right. 14:29:30

And what does it mean for it to be 14:29:30
a continuous layer? 14:29:32

A. Again, I think we have had this 14:29:34
conversation. But the continuous layer is that -- 14:29:37
that layer that has that structure but without 14:29:40
interruption. 14:29:45

Q. What structure? 14:29:45

A. A layer. I don't know how else to define 14:29:48
a layer. A layer is -- is the -- a layer in the 14:29:54
material. 14:30:00

Q. You don't know how to define a layer? 14:30:00

MR. SNYDER: Objection to form. 14:30:04

THE WITNESS: Yeah. 14:30:05

I think a person of ordinary skill would 14:30:06
understand what a layer is in -- in the device. 14:30:08

BY MR. SHEASBY: 14:30:11

Q. Yeah. 14:30:12

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

What is a layer in the device? 14:30:12

A. So a layer is, in the sequence of the device, in the vertical dimension or the third dimension, would be one of the parts of the stack of the device. 14:30:16 14:30:18 14:30:25 14:30:29

Q. So a layer is a part of the stack of the device? 14:30:29 14:30:32

MR. SNYDER: Objection to form. 14:30:32

THE WITNESS: That is one definition that one could apply. 14:30:33 14:30:38

BY MR. SHEASBY: 14:30:38

Q. Any other definitions? 14:30:38

A. Sitting here right now, I guess I can't think of another one. But, again, if we speak to a person of ordinary skill, they would understand what a layer is when we speak about -- and organically with that instruction. 14:30:42 14:30:45 14:30:49 14:30:52 14:30:55

Q. Right. 14:30:56

And what is that? 14:30:57

MR. SNYDER: Object to the form. 14:31:01

THE WITNESS: So, again, it would be as we build the device and the third dimension -- so the device is generally relatively large in two dimensions. The device -- there are deposited layers in the material, and those layers then form the 14:31:02 14:31:04 14:31:07 14:31:13 14:31:18

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

layers of the system. 14:31:21
BY MR. SHEASBY: 14:31:22
Q. Does the layer have to be deposited 14:31:22
simultaneously, all of the matrix materials in it? 14:31:25
A. So there is no -- as long as we can somehow 14:31:28
form that mixture, I don't believe that is necessary 14:31:36
that it has to be formed simultaneously. The 14:31:39
specification, the patent all discuss the formation 14:31:44
of that layer, and if there is some way to do it 14:31:48
without them, I don't see how. 14:31:51
Q. So there is no obstacle? You don't have to 14:31:55
form all the matrix materials in the functional layer 14:31:58
simultaneously? 14:32:01
A. The -- so if we are purely speaking about 14:32:02
the mixture of matrix materials as the matrix, the -- 14:32:10
it is the final product which is being described. 14:32:17
Q. Okay. So the layer doesn't have to be 14:32:20
formed simultaneously, and the matrix materials don't 14:32:24
have to be deposited simultaneously? 14:32:27
MR. SNYDER: Objection to form. 14:32:29
THE WITNESS: I'm sorry. 14:32:30
Could you ask that question again? 14:32:32
BY MR. SHEASBY: 14:32:34
Q. Sure. 14:32:34
The layer doesn't have to be formed at one 14:32:35

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

moment in time. 14:32:38

It could be formed iteratively? 14:32:40

MR. SNYDER: Objection to form. 14:32:43

THE WITNESS: So I guess I'm not sure 14:32:44

I agree with iteratively. But if the layer has grown 14:32:49

and if it has that mixed construction, then it -- it 14:32:53

is a mixed layer. 14:32:58

BY MR. SHEASBY: 14:33:00

Q. It can grow in multiple steps? 14:33:00

MR. SNYDER: Objection to form. 14:33:04

THE WITNESS: So it is -- again, without 14:33:06

trying to define specific details, in general, the 14:33:12

sequence is not specified by the -- by the -- by the 14:33:18

term under -- under either construction. 14:33:22

BY MR. SHEASBY: 14:33:25

Q. Okay. So I'm actually asking you to define 14:33:25

details. 14:33:28

Do you understand that? 14:33:32

A. So if you ask your question again, I might 14:33:33

be able to give a better answer. But as a general 14:33:37

matter, the term matrix or matrix material doesn't 14:33:40

specify the time at which the matrix is made and so 14:33:45

it specifies the structure after the matrix is done. 14:33:49

Q. And how about the layer? Can the layer be 14:33:54

formed in multiple steps? 14:34:08

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

MR. SNYDER: Objection to form. 14:34:11

BY MR. SHEASBY: 14:34:12

Q. Functional layer. 14:34:13

A. So, again, the functional layer -- there is no requirement in the term functional layer that is temporal. What matters is the layer has its formative device. 14:34:15 14:34:20 14:34:26 14:34:30

Q. Let's go to Exhibit A of the Humphrey report. 14:34:31 14:36:22

A. That's Exhibit Number 7? 14:36:37

Q. I believe so. 14:36:39

A. (Witness complies.) 14:36:43

Okay. I'm there now. 14:36:44

Q. Okay. Hmmm. 14:36:46

Okay. Let's go to Paragraph 205. 14:37:47

A. (Witness complies.) 14:37:59

Okay. I'm there now. 14:38:09

Q. So there are HOMO and LUMO values reported on -- on -- in the table in Paragraph 205? 14:38:10 14:38:16

A. I see those, yes. 14:38:18

Q. And putting aside the actual numbers, do those reflect the relative magnitude of difference between HOMO and LUMO values for the materials that are identified in that chart? 14:38:20 14:38:24 14:38:27 14:38:32

MR. SNYDER: Objection to form. 14:38:34

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

THE WITNESS: Give me a moment to double-check how those were measured. But if they were measured the same way, then their relative values would be comparable. 14:38:36 14:38:41 14:38:43 14:38:47

MR. SHEASBY: Now -- objection. Form. 14:38:49

BY MR. SHEASBY: 14:38:50

Q. I'm asking you as an expert, are the relative HOMO and LUMO values for those materials consistent with the numbers that are reported in this chart? 14:38:51 14:38:54 14:38:58 14:39:01

MR. SNYDER: Objection to form. 14:39:03

THE WITNESS: I have those numbers in my report. If you give me a moment, I can double-check using my method. 14:39:07 14:39:09 14:39:13

BY MR. SHEASBY: 14:39:18

Q. And tell me where you are going in your report. 14:39:19 14:39:22

A. Yeah. 14:39:22

Going to Page 225. Okay. So yeah. If you go to Paragraph 418, that is some indications of this particular measurement, and I just wanted to check the references. I looked up the references for how Mr. Humphrey had determined these, and the -- the reference for the [redacted] doesn't specify the measurement method. And that is the alleged first 14:39:35 14:40:08 14:40:13 14:40:15 14:40:19 14:40:23 14:40:28

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

matrix material; whereas, the other two materials were -- sorry. 14:40:33 14:40:38

The -- the [redacted], and so the -- the same technique generally has to be used in order to guarantee that the relative levels are correct. Measuring HOMO and LUMO is pretty complicated, unfortunately, and so there are some built-in biases for that particular method, and so it can be really challenging to confirm that the relative HOMO and LUMO levels are correct if they are measured through different methods or, in one case at least here, we don't even know the method. 14:40:49 14:40:57 14:41:01 14:41:06 14:41:09 14:41:13 14:41:17 14:41:21 14:41:26

MR. SHEASBY: Objection. Objection. Form. 14:41:29

BY MR. SHEASBY: 14:41:31

Q. The question I asked you was do you have different data on what the relative HOMO and LUMO measures are for any of the materials that Mr. Humphrey cites in his report -- or Dr. Humphrey cites -- Mr. Humphrey cites in his report? 14:41:31 14:41:33 14:41:37 14:41:39 14:41:42

A. So I did not do any measurement of the HOMO and LUMO levels. And I -- I made my comments based on Mr. Humphrey's -- Mr. Humphrey's analysis, and I have highlighted some concerns that I have. 14:41:48 14:41:54 14:41:58 14:42:03

MR. SHEASBY: Objection. Form. 14:42:06

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Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

BY MR. SHEASBY: 14:42:07

Q. I said did you -- did you reach -- did you have a different -- did you reach a conclusion of what the relative HOMO and LUMO levels are for the matrix materials that Mr. Humphrey identifies in this report? 14:42:07 14:42:10 14:42:12 14:42:15 14:42:19

A. I'm sorry. Could you ask that again? 14:42:24

Q. Sure. 14:42:26

Did you reach a conclusion on what the relatively -- relative HOMO and LUMO levels are for the materials that Mr. Humphrey identifies in his report as matrix materials? 14:42:27 14:42:30 14:42:32 14:42:35

A. So no. 14:42:37

I did not offer an opinion or conclusion on the relative HOMO and LUMO levels for these materials. 14:42:37 14:42:39 14:42:43

Q. And did you ask Samsung engineers what the relatively level -- rel- -- relative HOMO and LUMO levels were for these materials? 14:42:43 14:42:47 14:42:48

A. No. 14:42:50

Again, I -- in my report I detail my -- my concerns about Mr. Humphrey's technique, and none of that is a product of any discussion with Samsung engineers. 14:42:51 14:42:57 14:43:00 14:43:04

MR. SHEASBY: Objection. Form. 14:43:05

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

BY MR. SHEASBY: 14:43:06

Q. Did you speak to any Samsung engineers about what the relative HOMO and LUMO levels are for the materials Mr. Humphrey identifies as matrix materials in his report? 14:43:06 14:43:08 14:43:11 14:43:15

A. So I did not have any explicit discussion with any Samsung engineers regarding the measurements of the HOMO and LUMO levels of the materials in Mr. Humphrey's report. 14:43:17 14:43:22 14:43:27 14:43:30

Q. Okay. Do you have the technical capability of calculating HOMO and LUMO levels? 14:43:32 14:43:38

A. From simulation? 14:43:42

Q. From any source. 14:43:44

A. So I, personally, have access to the software that can do it, but I do not attempt to or generally simulate materials in order to calculate the HOMO or LUMO levels in any level of detail. 14:43:47 14:43:53 14:43:59 14:44:03

Q. Have you ever calculated HOMO and LUMO levels from materials? 14:44:07 14:44:09

A. I have -- I have in the past used software to calculate energy levels of organic semiconductors. 14:44:11 14:44:16

MR. SHEASBY: Objection. Form. 14:44:25

BY MR. SHEASBY: 14:44:26

Q. Have you ever used -- calculated HOMO and LUMO levels for matrix materials, such as those 14:44:26 14:44:30

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

specified in the '164 patent? 14:44:33
MR. SNYDER: Objection to form. 14:44:39
THE WITNESS: So I have not done any 14:44:40
simulation for any materials or the types of 14:44:42
materials which are being described here using any 14:44:45
simulation software. 14:44:50
BY MR. SHEASBY: 14:44:51
Q. Okay. 14:44:51
A. The simulations I have performed have been 14:44:51
for primarily organic photovoltaic applications, 14:44:54
which are somewhat different. 14:44:56
Q. Okay. And have you asked Samsung how they 14:44:57
pegged the HOMO and LUMO levels of their materials? 14:45:04
A. So the Samsung documentation, which 14:45:10
describes the HOMO and LUMO levels, generally 14:45:12
references the measurements, and Mr. Humphrey also 14:45:16
uses some of those references as well. But I did not 14:45:20
have any particular questions or discussion with 14:45:24
Samsung about analyzing any materials forming. 14:45:26
Q. For the '164 patent you propose combining 14:45:31
the Clix2 with a number of different references; 14:45:47
correct? 14:45:52
A. Yes, I do. 14:45:55
Q. And in the real world, have those references 14:45:56
ever been combined with the Clix2? 14:45:59

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

MR. SNYDER: Objection to form. 14:46:02
THE WITNESS: So yeah. 14:46:03
There have been a large number of 14:46:06
innovations in the organic light-emitting diode 14:46:09
space, and so I can't speak specifically as to which 14:46:12
ones may or may not have been developed based on my 14:46:16
proposed accommodations. 14:46:20
BY MR. SHEASBY: 14:46:20
Q. Did you ask any Samsung engineers if they 14:46:34
have ever combined the references in the way you 14:46:37
have -- where -- whether it would be reasonable to 14:46:39
combine the references -- references in the way you 14:46:41
disclose? 14:46:44
A. I have not had any discussions with Samsung 14:46:47
engineers regarding the specific combinations of 14:46:54
references that I had proposed. 14:47:00
MR. SHEASBY: I pass the witness. 14:47:02
MR. SNYDER: All right. Give us a few 14:47:05
minutes. 14:47:07
THE REPORTER: What did you just say? 14:47:17
MR. SHEASBY: He said give us a few minutes. 14:47:17
THE REPORTER: After that. 14:47:20
MR. SNYDER: Yeah. 14:47:21
Let's go off the record. 14:47:22
We'll come back in fifteen minutes. 14:47:25

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

THE VIDEOGRAPHER: Okay. This marks the end of media unit number six. 14:47:25 14:47:27

The time is 2:47 p.m. 14:47:30

We are off the record. 14:47:34

(Short recess taken.) 15:06:56

THE VIDEOGRAPHER: This marks the beginning -- oh, sorry. 15:06:56 15:07:57

This marks the beginning of media unit number seven. 15:07:58 15:08:01

The time is 3:08 p.m. 15:08:05

We are on the record. 15:08:07

MR. SNYDER: The defendants don't have any questions for the witness, but we would like to designate the deposition transcript as confidential, attorneys' eyes only pursuant to the protective order. 15:08:07 15:08:08 15:08:08 15:08:12 15:08:16

Also, we object to including as an exhibit documents that the witness did not discuss. 15:08:16 15:08:20

MR. SHEASBY: Okay. Thank you. 15:08:25

THE VIDEOGRAPHER: Mr. Sheasby, before we go off the record -- oh, he left already. 15:08:27 15:08:31

Okay. Mr. Snyder, do you need a copy of the video? 15:08:33 15:08:36

MR. SNYDER: Yes. 15:08:36

We are going to need the video, yes. 15:08:37

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

THE VIDEOGRAPHER: Do you want it synced with the transcript? 15:08:40 15:08:42

MR. SNYDER: Yes, please. 15:08:43

THE VIDEOGRAPHER: Okay. Perfect. 15:08:44

Suzanne, anything on the record or can I take us off? 15:08:44 15:08:45

MR. SNYDER: We are good. 15:08:45

THE VIDEOGRAPHER: Okay. Then this concludes the deposition. 15:08:46 15:08:47

And we are off the record at 3:08 p.m. 15:08:50

Given by Dr. Ioannis Kymissis -- sorry. Kymissis. 15:08:53 15:09:00

Total number of media units used was seven and will be retained by Veritext. 15:09:00 15:09:03

THE REPORTER: And when do you want the final? 15:09:03 15:09:33

MR. SNYDER: Final by June 17. 15:09:33

(Deposition Exhibit Number 4 was marked for identification.)

(Deposition Exhibit Number 5 was marked for identification.)

(Deposition Exhibit Number 6 was marked for identification.)

(Deposition Exhibit Number 8 was marked for identification.)

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

(Deposition Exhibit Number 9
was marked for identification.)
(Deposition Exhibit Number 10
was marked for identification.)
(Deposition Exhibit Number 15
was marked for identification.)
(Deposition Exhibit Number 17
was marked for identification.)
(3:08 p.m.)

--ooOoo--

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

STATE OF CALIFORNIA)
) ss.
COUNTY OF KERN)

I, IOANNIS KYMISSIS, Ph.D., do hereby certify:

That I have read the foregoing deposition;

That I have made such changes in form and/or substance to the within deposition, as might be necessary to render the same true and correct;

That having made such changes thereon, I hereby subscribe my name to the deposition.

I declare, under penalty of perjury, that the foregoing is true and correct.

Executed this _____ day of _____, 2025, at _____, California.

_____
IOANNIS KYMISSIS, Ph.D.

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

STATE OF CALIFORNIA)
) ss.
COUNTY OF KERN)

I, B. Suzanne Hull, a Certified Shorthand Reporter in the State of California, holding Certificate Number 13495, do hereby certify that IOANNIS KYMISSIS, Ph.D., the witness named in the foregoing deposition, was by me duly sworn; that said deposition, was taken Saturday, June 14, 2025, at the time and place set forth on the first page hereof.

That upon the taking of the deposition, the words of the witness were written down by me in stenotypy and thereafter transcribed by computer under my supervision; that the foregoing is a true and correct transcript of the testimony given by the witness.

Pursuant to Federal Rule 30(e), transcript review was requested.

I further certify that I am neither counsel for nor in any way related to any party to said action, nor in any way interested in the result or outcome thereof.

///

///

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

Dated this 17th day of June, 2025, at Bakersfield, California.



B. Suzanne Hull, CSR No. 13495

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

Ioannis Kymissis, Ph.D.
johnkym@gmail.com

JUNE 17, 2025

RE: Pictiva Displays International LTD v. Samsung Electronics Co., Ltd., Et Al.
6/14/2025, Ioannis Kymissis, Ph.D., (#7338172).

The above-referenced transcript has been completed by Veritext Legal Solutions and review of the transcript is being handled as follows:

__ Per CA State Code (CCP 2025.520 (a)-(e)) – Contact Veritext to schedule a time to review the original transcript at a Veritext office.

__ Per CA State Code (CCP 2025.520 (a)-(e)) – Locked .PDF Transcript - The witness should review the transcript and make any necessary corrections on the errata pages included below, notating the page and line number of the corrections. The witness should then sign and date the errata and penalty of perjury pages and return the completed pages to all appearing counsel within the period of time determined at the deposition or provided by the Code of Civil Procedure. Contact Veritext when the sealed original is required.

__ Waiving the CA Code of Civil Procedure per Stipulation of Counsel - Original transcript to be released for signature as determined at the deposition.

__ Signature Waived – Reading & Signature was waived at the time of the deposition.

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

_X_ Federal R&S Requested (FRCP 30(e)(1)(B)) – Locked .PDF Transcript - The witness should review the transcript and make any necessary corrections on the errata pages included below, notating the page and line number of the corrections. The witness should then sign and date the errata and penalty of perjury pages and return the completed pages to all appearing counsel within the period of time determined at the deposition or provided by the Federal Rules.

__ Federal R&S Not Requested - Reading & Signature was not requested before the completion of the deposition.

Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

Pictiva Displays International LTD v. Samsung Electronics Co., Ltd., Et Al.

Ioannis Kymissis, Ph.D. (#7338172)

E R R A T A S H E E T

PAGE_____ LINE_____ CHANGE_____

_____

REASON_____

PAGE_____ LINE_____ CHANGE_____

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REASON_____

PAGE_____ LINE_____ CHANGE_____

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REASON_____

PAGE_____ LINE_____ CHANGE_____

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REASON_____

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REASON_____

PAGE_____ LINE_____ CHANGE_____

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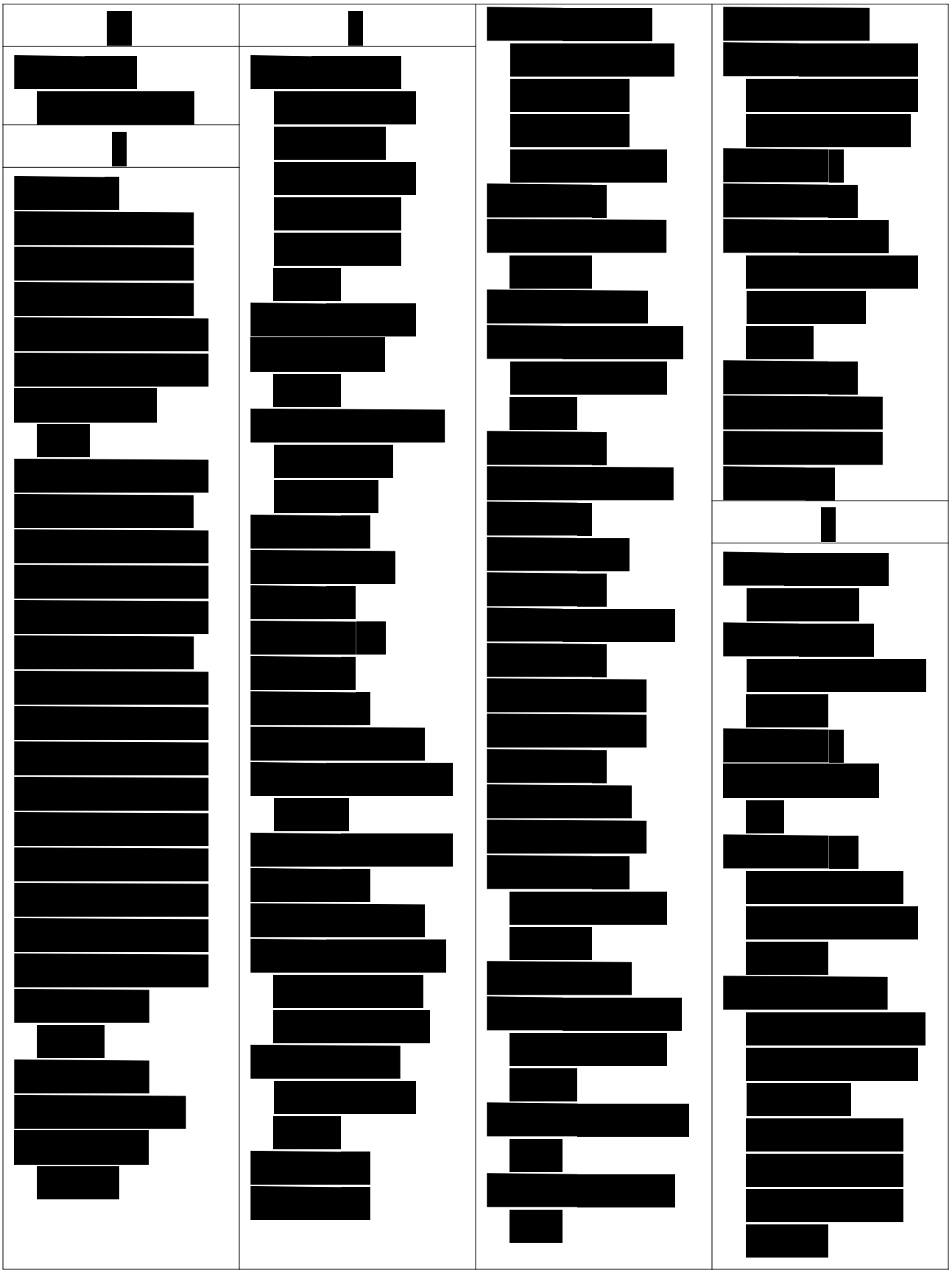
REASON_____

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(Ioannis Kymissis, Ph.D.) Date

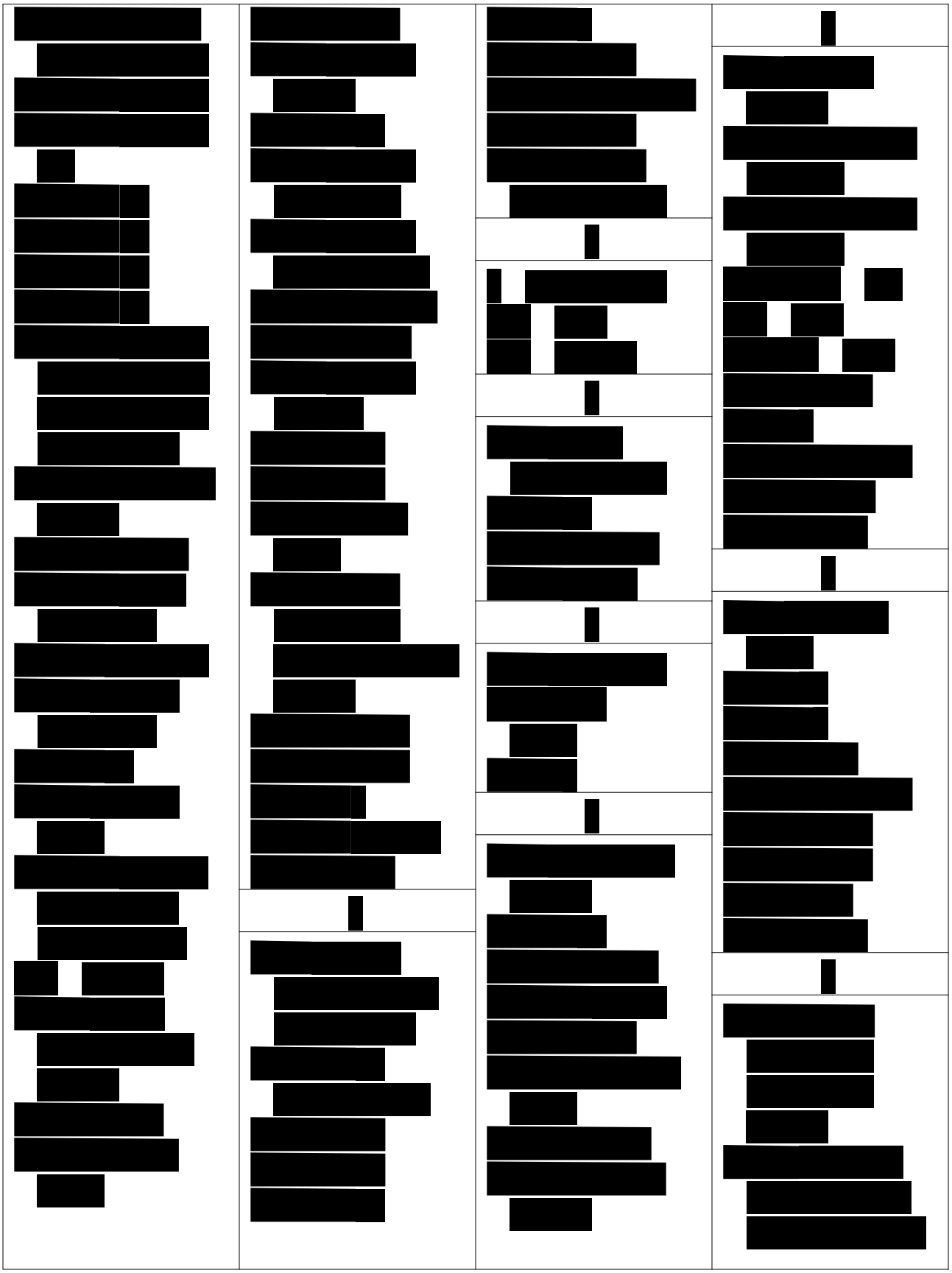
Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[& - 2008]



