

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG DISPLAY CO., LTD.

Petitioner,

v.

PICTIVA DISPLAYS INTERNATIONAL LTD.,

Patent Owner.

Case No. IPR2024-01222

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 opinions on the patentability of claims 34-37 and 40-46 of the ’389 patent as outlined in IPR2024-01222, based on the combination of (i) U.S. Patent Application Publication No. 2003/0206332 (“Yamazaki”) in view of the applicant admitted prior art (“AAPA”) and/or U.S. Patent Application Publication N. 2001/0052752 (“Ghosh”), (ii) Yamazaki in view of AAPA/Ghosh and Japanese Published Application No. H10-1069 (“Fujimori”), (iii) U.S. Patent Application Publication No. 2002/0140347 (“Weaver”), (iv) Weaver in view of U.S. Patent Application Publication No. 2003/0011300 (“Palanisamy”), and (v) Weaver in view of U.S. Patent No. 6,866,901 (“Burrows”).

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 time frame, 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 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.

III. Skilled Artisan

11. 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 declaration, I apply this definition of a person of ordinary skill in the art.

12. I have degrees in Ceramic Engineering, a branch of Materials Science, and collaborated on flat panel display (FPDs) technology at Philips in the 1980s as well as multiple FPD projects involving plasma, LED and OLED display technologies for TAEUS clients in the 1999-2003 time frame. Since 2005, I have

worked on several projects involving LCD, electrophoretic (E-ink) and OLED technologies.

13. 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.

14. 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 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 throughput or increase yield, which generally occurs in the context of commercial applications.

IV. The '389 Patent

15. 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.

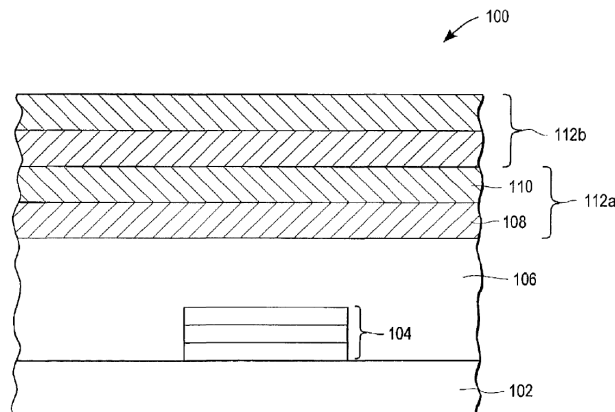


FIG. 1 (PRIOR ART)

16. The PML structure 112a 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 structure. *Id.* Direct thin-film encapsulation results in “thinner and/or lighter

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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.

17. 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.

18. 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).

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 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.

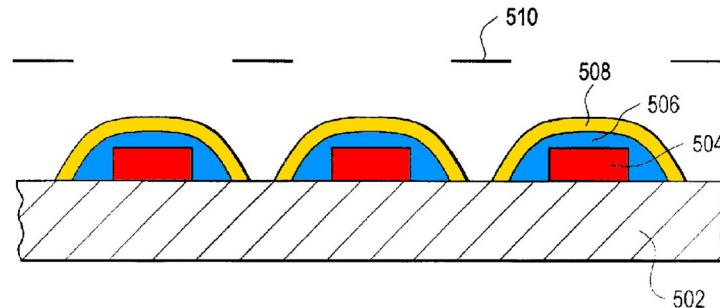


FIG. 5

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) and Boroson (US 6,590,157) (EX2022). See EX1002, 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 506

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“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 planarity, i.e., the thickness of the layer exceeds the depth of the imperfections and does not reproduce the underlying topology.

24. I note that the construction for “planarization layer” includes three prongs: (1) “a layer of material that planarizes”; (2A) the planarization allows the propagation of defects from one layer to another layer to be interrupted, and (2B) the planarization results in the topography of the underlying layer and/or structure not being reproduced by the planarization layer. I understand that, during the Markman hearing, Samsung argued that “from an engineering standpoint it is important” to have both 2A and 2B. 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_2025-05-30-Final, 212:9-213:9. By requiring that the two functions be called out and separately, Samsung is saying that those are distinct functions and one should not infer one function from the existence of another or from the presence of planarity.

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.” However, my analysis under the other sections below is not impacted by the specific construction of “planarization layer.”

B. “Selectively Depositing”

26. I understand that Samsung has proposed that “selectively depositing” 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.”).

28. I understand that Dr. Subramanian has taken the position that “selectively depositing” means that the material is deposited “where you wanted, 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_2025-05-30-Final 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."

VI. Claims 34, 35, 37 and 40 Are Not Obvious Over Yamazaki in View of AAPA/Ghosh

A. The Combination Does Not Disclose or Suggest a Claimed "Planarization Layer"

30. As noted above, I understand that in the district court action, the parties have agreed that "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.

31. I understand that Dr. Subramanian acknowledged that "[w]ithin [his] declaration, [he] did not address those" construction by the parties. He claims that "the structures that [he has] analyzed would meet those claim construction, or the analysis that [he has] done would meet those claim constructions, but [he hasn't] addressed that within [his] declaration. EX2020_2025-05-30-Final at 212:9-213:9.

Q. You are not taking any position regarding the correctness of Samsung's claim construction proposals in the district court; is that correct?

A. In the district court, yes, that's true. I haven't offered an opinion related to that.

Q. Okay.

Do you have a -- do you have personal opinions that you have not offered?

A. Yeah. I mean, I think they're generally reasonable claim constructions. I think the analysis that I do would meet those claim constructions, but I haven't offered that opinion.

Q. You did not perform that analysis; correct?

2 A. No. I agree.

Within my declaration, I did not address those. I think, were I to have to address them, I think they're reasonable, and I think the structures that I have analyzed would meet those claim constructions, or the analysis that I have done would meet those claim constructions, but I haven't addressed that within my declaration.

EX2020_2025-05-30-Final at 212:9-213:9; *see also* 211:16-21 (“the purpose of a planarizing layer is to reduce non-planarity in some way of the underlying topology” and “a test for that is does it do that”).

32. I also understand that Dr. Subramanian stated at his deposition that a “planarization layer” is “a layer that is – that achieves the planarization.” *Id.*, 10:7-

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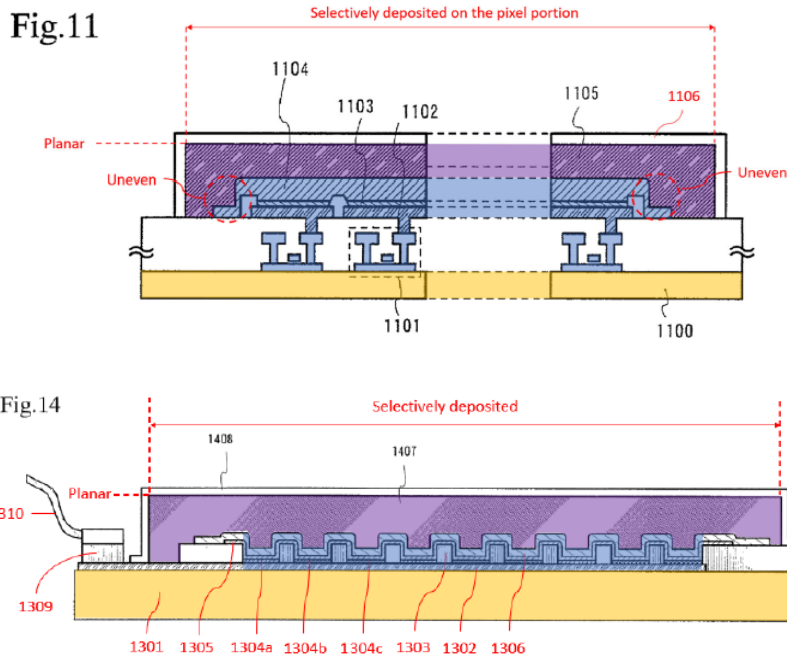
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20. And “what planarization would generally mean, putting aside any specific requirements of the claim, it’s generally referring to a function that results in an increase in planarity.” *Id.* He also claims that “any surface” can be characterized “in terms of its degree of non-planarity,” which he “would refer to how much it deviates from a perfectly flat surface,” and “[t]he goal of a planarization layer is to reduce that degree of non-planarity.” *Id.*, 11:3-21. He also stated that “[t]he planarity is not characterized simply by the magnitude of the non-planarity,” but “also characterized by the frequen[c]y of the non-planarity.” *Id.*, 15:1-17:15. Thus, according to Dr. Subramanian, even if “the magnitude of the asperities may increase,” there may still be planarization if there occurs “a lower frequency in terms of the spatial frequency of the asperities.” *Id.*

33. I note that the Petition’s assertion that Yamazaki’s cover layer is an alleged planarization layer relies on the fact that the material used supposedly “has planarity.” Petition at 27 (citing Yamazaki [0178]). But this disclosure alone does not provide any information on whether cover layer 1105 increases or decreases planarity compared to the underlying structure or layer. For example, Yamazaki says nothing about the smoothness or irregularity of the electrode layers. *See Yamazaki generally*. Instead, the Petition’s theory that an organic layer can “make[] a smooth surface on the relatively irregular surface of the cathode” is based on disclosures of Suzuki, but neither Samsung nor Dr. Subramanian claims

that Yamazaki and Suzuki's cathodes have similar surface topology. *See* Petition at 26-29.

34. Instead, the Petitioner's theory of flatness seems to be comparing the cover layer's surface topology and the steps or grid patterns of the underlying layers.



35. But this at most shows that the cover layers 1105 and 1407 do not reproduce the topology or topography of the underlying structures, but it does not show either layer 1105 or 1407 planarizes “such that the propagation of defects from one layer to another layer can be interrupted,” as required by the agreed-to construction.

36. Yamazaki does not mention “defect” or variations; nor does the Petition or Dr. Subramanian in connection with element 34[b] or 41[c]. The

Petition, for example, does not assert that the underlying cathode structure has defects. Pet. 26-29. Consequently, the Petition has not shown that either 1105 or 1407 constitutes a planarization layer under the agreed-to construction.

37. A person of ordinary skill in the art also would not find it obvious that Yamazaki's cover layer functions as a planarization layer that interrupts the propagation of defects from one layer to another layer as required by the agreed-to construction.

38. Specifically, Yamazaki suggests that the organic barrier layer formed by its methods has preferably a thickness range "between 10 nm and 300 nm." EX1005-Yamazaki, [0177].¹ Like the organic layer in Suzuki, Yamazaki's cover layers 1105 and 1407 were deposited directly on an electrode. *Compare* Yamazaki, Figs. 11, 14 *with* Suzuki, Fig. 1.

39. Suzuki also suggests using the same type of resins as Yamazaki. *Compare* EX1005-Yamazaki, [0178] (Yamazaki's resins include "epoxy resin,

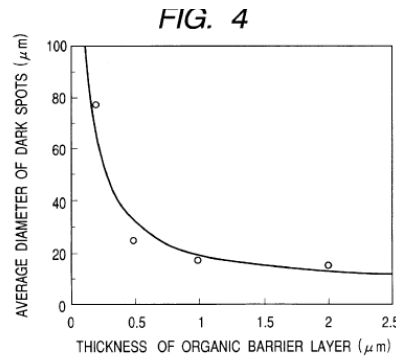
¹ Yamazaki's first embodiment, using electric field application method, provides for a cover layer of "preferably 0.1 μm to 20 μm " "after forming a barrier layer." EX1005, [0090]. In this embodiment, the cover layer is above and not below the barrier layer as required by the challenged claims. The disclosure there does not shed light on the characteristics of cover layer 1105 and 1407.

acrylic resin, polyimide, polyamide, and silicon[e] resin”) *with* EX1012-Suzuki, 6:7-25 (preferred resins include those formed from trimethylol acrylates, long-chain acrylates, epoxy acrylates, urethane acrylates, ether acrylates) & 6:56-64 (preferred examples include TPAC, polymethyl methacrylate, polyethylene terephthalate and the like).

40. As noted above, the Petition cites Suzuki to argue that organic layers like Yamazaki’s cover layers 1105 and 1407 were known to “‘make[] a smooth surface on the relatively irregular surface of the cathode’ when forming OLED devices.” Pet. 27. Thus, Suzuki is at least relevant to whether Yamazaki’s cover layer is a planarization layer under Samsung’s invalidity theory.

41. Suzuki discloses, however, large dark spots would form if the organic barrier layer in contact with the electrode is below 0.5 micron (or 500 nm). *See* EX1012, Fig. 4, 7:11-14 (“The organic barrier layer 20 should preferably be form[ed] in a thickness of 0.5 μm or over in order to ensure good coverage of the unit U and to effectively intercept moisture therewith.”); 9:8-9 (“As will be apparent from the figure [Fig. 4], the sealing effect is significant when the layer thickness is 0.5 [μm] or over.”).²

² A person of ordinary skill in the art would view the threshold thickness to be 1 μm because the curve in Figure 4 is still in rapid transition at 0.5 μm .



(EX1012, Fig. 4)

42. A person of ordinary skill in the art would realize that this $0.5\ \mu\text{m}$ threshold is the minimum thickness required to effectively interrupt defect propagation from one layer to another. But this threshold thickness is above the thickness range for Yamazaki's cover layer (10-300 nm or $0.01\text{-}0.3\ \mu\text{m}$). Thus, if Suzuki's disclosures and learnings apply to Yamazaki as well, a person of ordinary skill in the art would recognize that Yamazaki's organic layer could not effectively interrupt defect propagation from the cathode to the barrier layer to slow down the permeation of oxygen and moisture (that is, to decouple defects from one layer to another layer as required by the parties' agreed-to construction), and would therefore not qualify as a planarization layer.

43. Indeed, at the preferred range of thicknesses of $0.01\text{-}0.3\ \mu\text{m}$, the organic layer would be too thin to fully encapsulate particulates that could occur in manufacturing. *Cf.*, '389, 4:36-40. Thus, a person of ordinary skill in the art would recognize that the cover layers 1105 and 1407 were not designed to decouple defects. Rather, their ability to protect against moisture and oxygen

originates from their property of being materials that are “unlikely to allow[] substances such as moisture and oxygen to permeate.” Yamazaki, [0178]. That is, it is the oxygen and moisture permeation rate through the material(s), as opposed to the layer’s effectiveness in decoupling defects in barrier layers, that resulted in reduced oxygen and moisture permeation (if any).

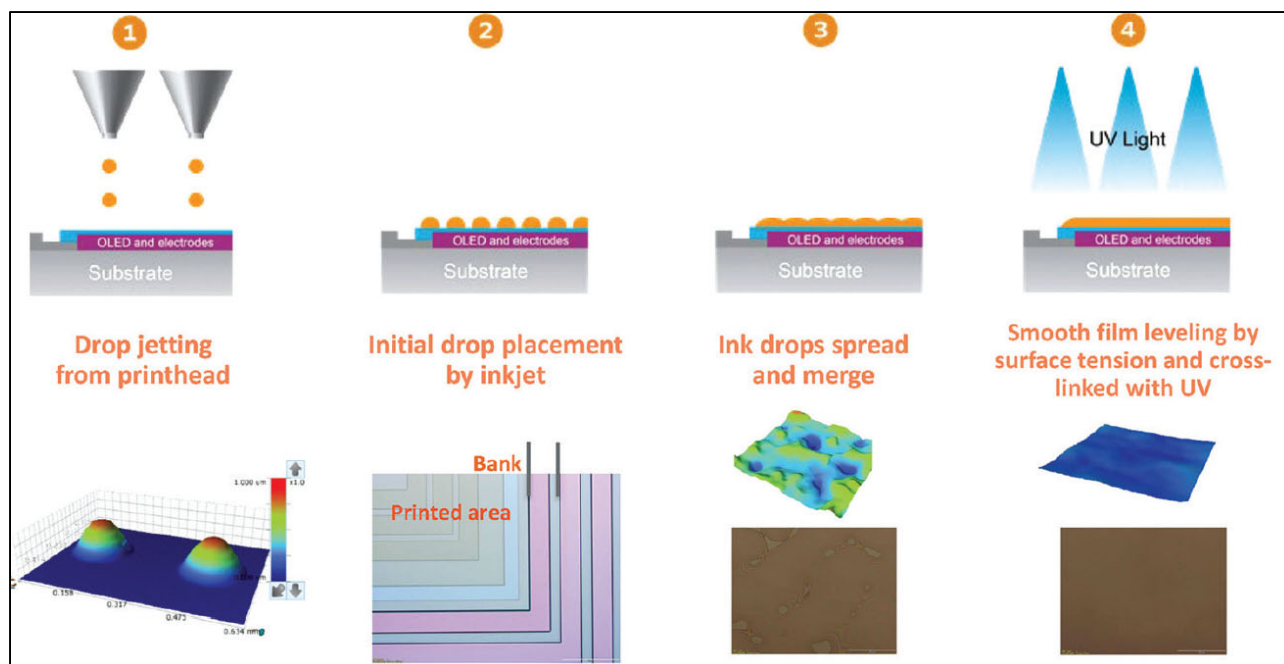
44. That is, in light of Suzuki’s experimental data and Yamazaki’s organic layer thickness, a person of ordinary skill in the art would recognize that Yamazaki’s organic layer would not function as a planarization layer as defined and would not have started with Yamazaki’s organic deposition method. I note that Yamazaki does not report the performance data of its devices, which might indicate that Yamazaki’s devices did not perform satisfactorily.

