SEL EXHIBIT 2011

INNOLUX CORPORATION v. PATENT OF SEMICONDUCTOR ENERGY LABORATORY CO., LTD.

IPR2013-00068

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

INNOLUX CORPORATION
Petitioner

v.

PATENT OF SEMICONDUCTOR ENERGY LABORATORY CO., LTD.
Patent Owner

CASE IPR2013-00068
PATENT 8,068,204

DECLARATION OF MICHAEL J. ESCUTI

I, Michael J. Escuti, do hereby declare and state that all statements made herein are based on my own personal knowledge and that all statements made on information and belief are believed to be true. I further do hereby declare and state that these statements are made with the knowledge that willful false statements are punishable by fine or imprisonment or both under 18 U.S.C. § 1001.

Dated: 24 July 2013

Michael J. Escuti

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I. INTRODUCTION

1. I have been retained by Semiconductor Energy Laboratory Co., Ltd. in this proceeding as an expert in the relevant art.

2. I have been asked to provide my opinions and views on the materials I have reviewed in this case related to U.S. Patent No. 8,068,204 (the "'204 patent") (Ex. 1001), and the scientific and technical subject matter at the time the '204 patent was filed.

3. My opinions and underlying reasoning for these opinions are set forth below.

A. Background And Qualifications

4. I am currently a tenured Associate Professor at North Carolina State University, in the Department of Electrical and Computer Engineering. As detailed below, I have over 15 years of experience directly relevant to the '204 patent, in liquid crystal display ("LCD") technologies, fabrication, optical physics, and electronic materials.

5. I received my Ph.D. in Electrical Engineering from Brown University in Providence, R.I., in 2002. My dissertation topic focused on novel liquid crystal display systems and devices, including both experimental fabrication and theoretical study. Upon earning my Ph.D., I apprenticed as a Post-Doctoral fellow in the Department of Chemical Engineering at Eindhoven University of

Technology, in the Netherlands, where my research focused on liquid crystal displays, and polymer-based organic light emitting diodes ("LEDs") and thin-film-transistors ("TFTs"). Following this, in 2004, I joined the faculty of North Carolina State University, where I established a research laboratory for "Opto-electronics and Lightwave Engineering," with a focus on liquid crystal displays (LCDs) and related applications.

6. In 2005, I co-founded the start-up ImagineOptix Corporation, which commercializes liquid crystal display components, systems, and optical thin-film technology developed within my academic laboratory. Since its inception, I have been a part-time advisor to the company with the title of Chief Scientific Officer, and in 2013, I joined the Board of Directors.

7. I have received numerous awards and distinctions, including the following:

- (2011) Presidential Early Career Award for Scientists and Engineers ("PECASE"), the highest award by the U.S. Government for young researchers, nominated by the National Science Foundation and personally awarded by President Barack Obama at the White House.
- (2011) Alcoa Foundation Engineering Research Achievement Award, awarded to one faculty NCSU member annually recognizing outstanding research.

- (2010) Faculty Early Career Development (CAREER) Award, from the National Science Foundation ("NSF").
- (2004) Glenn H. Brown Prize for Outstanding Ph.D. Dissertation, from the International Liquid Crystal Society ("ILCS").
- (2002) New Focus Award, Top Winner, from the Optical Society of America ("OSA").
- (1999) Best Student Paper Award, Society for Information Display ("SID").
- Member of the Institute of Electrical and Electronics Engineers ("IEEE"), Society of Photo-optical and Instrumentation Engineers ("SPIE"), and SID.

8. I have co-authored over 88 peer-reviewed journal and conference publications, and 1 book chapter. I have offered 23 invited research presentations. I am a named inventor on 5 issued and 10 pending United States patents and applications, respectively, and several additional foreign patents and applications.

9. I have supervised the graduation of five Ph.D. and three M.S. students, and currently advise an additional three Ph.D. students and two Post-Doctoral fellows. I have also mentored seventeen undergraduate researchers. Furthermore, I have created and/or teach several undergraduate and graduate courses relevant to the '204 patent. For example, with NSF support, I developed a laboratory course on "Liquid Crystal Displays and Organic Electronics," wherein both graduate and

undergraduate students fabricate LCDs and TFTs, among other devices. I am currently also developing a new undergraduate course entitled "Introduction to Nano-Science and Technology," wherein thin-film transistors play a prominent role. For several years, I have also taught the undergraduate "Electromagnetic Fields" course required for all majors in our department. I also took classes in LCD, VLSI, and semiconductor fabrication and design when I was an undergraduate (1992-1997) and graduate student (1997-2002).

10. My research at NCSU over the last nine years has been supported by approximately $5M in external research funds, in part from several government agencies, including the NSF, the United States Air Force Research Laboratory (AFRL), the Defense Advanced Research Projects Agency (DARPA), and the National Aeronautics and Space Administration (NASA). A further part of this support also comes from several strong partnerships with industry, including Raytheon, Lockheed Martin, Teledyne Scientific & Imaging, Boulder Nonlinear Systems, MZA Associates, and ImagineOptix.

11. My central expertise via training and research experience is in LCD design, fabrication, and modeling, including electronics, optics, and materials. I began working with LCDs in 1998. My first journal article on this topic (M.J. Escuti, et al., "Enhanced Dynamic Response of the In-plane Switching Liquid Crystal Display Mode Through Polymer Stabilization," *Applied Physics Letters*, vol. 75,

pp. 3264-3266 (1999)) addressed switching speeds of in-plane switching (IPS) mode. In 2002, I co-authored a chapter reviewing LCD technology (G.P. Crawford and M.J. Escuti, *Liquid Crystal Display Technology*, in "Encyclopedia of Imaging Science and Technology," ed. J.P. Hornak (John Wiley & Sons, Inc., 2002)). Several of my projects involve high resolution active-matrix displays, and the techniques used to fabricate and design them – for example, R.K. Komanduri, et al., "Late-News Paper: Polarization-Independent Liquid Crystal Microdisplays," *Society for Information Display Symposium Digest*, vol. 39, pp. 236-239, 2008. In this, and other more recent projects (unpublished), my students, industrial partners, and I designed, fabricated, and assembled systems involving electrical connections to LCD panels.

12. In my academic research, I direct both applied and fundamental research for applications including efficient liquid crystal displays, photonic switches, low-loss laser beam steering for high energy applications and laser communications, VIS/IR/MIR polarization imaging, and novel holographic elements. We routinely use and often fabricate our own liquid crystal devices, substrates, and fully functional systems for direct-view and projection-displays and other applications including telecommunications, remote sensing, and laser beam steering.

13. A copy of my curriculum vitae is attached as Appendix A. This includes a list of my patents and publications and a list of my prior testimony.

B. Compensation

14. I am being compensated at my standard rate of $330 per hour for my work in this matter. My compensation has not influenced any of my opinions in this matter and does not depend in any way on the outcome of this case.

C. Information Considered

15. The information I have considered in forming my opinions for this matter is set forth throughout my report and includes the documents listed in Appendix B.

II. LEGAL STANDARD OF PATENTABILITY

16. In forming my opinions and considering the patentability of the claims of the '204 patent, I am relying upon certain legal principles that counsel has explained to me.

17. I understand that for an invention claimed in a patent to be found patentable, it must be, among other things, new and not obvious in light of what came before it. Patents and publications which predated the invention are generally referred to as "prior art."

18. I understand that in this proceeding the burden is on the party asserting unpatentability to prove it by a preponderance of the evidence. I understand that "a preponderance of the evidence" is evidence sufficient to show that a fact is more likely than not.

19. I understand that in this proceeding, the claims must be given their broadest reasonable interpretation consistent with the specification. The claims after being construed in this manner are then to be compared to information that was disclosed in the prior art.

A. Anticipation

20. I understand that the following standards govern the determination of whether a patent claim is "anticipated" by the prior art. I have applied these standards in my analysis of whether claims of the '204 patent were anticipated at the time of the invention.

21. I understand that, for a patent claim to be "anticipated" by the prior art, each and every requirement of the claim must be found, expressly or inherently, in a single prior art reference in the manner recited in the claim. I understand that claim limitations that are not expressly found in a prior art reference are inherent only if the prior art necessarily includes the claim limitations.

22. I understand that it is acceptable to examine extrinsic evidence outside the prior art reference in determining whether a feature, while not expressly discussed in the reference, is necessarily present within that reference.

B. Obviousness

23. I understand that a claimed invention is not patentable if it would have been obvious to a person of ordinary skill in the field of the invention at the time the invention was made.

24. I understand that the obviousness standard is defined at 35 U.S.C. § 103(a) as follows:

> A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

25. I understand that the following tenets also govern the determination of whether a claim in a patent is obvious. I have applied these standards in my consideration of whether claims of the '204 patent would have been considered obvious at the time of the invention.

26. I understand that obviousness may be shown by considering more than one item of prior art but that the prior art must teach or suggest all the claim limitations.

27. I also understand that the relevant inquiry into obviousness requires consideration of four factors:

1. The scope and content of the prior art;

2. The differences between the prior art and the claims at issue;

3. The knowledge of a person of ordinary skill in the pertinent art; and

4. Whatever objective factors indicating obviousness or non-obviousness may be present in any particular case, such factors including commercial success of products covered by the patent claims; a long-felt need for the invention; failed attempts by others to make the invention; copying of the invention by others in the field; unexpected results achieved by the invention; praise of the invention by the infringer or others in the field; the taking of licenses under the patent by others; expressions of surprise by experts and those skilled in the art at the making of the invention; and that the patentee proceeded contrary to the accepted wisdom of the prior art.

28. I understand that for a claim to be obvious based on a combination of prior art, there must be some reason, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine such teachings. I also understand that the hypothetical

person of ordinary skill in the art must have had a reasonable expectation of success in making such combinations or modifications. Obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some reason to do so found either explicitly or implicitly in the references themselves or in the knowledge generally available to one of ordinary skill in the art. "The test for an implicit showing is what the combined teachings, knowledge of one of ordinary skill in the art, and the nature of the problem to be solved as a whole would have suggested to those of ordinary skill in the art." *In re Kotzab*, 217 F.3d 1365, 1370, 55 USPQ2d 1313, 1317 (Fed. Cir. 2000). *See also In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988); *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992).

29. I understand that the '204 patent is based on a series of continuation applications from an application (09/165,628) that was filed on October 1, 1998. I understand that the '204 patent claims the benefit of the foreign priority date of October 6, 1997.

C. The Person of Ordinary Skill In The Art

30. I believe a person of ordinary skill in the art in the field of the '204 patent would be aware of liquid crystal display structures, including techniques for providing connections therein and to circuits outside a sealant in 1997.

31. I understand that a "person of ordinary skill is also a person of ordinary creativity, not an automaton" and that would be especially true of anyone developing liquid crystal display structures.

D. Claim Construction

32. As noted above, I understand that in this proceeding the claims must be given their broadest reasonable interpretation consistent with the specification. I understand that the "broadest reasonable interpretation" is based on giving words of a claim their "plain meaning" unless such meaning is inconsistent with the specification. I understand that the "plain meaning" of a term means the ordinary and customary meaning given to the term by those of ordinary skill in the art at the time of the invention and that the ordinary and customary meaning of a term may be evidenced by a variety of sources, including the words of the claims themselves, the specification, drawings, and prior art.

33. I understand that in construing claims "[a]ll words in a claim must be considered in judging the patentability of that claim against the prior art." (MPEP § 2143.03, citing *In re Wilson*, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970)).

34. I understand that extrinsic evidence may be consulted for the meaning of a claim term as long as it is not used to contradict claim meaning that is unambiguous in light of the intrinsic evidence. *Phillips v. AWH Corp.*, 415

F.3d 1303, 1324 (Fed. Cir. 2005) (citing *Vitronics Corp. v. Conceptronic, Inc.*, 90 F.3d 1576, 1583-84 (Fed. Cir. 1996)). I also understand that in construing claim terms, the general meanings gleaned from reference sources must always be compared against the use of the terms in context, and the intrinsic record must always be consulted to identify which of the different possible dictionary meanings is most consistent with the use of the words by the inventor. *See, e.g., Ferguson Beauregard/Logic Controls v. Mega Systems,* 350 F.3d 1327, 1338, 69 USPQ2d 1001, 1009 (Fed. Cir. 2003).

III. THE '204 PATENT

A. The Background Of The '204 Patent

35. The '204 patent relates to an LCD device having, among other things, an auxiliary line, an external connection line, and structures patterned in specific locations of an LCD substrate to create a uniform gap between the LCD substrates.

36. Structures exist under the sealant 105, mainly an insulating film, a plurality of external connections lines 403 (or "second conductive line") and auxiliary lines 401 (or "first conductive line"). According to the '204 patent and FIG. 4A, lines 403 and 401 overlap and are electrically connected in parallel. Ex. 1001, col. 8, ll. 42-50. This achieves the effect of lowering electrical resistance. These wiring

structures under the sealant also create a height difference compared to regions under the sealant where such wiring structures are not present.