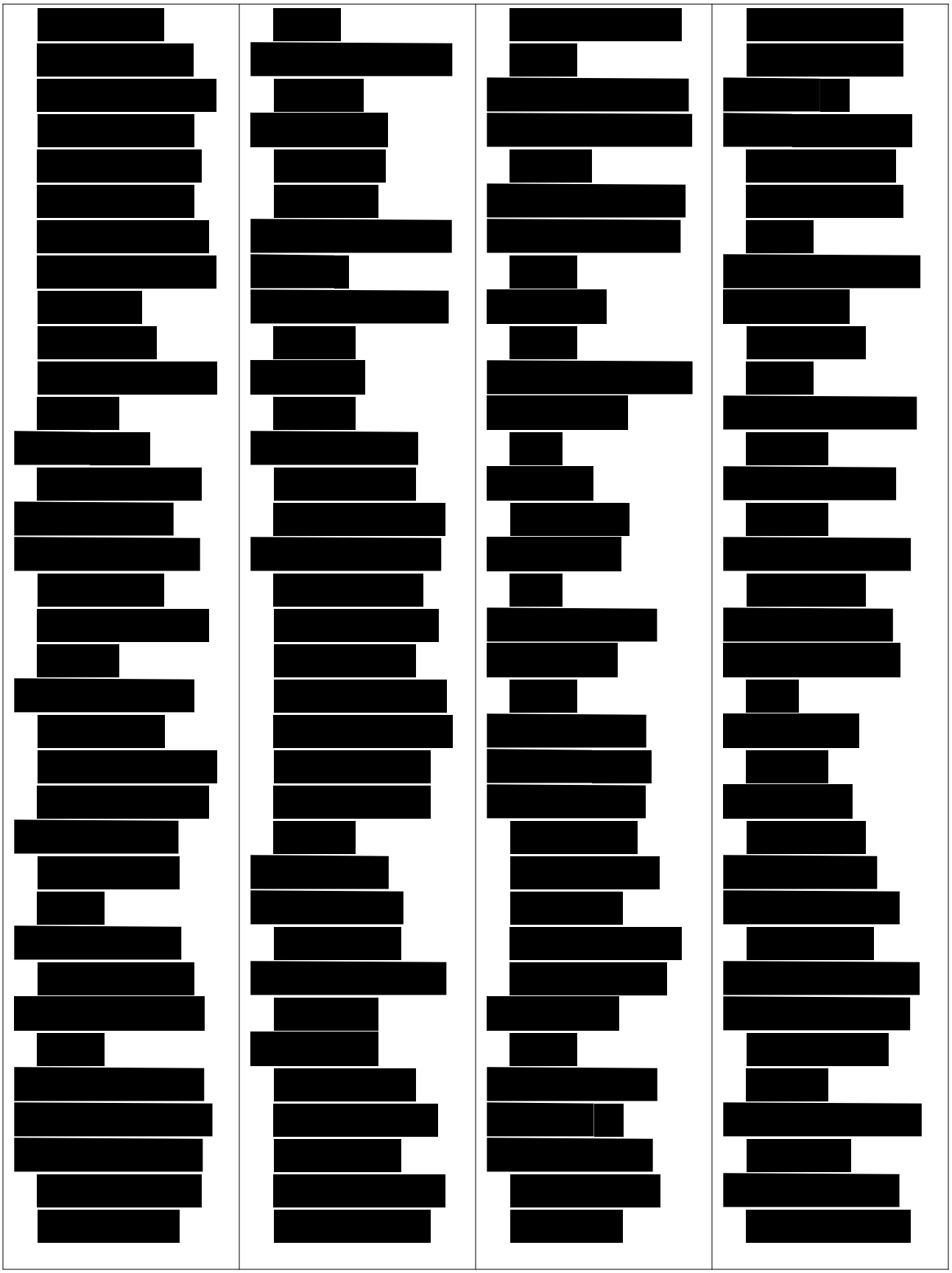
Veritext Legal Solutions
Calendar-CA@veritext.com 866-299-5127
Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[redacted]



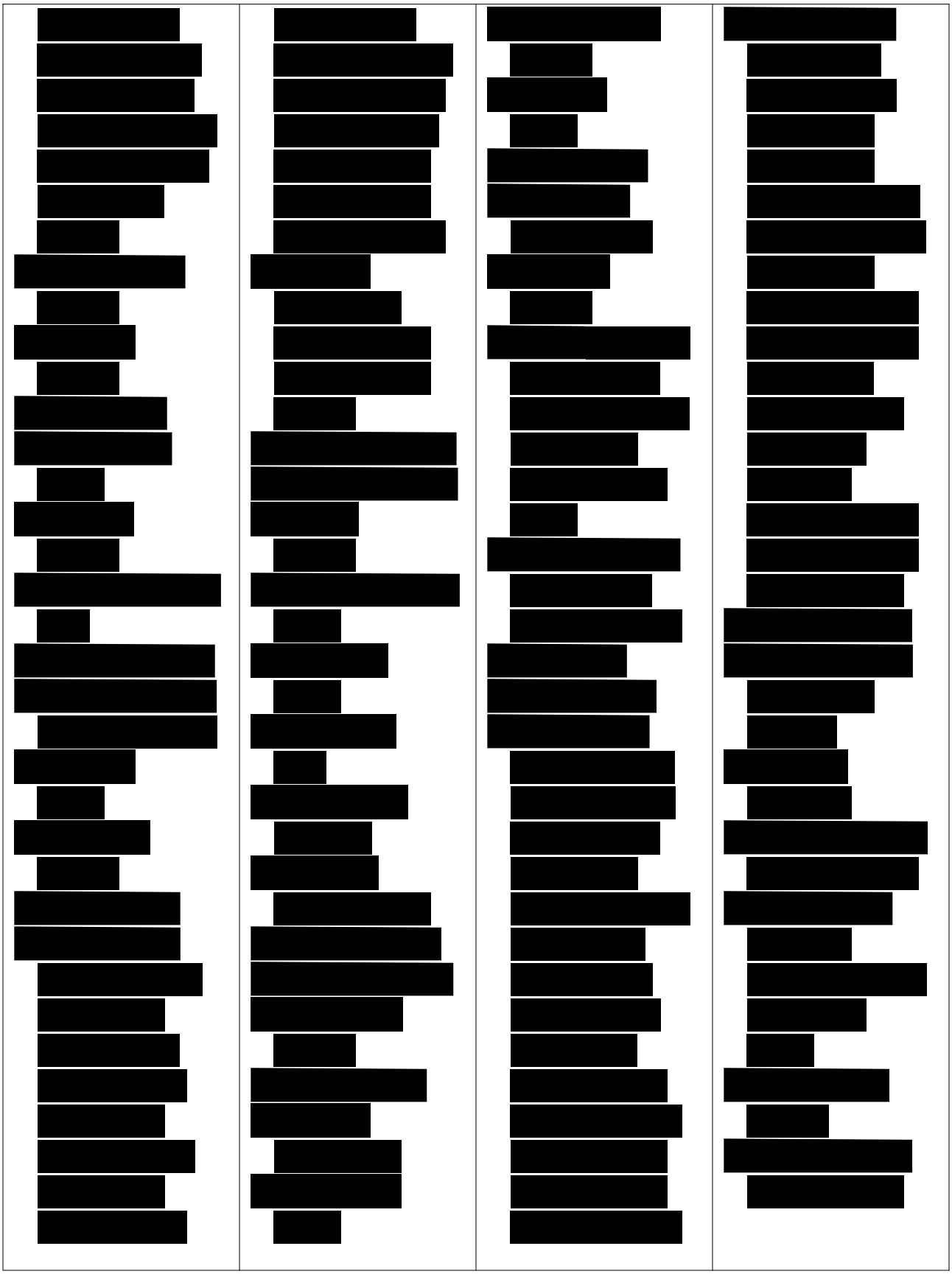
Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[redacted]



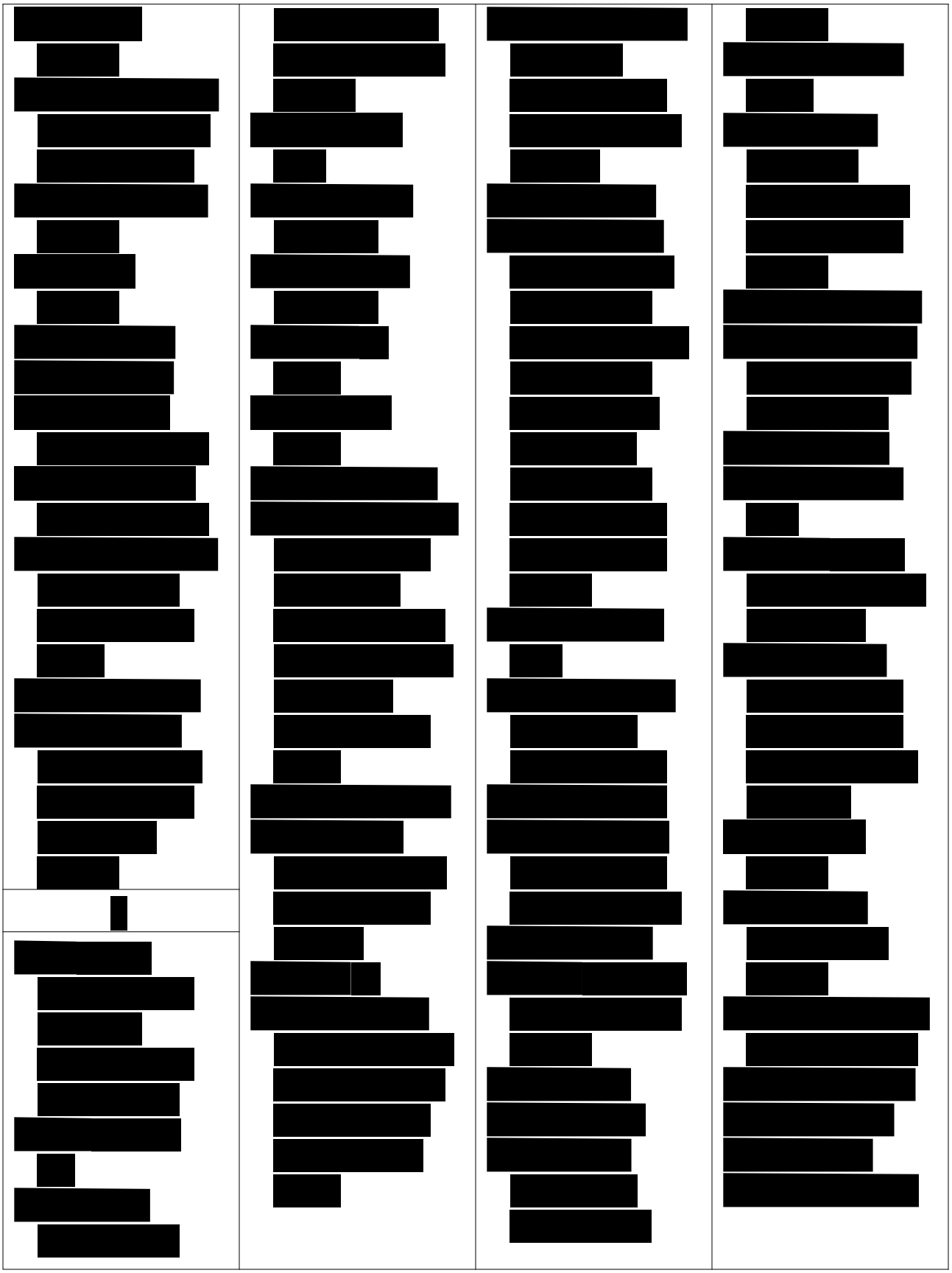
Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[analysis - attempt]



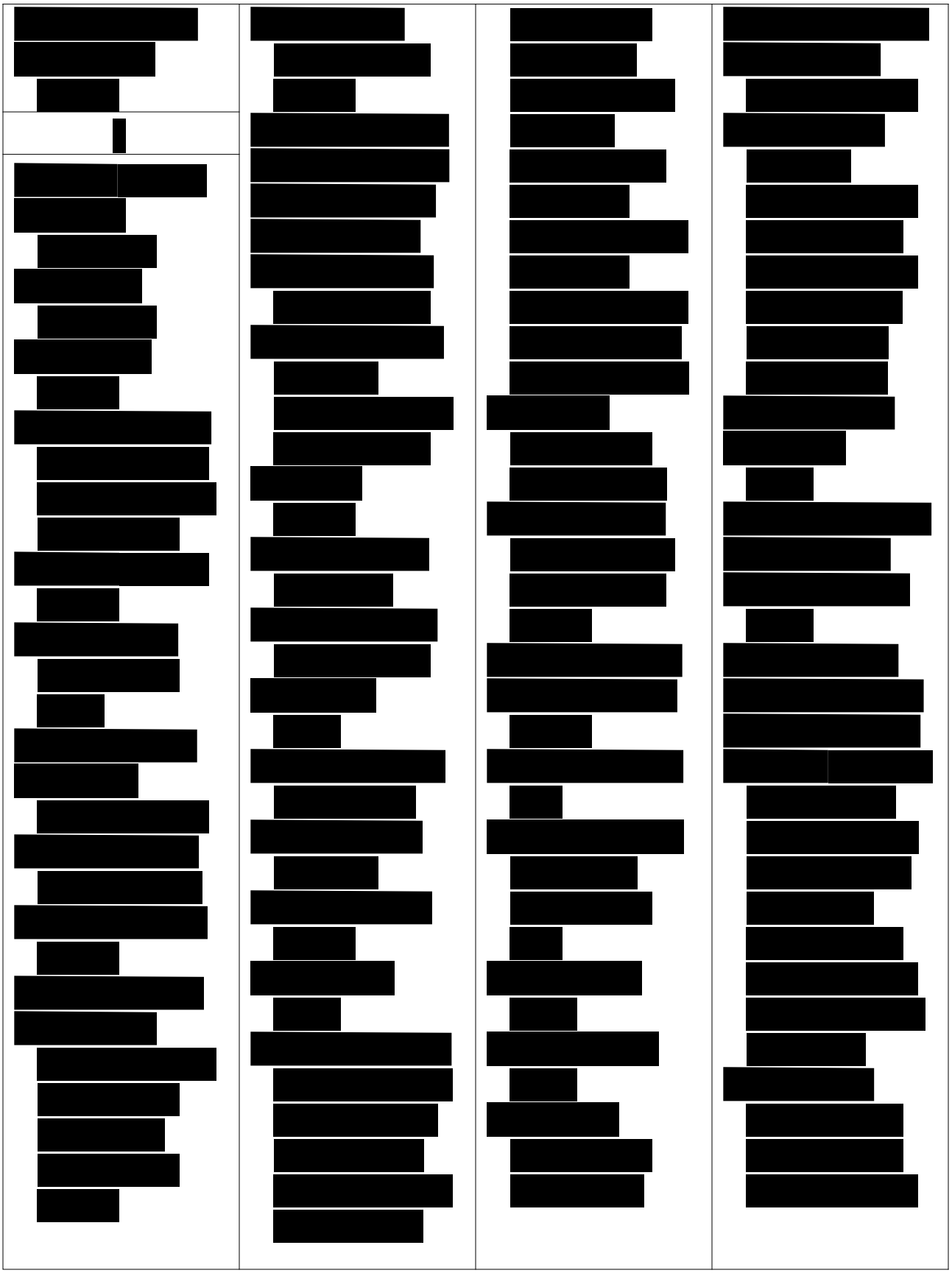
Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[attempted - business]



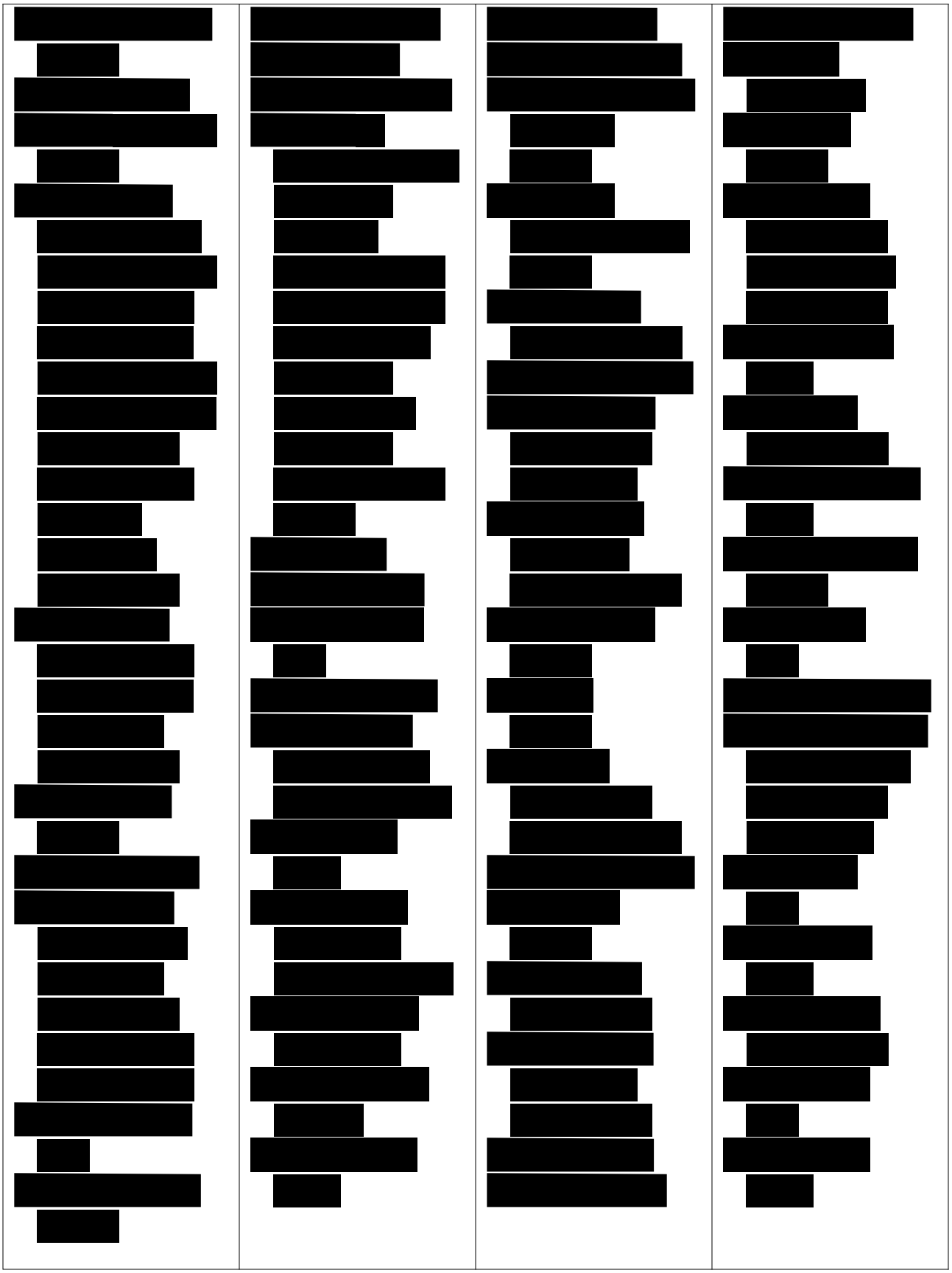
Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[butter - cited]



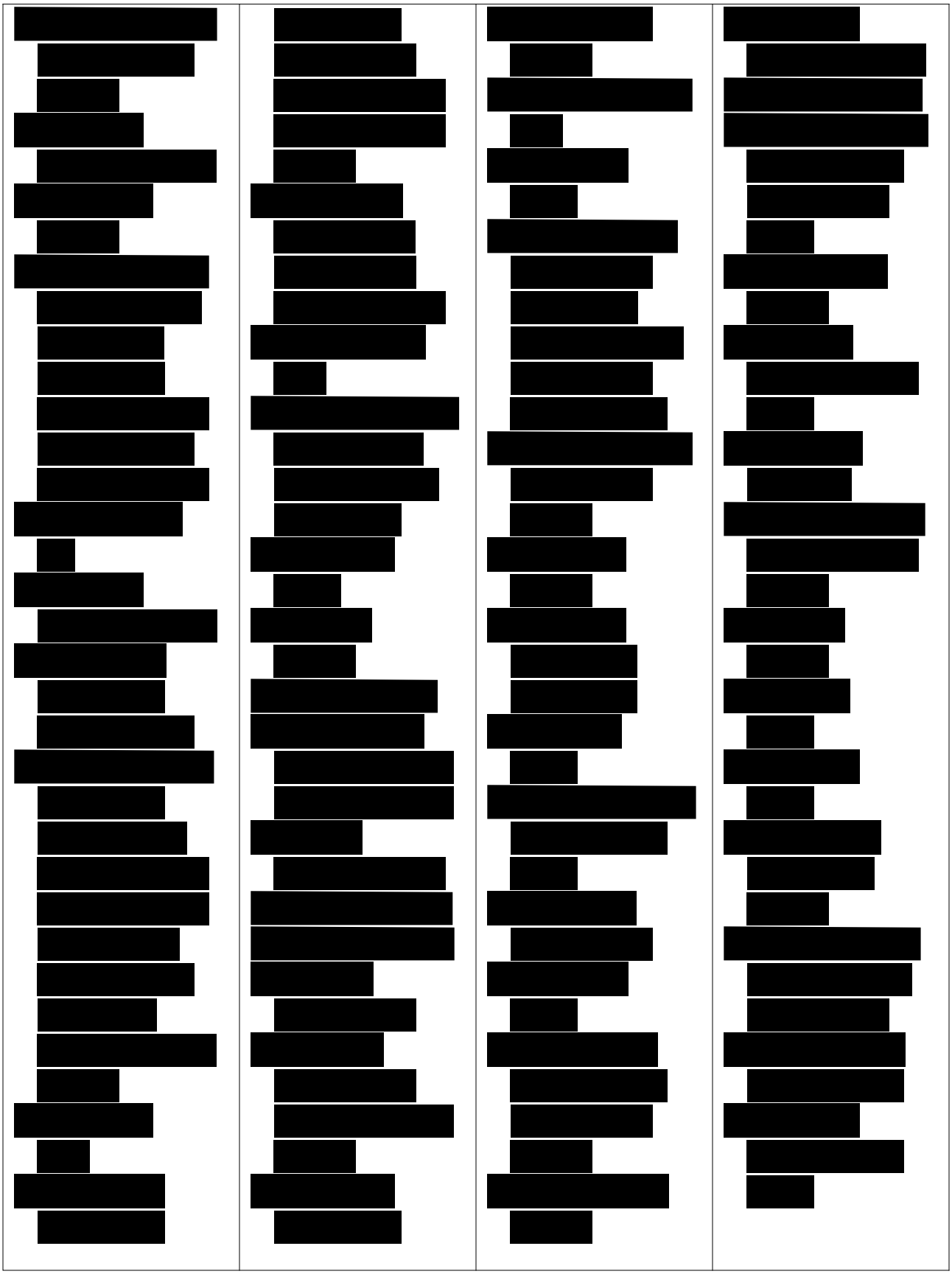
Pictiva EX2106
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IPR2024-01094

[cites - compensate]