45. I further note that there is no evidence that inkjet printing and electric field application method could deposit organic materials with sufficient thickness. Sturm, the only reference Petitioner cited that gave thicknesses for inkjet printed films, indicated a range of 40-70 nanometers for the films. Sturm, 4:20-24. Eight or more passes would be needed to obtain a film of 500 nanometers and more. The electric field application method similarly involves dissolving the cover layer material in a solvent to form an application liquid, atomizing the application liquid to create charged particles or droplets, controlling the application liquid by the electric field, and forming the cover layer over a substrate at the application

position. EX1005-Yamazaki, [0012]-[0013], [0038] (describing electric field application method in reference to EL layer, and “[t]he cover layer is formed by an application method that is similar to that for the formation of the EL layer”), [0142] (dissolving organic resin in a solvent to form “organic resin liquid” between 1×10^{-3} and 3×10^{-2} Pa-s or 1-30 cP). In each pass, the solvent would dissolve a bit of the deposited materials from the previous pass, changing the topologies and increasing the risk of defects as well as the risk of the material spreading onto undesired parts.

46. The difficulty to maintain planarity is further compounded by the fact that the organic layer needed to be formed over a relatively large area (2-3 orders larger than an EL area) and the planarity depended on ink drops spreading, merging and then levelling as designed over the large area and over multiple passes. *See* EX2030_2021-Moro, Fig. 2 (TFE inkjetting requires ink drop spread and merge and the resulting film then levels); EX2039 (ams-OSRAM0000167) (pixel sizes on the order of 0.22 mm^2 , about $1/1090^{\text{th}}$ the $19.97\text{mm} \times 11.97\text{mm}$ active area of a display³); EX2023_Subramanian_Molesa_2003, Figs. 2, 4-5 (inkjet printed films each over $\sim 100\mu\text{m} \times 100\mu\text{m}$ areas).

³ Petitioner maps each device to a display panel. Pet. 17-18.



(EX2030_Moro2021_Large-Scale_Manufacturing_of_Polymer_Planarization_Layers,⁴ Fig. 2)

47. There is thus no evidence that Yamazaki’s ink-jetting and electrical field application method could build up a sufficiently thick organic layer “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” as required by the agreed-to construction.

⁴ Available from

<https://sid.onlinelibrary.wiley.com/doi/epdf/10.1002/msid.11194>.

B. The Grounds 1-2 References Do Not Disclose “Selectively Depositing” a Barrier Layer over the At Least One Planarization Layer That is Deposited Over a Plurality of Devices on a Substrate

48. Samsung does not assert that Yamazaki discloses “encapsulating a plurality of devices fabricated upon a substrate” or “fabricating a plurality of devices on a substrate.” Instead, it relies on Applicant’s Admitted Prior Art and Ghosh for those limitations to argue that batch fabrication of multi-device substrate would be obvious. Pet. 19-25; EX2020_2025-05-30-Final, 26:13-20 (“Q: You don’t contend that Yamazaki either expressly or inherently discloses fabricating a plurality of devices on a substrate, do you? A: No, I do not.”).

49. Yamazaki therefore does not disclose “selectively depositing at least one planarization layer upon said devices” (plural) or “selectively depositing at least one barrier layer over said planarization layer” that is deposited “upon said devices” (plural), because Yamazaki does not involve multiple devices on a substrate, only a single display (device) per substrate.⁵ See Yamazaki, Figure 12.

50. AAPA does not disclose “selectively depositing at least one planarization layer upon said devices” (plural) or “selectively depositing at least

⁵ In IPR2024-01222, a claimed device is mapped to an OLED display. See Petition at 17-18 (“a *device* (active matrix OLED display panel)” and “a *device* (passive matrix OLED display panel)”).

one barrier layer over said planarization layer” that is deposited “upon said devices” (plural) either, because the ’389 inventions are for addressing the drawbacks caused by non-selective depositions of the PML in the prior art. *See* ’389 patent, 2:17-29.

51. Ghosh does not disclose “selectively depositing at least one barrier layer over said planarization layer” that is deposited “upon said devices” (plural), as the inventors pointed out during prosecution. EX1002 at 376 (“In *Ghosh*, the ‘second encapsulation layer 22’ (in the Office Action, the Examiner refers to this layer as the ‘barrier layer’), is nonselectively deposited using either atomic layer epitaxy or atomic layer deposition.”).

(a) Claims 34, 37

Claims 34 and 37 are rejected under 35 U.S.C. § 103(a) as being unpatentable over *Ghosh* in view of *Boroson* (“the proposed combination”).

With respect to claim 34, the Applicants submit that the proposed combination does not disclose “selectively depositing at least one barrier layer over said planarization layer” as recited in claim 25. In *Ghosh*, the “second encapsulation layer 22” (in the Office Action, the Examiner refers to this layer as the “barrier layer”), is nonselectively deposited using either atomic layer epitaxy or atomic layer deposition. *See, e.g., Ghosh* at ¶0027. *Boroson* also does not disclose selectively depositing a barrier layer. For these reasons, claim 34 is patentably distinguishable over the proposed combination. Claim 37 depends from claim 34. Accordingly, it is patentable over the proposed combination of *Ghosh* and *Boroson* for at least the reasons set forth above with respect to claim 34.

In addition, for the reasons described earlier, the Applicants submit that the Examiner has not established a prima facie case of obviousness since the Examiner has not provided an adequate suggestion to combine the *Ghosh* and the *Boroson* references.

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52. The examiner apparently agreed with the inventors and withdrew the rejections based on *Ghosh*. EX1002, 387.

7. Applicant's arguments filed 7/19/04 have been fully considered and are persuasive. Therefore, the rejection has been withdrawn. However, upon further consideration, a new ground(s) of rejection against claim 25 is made, as stated above.

53. To understand how a skilled artisan would have encapsulated multiple devices on a substrate, one would look to references that actually fabricated and encapsulated multiple devices on a substrate. This is important because the inventions as a whole relate to methods "of encapsulating a plurality of devices fabricated on a substrate," (34[pre], 41[pre]), not about encapsulating one device on one substrate.

54. As noted above, Yamazaki does not disclose encapsulating a plurality of devices on a substrate. It also does not suggest that its method could be extended to multiple devices on a substrate. *See* Yamazaki generally. And the Petition does not provide any reason for extending Yamazaki to what Samsung calls "batch fabrication," which seems to refer to fabricating multiple displays on a substrate. Pet. 29-32. Instead, it just proposes or posits what the deposition would be if Yamazaki were extended to multi-display fabrication. *Id.*

55. Both AAPA and Ghosh, which do relate to fabricating and encapsulating multiple devices on a substrate, disclosed non-selective deposition of

at least the barrier layer. The state of art as reflected in AAPA and Ghosh is therefore performing non-selective deposition of barrier layers on a multi-device substrate. In other words, none of Yamazaki, AAPA and Ghosh disclose “selectively depositing at least one barrier layer over said planarization layer” that is deposited “upon said [plurality of] devices” on a substrate. Grounds 1-2 therefore fail.

C. A Person of Ordinarily Skill in the Art Would Not Have Started with Yamazaki for Encapsulating Multiple OLED Devices on a Substrate

1. Yamazaki’s Methods Are Too Immature to Use a Starting Point for “Reduce[d] Costs, Increase[d] Throughput, and Increase[d] Yield”

56. As the Board noted, “Petitioner relies on Yamazaki as a starting point to show that encapsulating a plurality of devices on substrate with selectively deposited planarization and barrier layers as recited in the challenged claims was known in the prior art.” D.I. 16. But as noted above, Yamazaki discloses encapsulating a single device on a substrate, not multiple devices on a substrate. *See ¶¶ 48-49 above.* Yamazaki would therefore not be regarded as a starting point for encapsulating a plurality of devices on a substrate.

57. Samsung argues that “flat panel displays ... were conventionally manufactured in bulk on a large sheet of substrate, in order to reduce costs, increase throughput, and increase yield.” Pet.19; *see also* Pet. 22 (allegedly a

“POSITA would have been motivated to used batch fabrication when applying the methods of Yamazaki’s Figures 11 and 14 for *encapsulating a plurality* of OLED display panel devices on a large sheet of substrate because such batch fabrication was the conventional mode of manufacturing display panels for OLEDs”).

58. A person of ordinary skill in the art would immediately recognize that reduced costs, increased throughputs and increased yields are concerns specific to manufacturing and commercialization. In that context, a person of ordinary skill in the art would not have looked to Yamazaki’s experimental processes, because Yamazaki’s methods are far from ready for manufacturing. Just like methods for making a one-of-a-kind product are unlikely suitable for mass production, one would not look to Yamazaki when they were looking for manufacturing methods amenable to reduced costs, increased throughputs and increased yields at the time of the invention.

59. On the contrary, Yamazaki is silent on fundamental manufacturability concerns such as cost, throughput, repeatability, and yield. There is no demonstration that its method could be applied satisfactorily for just a single display, let alone multiple displays on a substrate. In fact, as the number of OLED devices multiplies on a substrate, defects and errors would multiply, the yield would drop exponentially, and the cost would increase drastically.

60. The obstacle with Yamazaki would be particularly severe because Yamazaki uses the same method to deposit the organic layers of the OLED and the organic cover layer of the encapsulant. Yamazaki, abstract (“By using a same film deposition method to form the EL layer and the cover layer”). I note that Samsung and Dr. Subramanian do not propose changing the manner by which Yamazaki fabricates its devices. *See* Pet. 19-33.

61. Using inkjet printing or electric field application methods would be challenging for both the EL and the encapsulant, but the challenges would be different. EX2032-Antoniadis, 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.”), 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.”); 221:18-222:10 (“a thin film encapsulation didn’t happen for another 10 years”); EX2012 (2018 invited talk summarizing challenges for inkjet printing in OLED).

62. With respect to the EL printing, one big challenge is the precision and resolution. EX2032_Antoniadis, 143:25-144:20 (“each pixel consists of three droplets and you have millions of pockets”; “You have to hit them all precisely”). Sturm’s results showed that inkjet printing yielded devices of half the efficiency

than spin coating. EX1013-Sturm, Fig. 5, 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.”).

63. Between 2003 and 2005, OSRAM studied the use of inkjet printing to deposit EL layers, and they were able to prove the concept with a demonstrator (*i.e.*, a prototype) for lighting after two years and six million in joint investment by DOE and OSRAM; but that was still a far cry from making multiple OLED devices/displays on a single substrate in a manufacturing setting. EX2032-Antoniadis, 13:1-9, 44:20-46:14, 113:8-15, 114:13-21, 115:20-25; *see also id.*, 92:14-16 (“There is a lot of work being done with inkjet printing but not successfully in mass production”); EX2032_Antoniadis-Ex5, pp. 7, 51-60 (OSRAM’s effort in inkjet-printing light-emitting-polymers).

64. A 2002 thesis noted that inkjet printing is “not proper since the pixel pitch at 28 μm is considered too large for microdisplays.” EX2043,⁶ 15.

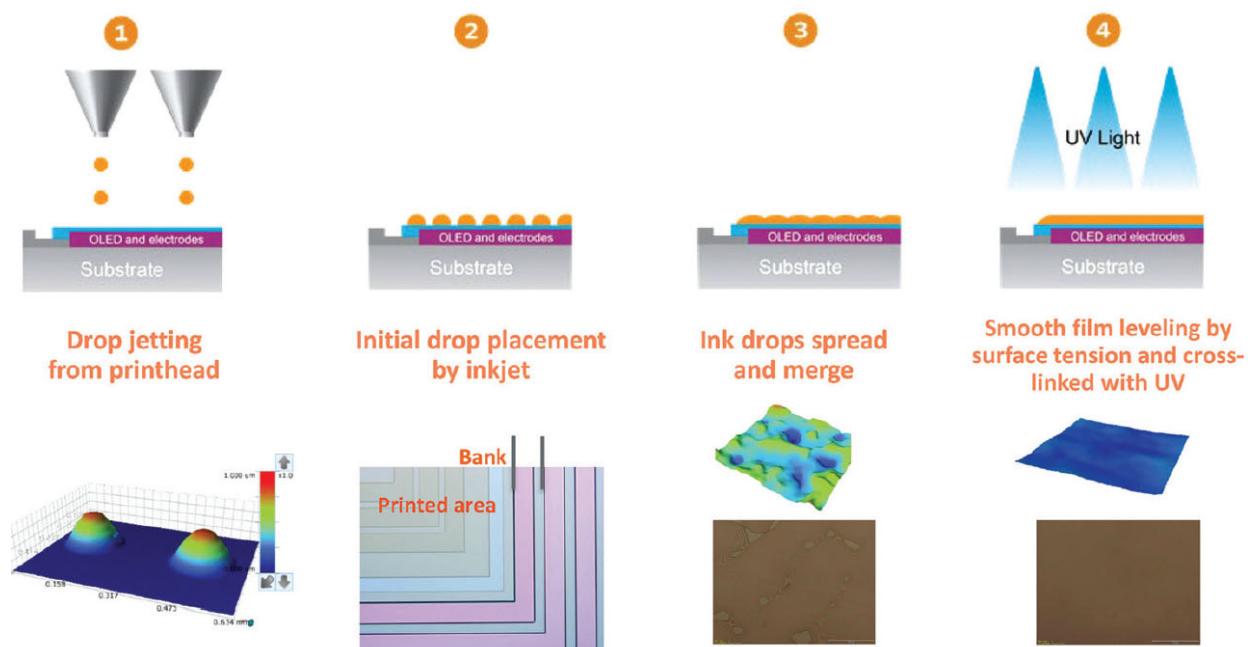
65. The encapsulant had its own challenges: it had to form a planar sheet over a much larger area than in the EL application because the TFE is supposed to cover all pixels on a display. As a comparison, an OLED display that OSRAM marketed had pixel sizes of 0.22 mm^2 , or about 1/1090th the size of the active area

⁶ 2002 student thesis with the title “OLED: Evaluation and clarification of the new Organic Light Emitting Display technology”, downloaded from <https://www.diva-portal.org/smash/record.jsf?pid=diva2%3A18218&dswid=4057>

of the display, which was 19.97mm×11.97mm. *E.g.*, EX2039 (ams-OSRAM0000167).

Display Format	80 Columns x 48 Rows
Pixel Pitch	0.25 mm Square
Pixel Size	0.22 mm Square
Color	Yellow x=0.455, y=0.540
Grayscale	4-bit
Active Area	19.97 (W) x 11.97 mm (H)

66. As shown below, to form an organic encapsulant layer through inkjet printing, the ink drops have to spread and merge and the resulting film then must level to obtain a planar film.



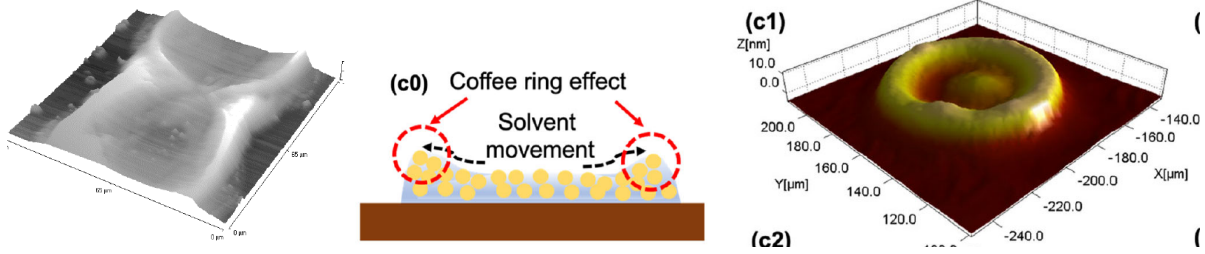
EX2030_Moro2021_Large_Scale_Manufacturing_of_Polymer_Planarization_Layers, Fig. 2); see also EX2034_Kateeva2017_Presentation,⁷ p.16.

⁷ Available from <https://nccavs-usergroups.avs.org/wp-content/uploads/TFUG2017/TFUG917-3-Hebb.pdf>.

67. The larger the printed area, the higher the likelihood for there to be defects in the film, such as non-planarity, pinholes, cracks, etc., *e.g.*, because it becomes more likely that not all the droplets spread and merge properly and/or because it becomes more difficult for the entire film to level. For example, while there were reports (after the invention dates) of overcoming the coffee-ring effects⁸ to form flat films over $100\mu\text{m}\times 100\mu\text{m}$ areas, those articles do not suggest the same solution could yield smooth films over areas 3+ orders larger. *See* EX2023, Figs. 2, 4-5; EX2036_s41467-023-43014-7_Large_area_inkjet_2023, Figs. c0-c1; EX2039 (ams-OSRAM0000167) ($19.97\text{mm}\times 11.97\text{mm}\sim 240\text{mm}^2$ active area of a display versus 0.22mm^2 pixel area).⁹ Additionally, as the encapsulant areas increase, solvent trapping and outgassing in subsequent process steps become more likely, which in turn negatively affect the resulting film's flatness, porosity and ability to decouple defects.

⁸ These are where the dried ink droplets have thicker edges than inner core due to differential solvent evaporation rates in different parts of the droplets.