37. The ’204 patent and FIG. 4B teach that a first adjustment layer (or first conductive layer or third conductive line) is provided in the same layer as the auxiliary lines and a second adjustment layer (or second conductive layer or fourth conductive line) is provided in the same layer as the external connection lines to solve the problem of height difference.

B. The Invention of the ’204 Patent

38. The ’204 patent discloses reducing the height difference under the sealant by adding an “adjustment layer” or “conductive layer.” The formation of an “adjustment layer” or “conductive layer” reduces the height difference that is caused by the formation of an auxiliary line and an external connection line. Ex. 1001, ’204 Patent, at FIG. 4B, col. 3, ll. 22-24, col. 9, ll. 12-51, col. 14, ll. 36-41. This results in a favorable display. It is my opinion that this advantage is achieved by the following limitation, in combination with the other limitations, found in claim 31 (with similar limitations in the other independent claims 38, 46, 54, 61, 68 and 76 involved in this IPR):

> an adjustment layer, at least part of the adjustment layer extending under the sealant;

39. The invention of the ’204 patent also provides the advantage of achieving low electrical resistance and low power consumption. The ’204 patent achieves this effect with the following structure disclosed in the ’204 patent: a first wiring (an auxiliary line or a first conductive line) and a second wiring (an external connection line or a second conductive line), both of which are electrically connected to each other and at least partially overlapped with each other. The ’204 patent explains that a signal is transmitted to both of the two wirings (i.e., transmitted to two paths), which results in reducing the wiring resistance for transmitting the signal. Ex. 1001, ’204 Patent, col. 8, ll. 42-50. This reduces power consumption by reducing the wiring resistance. Serious problems such as the delay and deterioration of signals in the case of transmitting the clock signal or video signal to the wirings can be avoided or minimized by lowering the wiring resistance. Ex. 1001, ’204 Patent, col. 8, l. 61-col. 9, l. 11. It is my opinion that this advantage is achieved by the following limitations in claim 31 (with similar limitations, in combination with the other limitations, in the other independent claims 38, 46, 54, 61, 68 and 76 involved in this IPR):

> an external connection line overlapping the auxiliary line with a first insulating film interposed therebetween, at least part of the external connection line and at least part of the auxiliary line extending under the sealant;
>
> wherein the external connection line is electrically connected to the auxiliary line;

40. The '204 patent also discloses an advantageous arrangement to minimize the failure of the bonding of the sealant to the substrate 101. A person of ordinary skill in the art would know that a sealant adheres poorly to a transparent conductive film made of ITO. For example, if the ITO of film 114 in FIG. 4A extends under the sealant 105, the adhesion of the sealant 105 becomes weak, which is likely to cause problems such as a decrease of moisture resistance and the peeling of the substrate. The '204 patent teaches a structure such that the sealant and the transparent conductive film do not overlap with each other. The sealant is in direct contact with the insulating film. Thus, because the transparent conductive film of the '204 patent is not under the sealant, the adhesion of the sealant is strongest. It is my opinion that this advantage is achieved by the following limitations, in combination with the other limitations, in claim 31 (with similar limitations in the other contested independent claims 38 and 46):

> a second insulating film interposed between the sealant and the external connection line; and
>
> wherein the sealant is in direct contact with the second insulating film.

41. In addition, this advantage is achieved by the following limitations, in combination with the other limitations, in claim 54 (with similar limitations in the other contested independent claims 61, 68, and 76):

> a transparent conductive layer over a first region of the second conductive line;

a sealant over a second region of the second conductive line;

wherein the sealant is in direct contact with the second insulating film.

42. Sealants are generally made of acrylate, methacrylate, or epoxide chemistries, and are essentially different types of glues or adhesives. It is known that sealants adhere to a surface because of open chemical bonds on each surface that can "grab" each other, with a strength that is dependent both on the chemistry of the sealant and surface. This property of adhesion strength must be balanced with other properties that affect its use in LCD fabrication, including viscosity, elasticity, tensile strength, and resistance to humidity and oxygen degradation and permeability. As a result of balancing all of these properties, the most common sealants used by the LCD industry at the time of the '204 patent were based on methacrylate chemistry, which generally bonds with highest strength to insulators and glass, and has a noticeably lower strength to metals and ITO. An additional consideration is that sealant failure occurs more often when there is a plurality of materials on the bonding surface. That is, the weakest part of a seal is usually the boundary between two different surface materials, where it tends to fail sooner than if the whole seal was formed on only one surface material or the other. It is therefore desirable to avoid sealing LCDs in such a way that the sealant is in contact with a conductor (e.g., ITO) in the terminal region and with another material (e.g., insulating resin) elsewhere.

43. Another advantageous effect is that a connection with high reliability can be achieved by the '204 invention because the entire region at the terminal portion where the transparent conductive film is formed can be used as the connection area with the FPC. This occurs in FIG. 4A because resin inter-layer film 113 is formed under the ITO film 114, and there will be no layer blocking the ITO film from connecting with the FPC. The entire area where the ITO film is formed corresponds to the region where the FPC can be formed. Because the unobstructed connection area will increase, the connection reliability between the ITO film and the FPC will increase. Because no other layer will be deposited over the transparent conductive film, the transparent conductive film will not be damaged due to the deposition or etching process of any such layer. Such damage would include a change in film properties and overetching. This results in a reliable connection with the FPC. One of skill in the art, at the time of the invention, would have understood that the '204 patent teaches this advantageous effect. This effect is achieved by the following limitation in combination with the other limitations, of claims 54, 61, 68, and 76: "wherein the second conductive line and the flexible printed circuit are in electrical contact through the transparent conductive layer;" and "wherein the second conductive line and the transparent conductive layer are in direct contact through an opening in the second insulating film".

44. The '204 patent teaches that the transparent conductive film does not extend to the sealant so that the sealant does not overlap the transparent conductive film. In the '204 patent, the sealant only is in direct contact with the second insulating film, which an ordinarily skilled artisan would understand increases adhesion with the sealant compared to the transparent conductive layer. A person of ordinary skill in the art would have understood that the ITO in the '204 patent is intentionally discontinued before the sealant region so as not to extend under the sealant.

C. **Prosecution History**

45. I was advised that the application which ultimately issued as the '204 patent was filed on January 20, 2011, and is a continuation of U.S. Application No. 12/252,793, filed on October 16, 2008, which is a continuation of U.S. Application No. 11/837,588, filed on August 13, 2007, which is a continuation of U.S. Application No. 10/384,943, filed on March 10, 2003, which is a continuation of U.S. Application No. 09/865,081, filed on March 24, 2001, which is a continuation of U.S. Application No. 09/481,278, filed on January 11, 2000, which is a continuation of U.S. Application No. 09/165,628, filed on October 1, 1998. The '204 patent also claims priority to a foreign patent, Japanese Patent Application No. JP 9-289160, filed on October 6, 1997. *See* Ex. 1001, '204 patent, at 1.

46. I understand the prosecution history of the '204 patent to be part of the intrinsic record of the '204 patent.

D. The Claims

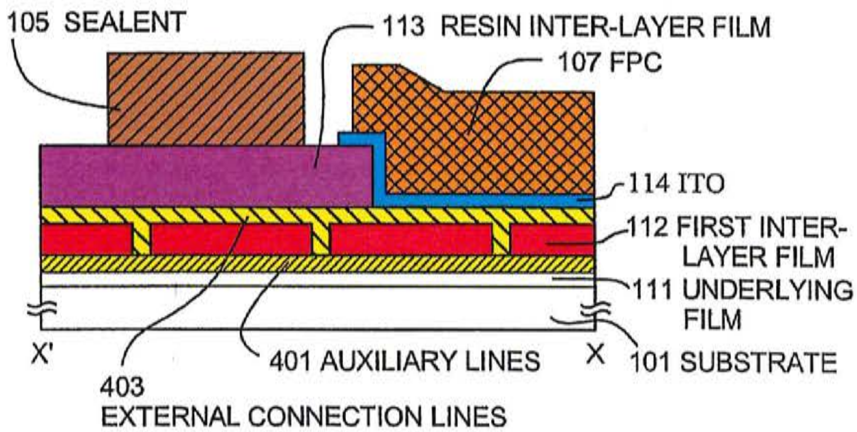
47. Claim 31 requires an auxiliary line, an external connection line overlapping the auxiliary line with a first insulating film interposed therebetween, a sealant, with the external connection line and auxiliary line both extending under the sealant and wherein the external connection line and auxiliary line are electrically connected. A second insulating film is interposed between the sealant and the external connection line, and the sealant is in direct contact with the second insulating film. A flexible printed circuit ("FPC") is over and in electrical contact with the external connection line though a transparent conductive film. Further, claim 31 requires an adjustment layer that at least partly extends under the sealant and that is electrically isolated from the auxiliary line, external connection line, thin film transistors and FPC. Claims 38 and 46 also recite similar limitations.

48. Claims 38 and 46 also recite "a second adjustment layer overlapping the first adjustment layer with the first insulating film interposed therebetween"; "wherein the first adjustment layer is formed from a same layer as the auxiliary line"; and "wherein the second adjustment layer is formed from a same layer as the external connection line."

49. Claim 54 recites a first conductive line with a first insulating film over it, then a second conductive line over the first insulating film and a second insulating film over the second conductive line. The second conductive line overlaps at least part of the first conductive line and they are in electrical contact with each other. A sealant is over the second region of the second conductive line and in direct contact with the second insulating film. The claim recites a transparent conductive layer over the first region of the second conductive line wherein the second conductive line and the transparent conductive layer are in direct contact through an opening in the second insulating film. The claim also recites a FPC over the first region of the second conductive line and wherein the second conductive line and the FPC are in electrical contact through the transparent conductive layer. Finally, the claim recites a conductive layer with at least part overlapped by the sealant and wherein the conductive layer is electrically isolated from the first conductive line, second conductive line, TFTs and FPC. Claims 61, 68, and 76 all recite similar limitations.

50. Additionally, claims 68 and 76 recite the following limitations: "a first conductive layer formed from a same layer as the first conductive line over the substrate"; "a second conductive layer formed from a same layer as the second conductive line over the substrate"; and "wherein the second conductive layer overlaps at least part of the first conductive layer."

51. One of ordinary skill in the art, at the time of the invention, would have understood that the claims of the ’204 patent disclose a specific layering structure and that this layering structure contributes to the advantages I discussed above. First, the claims require that the external connection line overlap the auxiliary line, with a first insulating film (shown below in red in annotated FIG. 4A) interposed between them. The external connection line and auxiliary line are in electrical contact through holes in the first insulating film. Second, the external connection line and auxiliary line must extend under the sealant. Third, a second insulating film (shown below in purple in annotated FIG. 4A) is interposed between the external connection line and sealant and the sealant is in direct contact with the second insulating film. Finally, a transparent conductive film/layer (shown below in blue in annotated FIG. 4A) is over the external connection line and provides electrical contact between the external connection line and the flexible printed circuit. This layering structure is required to achieve all of the above discussed advantages of the ’204 patent.



52. An ordinarily skilled artisan understands that this terminal is fabricated generally from the bottom up, beginning with the foundation of the substrate 101 and underlying film 111. This is required due to the deposition and patterning technologies available, both at the time of the '204 patent filing and at present.

53. In representative claim 31 (and claims 38 and 46 reciting similar limitations), the sequence of the disclosed subsequent layers necessarily follows. First, the auxiliary line metal (401 in FIG. 4A) is deposited. Second, the first insulating film (112 in FIG. 4A) is deposited and patterned to enable the required electrical connection between the auxiliary and external connection lines. Third, the external connection line metal (403 in FIG. 4A) is deposited. Following this, the second insulating film (113 in FIG. 4A) and then the transparent conductive film (114 in FIG. 4A) are deposited and patterned. The second insulating film is deposited on the external connection line and patterned such that the sealant can be provided on the second insulating film with the second insulating film being interposed

between the external connection line and the sealant. The transparent conductive film is then deposited and patterned such that the transparent conductive film electrically connects the external connection line to the FPC. The adjustment layer is formed before the second insulating film, shown in FIG. 4B as either of the two layers 402 and 404. This completes the fabrication of the external connection terminal on the active-matrix substrate.

54. In claim 54 (and claims 61, 68, and 76 reciting similar limitations), the sequence of the disclosed layers necessarily follows. First, the first conductive line metal (401 in FIG. 4A) is deposited. Second, the first insulating film (112 in FIG. 4A) is deposited and patterned to enable the required electrical connection between the first and second conductive lines. Third, the second conductive line metal (403 in FIG. 4A) is deposited. Fourth, the second insulating film (113 in FIG. 4A) is deposited and patterned to have an opening. Fifth, the transparent conductive film (114 in FIG. 4A) is deposited and patterned, so that it has direct contact with the second conductive line through this opening in the second insulating film, and so that it does not extend to where the sealant will be applied. Claim 54 recites: "a second insulating film over the second conductive line; a transparent conductive layer over a first region of the second conductive line." Thus, of the three layers (the second conductive line, the second insulating film, and the transparent conductive layer), the second conductive line must be the bottom layer. Claim 54

also recites: "wherein the second conductive line and the transparent conductive layer are in direct contact through an opening in the second insulating film." From this, it is understood that the second insulating film must be the middle layer and the transparent conductive layer is on top. That is, the opening in the second insulating film permits the contact between the second conductive line and the transparent conductive layer to occur. At the bottom of that opening, the transparent conductive layer 114 makes direct contact with the upper surface of the second conductive line 403. An additional conductive layer must be formed before the second insulating film, shown in FIG. 4B as either of the two layers 402 and 404. This completes the fabrication of the external connection terminal on the active-matrix substrate.