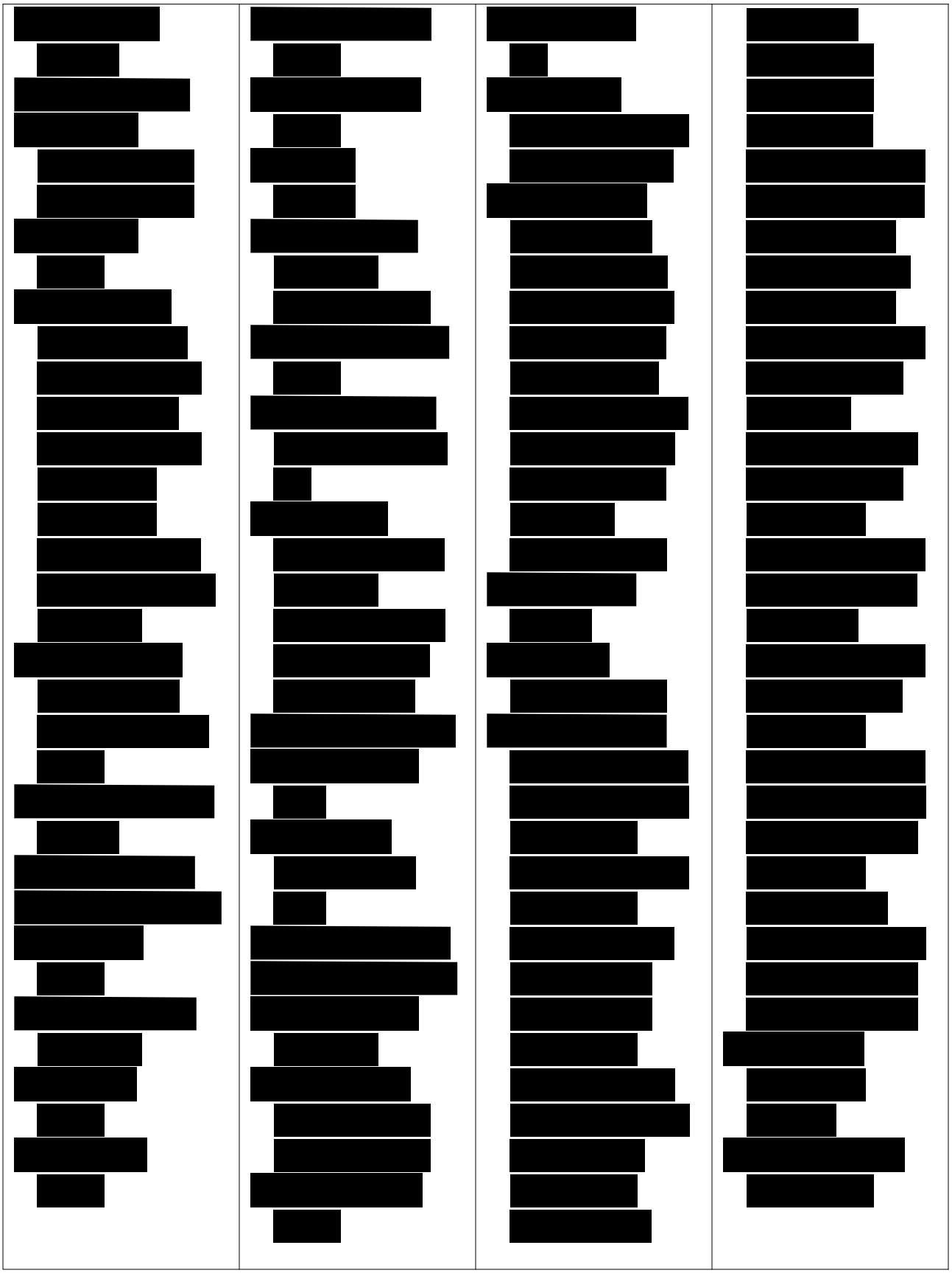
Pictiva EX2106
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IPR2024-01094

[complete - considered]



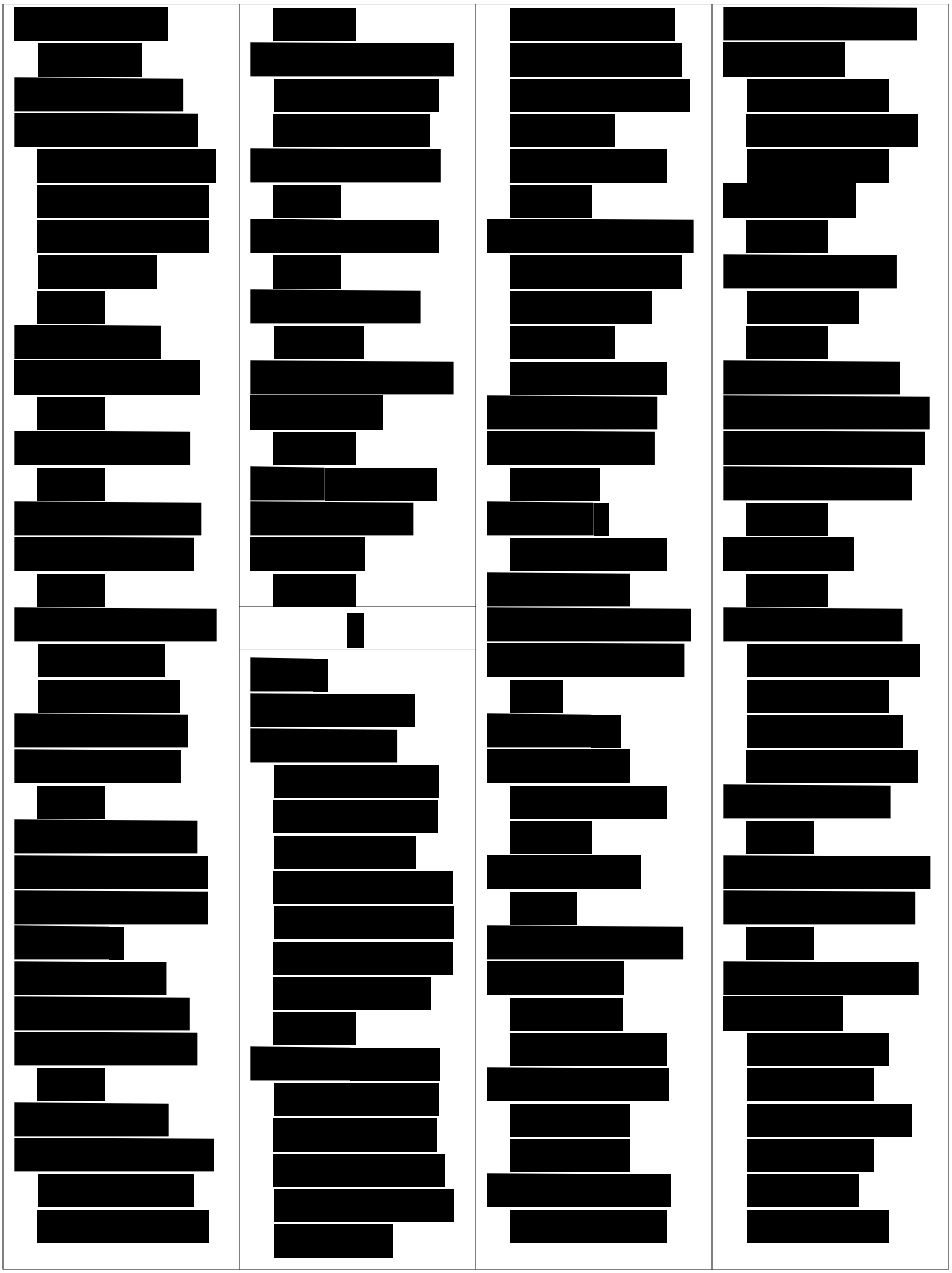
Pictiva EX2106
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IPR2024-01094

[considering - corresponding]



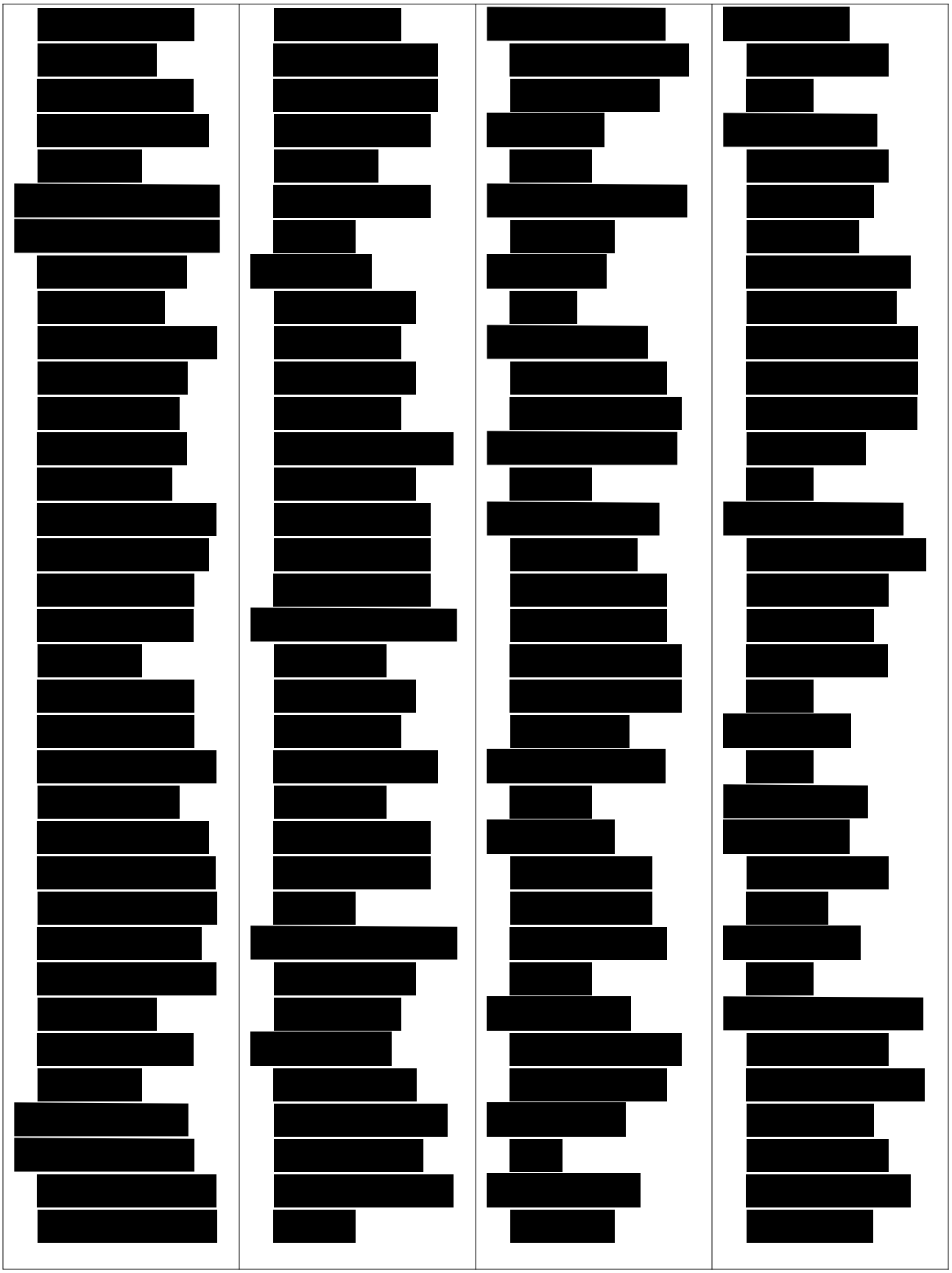
Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[corresponds - deposited]



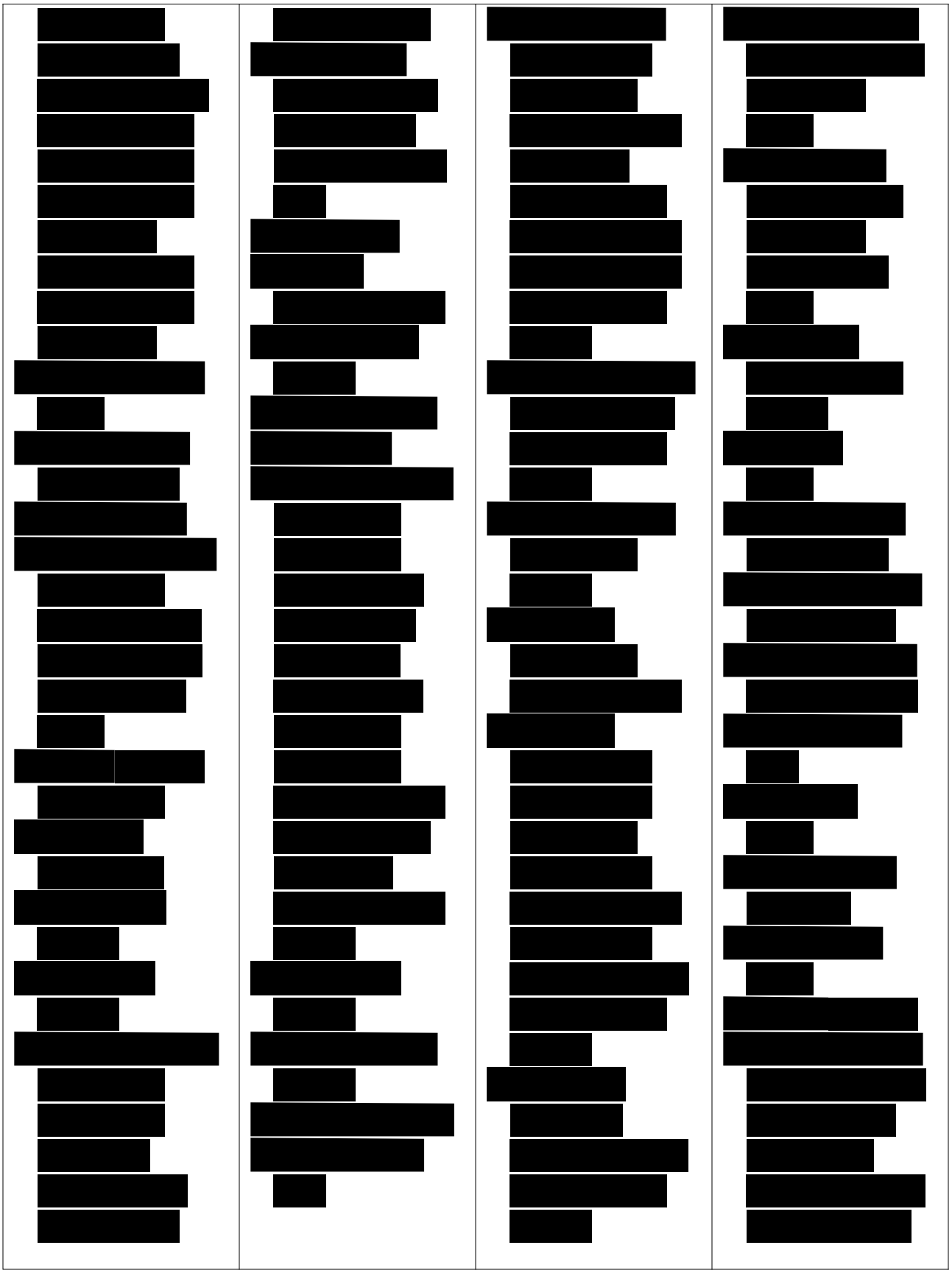
Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[deposited - different]



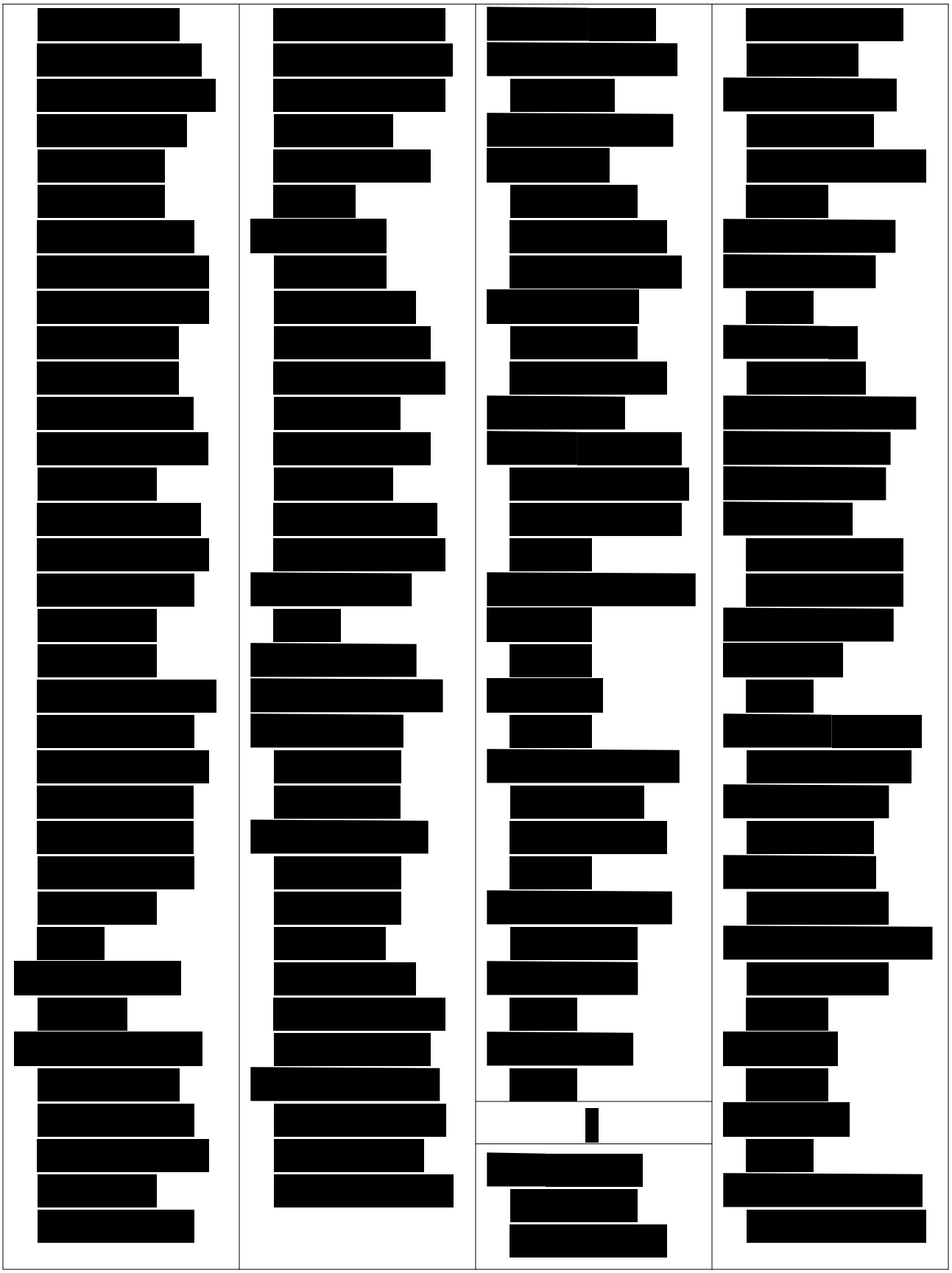
Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[different - document]



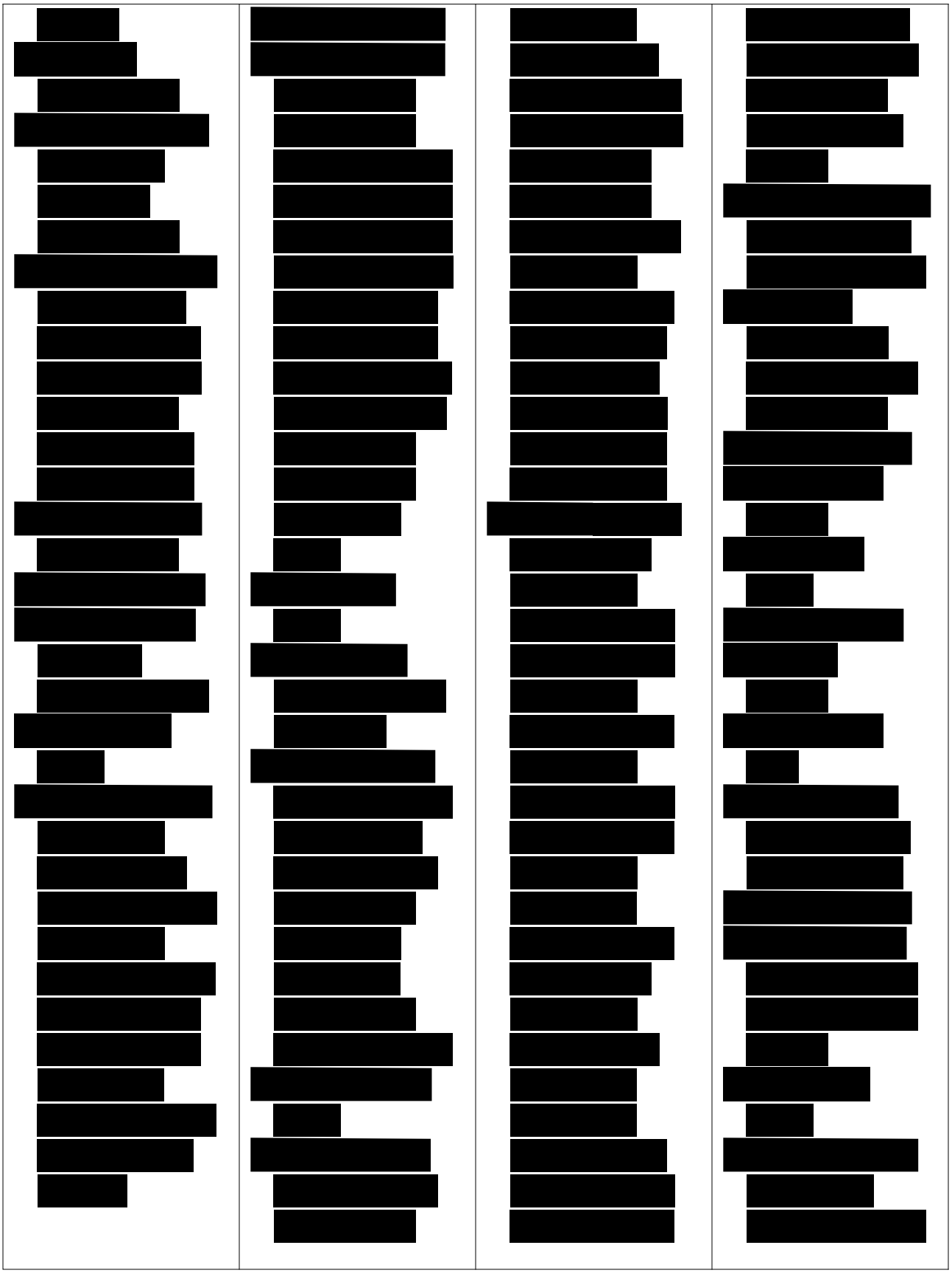
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IPR2024-01094

[document - electron]



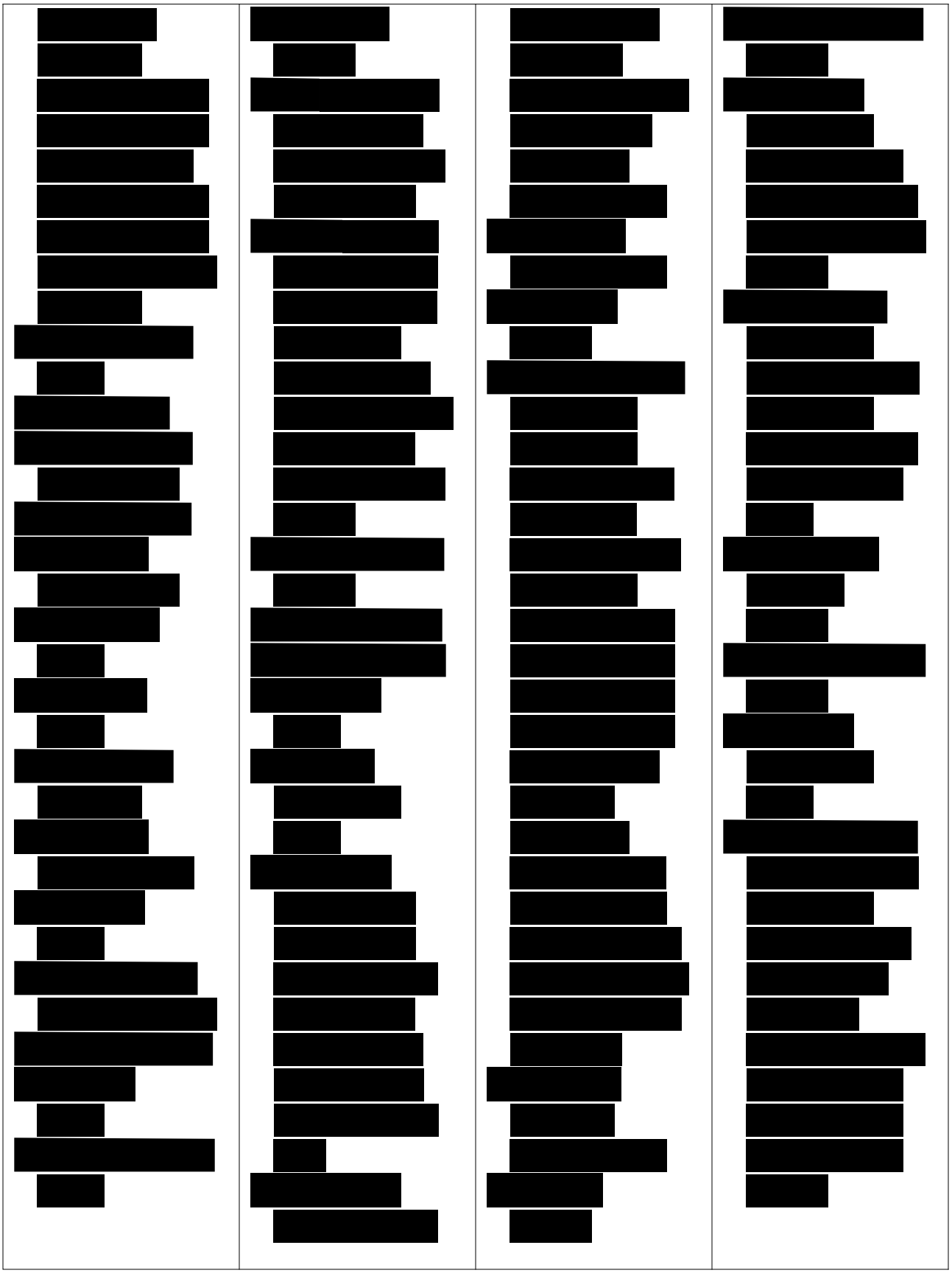
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IPR2024-01094

