**UNITED STATES PATENT AND TRADEMARK OFFICE**

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**BEFORE THE PATENT TRIAL AND APPEAL BOARD**

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SAMSUNG DISPLAY CO., LTD.

Petitioner, v.

PICTIVA DISPLAYS INTERNATIONAL LTD.,

Patent Owner.

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Case No. IPR2024-01223
Patent No. 6,949,389

# DECLARATION OF MR. KURT HUMPHREY

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I, Kurt Humphrey, declare as follows:

## I. Introduction

1. I have been retained as an independent expert on behalf of Pictiva Displays International Ltd. ("Patent Owner") to provide my opinion on whether the challenged claims are obvious over Kijima, Suzuki and other tertiary references.

2. I am being compensated for my time at my normal consulting rate. My compensation does not depend on the outcome of any matter or on any of the opinions provided below. I have no financial interest in this matter.

3. My testimony herein is based on my technical background, my years of experience in the field of microelectronics, photonics, and display technologies, the associated fabrication and deposition technologies, and my review of the materials cited herein.

4. I provide my testimony from the perspective of a person of ordinary skill in the art at the time of the invention (further addressed below). I am familiar with the knowledge and skill level of these people based on my decades of experience in display technology and frequent interactions with such people. For example, in the 2001-2002 timeframe, I served as Engineering Director at TAEUS International Corporation, and was the primary technical contributor on display technology projects including LCD, LED, plasma and OLED, as well as other photonics and optoelectronics assignments. Before then, between 1986-1989, I

assisted in setting up the state-of-the-art semiconductor fab (WAX) that would become a key LCD display research and pilot production facility for the Flat Panel Display (FDC) Company consortium led by Philips.

## II. Qualification and Experience

5. I am the founder and principal technologist of IP Enginuity LLC, an entity that provides engineering consulting to high-tech companies, inventors, patent holders and intellectual property professionals. I am also an Adjunct Professor in the College of Engineering at Colorado Technical University in Colorado Springs, specializing in instruction of general organic and inorganic chemistry for engineers. A copy of my CV is attached as Appendix A.

6. I obtained my Bachelor of Science and Master of Science degrees in Ceramic Engineering from the University of Missouri-Rolla (now Missouri University of Science and Technology), in Rolla, Missouri, in 1978 and 1980, respectively.

7. I worked as an engineer and engineering manager in the microelectronics industry for 20 years including positions with General Motors, AT&T Technologies, Philips Research Laboratories (Eindhoven, NL), United Technologies Microelectronics Center, and Rockwell Semiconductor Systems.

8. After serving as Director of Engineering for TAEUS International from 1999-2005, I launched IP Enginuity LLC to provide comprehensive technical



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expert consulting and engineering services to high-tech companies, inventors, patent holders and intellectual property professionals.

9. In addition to my extensive experience in developing microelectronics fabrication processes, materials characterization, and failure analysis methods for a variety of microelectronic products and components including CMOS digital logic and memory integrated circuits (ICs), smart power devices, complementary bipolar silicon-on-insulator (SOI) ICs, CMOS image sensors, automotive sensors and micro-electrical-mechanical systems (MEMS) gyroscopes, I have investigated and reverse-engineered several commercial OLED displays used in a variety of applications from smartphones and smart watches to medical devices.

10. I have been engaged by multiple major flat panel developers, users, OEMs and/or patent owners to investigate display IP and commercial OLED displays dating back to 2011. The OLED IP investigations required comparison of published OLED utility patents to commercially available displays in terms of their physical, material and electrical design and construction. Subsequent engagements have also involved technical investigations of sub-pixel design and construction as well as overall display layout including peripheral circuitry used to communicate touch sensor output with the specific microprocessors and microcontrollers used to interpret and execute the various product operations and functions associated with the touchscreen.



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## III. The ’389 Patent

11. The ’389 patent relates to encapsulating multiple organic light emitting diode (OLED) devices fabricated on a substrate. EX1001, Abstract, claims 34, 41. At the time of the inventions, thin film encapsulation methods were being explored as “a cheaper and better manner of encapsulation.” EX1001, 1:17-19. One way to achieve thin film encapsulation is using PML or polymer multi-layer comprising “alternating and repeating layers of an organic … and a barrier layer.” *Id.*, 1:19-22. The organic layer, such as layer 106, typically serves as a “planarization layer” that “is provided to give a planar surface for the deposition of the PML structure 112a” as depicted below. *Id.*, 1:30-36, Fig. 1.

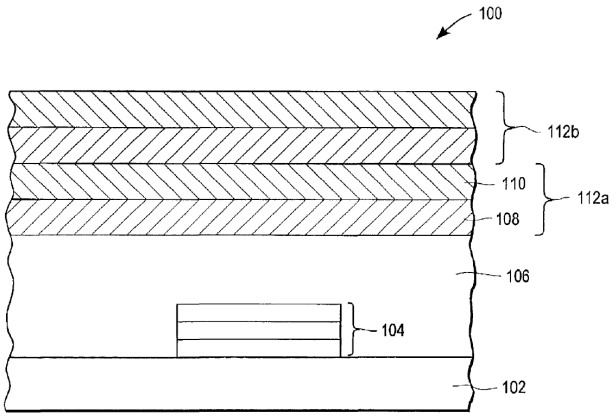



FIG. 1 (PRIOR ART)

12. The PML structure 112*a* includes a barrier layer 108 and another organic planarization layer 110. *Id.*, 1:37-47. The PML structure 112 may be repeated with the barrier layer deposited on a planarization layer of a lower PML



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structure. *Id.* Direct thin-film encapsulation results in "thinner and/or lighter and/or mechanically more flexible" encapsulation with "cost reduction and improved reliability." *Id.*, 1:48-52. The use of the planarization layer also addresses the drawbacks associated with "point defects (i.e., pin holes) in [the barrier layer's] surface." *Id.*, 1:56-62.

13. One significant drawback of the traditional direct thin film encapsulation method was that the PML structure was deposited on areas—such as "electrical contact pads," "scribe and break lines and/or glue lines"—that do not require and should in fact not have encapsulation. EX1001, 2:17-29.

14. The '389 patent addresses this drawback by providing for selective deposition of the PML layers and/or easy removal of materials deposited in undesired areas. EX1001, Figs. 3A-3B (using mask to selectively cure a portion of deposited organic layer and remove organic layer from undesired areas, followed by selective deposition of barrier layer), Figs. 4A-4B (selectively depositing barrier layer on deposited organic layer using a mask and using the barrier layer as an etching mask to remove organic layer from undesired areas), Fig. 5 (using a mask to selectively deposit organic layers and barrier layers), Figs. 6A-6E (using masks deposited on the substrate to control the areas of deposition for organic layers, followed by selective deposition of barrier layers); Figs. 7A-7C (using gas to direct organic materials away from undesired areas).



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## IV. Skilled Artisan

15. I understand that Samsung defines a person of ordinary skill in the art at the time of the invention as someone with "a bachelor's degree in Electrical Engineering, Materials Science, or a related field, and at least one year of experience in display technologies." Petition at 14-15. For the purpose of this IPR, I apply this definition of a person of ordinary skill in the art.

16. I have degrees in Ceramic Engineering, a branch of Materials Science, and I worked on flat panel display (FPDs) technology at Philips in the 1980s. Since 2011, I have worked on many projects involving plasma, LCD, electrophoretic (E-ink) and OLED technologies.

17. I was at least a person of ordinary skill in the art, if not one with above average skills, at the time of the invention (2001), under Samsung's definition of a person of ordinary skill in the art.

18. I note, however, persons with this low level of skills would have little in-depth knowledge needed to choose an appropriate encapsulation process for OLEDs on their own. Indeed, while they may have heard of certain deposition techniques, they would not have had enough educational background or experience to know which ones are suitable for OLED applications and under what conditions. For instance, in the early 2000s while some universities might have discussed OLEDs as part of a larger course on organic electronics, the courses would focus



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on the active layers of the OLEDs with a general reference to the need of encapsulation, but not on the details of encapsulation methods. Conversely, while some material science departments might have offered classes in deposition techniques, those would be generic, and not specific to OLEDs. Nor would they have enough intimate knowledge in chemistry and material sciences to develop and integrate new deposition techniques using new materials to reduce costs, increase throughout or increase yield, which generally occurs in the context of commercial applications.

## V. Claim Construction

### A. "Planarization Layer"

19. Each of the challenged independent claims 34 and 41 recites "depositing at least one planarization layer." I understand that Samsung and Pictiva agreed that the term "planarization layer" means "a layer of material that planarizes such that the propagation of defects from one layer to another layer can be interrupted and the topography of the underlying layer and/or structure is not reproduced." *See* EX2019 (Claim Construction Hearing Transcript), 28:25-29, 31:15-21, 35:5-8, 40:20-25.

20. This construction is consistent with the '389 patent. For example, the '389 patent describes how an organic layer provides a planar structure on which to deposit a barrier layer "to substantially cover point defects (e.g., dirt particles) in



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lower layers" such that "any point defects are not geometrically projected upwards into layers deposited above." EX1001, 4:33-41; *see also id.*, 1:56-62 ("The barrier layer should ideally not contain any point defects (i.e. pin holes) in its surface otherwise its usefulness as a barrier layer is severely compromised. That is primarily the reason that a planar organic layer is typically used as a substrate upon which the barrier layer is deposited.").

21. The construction is also consistent with FIG. 5 from the '389 patent, shown below, where the figure has been annotated to show the OLED device 504 in red, the organic planarization layer 506 in blue, and the barrier layer 508 in yellow.

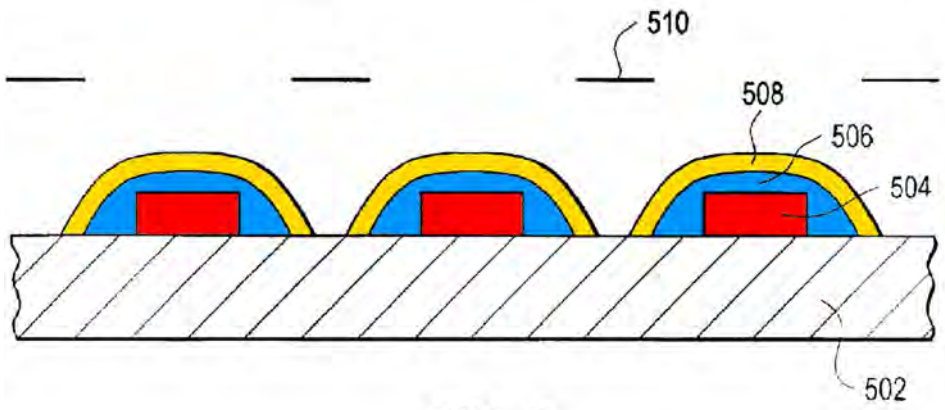



FIG. 5

22. The construction is also consistent with statements made to the examiner during prosecution of the '389 patent. Specifically, the examiner rejected the independent claims based on a combination of Ghosh (US 2001/0052752) (EX1006) and Boroson (US 6,590,157) (EX2022). *See* EX1002,



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292. For the recited "planarization layer," the examiner cited to Boroson's disclosure of a "sealing material 20." EX1002, 293 (citing to Boroson at col. 9, lines 28-52). In response, the applicant argued that Boroson's "'sealing material 20' is not a planarization layer since it is not used to interrupt the propagation of defects from one layer to another layer (see Applicants' specification at page 7, lines 16-21)." EX1002, 371. Page 7 of the specification contains the same disclosure cited above at EX1001, 4:33-41. *See* EX1002, 52 (page 7 of the specification).

23. The examiner also took the position that the "planarization layer" was met by another prior art reference, Palmans. *See* EX1002, 212. There, the applicant argued that the relied-on structure of Palmans, which were metal studs 5, "cannot be used as a planarization layer because the metal studs 5 do not provide a flat surface" and because "[m]etals, and copper in particular, that are evaporated onto a layer do not cover-up the imperfections of the underlying layer, but rather, the metals reproduce the topography of the underlying layer." EX1002, 18. I generally agree with that statement, unless the metal layer is formed of a sufficient thickness and flatness, *i.e.*, the thickness of the layer exceeds the depth of the imperfections and the layer does not reproduce the underlying topographical design features (such as steps, holes/gaps, trenches, concavity, curvature etc.).

24. I note that the construction for "planarization layer" includes three



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prongs: (1) "a layer of material that planarizes"; (2A) that the planarization allows the propagation of defects from one layer to another layer to be interrupted, and (2B) that the planarization results in the topography of the underlying layer and/or structure not being reproduced in the planarization layer. I understand that, during the claim construction hearing, Samsung argued that "from an engineering standpoint it is important" to have both conditions. EX2019 (Claim Construction Hearing Transcript), 36:24-37:16. Samsung added that "both of these functions were highlighted during prosecution to distinguish over just putting barrier layers on top of each other, for example, and that's because these two functions--shielding defects from traveling upwards and then providing a substantially smoother surface--are both important aspects of the planarization layer …." *Id.*, 38:13-19. I note that Dr. Subramanian agrees that the construction is "generally reasonable." EX2020, 05-30-2025 Subramanian Transcript, 212:9-213:9.

25. In my opinion, the agreed construction of "planarization layer" is consistent with the '389 patent and prosecution history, and therefore I have applied that construction below in Section VI, which addresses whether the cited prior art discloses the recited "planarization layer." I may also refer to certain requirements of this construction in other analysis below, such as prong 2B.

**B. "Selectively Depositing"**

26. I understand that Samsung has proposed that "selectively depositing"



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means "depositing a material in only desired areas, such that no additional processing must be performed for removing unwanted material." EX2003 at 7.

27. I also understand that, during the claim construction hearing, Samsung pointed to the statement in the '389 patent that "at a minimum, additional processing must be performed for the removal of the PML structure over these areas," and argued that "this is one of the key drawbacks that the claimed invention was seeking to improve upon with PML techniques;" namely, that "one of the drawbacks was that you would have to go back and remove unwanted areas where you had materials being deposited." EX2019 (Claim Construction Hearing Transcript), 46:19-47:3; *see also id*. at 48:1-4 ("Selectively deposit means that you're only putting it down in the areas where you want it and then there's no need for you to go back and do additional processing to remove materials."). I further note that a thin layer of encapsulant material that spreads from the deposited area does not form a "PML structure," which would be understood as alternating layers of organic-inorganic layers that perform the encapsulation function. EX1001, 1:19-22, 1:34-36, 1:43-46, Fig. 1. Therefore, the disadvantages of removing PML structure described in the '389 patent do not relate to the removal of thin layers of unintended trace residue material.

28. I understand that Dr. Subramanian has taken the position that "selectively depositing" means that the material is deposited "where you wanted,



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and it won't be where you don't, so that you don't need to do a subsequent removal step to remove it from unwanted regions." EX2020, 05-30-2025 Subramanian Transcript at 20:2-9; *see also id*., 23:2-17 (if materials deposited using a shadow mask are "in unwanted regions" and "I will follow that up with a removal process, whether it be an ash laser ablation or some other removal process, then it would not be selective"). Thus, Dr. Subramanian's understanding of "selectively depositing" is consistent with Samsung's district court position. I disagree with this position as selective depositions can often leave small quantities of unwanted material, e.g. trace residues, scum, etc. that require removal using wet chemical cleaning, e.g. descumming, or brief plasma etching, e.g. ashing, to remove the residues. The unpatterned, blanket removal of residues does not render the selective deposition, a non-selective or blanket deposition.

29. I am informed that an IPR petitioner is the master of its own petition and that it is supposed to set forth in the petition how the claims are to be construed and how the construed claims are unpatentable under the grounds it identified in the petition. I therefore have applied Samsung and Dr. Subramanian's construction of "selectively depositing" below in Section VII. However, my analysis under the other sections below is not impacted by the specific construction of "selectively depositing."



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## VI. The Proposed Combination of Kijima and Suzuki Does Not Have a Planarization Layer (All Grounds – Claims 34-37 and 40-46).

30. I note that Dr. Subramanian relies on the combination of Kijima and Suzuki under all grounds for allegedly satisfying the "planarization layer" of independent claims 34 and 41. EX1004, ¶¶ 79, 137 (Elements 34[b] and 41[c]). I do not agree that the combination of Kijima and Suzuki satisfies the "planarization layer" limitation under the construction agreed to by Samsung and Pictiva. *See supra*, Section V.A.

31. First, I would note that Suzuki's disclosed invention, implementation, and testing appears to be associated with an individual, discrete OLED device, not a "plurality of devices fabricated on a substrate" as required by the '389 patent. Therefore, Suzuki fails to show the applicability of the invention to an OLED display or OLED product consisting of a plurality of OLED devices fabricated on a substrate.

32. Second, based on Suzuki's own data, a POSITA would conclude that Suzuki's "protective layer", while potentially offering improvements in "dark spot" diameter, failed in Suzuki's stated objective: "It is another object of the invention to provide an organic electroluminescent device which can well prevent occurrence of a non-light-emitting region called dark spot." EX1012, 2:15-18. As noted in Figure 4 of Suzuki, dark spots persist using his "protective layer" even at



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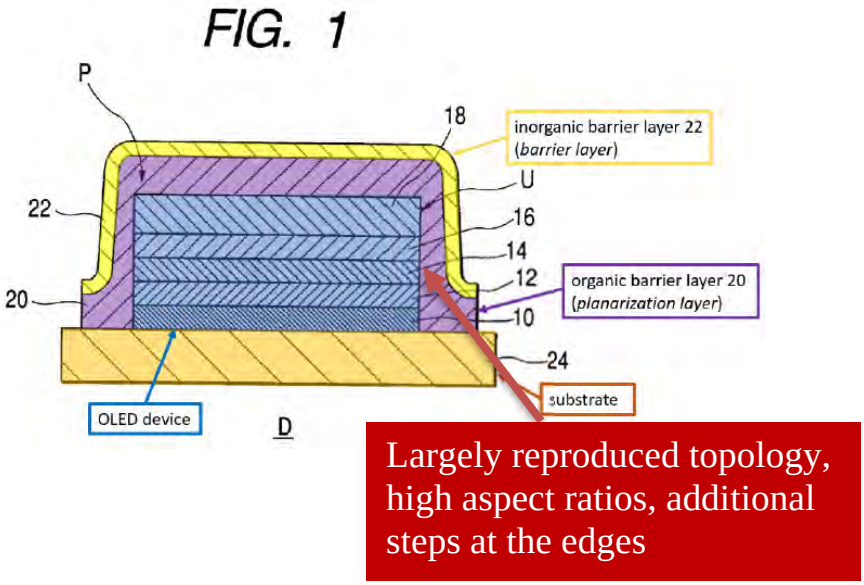
an organic layer thickness of 2 microns.

33. Third, the non-planar organic layer thicknesses of 1-2 microns as suggested by Suzuki, result in large step heights, that reproduce the underlying EL stack topology as shown in Fig. 1 below. It also creates additional steps at the edges. This would not result in a smooth surface with advantageously rounded corners as depicted in '389 Figs. 3A, 3B and 5, which most accurately depict surface of the disclosed planarization layer on which the barrier layer is deposited mitigating potential step coverage and defectivity issues, i.e. pinholes, cracks, etc. in the barrier layer.[1] Thus, inserting the thick non-planarizing organic layer of Suzuki into Kijima's sealing layers in all likelihood does not reduce dark spots, but may introduce additional problems with respect to barrier step coverage and defectivity in the device encapsulation. A person of ordinary skill in the art therefore would not insert an organic layer as depicted in Suzuki between Kijima's sealing films 7 and 8.

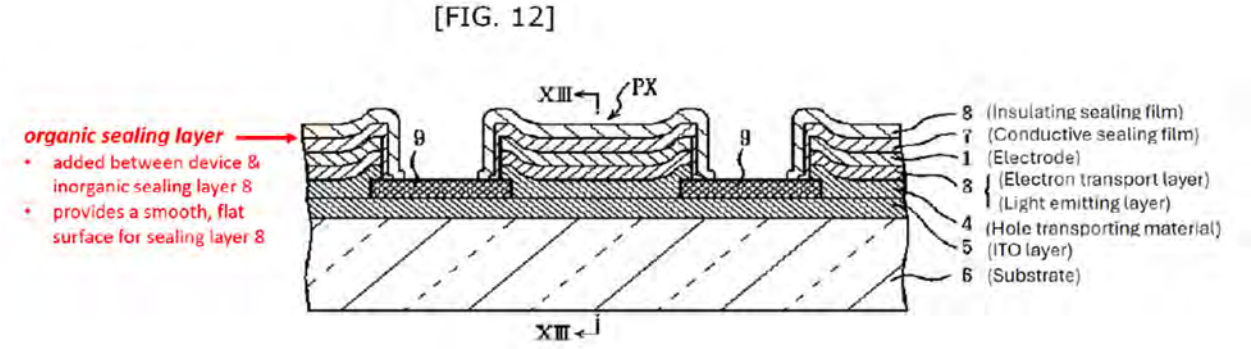
[1] The simplified drawings in Figs. 3B and 4B do not accurately render the planarization and barrier encapsulation layers resulting from the structures shown in 3A and 4A, respectively, and described in the associated '389 embodiments.



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34. I further note that Dr. Subramanian proposes to modify Kijima by interspersing an "organic barrier layer" between Kijima's conductive sealing film 7 and insulating sealing film 8, which Dr. Subramanian illustrates with the following annotation to Kijima's FIG. 12.

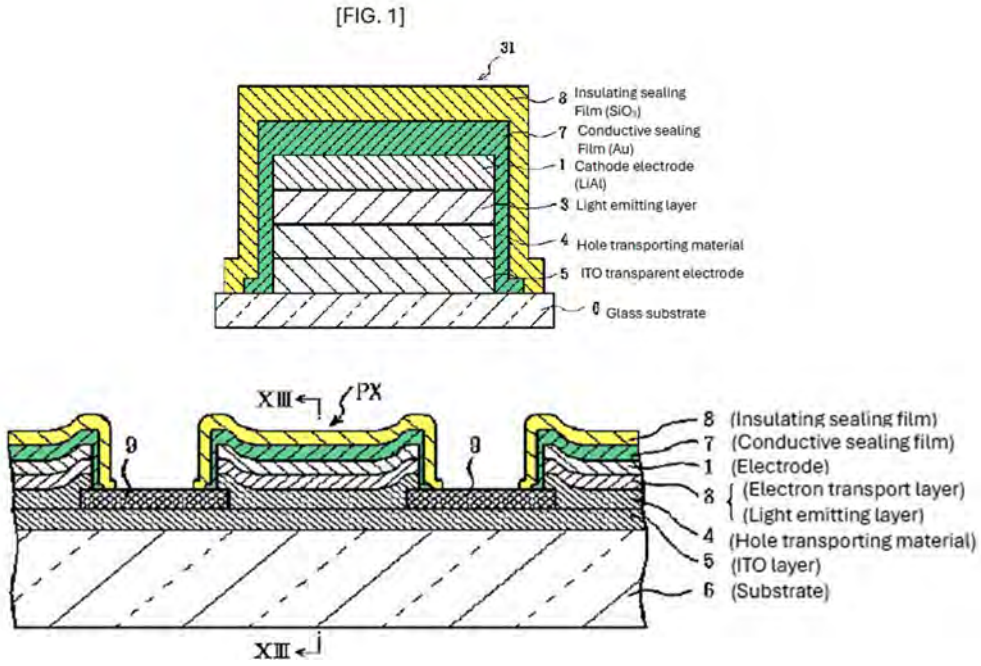



EX1004, ¶ 79.

35. However, when added to Kijima, the organic layer would have a substantially similar topography to the existing conductive sealing film 7 below it.

36. As seen above and below, the insulating sealing film 7 and the

conductive sealing film 8 have generally the topography.

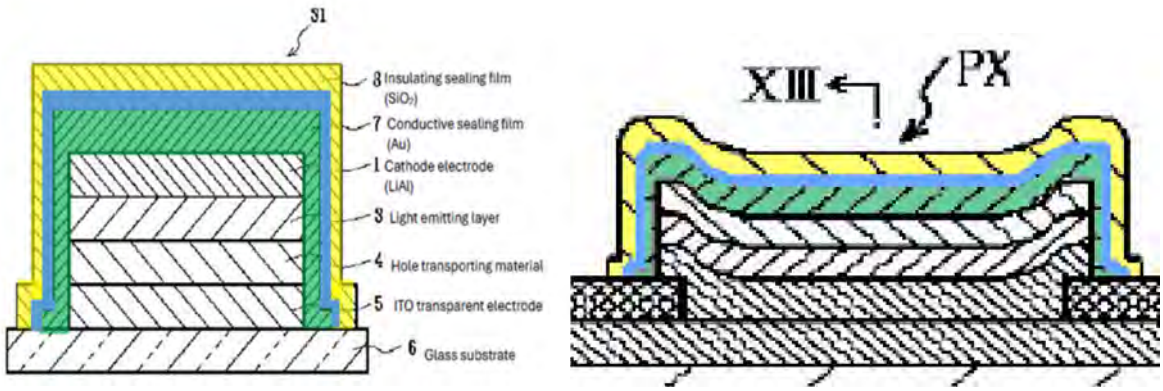



EX1010, FIGs. 1, 12.

37. The newly added organic sealing layer will be between the existing insulating sealing film 8 and the conductive sealing film 7. As such, a person of ordinary skill in the art would understand that the added organic layer (annotated in blue below) will have the same topography as the existing sealing film 7 below it (green) and the sealing film 8 (yellow) above it. Hence, the added organic sealing layer (blue) would be generally following the topography of the underlying conductive sealing film 7 (green), just like the inorganic sealing film 8 (yellow) generally following the topography of the underlying conductive sealing film 7, as illustrated below in modified Figures 1 and 12 of Kijima.



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38. I note that the topographies of the proposed combination shown above is different than what is described in the '389 patent. In particular, the organic barrier layer in the '389 patent has a topography that differs from the layer/structure below it by providing more rounded topology. See below.

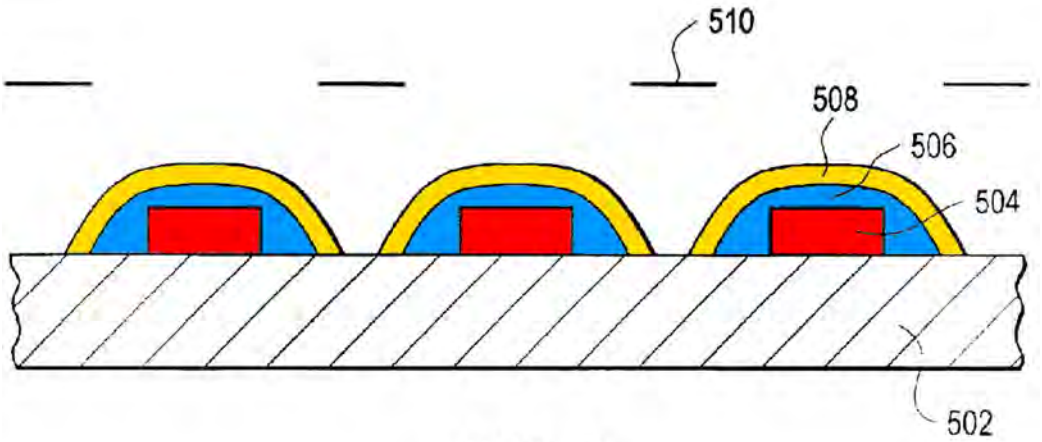



FIG. 5

EX1001, FIG. 5 (OLED device 504 is shown in **red**, the organic planarization layer 506 is shown in **blue**, and the barrier layer 508 is in **orange**).

39. This is consistent with the agreed construction of "planarization layer" and Dr. Subramanian's understanding of planarizing. *See* EX1004, ¶ 37; EX2020,

2025-05-30 Subramanian Transcript at 55:16-22 (noting that in Suzuki, "you can see there are layers that are clearly significantly rounded compared to the sharpness of the topology below it, so that would be a non-conformal coating, which then could be used for planarization").

40. I also note that Dr. Subramanian acknowledged that he did not draw the contours of the added organic layer in his declaration, but suggested at his deposition that the added organic layer would have the rounded corners as in Suzuki. EX2021, 2025-05-31 Subramanian Transcript, 23:2-24:14. But that would involve a change in the topology of the insulating sealing layer above it as well, so would be inconsistent with the original theory stated in the Petition and Dr. Subramanian's declaration, which just shows an arrow for where the organic layer would be added. That would not suggest to a person of ordinary skill in the art a change of topology of the inserted organic layer.

41. In addition, unlike Suzuki's cathode 18 made of non-gold and harder metals (see EX1012-Suzuki, 5:8-13), the conductive sealing film 7 is overlayed on the device and is expressly described as being "***thickly formed*** as a buffer layer." EX1010, [0056]. Kijima discloses that, after depositing a 2k angstrom (i.e., 0.2 μm) thick cathode made of LiAl or SrAl (*see* EX1010, [0049], [0061], [0065], [0069]), a 10k angstrom (*i.e.*, 1 μm) thick gold-based conductive sealing film 7 is deposited under vacuum (*id*., [0031]-[0032], [0050], [0062], [0066], [0070],



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[0052]). Thus, the thickness of Kijima's conductive sealing film 7 would be on the order of 1 micron and above. The 1 micron thickness is 5 times the thickness of the cathode, and should therefore be more than sufficient to cover any surface irregularities and roughness of the cathodes. A POSITA would already see Kijima's 1 micron thick but relatively soft Au layer as being thick and flexible enough (and expensive enough) to passivate or decouple defects from the cathode layer and therefore see little, if any, benefit to adding additional layers and processing steps which potentially create new material and processing issues such as film stresses, adhesion, defects, chemical compatibility problems, etc.