55. One of ordinary skill in the art understands that no other sequence is possible in claim 54 (and claims 61, 68, and 76). In particular, using the language of claim 54, both the transparent conductive layer (ITO 114) and the second insulating film (resin inter-layer film 113) must be over a portion of the second conductive line (external connection lines 403), *and* these two conductors must be in direct contact through an opening in this insulator. An ordinarily skilled artisan knows this claim language requires that the ITO be deposited after the insulator, not before.

56. The disclosure in claim 54 (and claims 61, 68, and 76), that the transparent conductive film is formed over the second insulating film and the FPC is connected

with the wirings through an opening in the transparent conductive film, is a significant feature of the '204 patent.

57. The remaining final steps for all claims in the '204 patent must occur during and after the joining of the active-matrix substrate and the counter substrate. After the sealant 105 is applied, the two substrates are joined. Then, the FPC 107 is attached.

58. Claim 54 requires that the transparent conductive layer be over a first region of the second conductive line and the sealant be over a second region of the second conductive line. This tells one of ordinary skill in the art that the sealant does not overlap the transparent conductive layer.

59. One of ordinary skill in the art would understand that the following claim elements all refer to the "adjustment layers" disclosed in the specification for reducing a height difference in the seal region: "adjustment layer," "first adjustment layer and second adjustment layer," "third conductive line and fourth conductive line," "conductive layer," and "first conductive layer and second conductive layer." Ex. 1001, '204 patent, at col. 3, ll. 22-24 and col. 9, ll. 33-46.

60. A person of ordinary skill in the art would understand that the auxiliary lines discussed in the specification also refers to the first conductive line, and the external connection lines discussed in the specification also refers to the second conductive line.

61. The phrase "contact through an opening" is used in claims 54, 59, 61, 66, 68, 73, 76, and 81. In the field of integrated circuit fabrication, "contact through an opening in an insulator" is a phrase which has a single meaning: "contact which occurs because of, or by virtue of, the opening."

62. As can be seen in FIG. 4A of the '204 patent, the upper wiring 403 extends downward through unnumbered openings in the first insulating film 112. These openings are sometimes called "through-holes," "contact holes," "contact openings," or simply "openings." In the claims, they are referred to as "openings." Claims 59, 66, 73, and 81 of the '204 patent require such an opening through the first insulating film to allow contact between these first and second conductive lines. Ex. 1001, '204 patent, at col. 8, ll. 42-50 and FIG. 4A. This form of connection is routine in the microelectronics fabrication art to connect one layer or structure that is located above an insulating film to another layer or structure that is located below the insulating film. To permit such contact to occur, the fabrication process establishes holes in the insulation film before the upper layer or structure is added. Then, when the upper layer or structure is added, often by a deposition or sputtering process, the upper layer or structure fills at least the bottom of the opening and thereby electrical contact or direct physical contact is established between the two otherwise unconnected layers or structures. In the

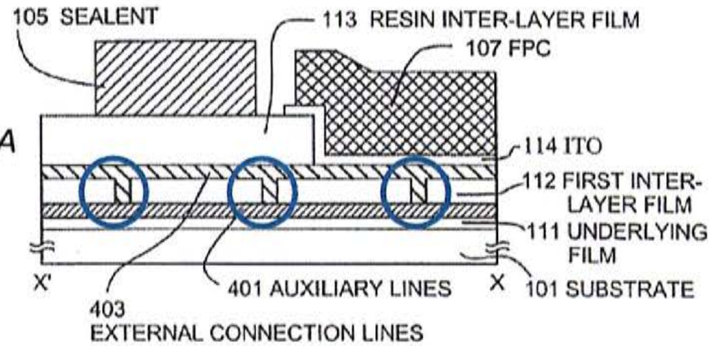
microelectronics art, including the LCD art, this is well known as making "contact through an opening."

63. To a person of ordinary skill in the LCD art, the phrase "contact through an opening" (in an insulating film) is clearly and immediately recognized as having just one meaning, which is the meaning described above. When this phrase is used with respect to an insulating film or layer, which is very common, it means that an opening is established in the insulating film, and the layer or structure which is located above the insulating film in the region of the opening extends into the opening so that it makes contact with the lower layer or structure beneath (on the other side of) the opening. The opening is a requirement of the contact. The contact occurs because of the opening, and the opening is the cause of the contact. There is no other meaning to the phrase "contact through an opening (in an insulating film) that I am aware of. This is an idiomatic phrase that was and is well-known in the microelectronics arts including the LCD art long before 1997. The phrase had the meaning in 1997 described above, and still has that meaning today. Often, these openings have been called "contact holes."

64. This phrase is used in precisely that way in the '204 patent where FIG. 4A shows three contact openings (reproduced below with circles around the contact openings) through the "first inter-layer film" 112 that permit the upper wiring 403

to extend into the openings and make direct contact with the upper surface of the lower wiring 401.

FIG. 4A

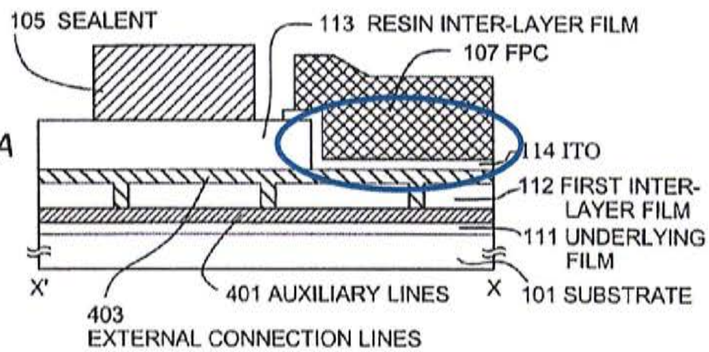


65. One reason for, and result of, electrically connecting the auxiliary lines 401 to the external connection lines 403 is to lower electrical resistance. As explained in the '204 patent specification, even when the second conductive line is made from a metal, the wiring faces a problem of high line resistance, which can cause propagation delay and deterioration of high frequency signals normally used in such LCD circuits and communicated via the flexible printed circuit referenced in the claims, thereby inhibiting optimal performance. Ex. 1001, '204 patent, at col. 8, l. 61 - col. 9, l. 11. The above configuration in the patent reduces this electrical resistance. *Id.* col. 8, ll. 42-50 and FIG. 4A.

66. FIG. 4A contains another example of "contact through an opening in an insulating film." In particular, the second insulating film 113 has an opening in it (see circle in annotated FIG. 4A below). After the opening is made, a subsequently-formed conductor is deposited on the remaining film 113 and other

exposed structure. In this case, the subsequently-formed conductor is ITO 114. When it is deposited, the ITO 114 lies on a horizontal region at the top of the insulating film 113, extends downward into the opening created in film 113, and directly contacts the upper surface of the upper wiring 403 that has been exposed by the opening.

FIG. 4A



67. This idiomatic phrase is well known throughout the industry. Patents and publications of many companies other than SEL conform to this idiomatic usage. Notably, Sukegawa uses the phrases "through holes" and "contact holes" consistently with how "though an opening" is used in the '204 patent. In Sukegawa, upper layer metal wiring 7 (and 7-1 and 7-2) is connected via through holes in inter-layer insulating film 3 to the lower layer metal wiring 2, which is found in the following disclosures: (1) "...the upper layer metal wiring 7-2 **is connected by way of the through holes** 6 at three positions to the lower layer metal wiring 2, while the upper layer metal wiring 7-1 connected by way of the transparent conductive film 8 to the upper layer metal wiring 7-2 **is connected** to

the lower layer metal wiring 2 **by way of the through hole** 6 at one position, respectively" (Ex. 1005, Sukegawa, at col. 6, ll. 61-67 (emphasis added)) and (2) "The [interlayer insulation film 3] is patterned to form upper layer metal wirings 7-1 and 7-2 **connected electrically** with the lower layer metal wiring 2 **in the contact holes** 6 in the terminal portion, respectively" (*Id.* at col. 4, ll. 52-55 (emphasis added)). Similarly in Shiba, FIG. 8 depicts a plurality of openings 131 that are formed in metal wiring 127 so that protective overcoat 241 will have ridges and valleys for creating an increased effective adhesion area. *See, e.g.*, Ex. 1003, Shiba, at col. 6, ll. 60-65 ("In the above embodiment, the first wiring line 127 is constituted by a plurality of narrow lines. However, a plurality of **openings** 131 may be formed in the first wiring line along the longitudinal direction, as shown in FIG. 8, so that the effective adhesion area between the sealing agent 113 and the array substrate 200 can be increased." (emphasis added)). Watanabe also uses the phrase "connected . . . through [a] contact hole" in the same way "contact through an opening" is used in the '204 patent. In Watanabe FIGS. 4B and 4A, the drain metal 411 and source metal 409 are connected through contact holes in insulating film 201 to the signal line 5 and pixel electrode 7, respectively. *See, e.g.*, Ex. 1004, Watanabe, at col. 9, ll. 57-60 ("The drain 411 of the TFT 3 **is connected** to the signal line 5 **through the contact hole** 417. The source 409 **is connected** to the pixel electrode 7 **through the contact hole** 415 and a conductive pattern." (emphasis added)), col. 9, ll. 34-36 ("A layer insulating film 201 is formed … and **contact holes** 415 and 417 are formed thereon." (emphasis added)). Thus, as in the '204 patent, the prior art and numerous other publications, the phrase "contact through an opening" is used to mean "contact which occurs because of, or by virtue of, the opening."

68. When persons of ordinary skill in the art as of 1997 read the phrase "contact through an opening in an insulating film" as used in the '204 claims, they understand that the opening permits the contact to occur, and that the two layers or structures in contact are on opposite sides of the opening. They understand that without the opening, the contact would not occur and that the contact occurs because of the opening.

69. I have been asked to consider how persons of ordinary skill in the art would interpret the phrase "contact through an opening in an insulating film" as that phrase appears in the '204 claims. In connection with that, I have examined the Declaration of Miltiadis Hatalis, Ph.D. (Ex. 1007), and I note that at ¶ 28, he states, "Instead, the claim terms of the '204 patent are used in their ordinary and customary sense as one skilled in the relevant field would understand them." Ex. 1007, Hatalis Decl., at ¶ 28. I agree to that extent. However, Dr. Hatalis then uses two different meanings for the phrase.

70. First, in ¶ 131, Dr. Hatalis applies claim element "...contact through an opening in the first insulating film" one way, where the opening allows one layer or film on one side of the opening to extend into the opening thereby to make contact with another layer or film on the opposite side of the opening, *i.e.,* the contact is because of the opening. This is the correct meaning of this idiomatic term of art.

71. However, Dr. Hatalis uses a completely different meaning in ¶ 114 where an opening is located above two layers that already were in contact with one another before the opening was created, so that the opening has no causal relationship to the contact. I did not see any evidence to support Dr. Hatalis' testimony that this phrase would be understood by persons ordinarily skilled in the art in the manner in which he applied it with respect to the Sukegawa reference, and I believe that his understanding implicit in ¶ 114 is technically incorrect and contrary to how one of ordinary skill in the LCD art in 1997 (and today) would understand the phrase.

72. The interpretation applied by Dr. Hatalis in ¶ 114 is unreasonably broad. While Dr. Hatalis does not expressly state in his declaration that "contact (of two layers) through an opening in the second insulating film" can result from placing an opening over the two layers that are already in contact with one another, this meaning is inherent to his reasoning and apparent understanding in ¶ 114.

However, in my opinion, one of ordinary skill in the art who sees this phrase in the claims of the '204 patent would *never* understand it to have this meaning. In this context, and without ambiguity, one of ordinary skill in the art understands that the two conductive layers which are in "contact through an opening in an insulating film" cannot make contact because of any other means than where the upper layer extends into the opening to reach the layer below the opening.

73. In my opinion, the broadest reasonable interpretation of the phrase "...contact through an opening in the ... insulating film" to a person of ordinary skill in the art in 1997 in light of the '204 patent is that the contact occurs by virtue of, and because of, the opening. To the extent that Dr. Hatalis suggests that where an opening lies *over* and *above* two layers that are already in contact where the upper surface of the lower layer is already in physical contact with the lower surface of the upper layer, that is *not* "contact through an opening" in an insulating film that lies on top of the upper layer. The meaning implied by Dr. Hatalis eviscerates the phrase "contact through an opening" in the claim, leaving it synonymous with the phrase "contact <u>below</u> an opening," which is clearly not supported by the specification.