[electron - engineers]



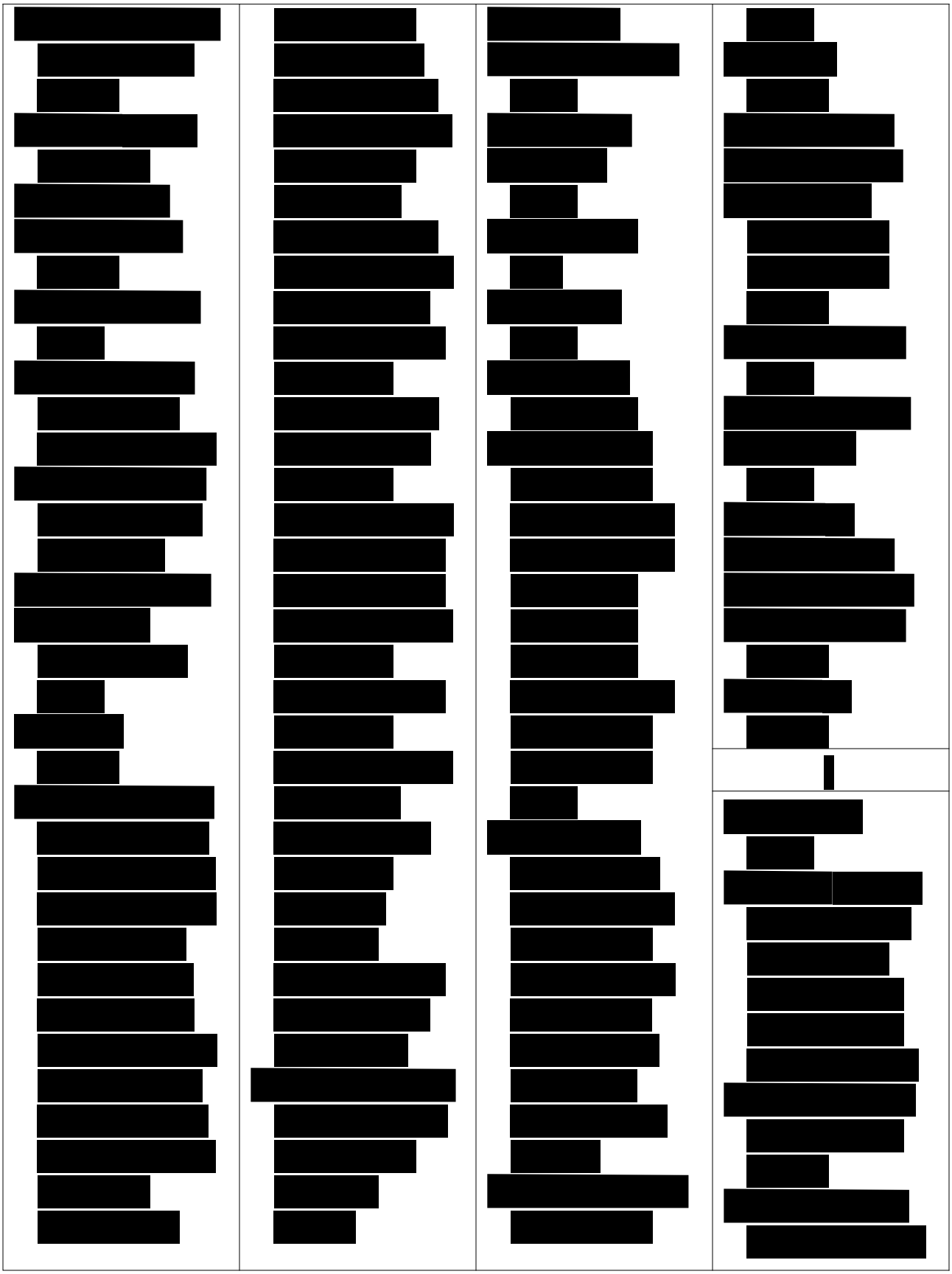
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IPR2024-01094

[engineers - example]



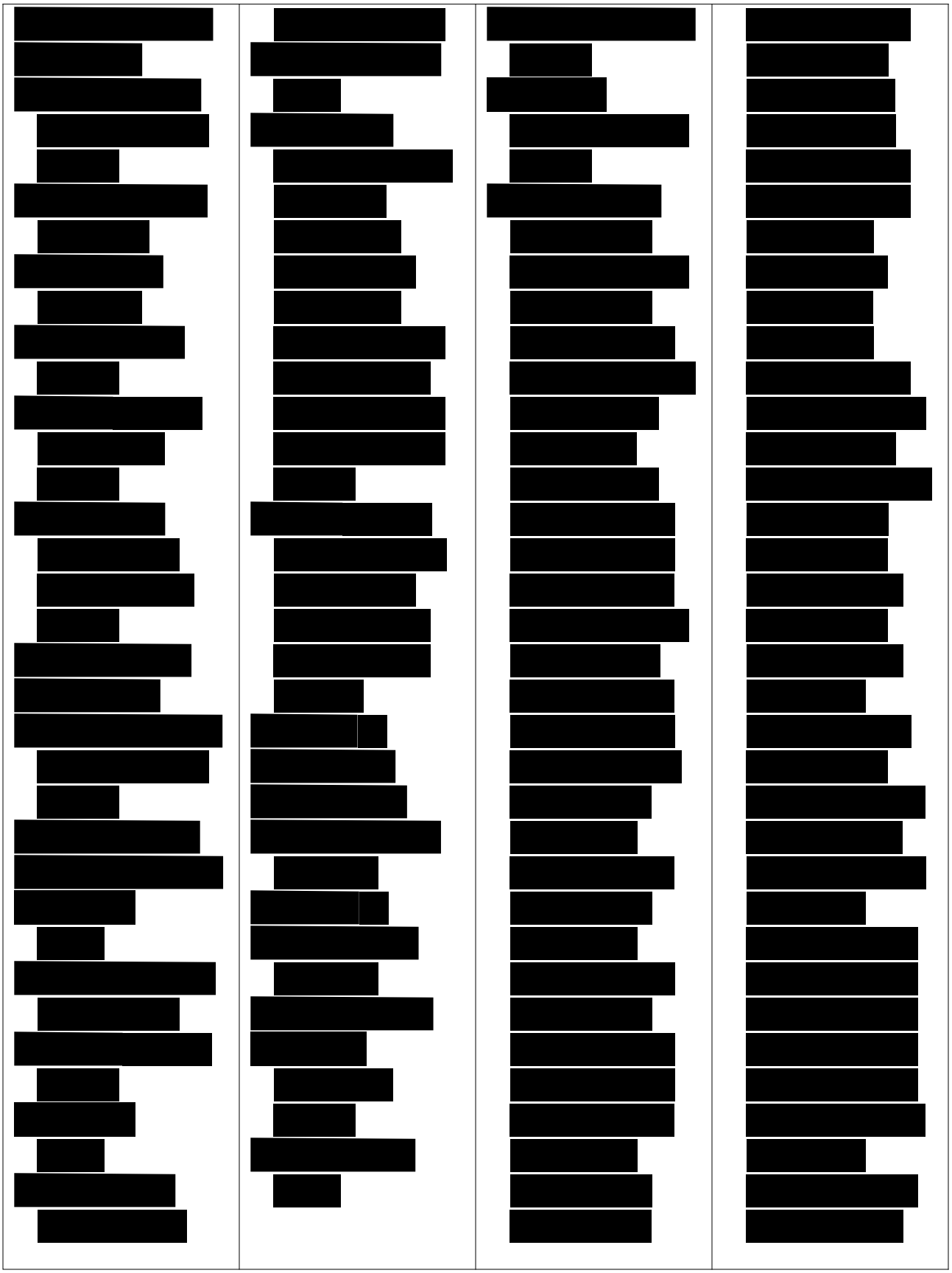
Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[examples - faculty]



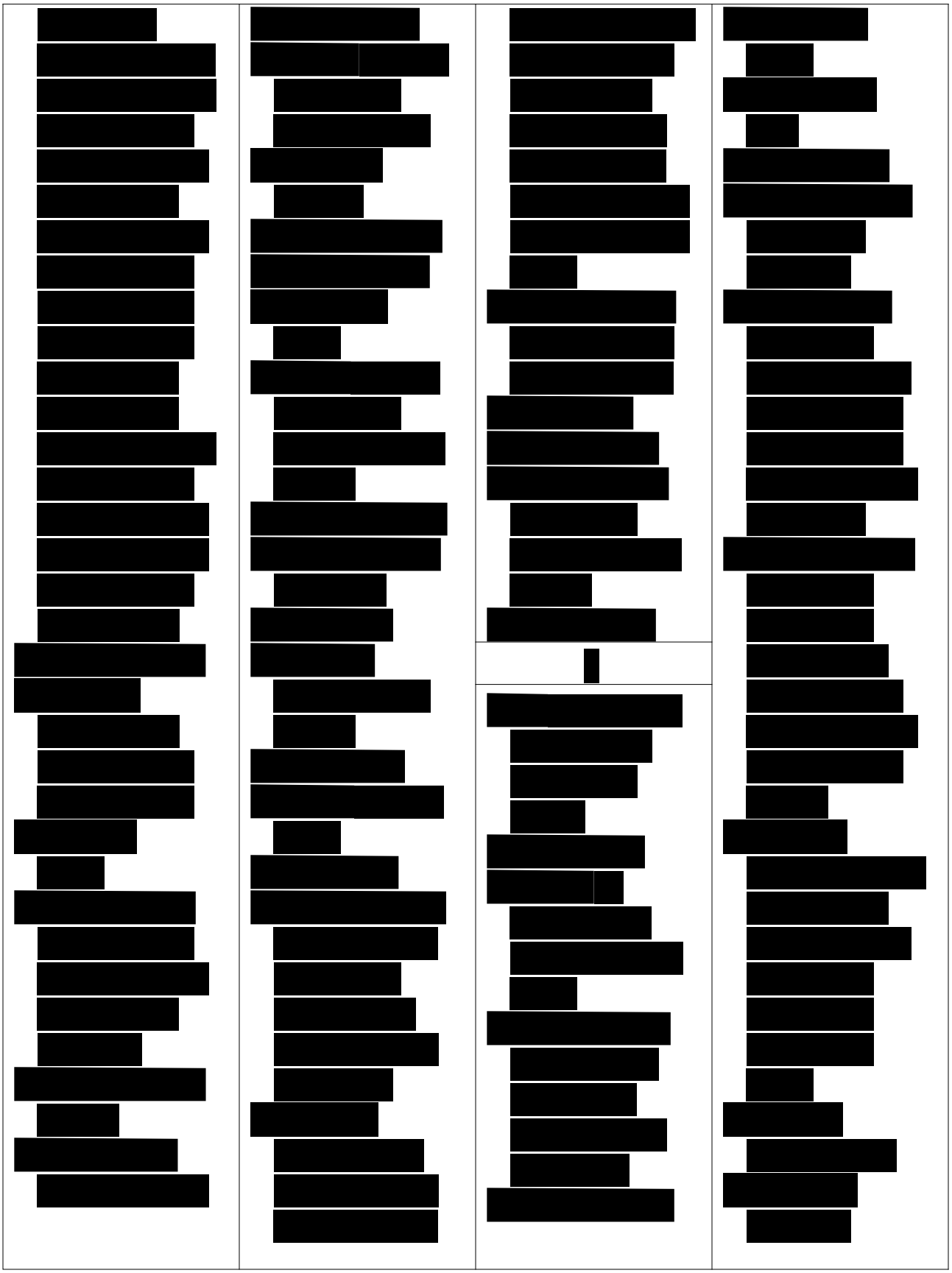
Pictiva EX2106
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IPR2024-01094

[fantastic - form]



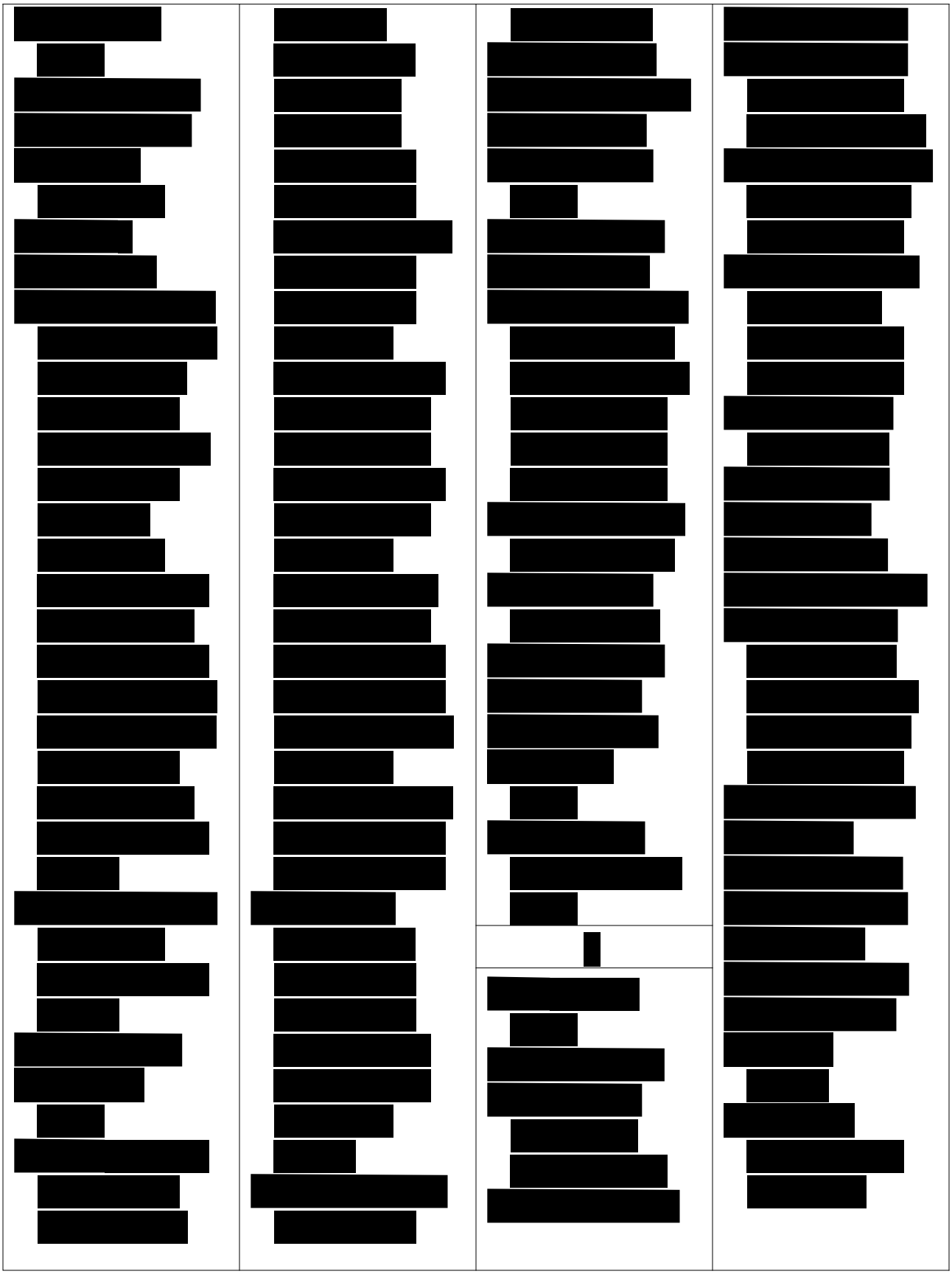
Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[form - generation]



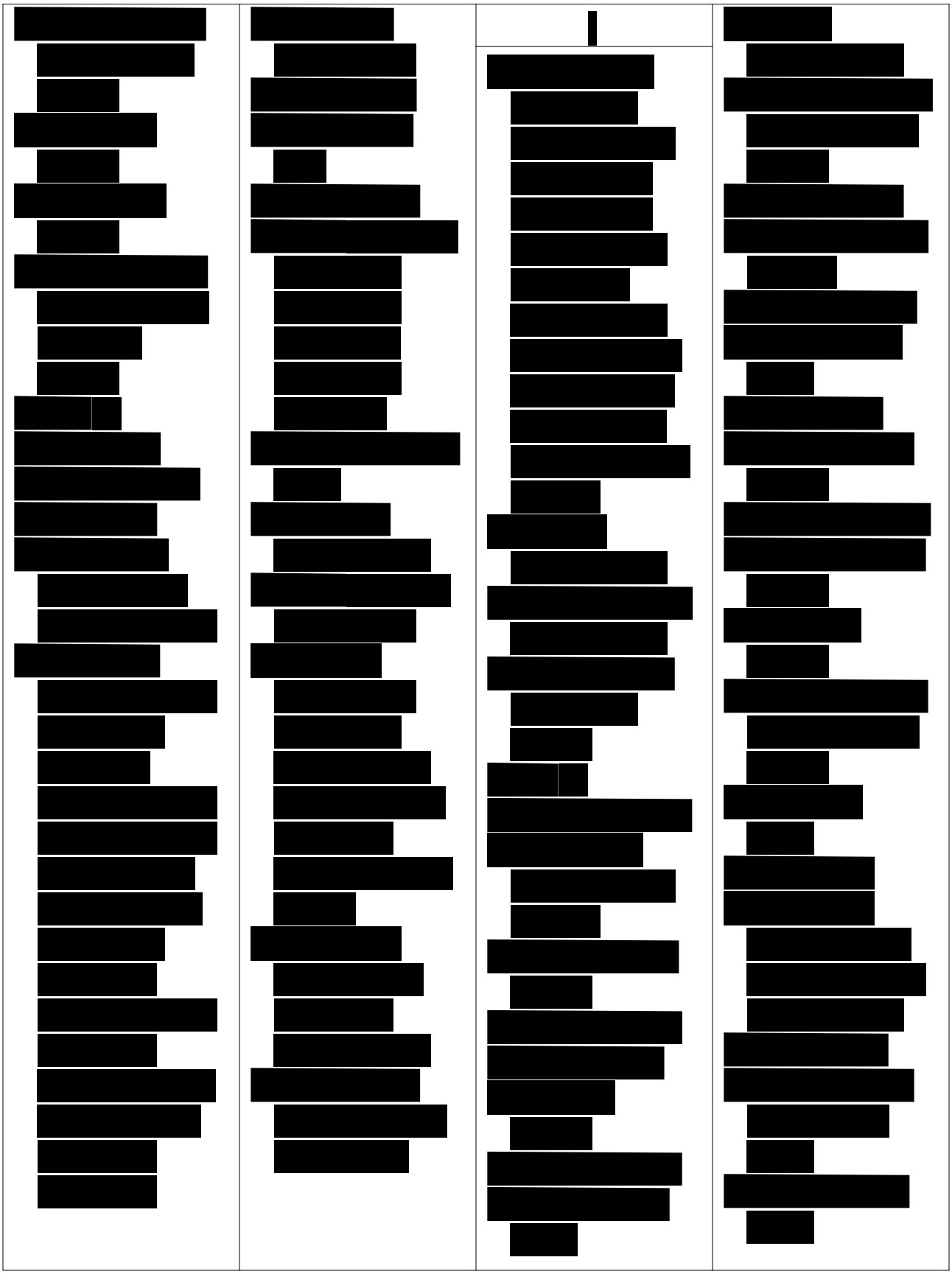
Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[geometrical - hexameric]



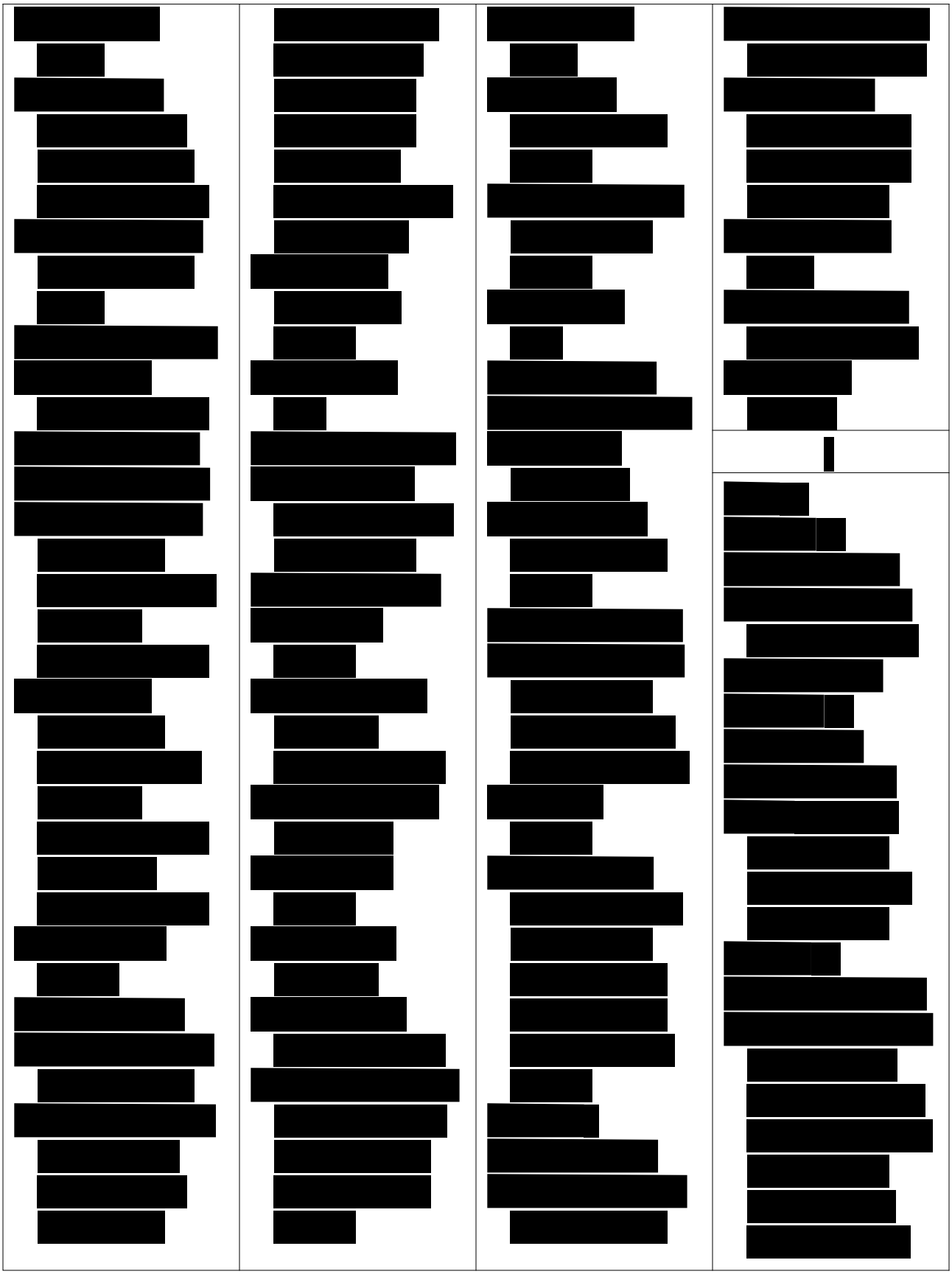
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Samsung v Pictiva
IPR2024-01094

[high - injection]