42. Dr. Subramanian takes the position that Kijima's conductive sealing film 7 is vulnerable to the same defects as the cathode as discussed in Suzuki. *See* EX1004, ¶¶ 80-81. I don't agree. For example, Kijima's conductive sealing film 7 is "thickly formed as a buffer layer" (EX1010, [0056]), and is "protecting the underlying organic layer and electrode and preventing oxidation of the electrode 1." EX1010, [0055]. Kijima discloses that its conductive sealing film 7 is the only required layer, and that the insulating film 8 is optional. *See* EX1010, [0030], [0097], Claim 1. Thus, given the thickness of Kijima's conductive sealing film 7 (at least 1 micron), the fact that it is protecting the electrode, and the fact that it is the only barrier layer required by Kijima, a POSITA would not expect Kijima's conductive sealing film 7 to suffer from the same degradation vulnerabilities as the



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cathode.

43. I further note that the types of cathode defects described in Suzuki are pinholes or other defects "through which moisture in air is adsorbed on the organic layer structure." EX1012, 5:41-46. Dr. Subramanian has testified that "for a one micron thick gold film," "pinhole defects will be almost nonexistent." EX2021, 2025-05-31 Subramanian Transcript at 61:16-22. In Kijima, the gold film is about 1 micron in thickness in order to protect the OLED organic layers during deposition of the insulating film. *E.g.*, EX1010-Kijima, [0056]; EX2021, 2025-05-31 Subramanian Transcript at 15:4-23. Thus, Kijima's gold film does not have pinhole defects that would have benefited from the organic layer as in Suzuki.

44. As to defects that are "mainly caused by foreign matter," (EX1012-Suzuki, 5:54-58), there is no evidence that such defects formed on Suzuki's cathode 18 made from Al, Mg, In, Sn, Zn, Ag, or alloys of Al-Li, Mg-Ag and Ag-Li also exist in Kijima's gold (Au) films. Additionally, Dr. Subramanian acknowledged that when properly controlled, the surface roughness of the gold film may be as little as 10 nm. EX2021, 2025-05-31 Subramanian Transcript, 62:17-64:9. This would suggest that defects caused by foreign matter are minimal.

45. While Dr. Subramanian suggests that the soft gold films would also



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suffer from asperities due to buckle defects (*id*.),[2] I have not seen any evidence that, at the time of the invention, such defects were known to be an issue when gold is used to seal OLED devices or that a person of ordinary skill in the art would have known to use a planarization layer to address this problem. EX2021, 2025-05-31 Subramanian Transcript, 67:1-69:3, 72:3-74:12. At any rate, Kijima does not indicate there are any issues with its gold conductive film, and in fact discloses that its gold film is the only required layer for "protecting the underlying organic layer and electrode and preventing oxidation of the electrode 1." EX1010, [0055]; see also id., [0030], [0097], Claim 1. This would suggest that buckle defects, if even present, do not generate sufficient permeation paths for oxygen or moisture. Moreover, buckle defects are not the type of defects that Suzuki addresses with use of an organic layer. EX1012, 5:51-58

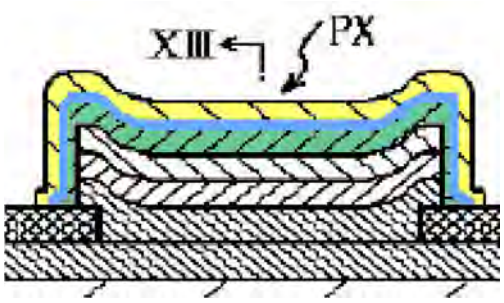
46. Furthermore, while Dr. Subramanian states in his declaration that "Kijima's conductive film 7 has a visibly uneven surface as illustrated in Figure 12" (EX1004, ¶80), he also acknowledged that Suzuki's layer 20 in FIG. 1 also "has an uneven surface" and that "just because a layer has an uneven surface as that term is used in paragraph 80 of [his] declaration doesn't mean that there would be a reason to add a planarization layer or smoothing layer on top of it." EX2021,

[2] Note that such defects are not defects caused by foreign matters.



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2025-05-31 Subramanian Transcript, 136:18-137:24. Put another way, the alleged uneven surface (*e.g.*, the dipping observed for the top surface of the gold sealing film) is not a reason for adding a planarization layer. This is particularly the case when the suggested final topology would reproduce the same unevenness (*e.g.*, the dipping in the top surface).




47. Importantly, in my opinion, even if the conductive sealing film 7 has the "defects or pinholes" observed for Suzuki's cathode layer 18 (a fact that has not been established), those defects are created incidentally on the surface of the underlying layer and is generally not considered to be part of the underlying layer's topography, which is a macroscopic property by design. Thus, even with an added organic layer, there would not be a planarization layer in the modified Kijima device. In that respect, I disagree with Dr. Subramanian that topography or topology could come from both intended and non-intended surface variations. EX2020, 2025-05-30 Subramanian Transcript, 51:1-8 ("topography and topology in the ['389] context of ***talking about changes in surface heights*** are, in this field, almost always used interchangeably"), 11:3-21 (alleging that "deviat[ion] from a



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perfectly flat surface" "can come from intentional topological variations … or they could come from non-intended topological variations such as surface roughness or unintentional features"). In my view, of the two functions that the claimed planarization layer is to perform (prongs 2A and 2B), the function for interrupting defect propagation has to do with hiding or passivating the non-intended topological variations caused by defects and pinholes, while the second function is to address the intended topological variations such as steps, trenches/gaps, concavity, curvatures, differences in height in different parts of the underlying layer etc.

48. Thus, the added organic layer from Suzuki does not satisfy the "planarization layer" limitation of independent claims 34 and 41 because it would either reproduce the topography of the underlying layer, i.e., Kijima's conductive sealing film 7, unlike the recited planarization layer which does not; or it would actually increase non-planarity as in Suzuki. *See supra*, Section V.A.

## VII. Kijima Does Not Disclose "Selectively Depositing" Material at Least Under Dr. Subramanian's Construction (Grounds I–III – Claims 34-37 and 40)

49. Independent claim 34 recites "selectively depositing at least one planarization layer upon said devices" (Element 34[b]) and "selectively depositing at least one barrier layer over said planarization layer." (Elements 34[c]).

50. Concerning the selective deposition of the planarization layer, the



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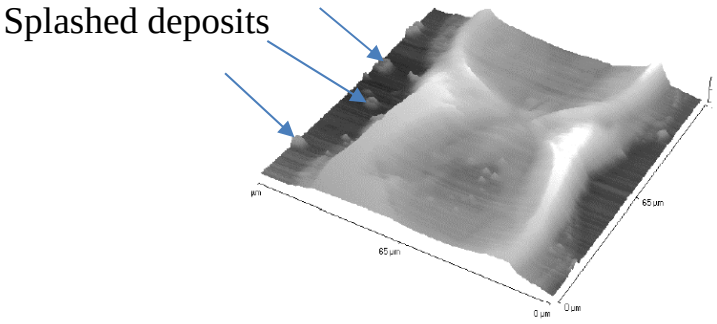
Petition first points to Kijima's shadow mask 23 to argue that the gold sealing film is selectively deposited. Pet., 28-29. It then states that the added organic layer "would be selectively deposited upon the OLED devices because the layer would be deposited on top of the OLED's conductive sealing film 7[.]" Pet., 36. I disagree because nothing precludes blanket deposition of the organic layer followed by patterned etching of the organic material to obtain the final deposited pattern, as was common at the time of Kijima and beyond. *See*, *e.g.*, EX1001, cols. 1-2 (discussing prior art non-selective deposition of PML), Figs. 3A-3B & 4A-4B (organic layer deposited in a blanket fashion followed by selective removal of the organic layer); EX1006-Ghosh, [0032] (patterning may be achieved by "ablation… following layer formation"). I note that Dr. Subramanian merely alleges that "the additional organic sealing layer [of Suzuki], as I have shown in the above Modification of Figure 12, ***could be*** readily deposited using the same selective deposition methods already used in Kijima." EX1004, ¶ 83. But that something could be done does not mean a skilled artisan would have done it.

51. As to claims 35-36, I will address below as to why a person of ordinary skill in the art would not have been motivated to perform inkjet printing or screen printing to deposit the materials. I note, however, there is no evidence that post-deposition removal process could be avoided, especially when dealing with multiple devices on a substrate. For instance, Dr. Subramanian acknowledged



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in 2003 that the splash wave associated with inkjet process resulted in coffee-ring and donut structures, which despite their efforts to optimize were never fully eliminated under conditions suitable for OLED device encapsulation (*e.g.*, at substrate temperatures below 130-160ºC). EX2023. The problem would multiply when there are multiple devices on a substrate such that it might be impossible to completely avoid coffee-ring formation at all device sites. The existence of coffee-ring structures can be detrimental to the deposition of the subsequent inorganic sealing layer and other materials as the residue would affect those materials' adhesions and film growth. As such, a post-deposition process would be needed.

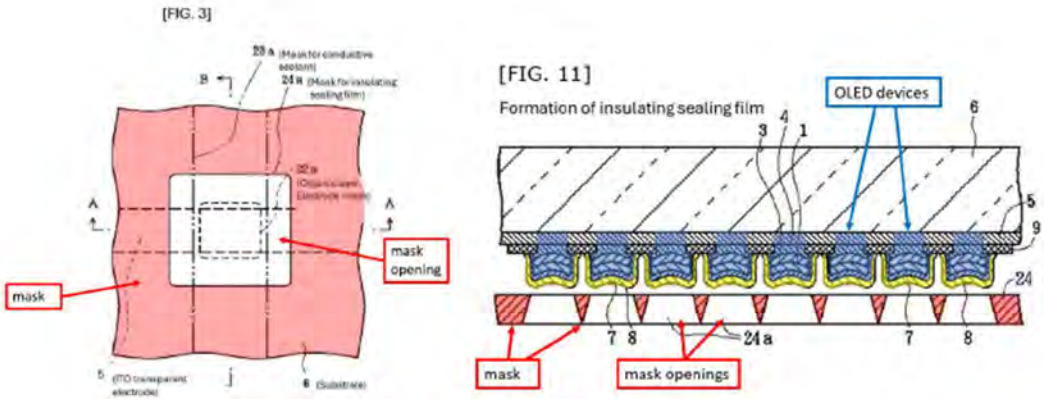



52. Regarding the selective deposition of the insulating sealing layer, Dr. Subramanian relies on Kijima's use of shadow mask 24. *See* EX1004, ¶ 69 ("Kijima discloses *selectively depositing* this insulating sealing film. For example, Kijima explains that the insulating sealing film 8 is deposited via a 'vacuum deposition device 11' using a 'mask 24' (red) having 'openings 24a.' *Id*., [0040]-[0041]. Since deposition of the sealing film is restricted to the areas exposed by the



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mask openings 24a, the film is selectively deposited upon the OLED devices, as shown in Figure 11. *Id*., [0051].") (original emphasis included); *see also id*., ¶ 91 (Element 34[c]), ¶ 145 (Element 41[e]). To illustrate this, Dr. Subramanian annotated Kijima's Figures 3 and 11, which I have reproduced below.




53. A shadow mask is a mask having apertures through which material is deposited onto a substrate. Kijima technique uses vacuum deposition through such a shadow mask. *See* EX1004, ¶ 96 (Dr. Subramanian stating that "a POSITA would have understood that Kijima's masks are shadow masks"); *see also id*., ¶¶94-96; EX2021, 2025-05-31 Subramanian Transcript, 111:21-112:1.

54. Dr. Subramanian contends that shadow masks restrict deposition to only the areas exposed by the mask openings, and hence "selectively deposit[]" material. *See* EX1004, ¶ 69, 91, 99. However, Dr. Subramanian does not identify any evidence or support that shadow masks can be used to "selectively deposit[]" material under the meaning he applied to the term. *See supra*, Section V.B. In fact,



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the same prior art he relies on teaches otherwise. For example, Fujimori is directed to improving the adhesion between the mask and the substrate using magnetic force in connection with the manufacturing of OLED display elements. *See* EX1014, [0029]. According to Fujimori, "[t]his effect reduces the proportion of the area where the deposited material or other material wraps around, i.e., the portion deposited from the mask opening that bleeds to the shadow portion of the mask, achieving fine pattern processing ***not conventionally possible***." *Id*. As such, a skilled artisan would understand that, without the use of a magnetic mask, Fujimori discloses that it was not possible to avoid having material bleed under the shadow mask. Fujimori further discloses that "[t]his is a major problem that can cause a short in the elements and crosstalk due to increased leakage current." *Id*., [0008]; *see id*. (explain the object is "to provide a method to achieve adequate adhesion between the mask and the substrate, which is necessary to achieve fine pattern processing with the mask, ***which has heretofore been impossible***.").

55. Fujimori discloses that "a pattern pitch of 2 mm is a suitable example for the mask." EX1014, [0035]; *see also id*., [0024] ("Although the shape and size of pixel varies depending on the display method, such as segmental or dot matrix, a pixel size of 2 mm square or smaller is preferable."). This is consistent with the patterning disclosed in Kijima, which likewise discloses creating a pattern with a pixel "size of 2 mm x 2 mm using a deposition mask 22 as depicted in FIG. 3."



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EX1010 (Kijima), [0040]. Thus, a person of ordinary skill in the art would understand from Fujimori that Kijima's shadow mask suffers from the same bleed effect described in Fujimori. In fact, I note that Dr. Subramanian specifically relies on the contention that Kijima would benefit from Fujimori's invention given the similar pixel sizes disclosed in Kijima and Fujimori, and "[g]iven the need for precision used in the pixels of Kijima …." EX1004, ¶¶129-131.

56. I note that Dr. Subramanian does not modify Kijima's shadow mask with Fujimori's magnetic mask for Grounds I-III. *See* EX1004, pages i-iii (table of contents showing Fujimori is relied on only under Ground IV). Therefore, because Fujimori itself indicates that Kijima's unmodified shadow mask (with 2 mm x 2 mm patterning) is unable to "selectively deposit[]" material, as Dr. Subramanian understands that term (*supra,* Section V.B), Dr. Subramanian has not established that Kijima discloses "selecting depositing" material, as required by Elements 34[b] and 34[c].

## VIII. A POSITA Would Not Have Carried Out the Proposed Modification of Kijima Based on Suzuki by Adding an Organic Barrier Layer (All Grounds – Claims 34-37 and 40-46)

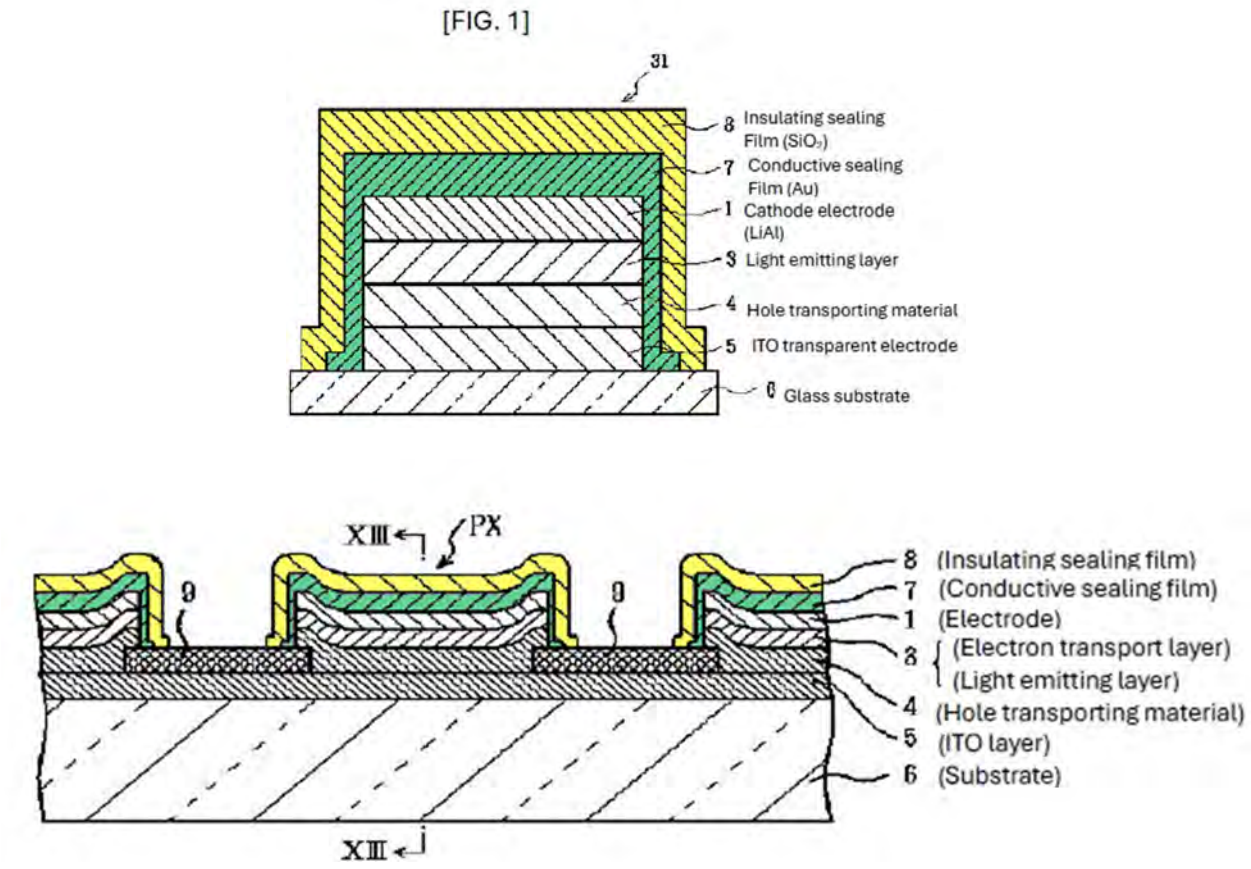
### A. Kijima's Conductive Sealing Film is a Protective Barrier Layer

57. Dr. Subramanian takes the position that Kijima's conductive sealing film 7 is only part of the device (EX1004, ¶63), and he does not treat the film 7 as being a protective barrier layer. But Kijima explains that the conductive sealing



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film 7 is a barrier layer and that it "protect[s] the underlying organic layer and electrode and preventing oxidation of the electrode 1 …." EX1010, [0055]. Kijima further explains that both "conductive sealing film 7 and an insulating sealing film 8 are successively formed on the electrode 1 so as to cover the side surfaces of the [EL] element," and that this is done for both films "using a vacuum deposition device." EX1010, [0038]. Thus, the structures of the conductive sealing film 7 and an insulating sealing film 8 are substantially the same in that each extends over the top of the device and down the sides of the entire device. *See* below.




EX1010, FIGs. 1, 12.



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58. The fact that the conductive sealing film 7 may be applied as a stripe does not change my analysis because both the conductive sealing film 7 and the insulating sealing film 8 cover all sides of the electrode and the device, and are therefore structurally substantially the same from the perspective of the electrode and device.

59. As noted above, Kijima discloses that the function of the conductive sealing film 7 is "protecting the underlying organic layer and electrode and preventing oxidation of the electrode 1." EX1010, [0055]. Significantly, this is the same function as the insulating sealing film 8. *See id*. ("further enhanc[ing] the effects of preventing oxidation of the electrode 1 and degradation of the organic layer."[3] I note that Dr. Subramanian agrees that the "functions or benefits" of the conductive sealing film 7 include "protecting the underlying organic layer and electrode and preventing oxidation of the electrode." EX2021, 2025-05-31 Subramanian Transcript at 152:14-24; *see also id*., 149:6-19; 151:10-16 (testifying that Kijima "identifies two sealing layers which are layers 7 and 8.").

60. A person of ordinary skill in the art would therefore understand that the conductive sealing film 7 is as much a protective barrier layer as is the

[3] Because of the material used for the conductive sealing film 7, it serves the important independent function of radiating heat during vapor deposition of the insulating sealing layer 8. EX1010, [0056]-[0057], [0074]-[0075].



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insulating film 8. For example, as noted above, Kijima describes how both the "conductive sealing film 7 and an insulating sealing film 8 are successively ***formed on the electrode 1*** so as ***to cover the side surfaces of the element***." EX1010, [0038]. Kijima repeatedly describes the sealing film 7 as being formed on the electrode, not as part of the electrode. See EX1010, [0050] ("form a conductive sealing film 7 so as to cover the surface of the laminate body of the organic layers 4, 3 and the electrode 1"), [0055] ("the conductive sealing film 7 provided on the electrode 1"), Claim 1.

61. Further supporting the fact that Kijima's conductive sealing film 7 is a barrier layer is the fact that it is the ***only required layer*** needed for "protecting the underlying organic layer and electrode and preventing oxidation of the electrode 1." EX1010, [0055]. The insulating film 8 is optional. *See id*., [0030] (Kijima describing the method of the present invention as "forming the electrode under vacuum film-forming conditions, and then forming ***at least*** a conductive sealing film thereon while maintaining the vacuum (and preferably further forming an insulating sealing film thereon)."); [0097] ("the electrode is formed under vacuum film-forming conditions, and ***then at least a conductive sealing film is formed thereon*** while maintaining the vacuum."); Claim 1 (reciting the "conductive sealing film" but not the "insulating sealing film").

62. Kijima's conductive sealing film 7 is also the only layer to perform



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the additional protective function of efficient dissipation of the radiant heat" and preventing "degradation of the organic layer due to radiant heat during vapor deposition of the insulating sealing film 8." EX1010 (Kijima), [0057], [0056]; *see also id*., [0075] (emphasizing the importance of "providing the conductive sealing film adjacent to and below the insulating sealing film").

63. Thus, a POSITA would understand that both of Kijima's sealing films are protective barrier layers, irrespective of whether they provide additional functions.

### B. A POSITA Would Not Have Inserted an Organic Layer Between a Conductive Barrier Layer and an Insulting Barrier Layer

64. Dr. Subramanian contends that a POSITA would have been motivated to combine Kijima and Suzuki because "Kijima uses a single inorganic layer for its insulating sealing film" and Suzuki teaches "the benefits of a 'protective double layer made of an organic barrier layer and an inorganic barrier layer.'" EX1004, ¶ 122 (citing Suzuki, Abstract); *see also id*., ¶ 79 ("instead of using a single inorganic 'insulating sealing film 8' as discussed in Kijima, it would have been obvious to use a two-layer structure that includes an organic layer as well as an inorganic layer.").

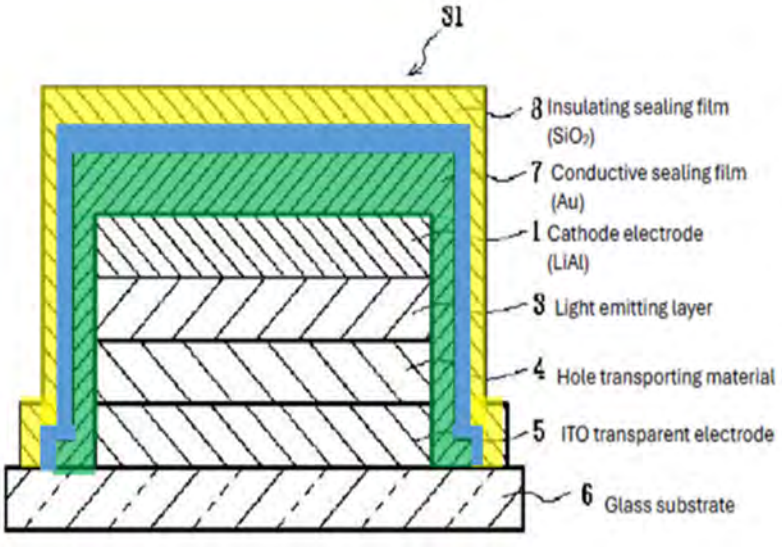
65. Dr. Subramanian's reasoning for combining Kijima and Suzuki is based on the incorrect assumption that Kijima's uses a single-layer barrier



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structure. This appears to be based on his classifying Kijima's conductive sealing film 7 as only being part of the device and not as being a barrier layer. As I described above, Kijima's conductive sealing film 7 is a protective barrier layer even if it performs additional functions.

66. Because Kijima already discloses a double-layer barrier structure that include both the conductive sealing film 7 and insulating sealing film 8, the proposed combination of Kijima and Suzuki actually creates a ***triple***-layer barrier structure. This arrangement is shown in the annotated version of Kijima's FIG. 1 below in which the conductive sealing film 7 is shown in green, the insulating sealing film 8 in yellow, and the proposed added organic layer from Suzuki shown in blue.




EX1010, FIG. 1 (annotated).

67. However, I note that Dr. Subramanian has not provided any analysis

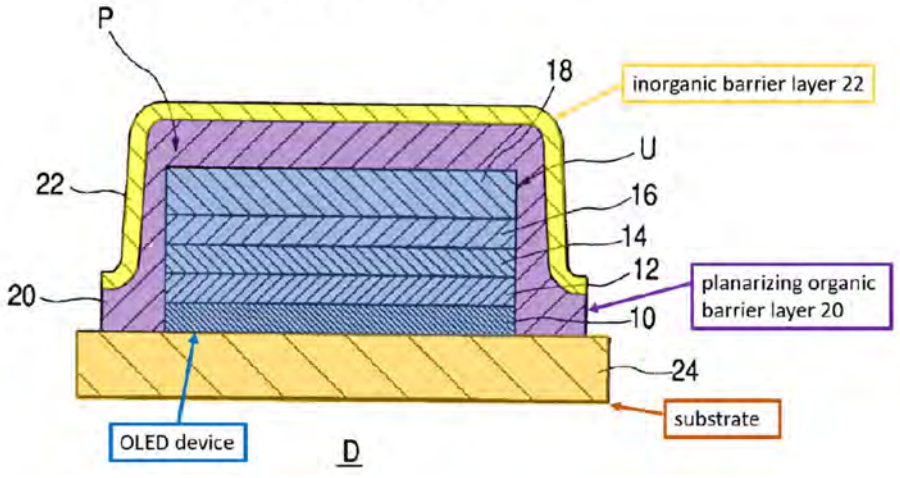


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as to why a POSITA would be motivated to create a ***triple***-layer barrier structure. Also, none of the prior art suggests any need or benefit of forming a triple-layer structure by inserting an organic layer between a conductive barrier layer and an insulating barrier layer. For example, Dr. Subramanian acknowledges that Kijima "doesn't talk about using three sealing layers it wouldn't identify benefits therewith because it's not even talking about three layers." EX2021, 2025-05-31 Subramanian Transcript at 151:17-152:1.

68. Suzuki discloses techniques for encapsulating OLED devices via a "protective double layer" that is "made of an organic barrier layer and an inorganic barrier layer." EX1012, [Abstract], Pet., 19. With reference to an annotated version of Suzuki's FIG. 1 below presented by Dr. Subramanian, the inorganic barrier 22 is applied to the organic layer 20, which is in turn applied directly to the cathode 18.

FIG. 1






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EX1004, ¶ 74.

69. Suzuki teaches that "[t]he protective layer P includes two layers including an organic barrier layer 20 covering defects or pinholes inevitably formed particularly in the uppermost cathode layer 18, and an inorganic barrier layer 22." EX1012, 5:51-54. I note that Dr. Subramanian acknowledges that Suzuki teaches "the benefits of a double barrier layer" and does not address "the use of triple barrier layers." EX2021, 2025-05-31 Subramanian Transcript at 150:11-17.

70. I also note that Komatsu is consistent in that it discloses a protective film comprising a "stacked layer structure of double layer, i.e. an organic material layer and an [inorganic] SiON." EX1017, 10:13-15; *see also* Pet., 35 (stating that "Komatsu closely tracks Suzuki's disclosure of a 'protective double layer made of an organic barrier and an inorganic barrier layer ….'"). Specifically, Komatsu uses an organic layer in addition to the inorganic SiON layer because "SiON alone is very difficult to form a thick protective film necessary for the organic electroluminescence device." EX1017, 11:32-36. Komatsu therefore combines SiON with "a layer of material having a lower internal stress than that of SiON, where lower moisture permeation can be attained in the protective film by the SiON layer and thick protective film formation can be attained by the layer of a material having a lower internal stress." *Id*., 11:37-45. In other words, Komatsu



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discloses that an inorganic layer with low moisture permeation property combined with a sufficiently thick under-layer is the key to protection against environmental elements and dark spots.

71. I understand that Dr. Subramanian testified that he has "done a lot of gold deposition within [his] past research." EX2021, 2025-05-31 Subramanian Transcript at 30:3-5, 61:3-6. Thus, it is telling that he testified he has never seen an OLED device that uses his proposed triple-layer protective structure, nor could he recall ever seeing in the literature a smoothing layer being on top of a gold film, with another inorganic barrier layer on top of the organic smoothing layer. *See id*. at 66:5-67:14, 71:11-19; *see also id*. at 67:1-14 (testifying that his group has "done planarization layers on top of gold …. But in our work I'm positive we did not put a third layer on top of that."). Dr. Subramanian also testified that even now he has still not seen the triple-barrier layer structure that he is proposing would have been obvious more than two decades ago at the time of the '389 patent. *See id*. at 71:11-72:2 ("Q. … I'm not just talking about at the time of the invention but since the invention as well. A. I understand. I mean, my answers would be the same."