⁹ In contrast to the solvent-based approaches in these papers, the '389 patent contemplated depositing monomer liquids (without solvent). EX1001, 6:61-62.



EX2023, Fig. 2; EX2036_s41467-023-43014-7_Large_area_inkjet_2023, Figs. c0-c1 (illustrating coffee-rings over *c.a.* $100\mu\text{m}\times 100\mu\text{m}$ or $0.1\text{mm}\times 0.1\text{mm}$ areas; there is no evidence that coffee rings could be substantially eliminated over the active area of a display that is 3+ orders of magnitude larger).

68. As background, even with more established evaporation processes, for TFE, “no one was using thin film encapsulation in 2000”, (EX2032-Antoniadis, 39:2-40:7), and Vitex, the assignee of Ghosh and “one of the pioneers in the field of flexible encapsulation,”¹⁰ was experimenting with TFE on 200-millimeter substrates at the time. EX2032-Antoniadis, 41:17-42:14. 200-millimeter substrates are about 1/3 the size of Gen1 mother glasses that Dr. Subramanian was referencing (*see* EX1003, ¶¶16-20). This illustrates the immaturity of the technology at the time for manufacturing, which was the reason for Samsung’s expansion of Yamazaki to multi-device substrate encapsulation.

¹⁰ EX1006-Ghosh, cover; EX2024_Park_Review_on_TFE_for_flexible_AMOLED at 4; EX2032-Antoniadis, 41:17-42:14.

69. Given the state of the art and the fact that a person of ordinary skill in the art would have only one year of experience in displays (and not even specifically on OLED displays), they would not start with Yamazaki's experimental approaches, if they were interested in manufacturing OLEDs. Figuring out how to solve the challenges facing just the EL or the encapsulant using Yamazaki's inkjet printing or electric field application method would be challenging enough. Combining the two, which would require them to tackle both the fine resolution for EL and the ability to form contiguous planar films over a large area for encapsulant, would be daunting with no reasonable expectation of success for a POSITA with the low skill level defined by Samsung.

70. Instead, if they were to start with Yamazaki's approaches, they would start with fabricating a single device on a substrate as Yamazaki did to perfect the techniques before attempting to expand it to multiple displays on a substrate using these experimental methods to form both the EL elements and the organic layer of the TFE. But as OSRAM's and other's experience demonstrated, making even just one display panel was challenging at the time of the invention; and to fabricate multiple devices on a substrate using the experimental method would be even more challenging with no reasonable expectation of success. EX2032-Antoniadis, 222:8-10 ("thin film encapsulation didn't happen for another 10 years"), 248:2-6 ("Q: Well, were you aware of an inkjet printing of the UV curable organic liquid?

A: I don't know if inkjet printing was used at that time or UV curable materials. I don't know that."), 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."), 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.").

2. Not Depositing Cover Layer under Vacuum Condition

71. Yamazaki discloses applying its cover layer "using the inkjet method" (e.g., cover layer 1105) or an electric field application method (e.g., cover layer 1407). EX1005, [0178]; [0202]-[0203] & [0188] (using the same application method as the EL layer and the EL layer is applied using the electric field application layer). Yamazaki discloses that, in ink-jet printing, "pressure is applied to the material chamber 1207 ... whereby the organic resin liquid provided in the material chamber 1207 is pushed out and then applied." *Id.*, [0182]. Yamazaki also discloses that the electric field application method involves dissolving the cover layer material in a solvent to form an application liquid, atomizing the application liquid to create charged particles or droplets, controlling the application liquid by the electric field, and forming the cover layer over a substrate at the application position. *Id.*, [0012]-[0013] and [0038] (describing electric field

application method in reference to EL layer, and “[t]he cover layer is formed by an application method that is similar to that for the formation of the EL layer”).

72. Yamazaki further discloses using inert gas or “an atmosphere of the solvent” when applying the EL layer to minimize exposure of an OLED device to oxygen and moisture. EX1005, [0087]. To the extent that inert gas or “an atmosphere of the solvent” is also used when applying the organic cover layers, the organic cover layer would also be deposited under atmospheric conditions rather than under vacuum. That is, OLED devices are exposed to gaseous atmospheres when the organic layer is deposited.

73. Yamazaki discloses several examples. In the first embodiment, Yamazaki uses an aluminum (“Al”) cathode protective layer, an inorganic barrier layer with materials such as silicon nitride or tantalum oxide, and an organic resin-based cover layer deposited using electric field application method. In the second embodiment, Yamazaki uses an aluminum (“Al”) cathode protective layer, an inorganic barrier layer with sputtered tantalum oxide, and an organic resin-based cover layer deposited using electric field application method. In the third embodiment, a relatively thin 10nm to 300nm organic resin is first deposited with ink-jet printing over the cathode and then a diamond like carbon (DLC) film is sputtered over the cover layer. In the fourth embodiment, after cathode deposition a protective cathode layer is formed by evaporative deposition of an aluminum

alloy, followed by sputtered silicon nitride and an organic resin (optionally doped with barium oxide), is deposited using electric field application method. In the fourth embodiment, the order of the inorganic barrier layer and the organic resin layer may be switched. The fifth through the seventh embodiments are similar to the first through the third embodiments, but with some differences in the emission layer materials.

74. Kijima (the primary reference at issue in IPR2024-01223) warns, however, exposing the OLED device to ambient atmosphere [0081] and thereby ambient atmospheric pressure [0071] before forming protective layers would lead to severe performance degradation over time and formation of “a large number of dark spots.” *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”). Kijima does not explain the reason for the observed degradation, *e.g.*, whether the severe performance degradation was due to exposure to atmospheric pressure, ambient atmospheric composition, or a combination of the two. Therefore, it is left to the reader to speculate as to the key variable(s) resulting in Kijima’s reported severe performance degradation associated with a temporary change from a vacuum to ambient atmospheric conditions. This warning and the associated uncertainty as to the actual causal factors for the catastrophic failure of Kijima’s devices would

dissuade a person of ordinary skill in the art, who just had one year of experience in displays and therefore would not be expected to be familiar with the myriad of failure mechanisms of OLEDs, from using inkjet printing or the electric field application method to apply the organic layer on the cathode except under vacuum even when the cathode has other protective layers.

75. Suzuki used vacuum to deposit both the organic and inorganic protective layers for protecting OLED devices. *See* EX1012, 8:48-55 (vacuum depositing TPAC as an organic barrier layer over an electroluminescent unit, followed by thermal treatment and vacuum deposition of an inorganic barrier layer), 8:64-9:3 (same); 9:13-17 (same), 9:26-34 (same).

76. But as noted above, Yamazaki taught “form[ing] the EL layer, the cathode, the barrier layer, and the cover layer in the same multi-chamber in succession without releasing them to the atmosphere.” EX1005, [0244]. A person of ordinary skill in the art would not have run such risks given Kijima’s and Yamazaki’s warnings. In fact, the risk of performance degradation would increase after depositing the top electrode:

In 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]. The top electrodes are deposited after the emission (EL) layer. *E.g.*, Yamazaki, [0177] (“Provided on the EL layer 1103 is a cathode 1104” followed by formation of organic cover layer 1105), [0198]-[0199] (top electrodes formed after EL layer formation). Hence, a person of ordinary skill in the art would recognize that, even if inkjet and the electric field application methods that typically use atmospheric pressure may be suitable for depositing organic light emitting EL layers, the encapsulation steps after depositing the top electrodes should still take place under vacuum in order to obtain a suitable and operable OLED device. *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”), [0082]-[0087] (comparative example 3, showing “[t]he adverse effects of exposing the element to the atmosphere before the formation of the insulating sealing film 8,” that is, the barrier layer). Hence, a POSITA would not have started with Yamazaki’s embodiments that would have deposited the first encapsulation/protective layer under pressure.

77. That is, in light of the state of the art, as reflected in Kijima and Suzuki, a POSITA would not have expected that OLED devices made in accordance with Yamazaki’s embodiment 3 or Figure 14 would have provided

acceptable performance and would not have started with the method to begin with. And unlike Kijima and Suzuki, Yamazaki did not provide any experimental data to show that the resulting devices would be suitable for their intended purposes.

D. Claim 35 Is Not Obvious

78. Claim 35 requires the planarization layer to be “deposit[ed] by ink jet of an organic layer.” As explained in Section A above (analysis incorporated here), Yamazaki’s 10-300nm organic layer (EX1005, [0177]) would be too thin to decouple defects or be effective against oxygen and moisture permeation. Additionally, as explained in Section A, there is no evidence that Yamazaki’s inkjet printing could yield an organic layer that meets the parties’ agreed-to construction, such as with sufficient planarity and interrupt defects from one layer to another layer to help protect against moisture and oxygen. Yamazaki itself does not suggest that its cover layer is intended to or can interrupt propagation of defects from one layer to another, or even that it can be sufficiently planar at the thickness needed to interrupt propagation of defects from one layer to another. Additionally, as explained in Section C, the inkjet printing—for both printing the EL elements and the encapsulant materials—was immature at the time. For these reasons, a POSITA would not have used Yamazaki’s ink-jet printing for depositing the EL layers and encapsulating a plurality of devices fabricated on a substrate.

79. I further note that when Yamazaki discusses flattening a step (similar to what Petitioner points to as evidence of flattening) for film 39 used to cover the thin-film-transistors, the reason is that “an EL layer formed later is very thin” and “there is a case where poor luminescence occurs due to existence of a step.”

Yamazaki, [0063]-[0064]. This differs from the pinhole defect decoupling to protect against oxygen and moisture permeation discussed in the '389 patent.

Compare '389, 1:56-62 (“One of the problems of the direct thin film encapsulation occurs with the barrier layer. 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.”). Put another way, Yamazaki does not disclose or suggest decoupling defects.

80. There is thus no evidence that a person of ordinary skill in the art would have found claim 35 obvious in view of Yamazaki and AAPA/Ghosh.

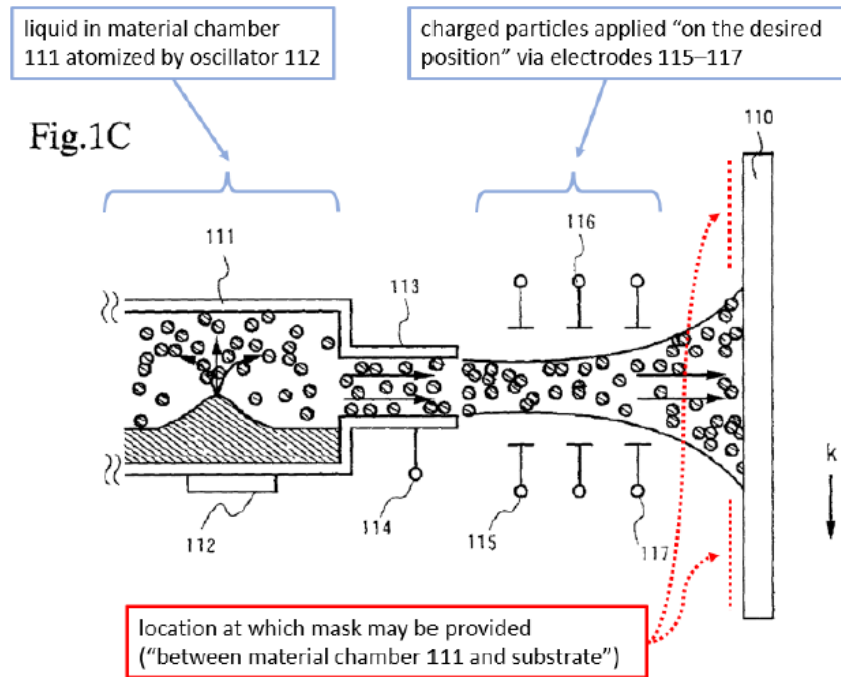
E. Claim 37 is Not Obvious

81. **Claim 37** requires depositing the planarization layer by “depositing an organic layer through a shadow mask.” Yamazaki deposits its organic layer using ink-jetting. *See* EX1005, [0178]. The inkjet method described for Embodiment 3 (Figure 11) does not mention the use of a mask. *See id.*, [0179]-[0182]. A person of ordinary skill in the art at the time of the invention would generally understand

inkjet printing to be a maskless deposition method. *See* EX2044-Shimoda, 5:45-50 (“In an inkjet method, ... processes such as mask fabrication and etching ... can be eliminated.”). That is, ink-jet printing is a patterned printing method whose deposition positions are controlled by print head instead of an external mask.

82. Yamazaki’s paragraph 86 of embodiment 1, where Yamazaki describes depositing an EL layer using the electric field application method, does state, however, “although *not used herein*, a mask may be provided” EX1005, [0086]. This would indicate to a person of ordinary skill in the art that the EL in embodiment 1 is formed without using a mask. Hence, to the extent any of the organic cover layers are deposited using the method described for embodiment 1, they would also not be deposited using a mask. This is consistent with Yamazaki’s description that “the application liquid for the EL layer is controlled by an electric field to thereby form the EL layer, resulting in making it possible to control the application position.” *Id.*, [0198]. In other words, electric field rather than mask controls where the application liquid will land or be applied to.

83. For that reason, even if a mask is used in the electric field application method, the mask is not a shadow mask because, as Samsung’s own annotation demonstrates, electrodes 115-117 define the positions at which the liquid is applied and the mask does nothing to further define that position:



(Pet. 34)

84. I have been asked to comment on whether Yamazaki's reference to Seiko-Epson's proposed application of EL using an electric field or an ink-jet makes Yamazaki's ink-jet and electric field application methods "known" encapsulation methods. As Samsung's own expert, Dr. Antoniadis testified, printing EL and printing encapsulant are completely different with different materials and different challenges. EX2032-Antoniadis, 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."), 142:20-143:19 ("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."). Thus, even if inkjet printing or electric field application method had been used to apply EL material, that does not make using these printing methods encapsulation, such as for thin film encapsulation, known.

85. Additionally neither method was applied to commercial OLED display production at the time of the invention. Circa 2000, evaporation and spin-coating were still the dominant deposition methods under development for commercial OLED displays. At the time of the '389 invention and the purported art, a POSITA would have approached the application of ink-jetting, and its electric field variant, to commercial OLED manufacturing with trepidation. Furthermore, use of a mask for the inkjet or electric field depositions would have further dissuaded a POSITA from experimenting with Yamazaki's deposition methods. Vapor deposition, *e.g.*, evaporation, was the dominant method of depositing small molecule organic EL materials circa 2000 while solution-based depositions, *e.g.* spin-coating, were used for macromolecules like polymers whose vaporization temperatures are too high and even vaporization under vacuum could lead to material degradation. For example, "While ***crystalline organic materials require vacuum deposition*** onto a glass substrate, it may be possible to layer polymers over this flexible TFT substrate using spin-casting or other inexpensive techniques such as ink-jet printing. The spin-cast process is expected to produce

OLED arrays no thicker than a sheet of paper in about two to three hours—much less than the fabrication time of an equivalent inorganic structure.” *See* EX2017 [<https://www.laserfocusworld.com/lasers-sources/article/16556776/back-to-basics-organic-leds>, July 2001].

86. Second, the novel aspect of Yamazaki is to use the same chamber to apply EL and the organic cover layer, “the EL layer, the cathode, the barrier layer, and the cover layer can be formed in the same multi-chamber in succession.” Yamazaki, abstract. This would supposedly improve the process efficiency. This would suggest that applying the ink-jetting and electric field application to both the EL organic layers and the organic cover layer is a novel aspect of Yamazaki, not known in the prior art. Thus, even if Seiko-Epson’s field application method and ink-jetting method were known to deposit EL organic layers, it does not follow that the same methods were “well-known” or “conventional” when it came to depositing the organic layers of an OLED encapsulant. Additionally, nothing indicates that those “known” methods for depositing EL layers involved the use of a mask.

87. It is also my opinion that Ghosh’s references to “well-known, conventional” means of deposition would not have inspired a person of ordinary skill in the art to include a shadow mask in Yamazaki’s ink-jetting or electric field application. Ghosh only teaches use of shadow masks in connection with its

evaporative methods. Ghosh, [0018] (“forming vapor phase monomer species able to condense and polymerize on the first dielectric oxide encapsulation layer”), [0032] (forming patterned first encapsulation layer 21 via a polymer layer using “shadow masking”). A person of ordinary skill in the art would have had no reason to apply the tools used in a vaporization process to Yamazaki’s solution-based process. Those are processes using completely different materials, equipment and tools.

88. The Petition also seems to suggest modifying Yamazaki so as to deposit a layer of liquid material using shadow mask in “flash evaporation.” Petition at 36. A person of ordinary skill in the art would not have replaced Yamazaki’s electric field application method or ink-jet method with Ghosh’s evaporation method, given that those are Yamazaki’s points of novelty.

89. Yamazaki is aware of evaporation as a way of depositing materials. For example, Yamazaki uses evaporation to deposit cathodes but it does not suggest making the organic layer via evaporation. EX1005, [0011]. Yamazaki therefore makes a deliberate choice of using ink-jetting and electric field application methods for depositing the organic cover layer (a process that does not involve the use of a shadow mask). A person of ordinary skill in the art would not ignore those express design decisions and replace those application methods with a shadow-mask based evaporation method.