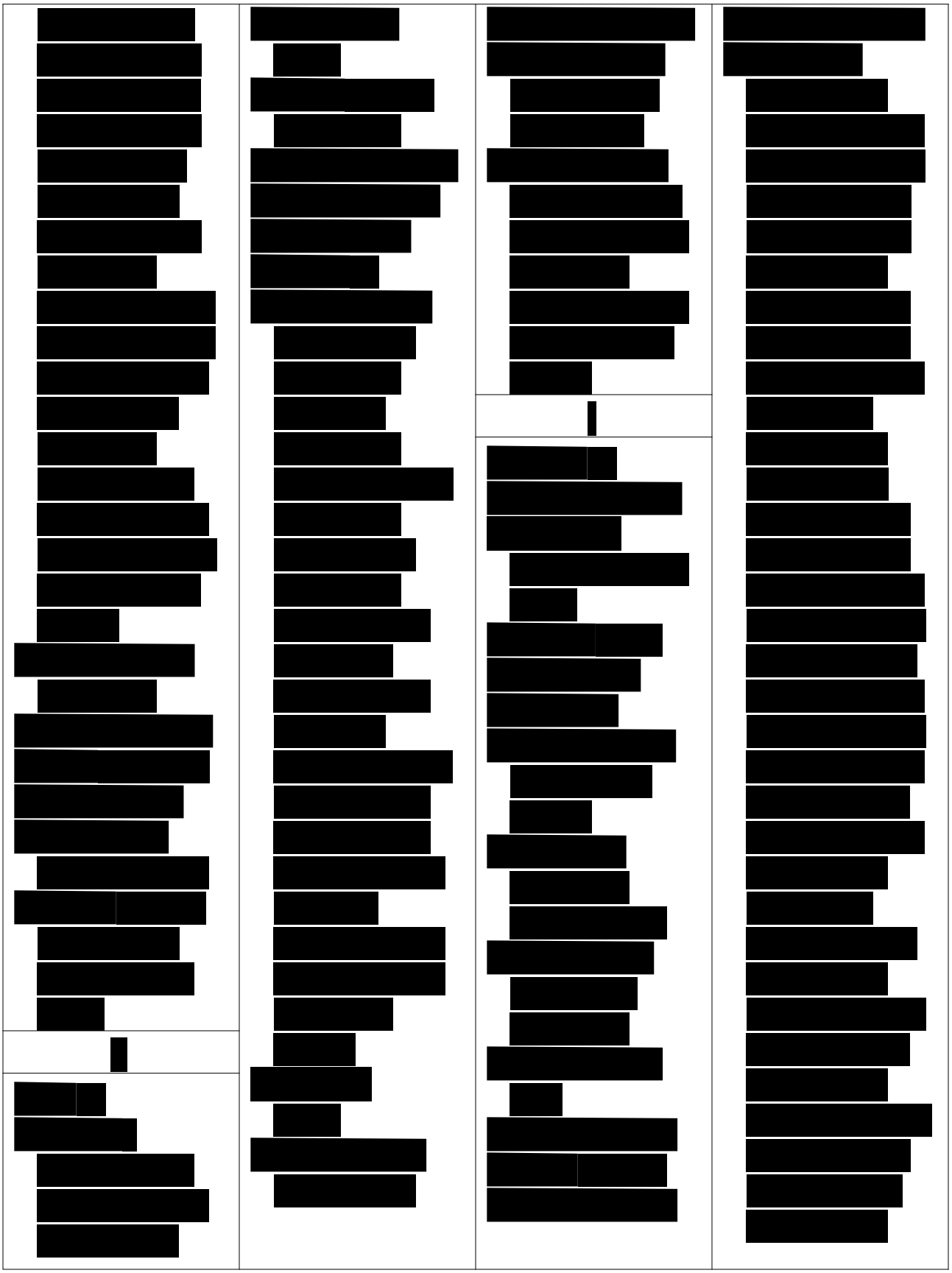
Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[innovations - joint]



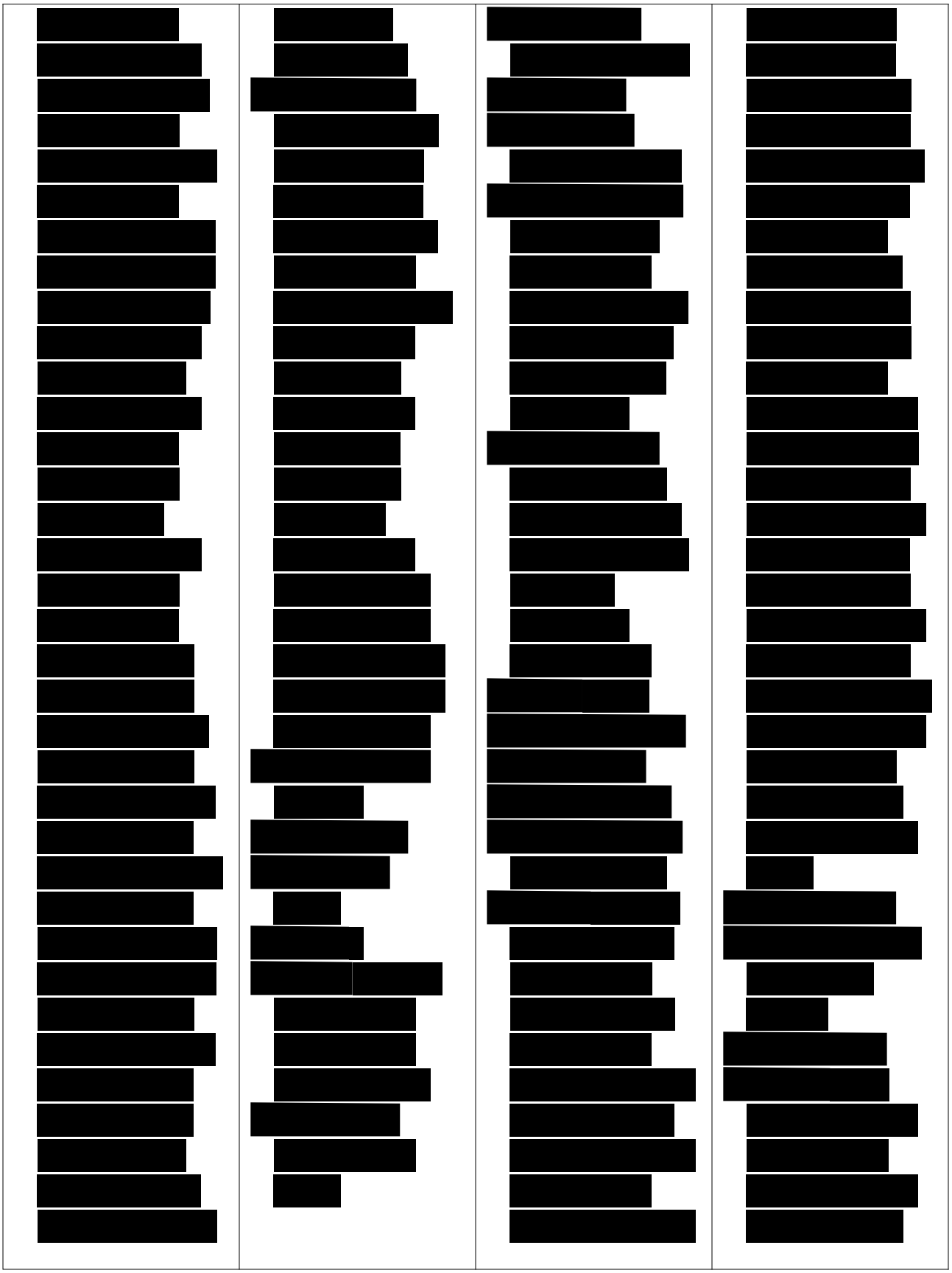
Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[joint - layer]



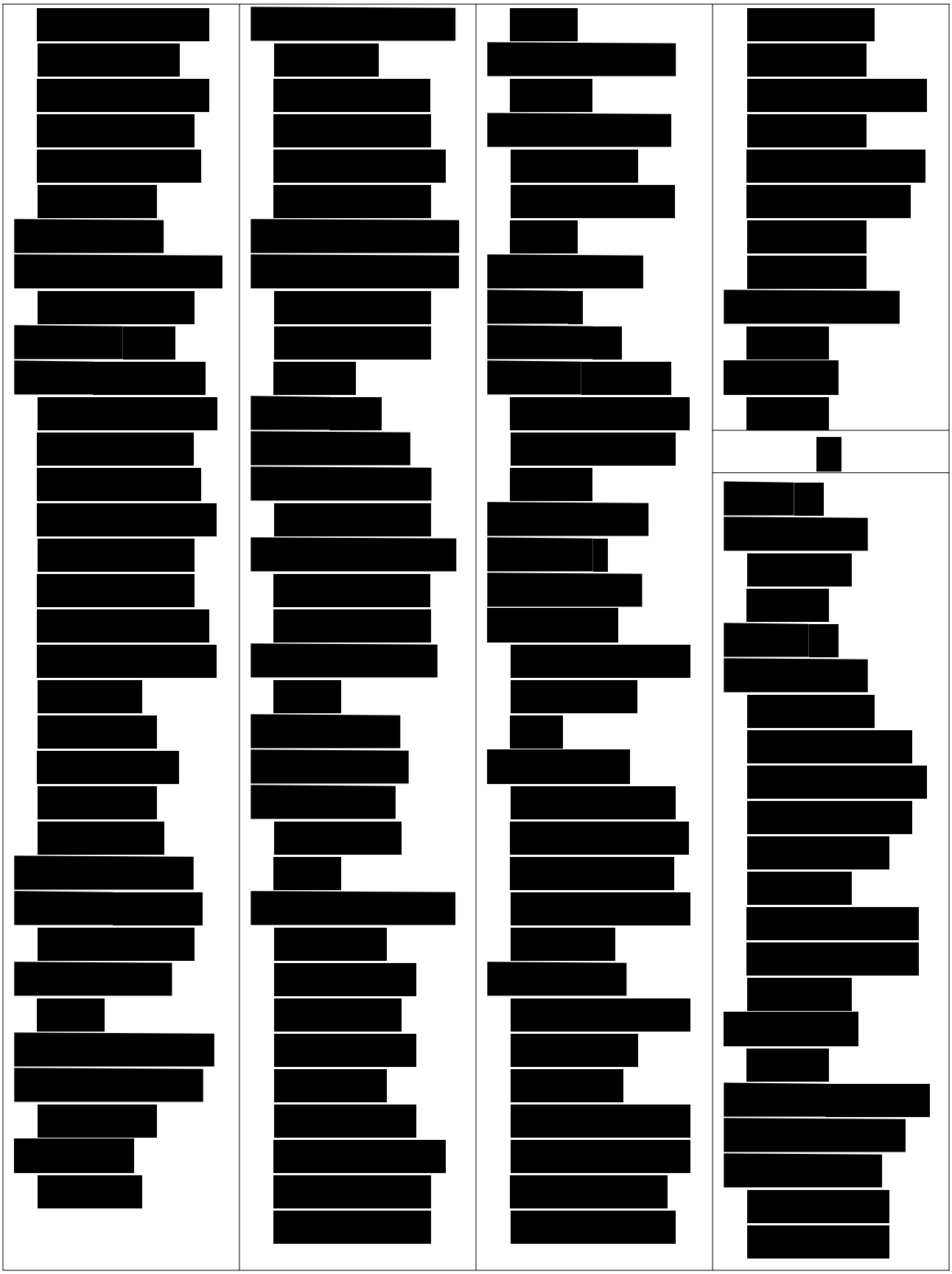
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Samsung v Pictiva
IPR2024-01094

[layer - line]



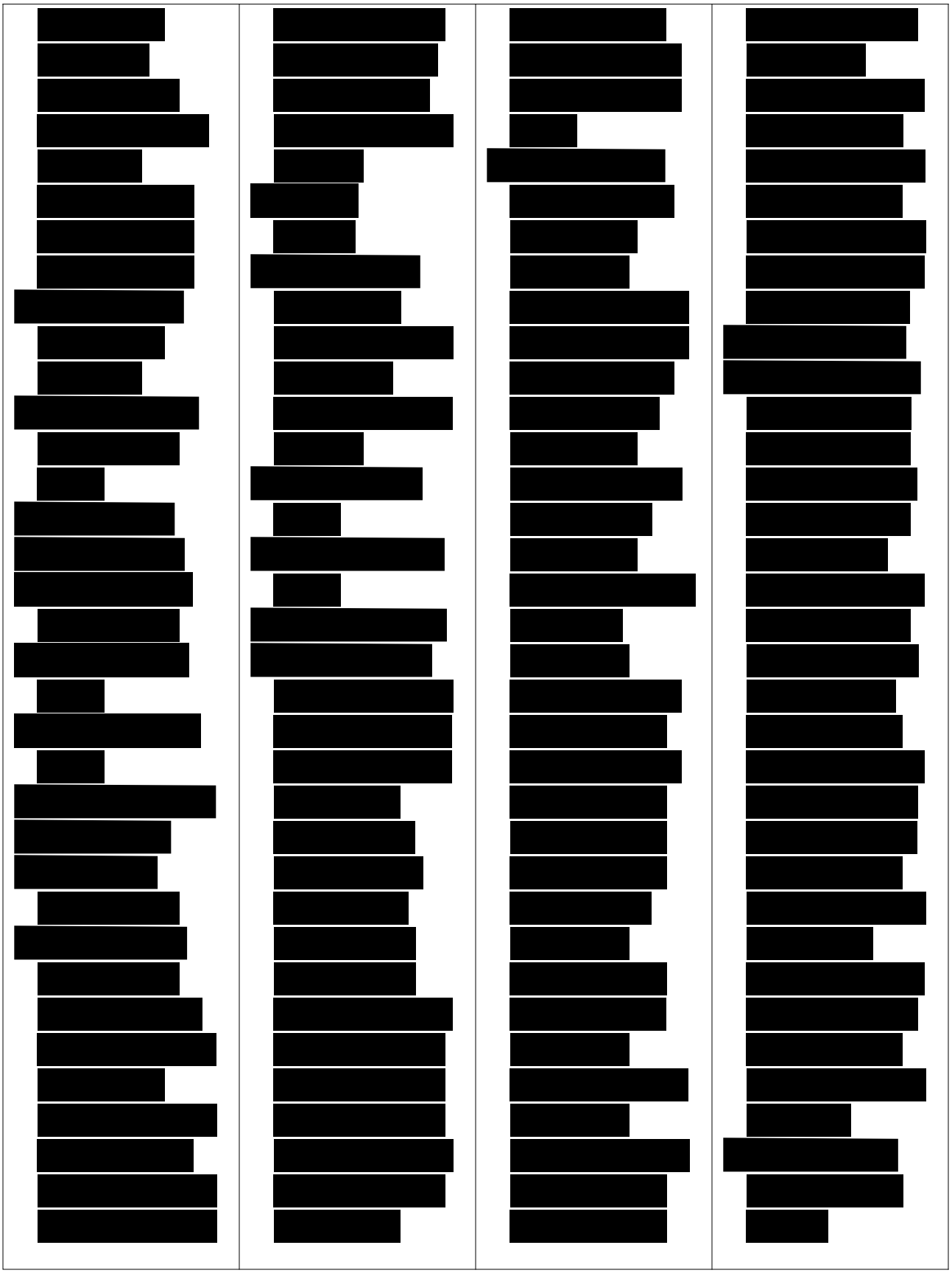
Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[line - make]



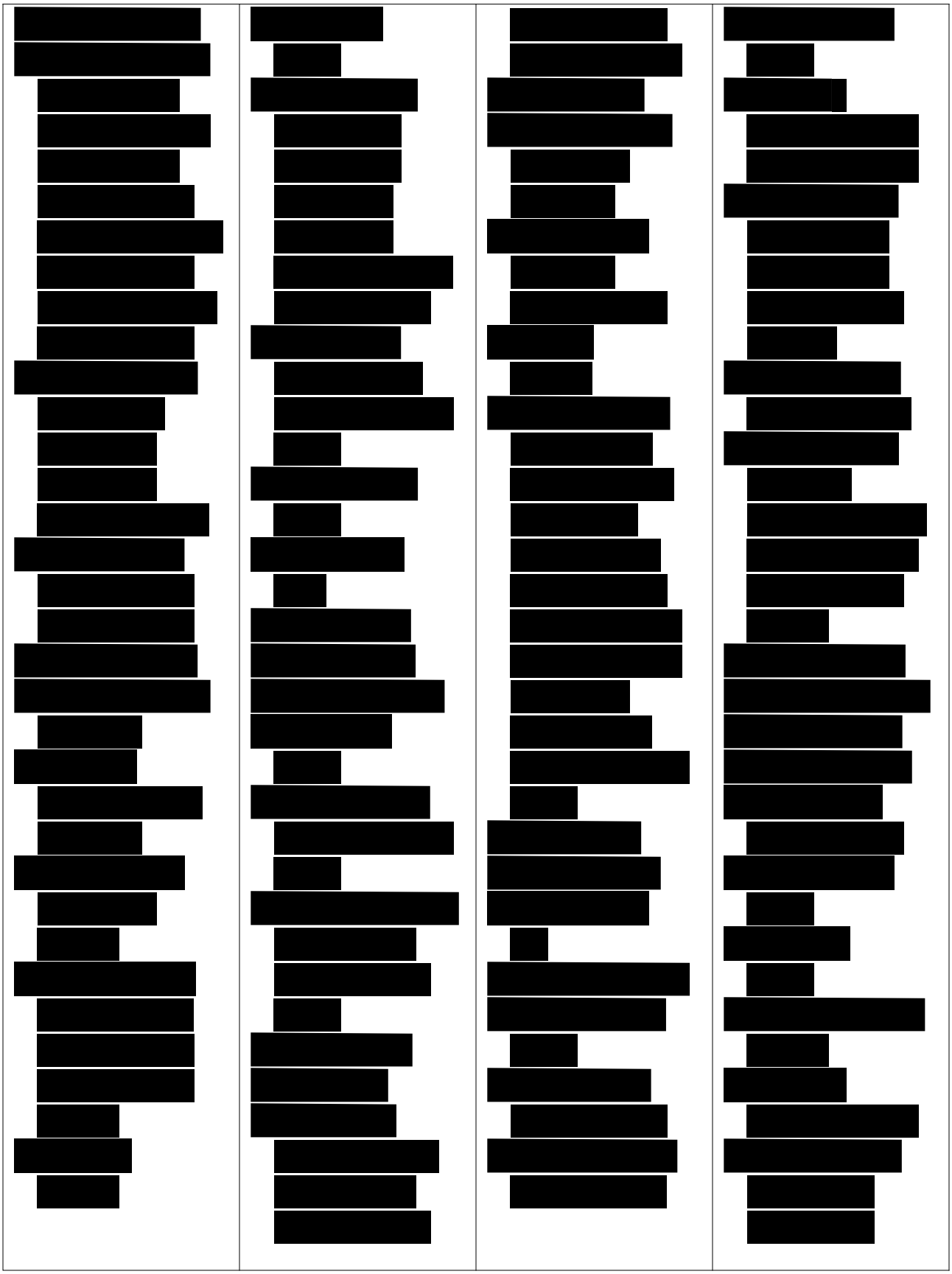
Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[make - matter]



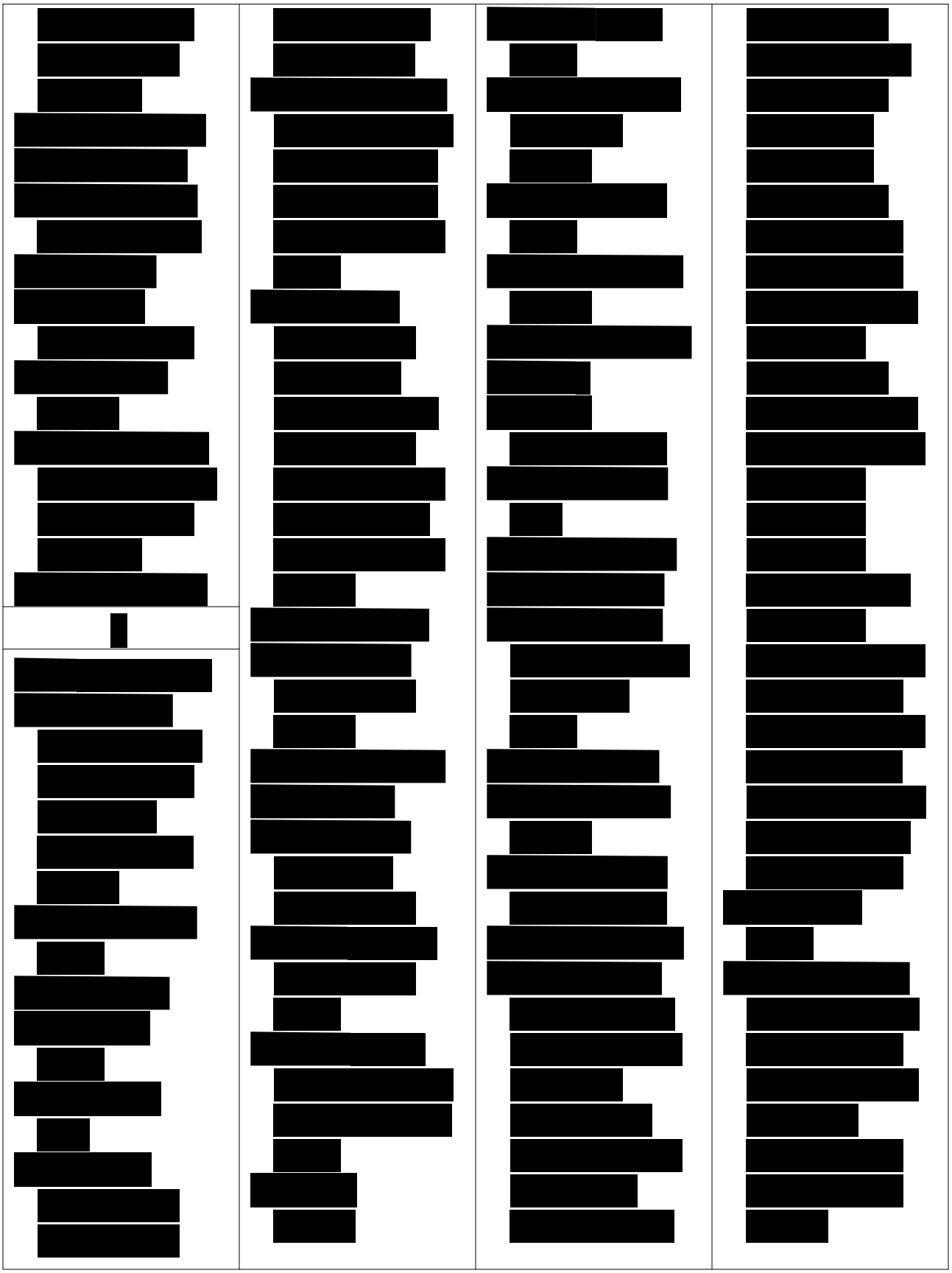
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Samsung v Pictiva
IPR2024-01094

[matters - moment]



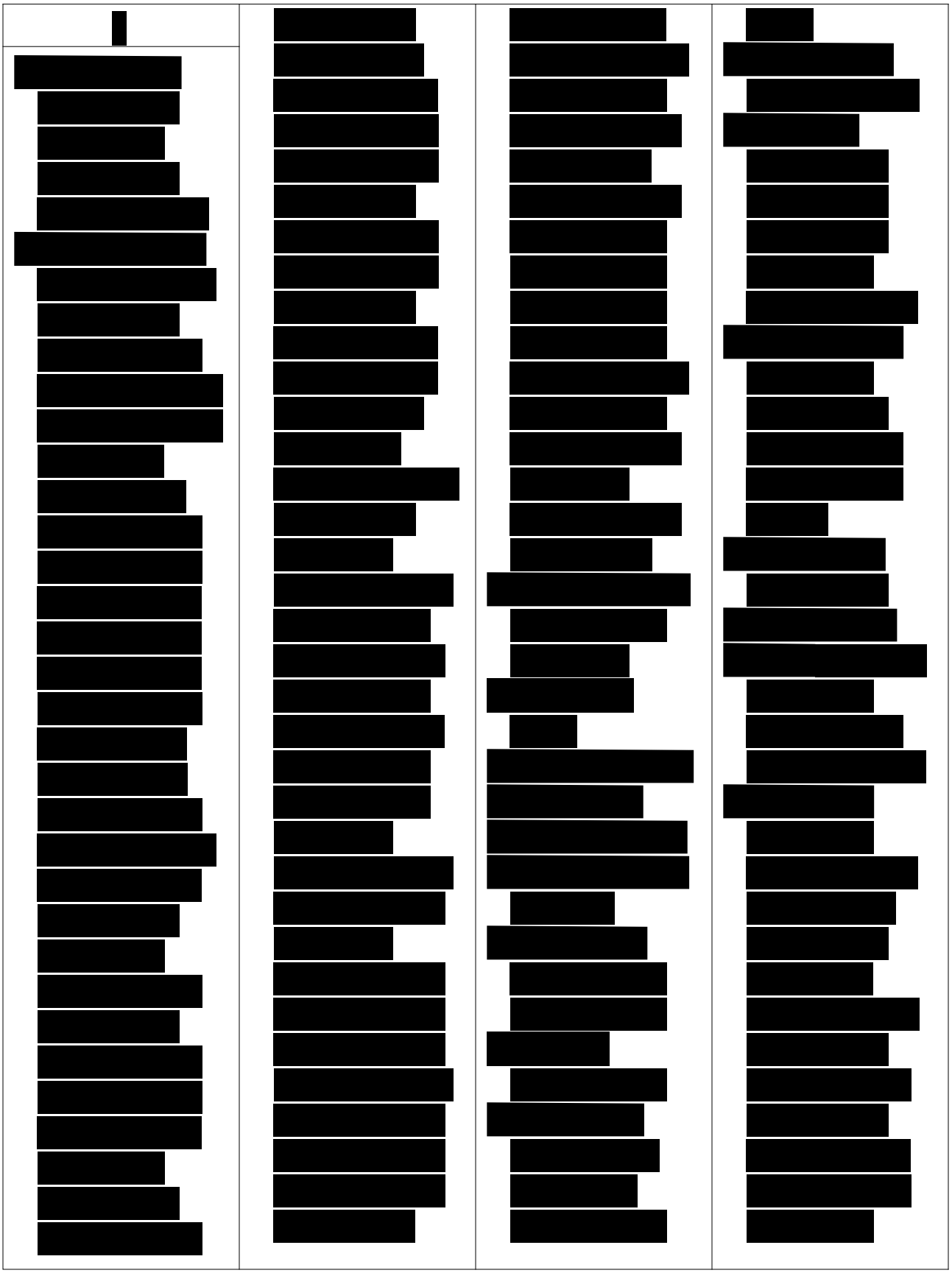
Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[moment - numbers]