74. I have been asked to consider whether "...contact through an opening in [an] insulating film" can mean contact "which occurs between the vertical limits of the opening." This is technically improper because it permits "contact" to be found

when the two layers supposedly in contact through the opening in the insulating film are not located on opposite sides of the insulating film but instead are both located beneath the opening. In the context of the specification and the claims, "contact through an opening" does not mean "contact which occurs between the vertical limits of the opening" unless such contact occurs because of, or by virtue of, the opening. A person of ordinary skill in the art would not interpret the claim phrase to mean merely within the vertical limits. In the context of the specification and claims, "contact through an opening" must be construed consistent with the relative orientation of structures shown in FIG. 4A and described in the specification of the '204 patent.

IV. PATENTABILITY OF THE '204 PATENT

A. The Sukegawa Patent (U.S. Patent No. 5,636,329)

75. The objective of Sukegawa is "having a terminal portion capable of preventing corrosion of a wiring layer without increasing the number of steps and without hindering the checking function during the steps." Ex. 1005, Sukegawa, at col. 1, l. 67-col. 2, l. 3.

76. Sukegawa does not explicitly disclose a sealant, because Sukegawa only discloses "sealing liquid crystal material in the gap." Sukegawa does not say how that is done, nor does it specifically identify a sealant anywhere. It is my opinion that a person of ordinary skill in the art would most commonly use a sealant to

accomplish the sealing of the liquid crystal. Nevertheless, there is no disclosure in Sukegawa (inherent or explicit) of the position of the sealant, relative to the terminal or the edge of the substrates.

77. One of skill in the art would not place a sealant in Sukegawa FIG. 2C directly next to silicone resin 13 due to the presence of upper layer metal wiring 7 and transparent conductive film 8, because this would lead to an uneven gap between the substrates if the counter substrate were to overlie this portion. Although the sealant is viscous and can fill in uneven surfaces, it was common at the time of the '204 patent for the sealant to include spacers. The presence of these spacers dispersed within the sealant would prevent the sealant from fully compensating for the unevenness caused by the presence of upper layer metal wiring 7 and transparent conductive film 8 under the sealant. The '204 patent discloses: "[Both] substrate[s] ... are provided in a face-to-face relationship **with a sealant including spacers** (spherical or cylindrical microscopic particles for maintaining an interval between the substrates) interposed there between. **Therefore, any uneven height difference in the sealant region where the sealant is provided** causes distortion of the counter substrate such as flexing and twisting to make the substrate interval uneven." Ex. 1001, '204 Patent, at col. 2, ll. 55-57 (emphasis added). An ordinarily skilled artisan would not consider placing the sealant immediately next to silicone resin 13 in FIG. 2C of Sukegawa,

but would instead place the counter substrate, and thus the sealant, farther away from the terminal so that the sealant would overly only the uniform surface of protective insulating film 9 and not metal wiring 7 or transparent conductive film 8.

78. Sukegawa discloses a specific wiring structure for the terminal portion, with the goal of preventing corrosion. Upper layer metal wiring 7 is protected by film 8 and protective insulating film 9 or anisotropic conductive film 10 to prevent corrosion, and upper layer metal wiring 7 clearly terminates and does not extend into the display portion.

79. In Sukegawa, upper layer metal wiring 7 does not extend into the display portion with lower layer metal wiring 2. This means the former is combined predominately "in series" with the latter, so that their resistances add, and any non-zero resistance of the upper layer metal wiring will increase the total resistance. Based on this disclosure, one of ordinary skill in the art would understand that Sukegawa will not realize the reduction of electrical resistance, which is one of the advantageous effects of the '204 patent. The '204 patent achieves this reduction in resistance from the terminal region to the display region because the two wirings are instead predominantly "in parallel."

80. In FIG. 3E, upper metal layer wiring 7 ends and does not extend into the display portion, meaning FIG. 3E fails to disclose the limitations of the auxiliary

line and external connection line extending under the sealant. One of skill in the art would not extend upper layer metal wiring 7 into the display portion because it would result in an undesirable gap difference. One of skill in the art would have understood that upper layer metal wiring 7 disclosed in FIG. 2C of Sukegawa cannot correspond to "external connection line" of the '204 patent. FIG. 2C of Sukegawa is a cross sectional view of a terminal portion. As shown in FIG. 1, the upper layer metal wiring 7 exists only in the terminal portion. Unlike the auxiliary line and external conductive line of the '204 patent, the upper layer metal wiring 7 is not a wiring to reduce the entire electrical resistance of the wirings. Instead, upper layer metal wiring 7 of Sukegawa is for reducing the resistance of wirings only in the terminal portion.

81. Sukegawa discloses the problem of the corrosion of the upper layer metal wiring 7. As the upper layer metal wiring 7 has the risk of corrosion, such risk would increase if the upper layer metal wiring 7 were extended. Therefore, a person of ordinary skill in the art would not extend the upper layer metal wiring 7.

82. Via an anisotropic conductive film 10, a tape carrier package 300 having a flexible wiring substrate 31 becomes connected to the terminal portion of the active matrix substrate 100 in such a way as to cover much of the opening in protective insulating film 9 but to leave a space for probe testing. That is, the

opening (unnumbered) in protective insulating film 9 is not completely covered by the anisotropic conductive film 10.

83. Sukegawa addresses the problem that a pinhole defect in transparent conductive film 8 of ITO could develop because ITO is chemically stable, but generally is not applied in thick layers; also ITO is not very moisture-resistant. Ex. 1005. at col. 1, ll. 28-49 and col. 3, ll. 36-42. If a pinhole develops in transparent conductive film 8 to expose upper layer metal wiring 7 beneath the pinhole, then corrosion 12 could result in not only upper layer metal wiring 7 but also the underlying lower layer metal wiring 2. FIG. 2B depicts such corrosion 12. *Id.*, at col. 3, ll. 42-53. The central disclosure in Sukegawa is the solution to this problem by removing the upper layer metal wiring 7 at the probe test region 14 (FIG. 3E and FIG. 4B) so that even if a pinhole develops in the transparent conductive film 8 or moisture penetrates it where it traverses region 14, no corrosion would result because only interlayer insulating film 3 would be exposed by the pinhole or to the moisture. *Id.* col. 6, ll. 9-38, col. 7, ll. 35-57, FIGS. 3E and 4B.

84. In Sukegawa, transparent conductive film 8 is necessary to prevent corrosion of upper layer metal wiring 7 during the manufacturing process prior to the time that upper layer metal wiring 7 is covered by anisotropic conductive film 10, protective insulating film 9, or silicon resin 13. Even a brief exposure of upper layer metal wiring 7 to the atmosphere could cause upper layer metal wiring 7 to

corrode. Thus, as a matter of best practices for manufacturing yield and device reliability, the transparent conductive film 8 should be applied to underlying metal layer 7 for protection, prior to metal wiring 7 being exposed to the atmosphere (i.e., especially water vapor or oxygen).

85. Sukegawa suggests that the transparent conductive film 8 cannot be made thick in order to ensure transparency; thus, pin-holes are easily formed in the film. These pin-holes will allow corrosion to occur on the metal wiring 7, which is formed under the transparent conductive film 8. Ex. 1005, Sukegawa, at col. 1, ll. 39-49. In order to resolve this defect, Sukegawa teaches forming the protective insulation film 9 or the anisotropic conductive film 10 over the transparent conductive film 8. Ex. 1005, col. 3, ll. 37-53 and col. 6, ll. 9-20. With this double coverage structure, the upper layer metal wiring 7 will not be exposed to the external air and will be protected against corrosion, even when the pin-holes are formed in the transparent conductive film 8. Ex. 1005, Sukegawa, at col. 6, ll. 22-26. That is, in Sukegawa, transparent conductive film 8 must be formed under the protective insulation film 9.

86. In claims 54, 61, 68, and 76 of the '204 patent, the second conductive line needs to have two regions; one is the region where a second conductive line is overlapped with the transparent conductive layer, and the other is the region where the second conductive line is overlapped with the sealant. Because upper layer

metal wiring 7 does not correspond to the second conductive line, Sukegawa also fails to disclose two regions of the second conductive line.

87. In Sukegawa, transparent conductive film 8 is formed under the protective insulation film 9 (the second insulating film). As shown in FIG. 3A of Sukegawa (annotated below), the insulating film 9 (shown in blue) has an opening (shown in red). As shown in FIG. 3E (annotated below), tape-carrier package 300 (flexible printed circuit) overlaps this opening in insulating film 9. Thus, where tape-carrier package 300 can contact the transparent conductive film 8 (red area in the figure below) is smaller compared to the area where it could contact if the transparent conductive film 8 were formed over insulating film 9.

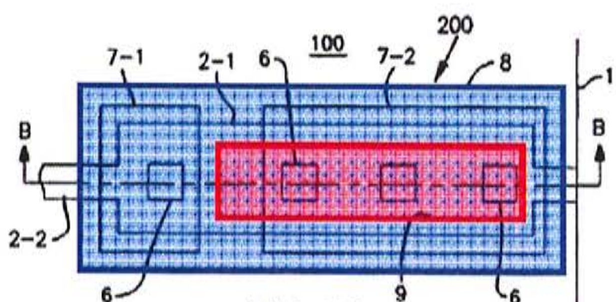


FIG. 3A

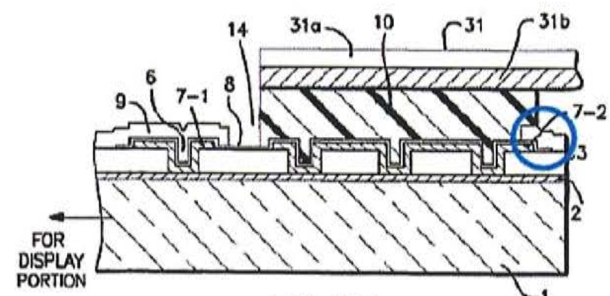


FIG. 3E

88. Sukegawa fails to disclose the limitation in claim 54 (and claims 61, 68 and 76): "a transparent conductive layer over a first region of the second conductive line . . . wherein the second conductive line and the flexible printed circuit are in electrical contact through the transparent conductive layer; wherein the second conductive line and the transparent conductive layer are in direct contact through an opening in the second insulating film." Because the protective insulating film 9

is formed over the transparent conductive film 8, the area where the tape-carrier package 300 can connect with the transparent conductive film 8 is limited. FIG. 3E shows that the connection is not made between the transparent conductive film 8 and tape-carrier package 300 in the blue circle due to the protective insulating film 9 formed between the tape carrier package 300 and transparent conductive film 8. These FIGS. 3A and 3E demonstrate that the anisotropic conductive film 10 cannot contact the full area of the transparent conductive film 8 because of the presence of the protective insulating film 9 on at least three sides. As a consequence, the resistance of the electrical connection from the tape-carrier package 300 to the active-matrix terminal will be higher than necessary. The '204 patent avoids this compromise by arranging the transparent conductive film after and above the second insulating film, such that the whole area of the FPC can contact it.

89. One of skill in the art would know that, to form a structure in which protective insulating film 9 is formed over the transparent conductive film 8, damage may be caused to the transparent conductive film 8 during the deposition and etching (e.g., change in film properties or thinning) of the protective insulating film 9. While this process sensitivity can be managed somewhat, it nevertheless presents increased risk and complication for manufacturing.

90. In Sukegawa, even if the transparent conductive film 8 can be formed over the protective insulating film 9 and extended to the display portion together with

the upper layer metal wiring 7 as in the '204 patent, Sukegawa does not suggest to one of ordinary skill in the art that the transparent conductive film 8 is ended *before* it reaches the sealant, as required by the '204 patent. That is, first, Sukegawa does not teach extending wiring 7, and second, if wiring 7 were to be extended, Sukegawa always discloses a transparent conductive film 8 that extends beyond wiring 7 (*see, e.g.*, FIGS. 1A, 1B, 2A, 2C, 3A, 3B, 3E, and 4B). Furthermore, Sukegawa also does not teach the positional relationship between the sealant and the transparent conductive film 8. Sukegawa discloses that upper layer metal wiring 7 is covered by transparent conductive film 8 and protective insulating film 9 in order to achieve a secure connection. Ex. 1005, Sukegawa, at col. 6, ll. 9-20. As long as the upper layer metal wiring 7 is extended, the transparent conductive film 8 is also continuously extended together with upper layer metal wiring 7. This means that the transparent conductive film 8 would be under the sealant. One of ordinary skill in the art would have known that if wiring 7 is extended in Sukegawa, the ITO layer 8 would also need to be extended and both would be under the sealant, which is counter to the advantageous effect of the '204 patent and all contested claims that provide for an adjustment layer to maintain an even cell gap. In addition, in claim 54, the "sealant is over a second region of the second conductive line" and the "transparent conductive layer over a first region of the second conductive line." A person of ordinary skill in the art would understand that, in the context of the '204 specification and claims, the plain meaning of first and second region is that two regions would not overlap. Thus, one of skill in the art would have known that if wiring 7 is extended in Sukegawa, ITO layer 8 would also be extended and both would be under the sealant, which is counter to claim 54 (and 61, 68, and 76), which recites that the transparent conductive film is only in the first region.