72. Thus, Dr. Subramanian has not established that a person of ordinary skill in the art would have constructed the proposed triple-layer barrier by inserted an organic layer between a conductive barrier layer and an insulting barrier layer.



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### C. Dr. Subramanian Has Not Established That a POSITA Would Have Added An Organic Layer On Top of Kijima's Conductive Sealing Film

73. Dr. Subramanian contends that adding an organic layer would allegedly "help 'cover defects' and smoothen surface irregularities of the underlying conductive element, and would thus flatten the contours of Kijima's conductive layer 7 prior to depositing the Insulating layer 8." EX1004, ¶81. I do not agree.

74. Kijima says nothing about defects in either its conductive sealing film 7 or insulating film 8, as Dr. Subramanian acknowledges. EX2021, 2025-05-31 Subramanian Transcript at 129:9-130:2. Regarding Suzuki, the "defects" and "surface irregularities" it describes are in the cathode layer 18. *See* EX1012, 5:41-45 ("it is inevitable that some pinholes or defects be formed during the course of the formation of the cathode 18, through which moisture in air is adsorbed on the organic layer structure"), 5:52-54 ("defects or pinholes inevitably formed particularly in the uppermost cathode layer 18", 5:62 ("the relatively irregular surface of the cathode 18"). Thus, Suzuki only addresses the use of a double-layer barrier structure in which an organic layer is applied directly to the cathode in order to fill in pinholes and other defects or irregularities in the cathode's surface. That, however, is not what Dr. Subramanian proposes. Dr. Subramanian proposes to add the organic layer on top (not beneath) of Kijima's existing conductive



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sealing layer 7. This means the benefits Suzuki describes as being accomplished by its organic layer would not exist in the proposed combination because Kijima's cathode is already covered by the gold sealing film, and hence there are no cathode pinholes or irregularities for the organic layer to fill and there is no evidence that Kijima's gold sealing film would benefit from use with an organic layer.

75. I also note that Dr. Subramanian suggests that Kijima's conductive sealing film 7 is vulnerable to the same problems known to exist for the cathode surface (EX1004, ¶ 80), and that therefore "the added organic sealing layer would help 'cover defects' and smoothen surface irregularities of the underlying conductive element, and would thus flatten the contours of Kijima's conductive layer 7 prior to depositing the Insulating layer 8." EX1004, ¶ 81. But as I have explained in paragraphs 42-46 above (which I incorporate here), Kijima's gold sealing film does not suffer from the same defects as Suzuki's cathode 18. For example, the types of cathode defects described in Suzuki are pinholes or other defects "through which moisture in air is adsorbed on the organic layer structure." EX1012, 5:41-46; EX1001, ¶80. And on that front, Dr. Subramanian acknowledges that "[t]he likelihood of getting pinhole defects in a one micrometer film will be basically zero or close to zero" and "pinhole defects will be almost nonexistent" for a one micron thick gold film. EX2021, 2025-05-31 Subramanian Transcript at 61:16-22.



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76. Dr. Subramanian states in his declaration that "Kijima's conductive film 7 has a visibly uneven surface as illustrated in Figure 12." EX1001, ¶80. However, he agreed that Suzuki's layer 20 in FIG. 1 also "has an uneven surface" and that "just because a layer has an uneven surface as that term is used in paragraph 80 of [his] declaration doesn't mean that there would be a reason to add a planarization layer or smoothing layer on top of it." EX2021, 2025-05-31 Subramanian Transcript at 136:18-137:24.

77. I understand that Dr. Subramanian indicated that gold layers can have other types of defects, such as asperities caused by buckle defects, which he acknowledged can be as little as 10 nanometers for Kijima's 1-micron thick gold layer. EX2021, 2025-05-31 Subramanian Transcript at 29:22-31:4. While Dr. Subramanian suggested that even such minor asperities can be an issue, I do not agree. For example, the insulating film 8, which Kijima in fact says is optional, would be able to cover and address any minor imperfections in the surface of the conductive sealing film 7. I also note that Kijima says nothing about any issues with its gold conductive film, which is specifically designed to protect the underlying device. EX1010, [0055]; *see also id*., [0030], [0097], Claim 1. In particular, Kijima's conductive sealing film 7 is "thickly formed as a buffer layer" (EX1010, [0056]), and is "protecting the underlying organic layer and electrode and preventing oxidation of the electrode 1." EX1010, [0055]. Kijima discloses



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that, after depositing a 2k angstrom (i.e., 0.2 μm) thick cathode made of LiAl or SrAl (*see* EX1010, [0049], [0061], [0065], [0069]), a 10k angstrom (*i.e.*, 1 μm) thick gold-based conductive sealing film 7 is deposited under vacuum (*id.*, [0031]-[0032], [0050], [0062], [0066], [0070], [0052]). Then, without breaking vacuum, a 2k angstrom (0.2 μm) thick SiO2 or Al2O3-based insulating sealing film 8 is deposited on the gold sealing film 7. *Id.*, [0031]- [0032], [0051], [0052], 32[0063], [0067], [0071]. Devices made in this manner exhibit the same performance after one month in air with "almost no dark spots [] observed." *Id.*, [0055], [0064], [0068], [0072]. Kijima states that it is important to have a "thickly formed" conductive sealing film 7 "as a buffer layer during deposition." *Id.*, [0056]. This would indicate that any buckling defects that the gold film may experience are not negatively affecting the moisture and oxygen penetration, and could already be adequately addressed by the insulating sealing film 8 deposited directly on top of it.

78. Moreover, a POSITA would not think Kijima's conductive sealing film 7 suffered from asperities, as Dr. Subramanian postulates, when Kijima specifically limited the thickness of the insulating film 8 to just 0.2 μm in each of his four embodiments and three Comparative Examples. *See* EX1010, ¶¶ [0051], [0063], [0067], [0071], [0074], [0079], [0085] (2k angstrom = 0.2 μm). Given



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Kijima's main concern is degradation caused by oxidation and moisture, if Kijima observed asperities in conductive sealing film 7 which allegedly caused "weak spots," as Dr. Subramanian theorizes, Kijima would have simply indicated a thicker insulating film 8 was needed than just 0.2 μm. EX2021, 2025-05-31 Subramanian Transcript at 65:6-12 (describing "weak spots developing over asperities because the sharpness of the asperity defect"). In any event, Kijima did not report any observed issues with its double layer structure.

79. I also understand that Dr. Subramanian has never heard of putting a smoothing layer on top of a gold film, with another inorganic barrier layer on top of the organic smoothing layer, which runs counter to his contention that a POSITA would construct the proposed triple-layer barrier because Kijima's gold layer purportedly has defects.

80. Thus, given the thickness of Kijima's conductive sealing film 7 (at least 1 micron), the fact that gold is relatively soft, that the sealing film 7 is protecting the electrode, and the fact that it is the only barrier layer required by Kijima, Kijima's conductive sealing film 7 would not be expected to suffer from material defects such that a person of ordinary skill in the art would have sought to put a further smoothing layer on top of Kijima gold film conductive sealing film 7), and then another inorganic barrier layer on top of the organic smoothing layer to create a triple-layer barrier structure.



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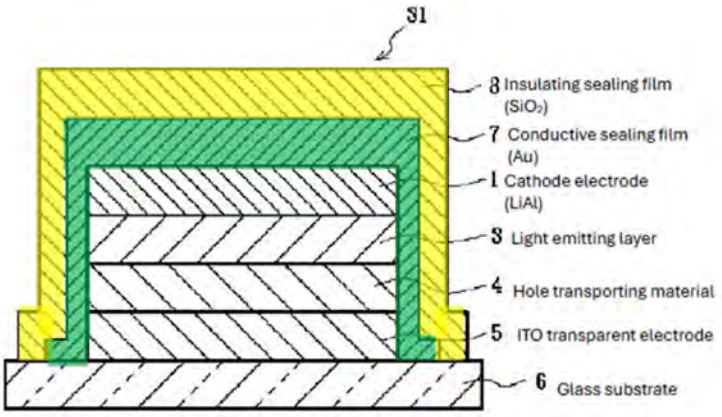
### D. Kijima's Existing Protective Double Layers Already Prevents Dark Spot Growth Better Than Suzuki's Approach

81. Kijima aims "[t]o provide a method for producing an optical element which exhibits good stability even when exposed to moisture and oxygen." EX1010, Abstract. Kijima observes that conventional OLEDs suffer from "a major problem" of "degradation." EX1010, [0026]. Kijima states that "the causes of this degradation are thought to include thermal degradation of the organic materials due to heat degradation accompanying light emission, the effects of moisture and oxygen contamination during production, and peeling of the organic layer due to oxidation of the cathode electrode." *Id.*

82. Kijima's solution is "[a] conductive sealing film 7 and an insulating sealing film 8 [that] are successively formed on a metal electrode 1 provided on a laminate body of organic layers 2, 3, and 4 including a light-emitting layer, and film formation is continuously performed in the same vacuum deposition device 11 as the organic layers 2, 3, and 4 and the metal electrode 1." *Id.*, [RESOLUTION MEANS]; *see also* [0027] ("When organic electroluminescent elements are applied to display devices and the like, the influence of the aforementioned factors on the life span of these elements is a major problem. Therefore, there is desire to provide a sealing film to protect the organic layer and the metal electrode, and then to continuously fabricate a sealing film structure in a vacuum.").



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83. According to Kijima, the result of this approach was that "almost no dark spots were observed, and the sealing effect of the sealing films 7 and 8 was remarkable." *Id*., [0054].

84. Kijima notes a second issue. In particular, "if the insulating sealing film is deposited in a vacuum deposition device, the effect of radiant heat during deposition of the insulating sealing film will be large, raising concern about the effect on organic layers such as the light emitting layer." *Id.*, [0028]. An object of Kijima is thus "to provide a method for producing a long-life optical element that hardly experience degradation of the organic layer and exhibits favorable stability even under atmospheric conditions." *Id.*, [0029].

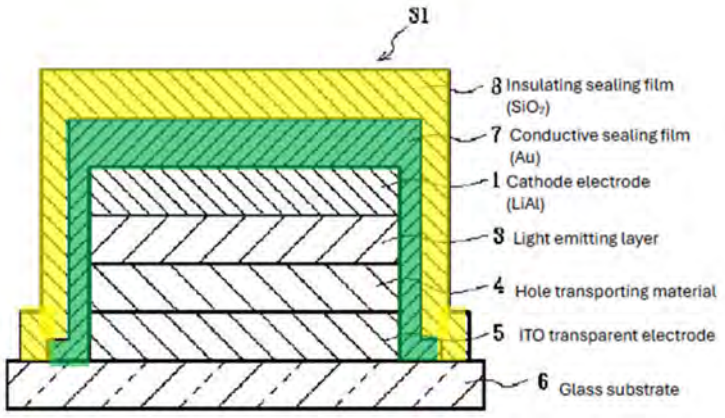
85. To address the perceived issue of radiant heat during deposition of insulating sealing film 8, Kijima proposes to use a conductive material "with good thermal conductivity," which can provide for "efficient dissipation of the radiant heat" and prevent "degradation of the organic layer due to radiant heat during



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vapor deposition of the insulating sealing film 8." Kijima, [0057], [0056]; *see also*, [0075] (emphasizing the importance of "providing the conductive sealing film ***adjacent to*** *and below* the insulating sealing film").

86. With reference to the figure below, Kijima proposes using "at least a conductive sealing film" 7 (green) on the top electrode (such as the cathode 1) "while maintaining the vacuum (and preferably further forming an insulating sealing film thereon)." *Id.*, [0030]. In the figure below, the conductive sealing film 7 is colored green and the insulating sealing film 8 is colored yellow.




87. Kijima discloses that, after depositing a 2k angstrom (i.e., 0.2 μm) thick cathode made of LiAl or SrAl (*see* EX1010, [0049], [0061], [0065], [0069]), a 10k angstrom (*i.e.*, 1 μm) thick gold-based conductive sealing film 7 is deposited under vacuum (id., [0031]-[0032], [0050], [0062], [0066], [0070], [0052]). Then, without breaking vacuum, a 2k angstrom (0.2 μm) thick SiO2 or Al2O3-based insulating sealing film 8 is deposited on the gold sealing film 7. *Id.*, [0031]-



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[0032], [0051], [0052], 32[0063], [0067], [0071]. Devices made in this manner exhibit the same performance after one month in air with "almost no dark spots [] observed." *Id.*, [0055], [0064], [0068], [0072].

88. Kijima also provides three comparative examples to emphasize the importance of conductive sealing film 7 and the need to maintain a vacuum before completing the deposition of the insulating sealing film 8. For example, in Comparative Example 1, the conductive sealing film is omitted. *Id.*, [0073]-[0074]. The resulting OLED is non-operative because "the organic layer had degraded due to radiant heat generated during deposition of the insulating sealing film 8." *Id.*, [0075]. This demonstrates the importance of "providing the conductive sealing film adjacent to and below the insulating sealing film[.]" *Id.* This is because being a "material with good thermal conductivity such as a metal," "efficient dissipation of the radiant heat can be expected." *Id.*, [0057]. Kijima states that it is important to have a "thickly formed" conductive sealing film 7 "as a buffer layer during deposition." *Id.*, [0056].

89. In Comparative Example 2, before depositing the conductive sealing film 7, the deposition chamber "was temporarily returned from vacuum to atmospheric pressure, and then the device was again evacuated to a vacuum." *Id.*, [0077]-[0078]. The resulting device showed significantly reduced stability and lifetime, with "a large number of dark spots." *Id.*, [0080]. This demonstrates the



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"adverse effects of exposing the elements to the atmosphere before the formation of the conductive sealing film 7," and 'the importance of … forming the conductive sealing film 7 under vacuum conditions." *Id.*, [0081].

90. In Comparative Example 3, before depositing the insulating sealing film 8, "the pressure inside the deposition device was temporarily returned from vacuum to atmospheric pressure, and then the device was again evacuated to a vacuum." *Id.*, [0084]. The resulting devices also showed worse performance with "an increase in dark spots" than a device whose sealing layers 7 and 8 were both deposited under vacuum. *Id.*, [0086]. This example demonstrates "the importance of forming all of the films under vacuum conditions." *Id.*, [0087]; see also [0058] ("the organic layer and above are formed continuously in the same vacuum deposition device, so productivity is high and there is no effect of oxygen in the atmosphere during production.").

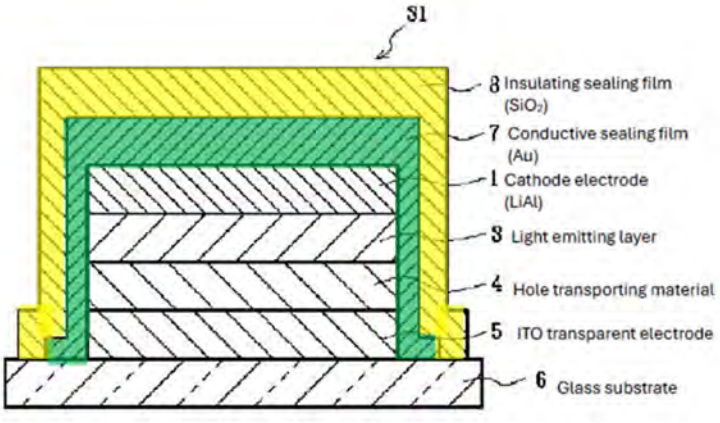
91. Thus, according to Kijima, (1) a sufficiently thick conductive sealing film such as a gold film of 1 micron and above is needed to address the radiant heat during the deposition of the inorganic sealing film 8; (2) both the conductive sealing film 7 and the inorganic sealing film 8 must be deposited under vacuum, without exposing the device to atmosphere before completing the deposition of both sealing layers.

92. Of note, Kijima does not describe the inorganic sealing layer 8 as a



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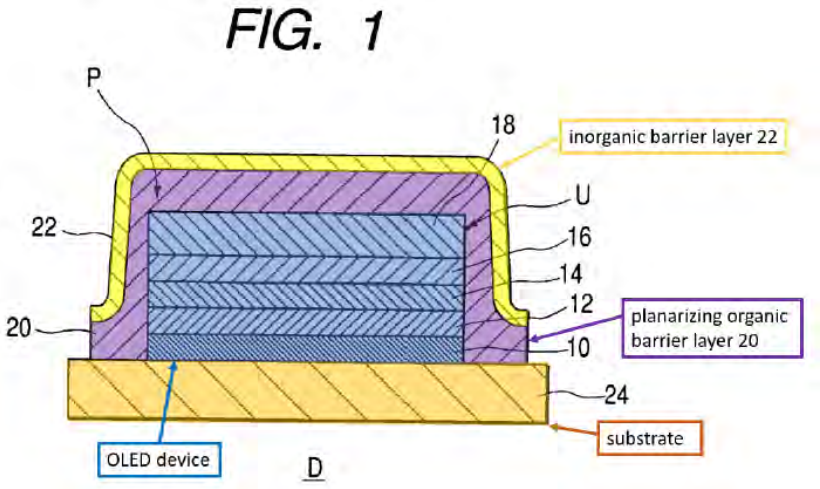
planarization layer. This is not surprising because the sealing layer 8 generally follows the topography of the underlying conductive sealing film 7. See below. That would suggest, as I note above, if an organic layer formed under vacuum is inserted between films 7 and 8, the inserted layer would likely assume the same topography as these two layers.




93. Suzuki also attempts to address the problem associated with "shortage of stability" and "dark spot[s]" in OLEDs. EX1012, 1:41-49. According to Suzuki, dark spots are caused by "moisture entering from defective portions" of the OLEDs. *Id.*, 1:50-52. Suzuki's solution is to provide a protective layer consisting of "an organic barrier layer 20 and an inorganic barrier layer 22." *Id.*, 2:26-29, 2:60-62, Fig. 1.



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EX1004, ¶ 50, 74 (annotated by Dr. Subramanian)

94. Suzuki does not describe organic barrier layer 20 as a "planarization layer." This is not surprising because Suzuki's organic layer generally follows the topography of the underlying layer but also creates steps near the edge of the OLED device that increases non-planarity of the underlying substrate, even though the organic layer can cover particles and other defects that are incidentally deposited on the surface of the underlying layer that is not designed to be part of the underlying layer's topography. I understand that Dr. Subramanian takes the position that Suzuki's organic layer can be a planarization layer because it has more rounded corners than the underlying cathode layer. A person of ordinary skill in the art would not consider the small curvatures at the corners, as shown in the figure, to be sufficient to make the organic layer one that reduces non-planarity, given the significant increase in non-planarity with the creation of steps.

95. Suzuki also does not mention masking during deposition of any of its layers. For example, the various layers can be deposited over the entire substrate surface and then selectively removed using laser ablation. *E.g.*, EX1006-Ghosh, [0032] (patterning may be achieved by "ablation… following layer formation").

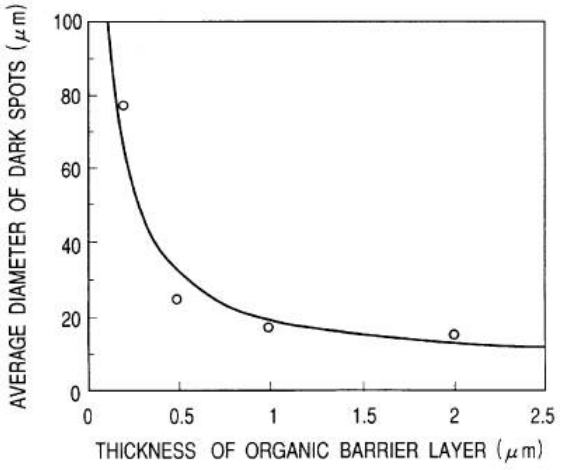
96. Unlike Kijima, Suzuki's devices still have dark spots, but the sizes of the dark spots are significantly reduced when the organic layer 20 is sufficiently thick, e.g., above 1 μm. *See* Fig. 4 (average diameter of dark spots approaches a plateau of slightly below 20 microns when the thickness of the organic barrier layer is 1μm and above).[4]

[4] Suzuki states that the threshold thickness is about 500 nm or 0.5 μm. But as shown in Figure 4, when the organic layer is 500nm thick, the size of the dark spots is still on the portion of the curve that is rapidly decreasing. A person of ordinary skill in the art would therefore consider the threshold thickness to begin at when the curve starts to flatten, or around 1μm.



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FIG. 4



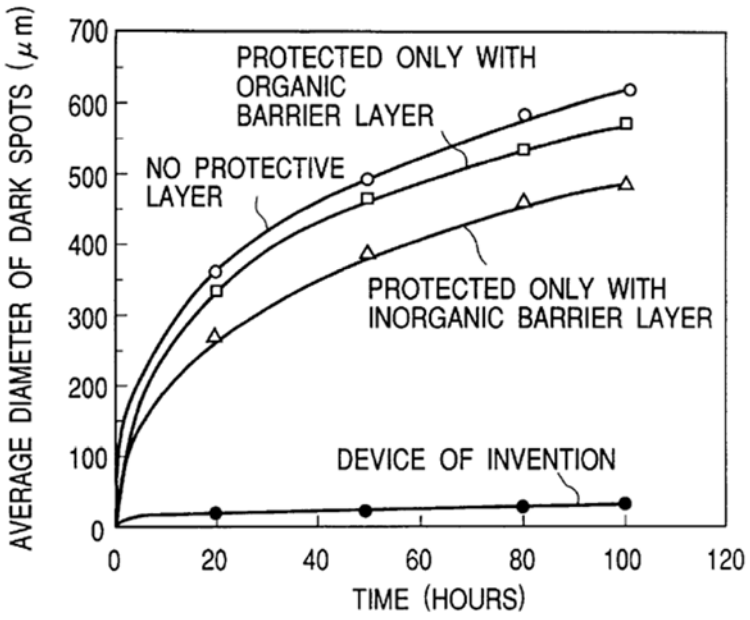

97. Suzuki describes its organic layer 20 as "exhibit[ing] good affinity for the metal or alloy cathode, cover[ing] defects in the electroluminescent unit U therewith and mak[ing] a smooth surface on the relatively irregularly surface of the cathode 18." EX1012, 5:59-62. Suzuki notes that "defects are mainly caused by foreign matter inevitably deposited on the electroluminescent unit U during the course of the fabrication thereof under very severely controlled conditions." *Id.*, 5:54-58. According to Suzuki, forming the inorganic barrier layer 22 "on the smooth surface of the organic barrier layer 20" "ensur[es] the formation of the layer 22, which is substantially defect-free and dense." *Id.*, 5:63-66. Suzuki uses the double-layer structure for moisture proofing and passivation. *Id.*, 5:66-67.

98. As shown below by the "Protected Only With Organic Barrier Layer" plot, Suzuki's organic layer 20 alone has relatively little impact on the decrease of dark spots.



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FIG. 3




99. The synergy observed between Suzuki's organic layer and inorganic layer that results in much improved protection against dark spots is due to the fact that Suzuki's cathode 18 allegedly has pinholes and other defects that the organic layer 20 can cover to provide a smoothing surface to ensure a defect-free and dense inorganic layer 22. *See* EX1012-Suzuki, Fig. 3 (compare performance of "Device of Invention" with the double layer structure with other plots), 5:59-67. But as I have noted above, there is no evidence that Kijima's gold film is suffering from the same "irregularities" as Suzuki's cathode 18. There is also no evidence that the addition of the organic layer would have further protected against dark spots compared to Kijima's existing double-layer sealing structure, such that a POSITA would have been motivated to make the proposed modification despite the added



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processing steps and the associated complications discussed below.

100. Thus, Dr. Subramanian has not adequately explained why a person of ordinary skill in the art would deviate from Kijima's double-layer barrier structure, which provides a "remarkable" sealing effect where "almost no dark sports were observed" based on the demonstrated modest improvement over no protective layer at all that is provided by adding an organic layer. EX1010, [0054].

101. Moreover, even if adding an organic layer provided a small improvement over no layer, that does not mean that the added organic layer would have any appreciable impact on Kijima's existing double-layer barrier structure. This is because Suzuki itself only compares the effectiveness of its organic layer to no layer at all, and Dr. Subramanian incorrectly treats Kijima as a single layer system.

### E. A POSITA Would Be Discouraged From Adding An Organic Layer to Kijima

102. Kijima discloses that devices made according to its double-layer method have "***almost no dark spots***" and that "the sealing effect of the sealing films 7 and 8 was remarkable." EX1010-Kijima, [0054], [0064] (same), [0068] (same), [0072] (same). And, I note that Dr. Subramanian presents no evidence or testing that suggests a thin organic film would have further improved Kijima EL device's resistance to moisture or dark spots.



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103. At the same time, a POSITA would have recognized that adding a third barrier layer to Kijima would have resulted in additional costs and potentially other material and processing issues due to the added organic layer in exchange for reduced performance. Pet., 32-36. This is because every time a layer is added, not only an additional processing step needs to be added, but one has to be concerned with issues such as

- Interfacial properties, including adhesions of the additional layer, to the layer immediately above and below (so it won't cause delamination)
- Stresses and associated failure caused by property mismatches between the new layer and the layer above and below, which can cause film stress; and the mismatched properties can be due to mismatches in thermal coefficients of expansion,
- the cohesion strength of the additional layer so it won't be the point of failure
- whether the deposition process of the additional layer is compatible with the already deposited layers and whether the deposited additional layer is compatible with the layer to be deposited, *e.g.*, whether there would be chemical reactions between layers



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- how it would affect light transmission, for example, whether it is sufficiently transparent to let through the desired wavelengths, how different or similar its refractive index is compared to the layer above or below, how thick it needs to be in order to provide the needed mechanical strength as well as resistance to moisture and oxygen, the incident light's angles and wavelengths
- added risk of contamination and defects with each additional deposition step.

104. Based on my experience, a POSITA would not have incurred the risks and expenses for additional process steps and materials, with no apparent benefits.

105. In addition, even if an OLED device without the thick gold layer could have defects on the cathode surface and could thus require a thick organic layer to attain the optimized protection against dark spots, Kijima's device—with its thick gold layer in combination with an insulating sealing film 8—does not suffer from the same problem and does not need an organic layer between the insulating sealing film 8 and the conductive film 7. EX1010-Kijima, [0030], [0056]-[0057], [0062]-[0064], [0066]-[0068], [0070]-[0072]. I note that, in contrast to Kijima's thick conductive layer of 1 μm and above, Suzuki's devices use only "a 150nm thick cathode." *See* EX1012-Suzuki, 8:11 (device having "a 150nm thick cathode"), 8:47-48 (same device as example 1), 8:64-65 (same), 9:13-14 (same),



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9:27-29 (same). The thinner cathode may suffer more from surface unevenness and because it is closer to the organic EL layer, it is more impacted by the particles generated by, *e.g.*, particulates from fine metal masks used to deposit the organic layers, a known complication associated with such masks. The soft and relatively thick gold film on top of the cathode would cover up those particulates.

106. Suzuki suggests that depositing only an inorganic barrier layer over an electrode is insufficient to prevent dark spots, (*see* EX1012-Suzuki, Figs. 3-4), but in Kijima an inorganic layer over a cathode already coated with a gold sealing layer is sufficient to prevent dark spots. *See* EX1010-Kijima, [0030], [0056]-[0057], [0062]-[0064], [0066]-[0068], [0070]-[0072]. This shows that Suzuki's cathode and Kijima's gold films are not comparable in terms of providing a suitable underlying surface for depositing the inorganic layer. Hence, even if the use of an organic layer was a known solution for addressing the dark spots caused by irregularities on Suzuki's electrode surfaces, that is not the situation presented in Kijima which does not suffer from that problem due to its existing dual sealing films and due to the different surface properties of the soft thick gold film versus the thin, hard cathode material. In other words, Kijima's encapsulation already effectively defends against oxygen and moisture to suppress dark spot growth, and I see no reason to believe that Suzuki's organic-inorganic layer structure would have brought any additional improvement in performance. I do, however, believe



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that a person of ordinary skill in the art would have recognized the additional costs needed to add the extra layer, and would not have done so if there were no expected benefit.

107. A person of ordinary skill in the art would also be deterred from inserting an organic layer between Kijima's conductive sealing layer and the insulating sealing layer because Kijima emphasizes the importance of "providing the conductive sealing film ***adjacent to*** and below the insulating sealing film[.]" EX1010-Kijima, [0073]-[0075]. For example, as demonstrated by Comparative Example 1, when the conductive sealing film is omitted, "the organic layer [EL] had degraded due to radiant heat generated during deposition of the insulating sealing film 8." *Id.*

108. A person of ordinary skill in the art would therefore recognize the importance of having a "material with good thermal conductivity such as a metal" so that "efficient dissipation of the radiant heat can be expected." *Id.*, [0057]. The person would recognize the importance of having a "thickly formed" conductive sealing film 7 that is "adjacent to and below the insulating sealing film" "as a buffer layer during deposition" (*id.*, [0056], [0075]), and follow that teaching.

109. Dr. Subramanian argues that because Kijima is concerned with radiant heat, reflection is most important. EX2021, 2025-05-31 Subramanian Transcript, 159:14-160:15. I disagree. Kijima mentions "radiant heat" because, under vacuum



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(as would be the case in Kijima's deposition process), heat transfer from the heat source (e.g., the evaporator) to the OLED substrate would occur almost exclusively through radiation because both conduction and convection would require some medium. But once that heat reaches the OLED, heat conduction pathway to remove that heat becomes important. For example, it would be beneficial to have the heat conducted away through the gold stripes to other parts of the substrate.