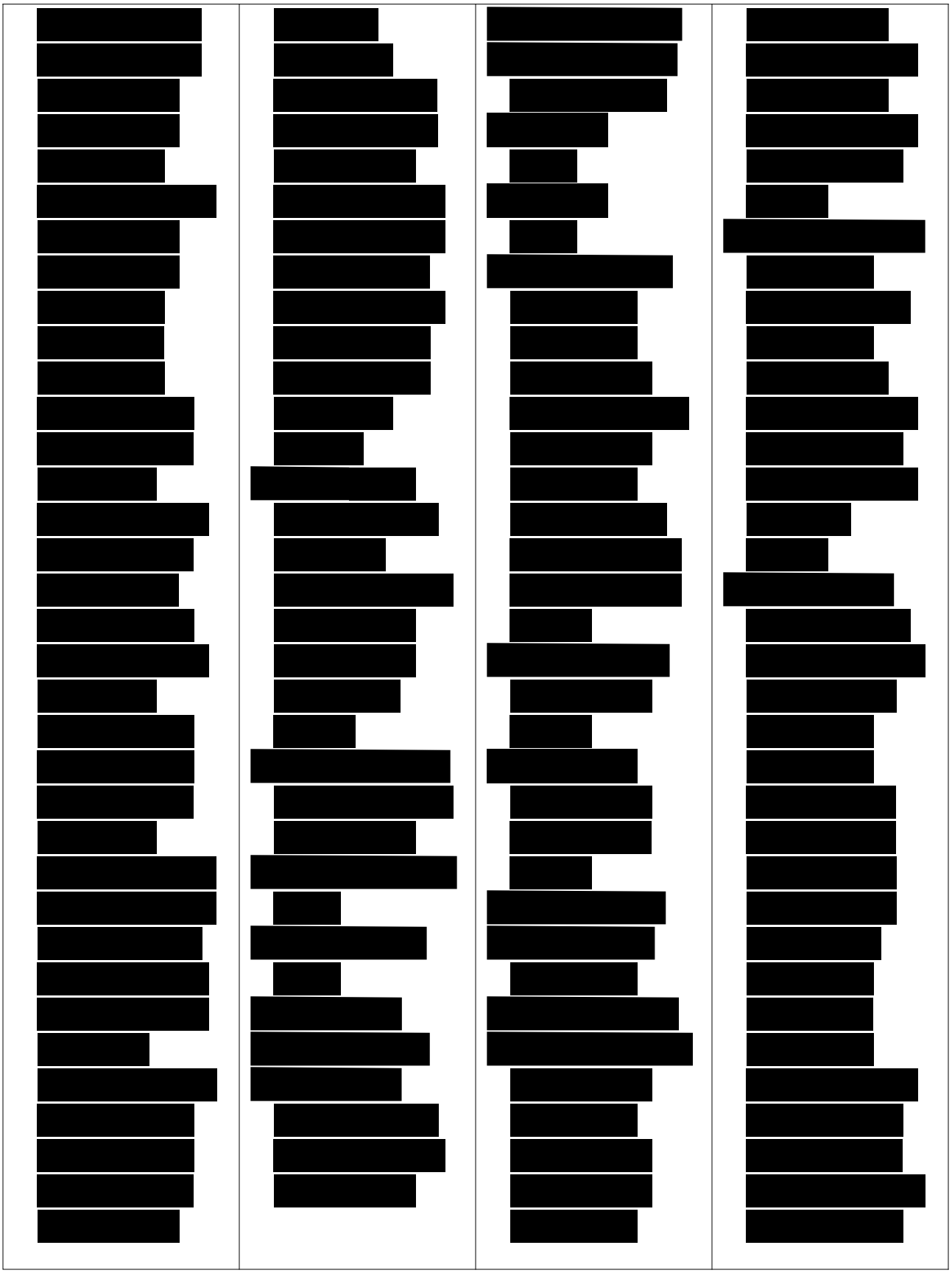
Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[object - okay]



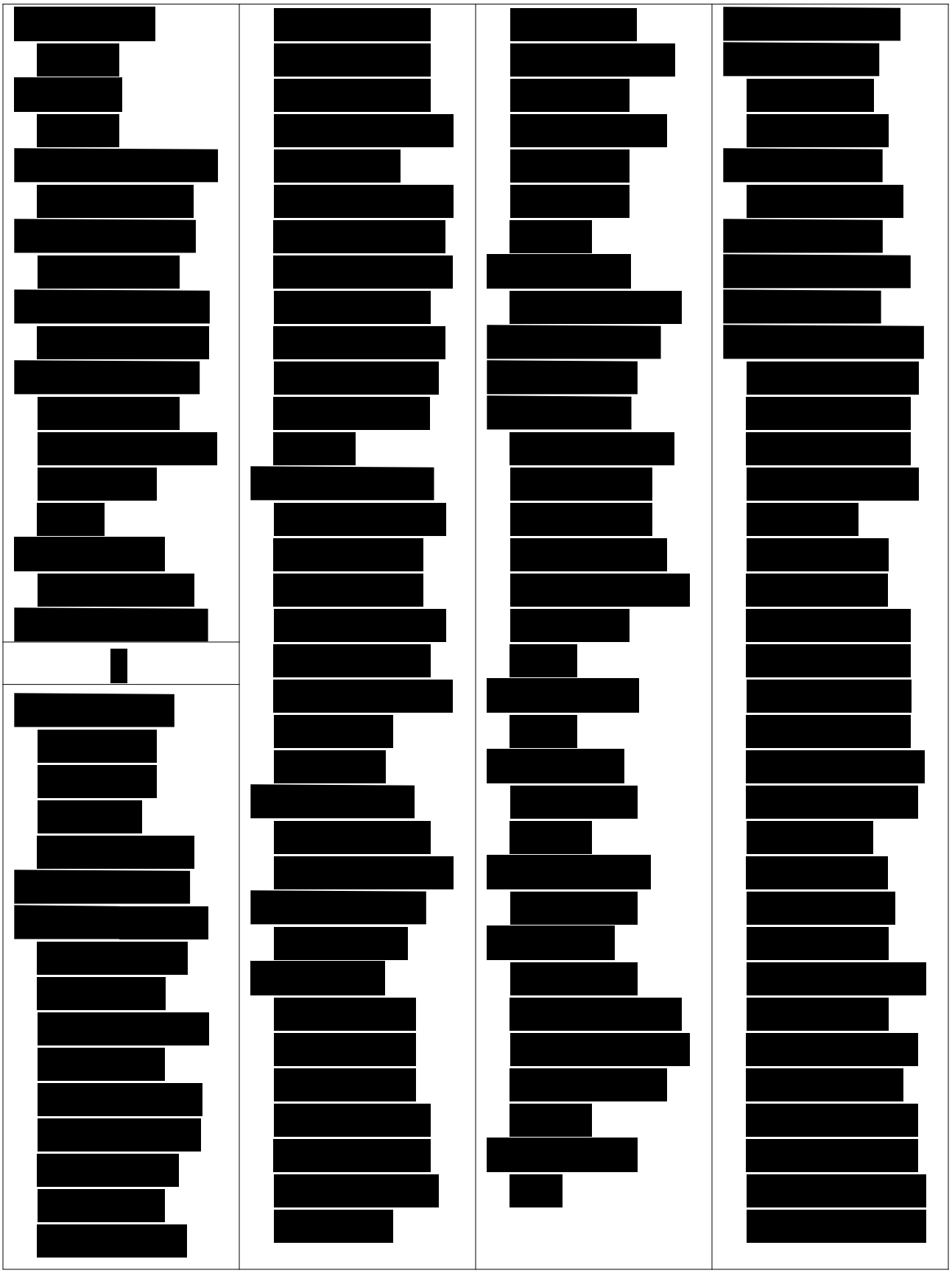
Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[okay - organic]



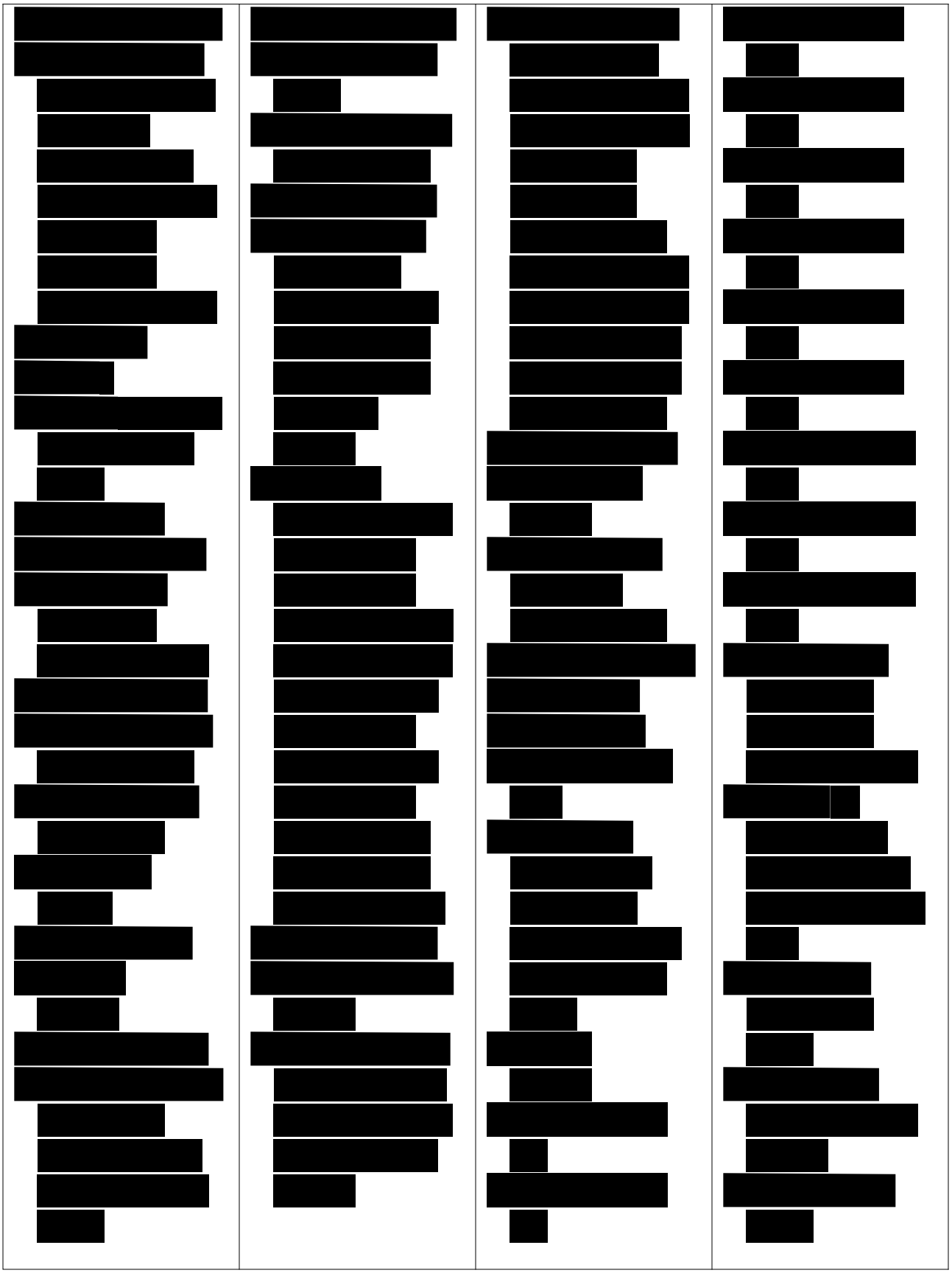
Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[organically - patent]



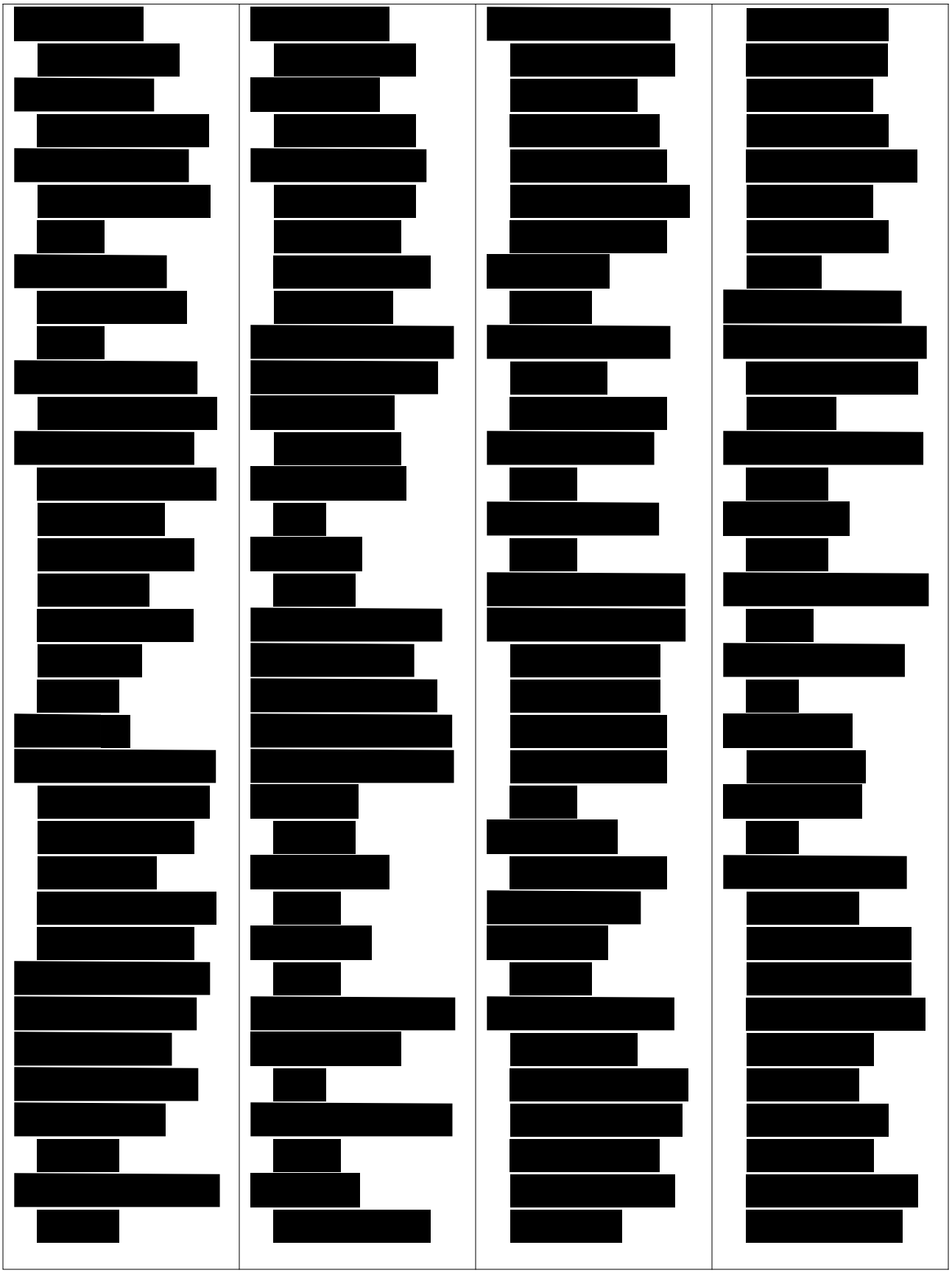
Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[patentese - placed]



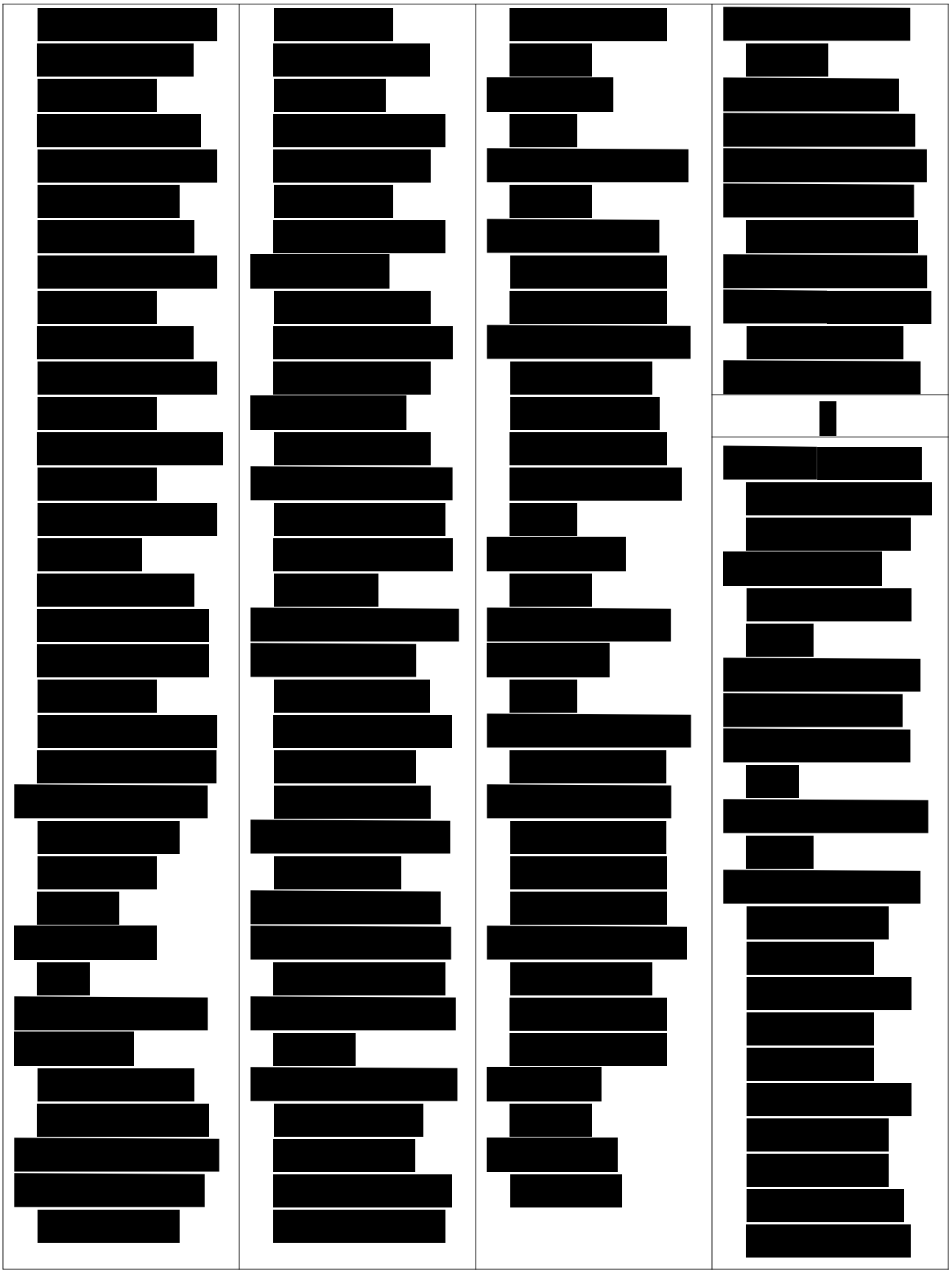
Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[placement - process]



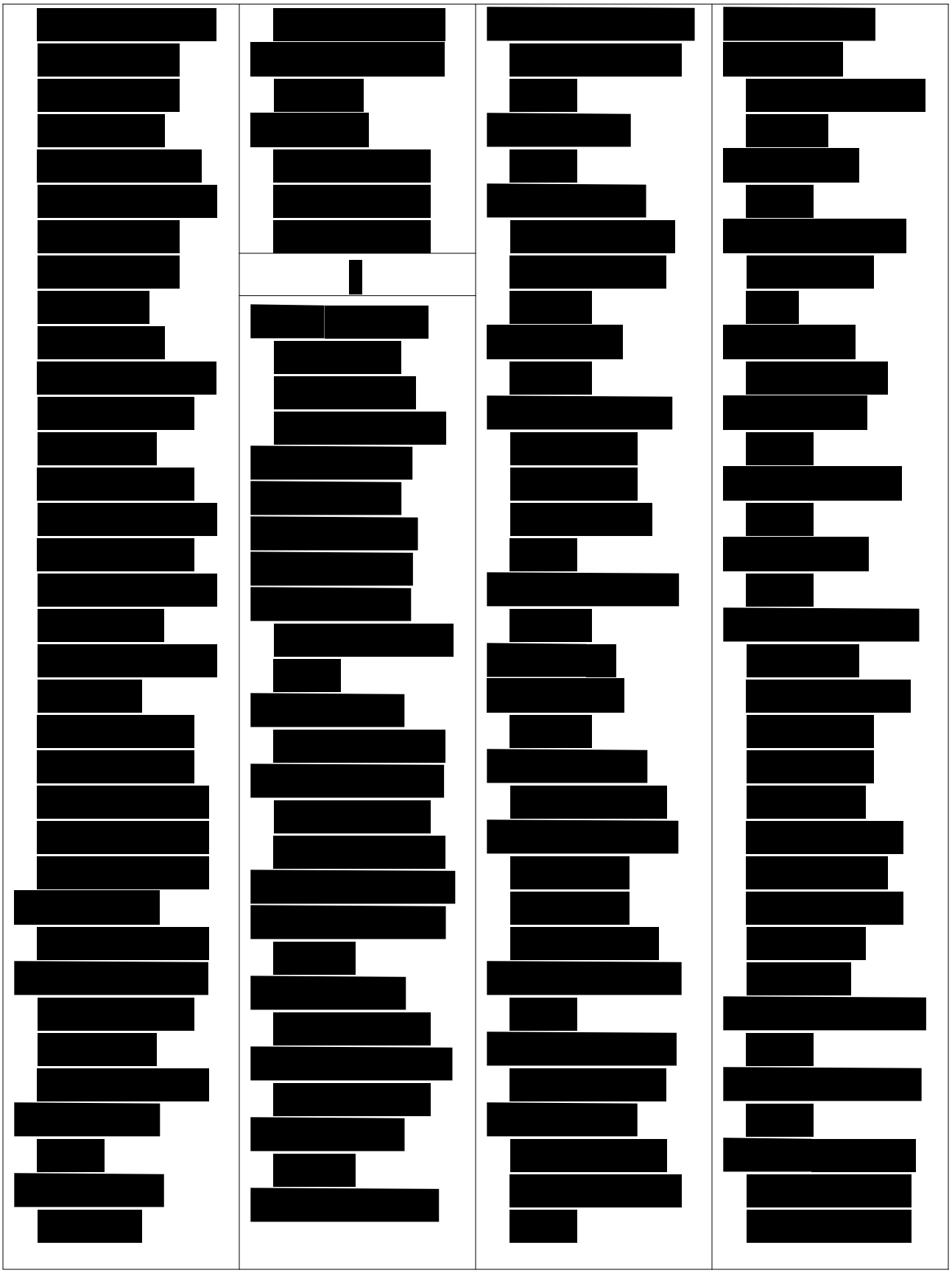
Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[process - question]