91. Sukegawa also fails to disclose the limitation in claim 54 (and similarly in claims 61, 68 and 76) that "the second conductive line and transparent conductive layer in are in direct contact through an opening in the second insulating film." In the '204 patent, a second insulating film must be formed over the second conductive line, an opening needs to be formed in the second insulating film, the transparent conductive layer needs to be formed over the second insulating film, and the transparent conductive layer needs to be in direct contact with the second conductive line. In FIG. 2C of Sukegawa, even though the second conductive line (upper layer metal wiring 7) and the transparent conductive layer (transparent conductive film 8) are directly connected with each other, the transparent conductive film 8 is formed under the second insulating film (protective insulating film 9). One of ordinary skill in the art would understand that, in the structure of FIG. 2C, the transparent conductive film 8 is directly connected with the upper

layer metal wiring 7 without passing through an opening and, thus, they are not connected through an opening.

B. The Shiba Patent (U.S. Patent No. 5,684,555)

92. Shiba discloses the objective "to provide an LCD panel, in which the width of a seal region can be reduced without lowering the strength of adhesion between the two substrates." Ex. 1003, Shiba, at col. 2, ll. 21-24. In order to increase adhesion between the sealing agent and the first substrate, Shiba teaches that "the first wiring line arranged in the seal region is constituted by a plurality of narrow lines." *Id.* at col. 2, ll. 44-47. That is, a "first wiring line 127 is drawn from the interconnecting pad 125a and divided into six narrow lines," and then it is divided into five narrow lines to serve as the second wiring lines 123-4. *Id.* at col. 6, ll. 5-7, 12-14. Four of the narrow lines are located in the seal region 111 and two are located in the boundary between the seal region and the display area. *Id.* at col. 6, ll. 21-24. Shiba also discloses the objective of not increasing the manufacturing steps. Ex. 1003, Shiba, at col. 6, ll. 25-35. Another objective of Shiba is to prevent flow of the sealing agent 113 from the sealing region 111. Ex. 1003, Shiba, at col. 3, ll. 6-10, col. 7, l. 63-col. 8, l. 12, FIGS. 7A and 7B. Flow out occurs when wide wiring is formed to cross the seal region 111, which is shown in FIG. 7A. Shiba prevents flow out problems by forming wiring 123-1 with a plurality of narrow lines, which is shown in FIG. 7B.

93. The objective of Shiba is counter to the goal of the '204 patent. Shiba discloses a plurality of thin wirings under the seal, generating ridges in the seal region which increase the substantial area for contact between the substrate side and sealing agent, and taking advantage of such effects, the peeling of sealing agent is reduced, which increases the strength of the sealant. A person of ordinary skill in the art would recognize that the teaching of ridges under the sealing agent is an essential element of Shiba for achieving the disclosed advantage of better sealant adhesion. Ex. 1003, Shiba, at col. 2, ll. 44-50.

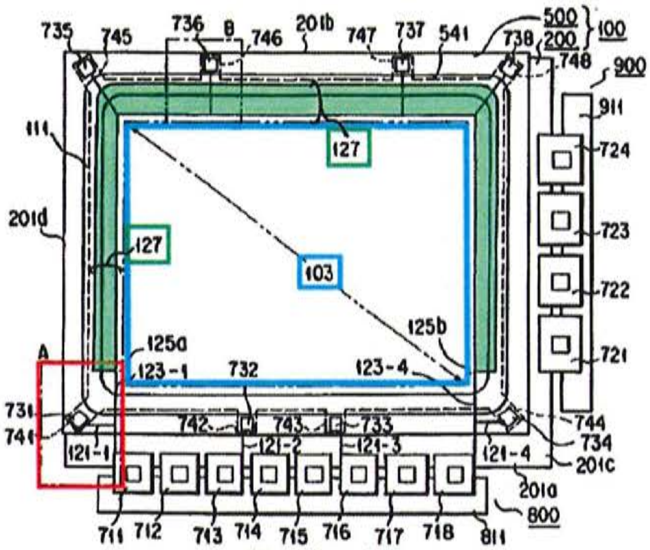
94. The object of the '204 patent, which is to provide an adjustment layer in order to reduce the height difference generated by wirings in the seal region, and the idea of Shiba, which is to proactively form wirings in the seal region to generate steps and take advantage of the ridges so that adhesion strength of sealing agent is ensured, conflict with each other. Shiba does not disclose or suggest the provision of an adjustment layer and instead discloses an objective that is counter to the objective of the '204 patent.

95. To a person of ordinary skill in the art, Shiba fails to disclose an external conductive line over a first insulating film over an auxiliary line, as required by the '204 patent. First, Shiba fails to disclose an insulating film disposed between the two-layered structure of wiring line 127. Second, Shiba also fails to teach that this two-layer structure of wiring line 127 should have one conductor over the other. At

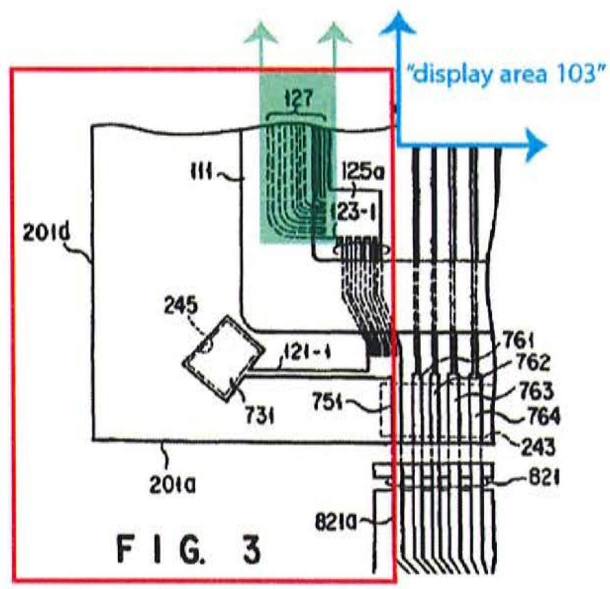
most, Shiba merely teaches that a single branched wiring can be formed in two metal deposition steps, and that the suggested two-layered structure can prevent defects and improve manufacturing yield. Ex.1003, Shiba, at col. 6, ll. 37-42. A person of ordinary skill in the art would not know at least four critical aspects: the relative positions of the metal wirings, the presence or not of an insulating layer in between the wirings, the patterning with openings of that hypothetical insulating layer, or the linear extent of any of the layers. It is my opinion that Dr. Hatalis has incorrectly amplified this two-sentence disclosure in Shiba. Ex. 1007, Hatalis Decl., at ¶¶ 47-51.

96. Shiba fails to disclose that the wirings 127 extend under the sealant into the display portion to reduce the electrical resistance. In FIG. 6, wirings 127 are shown running under the sealant. They do not extend under the sealant into the display region to reduce the electrical resistance of the wiring, as disclosed and claimed in the '204 patent. FIG. 1 of Shiba (annotated below) shows display area 103 (shown in blue). FIG. 3 (annotated below) is an expanded view (shown in red) of the lower left square of FIG. 1. These two figures, individually and together, demonstrate that wirings 127 do not extend under the sealant into the display area 103. Instead, these wirings 127 (shown below in green) follow the left, top, and right sides of the seal region 111, providing the multiple connections to the counter

substrate to support frame inversion disclosed as desirable by Shiba. Ex. 1003, Shiba, at col. 5, ll. 17-28.



F I G. 1



F I G. 3

97. Shiba discloses a specific wiring structure in the terminal portion, which does not include a transparent conductive layer. On the left side of FIG. 4, common pad 751 is on top of the gate dielectric 211 and partially covered by protective overcoat 241. A transparent conductive layer is not formed over common pad 751, or any other external connection pad or terminal.

98. In addition to the lack of explicit disclosure in Shiba, there is no implicit disclosure of a transparent conductive layer over the common pad 751 (or any external connection pad). Shiba states that transparent conductive layers such as ITO are used to form a pixel electrode and counter electrode. Ex. 1003, Shiba, at col. 1, ll. 36-39, col. 5, ll. 24-28. One of ordinary skill in the art would have understood that if a transparent conductive layer such as ITO were indeed created

in the terminal portion according to the disclosure in Shiba, then it would be under, not over, the common pad 751. It would be under the common pad 751 because the transparent conductive film would be formed from the same layer as the pixel electrode 251, and this electrode is disclosed in Shiba to be deposited and patterned before the deposition of the metal layer including both the common pad 751 and the TFT source metal 231. Ex. 1003, Shiba, at col. 6, ll. 25-35. This arrangement of the pixel electrode 251 under the source metal 231 can be observed within the TFT portion in FIG. 4.

99. Therefore, the only way a person of ordinary skill in the art would avoid increasing the number or complexity of manufacturing steps ***and*** create a transparent conductive film (ITO) in the terminal region according to the disclosure in Shiba, would be to arrange the ITO under the common pad 751. But this would serve no purpose; it would not improve reliability against moisture or oxidation, and would not reduce the resistance in a meaningful way. More importantly, this would still fail to meet the limitations of the '204 claims, which require a transparent conductive layer over the two wirings.

100. Specifically, Shiba fails to disclose a transparent conductive layer on top of common pad 751 because this would require an extra manufacturing step for a second deposition and patterning of the transparent conductive layer, which is counter to the teaching of Shiba to not "increase the number of manufacturing

steps." Ex. 1003, Shiba, at col. 6, ll. 25-35. It generally adds undesirable complexity and cost to add a manufacturing step.

101. The only alternative to this is to significantly modify the manufacturing sequence and TFT design disclosed in Shiba so that the common pad metal (and source/drain metals) are deposited and patterned before the deposition and patterning of the transparent conductive film. In my opinion, one of ordinary skill in the art would not go beyond the disclosure in Shiba in this way because of the severe manufacturing complications and significant risk for lower yield.

102. To explain this, I refer to Figure A below, as a schematic view of FIG. 4, highlighting the disclosure in Shiba on this issue. Figure A has a TFT portion in which source electrode 231 is formed on pixel electrode 251 (ITO). In addition, the protective overcoat 241 is formed on source electrode 231. Ex. 1003, Shiba, at col. 4, ll. 24-33. In the terminal portion, common pad 751 is formed from the same layer as the source electrode 231. Ex. 1003, Shiba, at col. 6, ll. 25-35.

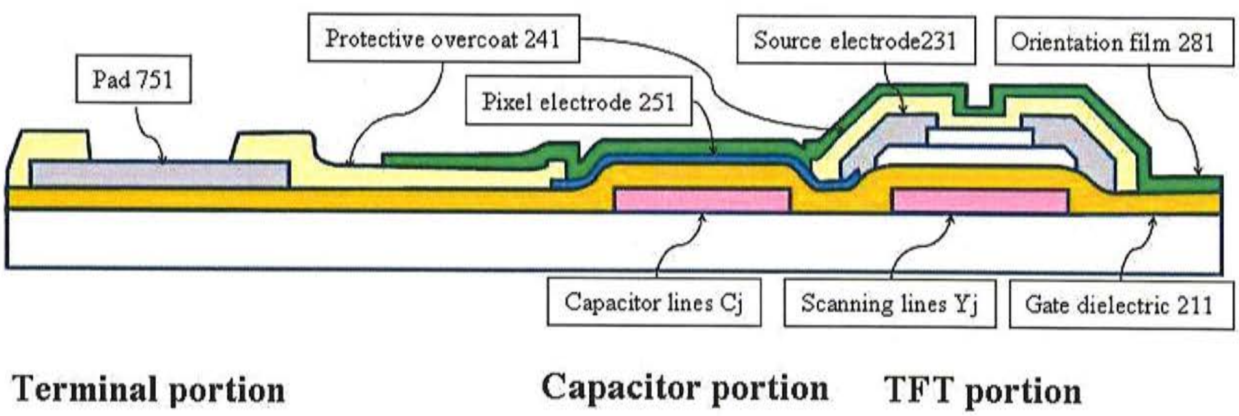


Figure A (Schematic View of Figure 4 of Shiba)

103. If the pixel electrode 251 were formed after the protective overcoat 241, as Dr. Hatalis has asserted is a trivial and obvious extension of the disclosure in Shiba (Ex. 2013, Hatalis Dep., at p. 69, l. 21-p. 71, l. 11), one of ordinary skill in the art still would not form the ITO film on protective overcoat 241 of Shiba because of the problems for manufacturing it creates. To explain this, I have provided Figure B below, a schematic view showing the same layer structure disclosed in Shiba except where the pixel electrode 251 is formed over the protective overcoat 241. An ITO film formed of the same layer as the pixel electrode 251 may be formed over the protective overcoat 241 and pad 751 at the terminal portion.