F. Claim 40 is Not Obvious

90. Claim 40 additionally requires that “the step for selectively depositing at least one barrier layer further comprises depositing by shadow mask, sputtering, ink jet deposition, screen printing, [or] evaporation.” For reasons stated for claim 34, claim 40 is not obvious.

VII. Claims 41-46 Are Not Obvious

91. Reasons stated in Sections VI.A through VI.C also apply to Ground II combinations. Additional reasons of non-obviousness are provided below.

A. A Person of Ordinary Skill in the Art Would Not Have Combined Yamazaki’s Electric Field Application Method with Fujimori’s Magnetized Mask

92. Samsung states that a person of ordinary skill in the art would have used Fujimori’s magnetized mask in Yamazaki’s electric field application method. Pet. 38 (Samsung alleging that “it would have been obvious to use this magnetic masking approach when applying Yamazaki’s method to encapsulate a plurality of OLED display panels in batch manufacturing ...”), Pet. 41 (citing Yamazaki [0086] to justify combining Yamazaki with Fujimori, [0086] is part of embodiment 1 that uses electric field application method). Of note here, Samsung does not assert that a person of ordinary skill in the art would have used a mask in connection with ink-jet printing. Yamazaki itself never suggests using a mask in ink-jet printing, which makes sense because ink-jet printing is a patterned printing method whose deposition positions are controlled by the printing head instead of

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an external mask. I am not aware of any ink-jet printing method that also used a shadow mask in the 2001-2002 time frame or even today. Shadow masks are to be avoided whenever possible as they are notorious particulate defect generators due to unavoidable excess deposition material that builds up on the shadow mask and the frequent cleaning or replacement of the used shadow masks.

93. Fujimori proposes using “a mask attached to a substrate with magnetic force” to improve adhesion between the mask and the substrate in order “to achieve fine pattern processing with the mask.” EX1014, [0009]-[0010]. As a preliminary matter, Yamazaki’s mask is not intended to be adhered to the substrate. For example, Yamazaki mentions in passing that “a mask may be provided between the material chamber 111 and the substrate to thereby control the positions on the substrate at which the application liquid is via the mask.” Yamazaki, [0086]. Providing a mask “between the material chamber ... and the substrate” would indicate to a person of ordinary skill in the art that the mask is not in contact with the substrate, but placed some distance away from the substrate. If the mask is not even in contact with the substrate, then there would be no reason to improve the adhesion between the mask and the substrate. That is, there is no reason to use Fujimori’s mask to supposedly improve adhesion.

94. Additionally, despite the proposed benefits of using a magnetically adhered mask, which was known in the art since the 1970s, I have never known of

an instance where a magnetically attached shadow mask was used in connection with an electric field application method, such as that described in Yamazaki. Similarly, electrostatic chucks commonly used in the display industry to accurately align and secure substrates, especially for masked film deposition processes, are not commonly used in conjunction with magnetic masks to my knowledge.

95. I understand that Dr. Subramanian had used magnetic masks and had separately used methods similar to Yamazaki's electric field application method, but never the two together. EX2020_2025-05-30_Final, 73:10-74:1. I also understand that Dr. Subramanian testified that he was not aware of anyone ever combining electric field application method with a magnetic mask in OLED or other application, at the time of the invention or since then, whether in commercialization or in research. EX2020_2025-05-30_Final, 70:6-74:1. Thus, it appears that his experience is similar to mine. In my view, the fact that no POSITAs or even experts have ever combined the use of a magnetic mask with an electric field application, despite the passage of more than 24 years since the invention, is a strong indication that the combination is not obvious.

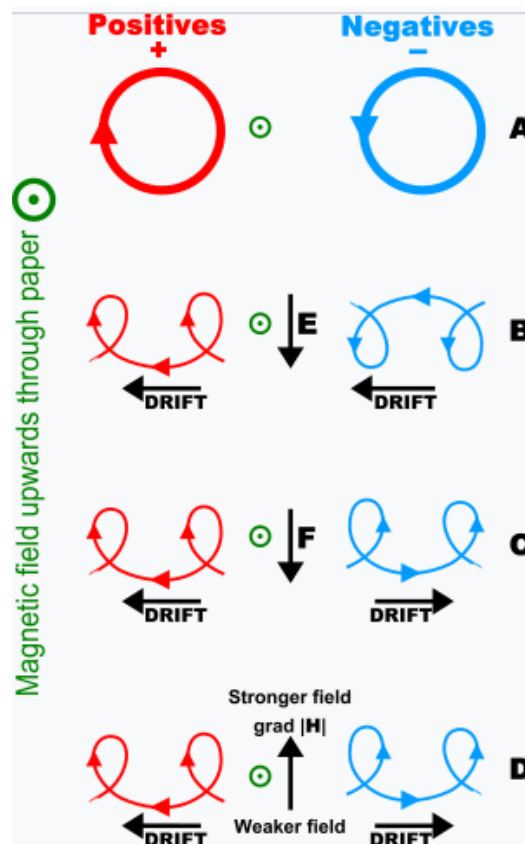
96. Consistent with my experience and knowledge (as well as that of Dr. Subramanian's), Fujimori uses a traditional evaporative deposition technique that does not utilize electric field to control the flight path of charged particles and deposition positions, as in Yamazaki. *E.g.*, EX1014, [0041] (Al deposited "with

the resistance heating deposition method” under vacuum); [0046] (lithium vapor was deposited followed by Al deposition); [0050] (under vacuum, organic materials for the emission layer were deposited under vacuum, and lithium vapor as well as Al was vapor-deposited).

97. This is not surprising because the addition of a magnetic field to the back of the substrate (in order to hold the masks) would have a complicated and unpredictable effect on the flight path of the charged particles of the organic materials to be deposited. For instance, Samsung states that the “electromagnet” used to adhere the mask “can electrically control the switching of the magnetic field.” Pet. 52. But that electromagnet and the associated force would be expected to alter the force operating on the charged particles. The electromagnet would affect the trajectory of the charged particles to be deposited on the substrate and there is no indication that the resulting combined forces could be controlled to reliably deposit the cover layer to the selected spots.

98. For instance, according to Lorentz force law, the force on a particle of charge q moving with a velocity v in an electric field E and a magnetic field B experience a force of $F = q(E + v \times B)$. That is, the force on the moving charged particle is a combination of (1) a force in the direction of the electric field E (proportional to the magnitude of the field and the quantity of charge), and (2) a force at right angles to both the magnetic field B and the velocity v of the charge

(proportional to the magnitude of the field, the charge, and the velocity). Thus, as the charge approaches the magnetic field, it veers off the path set by the electrodes 115-117 in Yamazaki Figure 1C. For instance, below are trajectories of a charged particle (A) in a homogenous field with no additional force; (B) in a homogenous field with an electric field; (C) with a non-EM force such as gravity; and (D) in an inhomogeneous field with gradient H .



(https://en.wikipedia.org/wiki/Lorentz_force)

99. The strength of a magnetic field experienced by a particle would vary depending on its distance from the magnet as well as its velocity (for instance, the particle may move at an accelerated velocity as it approaches the substrate). Thus,

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the Lorentz force on a charged particle would vary depending on the particle's distance from the magnet as well as the angle. As a result, there would not only be particle-to-particle variation within a material stream but also a time-dependent variation as the particles fly from the material chamber towards the substrate, to the back of which a magnetic is attached at certain places. This would introduce unpredictable change in the particles' trajectories, making it impractical to control the positions at which the particles will be deposited. This is particularly problematic given the fine scales on which the pixels are distributed.

100. That is why Fujimori does not disclose or suggest that its magnetic mask and the attendant magnets used to adhere the mask would be suitable for any and all deposition methods. In particular, Fujimori never mentions the electric field application method or ink-jet method as a suitable deposition method with its modified masks. *See* EX1014, [0041] (evaporation), [0044] (same), [0046] (same), [0050] (same). Thus, a person of ordinary skill in the art would not view applying the magnetic mask to Yamazaki's electric field application method as applying a known method to a similar application case with predictable results.

101. I understand that Dr. Subramanian disagrees with my view above. While he agrees that the charged particles "will tend to spiral" "in a corkscrew motion as [they] approach[] the surface," he insists that "the actual, lateral deviation will be small." EX2020_2025-05-30-Final, 233:3-22. I note that, as Dr.

Subramanian acknowledges, the charged particles would assume a Gaussian distribution for their velocities. *Id.*, 77:9-78:8. But there is not just a single Gaussian distribution, but multiple distributions dependent on the number of nozzles. They might differ from one another by only a small amount, but on top of those small deviations, you also have to add in the deviation from the added magnetic field. Thus, the particle-to-particle variations, the nozzle-to-nozzle variations, and the pass-to-pass variations, among other variations, just multiply over multiple devices. A small deviation for a single area could develop into a major problem when dealing with multiple devices on a substrate. For example, a 99.9% per-ejection accuracy rate would correspond to a 36.8% defect-free rate over a 1000 ejections; whereas the defect-free rate increased to 90.5% with a 99.99% per-ejection accuracy rate.

102. I further note that Fujimori does not use its magnetic masks for depositing encapsulation layers: it was only used for depositing electrodes and emission layers. Fujimori, [0041] (Al electrode), [0044] (Al electrode), [0046] (lithium doping and Al electrode), [0050] (emission layer and electrode), [0049] (despite disclosure in [0027], non-emitting black matrix region was applied using spin-coating followed by photolithography without the use of the magnetic mask). In that context, the pixels are closely spaced and even a small amount of deviation, multiplied over the number of pixels, could lead to a significantly increased defect

rate for the resulting display. This is in particular the case that the Gaussian distribution could differ slightly for each nozzle and each spot on the substrate. Even if deviations are small for each particle or stream of particles, multiplying over a large number of streams would significantly increase the uncertainties and error rate, as my example above illustrates.

103. While encapsulating multiple devices in an active area of the substrate while leaving the electric contact pads and scribe lines free of encapsulant materials generally does not require the same resolution, the errors also multiply over multiple displays.

104. Additionally, to the extent that the need for good mask adhesions to ensure very fine resolutions was absent in encapsulation at the time of the inventions, there would be no market or design need for a person of ordinary skill in the art to use a mask with improved adhesions, such as a magnetized mask as disclosed by Fujimori, for non-critical dimension encapsulation processing, especially when its usage would cause unpredictable interference with the electric field controlled charged particle flight path.

105. Fujimori's limited disclosure on the use of magnetic masks is consistent with Fujimori's reason to use the magnetic mask, which is to prevent "a short in the elements [or] cross-talk" caused by the deteriorated adhesion of the mask to the substrate. EX1014, [0008]. Depositing an insulating organic layer

would not cause a short in the element or cross-talk. Fujimori [0049] (not using masks for depositing insulating spacer and black matrix), [0050] (not using magnetic masks to deposit hole transport layer). Therefore, Fujimori also does not suggest the need to deposit magnetic masks for depositing encapsulation layers. Indeed, other encapsulation patents cited by Petitioner do not mention the use of magnetic masks for depositing encapsulation layers.

B. Missing Limitations

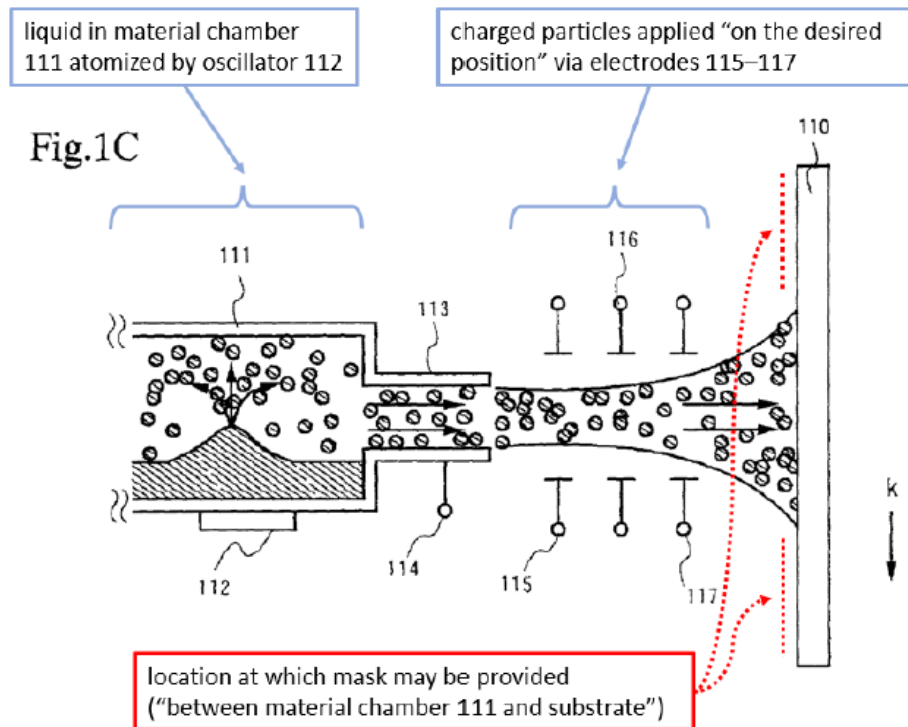
106. For reasons stated in Sections VI.A and VI.B, Ground II references do not disclose a claimed “planarization layer” or “selectively depositing” a barrier layer over at least one planarization layer that is deposited upon a plurality of devices on a substrate.

107. I have also been asked to comment on whether Yamazaki’s disclosure that “a mask may be provided *between* the material chamber 111 and the substrate to thereby control the positions on the substrate at which the application liquid is via the mask” in [0086] would suggest depositing the mask “on top of [the]

substrate” as required by element 41[b] or “in contact with said substrate” as required by claim 43.¹¹

108. A person of ordinary skill in the art would not understand placing a mask “between the material chamber ... and the substrate” as requiring the mask to be placed in physical contact with the substrate as Samsung suggests. Pet. 42-45 (arguing for the use of Fujimori’s magnetized mask for added adhesion between the substrate and mask). In fact, Samsung’s own figure shows that in Yamazaki, if a mask is used, the mask would not be in contact with the substrate. *See* Pet. 34 (reproduced below). If Yamazaki does not even intend its mask to be in contact with the substrate, then there would be no reason to use a mask in order to have the mask adhere to the substrate.

¹¹ The difference between 41[b] and 43 is that the mask is in direct contact with the substrate in claim 43, but may be indirectly on the substrate for element 41[b].



(Pet. 34)

109. In that case, the concerns expressed by Fujimori—that material would bleed below the mask due to warpage and other factors—would not apply to Yamazaki’s electric field application method (or the ink-jetting method) because the mask was not intended to adhere to the substrate in the first instance. As such, a person of ordinary skill in the art would not have modified Yamazaki to ensure that its mask adheres to the substrate as suggested.

110. I also note that in the above annotation by Samsung, electrodes 115-117 control the trajectory of the charged particles. The stream of the materials is shown to be narrower than the opening of the mask such that there is no deposition of the organic materials on the mask. But element 41[c] recites “*depositing at*

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least one planarization layer upon said mask and said plurality of devices.” In Samsung’s own annotation, the organic material is deposited on the devices, but not also “upon said mask.” And Samsung’s own depiction also does not show that the organic material is deposited “over the entire mask” as recited in claim 46.

111. Furthermore, in the above annotated figures by Samsung, because the mask is a distance away from the substrate, there would be no “removing said mask *from* said substrate” as recited by element 41[d] because the mask was never in contact with the substrate and there therefore would be no removal “from” the substrate.

112. Samsung argues that the mask “would need to be removed after forming the cover layer, in order to subsequently deposit the barrier layer.” Pet. 51. That is not necessarily true. For example, the distance between the mask and the substrate can be adjusted to control the area of coverage in a manner similar to that disclosed in Weaver. EX1008, Fig. 9, [0060] (“[A]s shown in FIG. 9, each deposition source can have the same aperture. However, in this embodiment, each source 221b-c and 222 a-c is provided at a larger distance from the substrate than is the adjacent upstream source ... such that the material being deposited from each source again covers a progressively wider area as the substrate proceeds downstream”); *see also* Burrows, 8:10-22 (disclosing using a mask “laterally

and at a distance from the substrate” to create an encapsulation layer where the barrier layer covers the organic layer).