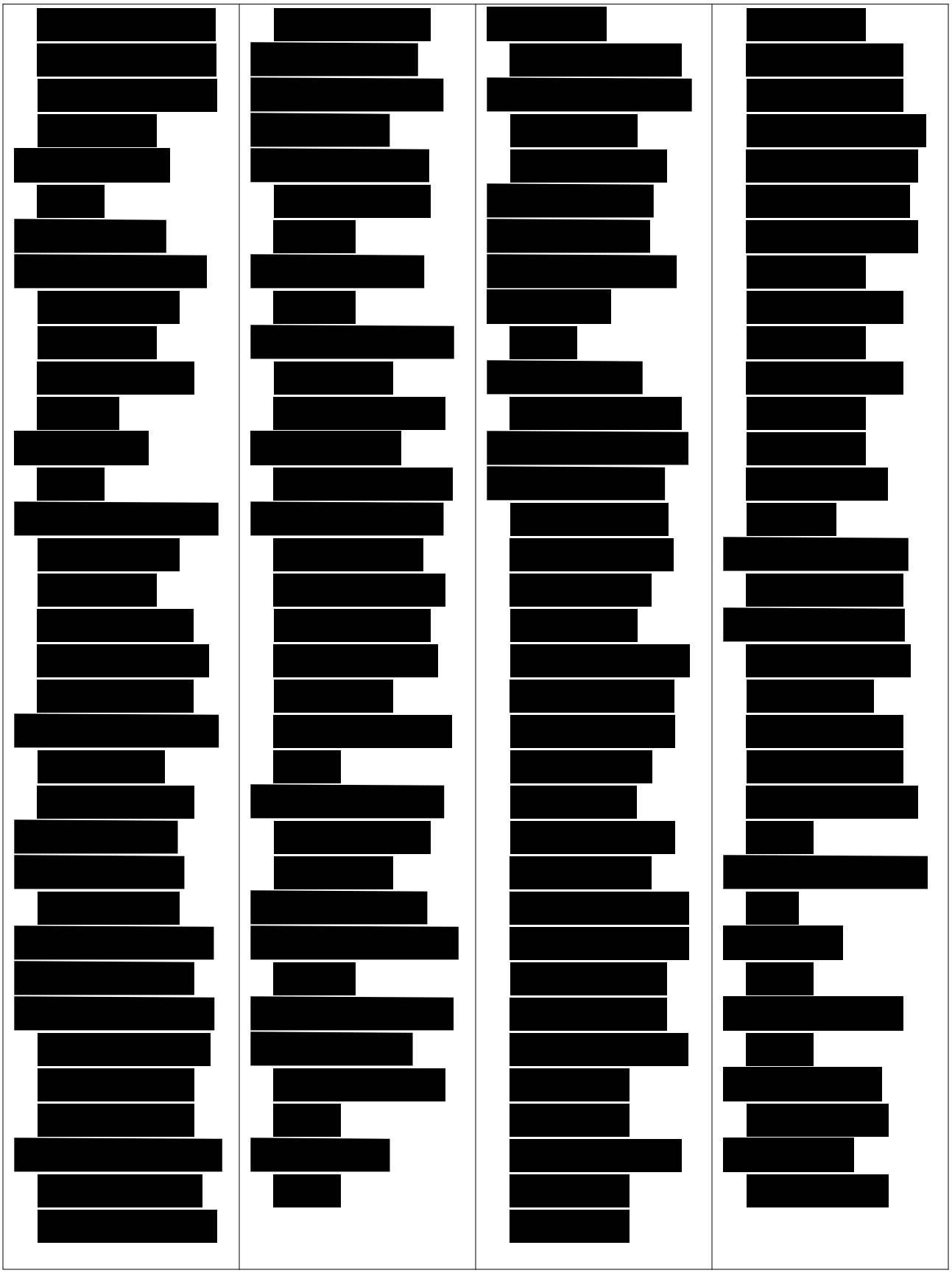
Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[question - red]



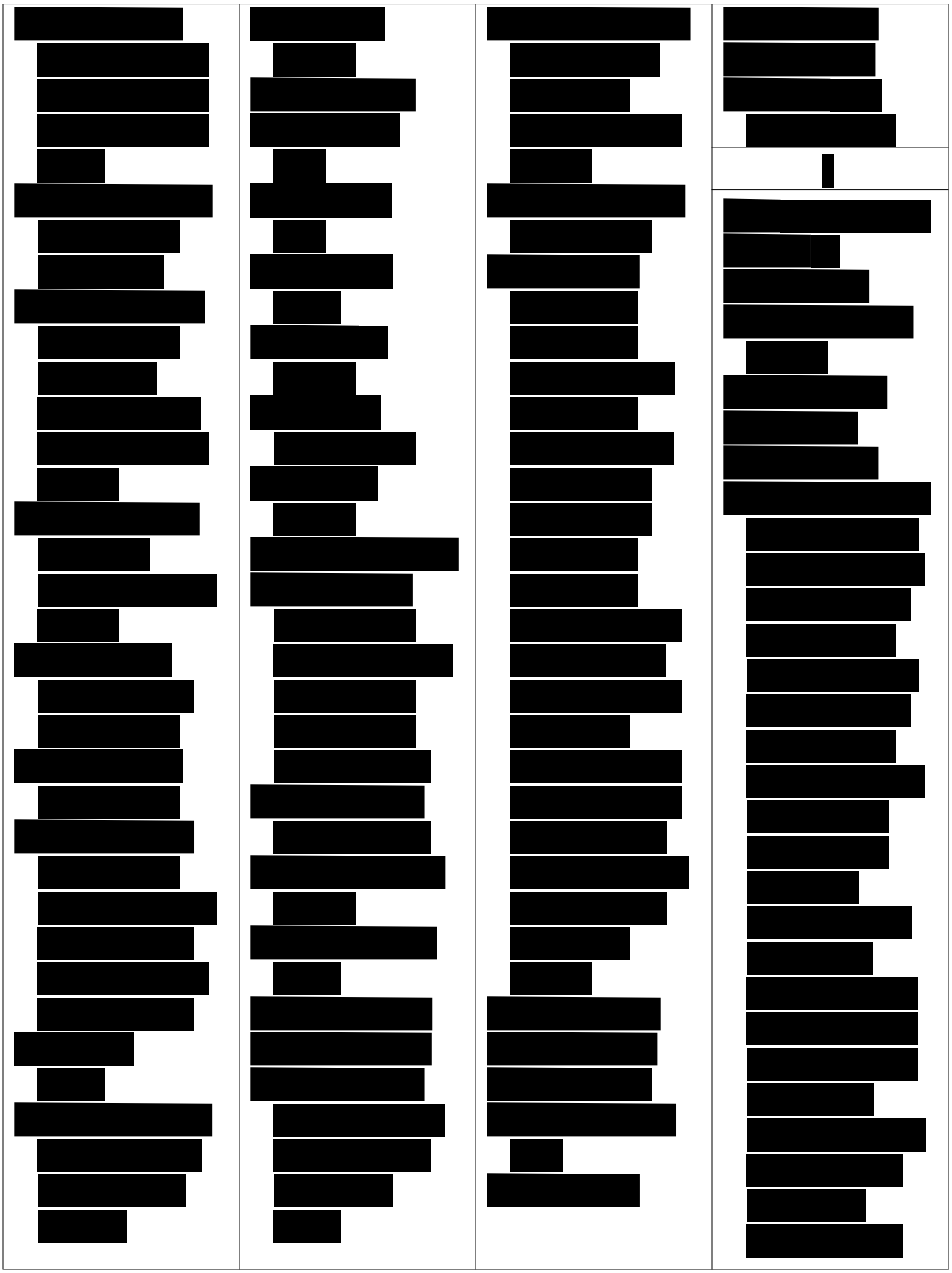
Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[red - represents]



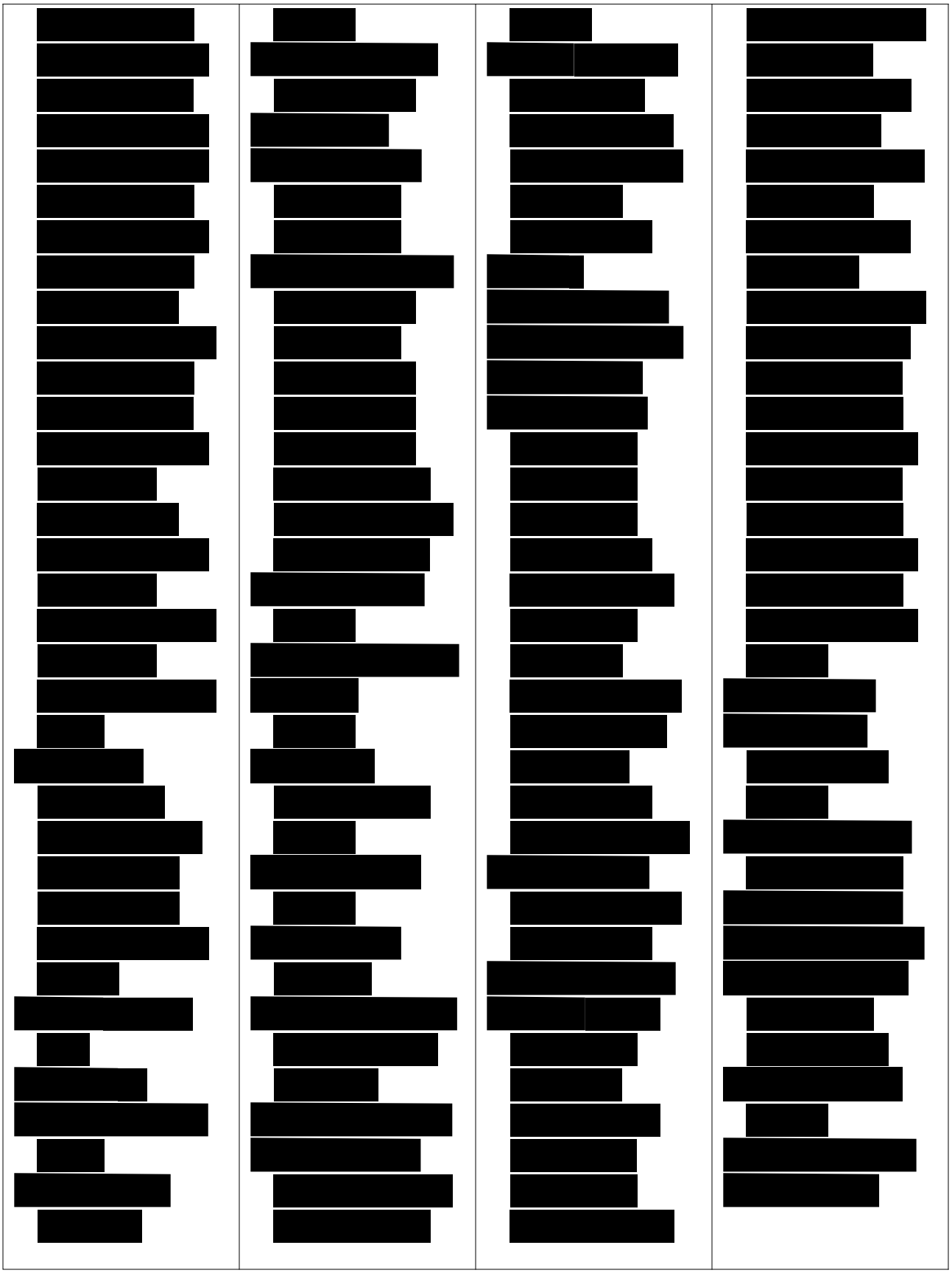
Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[request - samsung]



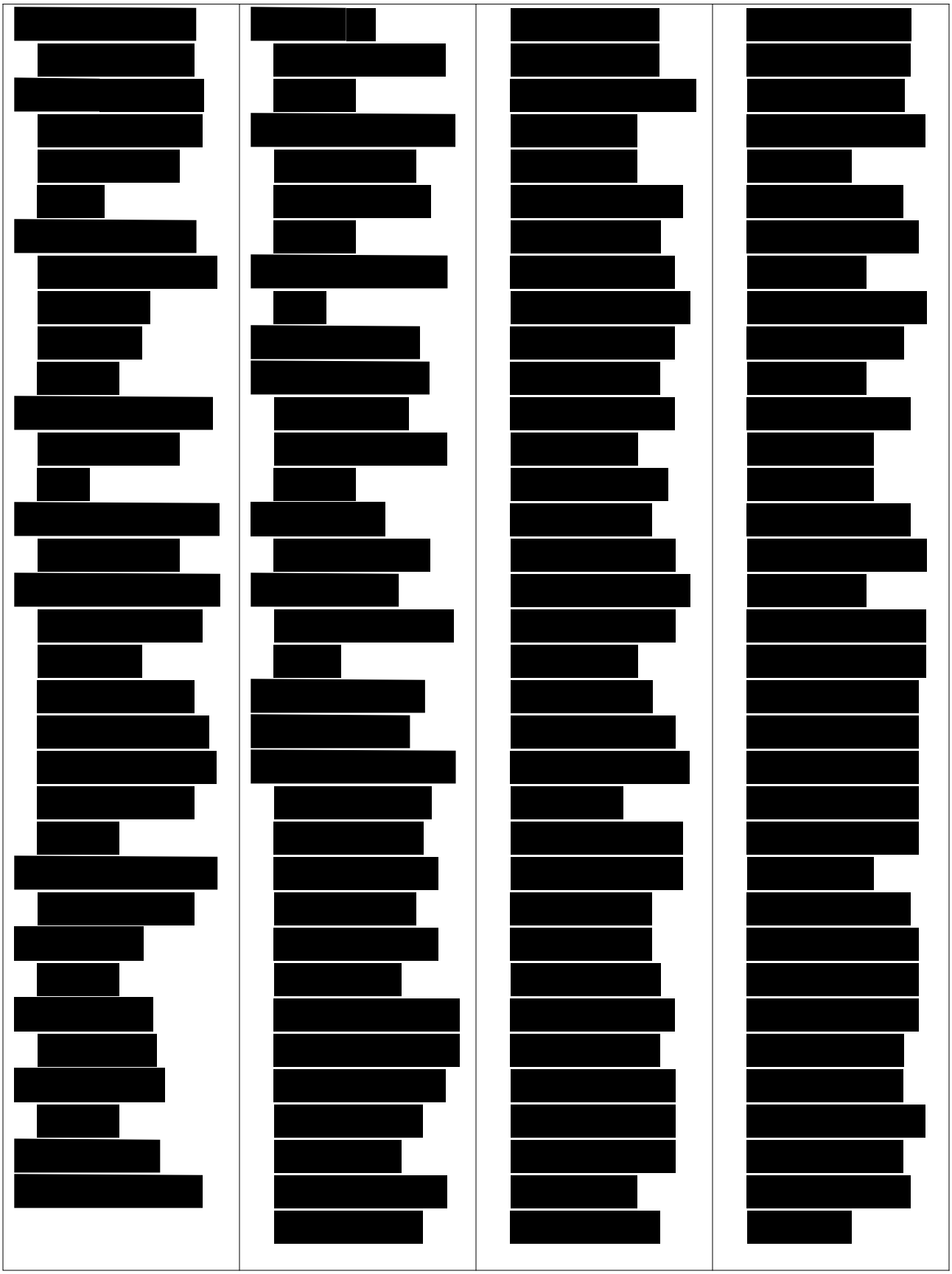
Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[samsung - sent]



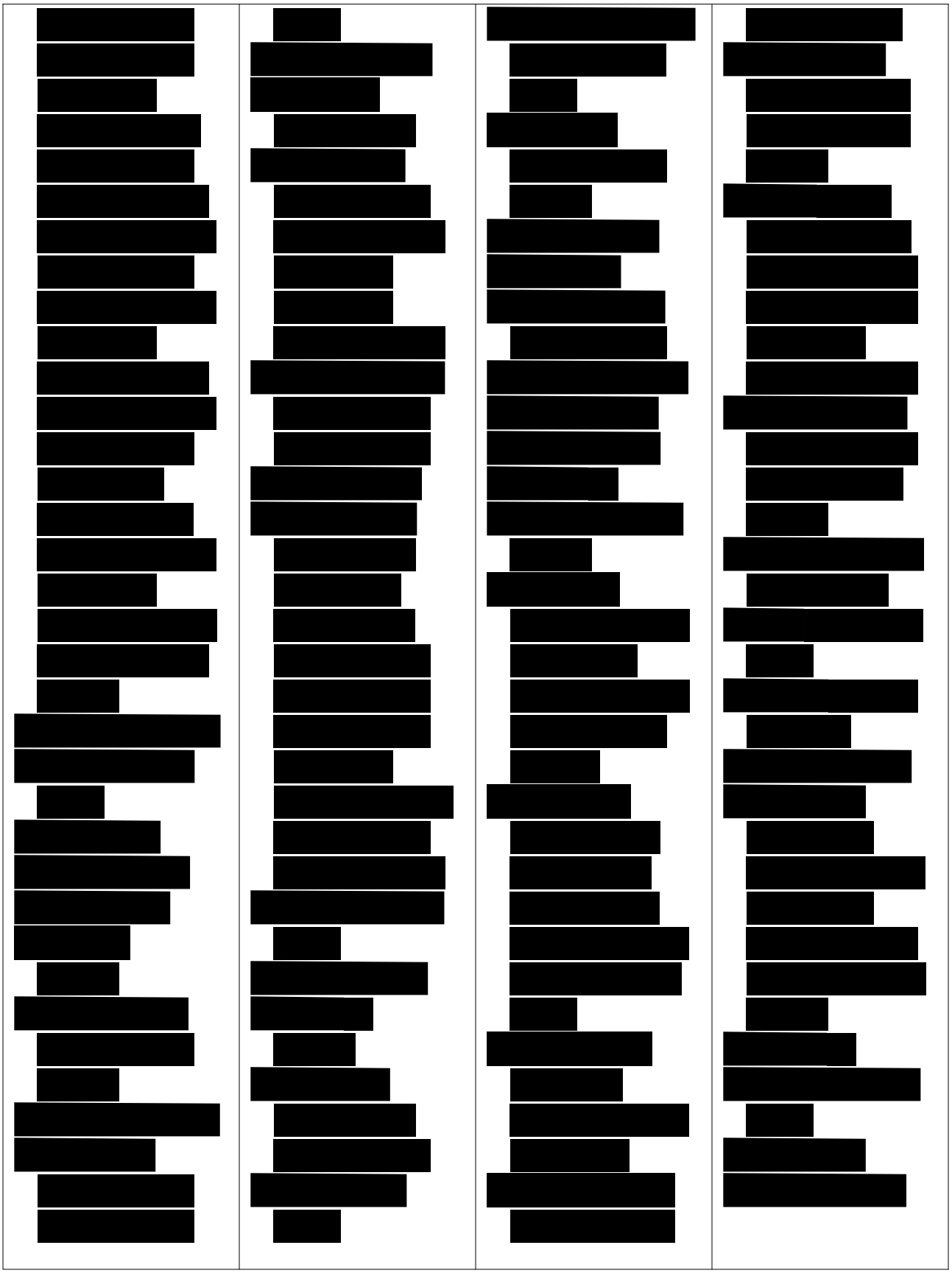
Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[sentence - sheasby]



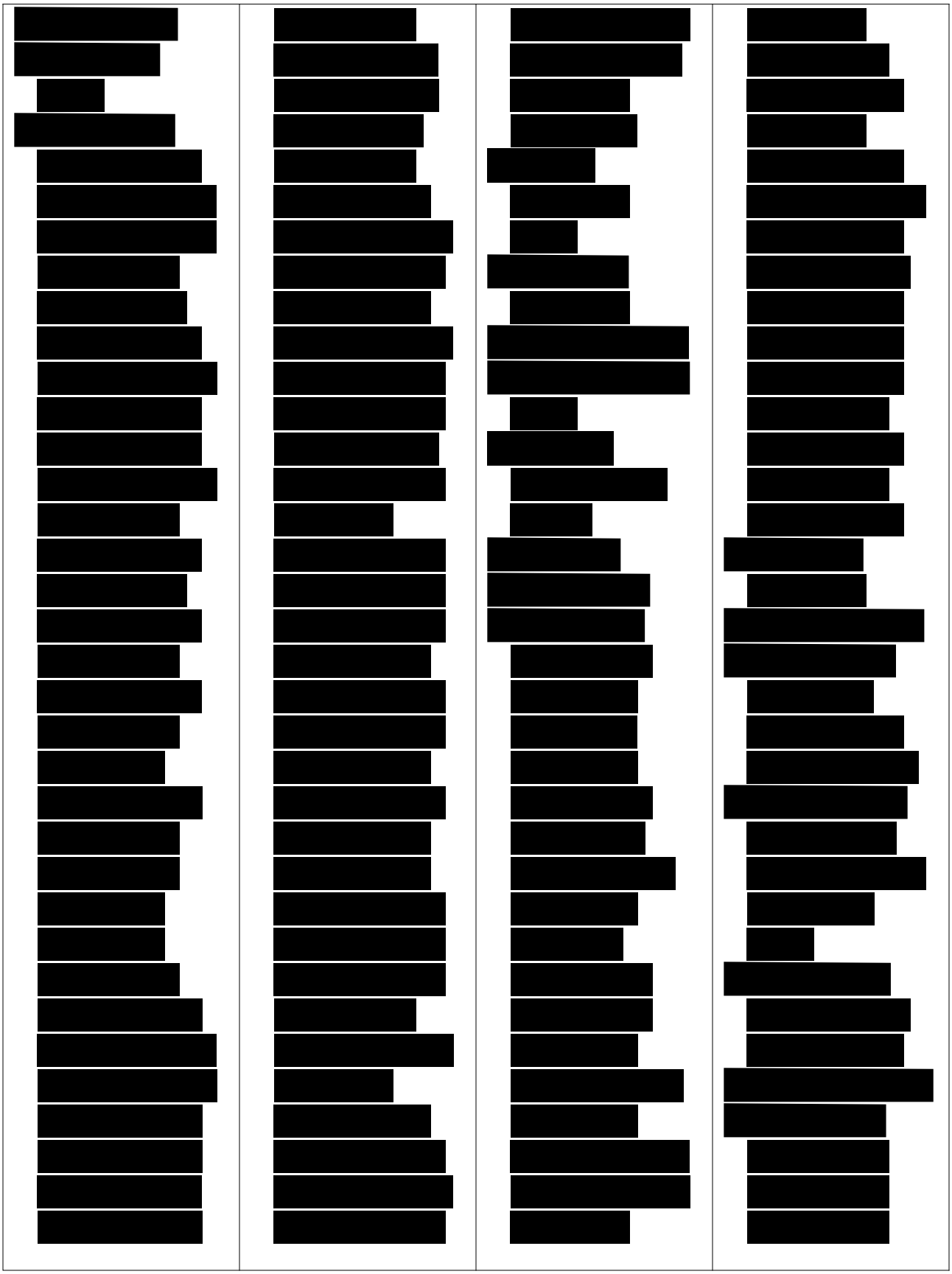
Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[sheasby - smaller]



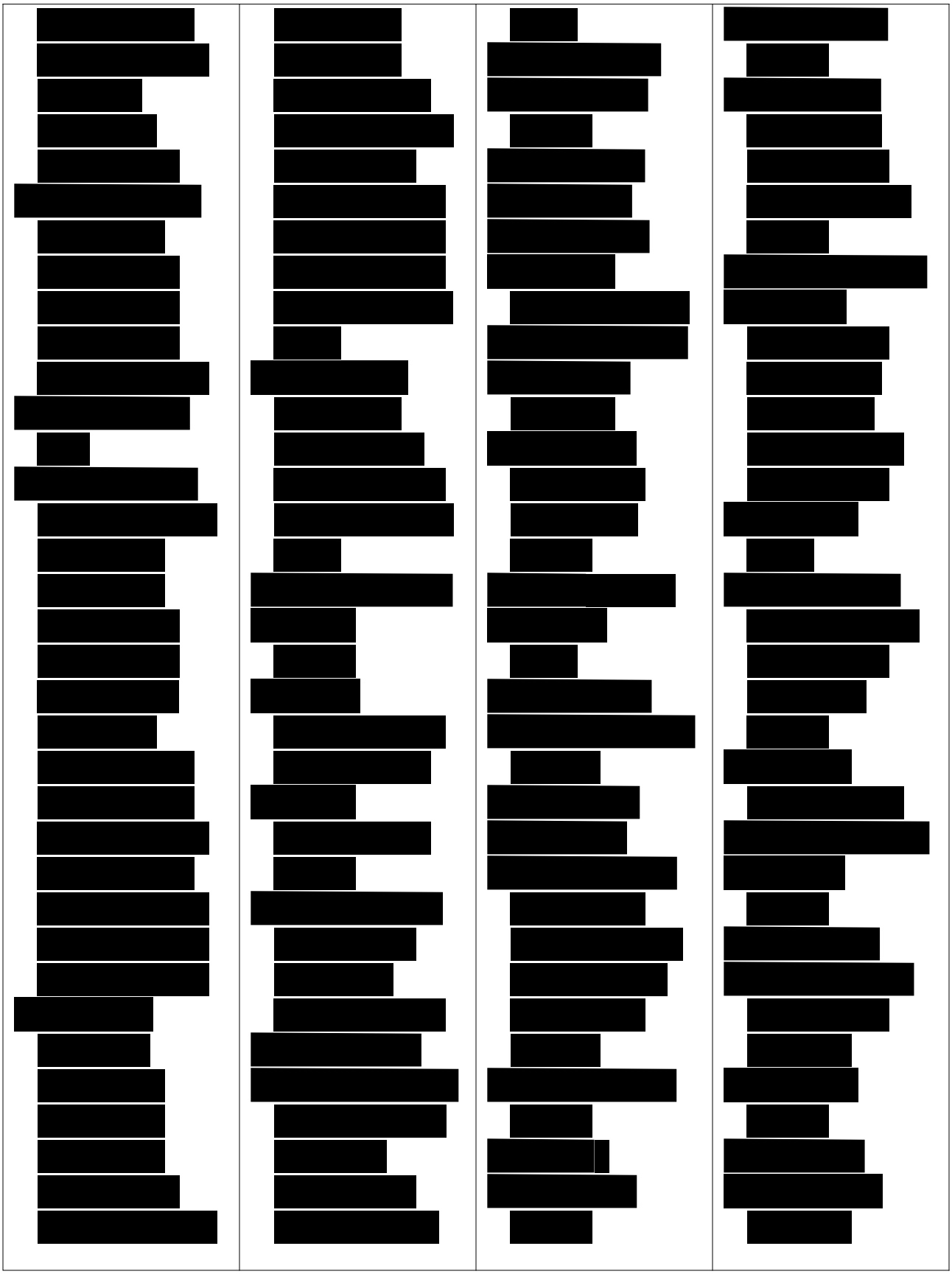
Pictiva EX2106
Samsung v Pictiva
IPR2024-01094