110. That is why Kijima emphasizes the need for "a material with good thermal conductivity," but mentions little about a highly reflective metal to reflect away the radiant heat (the mechanism that Dr. Subramanian emphasized at his deposition). I note that Dr. Subramanian provides no analysis on how the ability of heat conduction changes when an uncovered gold film is modified to one covered with polymers that are known to be poor heat conductors. And more importantly, it is not so much how Dr. Subramanian with many more years of experience would have viewed the problem, but how a person with skill levels defined by Dr. Subramanian would view. For instance, there is no indication that a person with the skill level defined by Dr. Subramanian would have studied heat transfer or fluid dynamics in order to make that determination.

111. Kijima emphasizes the importance of gold film's ability to protect the OLED organic layer from the radiant heat that reaches the OLED. EX1010-Kijima, [0075]. Given this critical feature, a person of ordinary skill in the art



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would be extremely hesitant to use a polymer-covered gold film during deposition of Kijima's insulating sealing film 8. This is particularly the case when Kijima expressly states that the gold film should be "adjacent to" the insulating sealing film 8. EX1010-Kijima, [0075]. A person of ordinary skill in the art with the skill level defined by Dr. Subramanian would not have enough experience in the displays, deposition techniques or heat transfer to make an independent assessment, but would instead follow the express instruction by Kijima.

112. I understand that Dr. Subramanian states that unlike the heat-sensitive OLED stack, there would be no concern with the stability of the organic sealing layer during inorganic deposition because those organic materials were often cured by applying heat. A 2021 review article on TFE observed, however, "[e]xposure to temperature and UV or particle radiation during inorganic deposition can lead to the organic layers' damage and instability." EX2030, p.5. The method for avoiding the damages were not reported until years after the invention date. *Id.* (ref. 18 date). At any rate, given the low skill level of the person of ordinary skill in the art and their inexperience in the field, but the understanding that OLED is extremely complicated with many countervailing considerations, unpredictable interactions, and poorly understood degradation pathways, they would not deviate from Kijima's express instruction of having the conductive sealing film "adjacent to" the inorganic layer.



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## IX. A POSITA Would Not Use Ink-Jetting to Deposit the Organic Layer Sequence in Kijima (Ground II – Claim 35)

113. None of Kijima, Suzuki and Sturm disclose using inkjet to deposit an organic layer in the context of encapsulating multiple devices on a substrate. For example, Dr. Subramanian agrees that "neither Kijima nor Suzuki hint using inkjetting to apply organic materials." EX2021, 2025-05-31 Subramanian Transcript, 114:16-21 ("Q: And we agree that neither Kijima nor Suzuki hint using inkjetting to apply organic materials. Correct? A. Yes, I think that's right. That's why I do the combination with Sturm for the claims that require inkjetting."). .

114. Sturm also does not discuss encapsulation, let alone using inkjet for that purpose. EX1013 (Sturm), 4:66-5:2; EX2021, 2025-05-31 Subramanian Transcript, 82:3-9 (Dr. Subramanian confirming that "it doesn't appear that there's any specific discussion of encapsulation within Exhibit 1013," Sturm). For example, in the figure on Sturm's cover page, layer 122 is formed by ink-jetting, with 122 being "a polymer semiconducting layer" having source/drain contacts 124/126 then formed over 122. EX1013, 6:52-67, Figs. 14(a)-(b). As another example, Sturm's Figures 7(a)-(c) show islands 22 and 24 deposited by inkjet, with electrodes 26, 28 then applied over 22 and 24. Id., 5:39-47. Likewise, in Figures 8(a)-(c), electrodes 40, 42, 44 are deposited over ink-jetted islands 34, 36 and 38 containing red, blue and green inks. Figures 9(a)-(c) use inkjet to deposit top and



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bottom contacts as well as organic materials contacting the contacts. *Id*., 5:64-6:5. Figure 10 involves ink-jetting top electrodes 60 and 62. *Id*., 6:6-13; *see also* 6:19-51 (ink-jetting used to deposit organic red/blue/green materials as well as contacts). None of the examples, however, involved using ink-jetting to deposit an organic layer for encapsulation, as Dr. Subramanian acknowledges. EX2021, 2025-05-31 Subramanian Transcript, 177:10-24 (stating "The devices and embodiments shown in Sturm do not have sealing and encapsulation layers of the type that we have been talking about in relation to the patent at issue.").

115. Because all three references do not disclose the limitation, the combination would not disclose the limitation either.

116. Duthaler also does not suggest using inkjet for depositing the organic sealing layer. Duthaler discloses "an addressing device for an electronic display," and "printing an encapsulant for protecting a portion of the addressing device." EX1016-Duthaler, 2:5-6, 2:13-30, 21:24-25:22. Duthaler, however, does not discuss OLED displays, but electrophoretic displays. *Id*.

117. Deposition techniques suitable for electrophoretic displays or "form[ing] electronic components or component arrays" (EX1016, 15:6-8) would not also be suitable for OLEDs. For example, electrophoretic displays do not share the same degree of sensitivity to moisture and oxygen as is well-known for OLED displays. For example, as shown in a recent paper demonstrates, the requirements



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for oxygen and moisture penetration rates in OLEDs are at least 1.5-4 orders of magnitude more stringent than other displays and applications.

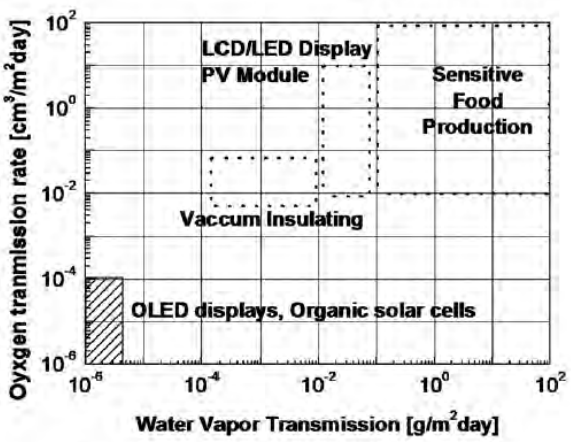



Figure 1. Barrier requirements for different applications.

EX2024, 2.

118. Duthaler describes electrophoretic displays as including "a capsule with one or more species of particle that either absorb or scatter light and that are suspended in a fluid." EX1016, 23:26-27. There is no evidence that any OLED devices would have this form of encapsulation.

119. A POSITA would not have considered an inkjetting process as described in Sturm would be suitable for forming an organic layer as required by Suzuki. In Sturm, "[t]he thickness of the dots ranged from 400 to 70 Angstroms," or about 40-70 nanometers. EX1013-Sturm, 4:20-24. This thickness is considerably thinner than the minimum of 500 nanometers needed to provide the needed sealing protection (EX1012-Suzuki, Fig. 4). Multiple passes would be required to obtain the needed thickness.



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120. But there is no evidence that inkjet printing a polymer-solution (Pet., 45) with multiple passes would provide the planarization property. Dr. Subramanian's 2003 work on gold nanoparticles demonstrates the difficulty in obtaining a planarized film using inkjet printing techniques, especially with materials that do not reflow to coalesce. *See* surface roughness for a gold film below.

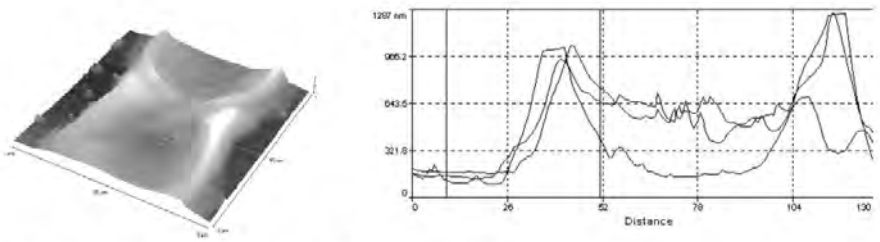



**Figure 2**: (left) atomic force micrograph showing the characteristics "coffee-ring" structure that results from splashing during droplet deposition, and (right) profilometry of a typical film formed using this process, showing the substantial roughness.

121. The same would be true for a polymer solution, which does not reflow at temperatures suitable for making OLEDs. While Dr. Subramanian was able to mitigate the coffee-ring effects by using elevated substrate temperatures (130-160ºC) coupled with lower-evaporation solvents that would not easily evaporate from the nozzles at the elevated temperatures, those conditions would not be suitable for OLEDs which are heat sensitive. *See* EX2021, 2025-05-31 Subramanian Transcript, 37:16-18 ("the OLED materials are extremely sensitive to heating"); EX1010-Kijima, [0056]-[0057] (using good thermal conductors to dissipate heat and prevent degradation of OLED organic materials). A substrate



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temperature of 130-160 ºC during TFE processing would likely result in thermal degradation of the EL organic materials and render the EL elements inoperable or at least reduce the EL elements lifetime, and therefore be unsuitable for OLED processing.

122. Dr. Subramanian observed that the coffee-ring effect and the resulting poor planarity was 'a known problem inkjet printing." EX2023 at 2 (H8.3.2). This may explain Sturm's reported degradation in device performance with inkjet printed OLED devices compared to spin coating. *See* EX1013 (Sturm), 5:13-16 ("FIG. 5 shows the L-I characteristic of the two devices, which shows that the efficiency of ***the ink-jet printed device is about a factor of two less efficient than the spin coated device***."); *see also id*., Figs. 4-5 and associated text; Subramanian Day 2 Final at 96:25-97:22. Spin coating, which is a more conventional approach, is already disclosed in Suzuki as being a deposition method suitable for its organic layer, as Dr. Subramanian acknowledges. *See* EX1012, 4:34-38, 6:26-27; EX2021, 2025-05-31 Subramanian Transcript at 115:6-10.

123. Hence, none of the prior art, including Sturm and Duthaler, shows that a planarization layer could be so obtained under conditions suitable for making OLED devices. Sturm and Duthaler and other evidence therefore does not suggest using inkjet to deposit a polymer solution to form an organic planarization layer as proposed. I further note that as Samsung's own expert, Dr. Antoniadis testified

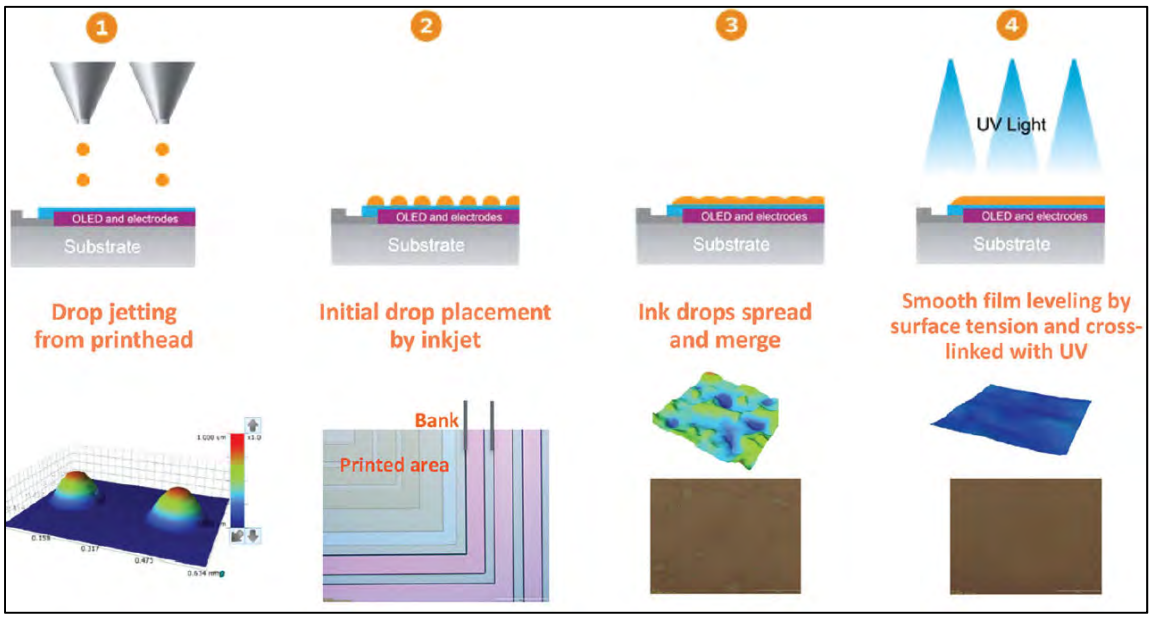


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that inkjet printing of OLED EL layer differs greatly from that for encapsulant. EX2031 (Antoniadis Transcript), 142:20-144:20 ("Q: Are you saying that the inkjet printing technology for TFE encapsulation is very different than the inkjet printing technology for the OLED pixel areas? A: Yes. Yes. That's a good question. Very different indeed. …."), 141:25-142:19 ("TFE doesn't qualify you for full color and vice versa, developing full color doesn't qualify you for TFE. These are different engines, right, so ***you cannot infer one from the other***."). For example, the ability to form a contiguous planar film over a large area is not a concern for Sturm's EL elements, but would be for an encapsulant covering a much larger area. *See* EX2023 [Subramanian_Molesa_2003], Fig. 2 (film size on the order of 100-microns); EX2039 (ams-OSRAM0000167) (pixel sizes on the order of 0.22 $m^2$, about $1/1090^{th}$ the 19.97mm×11.97mm active area of a display). In inkjet-printing based method, the organic film relies on effective ink drop spread and merge as well subsequent film leveling. *See* EX2030, Fig. 2; EX2034 p. 16. These steps become more challenging as the spreading and leveling areas increase. Additionally, as the encapsulant areas increase, the likelihood of solvent trapping and outgassing in subsequent steps becomes higher, which affect the resulting film's smoothness and porosity. I further reference my discussions in IPR2024-01222 on the different concerns for the inkjet printing process for EL versus encapsulation.



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124. Dr. Subramanian argues that if inkjet printing is used for the planarization layer, it could also be used for other layers. EX2021, 2025-05-31 Subramanian Transcript, 214:1-216:1. The proposal would not yield an operable structure.

125. First, as Dr. Subramanian's own paper indicates, before 2003, there were no suitable gold nanoparticles that could be sintered below 200 ºC, rending them unsuitable for OLEDs. See EX2025 (2003 paper reporting thiol-derivatized gold nanoclusters suitable for use in printed circuits on plastic); EX2021, 2025-05-31 Subramanian Transcript, 37:16-18 ("the OLED materials are extremely sensitive to heating"), 40:5-13 (claiming that the inorganic barrier layer in Suzuki was deposited at "barely above room temperature"), EX1010-Kijima, [0075] (radiative heat during Kijima's inorganic layer deposition degrades OLED organic

material). Hence, at the time of the invention, there is no evidence that inkjet could be used to form the gold film required to perform the sealing function.

126. Second, to form a suitable ink for the insulating inorganic film, the inorganic nanoparticles had to be surface-functionalized with suitable organic molecules in order to be dispersed in organic solvents. There are a number of issues with forming these nanoparticle solutions. First, at the time, typical colloidal silica and other particles for typical barrier layer materials—which are metal oxides and/or nitrides—tend to be hydrophilic. And it was (and still is) extremely difficult to remove water and solvents from the resulting film. But given the purpose of the organic sealing layer, their retention of water would not be suitable for the intended use.

127. Third, to get a 1 micron or so film, the particles cannot be larger than 1 micron, and given the propensity of particles to agglomerate, the particle sizes for a 1 micron thick film should not be more than one-tenth to one-quarter the film thickness.[5] Hence, the maximum particle size should be no more than 250 nanometers.

[5] This is consistent with Duthaler's disclosure that "the largest particle size should be smaller than one-fourth of the diameter of the ink jet orifice, but preferably is smaller than one-tenth of the diameter of the ink jet orifice." EX1016, 15:12-15. The stated particle size range would be based on an estimate of the degree of particle aggregation.



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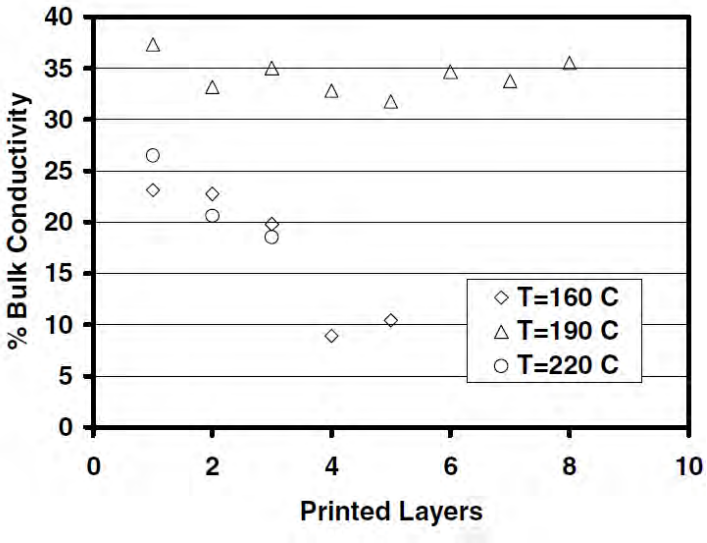
128. Because of the relatively small size of the particles, the surface areas of the particles are large. Hence, the loading of the particles must be fairly low to maintain the suitable viscosity for inkjetting (supposedly below 100cP, EX1016, 15:9-10). Additionally, these colloidal solutions tend to have increased viscosities upon shearing due to hydrogen bonding. *See* EX2026. Given that inkjetting would involve injection out of a nozzle subject to shear force, clogging could be a challenge. These solutions, however, tend to unstable at high temperatures, so heating to reduce viscosity may not be an option.

129. Fourth, nanofilms created from solutions, however, tended to be porous under process conditions suitable for OLEDs. (https://pubs.acs.org/doi/10.1021/cm034253d). For example, in https://pubs.acs.org/doi/10.1021/cm034253d (which does not involve inkjetting), $O_2$ plasma or calcification was used to remove residue organics from the resulting film. EX2027. I reference this paper even though it does not involve inkjet processing because it provides an estimate of the film porosity from a process where a large quantity of organics are used to compatibilize the silicate particle surface with solvents. After the lower-temperature $O_2$ plasma treatment (which might not be suitable for an OLED device), the film density was about 1.0 g/cm$^3$, significantly lower than the 2.2-2.6 g/cm$^3$ density for silica. *Id.* at 3311-3312. This means that the resulting material has a lot of porosity and is thus unsuitable to



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serve as a barrier against oxygen and moisture. Calcification can provide a dense film, but it needed to be done at 450 ºC (*id.*), which would be incompatible with an OLED device. Likewise, Dr. Subramanian's test results, showing that the conductivity of its 1-1.5 micron thick gold films was <40% of the bulk conductivity (and up to 70% for thinner films), indicate that there is considerable residual organics in the film. EX2023, at 4 (H.8.3.4, Fig. 6).




130. A porous film or a film with a large amount of organics would not be suitable as a barrier layer to keep out oxygen and moisture as those porous areas or areas containing organic materials would serve as a permeation path for oxygen and moisture. EX1012-Suzuki, 5:63-66 (inorganic barrier layer 22 should be "substantially defect-free and dense"). The protection against moisture would be further weakened if the surface functionalized group contains hydrophilic groups such as amine, amino acids, alkoxides. *See* EX2028. Thus, a person of ordinary



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skill in the art would not, as Dr. Subramanian alleges, use inkjet to form the barrier layers or the metal layers.

131. Additionally, Kijima makes clear "the importance of forming all of the films under vacuum conditions." EX1010, [0087]. In fact, Kijima warns against exposing devices to atmospheric conditions before forming a protective layer. *See* EX1010, [0076]-[0081] (a comparative example to demonstrate "the adverse effects of exposing the element [OLED device] to the atmosphere before the formation of the conductive sealing film 7"); see also *id*., [0082]-[0087]. Kijima does not explain why the failure occurs when the devices are exposed to atmosphere before encapsulation, only that failure occurs. Kijima's Comparative Example 3 demonstrates that even temporary exposure to atmospheric conditions results in "an increase in dark spots." *Id*., [0084]-[0086].

132. Dr. Subramanian proposes to deposit the newly added organic layer using Sturm's ink-jetting method followed by the inorganic barrier layer 8. EX1004, ¶¶ 100-102. However, Sturm's ink-jetting is performed under atmospheric conditions. EX1013-Sturm, 1:58-60 (describing drawbacks of vacuum depositing organic layers), 4:59-61 (describing use of a vacuum chamber only "***After*** ink-jet printing"); EX1016, 3:15-17 (contrasting "ink jet printing step" with "a printing step involving a vacuum based process"); EX2021, 05-31-2025 Subramanian Transcript, at 106:8-13 ("Q: And do you apply the inkjet in a



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vacuum? A. No. ….").

133. Weaver is a reference that Dr. Subramanian lists under the materials he considered. *See* EX1004, ¶ 8 (listing EX1008 as U.S. Patent Application Publication No. 2002/0140347 ("Weaver")). Weaver discusses the concern of susceptibility to oxygen and moisture which occurs after the cathode is deposited. Specifically, Weaver states that "[i]n forming an OLED, a layer of metal is typically utilized as the cathode to ensure efficient electron injection and low operating voltages. However, metals and their interface with the organic material are susceptible to oxygen and moisture, which can severely limit the lifetime of the devices. Moreover, moisture and oxygen are also known to increase 'dark spot areas' in connection with OLEDs." EX1008 (Weaver), [0004].

134. A POSITA would understand that even though inkjetting may be suitable for depositing organic light emitting layers, after cathode deposition, subsequent encapsulation steps must occur under vacuum conditions in order to obtain a suitable and operable OLED device. This is clearly important to Kijima. *See* EX1010-Kijima, [0076]-[0081] (comparative example 2, showing the "adverse effects of exposing the element to the atmosphere before the formation of the conductive sealing film 7").

135. Thus, given Kijima's warning against exposure to atmospheric conditions after cathode formation, a person of ordinary skill in the art would be



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dissuaded to use Sturm's inkjet method to apply the organic layer except under low pressure and controlled atmospheric conditions even when the cathode has other protective layers.

136. While Dr. Subramanian acknowledged that inkjet cannot be applied under vacuum conditions, he suggested during his deposition that it can instead be applied under nitrogen. *See* EX2021, 2025-05-31, Subramanian Transcript, 106:8-13. In particular, during his deposition Dr. Subramanian described a process using a "glove box" connected to the evaporator "[a]nd then you have an inkjet printer inside the glove box" which is itself under nitrogen so that "[y]ou come out of the evaporator, straight into the glove box which is under nitrogen and then the inkjet printer is under nitrogen." *See Id.* at 106:14-107:7. But Dr. Subramanian did not mention using a "glove box" or nitrogen in any manner in his declaration. Instead, Dr. Subramanian stated that he proposes "to use *depositing by ink jet* ***as taught in Sturm*** to selectively deposit the added organic sealing layer that serves as the *planarization layer* in the modified Kijima method." EX1004, ¶ 106 (bold emphasis added). Sturm, however, does not mention using a "glove box" or nitrogen at all, nor do any of the other prior art references. Therefore, using Dr. Subramanian's new "glove box" under nitrogen to inkjet print the added organic sealing layer would represent a significant modification of Dr. Subramanian's proposed "method of encapsulation" based on Kijima, Suzuki, and Sturm.



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137. There is also no evidence that performing inkjet printing under nitrogen would be suitable for modified Kijima. Pet., 41-46. Unlike the '389 patent which contemplates uses inkjet to apply monomers that will be subsequently cured ('389, 6:61-63), Samsung/Sturm proposes using "polymer solutions." Pet., 45. While monomers, such as acrylate monomers, are often liquids that can be dispensed without solvents, large amounts of solvents would be needed to formulate polymers into 100cP or less solutions. EX1016-Duthaler, 15:9-10. Outgassing of trapped solvents in the resulting polymer film in subsequent process or over time would be a major concern; and such outgassing would create voids susceptible to oxygen/moisture penetration as well as surface defects that negate the purported benefits for including the organic layer.

138. The main goal of Kijima is to provide a barrier solution that "hardly experiences degradation of the organic layer" (EX1010, [0029]) and which has "***almost no dark spots***". *Id*., [0054]. Modifying Kijima to use of ink-jetting would, appear to a person of ordinary skill in the art, directly undermine the effectiveness of Kijima's barrier as explained above. Thus, a person of ordinary skill in the art would not have been motivated to adopt an ink-jetting approach as proposed.

139. I would also note that Sturm's devices built with inkjet printing performed worse than the one built with spin coating. *See* EX1013 (Sturm), 5:13-16 ("FIG. 5 shows the L-I characteristic of the two devices, which shows that the



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efficiency of ***the ink-jet printed device is about a factor of two less efficient than the spin coated device***.”); *see also id*., Figs. 4-5; EX2021, 05-31-2025 Subramanian Transcript, at 96:25-97:22. I note that spin coating is a more conventional approach than inkjet printing. It is also expressly disclosed in Suzuki as being a deposition method for its organic layer, as Dr. Subramanian acknowledges. *See e.g.*, EX1012, 4:34-38, 6:26-27; EX2021, 05-31-2025 Subramanian Transcript, at 115:6-10.

140. Although depositing an active layer is very different than depositing an encapsulant and a person of ordinary skill in the art therefore would not look to the method of depositing fine components in the pixel regions for ideas on how to deposit an encapsulant, to the extent the method in one would inspire a person of ordinary skill in the art to apply the same in another, the significantly worse performance would demotivate the person of ordinary skill in the art to actually use the method.

141. Thus, in my opinion none of the prior art references cited by Dr. Subramanian, including Sturm, supports his argument that a POSITA would have been motivated to use ink-jetting to deposit an OLED barrier layer.

## X. A POSITA Would Not Use Screen-Printing to Deposit the Organic Layer Sequence in Kijima (Ground III – Claim 36)

142. As noted above, Kijima expressly teaches “the importance of forming



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all of the films under vacuum conditions." EX1010, [0087]. However, implementing Kijima's deposition methodology using screen-printing would break the vacuum before completing the encapsulation process because screen-printing is not performed under vacuum conditions, as Dr. Subramanian acknowledged. EX2021, 05-31-2025 Subramanian Transcript, at 177:25-178:18 (Dr. Subramanian testifying that he is "not aware of any specific examples of screen printing being performed in vacuum.").

143. I also note that Duthaler distinguishes "screen printing" with "a printing step involving a vacuum based process …." EX1016, 3:18-20. But Dr. Subramanian does not explain why a POSITA would ignore Kijima's express warning about atmospheric conditions and expose the device to atmospheric pressure before completing the entire encapsulation process.

144. As with inkjet printing, Dr. Subramanian suggested during his deposition that screen-printing can instead be applied under nitrogen to avoid atmospheric conditions. *See* EX2021, 05-31-2025 Subramanian Transcript, at 178:16-18 . But again Dr. Subramanian did not mention using nitrogen in any manner in his declaration. Instead, Dr. Subramanian stated that he proposes "to use *depositing by screen printing* ***as taught in Duthaler*** to selectively deposit the additional organic sealing layer that serves as the *planarization layer* in the modified Kijima method." EX1004, ¶ 106 (bold emphasis added). Duthaler,



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however, does not mention using nitrogen at all. Therefore, using Dr. Subramanian's new nitrogen approach to screen-print the added organic sealing layer would represent a significant modification of Dr. Subramanian's proposed "method of encapsulation" based on Kijima, Suzuki, and Duthaler.

145. Dr. Subramanian also does not demonstrate that using screen printing in Kijima would have improved Kijima's throughput or lowered its cost. For instance, Kijima expressly discloses that its existing deposition method forms the various layers "continuously in the same vacuum deposition device" and provides "high" "productivity," while precluding "effect of oxygen in the atmosphere during production." EX1010, [0058].

146. In fact, a POSITA would have been dissuaded from disrupting Kijima's continuous use of vacuum deposition with screen printing because screen printing requires a different set of equipment and operating conditions, and this would negatively impact Kijima's demonstrated high productivity. Specifically, screen-printing would require new equipment and cannot be easily integrated into Kijima's evaporative vacuum deposition chamber or conditions. Screen-printing would therefore likely disrupt Kijima's continuous use of vacuum deposition, which would negatively affect Kijima's productivity. Thus, screen-printing would not only expose the devices to air before completion of encapsulation, but would also require a new set of equipment and processing conditions. A person of



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ordinary skill in the art would recognize that instead of improving Kijima's productivity or lowering Kijima's cost, including screen printing in Kijima would actually increase cost by requiring a new set of equipment beyond the vacuum deposition chambers that Kijima already has and would lower the productivity. This is because now, instead of forming films "continuously … in the same vacuum deposition device 11," the devices need to be removed from the vacuum deposition device to screen-print the organic layer, dry the organic layer and then put the devices back into the vacuum deposition device.