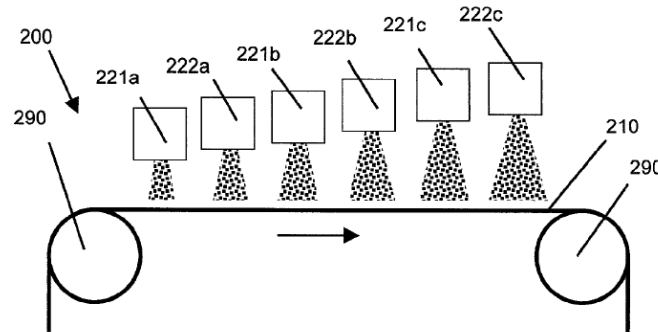
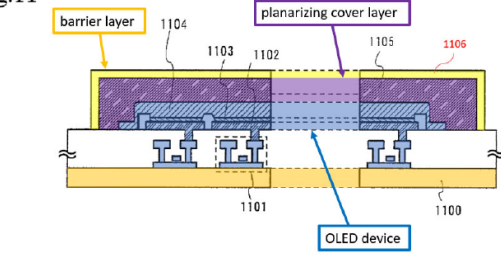
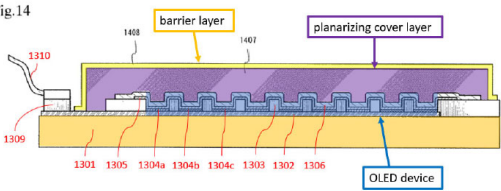
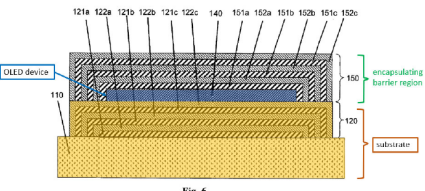
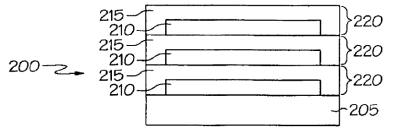


Fig. 9

113. Weaver’s and Burrow’s deposition also results in a subsequent layer wrapping around a previously deposited layer, just as in Yamazaki, as shown below. Thus, by placing the masks where the sources 221a-c and 222a-c are, that is, at variable distances away “between the material chamber 111 and the substrate to thereby control the positions on the substrate at which the application liquid is via the mask,” progressively larger layers could be obtained without removing the masks.

Yamazaki	Weaver/Burrows
Fig. 11  Fig. 14  (Yellow barrier layer surrounding the purple planarization layer)	Fig. 6  (barrier layer 151b surrounding the planarization layer 151a) FIG. 2  (Burrows, barrier layer 215 wraps around decoupling layer 210)

114. And because Yamazaki's mask is not in contact with the substrate, there is no need for the material to be non-sticking to the OLED substrate over the areas in between the active areas, as required by claim 44.

VIII. Claims 34-37 and 40 Are Not Obvious Over Weaver Alone or in View of Palanisamy or Burrows

A. Weaver Does Not Disclose a Claimed Planarization Layer

115. Weaver describes its "planarizing material" as "a material that forms a smooth planar surface upon application, rather than forming a surface that reflects irregular contours of the underlying surface." EX1008, [0035]. The Petition likewise only argues that Weaver's "planarizing layer 151a constitutes a *planarization layer* because it is used to form a smooth planar surface," citing to

Weaver, [0035]. Pet. 71. Neither Samsung nor Dr. Subramanian analyzes whether Weaver's layer 151a enables or disables "the propagation of defects from one layer to another [to be] interrupted" as required under the parties' agreed-to construction. *See* Pet. 70-73. Nor does Weaver mention defects.

116. Additionally, Weaver actually follows the topology of the underlying layers, and therefore also does not meet the requirement that "the topography of the underlying layer and/or structure is not reproduced" in the agreed-to construction.

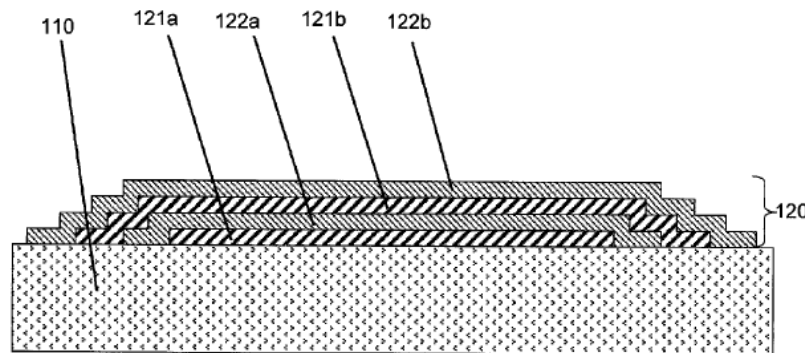


Fig. 5

117. For example, in Figure 5 above, planarizing layer 121a follows the surface topology of the underlying substrate 110 and the planarizing layer 121b follows the topology of high-density layer 122a. For instance, where the high-density layer 122a has steps along the edges of the deposition, so does 121b. And where the substrate has a general flat topology (except for unintentionally created surface irregularity), the planarizing layer also has that topology. In other words,

Weaver's "planarizing layer" reproduces the topology of the underlying layer.

Similarly in Figure 6 below as well as in Figure 7, layers 151a-c follow the topology of the underlying layers 140, 152a-b respectively.

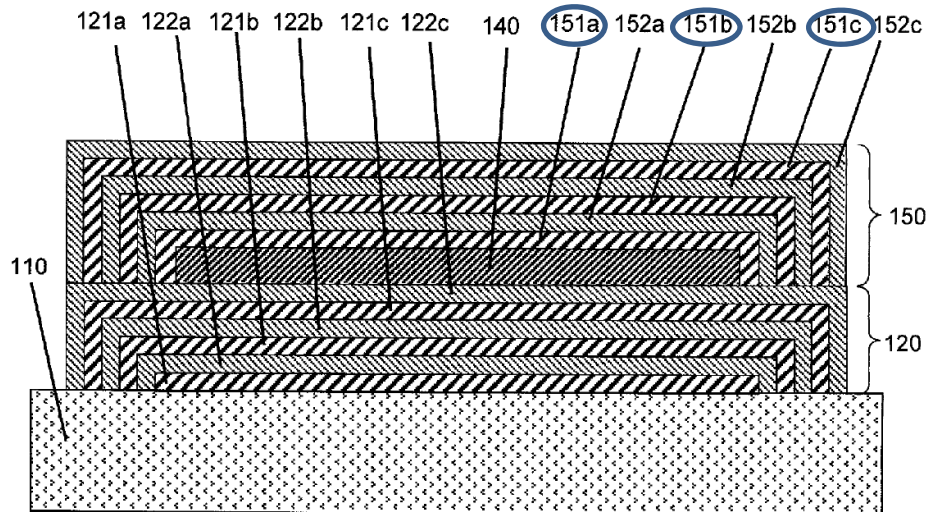


Fig. 6

B. Weaver Does Not Perform Selective Deposition

118. Samsung argues that Weaver selectively deposits layer 151a is selectively deposited because Figure 6 shows it “as surrounding the OLED device from the top and sides, but not extending laterally over the entire surface of the substrate.” Pet. 71-72.

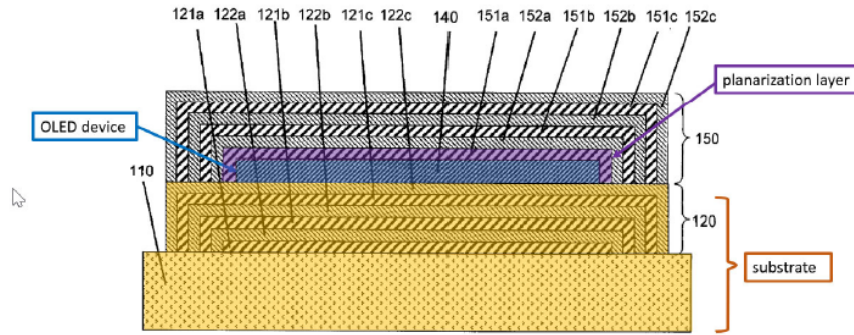


Fig. 6

119. The final configuration does not inform how that configuration is obtained. For example, the same configuration in Figure 6 can be obtained through non-selective deposition followed by patterned etching, as was well known. *E.g.*, EX1001, 2:21-23 (discussing “additional processing ... for the removal the PML structure over [certain] areas”), EX1006-Ghosh, [0032] (patterning to expose substrate surfaces can be done by “ablation ... following layer formation”).

120. For that same reason, contrary to Samsung’s theory (Pet. 75), the fact that ‘the high-density layer [i]s surrounding the [alleged] planarization layer from the top and sides, but not extending laterally over the entire surface of the substrate’ does not inform how that final structure is obtained.

121. The Petition also cites Weaver’s Figure 8 and [0057]-[0059] to argue that the alleged planarization layer and barrier layer are selectively deposited. Pet. 72-73, 75.

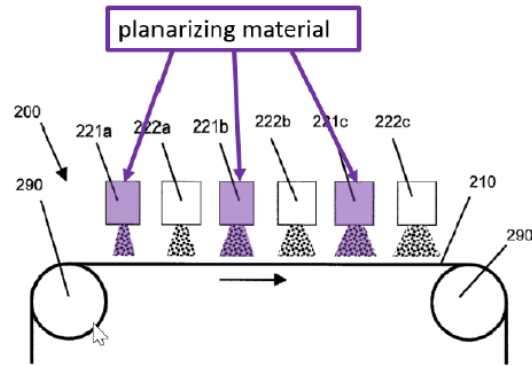


Fig. 8

122. But as Weaver makes clear, Figure 8 (and Figure 9) as well as [0057]-[0059] relate to forming barrier region 120s over the substrate to form a covered substrate, not about sealing the OLED structure 140. For example, Weaver states, “FIG. 8 is a schematic diagram of an apparatus for forming the covered substrate of Fig. 2” [0022]; see also [0023] (Fig. 9 is also for illustrating “forming the covered substrate Fig. 2”). Figure 2, “is a cross-sectional view of a covered substrate ...” and Figure 2 does not have any device above the covered substrate.

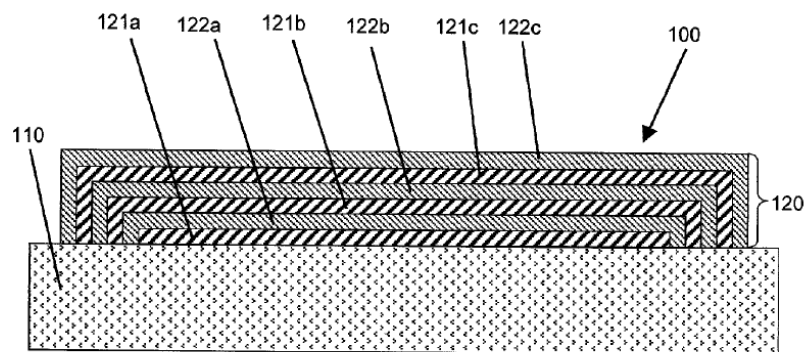
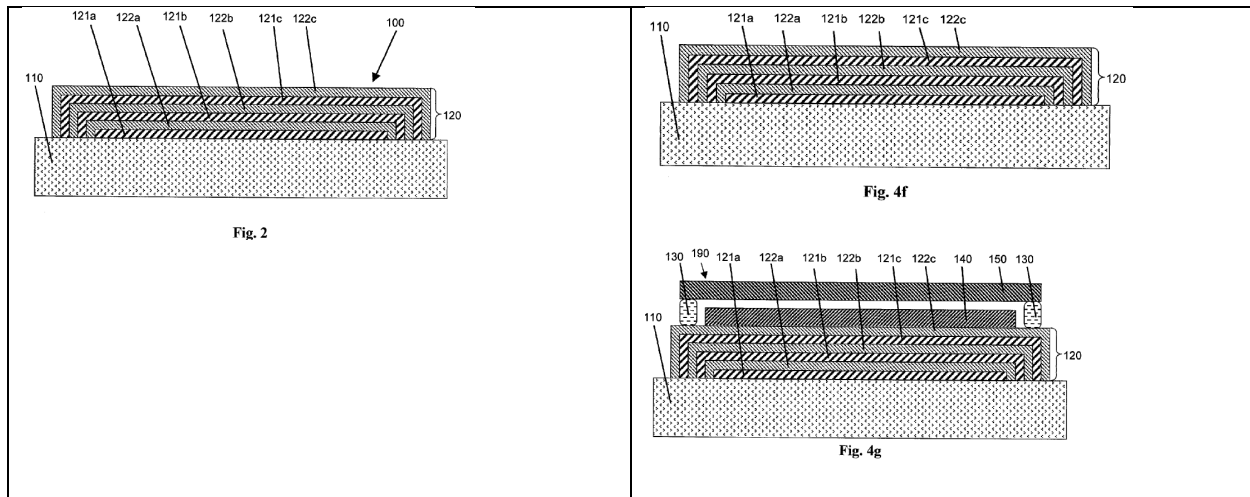


Fig. 2

123. Weaver [0054] explains that the discussions “in connection with FIGS. 4a-4g, FIG. 8 and FIG. 9” concern “*layers over a substrate material,*” not

layers over OLED devices as required by the claims. Figures 4a-4f shows how a configuration as that in Figure 2 is formed step by step. Figure 4g describes the formation of an “additional barrier region 150” that is “adhered to the substrate via adhesive region 130” to “completely enclose[e] the OLED 140 within the OLED structure 190, protecting it from moisture and oxygen.” Weaver, [0056]. Samsung does not argue that the barrier region 150 in Figure 4g meets or suggests the claim limitations.



124. Weaver does not expressly describe the process by which barrier structure 150 that encapsulates the OLED 140 in Figure 6 is made. Nor does it suggest that the barrier structure 150 should be made by the same apparatus or process as shown in Figures 8-9. *See* Weaver [0054]-[0061]. The Petition does not provide a reason for why structure 150 should be made in the same way as structure 120, but assumes that it would be. Pet. 72-73, 75.

125. But unlike substrates before any device attachment in Figures 2, 4g and 5, which do not contain any circuitry elements and need to leave uncovered electrical contact pads and are therefore more tolerant of positional misalignment, the barrier region 150 in Figure 6 may need to take these into consideration. There is no evidence that Weaver's progressive deposition technique could handle the more demanding sealing of OLED devices.

126. A 2015 presentation by Kateeva, the dominant inkjet printer supplier for thin film encapsulation, stated that "[f]or the inorganic layer the only option in R2R [roll-to-roll] is blanket coating followed by removal material at the end of the process." EX2100, p.20.

- For the inorganic layer the only option in R2R is blanket coating followed by removal material at the end of the process (Option 2 stack)

127. The Option 2 stack refers to the below:

• When depositing TFE over the OLED SSL cell, need method to pattern the stack in such a way that electrodes are exposed and edge is fully sealed by inorganic	
Option 1: Deposit Patterned Organic and Inorganic	Option 2: Deposited Patterned Organic Deposit Blanket Inorganic (and etch at the end)

(EX2100, p. 14)

128. While selective patterning of the inorganic materials is possible in plate processing, according to Kateeva, such is not possible in a roll-to-roll process. *Id.*, pp. 15, 20. That is, according to the Kateeva 2015 presentation,

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selective deposition of the barrier layer, as required by 34[c], was not an option for roll-to-roll processing, which is used by Weaver.

129. Dr. Subramanian disagreed with Kateeva and stated that he did selective deposition of inorganic materials in 2005-2006 (after the critical date) using gravure printing. EX2020_2025-05-30_Final, 62:4-17. But Gravure printing was not one of the techniques or sources identified in Weaver. *Compare* Weaver, [0057] (“Preferred sources are thermal evaporation, sputtering, PECVD and electron beam sources for the high-density layer”). And the work was done years after the priority date at any rate. There is thus is no evidence that selective deposition of barrier layers over an OLED (as opposed to a substrate) in a web-based (i.e., roll-to-roll) process was known at the time of the invention.

130. I have also been asked to explain how Weaver controls its area of coverage. The answer is that Weaver controls the coverage area by controlling the amount of material deposited. *E.g.*, [0059] (“In FIG. 8, each deposition source is provided with an aperture that is larger than that of the adjacent upstream source ... such that the material being deposited from each source progressively covers a wider area as the substrate proceeds downstream”). In other words, Weaver does not intentionally create a patterned/selective deposition as in ink-jet printing or masked deposition of encapsulation layers.

C. A Person of Ordinary Skill in the Art Would Not Have Used Ink-Jet in Weaver (Claim 35)

131. Conspicuously, Weaver does not mention ink-jet printing. Instead, in connection with the Figure 8 embodiment, Weaver discloses that the preferred sources for depositing the planarization layer are “thermal evaporation, organic vapor phase deposition (OVPD), chemical vapor deposition (CVD), spraying and flash evaporation sources.” EX1008, [0057]. Ink-jetting is conspicuously absent among the broad list of deposition techniques disclosed. *Id.*

132. While Dr. Subramanian states that I have ignored the “and so forth” phrase in Weaver, [0035], the fact is Weaver does not mention inkjet printing. And if Weaver’s disclosure is open-ended as Dr. Subramanian is arguing, then “inkjet” printing cannot be just one of a finite number of predictable solutions, because the list can simply be unlimited, and can also include sputtering, gravure, flexographic printing, flatbed and rotary screen printing, soft lithography, laser ablation, offset printing, ALD etc. *See* EX2035_2015-02-13-DOE_Draft_Report¹² at 3-7, 22 (not specific to OLEDs). The existence of many other choices indicates that ink-jetting is not just one of a finite number of choices, but that it is one of a large number of choices. At any rate, be it Burrows at Vitex which specialized in

¹² Available from
<https://www.energy.gov/sites/prod/files/2015/02/f19/QTR%20Ch8%20-%20Roll%20To%20Roll%20Processing%20TA%20Feb-13-2015.pdf>

developing a commercial version of PML or Weaver at UDC who collaborated with Burrows, (see EX2037_Burrows_Weaver_2001_SPIE), neither mentioned inkjet, again suggesting that it was not obvious to persons working in the field to use inkjet to obtain a planarization layer. *See also* EX2037 (describing a vacuum based process to obtain cover substrate).