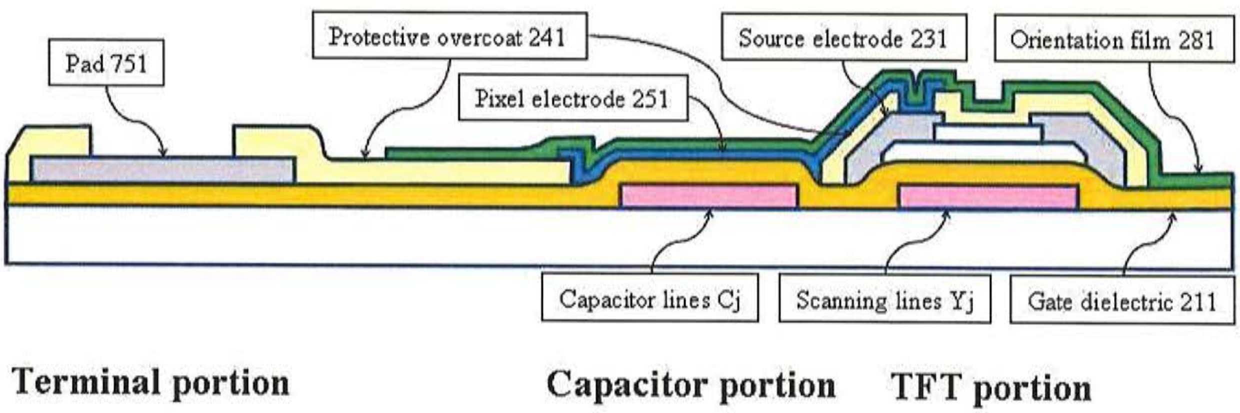


Figure B (Modified Figure 4 of Shiba)

104. In comparing the capacitor portion of Figures A and B, we see that the opening of the protective overcoat 241 in each structure is formed in a different portion. The storage capacitor in Figure A is formed of three layers, on which the opening of the protective overcoat 241 is formed: the storage capacitor line Cj, the gate dielectric 211, and the pixel electrode 251. Ex. 1003, Shiba, at col. 4, ll. 4 - 8

and ll. 11-15. Although the storage capacitor in Figure B is also formed of the same three layers, the opening of the protective overcoat 241 is in this case formed under the pixel electrode 251.

105. There is a key difference between these two capacitor portions. In Figure A, when etching is performed to form the capacitor opening in the protective overcoat 241, one of ordinary skill would know that the gate dielectric 211 is protected from damage by the previously deposited pixel electrode 251, which acts as a barrier layer. However, in Figure B, a person of ordinary skill in the art would expect the gate dielectric 211 to be seriously damaged during the capacitor opening etching in protective overcoat 241 since there is no layer that could function as a barrier layer. In the structure of Figure B, a higher etching control is required in forming the opening, because it is technically difficult to reliably and uniformly stop the etch of the protective overcoat 241 at the capacitor portion and remove it without overetching or damaging the gate dielectric 211, especially at the time of the '204 patent. This is critical since the capacitor's electrical properties are highly sensitive to the thickness of its insulator, and one of ordinary skill in the art knows that the pixel capacitor has a direct and dramatic effect on LCD viewing properties, including its frame rate, contrast ratio, brightness, and color.

106. For this reason, one of ordinary skill in the art would not change the structure of Figure A, in which the thickness of the insulating film can be

controlled easily in the capacitor portion, to that of Figure B, in which the thickness of the insulating film cannot be controlled easily. Forming ITO over common pad 751 would either require additional manufacturing steps, which is counter to the teachings of Shiba, or require an intolerable increase in etching sensitivity in etching the protective overcoat 241, which is counter to the normal practice and inclination of an ordinarily skilled artisan.

C. **Shiba with Sukegawa**

107. Even considering the teachings of Sukegawa, only schematic Figure C below is an obvious result to one of ordinary skill in the art because Sukegawa discloses ITO 8 being deposited directly on upper layer metal wiring 7, and under insulation film 9, for preventing corrosion of the underlying metal layer.

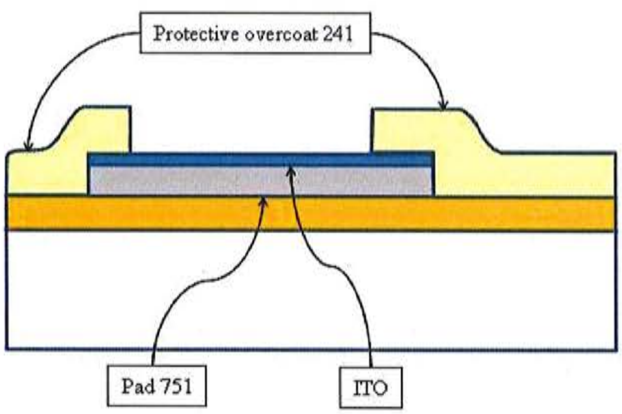


Figure C

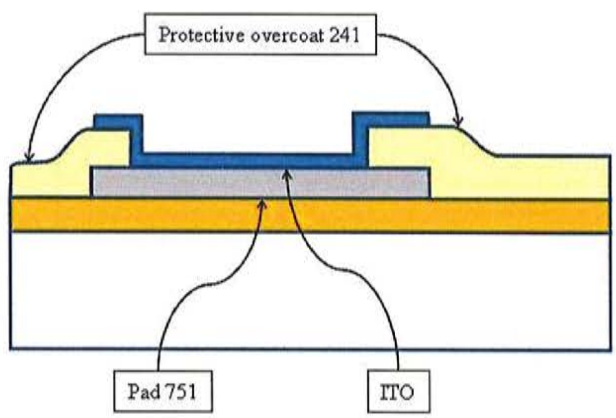


Figure D

108. Figure C is different from FIG. 4A and claims 54, 61, 68 and 76 of the '204 patent in which ITO 114 is formed after and partially over second insulating film 113.

109. Sukegawa discloses that corrosion (oxidation) of upper layer metal wiring 7 is prevented since upper layer metal wiring 7 is covered by transparent conductive film 8 and protective insulating film 9. Ex. 1005, Sukegawa, at col. 6, ll. 9-20. In Sukegawa, transparent conductive film 8 must be formed directly on upper layer metal wiring 7, before the protective insulating film 9. One of skill in the art would understand that if the transparent conductive film of Sukegawa is formed in the terminal portion of Shiba, the transparent conductive film should be provided directly on the common pad 751 in order to prevent corrosion of the common pad 751, which is formed in the same step of forming the data lines Xi. Ex. 1003, Shiba, at col. 6, ll. 36-41. A person of ordinary skill in the art, trying to provide the ITO on the common pad 751 of Shiba in view of the teaching of Sukegawa, would adopt the structure of Figure C.

110. One of ordinary of skill in the art would not form the transparent conductive film over the protective overcoat 241 because even if the transparent conductive film were formed over the common pad 751 (Figure D) for the purpose of oxidation resistance, the transparent conductive film would not also cover the protective overcoat 241. Sukegawa also discloses that ITO layer 8 is deposited under protective insulating film 9. Thus, given the teachings of Sukegawa, the ITO would be provided under protective overcoat 241 (Figure C).

111. Combining Shiba and Sukegawa only results in the structure of Figure C. The '204 patent claims require that the ITO is the top layer (the ITO 114 is formed on the resin inter-layer film 113), which is different from Figure C above.

D. The Watanabe Patent (U.S. Patent No. 5,504,601)

112. Watanabe discloses the objective of providing an equal gap between the substrates by creating adjustment layers in the sealing region. Watanabe discloses gap adjusting layers 25 and 27 around the leads for adjusting the cell gap. There are two key characteristics of gap adjusting layers 25 and 27. First, the gap adjusting layers are formed so as not to short circuit with the signal and scanning lines (which have lead portions 13 and 17, respectively). Ex. 1004, Watanabe, at col. 5, ll. 49-51, col. 13, ll. 35-37. Second, the gap adjusting layers are formed from the same layer as the conductive lines and lead portions 5, 9, 13, and 17. Ex. 1004, Watanabe, at col. 12, ll. 49-65. This is seen in Watanabe FIG. 5, which shows the substrate gap adjusting layers 25 and 27 cannot touch or extend over the lead portions. Ex. 1004, Watanabe, at col. 13, ll. 35-48. FIG. 5 below shows substantial space is required in the sealing region to create gap adjusting layers that do not contact each other or the lead portions. Based on these characteristics and FIG. 5 compared to FIG. 9 (prior art), one of ordinary skill in the art would have understood that a wider space in the sealant is required to create gap adjusting layers 25 and 27, as compared to the prior art.

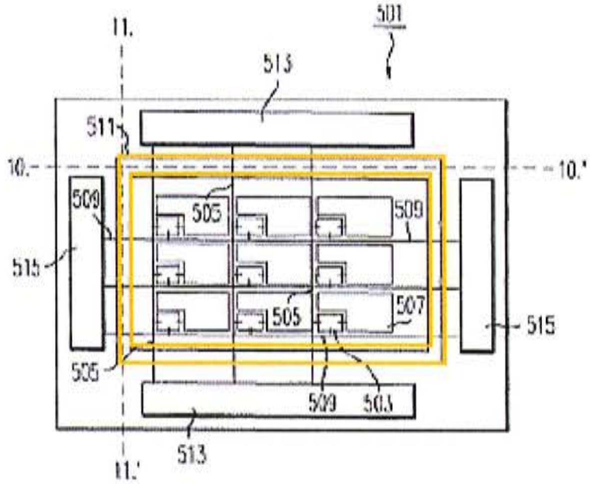
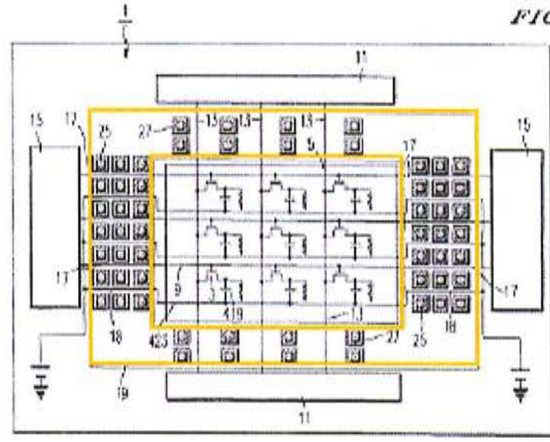


FIG. 9
PRIOR ART



113. One of ordinary skill in the art would also recognize that the structures of Watanabe are different than those in the '204 patent due to their disclosed location. In Watanabe, the adjusting layers are only in between or around the leads (i.e., the scanning signal and data lines connecting from the terminals to the display region). Ex. 1004, Watanabe, at FIGS. 1, 5-7, 8A. However, in the '204 patent the adjustment layers are disclosed expressly elsewhere, and in particular, around the edge of the display (*see* Ex. 1001, '204 patent, at FIGS. 1 and 5).

114. One of ordinary skill in the art would recognize that the structures of Watanabe would cause a flow out problem in the seal region. *See* Ex. 1003, Shiba, at col. 3, ll. 6-10, col. 7, l. 63-col. 8, l. 12, FIGS. 7A and 7B. FIG. 7 of Watanabe discloses gap adjusting layers 32, which are formed across seal region 19. FIG. 8A also discloses gap adjusting layers extending across the seal region. One of ordinary skill in the art would have understood that if the objective was to prevent

flow of the sealing agent, one of skill should avoid forming the adjusting layers of Watanabe, which extend across the seal region.

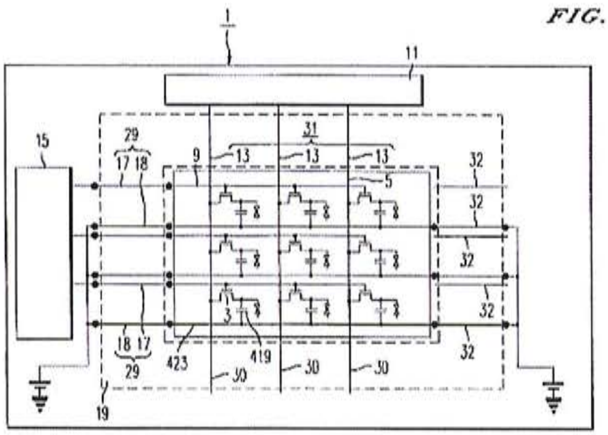


FIG. 7

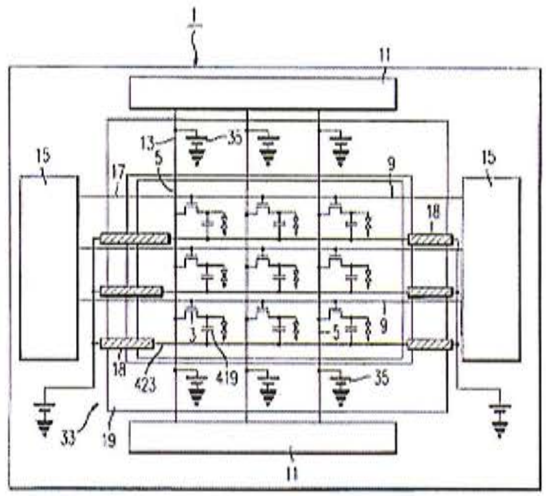


FIG. 8A

E. **Shiba with Watanabe**

115. One of the features of Shiba is a plurality of wirings that are formed in parallel in the same layer in the seal region over the substrate (Shiba, at col. 2, ll. 44-50). A feature of Watanabe is to provide a substrate gap adjusting region or substrate gap adjusting layers 25 and 27 so that the substrate gap at the region where sealing member 19 is formed becomes equal. Ex. 1004, Watanabe, at col. 6, ll. 40-57 and FIG. 5. The idea of Shiba to proactively provide steps under the sealing agent and the idea of Watanabe to provide a member for decreasing the unevenness under the sealing member conflict with each other. Therefore, there would have been no motivation or suggestion to combine these two references.