147. Solvent trapping and the subsequent voiding and non-planarity due to outgassing would be an even bigger concern than inkjet printing because screen printing requires higher viscosity compositions than inkjetting and it does not have the benefit of solvent drying during drop flight. EX2021, 2025-05-31 Subramanian Transcript, 119:19-22 (screen printing viscosity in the range of "thousands to tens of thousands of millipascal seconds" or thousands to tens of thousands cP); EX1016-Duthaler, 15:6-10 (inkjet "demands the use of low viscosity fluids (i.e., fluids having viscosities below approximately 100 cP); Subramanian 2003 paper (discussing solvent drying during ink droplet flight)

## XI. A POSITA Would Not Have Been Motivated to Modify a Kijima-Suzuki Method of Encapsulating OLED Devices Based on Fujimori (Ground IV – Claims 41-46)

148. As an initial matter, Dr. Subramanian has not shown that claims 41-46



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are obvious for the reasons I described above in Sections VI & VIII, which apply to all grounds.

149. In addition, a POSITA would not have used Fujimori's mask in Kijima. This is because the problem that Fujimori attempts to address is that of deposition material wrapping around and under the shadow, which is particularly an issue for fine patterned masks. EX1014, [0008]. According to Fujimori, this is a significant problem that can "cause a short in the elements and crosstalk due to increased leakage current." EX1014, [0008]. I also note that Fujimori's motivations to mitigate shorts and crosstalk would only apply to conductive films and materials, not to the organic monomers/polymers and inorganic barrier layers taught by Suzuki.

150. But Fujimori as a whole does not disclose or suggest using its magnetized masks for depositing encapsulation layers, be it an organic planarization layer or an inorganic barrier layer. *See* EX1014 *generally*. Instead, Fujimori uses the magnetized masks to deposit

- (1) electrodes, in particular the electrodes above the (OLED) organic layers, *see* EX1014, [0026], [0041]-[0042], [0044], [0047], [0048];
- (2) materials to create closely spaced blue, green and red multicolor regions, *see* EX1014, [0050]; and
- (3) non-emission regions such as the black matrix that blackens the



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gaps between the light-emitting region to improve contrast or pixel define layers that surround/define emission regions and insulate electrodes from one another, *see id.*, [0027].

151. Notably, for the non-emission regions such as the black matrix, in the actual examples, no masks were used to develop the black matrix. *See id.*, [0049]. Instead, "spin-coating" followed by "conventional photolithography method" was used "to form a black layer … that served as both a spacer and a black matrix." *Id.* Moreover, for non-conductive layers used for encapsulation, magnetic masks would be an unnecessary complication since conventional shadow masks would be adequate for OLED encapsulation applications. Thus, a POSITA would not have used Fujimori's magnetic mask to deposit Kijima's encapsulation layer.

152. A person of ordinary skill in the art also would not use Fujimori's magnetized mask to deposit the proposed organic encapsulation layer because the insulating organic layers won't "cause a short in the elements" or "crosstalk," the problem that led to Fujimori's invention. EX1014, [0008]. That is, there lacks a motivation of the person of ordinary skill in the art to use Fujimori's magnetized mask for depositing the organic encapsulation layer.

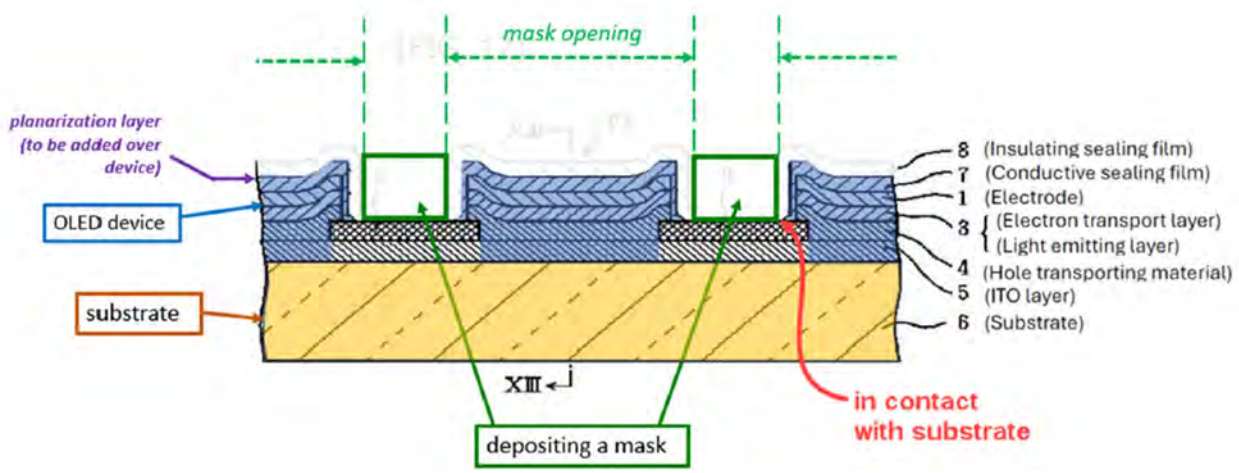
## XII. The Proposed Combination of Ground IV Does Not Satisfy the Additional Limitations of Claim 43

153. Claim 43 further recites that the "the step of depositing said mask



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further comprises depositing said mask such that said mask is in contact with said substrate." Dr. Subramanian provides the annotated version of Kijima's FIG. 12 below to suggest that the mask for the planarization layer would be in contact with Kijima's substrate.

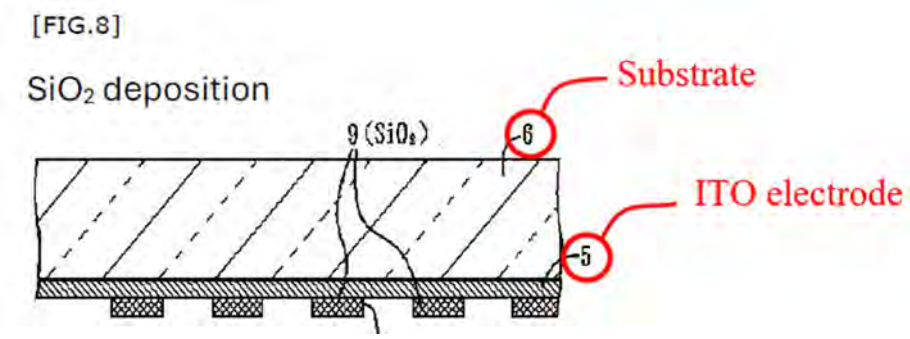



EX1004, ¶ 147.

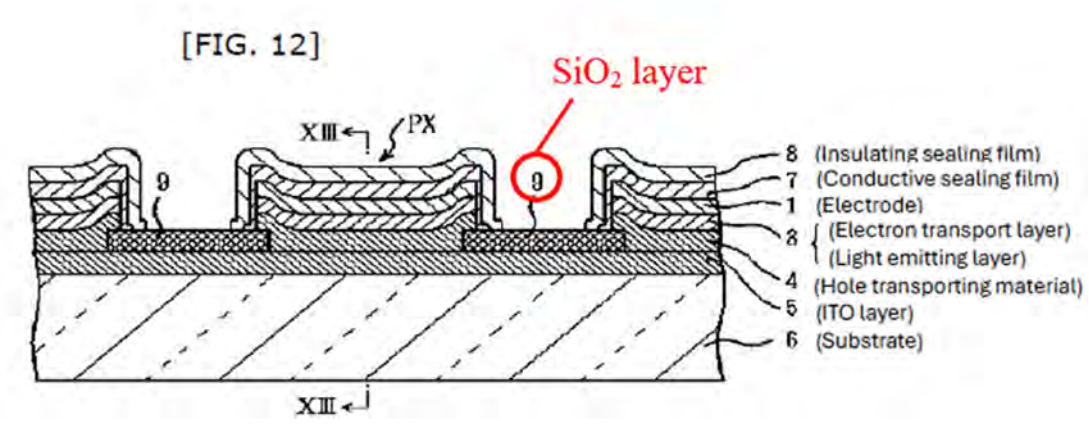
154. However, the red arrow added by Dr. Subramanian, labeled "in contact with substrate," is not actually pointing to the top of Kijima's substrate 6, which he has highlighted in beige. Instead, when Fujimori's mask is used to deposit the alleged planarization layer from Suzuki, which is necessarily *after* Kijima's has deposited the ITO electrode 5, as shown above, the substrate will have been covered at that point by at least the ITO electrode 5 as well as the insulating SiO2 area 9. EX1010, [0040]. I have annotated Kijima's FIG. 8 below to show this.



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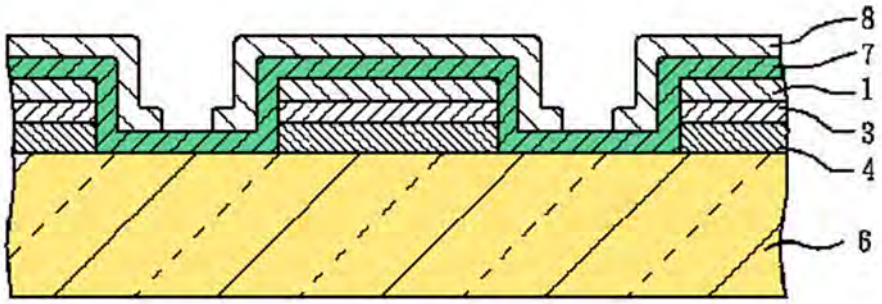

155. In addition to the substrate 6 being covered by the ITO electrode 5, Kijima also discloses that the $SiO_2$ layer 9 is deposited on the entire surface as well. EX1010, [0040] (describing that after the ITO electrode 5 is deposited on the glass substrate 6, "then $SiO_2$ 9 is deposited on the entire surface, which is then etched into a prescribed pixel pattern to form a large number of openings 15, through which the transparent electrodes 5 are exposed."). Thus, the red arrow Dr. Subramanian added to the annotated version of FIG. 12 above is actually pointing to the top surface of $SiO_2$ layer 9, which is above the ITO electrode 5, and not to the top of substrate 6. See below.




156. FIG. 13 of Kijima depicts FIG. 12 along line XIII-XIII of FIG. 12. As

shown in the annotated version of FIG. 13 below, the substrate 6 (beige) is covered by the conductive sealing film 7 (green), as shown below.

[FIG. 13]




157. I also note that Dr. Subramanian confirmed that the ITO electrode 5 is part of the device, not the substrate, and also that "Region 9 is not part of substrate 6." EX2021, 05-31-2025 Subramanian Transcript, at 189:3-15, 189:24-190:4. This means that the prior art combination for Ground IV cannot deposit Fujimori's mask on top of said substrate (as required by Element 41[b]), and also deposit the alleged planarization layer from Suzuki upon that same mask (as required by Element 41[c]), while also depositing the mask "in contact with the substrate" (as required by Claim 43).

## XIII. Conception and Reduction to Practice

### A. Conception

#### 1. February 8, 2001 Email

158. The challenged claims 34, 35-37, 41 and 46 of the '389 Patent were conceived by February 8, 2001. An email chain on that day confirms that the



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inventors had conceived the concepts described in the patent. *See* EX2029 (same as IPR2024-01222, EX2006) [Invention Disclosures] at 1. The February 8, 2001 email exchange indicates that the discussion relates to "producing an array of small displays on a large plate of glass," i.e., to producing multiple display devices on a substrate. *Id.* at 1.

159. The email exchange also indicates that it relates to producing a multi-layer encapsulation that includes at least one organic layer and a barrier layer over the organic layer. This is understood from the reference to "PML," "LML" (or liquid PML, see EX2042_U.S.2008/0008893) and the use of the term "barrier layer." The '389 Patent explains how the term "PML" would have been understood by the inventors. According to the inventors, "PML" is the abbreviation for "polymer multi-layer," which "comprise[es] alternating and repeating layers of an organic (usually acrylate or the like) and a barrier layer." EX1001-'389 Patent, 1:19–22. The inventors understood PML structures as "[t]ypically" including "a planarization layer" that "is provided to give a planar surface" for deposition of an upper layer, such as another PML structure or a "barrier layer." *Id.*, 1:31–37, 1:41–44.

160. The planarization layer may be formed on top of an OLED device or a barrier layer. *Id.*; *see also id.* Fig. 6 (planarization layer 106 formed over an OLED device 104 and a planarization layer 110 formed over a barrier layer 108). The



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inventors regarded barrier layers as "provid[ing] the necessary environmental isolation from the corrosive effects of oxygen and moisture." *Id.*, 1:39–41.

161. The '389 patent's background section also explains that "the primary reason that a planar organic layer is typically used as a substrate upon which the barrier layer deposited" is to ensure that "[t]he barrier layer should ideally not contain any point defects (i.e. pin holes) in its surface." *Id.*, 1:56-62. That is, the organic layer interrupts or minimizes defect propagation from one layer to another. *Id.*

162. The inventors' understanding of the structure of the PML and the respective layers' functions as reflected in the '389 patent's background section matches the construction of the planarization layer in the '389 Patent: "a layer of material that planarizes such that the propagation of defects from one layer to another layer can be interrupted and the topography of the underlying layer and/or structure is not reproduced." EX2019 (Claim Construction Hearing) at 28:25-29:5, 31:15-21, 35:5-8, 40:20-25.

163. In the email, Inventor Pichler referenced "PML" and "LML" and discussed a non-selective deposition technique involving "spinning … a …cross-linkable solution … with subsequent cross-linking and barrier layer sputtering …." EX2006, p.1. Inventor Frischknecht responded with proposals for selectively depositing an "acrylate layer" while "keeping the electrical pins free of the



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coating" and "masking the areas for the scribe lines[.]" *Id.* Those selective deposition techniques included "vapor deposition through a shadow mask," ink-jetting, screen printing and/or spin-coating via a mask. *Id.* Given this context, a POSITA would understand that the inventors were discussing selectively depositing an organic planarization layer of the PML. That is, even though the term "planarization layer" does not appear in the email communications, the reference to "PML" and the inventors' general understanding of the structures and functions of "PML" indicates that the inventors had conceived the concept of an organic "planarization layer" as part of their conception. *See also*, *e.g.*, EX1001-'389 Patent, 1:17–22, 1:30–36, 1:41–44.

164. The inventors exchanged ideas for selectively depositing organic (planarization) layers and barrier layers to avoid deposition on scribe lines and electric pins. EX2029 [Invention Disclosures] at 1. Those included depositing the organic layer by ink-jetting, screen printing using a mask, and vaporization through a mask, and depositing the barrier layer by sputtering "through a mask." *Id.* For example, Inventor Frischknecht expressed his preference for "vapor deposition through a shadow mask" and his expectation that this method "will keep the pins free of coating." *Id.* He also suggested "masking the area for the scribe lines" as "a good practice" because he is "not too sure if scribing through the [PML] multilayer is a good idea." *Id.* He also proposed ink-jetting, screen printing and/or spin-



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coating via a mask for depositing at least the organic layer. *Id.* Inventor Pichler in turn suggested sputtering the barrier layer through a mask to selected areas over the OLED devices to leave contact pads and scribe lines free of the barrier layer. *Id.*

165. The email also indicates that Inventor Frischknecht proposed using a "shadow mask" to cover areas other than the OLED devices, and then depositing an acrylate planarization layer through the shadow mask. Specifically, Frischknecht said that he had "previously considered spin coating the acrylate layer," but also "anticipated that vapor deposition through a shadow mask will keep the pins free of the coating." *Id.* Frischknecht therefore suggested that "it very well may be that vapor deposition through a shadow mask is the easiest method for producing an array of small displays on a large plate of glass." *Id.* Frischknecht's proposal also indicates that he conceived the acrylate layer covering potentially the entire mask. For example, Frischknecht stated that the mask would likely cover the "pins" as well as the "scribe lines." *Id.* Frischknecht also asked for Inventor Pichler's input on using a mask while "spin coating" the organic layer. *Id.*

166. The specification of the '389 Patent makes clear that the inventors understood that this mask could be placed against the devices and removed after use. The specification refers to a "shadow mask", and explains that this mask "might be a film laminated to the OLED or a mask pressed or pushed or clamped to the OLED." EX1001-'389 Patent, 7:2, 7:28–29. The mask also "might be a



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multi-use mask ***or a one-off that then gets removed***." *Id.*, 7:30–31. The specification further explains that that the inventors would have understood that such a mask could be made of various kinds of material, including "a metal, ceramic, or plastic foil or sheet; it could also comprise a PTFE (Teflon) or a poly-Siloxane type material (e.g. polydimethylsiloxane) or generally any material that does not stick to the OLED." *Id.*, 7:32–35.

167. The following chart provides an element-by-element mapping of the ideas conceived by February 8, 2001 against the elements of the asserted claims:

| **Element** | **Evidence** |
|---|---|
| 34[pre] & 34[a] | "[I]t may very well be that vapor deposition through a shadow mask is the easiest ***method for producing an array of small displays on a large plate of glass.***" |
| 34[b] | "I anticipate that vapor deposition through a shadow mask will keep the pins free of the coating; therefore I have been quite partial to the vapor deposition method. Also I am not too sure if scribing through the multilayer is a good idea; therefore, I anticipate that masking the area for the scribe lines will be a good practice."<br><br>"[I]t very well may be that ***vapor deposition through a shadow mask*** is the easiest method for producing an array of small displays on a large plate of glass."<br><br>"[W]e could consider printing techniques (Screen/Inkjet)."<br><br>"Any thoughts on masking for spin coating"? |
| 34[c] | "Spin-, roll- or whatever-coat, cross-link/cure and then ***sputter the dielectric barrier through a mask over the*** |

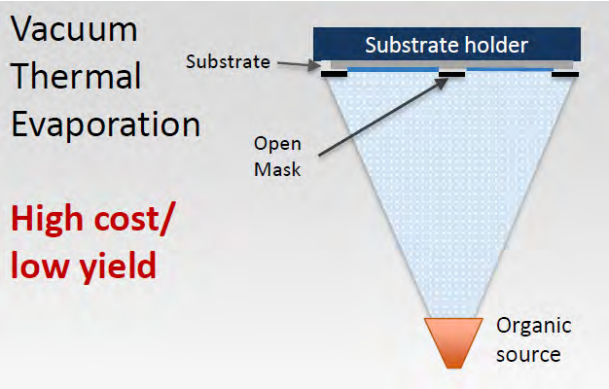


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| | |
|---|---|
| | ***OLED area only***, i.e. leave the contact pads, scribe lines, etc. free from the barrier and then stick the whole thing in, for example, a plasma asher and ash-off the organic where there is no dielectric barrier film." |
| 35-36 | "[W]e could consider printing techniques (Screen/Inkjet)." |
| 37 | "I anticipate that vapor deposition through a shadow mask will keep the pins free of the coating; therefore I have been quite partial to the vapor deposition method. Also I am not too sure if scribing through the multilayer is a good idea; therefore, I anticipate that masking the area for the scribe lines will be a good practice." |
| 41[pre] & 41[a] | "[I]t may very well be that vapor deposition through a shadow mask is the easiest ***method for producing an array of small displays on a large plate of glass.***" |
| 41[b] | "I anticipate that vapor deposition ***through a shadow mask*** will keep the pins free of the coating . . . . Also, I am not too sure if scribing through the multilayer is a good idea; therefore, I anticipate that ***masking the area for the scribe lines*** will be a good practice."<br><br>"Any thoughts on ***masking for spin coating?***"<br><br>"[I]t very well may be that ***vapor deposition through a shadow mask*** is the easiest method for producing an array of small displays on a large plate of glass."<br><br>(A person of ordinary skill in the art would understand that shadow masks would be placed on top of substrate, with the opening placed on top of the devices so that the materials to be deposited would encapsulate the devices.) |
| 41[c] | "[I]t may very well be that ***vapor deposition through a shadow mask*** is the easiest method for producing an array of small displays on a large plate of glass." |



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| | |
|---|---|
| | "Any thoughts on ***masking for spin coating?***"<br><br>"[I]t very well may be that ***vapor deposition through a shadow mask*** is the easiest method for producing an array of small displays on a large plate of glass."<br><br>"YES, I believe there may be a combination technique with spin-coating that I believe should work … Spin-, roll- or whatever-coat, cross-link/cure and then sputter the dielectric barrier through a mask over the OLED area only, i.e. leave the contact pads, scribe lines, etc. free from the barrier and then stick the whole thing in, for example, a plasma asher and ash-off the organic where there is no dielectric barrier film."<br><br>(A person of ordinary skill in the art would understand that vapor deposition through a shadow mask would generally deposit materials on both the mask and through the opening onto the plurality of devices to be encapsulated.) *See* illustration below. EX2034, p. 14.<br><br> |
| 41[d] | "I anticipate that vapor deposition ***through a shadow mask*** will ***keep the pins free*** of the coating . . . . Also, I am not too sure if scribing through the multilayer is a good idea; therefore, I anticipate that ***masking the area for the scribe lines*** will be a good practice."<br><br>"YES, I believe there may be a combination technique with spin-coating that I believe should work … Spin-, roll- or whatever-coat, cross-link/cure and then sputter the |

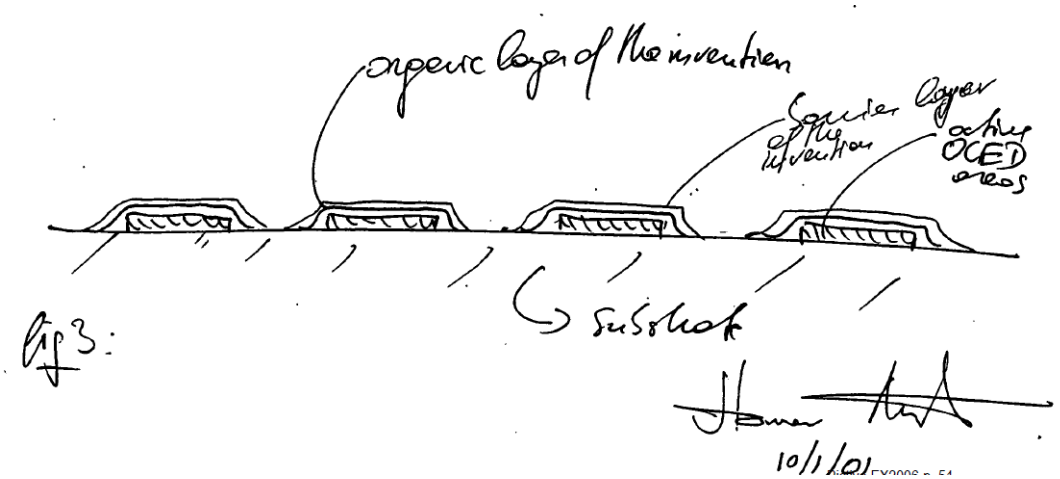
| | |
|---|---|
| | dielectric barrier through a mask over the OLED area only, i.e. leave the contact pads, scribe lines, etc. free from the barrier and then stick the whole thing in, for example, a plasma asher and ash-off the organic where there is no dielectric barrier film."<br><br>(A POSITA would understand that the vapor deposition mask used for the organic layer deposition is removed in order to use the mask for sputtering the barrier layer.) |
| 41[e] | "Spin-, roll-, or whatever-coat, cross-link/cure and then ***sputter the dielectric barrier through a mask over the OLED area only***, i.e. leave the contact pads, scribe lines, etc. free from the barrier. . . ." |
| 46 | "I anticipate that vapor deposition through a shadow mask will ***keep the pins free of the coating***; therefore, I have been quite partial to the vapor deposition method. Also, I am not too sure if scribing through the multilayer is a good idea; therefore, I anticipate that ***masking the area for the scribe lines*** will be a good practice. . . . [I]t very well may be that vapor deposition through a shadow mask is the easiest method for producing an array of small displays on ***a large plate of glass.***" |

### 2. September 30, 2001 Invention Disclosures

168. The invention disclosures witnessed on Oct. 1, 2001, included the following figure showing an "organic layer of the invention" deposited upon the "active OLED areas" (which are fabricated on "Substrate") and covered by "barrier layer of the invention":



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EX2029, p. 51).

169. It can also be seen that the barrier layers and the organic layers are deposited in selected areas, *e.g.*, not between the active OLED areas. *Id.* Both the lab notes dated August 14 and August 15, 2001 and witnessed on October 1, 2001 and the invention disclosures witnessed on October 1, 2001 also discussed the use of ink-jetting to dispense the organic layer. *E.g.*, EX2029, p. 42 ("I conceived a significant part of this invention, namely ink-jet printing of the UV-curable liquid prior to the dielectric deposition on August 14, 2001 and did not tell anybody about it.").

170. This is materially the same as Figure 5 of the issued '389 patent which describes an example of a process that falls within the scope of claim 34:



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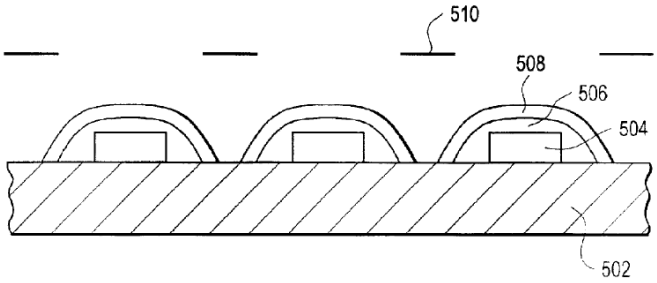
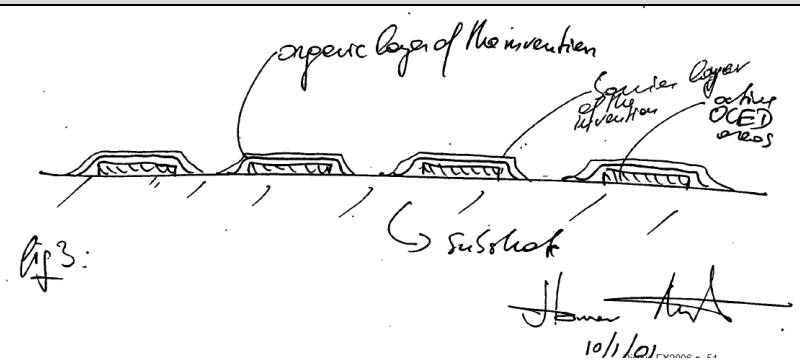
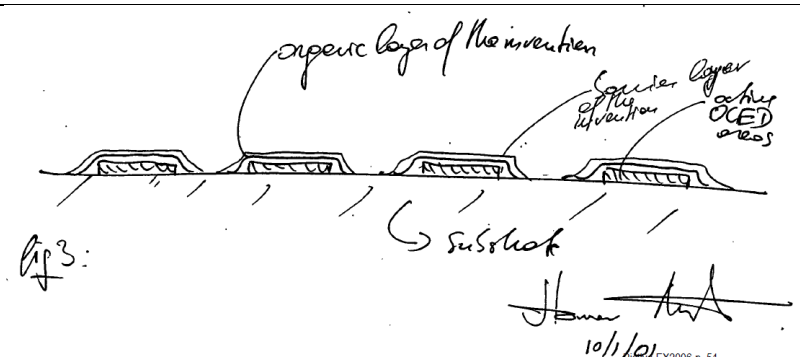



FIG. 5

171. Hence, in addition to the February 8, 2001 email, the witnessed invention disclosures provide further support of earlier conception (*i.e.*, no later than October 1, 2001):

| **Element** | **Evidence** |
|---|---|
| 34 [pre]. A method of encapsulating a plurality of devices fabricated upon a substrate, the steps of said method comprising:<br><br>34[a] fabricating a plurality of devices on a substrate; | <br>(EX2029, p. 51)<br><br>(showing encapsulation of multiple active OLED areas on a substrate, each active area having at least one fabricated OELD device, where the barrier layer and the organic layer are selectively deposited over |

| | |
|---|---|
| | the organic planarization layer, but not in between active areas).<br><br>1. A process for directly encapsulating a multitude of OLED devices fabricated on an undevided substrate sheet (can be foil) by putting the encapsulation layer directly (in contact with) on the top-most layer of the to-be encapsulated OLED displays and by using a combination of at least one organic layer and at least one inorganic barrier layer whereby said organic layer is deposited / condensed on the OLED substrate in the form of an unpatterned liquid film; whereby: the unpatterned liquid film is cross-linked in a patterned manner, non-cross-linked areas are subsequently removed, followed by the deposition, in a patterned manner, of a barrier layer over at least part of the layer covered with the cross-linked organic layer.<br><br>17. New independent claim: As claim 1 but this time the organic is deposited and cured (if necessary) ALL OVER and only the barrier layer is deposited in a patterned manner, said patterned barrier layer also then acts as an etch stop to remove the organic over unwanted areas (i.e. the areas where the barrier layer is not deposited).<br><br>28. New independent claim: As claim 1 and 17 but now the organic itself is already during the deposition (by nature of the deposition process itself) deposited in a patterned manner, then curing of the organic (if necessary as e.g. for the UV-curable organics) then patterned deposition of the barrier, no need to remove e.g. non-UV-cured organic.<br><br>(EX2029, pp. 47-48) |
| 34[b] selectively depositing at least one planarization layer upon said devices; and | <br>(showing the oganic planarization layer is selectively deposited upon the OLED devices, but not in between active areas).<br><br>Additionally, ink-jetting is preferred application method:<br><br>Has this invention been prototyped or tested yet? If so, when, where, by who? What were the results? Not tested yet; internally I am certain and outside our company - I am not aware of anybody who tried it and/or any prior art; Important note: I conceived a significant part of this invention, namely ink-jet printing of the UV-curable liquid prior to the dielectric deposition on August 14, 2001 and did not tell anybody about it; I did some prior art seaching to check UV-curable liquid ink-jet printing. Only when I sat down to write this invention disclosure and looked up old e-mails (that to Kyle Frischknecht on Feb 8, 2001), I realized that in fact Kyle was thinking about ink-jet (or screen printing) of the PML UV-curable liquid plus other parts of the invention himself also; see attached e-mail conversation.<br><br>(EX2029, p. 42) |



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28. New independent claim: As claim 1 and 17 but now the organic itself is already during the deposition (by nature of the deposition process itself) deposited in a patterned manner, then curing of the organic (if necessary as e.g. for the UV-curable organics) then patterned deposition of the barrier, no need to remove e.g. non-UV-cured organic.