133. I also note that Palanisamy does not describe using inkjet to deposit a planarization layer. Rather, the layer it deposits is a “passivation” layer. *See* EX1007-Palanisamy, [0021]. Generally, a passivation layer need not decouple defects from one layer to another, provide a planar surface, or not reproduce underlying topography. Thus, Palanisamy does not disclose or suggest using inkjet to deposit a planarization layer as required by claim 35.

134. I understand that Samsung argues that a person of ordinary skill in the art would have used ink-jet printing in Weaver’s Figure 8 embodiment because ink-jetting is a non-contact deposition method that can minimize the risk of contamination. Pet. 79. But Weaver’s web-based process shown in Figure 8 already uses a “non-contact deposition technique,” so it also would have a minimized contamination risk under Samsung’s theory. In fact, Burrows explains that in its continuous roll-to-roll process, “[t]he mask is positioned laterally and at a distance from the substrate.” EX1009-Burrows, 8:10-21. That would also be a non-contact deposition technique.

135. Samsung also argues that a person of ordinary skill in the art would have used ink-jetting because it is “a directed deposition technique.” Pet. 79. Again, Weaver’s web-based process in Figure 8 also uses nozzles to direct material to the deposition area. That is, it is also a directed deposition technique. I understand that Dr. Subramanian testified that the nozzles depicted in Weaver Figures 8-9 apply to “all of the techniques that are called out” and “you can use nozzles to control the directivity of evaporation et cetera, et cetera.” EX2020_2025-05-30_Final, 136:14-137:2. It thus appears that he and I agree that Figures 8-9 depict directed deposition techniques.

136. It is also worth noting that Weaver includes “spraying” in his list of deposition techniques but there is no mention of inkjet deposition. In conventional inkjet deposition, the heads move while the substrate remains fixed. Weaver’s web-based deposition process is the exact opposite as shown in Fig. 8 below where the nozzles are fixed and the substrate moves.

137. And to the extent that ink-jetting is “conducive to depositing multiple coats, allowing for the deposition of thicker layers,” so can Weaver’s existing method that uses multiple nozzles, each depositing one layer of materials. *See* Fig. 8 (annotation by Petitioner below). Moreover, as explained above, because ink-jetting involves depositing materials dissolved in solutions, multiple coats would increase the risk of the solution re-dissolving a portion of already deposited and

dried ink material and the risk of the materials seeping to adjacent regions. Indeed, if Sturm's inkjet printing thickness is representative, it may take more than a dozen passes in order to get the desired thickness of 500 nm and more. Specifically, Sturm's inkjet printed layers are about 40-70nm, Suzuki indicated that at least 500 nanometer would be needed to provide the needed sealing in conjunction with a barrier layer; and $500 \div 40$ is more than 12. With that many passes, there is no evidence of the resulting film's topology as I have explained above in connection with the Yamazaki grounds. Furthermore, given the number of passes needed, inkjet printing may be much slower than Weaver's preferred methods, such as evaporation. For example, Burrows et al. reported at the 2001 SPIE Proceedings that evaporative technique for forming a covered substrate could proceed at rates up to 1 $\mu\text{m/s}$ and form up to 5 μm of polymer in one pass. EX2037 at 77.

138. As to scalability, the Petition does not explain why the various evaporation processes or spraying are any less scalable. For example, EX1009-Burrows proposed the same wrap-around structure as Weaver. *Compare* EX1009 and Weaver. And for its continuous roll-to-roll (the same as Weaver's web process), Burrows only proposed a mask-based process, and a person of ordinary skill in the art would not link a mask-based process with an inkjet printing process. EX2044-Shimoda, 5:45-50 ("In an inkjet method, ... processes such as mask fabrication and etching ... can be eliminated.").

139. Additionally, Weaver's methods can provide scalability by ganging together large numbers of nozzle heads to "rapidly print over large areas." Pet. 79. For example, Figure 8 shows just one nozzle array for one cross-sectional area, and in practice, there are other cross-sectional areas (not shown) with similar nozzle arrays.

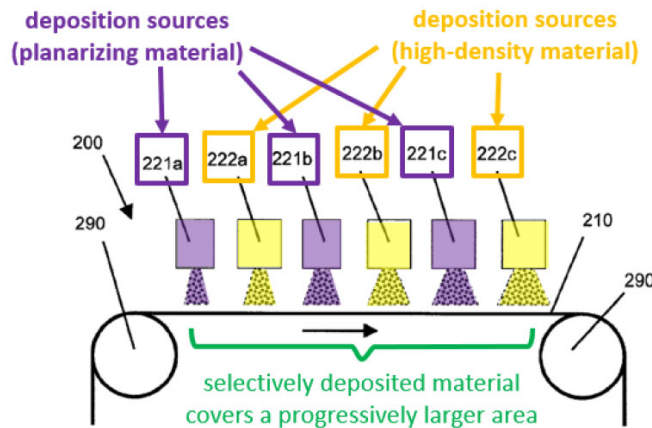


Fig. 8

140. Thus, in the above annotated figure, the nozzles are above the substrate and do not contact the moving substrate, and therefore have a minimal risk of contamination. In addition, each nozzle in the nozzle array directs the desired amount of materials to the substrate to add one coated layer to form multiple coats as illustrated in Weaver Figures 4-6, and there can be multiple nozzle arrays for scalability. Put another way, Weaver's method already provides the same alleged benefits as ink-jetting, but does so without using an ink-jet head. A person of ordinary skill in the art would not have substituted Weaver's method

with ink-jetting that does not seem to have any added benefits, but would require an ink-jet printer that adds costs, but no associated benefits.

D. A Person of Ordinary Skill in the Art Would Not Have Used Screen-Printing in Weaver (claim 36)

141. Weaver also does not mention using screen-printing for depositing its planarizing layer or high-density layer. *See* EX1008, [0035], [0057]. Screen-printing also would not be suitable for web-based process used in Weaver's Figure 8. For instance, screen printing does not use nozzles depicted in Figure 8 and it is not clear how screen printing could yield the "progressively larger cooperative barrier layers" that are at the heart of Weaver. Pet. 81-85.¹³

142. Samsung argues that a person of ordinary skill in the art would have used screen printing because it allegedly provided for "rapid processing time at lower temperatures," and "enabl[ed] a range of material viscosities to be used for Weaver's planarizing layer 151a." Pet. 83 (cleaned up). Samsung cites to Palanisamy for these alleged benefits. But Palanisamy does not involve depositing

¹³ Dr. Subramanian testified that Sue Carter's work indicated how this could be done. I have reviewed her work as reflected in U.S. Patent No. 6,605,483 and U.S. Patent No. 7,115,216, but they do not relate to OLED encapsulation, planarization layer or roll-to-roll process. They therefore do not undermine my opinions stated here.

multiple layers successively. *See* Palanisamy, [0024]-[0026]. And as noted above, Palanisamsy is not about depositing a planarization layer, but a passivation layer.

143. And while Weaver’s method allows for continuous deposition of the successive layers as the substrate moves through the process line, in screen-printing, a new screen would need to be set down and then removed for each successive layer. This would add process steps and reduce, rather than increase, the process speed. The Petition also does not explain why being able to use a range of material viscosities is a desirable or even suitable choice for Weaver’s continuous process. Pet. 82-84.

144. For the same reasons stated for ink-jetting (claim 35), screen-printing is not “one of a finite number of predictable solutions for ‘selectively applying an organic passivation material’ for OLEDs.” Weaver itself gives many other specific examples of suitable techniques for depositing the planarization layers—ranging from dipping, spin coating, spraying to various evaporation techniques (OVPD, CVD, flash evaporation) and sputtering. EX1008, [0035], [0057]. No screen-printing is mentioned. *Id.* The existence of many other choices indicates that screen-printing is not just one of a finite number of choices, but that it is one of a large number of choices.

E. Claim 37 Is Not Obvious Over Weaver in View of Burrows

145. Burrow's continuous roll-to-roll process involved the placement of a mask "a distance from the substrate." EX1009-Burrows, 8:10-21. When materials are deposited through the opening of a mask that is placed some distance away from the substrate, some subsequent material removal step would very likely have to be performed to remove bled-through materials. That would not constitute selective deposition under Petitioner's and Dr. Subramanian's understanding of "selectively depositing" because it would involve subsequent removal of materials from unwanted areas.

146. Samsung argues that because Weaver's nozzles have respective apertures, Weaver would suggest the use of a shadow mask, because "[a] 'shadow' mask is a mask having apertures" Pet. 85 (emphasis in original). But an aperture in *nozzles* has nothing to do with an aperture size in *masks*, and the reference to one would not suggest the other to a person of ordinary skill in the art. And Samsung does not explain why a person of ordinary skill in the art would add a shadow mask to Weaver, which does not show the use of a shadow mask but allegedly can already provide for selective deposition. Pet. 85-89. Samsung argues that Weaver's Figure 8 apparatus for web-based processing of OLED devices is allegedly "ready for improvement." Pet. 89. But it is unclear what those improvements are or even what their drawbacks are.

147. In my opinion, Burrow's method would be more costly than Weaver's with no clear advantages. For example, Weaver's Figure 8 apparatus could deposit progressively larger cooperative barrier layers without the use of shadow masks and different work stations. *See* EX1008, Fig. 8, [0057]-[0059]. In contrast, Burrow's method needs not only additional equipment (shadow masks and process stations), but also additional process steps to align the masks with the substrate, to remove the masks in order to deposit barrier layers that cover a larger area, and to move the substrate through different processing stations. *See* Burrows, 8:10-47. Thus, replacing Weaver with Burrow's method would not be an improvement but a step-back.

148. Nor is there any evidence that "a shadow mask allows precise control of the positions on the substrate where the planarizing layers are formed." As noted above, Burrows suggests placing the mask a distance away from the substrate in a roll-to-roll continuous process. Burrows, 8:10-21. It is not clear how a mask placed some distance away from the substrate would provide better control than precise control of the nozzle positions and/or aperture sizes.

IX. Conception and Reduction to Practice

A. Conception

1. February 8, 2001 Email

149. 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* EX2006 (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 fabricating and then encapsulating multiple display devices on a substrate. *Id.* at 1.

150. 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.

151. 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

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

152. 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.*

153. 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.

154. 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

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.

155. The inventors exchanged ideas for selectively depositing organic (planarization) layers and barrier layers to avoid deposition on scribe lines and electric pins. EX2006 [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-

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.*

156. 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.*

157. 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

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.

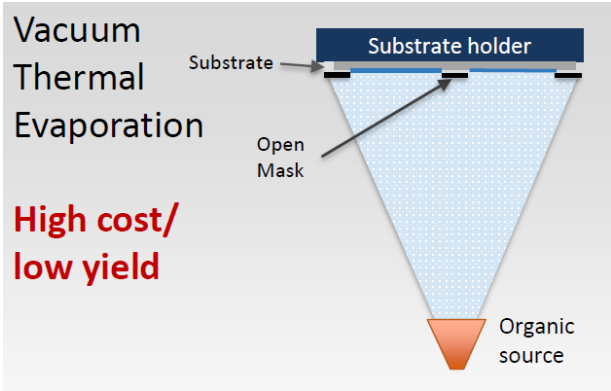
158. The following chart provides an element-by-element mapping of the ideas conceived by February 8, 2001 against the elements of the asserted claims:

Element	Evidence
34[pre] & 34[a]	“[I]t may very well be that vapor deposition through a shadow mask is the easiest <i>method for producing an array of small displays on a large plate of glass.</i> ”
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.” “[I]t very well may be that <i>vapor deposition through a shadow mask</i> is the easiest method for producing an array of small displays on a large plate of glass.” “[W]e could consider printing techniques (Screen/Inkjet).” “Any thoughts on masking for spin coating”?
34[c]	“Spin-, roll- or whatever-coat, cross-link/cure and then <i>sputter the dielectric barrier through a mask over the OLED area only</i> , i.e. leave the contact pads, scribe lines,

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	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 <i>method for producing an array of small displays on a large plate of glass.</i> ”
41[b]	“I anticipate that vapor deposition <i>through a shadow mask</i> 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 <i>masking the area for the scribe lines</i> will be a good practice.” “Any thoughts on <i>masking for spin coating?</i>” “[I]t very well may be that <i>vapor deposition through a shadow mask</i> is the easiest method for producing an array of small displays on a large plate of glass.” (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 <i>vapor deposition through a shadow mask</i> is the easiest method for producing an array of small displays on a large plate of glass.” “Any thoughts on <i>masking for spin coating?</i>” “[I]t very well may be that <i>vapor deposition through a</i>

	<i>shadow mask</i> is the easiest method for producing an array of small displays on a large plate of glass.” “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.” (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. 
41[d]	“I anticipate that vapor deposition <i>through a shadow mask</i> will <i>keep the pins free</i> of the coating Also, I am not too sure if scribing through the multilayer is a good idea; therefore, I anticipate that <i>masking the area for the scribe lines</i> will be a good practice.” “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

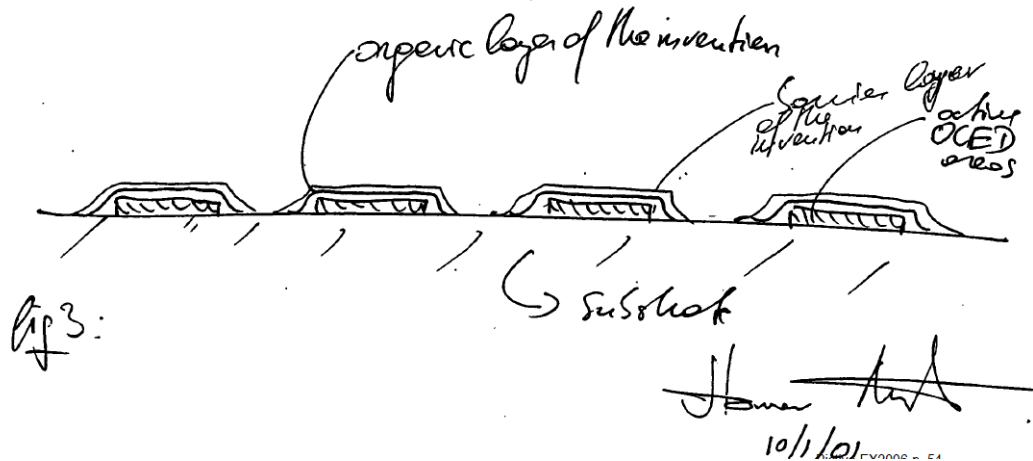
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	there is no dielectric barrier film.” (A POSITA would understand that the vapor deposition mask used for the organic layer deposition is removed in order to use the mask for sputtering the barrier layer.)
41[e]	“Spin-, roll-, or whatever-coat, cross-link/cure and then <i>sputter the dielectric barrier through a mask over the OLED area only</i>, i.e. leave the contact pads, scribe lines, etc. free from the barrier. . . .”
46	“I anticipate that vapor deposition through a shadow mask will <i>keep the pins free of the coating</i>; 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 <i>masking the area for the scribe lines</i> 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 <i>a large plate of glass</i>.”

2. September 30, 2001 Invention Disclosures

159. 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”:



EX2006, p. 51.

160. 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.*, EX2006, 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.”).

161. 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:

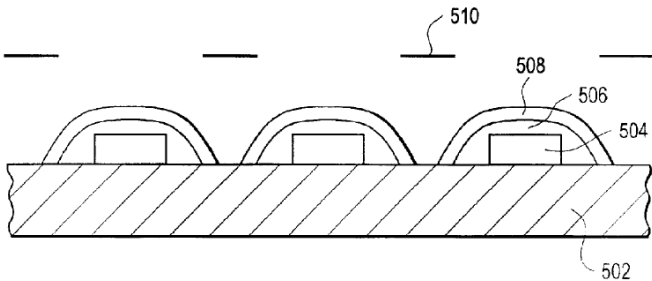
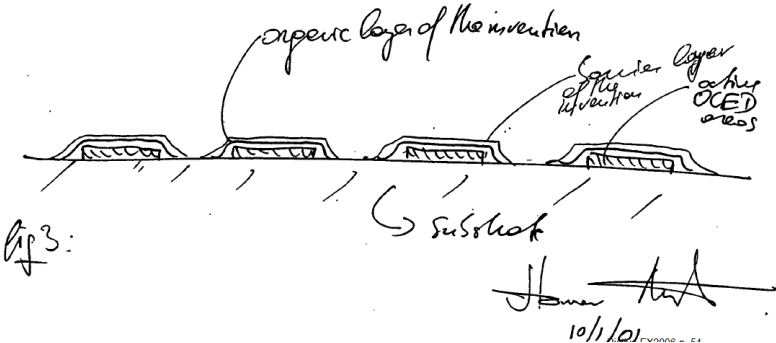
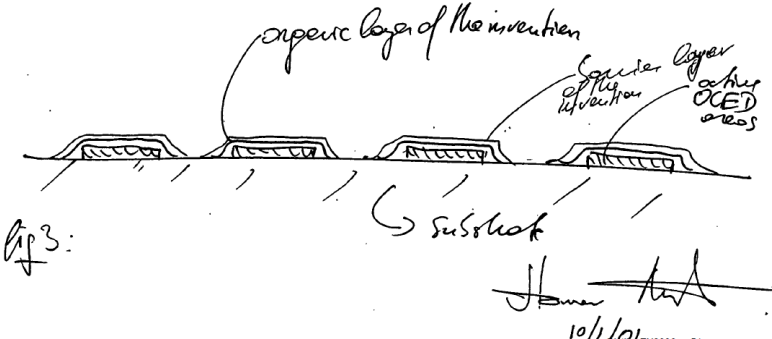


FIG. 5

162. 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: 34[a] fabricating a plurality of devices on a substrate;	(EX2006, p. 51) (showing encapsulation of multiple active OLED areas on a substrate, each active area having at least one fabricated OLED device, where the barrier layer and the organic layer are 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 undevide 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 <u>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).</u> 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 <u>patterned deposition of the barrier</u>, no need to remove e.g. non-UV-cured organic. (EX2006, pp. 47-48)
34[b] selectively depositing at least one planarization layer upon said devices; and	 (showing the organic planarization layer is selectively deposited upon the OLED devices, but not in between active areas). Additionally, ink-jetting is preferred application method: <u>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 searching 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.</u> (EX2006, p. 42)

	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. (EX2006, 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. (EX2006, 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 undivided 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. (EX2006, 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. 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. (EX2006, p. 48) Has this invention been prototyped or tested yet? If so, when, where, by who? What were the results? <u>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 searching 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.</u> (EX2006, 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. 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. 31. Any of the preceding claims, with the addition of... (EX2006, 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.