[smart - speak]



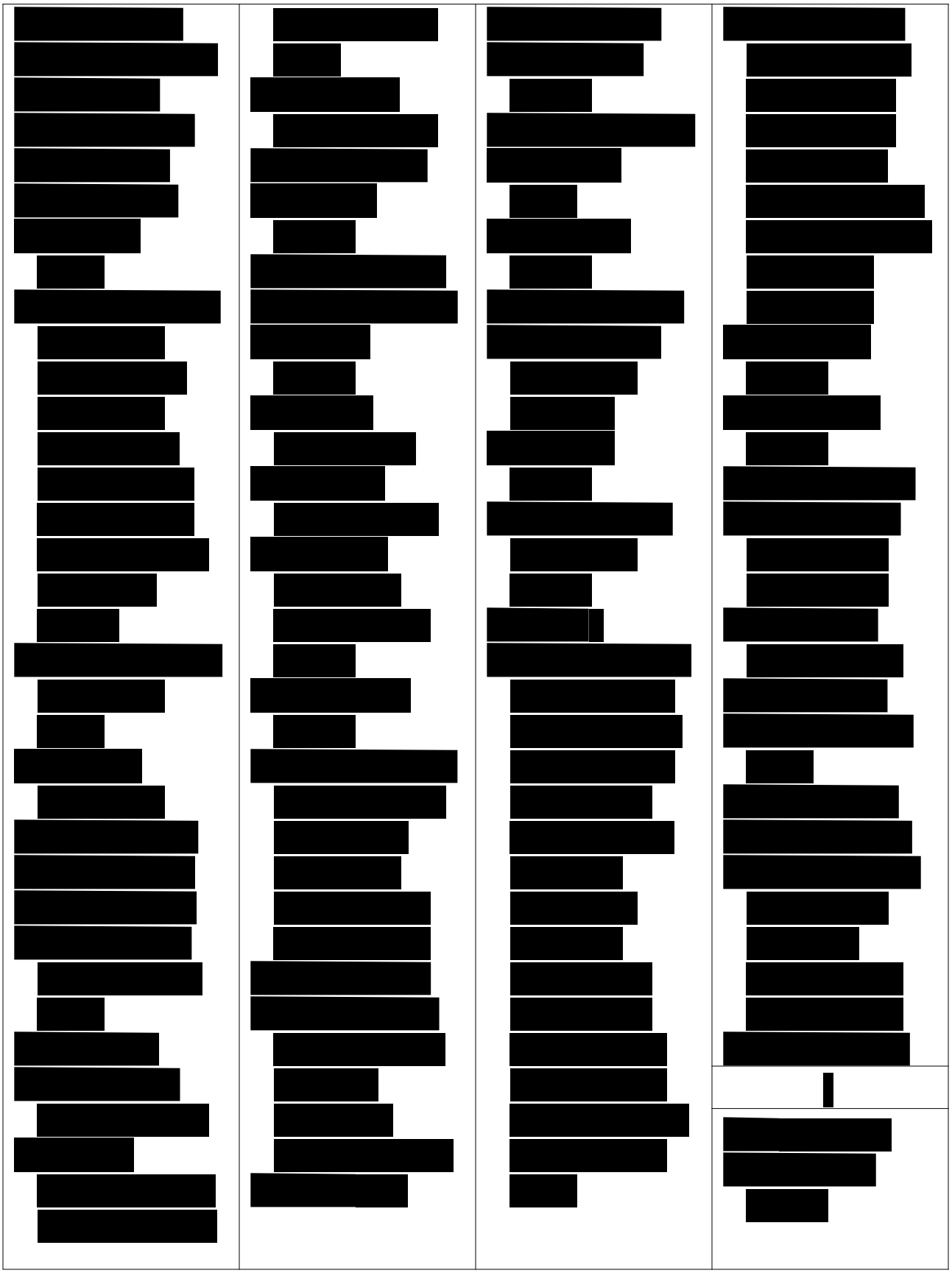
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Samsung v Pictiva
IPR2024-01094

[speak - stockholders]



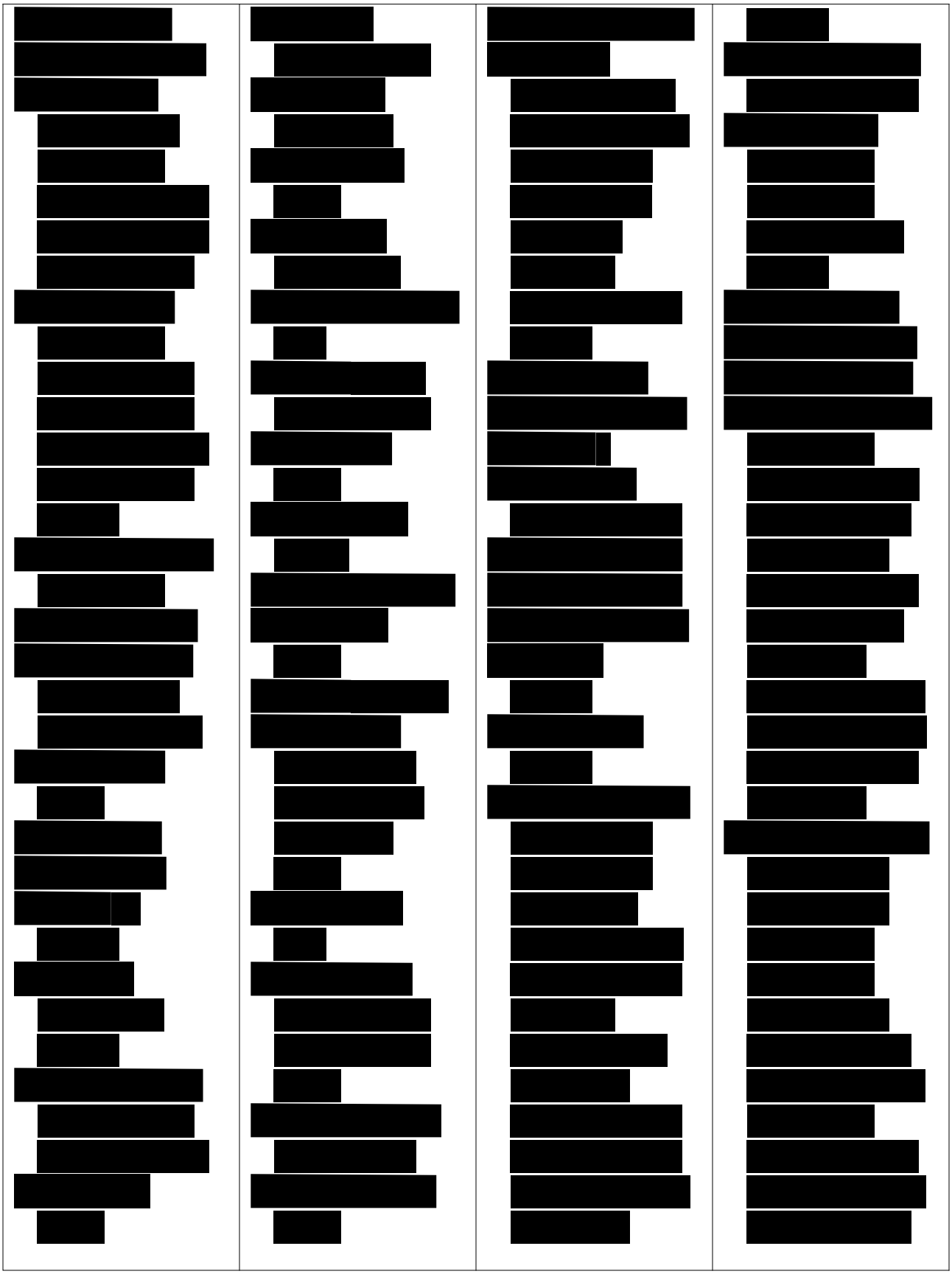
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Samsung v Pictiva
IPR2024-01094

[stored - table]



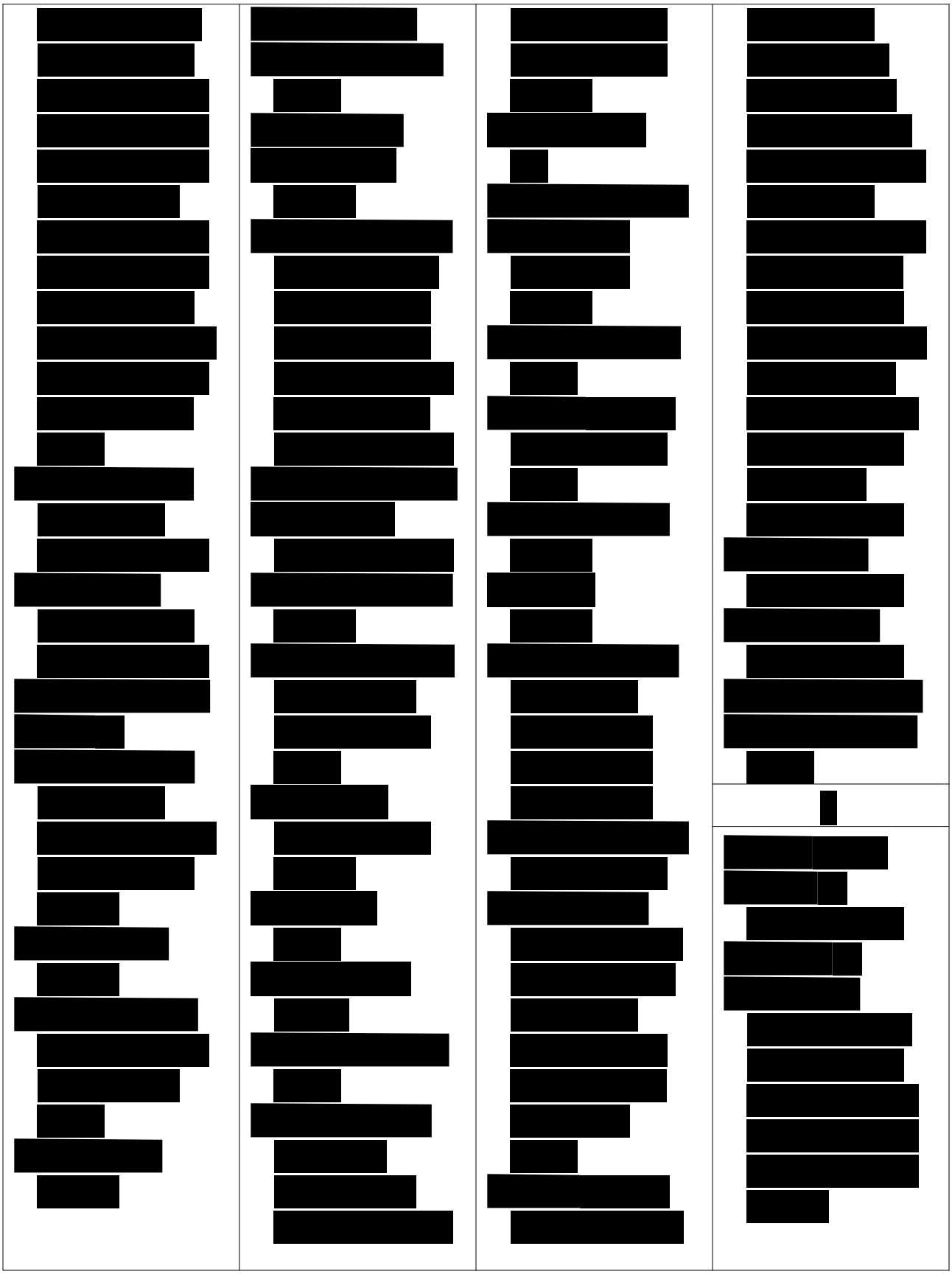
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Samsung v Pictiva
IPR2024-01094

[tabs - time]



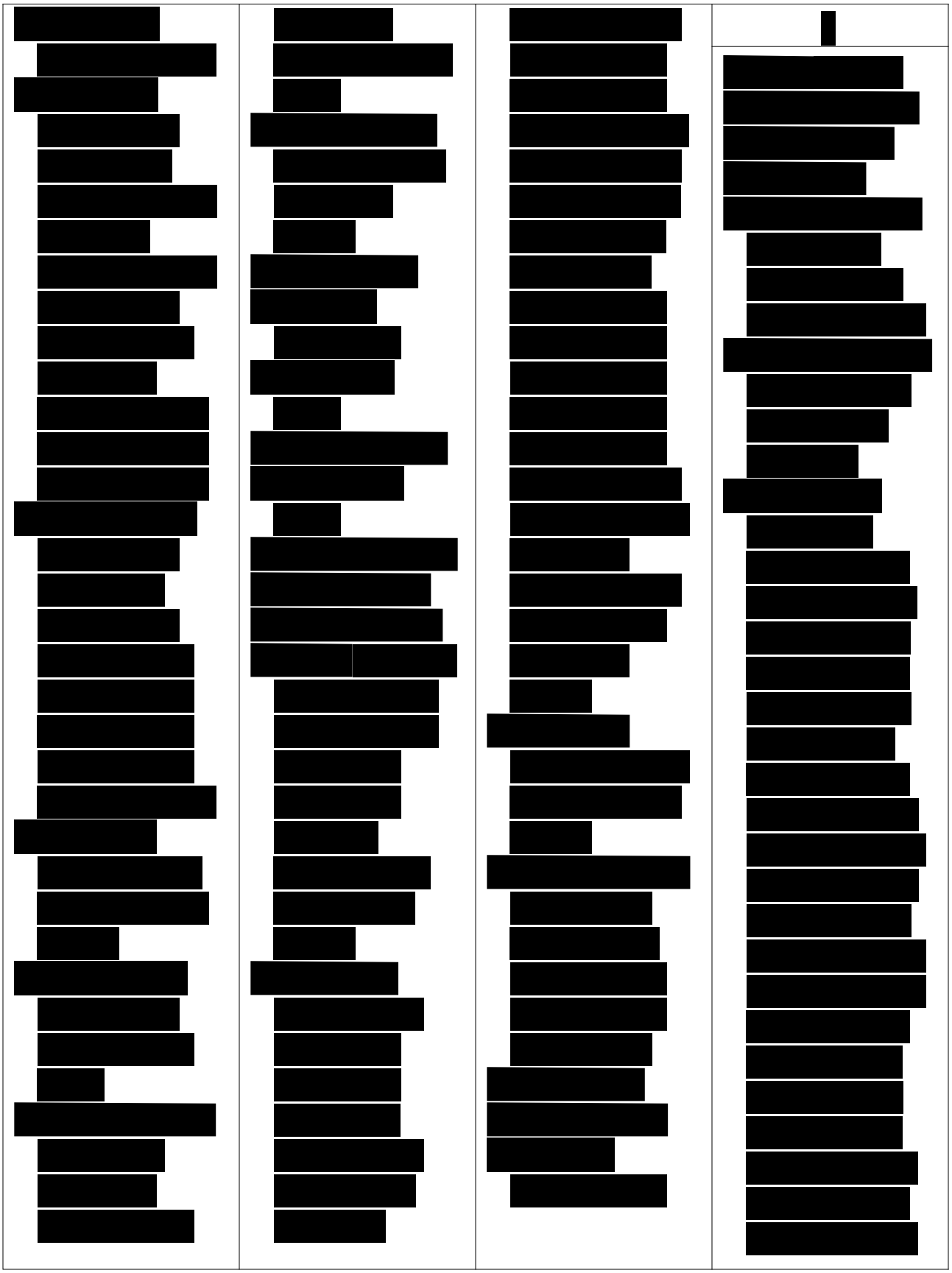
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Samsung v Pictiva
IPR2024-01094

[time - under]



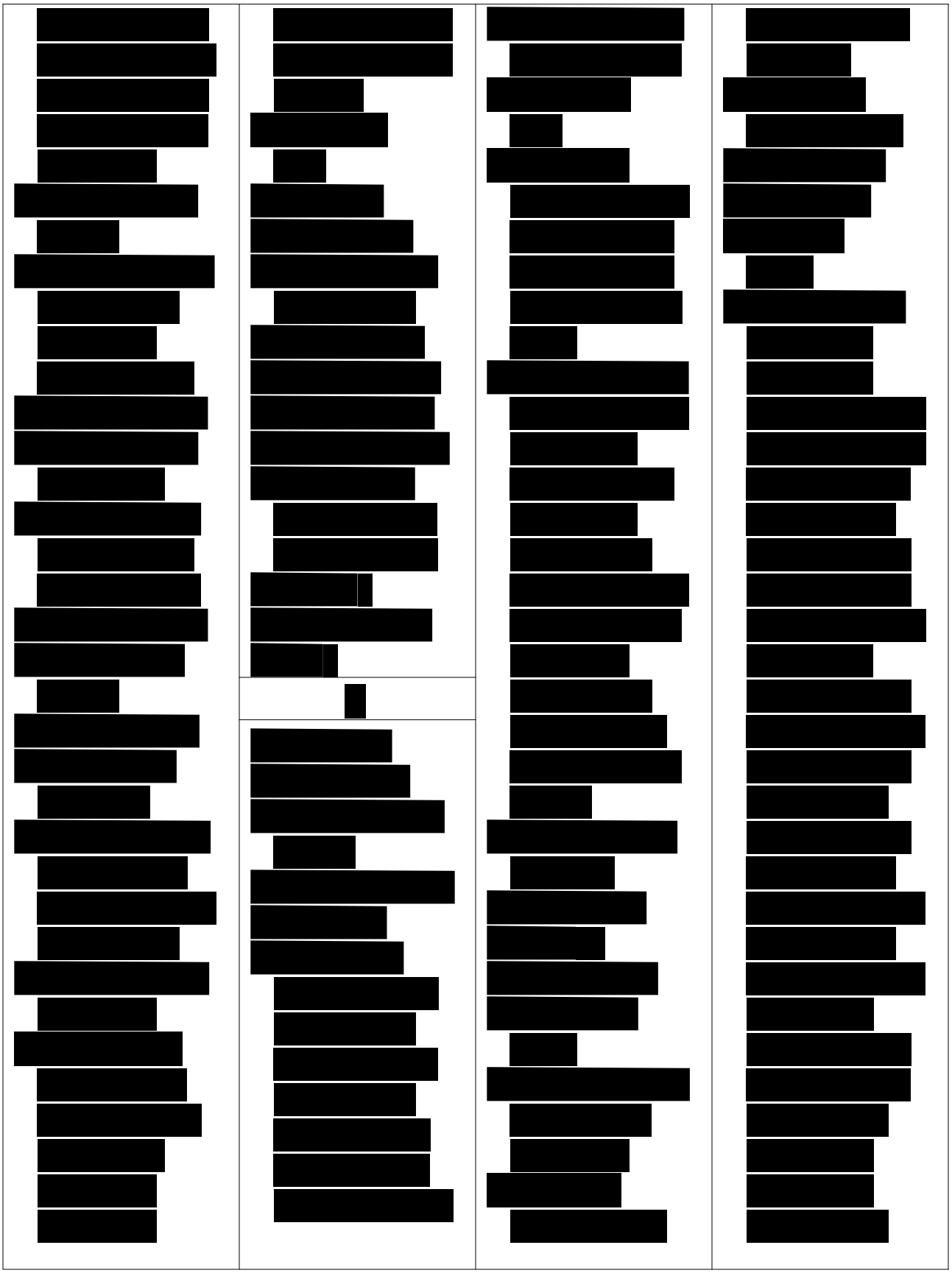
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IPR2024-01094

[underneath - vaporization]



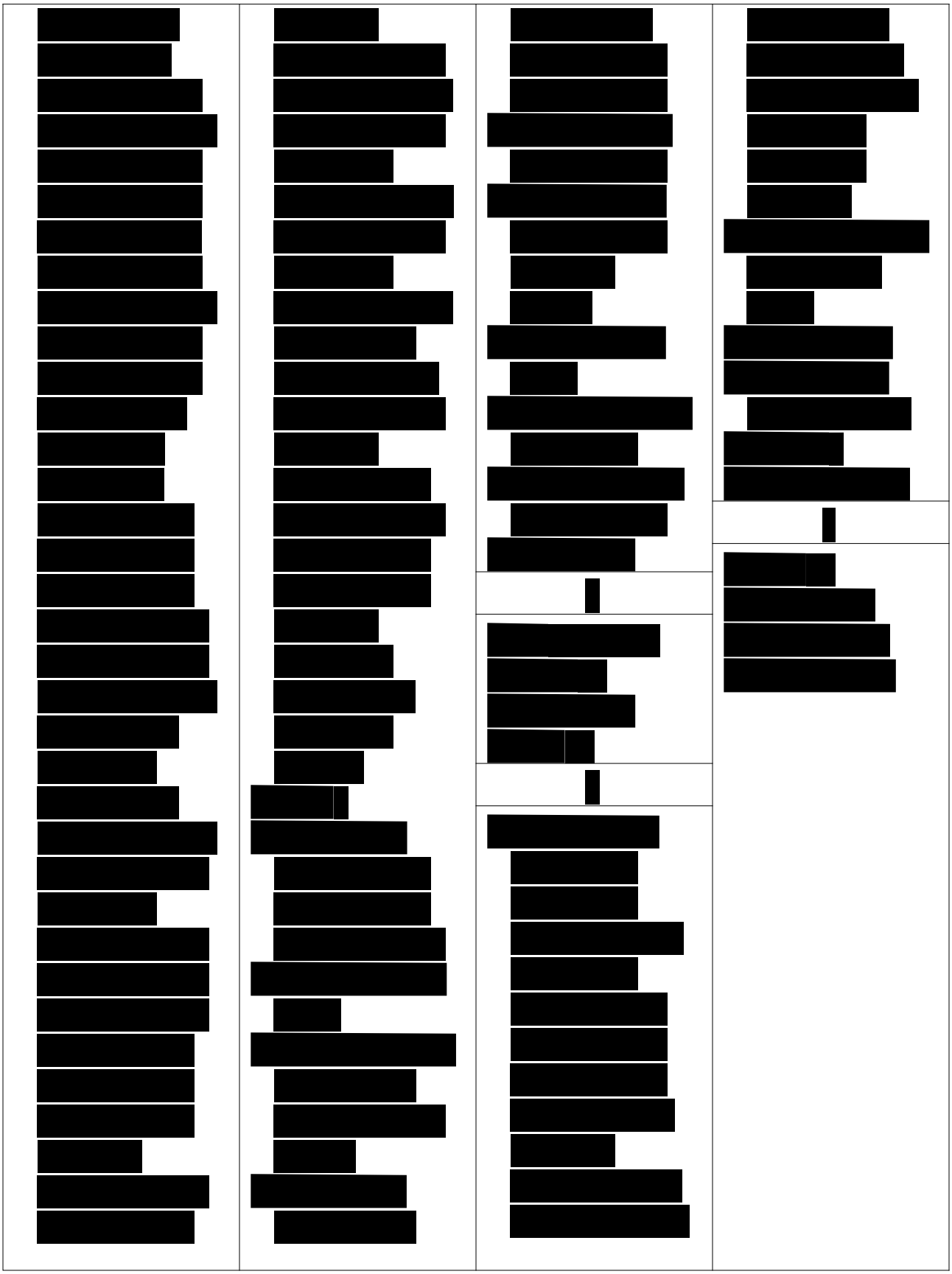
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IPR2024-01094

[vaporization - witness]



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IPR2024-01094

[witness - zoom]



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Samsung v Pictiva
IPR2024-01094

Federal Rules of Civil Procedure

Rule 30

(e) Review By the Witness; Changes.

(1) Review; Statement of Changes. On request by the deponent or a party before the deposition is completed, the deponent must be allowed 30 days after being notified by the officer that the transcript or recording is available in which:

(A) to review the transcript or recording; and

(B) if there are changes in form or substance, to sign a statement listing the changes and the reasons for making them.

(2) Changes Indicated in the Officer's Certificate. The officer must note in the certificate prescribed by Rule 30(f)(1) whether a review was requested and, if so, must attach any changes the deponent makes during the 30-day period.

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VERITEXT LEGAL SOLUTIONS

COMPANY CERTIFICATE AND DISCLOSURE STATEMENT

Veritext Legal Solutions represents that the foregoing transcript is a true, correct and complete transcript of the colloquies, questions and answers as submitted by the court reporter. Veritext Legal Solutions further represents that the attached exhibits, if any, are true, correct and complete documents as submitted by the court reporter and/or attorneys in relation to this deposition and that the documents were processed in accordance with our litigation support and production standards.

Veritext Legal Solutions is committed to maintaining the confidentiality of client and witness information, in accordance with the regulations promulgated under the Health Insurance Portability and Accountability Act (HIPAA), as amended with respect to protected health information and the Gramm-Leach-Bliley Act, as amended, with respect to Personally Identifiable Information (PII). Physical transcripts and exhibits are managed under strict facility and personnel access controls. Electronic files of documents are stored in encrypted form and are transmitted in an encrypted

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IPR2024-01094

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