29. As claim 28 whereby the organic is deposited through a shadow mask using methods as described for claims 1 and 17.

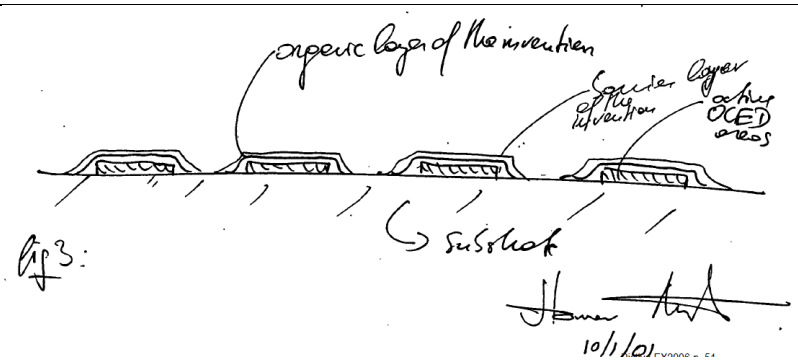
30. As claim 28 whereby the organic is printed, in particular using screen-printing or ink-jet printing.

(EX2029, p. 48)

28. New independent claim: As claim 1 and 17 but now the organic itself is already during the deposition (by nature of the deposition process itself) deposited in a patterned manner, then curing of the organic (if necessary as e.g. for the UV-curable organics) then patterned deposition of the barrier, no need to remove e.g. non-UV-cured organic. Note added on October 14, 2001: we need to make sure to write this broad in the sense that any printing technique suitable for printing the organic layer of the invention is used; ink-jet or screen-printing (below) are only preferred.

(EX2029, p. 10)

34[c] selectively depositing at least one barrier layer over said planarization layer.




(showing the barrier layer is selectively deposited over the organic planarization layer, but not in between active areas).

1. A process for directly encapsulating a multitude of OLED devices fabricated on an undevided substrate sheet (can be foil) by putting the encapsulation layer directly (in contact with) on the top-most layer of the to-be encapsulated OLED displays and by using a combination of at least one organic layer and at least one inorganic barrier layer whereby said organic layer is deposited / condensed on the OLED substrate in the form of an unpatterned liquid film; whereby: the unpatterned liquid film is cross-linked in a patterned manner, non-cross-linked areas are subsequently removed, followed by the deposition, in a patterned manner, of a barrier layer over at least part of the layer covered with the cross-linked organic layer.

17. New independent claim: As claim 1 but this time the organic is deposited and cured (if necessary) ALL OVER and only the barrier layer is deposited in a patterned manner, said patterned barrier layer also then acts as an etch stop to remove the organic over unwanted areas (i.e. the areas where the barrier layer is not deposited).

28. New independent claim: As claim 1 and 17 but now the organic itself is already during the deposition (by nature of the deposition process itself) deposited in a patterned manner, then curing of the organic (if necessary as e.g. for the UV-curable organics) then patterned deposition of the barrier, no need to remove e.g. non-UV-cured organic.

(EX2029, pp. 47-48)

| | |
|---|---|
| 35. The method as recited in claim 34 wherein the step for selectively depositing at least one planarization layer further comprises depositing by ink jet of an organic layer. | 1. A process for directly encapsulating a multitude of OLED devices fabricated on an undevided substrate sheet (can be foil) by putting the encapsulation layer directly (in contact with) on the top-most layer of the to-be encapsulated OLED displays and by using a combination of at least one organic layer and at least one inorganic barrier layer whereby said organic layer is deposited / condensed on the OLED substrate in the form of an unpatterned liquid film; whereby: the unpatterned liquid film is cross-linked in a patterned manner, non-cross-linked areas are subsequently removed, followed by the deposition, in a patterned manner, of a barrier layer over at least part of the layer covered with the cross-linked organic layer.<br><br>28. New independent claim: As claim 1 and 17 but now the organic itself is already during the deposition (by nature of the deposition process itself) deposited in a patterned manner, then curing of the organic (if necessary as e.g. for the UV-curable organics) then patterned deposition of the barrier, no need to remove e.g. non-UV-cured organic.<br>29. As claim 28 whereby the organic is deposited through a shadow mask using methods as described for claims 1 and 17.<br>30. As claim 28 whereby the organic is printed, in particular using screen-printing or ink-jet printing.<br><br>(EX2029, p. 48)<br><br>Has this invention been prototyped or tested yet? If so, when, where, by who? What were the results? Not tested yet; internally I am certain and outside our company - I am not aware of anybody who tried it and/or any prior art; Important note: I conceived a significant part of this invention, namely ink-jet printing of the UV-curable liquid prior to the dielectric deposition on August 14, 2001 and did not tell anybody about it; I did some prior art seaching to check UV-curable liquid ink-jet printing. Only when I sat down to write this invention disclosure and looked up old e-mails (that to Kyle Frischknecht on Feb 8, 2001), I realized that in fact Kyle was thinking about ink-jet (or screen printing) of the PML UV-curable liquid plus other parts of the invention himself also; see attached e-mail conversation.<br><br>(EX2029, p. 42) |
| 36. | 1. A process for directly encapsulating a multitude of OLED devices fabricated on an undevided substrate sheet (can be foil) by putting the encapsulation layer directly (in contact with) on the top-most layer of the to-be encapsulated OLED displays and by using a combination of at least one organic layer and at least one inorganic barrier layer whereby said organic layer is deposited / condensed on the OLED substrate in the form of an unpatterned liquid film; whereby: the unpatterned liquid film is cross-linked in a patterned manner, non-cross-linked areas are subsequently removed, followed by the deposition, in a patterned manner, of a barrier layer over at least part of the layer covered with the cross-linked organic layer.<br><br>28. New independent claim: As claim 1 and 17 but now the organic itself is already during the deposition (by nature of the deposition process itself) deposited in a patterned manner, then curing of the organic (if necessary as e.g. for the UV-curable organics) then patterned deposition of the barrier, no need to remove e.g. non-UV-cured organic.<br>29. As claim 28 whereby the organic is deposited through a shadow mask using methods as described for claims 1 and 17.<br>30. As claim 28 whereby the organic is printed, in particular using screen-printing or ink-jet printing.<br><br>(EX2029, p. 48) |
| 37. | 1. A process for directly encapsulating a multitude of OLED devices fabricated on an undevided substrate sheet (can be foil) by putting the encapsulation layer directly (in contact with) on the top-most layer of the to-be encapsulated OLED displays and by using a combination of at least one organic layer and at least one inorganic barrier layer whereby said organic layer is deposited / condensed on the OLED substrate in the form of an unpatterned liquid film; whereby: the unpatterned liquid film is cross-linked in a patterned manner, non-cross-linked areas are subsequently removed, followed by the deposition, in a patterned manner, of a barrier layer over at least part of the layer covered with the cross-linked organic layer. |

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| | 28. New independent claim: As claim 1 and 17 but now the organic itself is already during the deposition (by nature of the deposition process itself) deposited in a patterned manner, then curing of the organic (if necessary as e.g. for the UV-curable organics) then patterned deposition of the barrier, no need to remove e.g. non-UV-cured organic.<br>29. As claim 28 whereby the organic is deposited through a shadow mask using methods as described for claims 1 and 17.<br><br>(EX2029, p. 48) |
| 40 | 1. A process for directly encapsulating a multitude of OLED devices fabricated on an undevided substrate sheet (can be foil) by putting the encapsulation layer directly (in contact with) on the top-most layer of the to-be encapsulated OLED displays and by using a combination of at least one organic layer and at least one inorganic barrier layer whereby said organic layer is deposited / condensed on the OLED substrate in the form of an unpatterned liquid film; whereby: the unpatterned liquid film is cross-linked in a patterned manner, non-cross-linked areas are subsequently removed, followed by the deposition, in a patterned manner, of a barrier layer over at least part of the layer covered with the cross-linked organic layer.<br><br>14. As claim 1 whereby the barrier layer (materials and deposition methods see above) is sputtered through shadow mask over the area of UV-cured organic. A mask old: Sam's =<br><br>28. New independent claim: As claim 1 and 17 but now the organic itself is already during the deposition (by nature of the deposition process itself) deposited in a patterned manner, then curing of the organic (if necessary as e.g. for the UV-curable organics) then patterned deposition of the barrier, no need to remove e.g. non-UV-cured organic.<br><br>(EX2029, pp. 47-48)<br><br>The deposition of the barrier layer can be any suitable method known in the prior art to deposit dielectric layers, e.g. sputtering or reactive sputtering (DC, AC; pulsed, combinations thereof, etc.). Evaporation of such dielectrics (resistive heating or electron-beam) or metal films is possible also and so are ion-beam assisted deposition methods or other plasma-enhanced deposition methods.<br><br>(*id.* at p. 47) |

### 3. October 14, 2001 Supplemental Invention Disclosures

172. The supplemental disclosure on October 14, 2001 provides clear support that the inventions claimed by claims 41 and 43-46 were conceived no later than October 14, 2001:

**Material added on October 14, 2001 (see lab book 07, page 12):**

This goes on somewhere after the independent claim 28 and its dependent claims and this section could be the basis for another independent claim, namely:

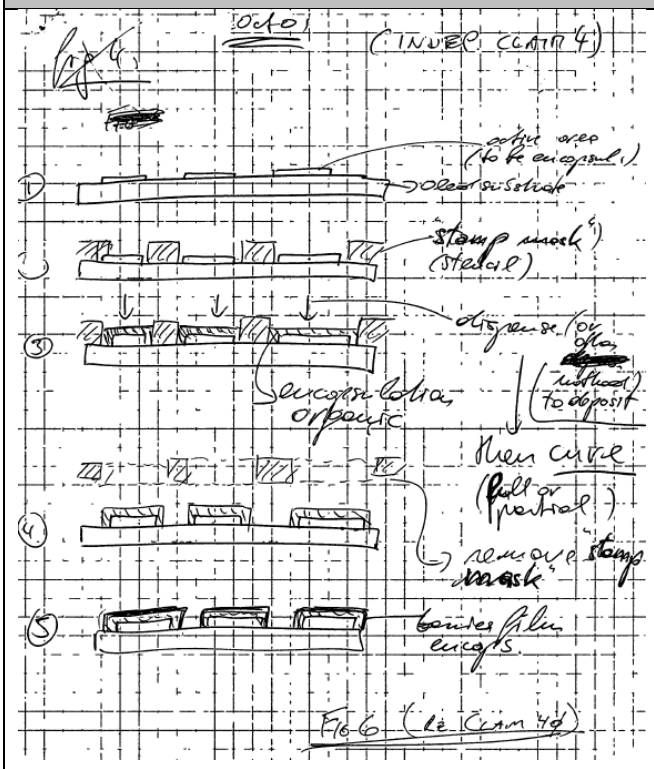
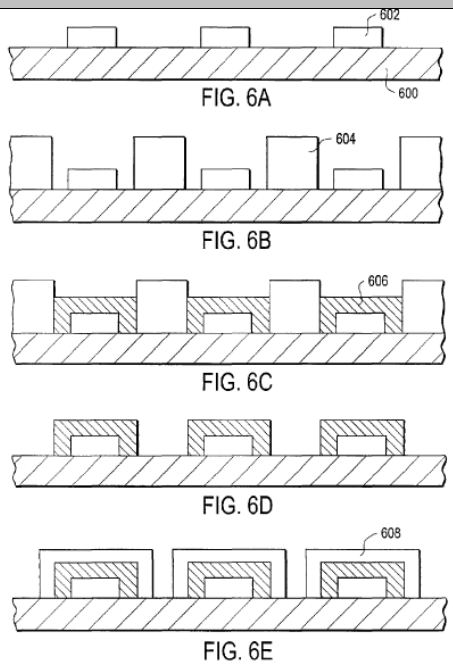
As e.g. claim 28 but instead of directly printing the organic using e.g. screen-printing or ink-jet printing the OLED is covered with a mask which is in direct contact with the OLED and the organic (e.g. the UV cure epoxy) is then dispensed, squashed, rolled, blade coated, dropped into, sprayed onto, etc. the mask openings and then the cure happens; after the cure the mask is removed and the OLED encapsulation (i.e. with the barrier film deposition continues); said mask to confine the organic has openings over the area where the encapsulation on the OLED needs to happen. Said mask could be a film laminated to the OLED or a mask pressed or pushed or clamped etc. to the OLED. The cure of the organic while the mask (to confine the organic) is there could be a multi-step cure, e.g. partical cure, remove the mask and then complete the cure. Said mask could be a multi-use mask or a one-off (e.g. in the case of a lamination) that then gets thrown away. Said mask could be a metal, ceramic or plastic foil or sheet; could in particular be a PTFE (Teflon) or a poly-siloxane-type material (e.g. polydimethylsiloxane such as often used for soft lithography) or generally any material that does not stick to the OLED (too much to cause damage or delaminate OLED material from the OLED glass when the mask is removed) and a material to which the encapsulation organic does not stick to well so that the mask removal after encapsulation organic deposition and cure (complete or partial) does not remove encapsulation organic. …… but the mask is such that it can be brought in contact with the OLED sufficiently well so that the encapsulation organic is confined over the desired areas and does not seep under the areas where the encapsulation organic is not desired (e.g. contact pads etc.). Said mask is some sort of a 'stamp-mask'. See figure 4 below for a brief description of this concept. This concept is in particular useful for liquid encapsulation organics (see PML).

(EX2029, p. 11)

173. In fact, Fig. 6A-6E of the '389 patent are materially the same as the drawings dated Oct. 1, 2001 (EX2029, p. 8):



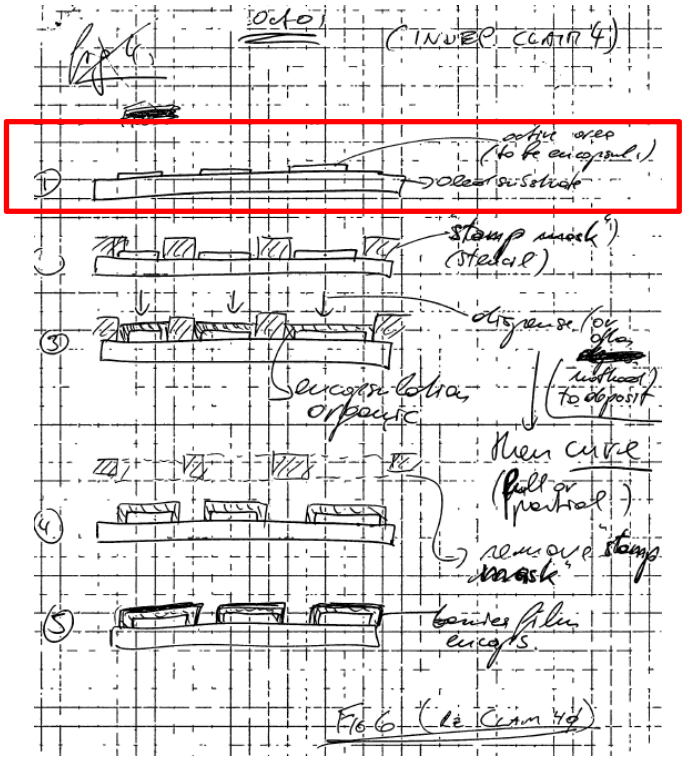
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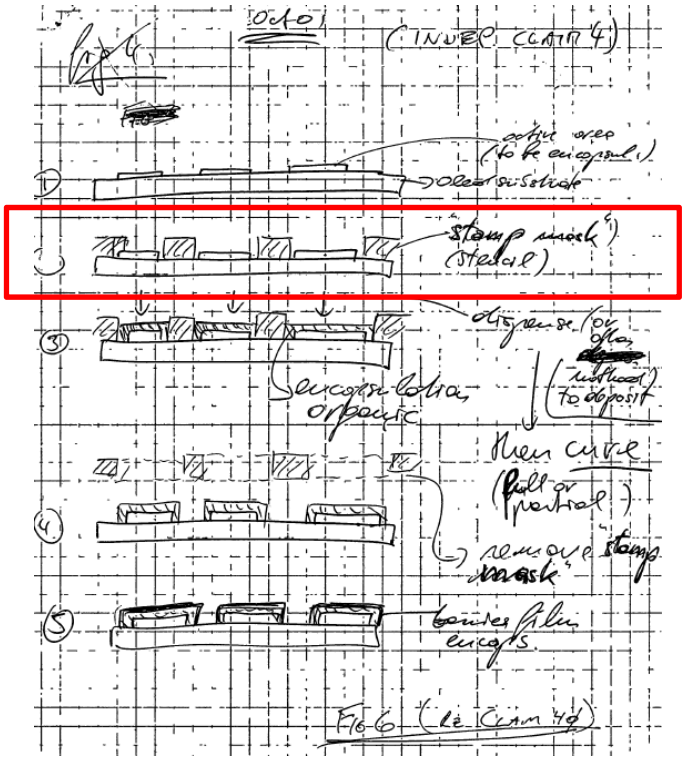
| IPR2024-01222, EX2006, p. 8: | ’389, Fig. 6: |
|---|---|
|  |  |

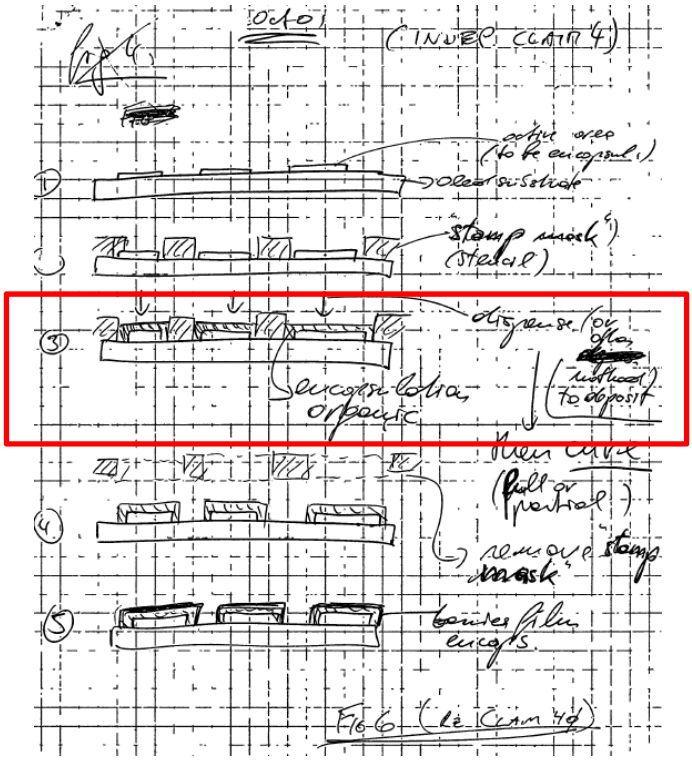


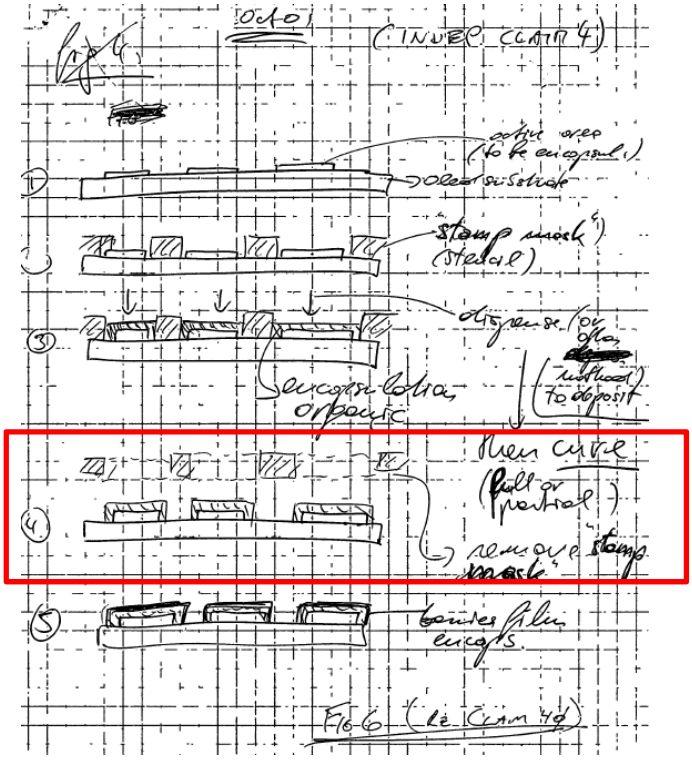
174. Thus, claims 41 and 43-46 were clearly conceived before Pagano:

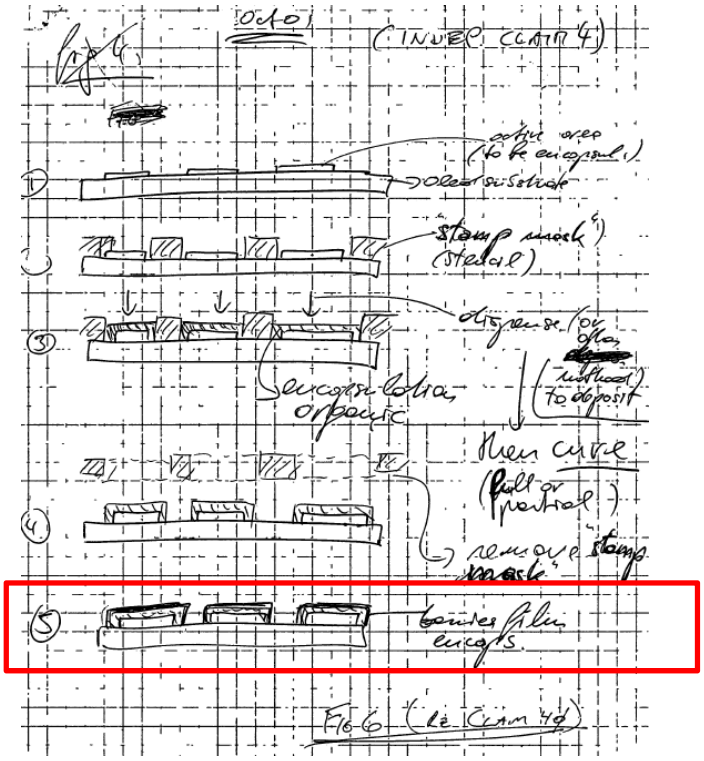
| Element | Evidence |
|---|---|
| 41 [pre]. A method of encapsulating a plurality of devices fabricated upon a substrate, the steps of said method comprising:<br><br>41[a] fabricating a | 1. A process for directly encapsulating a multitude of OLED devices fabricated on an undevided substrate sheet (can be foil) by putting the encapsulation layer directly (in contact with) on the top-most layer of the to-be encapsulated OLED displays and by using a combination of at least one organic layer and at least one inorganic barrier layer whereby said organic layer is deposited / condensed on the OLED substrate in the form of an unpatterned liquid film; whereby: the unpatterned liquid film is cross-linked in a patterned manner, non-cross-linked areas are subsequently removed, followed by the deposition, in a patterned manner, of a barrier layer over at least part of the layer covered with the cross-linked organic layer.<br><br>17. New independent claim: As claim 1 but this time the organic is deposited and cured (if necessary) ALL OVER and only the barrier layer is deposited in a patterned manner, said patterned barrier layer also then acts as an etch stop to remove the organic over unwanted areas (i.e. the areas where the barrier layer is not deposited).<br><br>28. New independent claim: As claim 1 and 17 but now the organic itself is already during the deposition (by nature of the deposition process itself) deposited in a patterned manner, then curing of the organic (if necessary as e.g. for the UV-curable organics) then patterned deposition of the barrier, no need to remove e.g. non-UV-cured organic. |

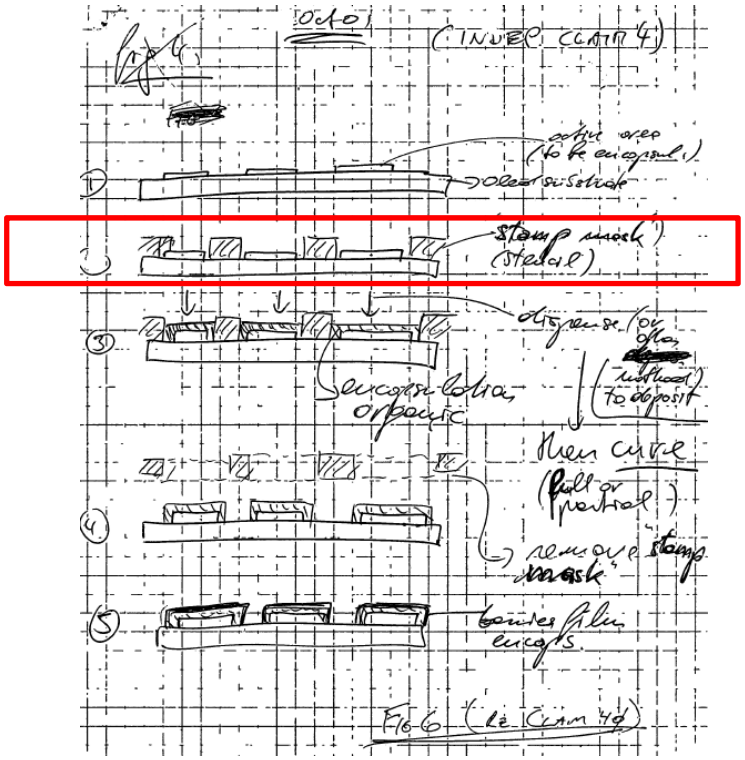
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|---|---|
| plurality of devices on a substrate; | (EX2029, pp. 47-48)<br><br>As e.g. claim 28 but instead of directly printing the organic using e.g. screen-printing or ink-jet printing the OLED is covered with a mask which is in direct contact with the OLED and the organic (e.g. the UV cure epoxy) is then dispensed, squashed, rolled, blade coated, dropped into, sprayed onto, etc. the mask openings and then the cure happens; after the cure the mask is removed and the OLED encapsulation (i.e. with the barrier film deposition continues); said mask to confine the organic has openings over the area where the encapsulation on the OLED needs to happen. Said mask could be a film laminated to the OLED or a mask pressed or pushed or clamped etc. to the OLED. The cure of the organic while the mask (to confine the organic) is there could be a multi-step cure, e.g. partical cure, remove the mask and then complete the cure. Said mask could be a multi-use mask or a one-off (e.g. in the case of a lamination) that then gets thrown away. Said mask could be a metal, ceramic or plastic foil or sheet; could in particular be a PTFE (Teflon) or a poly-siloxane-type material (e.g. polydimethylsiloxane such as often used for soft lithography) or generally any material that does not stick to the OLED (too much to cause damage or delaminate OLED material from the OLED glass when the mask is removed) and a material to which the encapsulation organic does not stick to well so that the mask removal after encapsulation organic deposition and cure (complete or partial) does not remove encapsulation organic. ..... but the mask is such that it can be brought in contact with the OLED sufficiently well so that the encapsulation organic is confined over the desired areas and does not seep under the areas where the encapsulation organic is not desired (e.g. contact pads etc.). Said mask is some sort of a 'stamp-mask'. See figure 4 below for a brief description of this concept. This concept is in particular useful for liquid encapsulation organics (see PML).<br><br>(IPR2024-01222 EX2006, p. 11)<br><br><br><br>(EX2029, p.8) |