	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. (EX2006, p. 48)
40	1. A process for directly encapsulating a multitude of OLED devices fabricated on an undivided 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. 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. <i>→ more solid: source =</i> 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. (EX2006, pp. 47-48) 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. (<i>id.</i> at p. 47)

3. October 14, 2001 Supplemental Invention Disclosures

163. 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):

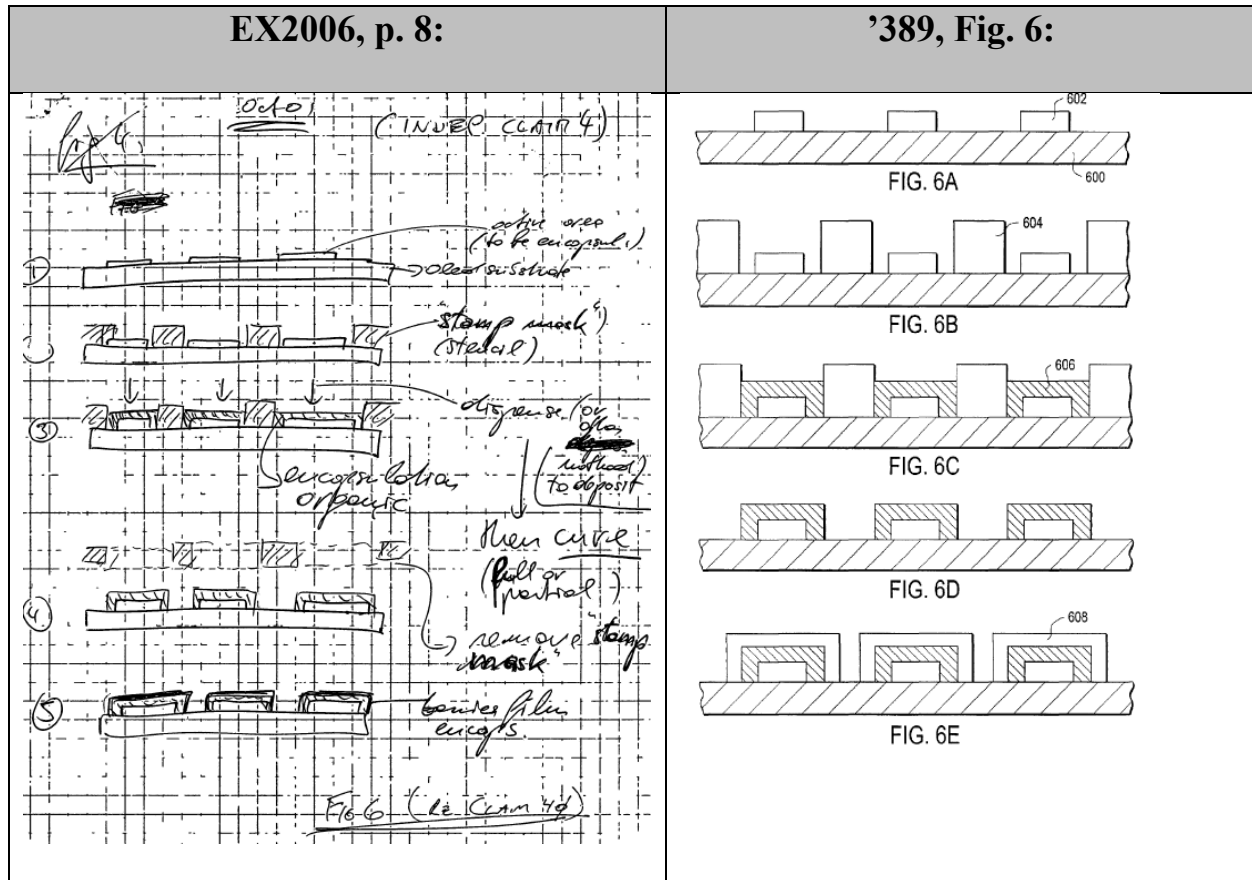
This goes on somewhere after the independent claim 28 and its dependent claims and this section could be the basis for another independent claim, namely:

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. partial 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).



(EX2006, p. 11)

164. In fact, Fig. 6A-6E of the '389 patent are materially the same as the drawings dated Oct. 1, 2001 (EX2006, p. 8):



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

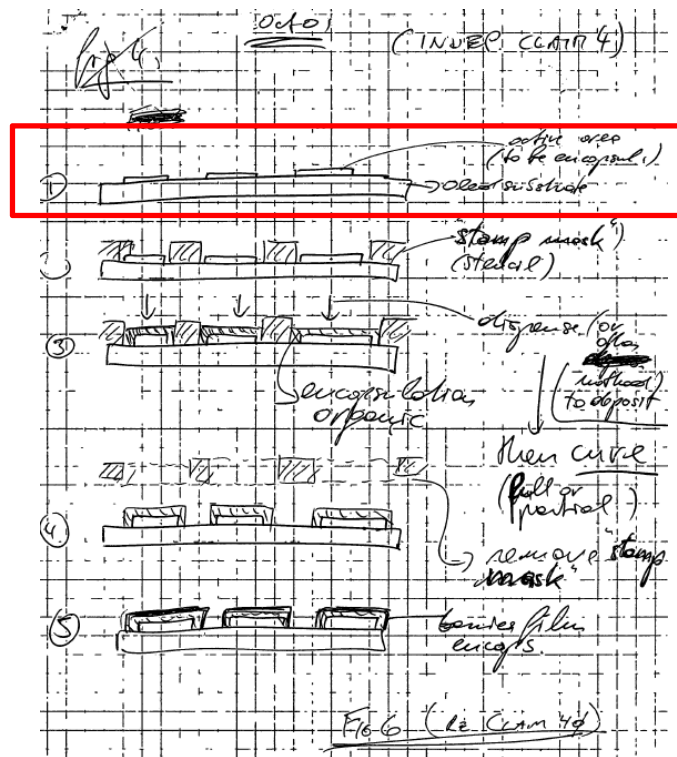
Element	Evidence
41 [pre]. A method of encapsulating a plurality of devices fabricated upon a substrate, the steps of said method comprising: 41[a] fabricating a plurality of	1. A process for directly encapsulating a multitude of OLED devices fabricated on an undivided substrate sheet (can be foil) by 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.

devices on a substrate;

(EX2006, pp. 47-48)

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. partial 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).

(IPR2024-01222 EX2006, p. 11)

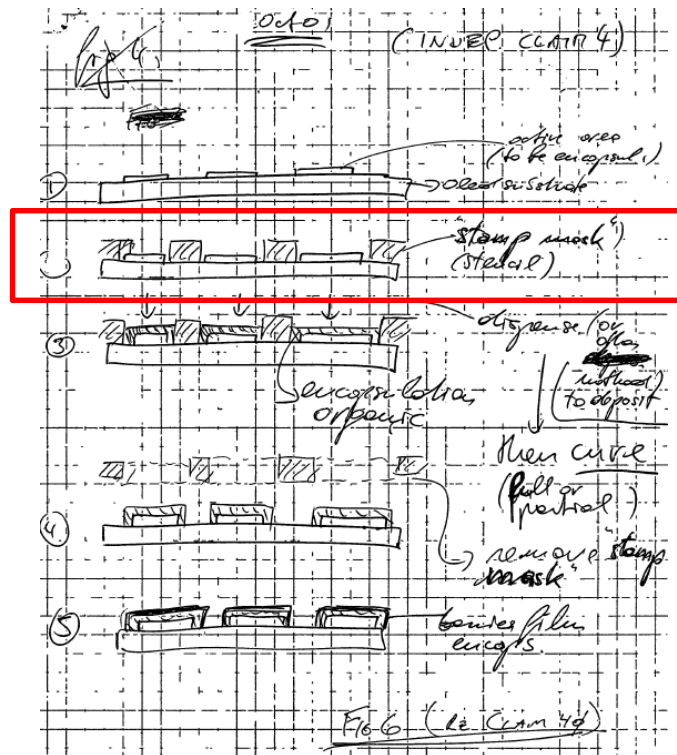


(EX2006, p.8)

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. partial 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).

(EX2006, p. 11)

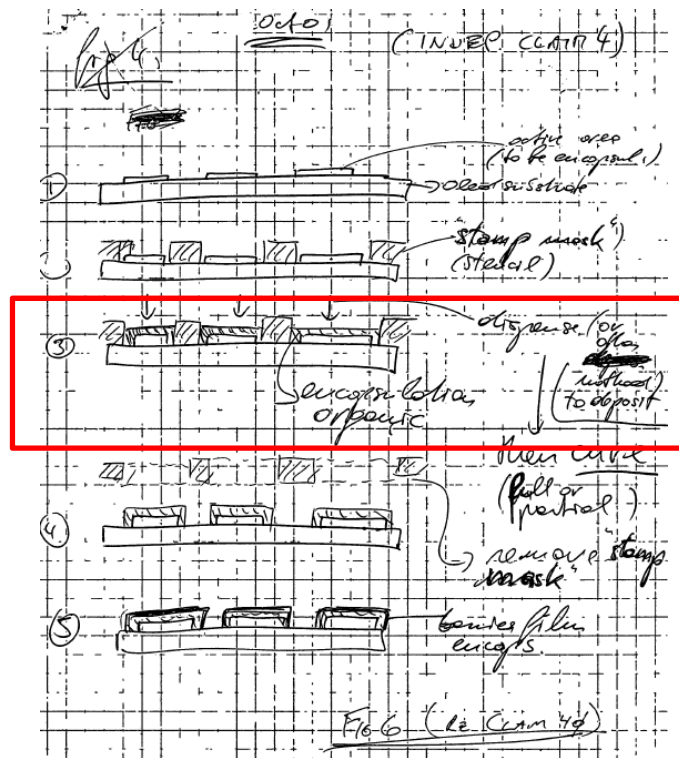


(EX2006, p.8)

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. partial 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).

(EX2006, p. 11)

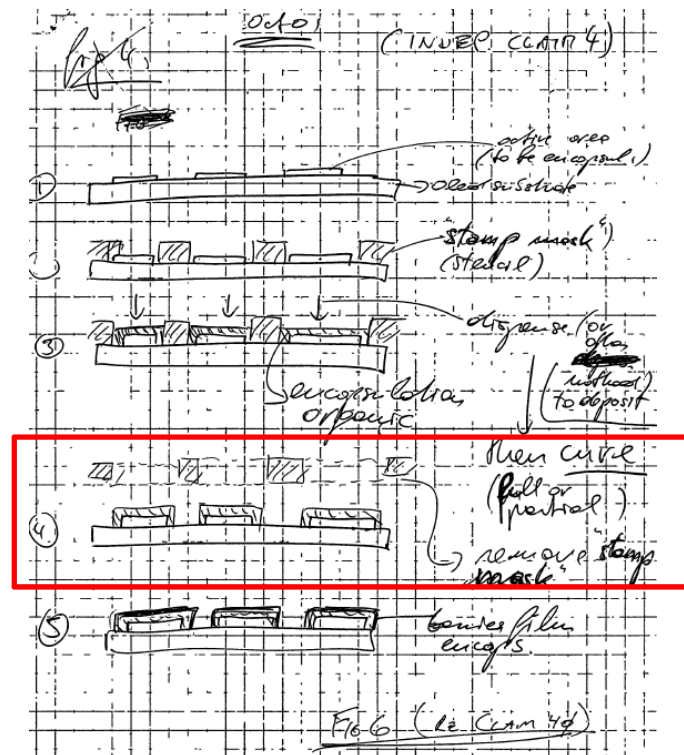


(EX2006, p.8)

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. partial 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).

(EX2006, p. 11)



(EX2006, p.8)

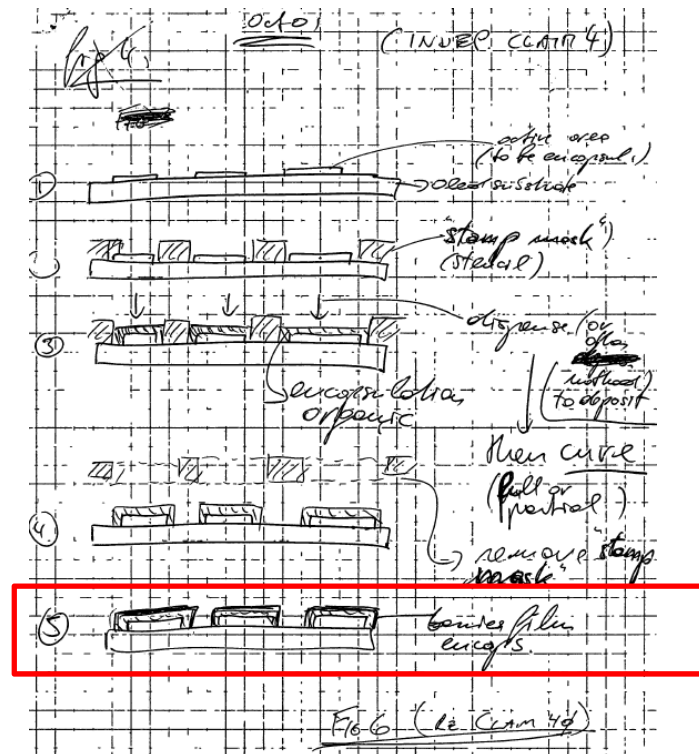
41[e]
selectively
depositing at
least one
barrier layer
over said
planarization
layer.

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.

(EX2006, p. 48)

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. partial 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).

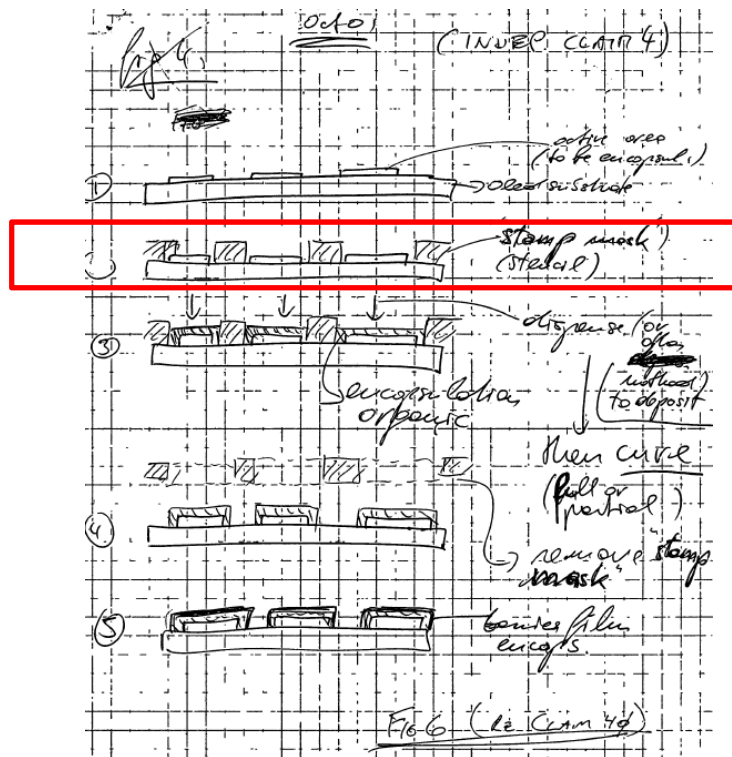
(EX2006, p. 11)



(EX2006, p.8)

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. partial 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).