116. Space is required for obtaining enough insulation so that the adjustment layers disclosed in Watanabe are formed in the seal region, and making such space results in increase of the seal region. One of the objects of the invention of Shiba is to reduce the width of the seal region and to reduce the non-display region including the seal region. Ex. 1003, Shiba, at col. 1, ll. 64-66 and col. 2, ll. 20-28. Because the adjustment layers of Watanabe are inconsistent with the objective of Shiba, one of skill in the art would not find it obvious to combine the teachings of Watanabe with Shiba.

117. One of ordinary skill in the art would also not combine Watanabe with Shiba because the adjusting layers of Watanabe are counter to the objective of Shiba to prevent flow out of the sealing agent. That is, Shiba discloses the idea of preventing the flow out of the sealing agent by forming the wiring line as a plurality of narrow lines. Ex. 1003, Shiba, at col. 3, ll. 6-10, col. 7, l. 63-col. 8, l. 12, FIGS. 7A and 7B. Watanabe, however, discloses gap adjusting layers that cross the sealing region. Ex. 1004, Watanabe, at FIGS. 7 and 8A. Because the gap adjusting layers of Watanabe would create the same flow out problem that Shiba discloses solving, one of ordinary skill in the art would not apply the adjusting layers of Watanabe to the seal region of Shiba.

V. CONCLUSION

For the reasons set forth above, it is my opinion that the subject matters claimed in 31, 33, 36, 38, 40, 43, 45, 46, 48, 51, 53, 54, 56, 59, 61, 63, 66, 68, 70, 73, 75, 76, 78, 81, and 83 of the '204 patent were novel as of the filing date and would not have been obvious to a person of ordinary skill in the art.

APPENDIX A

Curriculum Vitae of Michael Escuti

MICHAEL JAMES ESCUTI

North Carolina State University
Department of Electrical and Computer Engineering
2410 Campus Shore Dr, Box 7914
Raleigh, NC 27695

(919) 274-7508 (mobile)
(919) 513-7363 (office)
mjescuti@ncsu.edu
go.ncsu.edu/oleg

Professional Preparation

2002 PhD in Electrical Engineering, Brown University
Dissertation: "Structured Liquid Crystal/Polymer Composites as Photonic Crystal Switches and LCD Innovations" – *Advisor*: Dr. Gregory P. Crawford
1999 MSc in Electrical Engineering, Brown University
1997 BS (magna cum laude) in Electrical & Computer Engineering, Drexel University

Professional Experience

2010-present	Associate Professor, Dept. Electrical & Computer Engineering, NC State Univ
2005-present	Chief Science Officer, ImagineOptix Corporation
2004-2010	Assistant Professor, Dept. Electrical & Computer Engineering, NC State Univ
2002-2004	Post-Doc, Dept. Functional Polymers, Eindhoven Univ of Tech (Netherlands)

Honors and Awards

2011 Presidential Early Career Award for Scientists and Engineers (PECASE)
2011 Alcoa Foundation Engineering Research Achievement Award, NC State Univ
2010 Faculty Early Career Development (CAREER) Award, National Science Foundation
2004 Glenn Brown Award for Outstanding PhD Dissertation, International Liquid Crystal Soc
2003 First Prize – Art & Liquid Crystals Competition, European Conf. Liquid Crystals
2002 OSA/New Focus Student Award, Top Winner, CLEO/QELS Conference
2001 Graduate Student Silver Award, Materials Research Soc. Fall Meeting
2001 Sigma Xi Outstanding Graduate Student Research Award, Brown University
2000 Citation of Excellence in Science Education, RI House of Representatives
1999 Best Student Paper Award, Society for Information Display, International Symposium
1997 Citation of Excellence in Engineering Design, Drexel University

Publications and Patents Summary

Inventor on 5(10) US patents issued(pending), and 6 additional foreign patents and applications. Authored 33 journal articles, 57 refereed conference proceedings, 23 invited research presentations, and 1 book contribution. As of April 2013 per ISI Web of Knowledge™ (across journal papers): Accumulated Citations 647, and h-index 14

External and Internal Sponsored Research Activities

External Funding: ~ $ 5M (overall), ~ $ 3.7M (to NCSU), ~ $ 3.5M (as PI/co-PI)
Prime Sponsors (Gov't): Natl Science Foundation, NASA, US Air Force Research Lab, DARPA
Industry Partners, Sponsors: Raytheon, SAIC, Boulder Nonlinear Sys, ImagineOptix, Teledyne

Expert Witness Experience

Ongoing: Patent dispute, before District Court of New Jersey (Civil Action No. 12-952)
Technology: Optical Data Storage, CD/DVD/Blueray-Disc, Holograms
Supporting: Samsung et al (Defendants) v Voxpath RS LLC
Role: Wrote expert report, anticipate addl report, deposition, testimony at trial
Firm: Greenberg Traurig

Closed 2012: Patent dispute, before US International Trade Commission (ITC No. 337-TA-836)
Technology: LCD system technologies
Supporting: LG Electronics et al (Respondents) v Graphics Properties Holdings
Firm: Greenberg Traurig
Role: Expert reports, witness statements, extensive lab testing, deposition; settlement prior to hearing

Closed 2012: Patent dispute, before US International Trade Commission (ITC No. 337-TA-805)
Technology: LCD backlights
Supporting: LG Display, LG Electronics et al (Respondents) v Ind Tech Res Instr
Firm: Steptoe & Johnson
Role: Expert reports, witness statements, deposition, extensive lab testing, testified at hearing

Closed 2011: Patent dispute, before US International Trade Commission (ITC No. 337-TA-749)
Technology: LCD optics, viewing angle compensation
Supporting: Thomson (Complainants) v Chimei Innolux, AU Optronics, et al
Firm: Kirkland & Ellis
Role: Expert reports, witness statements, deposition, tutorial, testified at hearing

Teaching and Mentoring Experience

I have previously graduated 5 PhD and 3 MST students as Chair, and currently advise 3 PhD and 0 MST students. I have directed 16 undergraduate researchers, and mentor 2 Post-Docs. Classes Taught: ECE-200 (Intro to Electrical Circuits, Signals, Sys), ECE-303 (Electromagnetic Fields), ECE-492K (Optical Communications), ECE-492S (Organic Electronics & LCDs)

Professional Memberships

SPIE – International Society for Optical Engineering (2000-present), IEEE – Institute of Electrical and Electronics Engineers (1996-present), ILCS – International Liquid Crystal Society (2002-present), SID – Society for Information Display (1999-2002, 2006-present), OSA – Optical Society of America (2000-present), MRS – Materials Research Society (2001-2005)

Journal Publications (peer-reviewed)

1) R.K. Komanduri, K.F. Lawler, and M.J. Escuti, " Multi-twist retarders: broadband retardation control using self-aligning reactive liquid crystal layers", *Optics Express*, **vol. 21**, no. 1, pp. 404-420, 2013.
2) Y. Li, J. Kim, M.J. Escuti, "Orbital angular momentum generation and mode transformation with high efficiency using forked polarization gratings," *Applied Optics*, **vol. 51**, no. 34, pp. 8236-8245, 2012.
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13) P.F. McManamon, P.J. Bos, M.J. Escuti, J. Heikenfeld, S. Serati, H. Xie, and E.A. Watson, "A Review of Phased Array Steering for Narrowband Electro-Optical Systems," *Proceedings of the IEEE*, **vol. 97**, no. 6, pp. 1078-1096, 2009.
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15) J. Kim and M.J. Escuti, "Demonstration of polarization grating imaging spectropolarimeter (PGIS)," *Proc. SPIE - Polarization: Measurement, Analysis, and Remote Sensing IX*, **vol. 7672**, art. no. tbd, 2010.
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17) J. Kim and M.J. Escuti, "Demonstration of The Polarization Grating Imaging Spectropolarimeter," *Proc. SPIE - Imaging Spectrometry XIV*, **vol. 7457**, art. no. 745716, 2009.
18) R.K. Komanduri, C. Oh, and M.J. Escuti, "Polarization Independent Projection Systems Using Thin Film Polymer Polarization Gratings and Standard Liquid Crystal Microdisplays," *SID Symposium Proceedings*, **vol. 40**, pp. 487-490, 2009.
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20) B.L. Conover, and M.J. Escuti, "Laboratory teaching modules on organic electronics and liquid crystal displays for undergraduate and graduate education," *Proc. MRS - Symposium H: Physics and Technology of Organic Semiconductor Devices*, art. no. H8.3, 2008.
21) C. Packham, M.J. Escuti, G. Boreman, I. Quijano, J.C. Ginn, B. Franklin, D.J. Axon, J.H. Hough, T.J. Jones, P.F. Roche, M. Tamura, C.M. Telesco, N. Levenson, J.M. Rodgers, and J.P. McGuire, "Design of a mid-IR polarimeter for SOFIA," *Proc. SPIE - Ground-based and Airborne Instrumentation for Astronomy II*, **vol. 7014**, art. no. 70142H, 2008.
22) B.L. Conover and M.J. Escuti, "Anisotropic Particle Motion In Optical Landscapes Modeled Via The T-Matrix Optical Scattering Approach," *Proc. SPIE - Optical Trapping and Optical Micromanipulation V*, **vol. 7038**, art. no. 703819, 2008.
23) R.W. Going, B.L. Conover, and M.J. Escuti, "Electrostatic Force And Torque Description Of Generalized Spheroidal Particles In Optical Landscapes," *Proc. SPIE - Optical Trapping and Optical Micromanipulation V*, **vol. 7038**, art. no. 703826, 2008.
24) C. Oh and M.J. Escuti, " Electrically Switchable Achromatic Liquid Crystal Polarization Gratings On Reflective Substrates," *Proc. SPIE - Liquid Crystals XII*, **vol. 7050**, art. no. 705019, 2008.
25) J. Kim, C. Oh, M.J. Escuti, L. Hosting, and S. Serati, "Wide-Angle Nonmechanical Beam-Steering Using Thin Liquid Crystal Polarization Gratings," *Proc. SPIE - Advanced Wavefront Control: Methods, Devices, and Applications VI*, **vol. 7093**, art. no. 709302, 2008.
26) J. Kim and M.J. Escuti, "Snapshot Imaging Spectropolarimeter Utilizing Polarization Gratings," *Proc. SPIE - Imaging Spectrometry XIII*, **vol. 7086**, art. no. 708603, 2008.

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31) E. Nicolescu and M.J. Escuti, "Polarization-Independent, Tunable Optical Filters Based On Liquid Crystal Polarization Gratings," *Proceedings of the SPIE - Optics & Photonics Conference*, **vol. 6654**, art. no. 665405, 2007.
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33) C. Oh and M.J. Escuti, " Achromatic Polarization Gratings as Highly Efficient, Thin-Film, Polarizing Beamsplitters for Broadband Light," *Proceedings of the SPIE - Optics & Photonics Conference*, **vol. 6682**, art. no. 668211, 2007.
34) C. Oh and M.J. Escuti, " Achromatic Diffraction Using Reactive Mesogen Polarization Gratings," *Society for Information Display Symposium Digest*, **vol. 38**, pp. 1401-1404, 2007.
35) M.J. Escuti and W.M. Jones, "A Polarization-Independent Liquid Crystal Spatial-Light-Modulator," *Proceedings of the SPIE - Optics & Photonics Conference*, **vol. 6332**, art. no. 63320M, 2006.
36) M.C. Ozturk and M.J. Escuti, "A New Introductory Course On Signals, Circuits and Systems," *American Society for Engineering Education Annual Conference*, **vol. 2532**, art. no. 2473, 2006.
37) M.J. Escuti, C. Oh, C. Sanchez, C. Bastiaansen, and D.J. Broer, "Simplified Spectropolarimetry Using Reactive Mesogen Polarization Gratings," *Proceedings of the SPIE - Optics & Photonics Conference*, **vol. 6302**, art. no. 630207, 2006.
38) B.L. Conover and M.J. Escuti, "The response of particles with anisotropic shape within an optical landscape and laminar flow," *Proceedings of the SPIE - Optics & Photonics Conference*, **vol. 6326**, art. no. 632614, 2006.
39) C. Oh, R. Komanduri, and M.J. Escuti, "Finite-difference-time-domain analysis of polarization gratings," *Proceedings of the SPIE - Optics & Photonics Conference*, **vol. 6326**, art. no. 632638, 2006.
40) C. van Heesch, C. Sanchez, M.J. Escuti, D.J. Broer, and C. Bastiaansen, "Holographic phase gratings in back and frontlights for liquid crystal displays," *Proceedings of the SPIE - Optics & Photonics Conference*, **vol. 6355**, art. no. 635501, 2006.
41) W.M. Jones, C Oh, R Komanduri, and M.J. Escuti, "Polarization-Independent Modulation for Projection Displays Using Small-Period LC Polarization Gratings," *International Display Research Conference*, **vol. 26**, art. no. 12.5, 2006.
42) M.J. Escuti and W.M. Jones, "Polarization independent switching with high contrast from a liquid crystal polarization grating," *Society for Information Display Symposium Digest*, **vol. 37**, pp. 1443-1446, 2006.
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44) C. Oh, R. Komanduri, and M.J. Escuti, "FDTD and elastic continuum analysis of the liquid crystal polarization grating," *Society for Information Display Symposium Digest*, **vol. 37**, pp. 844-847, 2006.