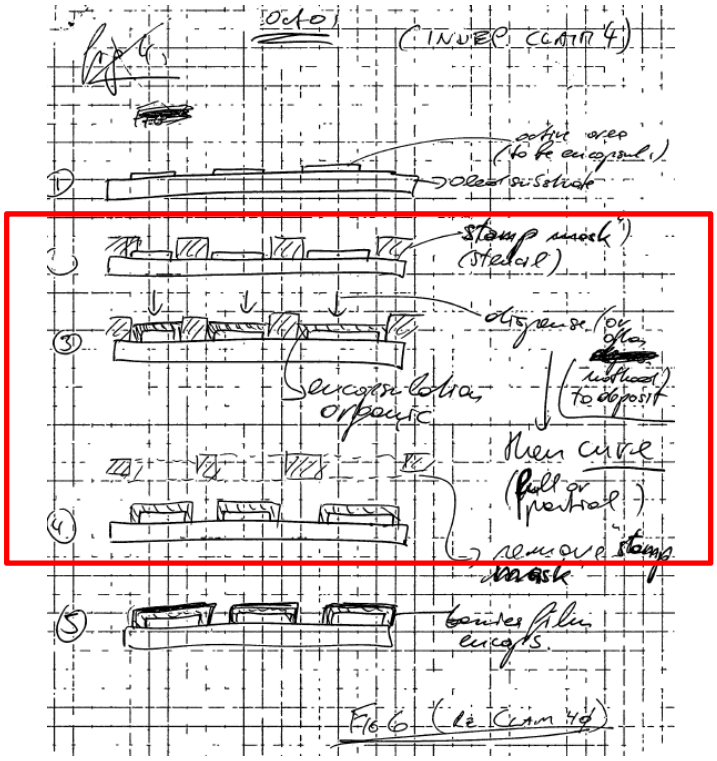
| | |
|---|---|
| 41[b] depositing a mask on top of said substrate, such that mask openings are placed on top of said devices; | As e.g. claim 28 but instead of directly printing the organic using e.g. screen-printing or ink-jet printing the OLED is covered with a mask which is in direct contact with the OLED and the organic (e.g. the UV cure epoxy) is then dispensed, squashed, rolled, blade coated, dropped into, sprayed onto, etc. the mask openings and then the cure happens; after the cure the mask is removed and the OLED encapsulation (i.e. with the barrier film deposition continues); said mask to confine the organic has openings over the area where the encapsulation on the OLED needs to happen. Said mask could be a film laminated to the OLED or a mask pressed or pushed or clamped etc. to the OLED. The cure of the organic while the mask (to confine the organic) is there could be a multi-step cure, e.g. partical cure, remove the mask and then complete the cure. Said mask could be a multi-use mask or a one-off (e.g. in the case of a lamination) that then gets thrown away. Said mask could be a metal, ceramic or plastic foil or sheet; could in particular be a PTFE (Teflon) or a poly-siloxane-type material (e.g. polydimethylsiloxane such as often used for soft lithography) or generally any material that does not stick to the OLED (too much to cause damage or delaminate OLED material from the OLED glass when the mask is removed) and a material to which the encapsulation organic does not stick to well so that the mask removal after encapsulation organic deposition and cure (complete or partial) does not remove encapsulation organic. …… but the mask is such that it can be brought in contact with the OLED sufficiently well so that the encapsulation organic is confined over the desired areas and does not seep under the areas where the encapsulation organic is not desired (e.g. contact pads etc.). Said mask is some sort of a 'stamp-mask'. See figure 4 below for a brief description of this concept. This concept is in particular useful for liquid encapsulation organics (see PML).<br><br>(EX2029, p. 11)<br><br><br><br>(EX2029, p.8) |

| | |
|---|---|
| 41[c] depositing at least one planarization layer upon said mask and said plurality of devices; | As e.g. claim 28 but instead of directly printing the organic using e.g. screen-printing or ink-jet printing the OLED is covered with a mask which is in direct contact with the OLED and the organic (e.g. the UV cure epoxy) is then dispensed, squashed, rolled, blade coated, dropped into, sprayed onto, etc. the mask openings and then the cure happens; after the cure the mask is removed and the OLED encapsulation (i.e. with the barrier film deposition continues); said mask to confine the organic has openings over the area where the encapsulation on the OLED needs to happen. Said mask could be a film laminated to the OLED or a mask pressed or pushed or clamped etc. to the OLED. The cure of the organic while the mask (to confine the organic) is there could be a multi-step cure, e.g. partical cure, remove the mask and then complete the cure. Said mask could be a multi-use mask or a one-off (e.g. in the case of a lamination) that then gets thrown away. Said mask could be a metal, ceramic or plastic foil or sheet; could in particular be a PTFE (Teflon) or a poly-siloxane-type material (e.g. polydimethylsiloxane such as often used for soft lithography) or generally any material that does not stick to the OLED (too much to cause damage or delaminate OLED material from the OLED glass when the mask is removed) and a material to which the encapsulation organic does not stick to well so that the mask removal after encapsulation organic deposition and cure (complete or partial) does not remove encapsulation organic. ..... but the mask is such that it can be brought in contact with the OLED sufficiently well so that the encapsulation organic is confined over the desired areas and does not seep under the areas where the encapsulation organic is not desired (e.g. contact pads etc.). Said mask is some sort of a 'stamp-mask'. See figure 4 below for a brief description of this concept. This concept is in particular useful for liquid encapsulation organics (see PML).<br><br>(EX2029, p. 11)<br><br><br><br><br>(EX2029, p.8) |

| | |
|---|---|
| 41[d] removing said mask from said substrate; and | As e.g. claim 28 but instead of directly printing the organic using e.g. screen-printing or ink-jet printing the OLED is covered with a mask which is in direct contact with the OLED and the organic (e.g. the UV cure epoxy) is then dispensed, squashed, rolled, blade coated, dropped into, sprayed onto, etc. the mask openings and then the cure happens; after the cure the mask is removed and the OLED encapsulation (i.e. with the barrier film deposition continues); said mask to confine the organic has openings over the area where the encapsulation on the OLED needs to happen. Said mask could be a film laminated to the OLED or a mask pressed or pushed or clamped etc. to the OLED. The cure of the organic while the mask (to confine the organic) is there could be a multi-step cure, e.g. partical cure, remove the mask and then complete the cure. Said mask could be a multi-use mask or a one-off (e.g. in the case of a lamination) that then gets thrown away. Said mask could be a metal, ceramic or plastic foil or sheet; could in particular be a PTFE (Teflon) or a poly-siloxane-type material (e.g. polydimethylsiloxane such as often used for soft lithography) or generally any material that does not stick to the OLED (too much to cause damage or delaminate OLED material from the OLED glass when the mask is removed) and a material to which the encapsulation organic does not stick to well so that the mask removal after encapsulation organic deposition and cure (complete or partial) does not remove encapsulation organic. …… but the mask is such that it can be brought in contact with the OLED sufficiently well so that the encapsulation organic is confined over the desired areas and does not seep under the areas where the encapsulation organic is not desired (e.g. contact pads etc.). Said mask is some sort of a 'stamp-mask'. See figure 4 below for a brief description of this concept. This concept is in particular useful for liquid encapsulation organics (see PML).<br><br>(EX2029, p. 11)<br><br><br><br><br>(EX2029, p.8) |

| | |
|---|---|
| 41[e] selectively depositing at least one barrier layer over said planarization layer. | 28. New independent claim: As claim 1 and 17 but now the organic itself is already during the deposition (by nature of the deposition process itself) deposited in a patterned manner, then curing of the organic (if necessary as e.g. for the UV-curable organics) then patterned deposition of the barrier, no need to remove e.g. non-UV-cured organic.<br><br>(EX2029, p. 48)<br><br>As e.g. claim 28 but instead of directly printing the organic using e.g. screen-printing or ink-jet printing the OLED is covered with a mask which is in direct contact with the OLED and the organic (e.g. the UV cure epoxy) is then dispensed, squashed, rolled, blade coated, dropped into, sprayed onto, etc. the mask openings and then the cure happens; after the cure the mask is removed and the OLED encapsulation (i.e. with the barrier film deposition continues); said mask to confine the organic has openings over the area where the encapsulation on the OLED needs to happen. Said mask could be a film laminated to the OLED or a mask pressed or pushed or clamped etc. to the OLED. The cure of the organic while the mask (to confine the organic) is there could be a multi-step cure, e.g. partical cure, remove the mask and then complete the cure. Said mask could be a multi-use mask or a one-off (e.g. in the case of a lamination) that then gets thrown away. Said mask could be a metal, ceramic or plastic foil or sheet; could in particular be a PTFE (Teflon) or a poly-siloxane-type material (e.g. polydimethylsiloxane such as often used for soft lithography) or generally any material that does not stick to the OLED (too much to cause damage or delaminate OLED material from the OLED glass when the mask is removed) and a material to which the encapsulation organic does not stick to well so that the mask removal after encapsulation organic deposition and cure (complete or partial) does not remove encapsulation organic. …… but the mask is such that it can be brought in contact with the OLED sufficiently well so that the encapsulation organic is confined over the desired areas and does not seep under the areas where the encapsulation organic is not desired (e.g. contact pads etc.). Said mask is some sort of a 'stamp-mask'. See figure 4 below for a brief description of this concept. This concept is in particular useful for liquid encapsulation organics (see PML).<br><br>(EX2029, p. 11)<br><br><br><br><br>(EX2029, p.8) |

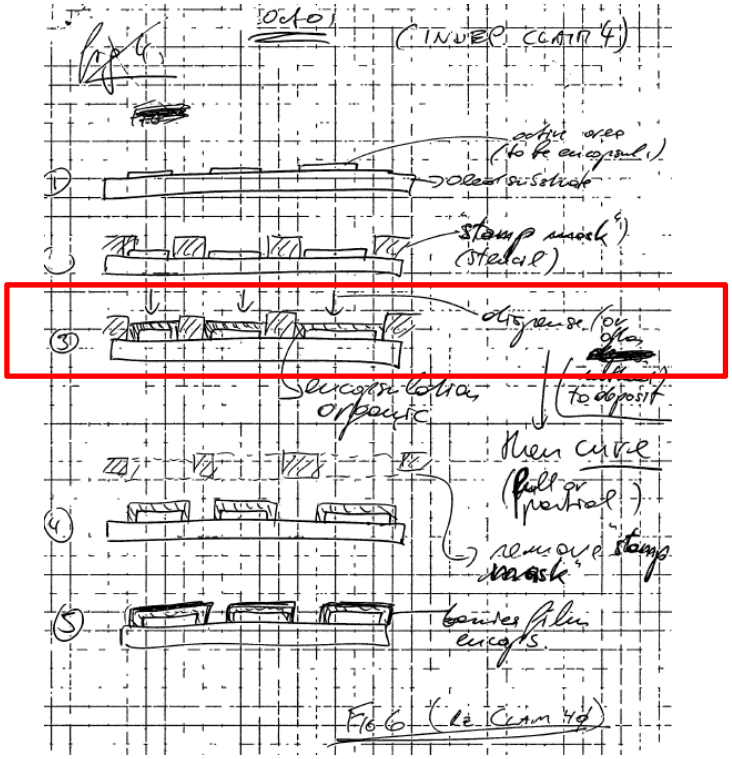
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|---|---|
| 43. The method as recited in claim 41 wherein the step of depositing said mask further comprises depositing said mask such that said mask is in contact with said substrate. | As e.g. claim 28 but instead of directly printing the organic using e.g. screen-printing or ink-jet printing the OLED is covered with a mask which is in direct contact with the OLED and the organic (e.g. the UV cure epoxy) is then dispensed, squashed, rolled, blade coated, dropped into, sprayed onto, etc. the mask openings and then the cure happens; after the cure the mask is removed and the OLED encapsulation (i.e. with the barrier film deposition continues); said mask to confine the organic has openings over the area where the encapsulation on the OLED needs to happen. Said mask could be a film laminated to the OLED or a mask pressed or pushed or clamped etc. to the OLED. The cure of the organic while the mask (to confine the organic) is there could be a multi-step cure, e.g. partical cure, remove the mask and then complete the cure. Said mask could be a multi-use mask or a one-off (e.g. in the case of a lamination) that then gets thrown away. Said mask could be a metal, ceramic or plastic foil or sheet; could in particular be a PTFE (Teflon) or a poly-siloxane-type material (e.g. polydimethylsiloxane such as often used for soft lithography) or generally any material that does not stick to the OLED (too much to cause damage or delaminate OLED material from the OLED glass when the mask is removed) and a material to which the encapsulation organic does not stick to well so that the mask removal after encapsulation organic deposition and cure (complete or partial) does not remove encapsulation organic. ..... but the mask is such that it can be brought in contact with the OLED sufficiently well so that the encapsulation organic is confined over the desired areas and does not seep under the areas where the encapsulation organic is not desired (e.g. contact pads etc.). Said mask is some sort of a 'stamp-mask'. See figure 4 below for a brief description of this concept. This concept is in particular useful for liquid encapsulation organics (see PML).<br><br>(EX2029, p.8, showing that the mask is direct contact with the substrate) |

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| 44. The method as recited in claim 41 wherein the step of depositing said mask further comprises depositing a mask, said mask comprising a material substantially non-sucking to OLED substrate over the areas in between the active areas. | As e.g. claim 28 but instead of directly printing the organic using e.g. screen-printing or ink-jet printing the OLED is covered with a mask which is in direct contact with the OLED and the organic (e.g. the UV cure epoxy) is then dispensed, squashed, rolled, blade coated, dropped into, sprayed onto, etc. the mask openings and then the cure happens; after the cure the mask is removed and the OLED encapsulation (i.e. with the barrier film deposition continues); said mask to confine the organic has openings over the area where the encapsulation on the OLED needs to happen. Said mask could be a film laminated to the OLED or a mask pressed or pushed or clamped etc. to the OLED. The cure of the organic while the mask (to confine the organic) is there could be a multi-step cure, e.g. partical cure, remove the mask and then complete the cure. Said mask could be a multi-use mask or a one-off (e.g. in the case of a lamination) that then gets thrown away. Said mask could be a metal, ceramic or plastic foil or sheet; could in particular be a PTFE (Teflon) or a poly-siloxane-type material (e.g. polydimethylsiloxane such as often used for soft lithography) or generally any material that does not stick to the OLED (too much to cause damage or delaminate OLED material from the OLED glass when the mask is removed) and a material to which the encapsulation organic does not stick to well so that the mask removal after encapsulation organic deposition and cure (complete or partial) does not remove encapsulation organic. ..... but the mask is such that it can be brought in contact with the OLED sufficiently well so that the encapsulation organic is confined over the desired areas and does not seep under the areas where the encapsulation organic is not desired (e.g. contact pads etc.). Said mask is some sort of a 'stamp-mask'. See figure 4 below for a brief description of this concept. This concept is in particular useful for liquid encapsulation organics (see PML).<br><br>(EX2029, p. 11)<br><br><br><br>(EX2029, p.8, showing that the mask is contact with substrate in between OLED active areas, which is the part that should be non-sticking) |

| | |
|---|---|
| 45. The method as recited in claim 41 wherein the step of depositing said mask further comprises depositing a mask, said mask comprising a metal, a ceramic, a plastic, a polymer, PTFE, or poly-siloxane. | As e.g. claim 28 but instead of directly printing the organic using e.g. screen-printing or ink-jet printing the OLED is covered with a mask which is in direct contact with the OLED and the organic (e.g. the UV cure epoxy) is then dispensed, squashed, rolled, blade coated, dropped into, sprayed onto, etc. the mask openings and then the cure happens; after the cure the mask is removed and the OLED encapsulation (i.e. with the barrier film deposition continues); said mask to confine the organic has openings over the area where the encapsulation on the OLED needs to happen. Said mask could be a film laminated to the OLED or a mask pressed or pushed or clamped etc. to the OLED. The cure of the organic while the mask (to confine the organic) is there could be a multi-step cure, e.g. partical cure, remove the mask and then complete the cure. Said mask could be a multi-use mask or a one-off (e.g. in the case of a lamination) that then gets thrown away. Said mask could be a metal, ceramic or plastic foil or sheet; could in particular be a PTFE (Teflon) or a poly-siloxane-type material (e.g. polydimethylsiloxane such as often used for soft lithography) or generally any material that does not stick to the OLED (too much to cause damage or delaminate OLED material from the OLED glass when the mask is removed) and a material to which the encapsulation organic does not stick to well so that the mask removal after encapsulation organic deposition and cure (complete or partial) does not remove encapsulation organic. …… but the mask is such that it can be brought in contact with the OLED sufficiently well so that the encapsulation organic is confined over the desired areas and does not seep under the areas where the encapsulation organic is not desired (e.g. contact pads etc.). Said mask is some sort of a 'stamp-mask'. See figure 4 below for a brief description of this concept. This concept is in particular useful for liquid encapsulation organics (see PML).<br><br>(EX2029, p. 11) |



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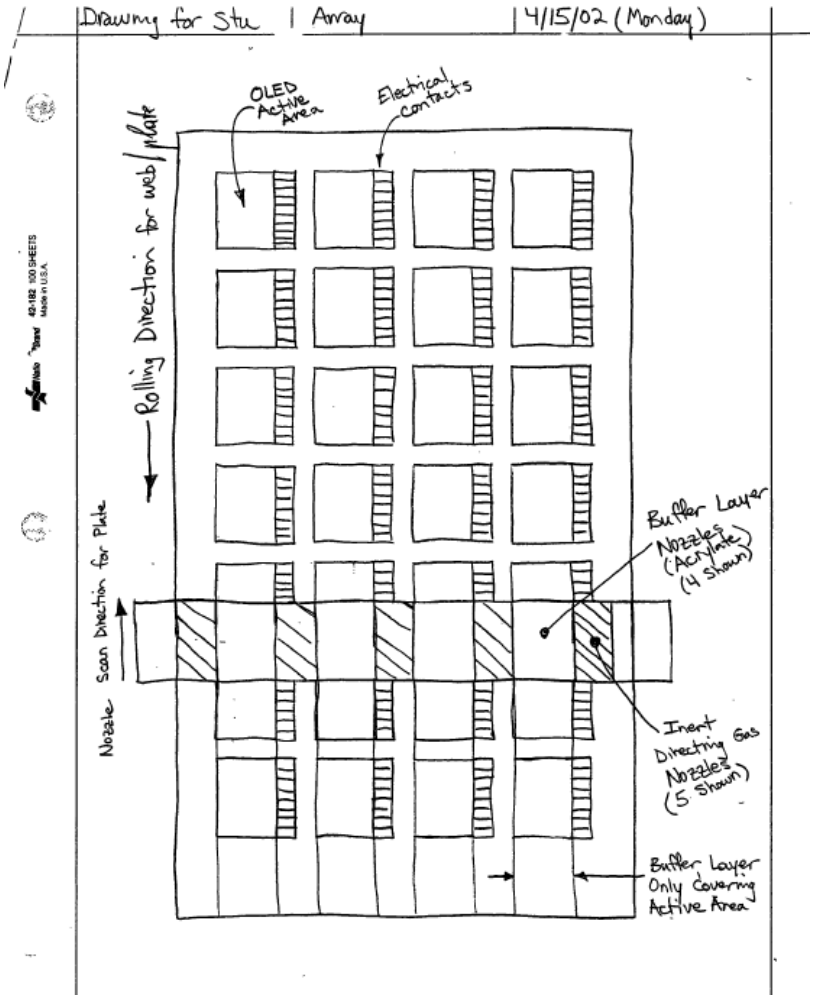
| | |
|---|---|
| 46. The method as recited in claim 41 wherein the step of depositing at least one planarization layer further comprises depositing an organic layer over the entire mask. | As e.g. claim 28 but instead of directly printing the organic using e.g. screen-printing or ink-jet printing the OLED is covered with a mask which is in direct contact with the OLED and the organic (e.g. the UV cure epoxy) is then dispensed, squashed, rolled, blade coated, dropped into, sprayed onto, etc. the mask openings and then the cure happens; after the cure the mask is removed and the OLED encapsulation (i.e. with the barrier film deposition continues); said mask to confine the organic has openings over the area where the encapsulation on the OLED needs to happen. Said mask could be a film laminated to the OLED or a mask pressed or pushed or clamped etc. to the OLED. The cure of the organic while the mask (to confine the organic) is there could be a multi-step cure, e.g. partical cure, remove the mask and then complete the cure. Said mask could be a multi-use mask or a one-off (e.g. in the case of a lamination) that then gets thrown away. Said mask could be a metal, ceramic or plastic foil or sheet; could in particular be a PTFE (Teflon) or a poly-siloxane-type material (e.g. polydimethylsiloxane such as often used for soft lithography) or generally any material that does not stick to the OLED (too much to cause damage or delaminate OLED material from the OLED glass when the mask is removed) and a material to which the encapsulation organic does not stick to well so that the mask removal after encapsulation organic deposition and cure (complete or partial) does not remove encapsulation organic. …… but the mask is such that it can be brought in contact with the OLED sufficiently well so that the encapsulation organic is confined over the desired areas and does not seep under the areas where the encapsulation organic is not desired (e.g. contact pads etc.). Said mask is some sort of a 'stamp-mask'. See figure 4 below for a brief description of this concept. This concept is in particular useful for liquid encapsulation organics (see PML).<br><br>(EX2029, p.8, showing that the organic layer is deposited over the entire mask) |

175. Inventor Pichler also did drawings on April 15, 2002 "for Stu."

EX2029, pp. 12-13.

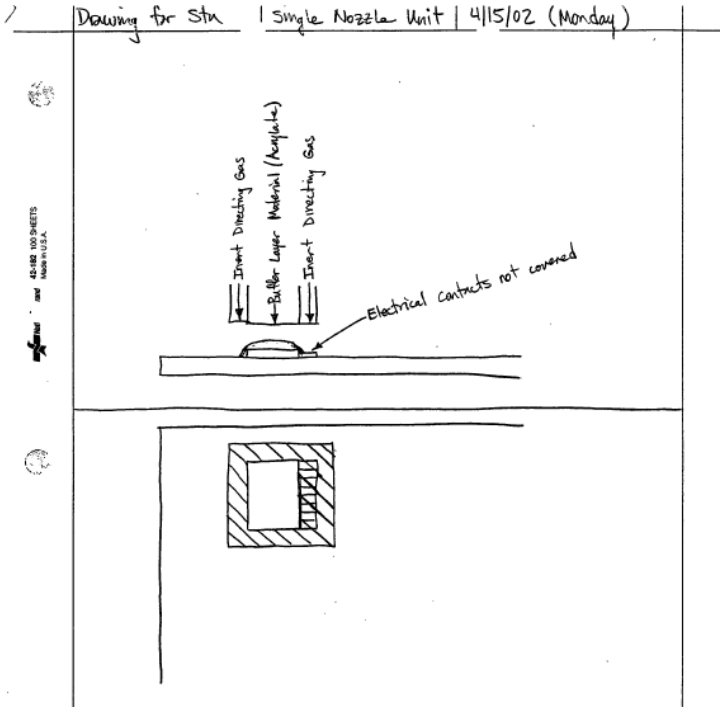


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176. "Stu" referenced in the drawings appears to be Attorney Stuart P. Kaler who filed the '389 application. EX1002, p.34.



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05-03-02 A

Siemens Corporation
Attn: Elsa Keller, Legal Administrator
Intellectual Property Department
186 Wood Avenue South
Iselin, NJ 08830

PATENT APPLICATION
Attorney Docket No.: 2002P03156US
Express Mail Label No. EV 048645610US
Date of Deposit: May 2, 2002

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

THE ASSISTANT COMMISSIONER FOR PATENTS
Washington, D.C. 20231

TRANSMITTAL LETTER FOR NEW APPLICATION

Sir:

Transmitted herewith for filing is a(n) [X]Original patent application.
[X] Utility [ ] Design [ ]Continuation-in-part application

INVENTOR(S): Karl Pichler and Kyle D. Firschknecht

TITLE: IMPROVED ENCAPSULATION FOR ORGANIC LIGHT EMITTING DIODES DEVICES

Enclosed with this Transmittal (submitted in duplicate) are:

[X] Twenty-four (24) page specification.
[X] Eight (8) sheets of drawings [ ] formal [X] informal drawings (one set)
[X] The Declaration and Power of Attorney [] signed [ X] unsigned
[X] Filing fee has been calculated as shown below (other than small entity):

| For | Number Filed | Number Extra | Rate | Additional Fees |
|---|---|---|---|---|
| Total Claims | 58 - 20 | = 38 | x $ 18 | $684.00 |
| Indep. Claims | 8 - 3 | = 5 | x $ 84 | $420.00 |
| [ ] First Presentation of a Multiple Dependent Claim | | | + $260 | $ -0- |
| | | Basic filing Fee | | $ 740.00 |
| | | | Total | $1,844.00 |

Please charge my Deposit Account No. 19-2179 in the amount of $1,844.00. The Commissioner is hereby authorized to charge any fees that may be required, or credit any overpayment to Deposit Account No. 19-2179 pursuant to 37 CFR 1.25. A duplicate copy of this sheet is enclosed.

PLEASE MAIL CORRESPONDENCE TO:
Siemens Corporation
Attn: Elsa Keller, Legal Administrator
Intellectual Property Department
186 Wood Avenue South
Iselin, NJ 08830

Respectfully submitted,
Stuart P. Kaler
Stuart P. Kaler, Reg. No. 35,913
Attorney(s) for Applicant(s)
Date: May 2, 2002
Telephone: 650-694-5191

177. Figures 7A-7C of the filed application are based on the 4/15/2002 drawings prepared "for Stu." *Compare* figures on EX2029, pp. 12-13 with EX1002, 43-44. In addition to Figures 7A-7C, the filed applications also included the drawings for Figures 1-2, 3A-3B, 4A-4B, 5 and 6A-6E. In my opinion and based on my experience for obtaining my own patent applications, filing the application 14 work days after receiving the draft drawings for a subset of the figures showed reasonably continuous diligence in prosecuting the patent. For



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example, it would take time to draw the various figures, for the inventors to review the application and provide feedback, and for the attorney to incorporate that feedback. Additionally, the application as filed also included administrative papers that would also take time to prepare. EX1002, pp. 35, 75-76. When I worked as an engineer in multinational companies, it was not unusual for it to take weeks for an application to be finalized after the inventors received a draft application, given that in-house patent counsel often had many applications on the docket at a given time and the inventors also had to work their engineering projects.

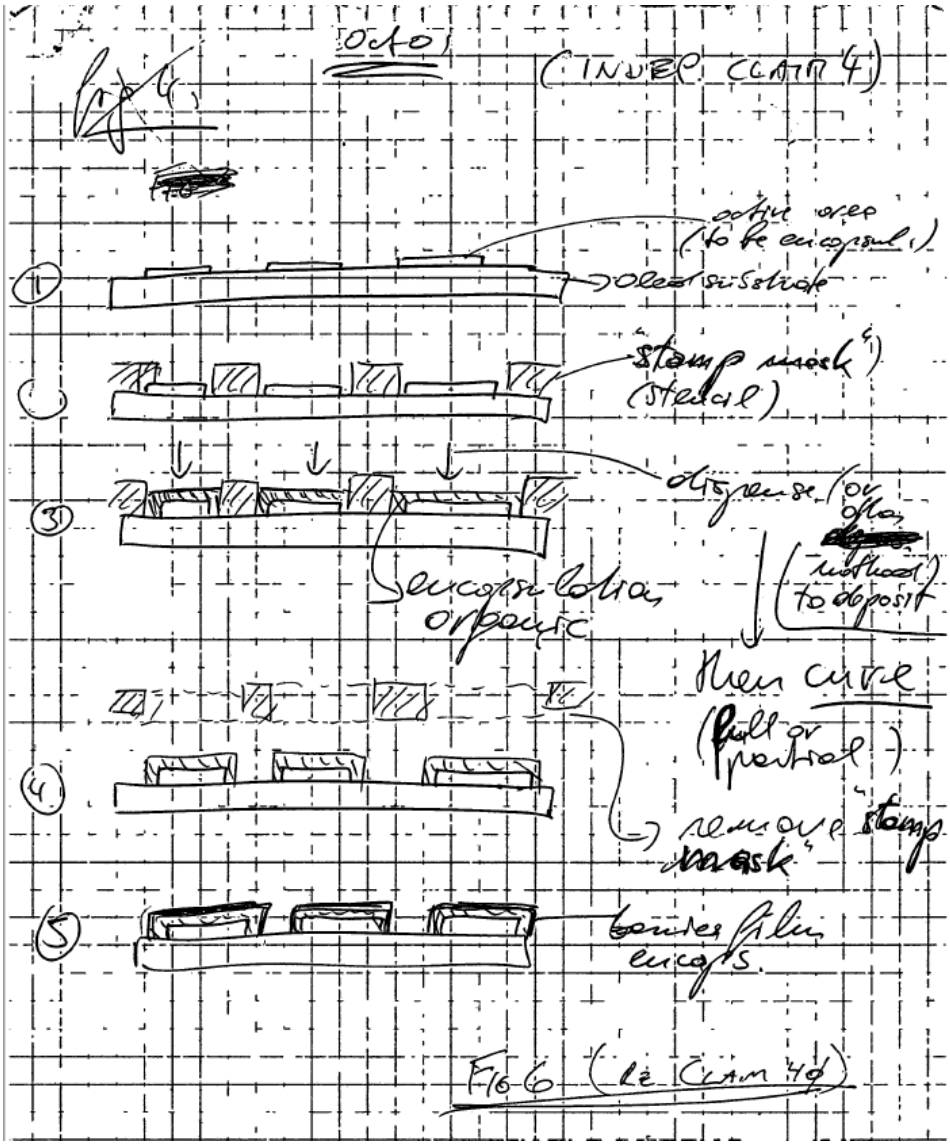
**B. Reasonably Continuous Diligence**

178. It is also my opinion that the inventors worked diligently to reduce their invention to practice after conception.

179. After the February 8, 2001 email exchange, Inventor Pichler continued to work on improving the encapsulation process, including by sketching out additional thoughts about ink-jetting processes on August 14 and 15, 2001. EX2029 at 40–41. As part of the invention disclosure process, he fleshed out the inventive ideas with detailed description, drawings and proposed claims on September 30, 2001. *Id.* at 8, 14–38. He further developed the invention on October 1 with drawings of Figure 6. *Id.* at 8.



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180. The above sketches later became Figure 6 of the ‘389 patent.