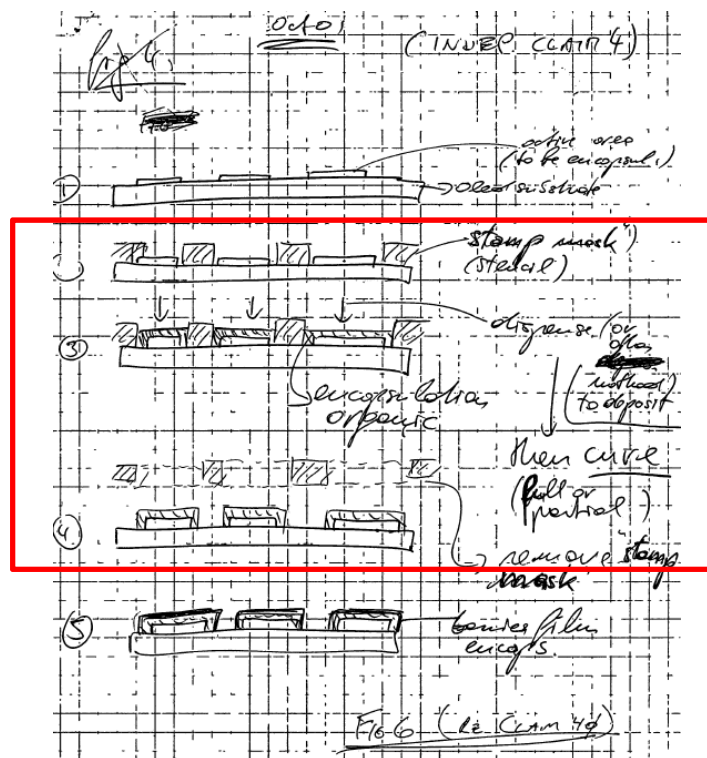


(EX2006, p.8, showing that the mask is direct contact with the substrate)

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-sticking 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. partial 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).

(EX2006, p. 11)

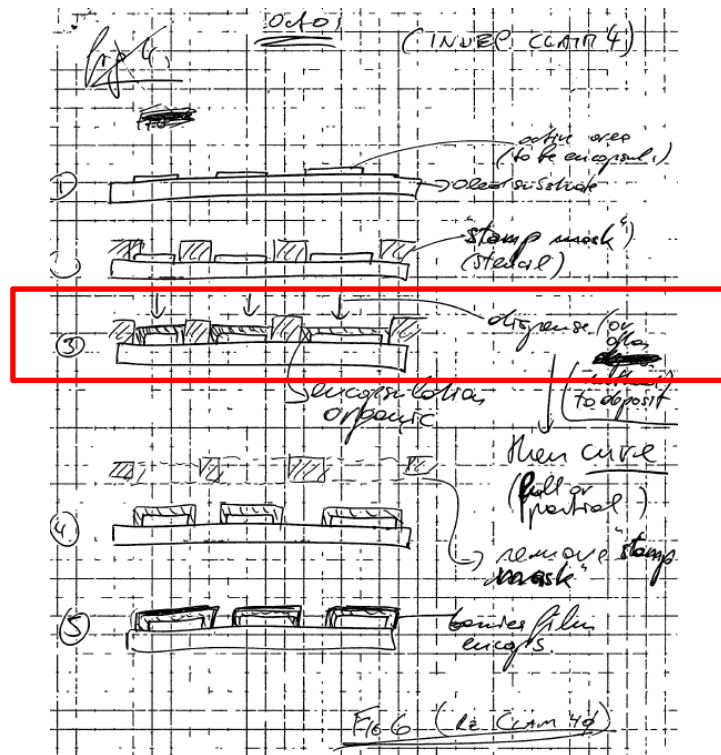


(EX2006, p.8, showing that the mask is contact with substrate in between OLED active areas, which is the part that should be non-sticking)

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). (EX2006, 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.

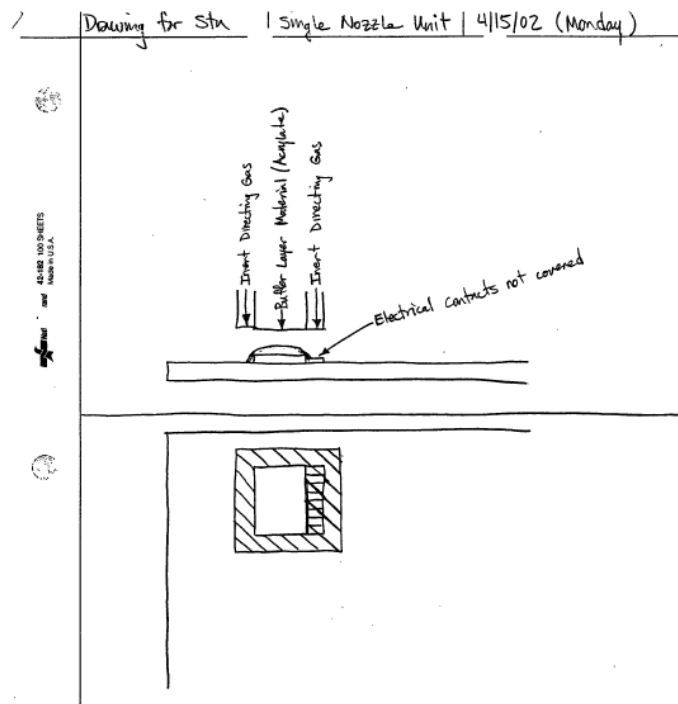
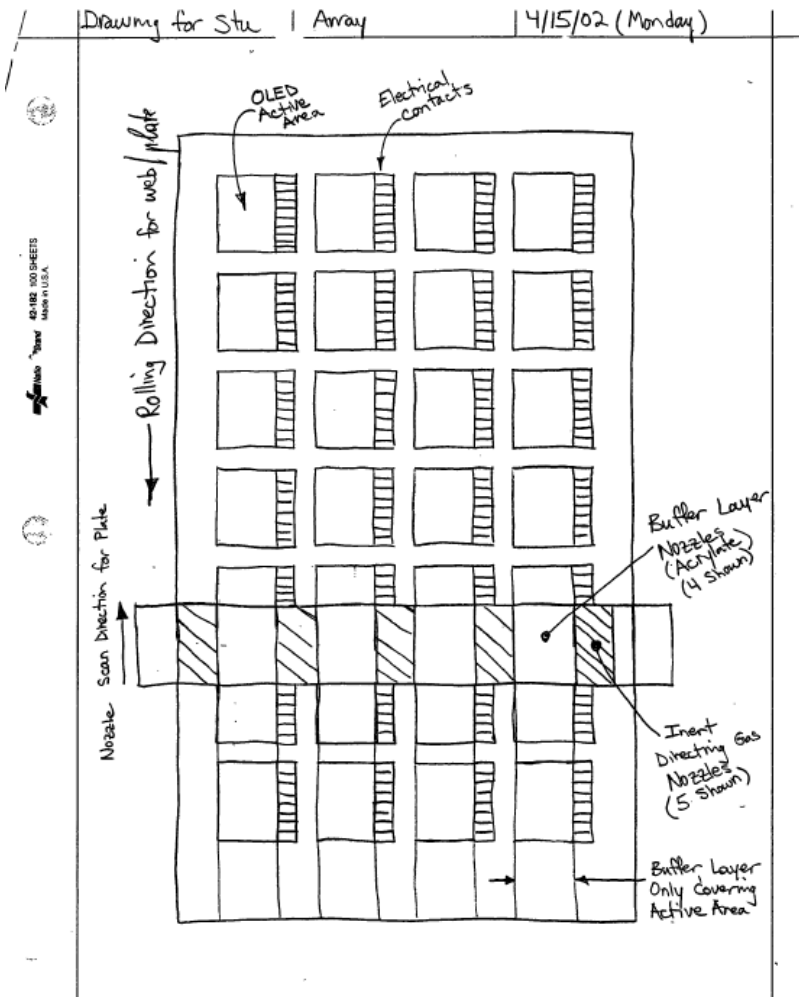
As e.g. claim 28 but instead of directly printing the organic using e.g. screen-printing or ink-jet printing the OLED is covered with a mask which is in direct contact with the OLED and the organic (e.g. the UV cure epoxy) is then dispensed, squashed, rolled, blade coated, dropped into, sprayed onto, 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. partial 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).



(EX2006, p.8, showing that the organic layer is deposited over the entire mask)

166. Inventor Pichler also did drawings on April 15, 2002 “for Stu.”

EX2006, pp. 12-13.



167. “Stu” referenced in the drawings appears to be Attorney Stuart P.

Kaler who filed the '389 application. EX1002, p.34.

95 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) ☒ Original patent application.
☒ 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:

☒ Twenty-four (24) page specification.
☒ Eight (8) sheets of drawings ☐ formal ☒ informal drawings (one set)
☒ The Declaration and Power of Attorney ☐ signed ☒ unsigned
☒ 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

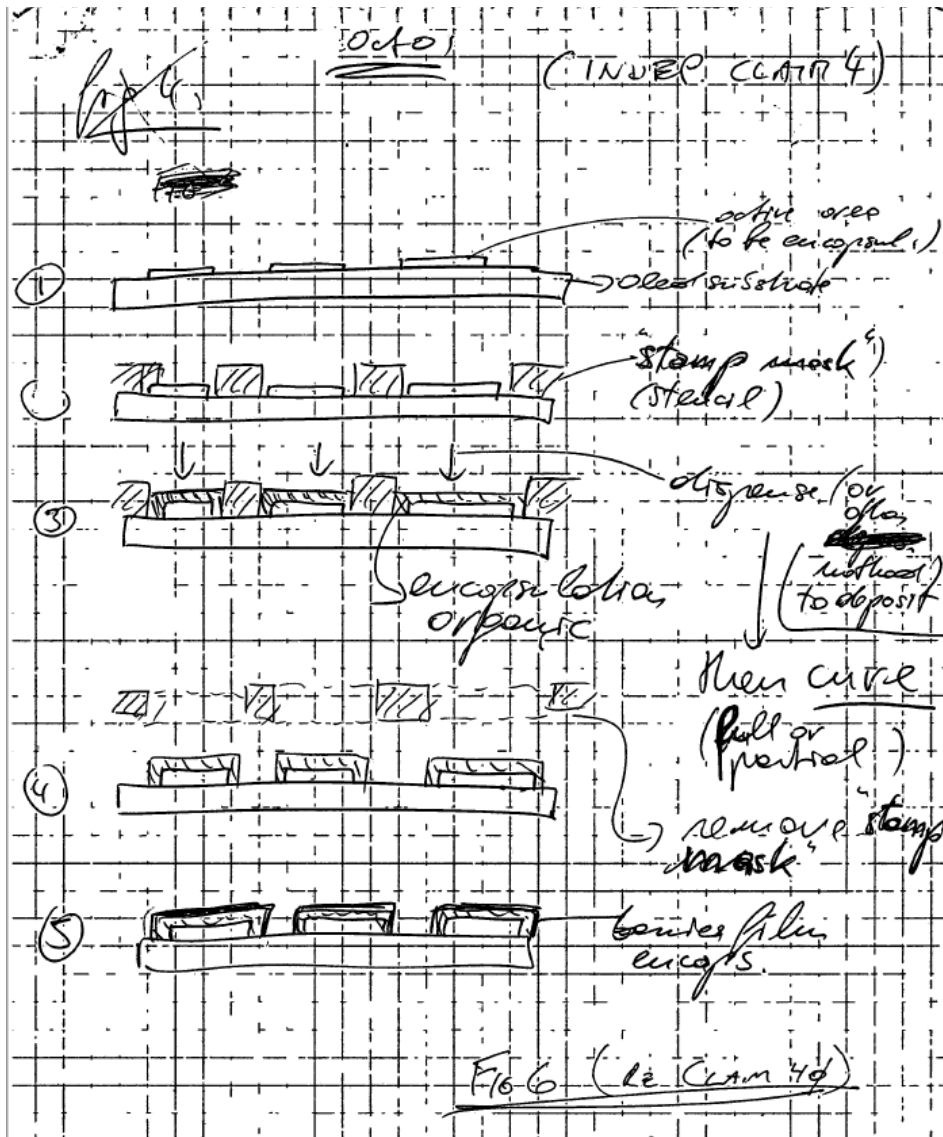
168. Figures 7A-7C of the filed application are based on the 4/15/2002 drawings prepared “for Stu.” Compare figures on EX2006, pp. 12-13 with EX1002, 43-44. In addition to Figures 7A-7C, the filed applications also included the drawings for Figures 1-2, 3A-3B, 4A-4B, 5 and 6A-6E. In my opinion and based 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 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

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

170. 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. EX2006 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.



171. The above sketches later became Figure 6 of the '389 patent.

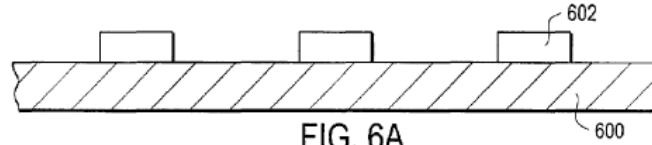


FIG. 6A

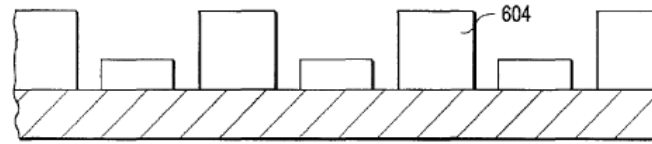


FIG. 6B

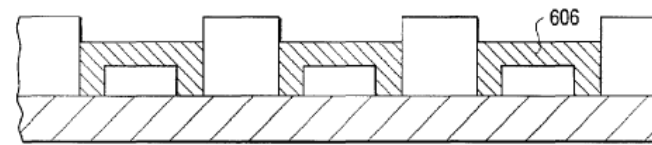


FIG. 6C

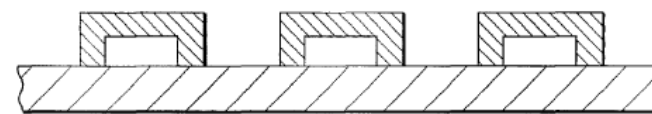


FIG. 6D

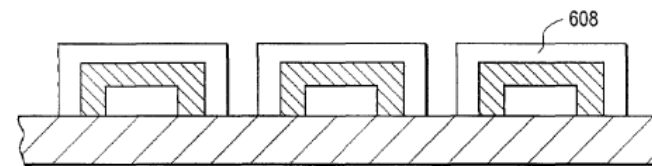


FIG. 6E

172. 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.

INAP
#3

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
INDP
#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

173. As also noted in paragraphs 166-168, 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.

174. 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.

175. 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,

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”).

176. 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”).

177. 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

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. EX2006 [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.

178. 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.

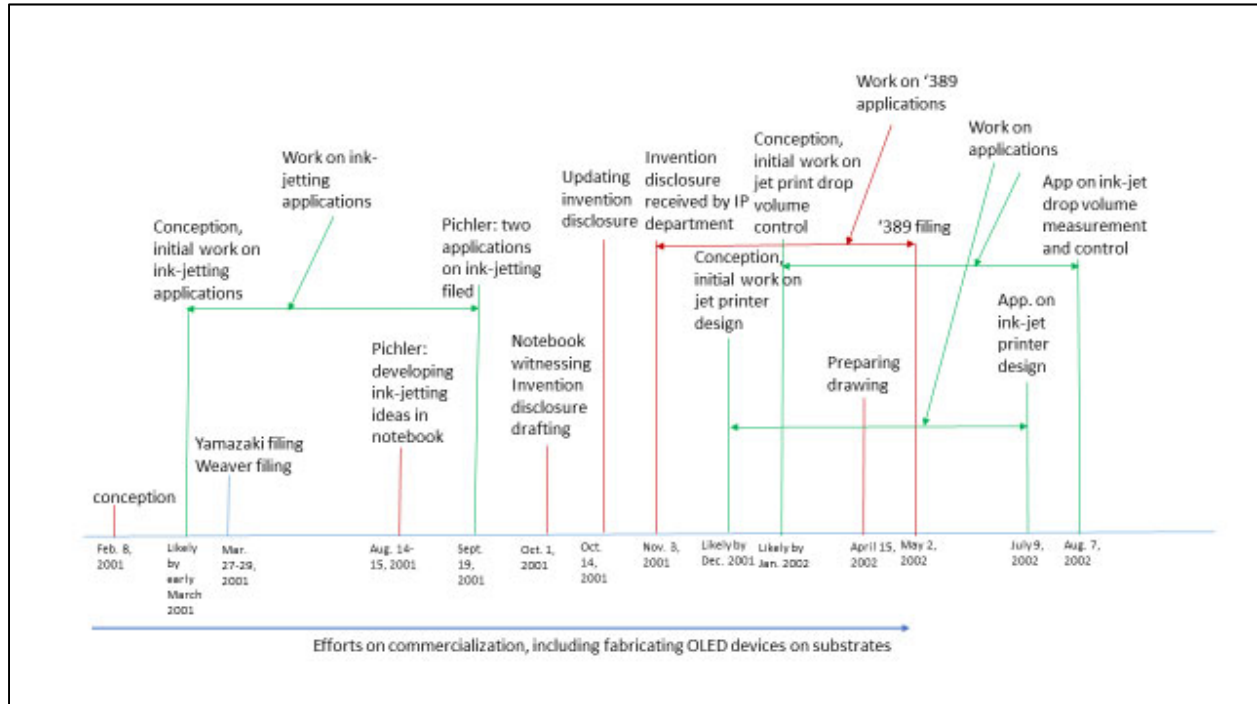
179. I also understand that Dr. Antoniadis testified that in the relevant period, the inventors were also working on commercialization of OLED displays,

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.

180. 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

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

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



182. 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 Denver, Colorado.

/Kurt Humphrey/

Kurt Humphrey

APPENDIX A

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 Egnuity 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 TiSi₂ 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.

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