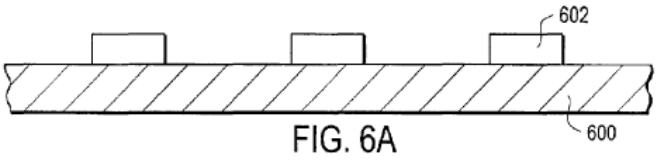



FIG. 6A

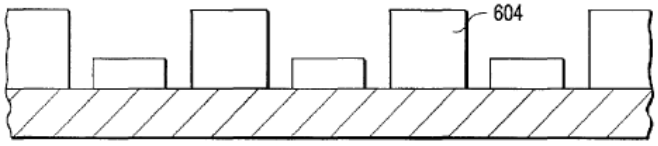



FIG. 6B

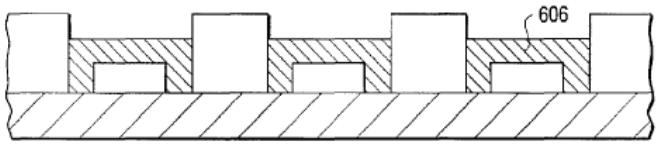



FIG. 6C

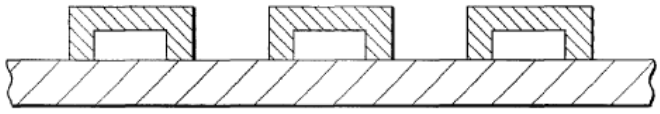


FIG. 6D

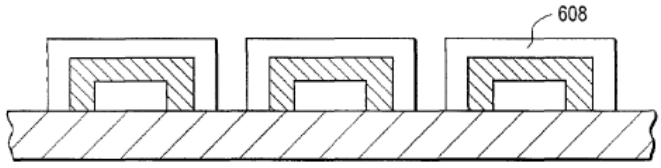
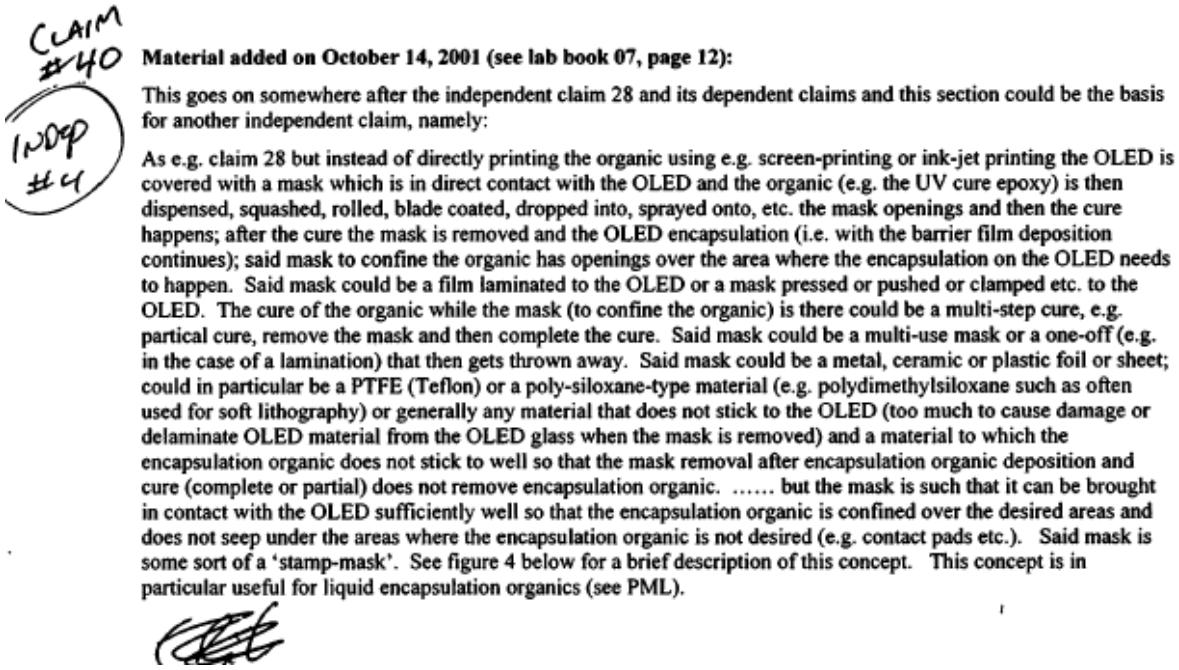



FIG. 6E

181. He then wrote out the corresponding claims on October 14, 2001, describing in detail a method by which the planarization layer could be deposited onto a mask that was then removed. *Id.* at 10-11.




28. New independent claim: As claim 1 and 17 but now the organic itself is already during the deposition (by nature of the deposition process itself) deposited in a patterned manner, then curing of the organic (if necessary as e.g. for the UV-curable organics) then patterned deposition of the barrier, no need to remove e.g. non-UV-cured organic. Note added on October 14, 2001: we need to make sure to write this broad in the sense that any printing technique suitable for printing the organic layer of the invention is used; ink-jet or screen-printing (below) are only preferred.



CLAIM #40

INDEP #4

**Material added on October 14, 2001 (see lab book 07, page 12):**

This goes on somewhere after the independent claim 28 and its dependent claims and this section could be the basis for another independent claim, namely:

As e.g. claim 28 but instead of directly printing the organic using e.g. screen-printing or ink-jet printing the OLED is covered with a mask which is in direct contact with the OLED and the organic (e.g. the UV cure epoxy) is then dispensed, squashed, rolled, blade coated, dropped into, sprayed onto, etc. the mask openings and then the cure happens; after the cure the mask is removed and the OLED encapsulation (i.e. with the barrier film deposition continues); said mask to confine the organic has openings over the area where the encapsulation on the OLED needs to happen. Said mask could be a film laminated to the OLED or a mask pressed or pushed or clamped etc. to the OLED. The cure of the organic while the mask (to confine the organic) is there could be a multi-step cure, e.g. partical cure, remove the mask and then complete the cure. Said mask could be a multi-use mask or a one-off (e.g. in the case of a lamination) that then gets thrown away. Said mask could be a metal, ceramic or plastic foil or sheet; could in particular be a PTFE (Teflon) or a poly-siloxane-type material (e.g. polydimethylsiloxane such as often used for soft lithography) or generally any material that does not stick to the OLED (too much to cause damage or delaminate OLED material from the OLED glass when the mask is removed) and a material to which the encapsulation organic does not stick to well so that the mask removal after encapsulation organic deposition and cure (complete or partial) does not remove encapsulation organic. …… but the mask is such that it can be brought in contact with the OLED sufficiently well so that the encapsulation organic is confined over the desired areas and does not seep under the areas where the encapsulation organic is not desired (e.g. contact pads etc.). Said mask is some sort of a 'stamp-mask'. See figure 4 below for a brief description of this concept. This concept is in particular useful for liquid encapsulation organics (see PML).

*Compare* to EX1001-'389, claims 41-46

182. As also noted in paragraphs 175-177, Inventor Pichler also drew a diagram that became Figures 7A-7C of the '389 patent on April 15, 2002. *Id.* at 11-12. The drawing reflects the fact that work on drafting the application leading to the '389 patent had been underway by at least April 2002.

183. Patent filing between 2001 and 2003 by the inventors also provides evidence of reasonable diligence exercised by the inventors. Even if these efforts were not specifically directed to encapsulating electronic devices, I understand that they can be used to demonstrate reasonable diligence because the work was on related parts of a research program that resulted in the patent. For example, I am informed and therefore understand that diligence is not negated if the inventor works on improvements and evaluates alternatives while developing an invention



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and can be shown by work required to develop a first invention in order to develop or reduce to practice a second invention. I also understand that the Court previously found that activities directed at building a plant to practice the claimed process of producing tetrafluoroethane on a large scale constituted efforts toward actual reduction to practice, and were evidence of diligence, even though the plant building itself did not involving practicing the claimed process. I also understand that efforts directed to fabricating a plurality of OLED devices on a substrate can be used to show diligence because without the devices, there would be nothing to encapsulate.

184. For example, Inventor Pichler was named in a pair of applications filed on September 19, 2001, both involving using selective deposition techniques such as ink-jetting to deposit organic layers of OLED devices. *See, e.g.*, U.S. Patent Application No. 2003/0054579 at [0002] (uniform deposition of polymer layers over the whole substrate could cause "the resultant OLED display unreliable"), [0003] ("desirable to deposit the polymer layers precisely on the display initially"), [0004] (disclosing "a novel method for fabricating an OLED display wherein one or more conducting polymer layers is/are selectively deposited over the surface of the display"); U.S. Patent Application No. 2003/0052616 at [0012] ("The active layers … could be deposited selectively via ink jet printing (continuous stream, drop-on demand, micro-contact printing, etc.), screen printing,



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off-set printing, electrostatic printing, gravure printing, flexographic printing, laser-induced thermal transfer, shadow stencil masking … or other"); [0013]-[0014] (organic layer 108 may be deposited "up to several microns thick" so that "large particle impurities … that find their way on the surface of the active panel during manufacture can be nicely coated and covered under the thick polymer layer" and avoid "a pinhole defect, which otherwise would have shorted anode and cathode").

185. These efforts were directed towards fabricating OLED devices to be encapsulated, as related to, for example, elements 34[a] and 41[a] of the '389 patent (a requisite part of the invention for subsequent encapsulation steps). *See, e.g.*, U.S. Patent Application No. 2003/0054579, pending claims (directed to methods for "fabricating an organic light emitting display"); U.S. Patent Application No. 2003/0052616, pending claims (directed to "[a]n OLED light source").

186. An application filed on July 9, 2002 by Pichler and co-inventor described an improved design for a print head of an ink-jet printer and ink-jetting method. *See, e.g.*, U.S. Patent Application No. 2003/0054579, pending claims (directed to methods for "fabricating an organic light emitting display"); U.S. Patent Application No. 2003/0052616, pending claims (directed to "[a]n OLED light source"). This was followed by an application filed on August 7, 2002 that



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describes novel ways to measure inkjet drop volume and thereby control ink-jet printing. U.S. Patent Application No. 2010/7121642, abstract. This work on improving ink-jet printing constituted qualifying work because ink-jetting was one of the proposed ways to selectively deposit the organic layer of the thin-film encapsulation at issue in the ’389 patent. EX2029 [Invention Disclosures] at 1 (discussing using inkjetting to deposit organic layers). The July and August filing of the invention suggests that the invention was likely disclosed by early 2002, demonstrating reasonably continuous work by Inventor Pichler on selective deposition techniques after the October 2001 invention disclosure.

187. Other OSRAM engineers were also working in the critical time period on improving the selective deposition. For example, OSRAM filed an application on May 3, 2002 on improved targeted delivery of inkjet droplets. U.S. Patent No. 6,702,419 (teaching using two cameras to help determine an angular displacement of the nozzle for targeted inkjet droplet delivery). The first named inventor of that application, Mr. Stoessel, is a co-inventor of U.S. Patent Application No. 2004/0009304 mentioned above. Thus, work reflected in the ’419 patent also constituted efforts toward to reducing the inventions claimed by ’389 Patent to practice, thereby showing the inventors’ diligence.

188. I also understand that Dr. Antoniadis testified that in the relevant period, the inventors were also working on commercialization of OLED displays,



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and often had to devote full time to supporting the commercialization efforts, which included fabricating a plurality of OLED devices on a substrate. EX2032 (Antoniadis Transcript), 217:25-219:25, 220:1-21 ("The most important project for all of us was to help the manufacturing to introduce the products in the market. And introducing the products in the market was very stressful for all us. … So very frequently, many of us will stop everything we were doing and we would focus on this."); 112:1-22 (OSRAM introduced its first OLED display in May 2003). Based on my own experience working on manufacturing lines, product launch would be extremely time consuming and would constrain the inventors' availability to work on less urgent matters. But the patent filings above indicated that the inventors did not abandon the ideas but continued to improve on the ideas and to work on related research that could also benefit the inventions.

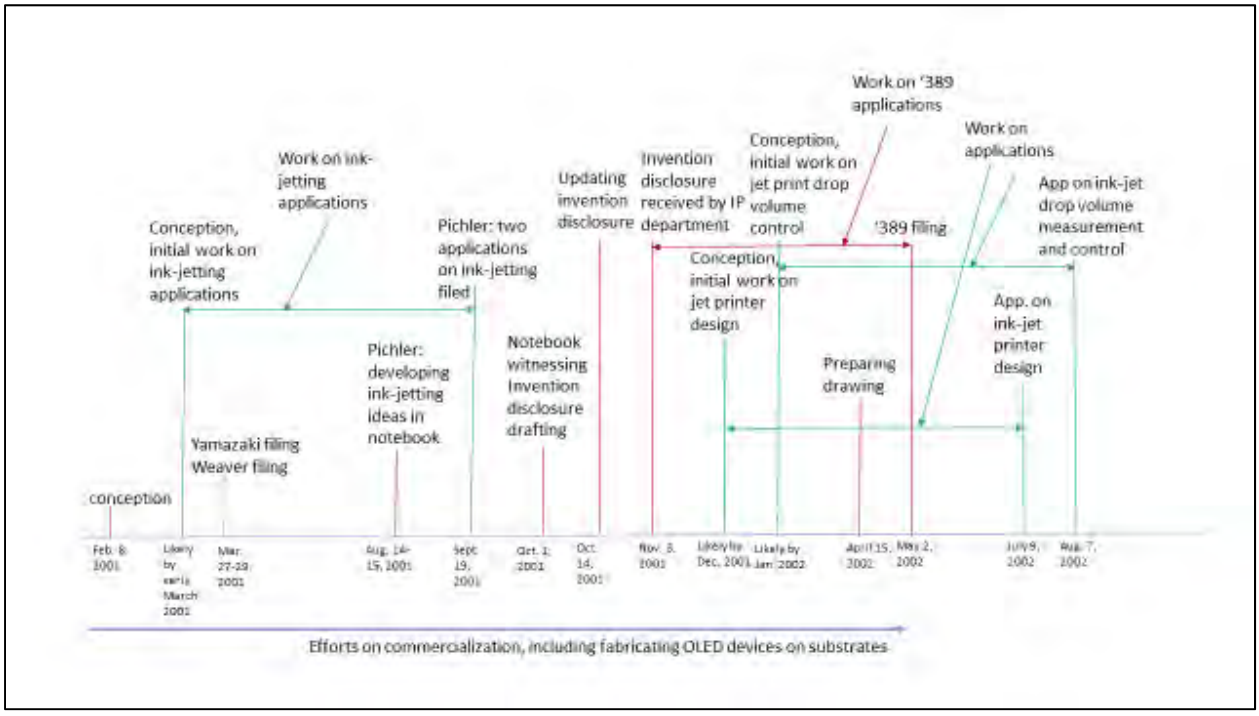
189. I also note that the interval (7 months) between the invention disclosure (end of September 2001) and the filing (early May, 2002) was typical of my experience when I worked in industry as well. Generally, there would be a scheduled meeting about 1-2 months after the invention disclosures that ranked the invention disclosures, and the selected disclosures would then be assigned to a patent attorney. A meeting between the patent attorney and the inventors would then be scheduled within 1-2 months for the attorney to understand the inventions. Depending on the existing work load, it may be another 2-3 months for the



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applications to be drafted; the inventors would then review the draft application to provide feedback and there could be further follow-up discussions/meetings.

190. A timeline for these relevant activities illustrates that the inventors worked diligently to reduced their inventions to practice:




191. It is my opinion that these activities in the critical period provide substantial objective evidence of continuous improvement on creating a commercial OLED embodying the inventions during the critical period and filing a completed patent application for the invention.

I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Executed on June 20, 2025 in Honolulu, Hawaii

*/Kurt Humphrey/*

Kurt Humphrey

# APPENDIX A

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# Kurt D. Humphrey

## Semiconductor Devices/ICs, Process Technology, and Materials Expert

After graduating with his B.S. in Ceramic Engineering, Mr. Humphrey accepted a Product Development engineering position with General Motors' AC Spark Plug division where he developed and patented the seminal process for PVD deposition of Pt catalytic coatings on partially-stabilized zirconia oxygen sensors for state-of-the art automotive emission control systems. Kurt was subsequently awarded a GM Graduate Study Fellowship and continued research in the area of automotive electronics with the development of novel methods for fabricating multilayer ceramic capacitors and other piezoelectric components through funding by General Motors Research Laboratories. After completing his M.S. degree in Ceramic Engineering, Kurt joined Delco Electronics (Delphi) Division of General Motors where he led process development and engineering in the areas of Czochralski (Cz) single-crystal silicon growth and semiconductor device/IC fabrication for bipolar, MOS, and silicon vacuum transducer (MAP sensor) products.

Mr. Humphrey's expertise in materials and microelectronics subsequently led to assignments as Thin Films Process Development Manager where he developed and transferred to production the PVD tantalum salicide (TaSi) process used in AT&T's and Bell Labs' DRAM memory products. Kurt subsequently served as Submicron Process Integration Manager at N.V. Philips Research Labs in Eindhoven, NL including development of next-generation isolation, contact plug, via metallization and ILD gap-fill processes for state-of-the-art semiconductor device production. While at Philips, Kurt collaborated with engineers at AMD, Intel, TSMC, Texas Instruments, and Siemens on advanced materials development and IC process/fabrication technology through formal technology transfer agreements between the companies.

Mr. Humphrey came to Colorado Springs as Process Integration Manager for United Technologies Microelectronics Center (UMTC) developing and patenting state-of-the-art radiation-hardened triple-level metal (TLM) CMOS, programmable amorphous silicon anti-fuse, and deep-trench fully-isolated, complimentary bipolar silicon-on-insulator (SOI) process technologies. Kurt transferred to Rockwell Semiconductor Systems/Conexant where he served as Advanced Process Integration Manager for 90nm CMOS pilot production of analog modem and other custom logic chips. Later, with Rockwell and Conexant, Kurt developed and patented a commercial process for volume manufacturing of bulk micro-machined MEMS products in cooperation with Boeing and Honeywell. During his long tenure in the industry, Mr. Humphrey worked with key semiconductor, automotive component, consumer electronics, and materials suppliers including Applied Materials, ASML, AT&T, Ericsson, Huawei, LG, Nikon, Nokia, Novellus, Panasonic, SOITEC, Shin Etsu (SEH), JSR, TOK, Samsung, Sumitomo, Toshiba, and many others to develop next-generation electronic components, displays and fabrication technologies.

Kurt has spent the past 25 years as a full-time IP consultant and subject matter expert (SME) in solid-state automotive and consumer electronics, as well as a host of other leading-edge technologies. Kurt has served as a consulting and/or testifying expert in multiple lawsuits including an ITC patent infringement case between HP and Acer and provided trial testimony as the sole testifying expert for the plaintiff (the Houston Rockets parent organization) v. iLight Technologies in a 2012 product liability case involving LED lighting technology. The jury found for the Plaintiff. Most recently, Kurt has provided expert analyses, reports and declarations in support of wireless telecom IPRs instituted by the USPTO's Patent Trial and Appeal Board (PTAB) and anti-trust cases involving robotic surgical platforms. Mr. Humphrey has been engaged numerous times to provide forensic/reverse engineering services and subject matter expertise primarily in the areas of commercial and industrial electronics and high-tech materials, and has analyzed literally thousands of patents and countless high-profile patent portfolios for clients in the Global High-tech Top 100.

In addition to his consulting work, Mr. Humphrey currently serves as Adjunct Professor of Chemistry in the College of Engineering at Colorado Technical University.

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## PROFESSIONAL EXPERIENCE

**IP *Enginuity* LLC.** **2005-Present**

Managing Director/Principal Technologist

- Comprehensive Engineering Services Provider for the Intellectual Property and Patent Asset Management, Licensing, Litigation and Technology Transfer Industries.
- Prepare strategies and manage engineering services relating to IP asset and patent evaluation; reverse/forensic engineering and re-engineering; patent enforcement, assertion and licensing; portfolio mining; prior art searches; technology transfer; and IP litigation support.
- Primary technical contributor on projects relating to MCT/CZT IR focal plan arrays for the United Technologies Science Center, semiconductor devices and advanced/engineered materials including forensic and patent infringement investigations into LED lighting systems, LED phosphors, OLED panels and solid-state DFB laser devices, wireless telecom and optical networking components, protocols and standard essential patents (SEPs), consumer electronics, photonics and opto-electronic devices; MEMS and sensors; flat panel displays (FPDs), and biotech/medical products and systems.
- Expert witness experience in patent infringement, product liability, and anti-trust litigations.

**TAEUS International Corp.** **1999 – 2005**

Director, Engineering Services

- Managed patent evaluation and reverse engineering projects from the initial proposal through project completion and final review.
- Serve as a primary technical contributor/SME on wireless telecom/networking standards incl. 802.11, Bluetooth and 3G/4G cellular and associated SEPs, optical networking and opto-electronic/photonics components including collaboration with Dartmouth and HP scientists to measure and characterize non-linear optical effects in commercial optical fibers. Also as an SME on a variety of compound semiconductor devices, solid state DFB/quantum well lasers, photonics/opto-electronics components, FPD technologies, e.g. LCD, plasma and LED/OLED, , MEMS, sensors,) etc. and biotech related projects.
- Specific responsibilities include client interface, project definition, cost, resource and schedule planning, technical input, supervision of staff engineers, external consultants and labs, patent evaluation, claim chart construction, and technical report writing.
- Clients included many Global 100 high tech companies and leading U.S. patent law firms.

**Rockwell Semiconductor Systems/Conexant Systems** **1995 - 1999**

Advanced Process Development Manager

- Assess new business opportunities, perform technical audits and generate comprehensive business and financial plans for review and approval by Rockwell CEO and senior staff.
- Primary focus on state-of-the-art semiconductor products e.g., Power-Trench Diodes and Trench IGBTs, CMOS imagers and MEMS gyros.
- Coordinate design rules, mask/reticle specifications, test chip design/layout, process qualification and transfer to production for 90nm CMOS process development in Rockwell's Advanced Process Technology (APT) department in Newport Beach.

Process Integration Manager

- Demonstrated first fully-functional Trench IGBTs and silicon MEMS gyro using 125mm substrates.
- Authored 3 MEMS and 1 SAW filter disclosures; 1 MEMS patent issued, others pending.
- Successful completion of comprehensive STI and 90nm CMOS process development test chips in record time to support an aggressive 90nm qualification schedule.



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**United Technologies Corp. (UTMC)** **1989 – 1995**

Process Integration Manager

- Direct next-generation CMOS and bipolar process technology development. Development projects included: ACUTE (advanced dielectrically-isolated, complementary bipolar linear array process on SOI), UTERPROG ( radiation-hardened 1.0µ CMOS PAL technology utilizing vertical amorphous Si antifuses), and UTERTLM (1.0µ triple-level metal, rad-hard CMOS)
- Developed advanced amorphous silicon metal-to-metal antifuse technology to support 256k RHPROM and RHPAL field programmable products; 2 patents issued.
- Developed novel trench-isolated, complementary bipolar SOI process, 1 patent issued

**Philips Research Labs (Eindhoven, The Netherlands)** **1986 – 1989**

Process Integration Manager

- Direct development of 0.7µ CMOS process from R&D phase through final product qualification as part of the Philips/Siemens "Mega" project. Project deliverables included commercial 1M SRAM and 4M DRAM products.
- Directed activities of 10 senior technologists.
- Developed first sub-micron CMOS process utilizing retro-wells, suppressed-BB LOCOS, salicide with $TiSi_2$ local interconnect, W plugs and I-line lithography.
- Integration team produced Philip's first fully-functional 1M SRAM using state-of-the-art 0.7µ CMOS process (C1DM)

**AT&T Technologies** **1983 – 1986**

Process Engineering and Yield Enhancement Manager

- Coordinate DRAM process transfer from R&D to fab, and direct yield enhancement activities for 256k DRAM production in new 125mm line (KC-1).
- Section Leader for Thin Films/Ion Implantation Engineering
- Key contributor in successful start up of new 125 mm high volume memory fab (KC-1);
- Representative on corporate committee for thin film metallization processes and invited speaker at SEMI/ASTM meeting on PVD target specifications.

**DELCO Electronics Div. General Motors** **1980 – 1983**

Process Development Engineer (Silicon Crystal Growing, Bipolar and MOS Fabs)

- Provide production engineering support, initially for Si crystal growing area, and later for MOS diffusion and LPCVD areas
- Evaluated external silicon wafer suppliers and introduced intrinsic-gettered substrates into MOS fab resulting in an average 7% increase in die yield across all devices

**AC Spark Plug Div., General Motors** **1978 – 1980**

Associate Process Development Engineer

- Developed process for depositing Pt catalytic thin films onto partially-stabilized zirconia oxygen sensors
- Key investigator and inventor on U.S. patent: "Electrode Sputtering Process for Exhaust Gas Oxygen Sensor"
- GM Graduate Study Fellowship Award



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## EDUCATION and ACADEMIA

M.S. Ceramic Engineering, University of Missouri - Rolla
B.S. Cum Laude, Ceramic Engineering, University of Missouri – Rolla
Current Adjunct Professor of Chemistry in the College of Engineering at Colorado Technical University-Colorado Springs.

## U.S. PATENTS:

6,337,027 Microelectromechanical device manufacturing process
5,759,876 Method of making an antifuse structure using a metal cap layer
5,658,819 Antifuse structure and process for manufacturing the same
5,344,785 Method of forming high speed, high voltage fully isolated bipolar transistors on a SOI substrate
4,253,931 Electrode sputtering process for exhaust gas oxygen sensor

## HONORS

General Motors Graduate Study Fellowship – 1979
United Technologies Silver Quill Award – 1994
Rockwell Outstanding Achievement Award – 1998

## PROFESSIONAL MEMBERSHIPS

Institute for Electrical and Electronics Engineers (IEEE) / Electron Devices Society
Colorado Photonics Industry Association
Licensing Executive Society (LES)
Intellectual Property Owners Association (IPO)
Society for Optical Engineering (SPIE)
Intellectual Asset Management (IAM)

## EXPERT LITIGATION CASE HISTORY

2007 – ITC Case No. 337-TA-606, *Hewlett Packard (Plaintiff) v. Acer International*:
Provided expert reverse engineering services, expert report and deposition for the Plaintiff

2012 – District Court 157th Judicial District Harris County Texas Cause No.2009-76645, *Clutch City Sports and Entertainment a.k.a. Houston Rockets (Plaintiff) v. iLight Technologies*:
Provided expert failure analysis services, expert report, deposition and trial testimony for the Plaintiff. Jury decided in favor of the Plaintiff.

2018 – IPR Case IPR2017-001889 before the USPTO PTAB, *Sprint Spectrum v. General Access Solutions (Patent Owner)*:
Provided expert declaration and was deposed on behalf of the Patent Owner

2020 - IPR Case IPR2019-01668 before the USPTO PTAB, *Samsung Display (Petitioner) v. Solas OLED (PO)*: Provided expert declaration in support of the Patent Owner

2021 – Western District of Texas Civil Action No.: 6:20-cv-879 (ADA), *Proxense LLC (Plaintiff) v. Target Corp.*: Provided expert declaration and deposed on behalf of the Plaintiff

2021 - Middle District of Florida, Tampa Division, Case No. 8:20-cv-02274, *Rebotix Repair LLC (Plaintiff) v. Intuitive Surgical, Inc.*:
Provided expert report and expert deposition on behalf of Plaintiff

2021 – Southern District of Iowa Central Division, Case No. 4:19-cv-00330-RGE-CFB, Neogen Corp. v. Innovative Reproductive Technology LLC: Provided expert report, scheduled for trial testimony in June



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2022 – IPR Case IPR2021-00929 (US 7,080,330) before the USPTO PTAB, *Western Digital Technologies, Inc.(Petitioner) v. Ocean Semiconductor LLC (Patent Owner)*: Provided expert declaration and was deposed on behalf of the Patent Owner

2022 – IPR Case IPR2021-01339 (US 8,686,538) before the USPTO PTAB, *Applied Materials, Inc.(Petitioner) v. Ocean Semiconductor LLC (Patent Owner)*: Provided expert declaration and was deposed on behalf of the Patent Owner

2022 – IPR Case IPR2021-01340 (US 6,725,402) before the USPTO PTAB, *Applied Materials, Inc.(Petitioner) v. Ocean Semiconductor LLC (Patent Owner)*: Provided expert declaration and was deposed on behalf of the Patent Owner

2022 – IPR Case IPR2021-01342 (US 6,968,248) before the USPTO PTAB, *Applied Materials, Inc.(Petitioner) v. Ocean Semiconductor LLC (Patent Owner)*: Provided expert declaration and was deposed on behalf of the Patent Owner

2022 – IPR Case IPR2021-01344 (US 6,907,305) before the USPTO PTAB, *Applied Materials, Inc.(Petitioner) v. Ocean Semiconductor LLC (Patent Owner)*: Provided expert declaration and was deposed on behalf of the Patent Owner

2022 – IPR Case: IPR2021-01349 (US 6,420,097) before the USPTO PTAB, *ST Microelectronics, Inc. (Petitioner) v. Ocean Semiconductor LLC (Patent Owner)*: Provided expert declaration on behalf of the Patent Owner.

2023 – *Surgical Instrument Service Co v. Intuitive Surgical, Inc*., Northern District of California, Case No. 3:21-cv-03496-VC: Provided expert report, rebuttal report and was deposed on behalf of the Plaintiff. Provided jury trial testimony in District Court of Northern California in January 2025.

2024 – PICTIVA DISPLAYS INTERNATIONAL LTD., v. SAMSUNG ELECTRONIC CO., LTD and SAMSUNG ELECTRONICS AMERICA, INC., EDTx, Civil Case: 2:23-cv-00495-JRG. Currently engaged as a technical expert in a patent infringement matter on behalf of the Plaintiff.