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46) J. Qi, M.J. Escuti, and G.P. Crawford, "Modeling of Three-Dimensional Structured Liquid Crystal/Polymer Dispersions for Reflective Displays", *Int. Display Manufacturing Conf.*, **vol. 3**, art. no. P2-13, 2003.
47) M.J. Escuti and G.P. Crawford, "Viewing-angle Compensation in LCDs: Modeling of Fiber Optic Face Plates", *Int. Display Manufacturing Conf.*, **vol. 3**, art. no. P2-20, 2003.
48) M.J. Escuti and G.P. Crawford, "Switchable Photonic Lattices with Polymer Dispersions of Liquid Crystals", *Polymer Preprints*, **vol. 43**, pp. 540-541, 2002.
49) M.J. Escuti and G.P. Crawford, "The Electro-Optic Effects of 3D Lattices in H-PDLC Reflective Displays," *Asia Display Symposium Digest*, **vol. 8**, art. no. LCST-08, 2002.
50) M.J. Escuti and G.P. Crawford, "Fiber-Optic Faceplate Viewing-Angle Compensation in LCDs," *Asia Display Symposium Digest*, **vol. 8**, art. no. LCST-07, 2002.
51) M.J. Escuti and G.P. Crawford, "Tailoring Morphology in Holographic-Polymer Dispersed Liquid Crystals for Reflective Display Applications," *Society for Information Display Symposium Digest*, **vol. 33**, pp. 550-553, 2002.
52) M.J. Escuti and G.P. Crawford, "Polymer Dispersed Liquid Crystals as Mesoscale 2D and 3D Lattices," *Materials Research Society Symposium Proceedings*, **vol. 709**, pp. 293-298, 2002.
53) M.J. Escuti, D. Cairns, J. Vedrine, and G.P. Crawford, "Optical-strain characteristics of ordered reactive mesogen films for viewing–angle compensation," *Society for Information Display Symposium Digest*, **vol. 32**, pp. 870-873, 2001.
54) M.J. Escuti, P.Kossyrev, and G.P.Crawford, "Enhanced Viewing Volume of Holographic LC/Polymer Dispersions," *Asia Display Symposium Digest*, **vol. 6**, pp. 110-115, 2000.
55) M.J. Escuti, P. Kossyrev, C.C. Bowley, S. Danworaphong, G.P. Crawford, T.G. Fiske, J. Colegrove, L.D. Silverstein, A. Lewis, and H. Yuan, "Diffuse H-PDLC Reflective Displays: An Enhanced Viewing-Angle Approach," *Society for Information Display Symposium Digest*, **vol. 31**, pp. 766-769, 2000.
56) A.K. Fontecchio, M.J. Escuti, C.C. Bowley, B. Sethumadhavan, G.P. Crawford, L. Li, and S. Faris, "Spatially Pixelated Reflective Arrays from Holographic-Polymer Dispersed Liquid Crystals," *Society for Information Display Symposium Digest*, **vol. 31**, pp. 774-777, 2000.
57) M.J. Escuti, C.C. Bowley, G.P. Crawford, and S. Zumer, "A Model of the Fast-Switching Polymer-Stabilized IPS Configuration," *Society for Information Display Symposium Digest*, **vol. 30**, pp. 32-35, 1999. (Best Student Paper Award)

Invited Research Presentations

1) 2013 *American Chemical Society* at New Orleans (LA), "On patterning liquid crystal monomers into perfect geometric phase holograms," in Liquid Crystals and Polymers Session
2) 2012 *OSA Frontiers in Optics* at Rochester (NY), "Geometric Phase Holograms - Fabricating Generalized Polarization Gratings Enabling Arbitrary Wavefront Control with Perfect Efficiency," in Optical Design and Unconventional Polarization Session
3) 2012 *Microsoft Research* in Redmond (WA), "Polarization gratings & multi-twist retarders: 'perfect' wavefront manipulation & 'fully' tailorable broadband retardation control"
4) 2012 *European Patent Office in Munich* (Germany), "Innovation and Success in University/Industry Partnership: the technology and story of commercialization of functional polymer optics"
5) 2012 *St. Petersburg State University, Invited Research Seminar,* in St. Petersburg (Russia), "Liquid Crystal Polarization Gratings as 'perfect' diffractive elements via the geometric

phase: fundamental insights, novel photonic devices, and commercialization", Physics Department

6) 2012 *NCSU, Physics Department Colloquium* in Raleigh (NC), "Polarization gratings and beyond: how liquid crystals + holography = 'perfect' wavefront manipulation"
7) 2012 *US Air Force Research Laboratory (AFRL)* at Dayton (OH), "Liquid Crystal Polarization Gratings – review and prospects of their use in visible thru infrared applications".
8) 2012 *SPIE Photonics West* at San Diego (CA), "Liquid Crystals in Diffraction Gratings Review" Liquid Crystals Session
9) 2011 *SPIE Defense, Security, & Sensing* at Orlando (FL), "A liquid crystal shutter for unpolarized broadband light," Acquisition, Tracking, Pointing, and Laser Systems Technologies Session
10) 2011 *SPIE Defense, Security, & Sensing* at Orlando (FL), "LC polarization gratings: performance review and prospects for visible through longwave infrared applications," Acquisition, Tracking, Pointing, and Laser Systems Technologies Session
11) 2010 *University of Arizona Invited Research Seminar* at Tucson (AZ), "Polarization Gratings – Novel Efficient Optical Elements," College of Optical Sciences
12) 2010 *SPIE Optics & Photonics* at San Diego (CA), "Liquid Crystal Polarization Gratings With Large Diffraction Angles - Efficiency and Polarization Trends and Compensation," Liquid Crystal Switches, Modulators, Lasers Session
13) 2008 *SPIE Optics & Photonics* at San Diego (CA), "Polarization Freedom For Liquid Crystal Devices," Liquid Crystal Switches, Modulators, Lasers Session
14) 2007 *SPIE Optics & Photonics* at San Diego (CA), "DAZLE: A New Approach to Adaptive Imaging", Atmospheric and Space Optical Systems Session
15) 2006 *International Liquid Crystal Conference* at Keystone (CO), "Polarization-Independent Modulation and Simplified Spectropolarimetry Using LC Polarization Gratings", Novel Devices and Applications Session
16) 2006 OSA/SPIE *Optics in the Southeast Conference* at Charlotte (NC), "Anisotropic Gratings for Polarization-Independent Modulation & Simplified Spectropolarimetry", Micro- and Nano-Optics Section
17) 2006 *Brown University Invited Seminar* at Providence (RI), "Polarization-Independent Modulation and Other Tricks with LC Polarization Gratings"
18) 2006 *Kent State University, Liquid Crystal Institute Invited Seminar* at Kent (OH), "Reactive and Switchable LC Polarization Gratings"
19) 2005 *North Carolina Photonics Consortium* at Raleigh (NC), "Polarization Gratings in Photonics: the Hidden uncovered by the Asymmetric"
20) 2004 *International Liquid Crystal Conference* at Ljubljana (Slovenia), Invited ILCS Award Talk: "Structured LC/Polymer Composites as Tunable Photonic Crystals"
21) 2002 *American Chemical Society Annual Meeting* at Boston (MA), "Switchable Photonic Lattices with Polymer Dispersions of Liquid Crystals"
22) 2002 *Josef Stefan Institute Invited Seminar, Univ of Ljubljana* (Slovenia), "Holographic-PDLCs and Novel Structures from Reactive Mesogens"
23) 2000 *Brownbag Research Seminar, NASA Glenn Research Center* at Cleveland (OH), "Investigations into Bulk and Polymer Dispersed Liquid Crystals in Microgravity"

MICHAEL JAMES ESCUTI

Patents Issued (US & Foreign)

1) *US Patent No. 8,339,566* (issued 2013), "Low-Twist Chiral Nematic Liquid Crystal Polarization Gratings and Related Fabrication Methods", M.J. Escuti, C. Oh, and R. Komanduri.
2) *US Patent No. 8,358,400* (issued 2013), "Methods of Fabricating Liquid Crystal Polarization Gratings on Substrates and Related Devices", M.J. Escuti.
3) *US Patent No. 8,064,035* (issued 2011), "Polarization gratings in mesogenic films", M.J. Escuti, C. Sanchez, C.W.M. Bastiaansen, and D.J. Broer.
4) *US Patent No. 7,692,759* (issued 2010), "Polarization gratings in mesogenic films", M.J. Escuti, C. Sanchez, C.W.M. Bastiaansen, and D.J. Broer.
5) *US Patent No. 7,006,747* (issued 2006), "Optical devices incorporating photo reactive polymers", M.J. Escuti, G.P. Crawford, and R.C. Allen.
6) *European Patent No. EP2350736* (issued 2013), "Polarization-Independent Liquid Crystal Display Devices Including Multiple Polarization Grating Arrangements and Related Devices", M.J. Escuti, C. Oh, R. Komanduri, B.L. Conover, and J. Kim.
7) *European Patent No. EP2137571* (issued 2013), "Methods of Fabricating Liquid Crystal Polarization Gratings", M.J. Escuti.
8) *European Patent No. EP2388625* (issued 2013), "Low-Twist Chiral Liquid Crystal Polarization Gratings and Related Fabrication Methods", M.J. Escuti, C. Oh, and R. Komanduri.
9) *European Patent No. WO2006041278* (issued 2006), "Waveguide Comprising An Anisotropic Diffracting Layer", C. Sanchez, C. Bastiaansen, D.J. Broer, M.J. Escuti, and C. van Heesch.

Patent Applications Pending (US & Foreign)

1) *US Patent Appl. No. 13/646,166*, "Multi-Twist Retarders for Broadband Polarization Transformation and Related Fabricated Methods", M.J. Escuti, R.K. Komanduri, and K.F. Lawler.
2) *US Patent Appl. No. 13/387,942*, "Beam Steering Using Stacked Liquid Crystal Polarization Gratings", M.J. Escuti, J. Kim, C. Oh, and S. Serati.
3) *US Patent Appl. No. 13/122,244*, "Polarization-Independent Liquid Crystal Display Devices Including Multiple Polarization Grating Arrangements and Related Devices", M.J. Escuti, C. Oh, R. Komanduri, B.L. Conover, and J. Kim.
4) *US Patent Appl. No. 12/596,176*, "Multi-Layer Achromatic Liquid Crystal Polarization Gratings and Related Fabrication Methods", M.J. Escuti and C. Oh.
5) *US Provisional Appl. No. 61/784,683*, K. Gundogdu, B. Gokce, Y. Li, and M.J. Escuti.
6) *US Provisional Appl. No. TBA*, M.J. Escuti, J. Kim, R.K. Komanduri, and E. Clark.
7) *US Provisional Appl. No. 61/713,770*, M.J. Escuti, M.N. Miskiewicz, and J. Kim.
8) *US Provisional Appl. No. 61/796,974*, M.W. Kudenov and M.J. Escuti.
9) *US Provisional Appl. No. 61/629,655*, M.W. Kudenov and M.J. Escuti.
10) *US Provisional Appl. No. 61/544,888*, M.J. Escuti, R.K. Komanduri, J. Kim, and K.F. Lawler.
11) *International Appl. No. WO2006064431*, "Porous holographic film", C. van Heesch, C. Sanchez, M.J. Escuti, C. Bastiaansen, and D.J. Broer.
12) *International Appl. No. WO2006088369*, "Luminescent Object And Utilisation Thereof", M.G. Debije, C. Bastiaansen, D.J. Broer, M.J. Escuti, and C. Sanchez.

Invited Book Chapter

1. G.P. Crawford and M.J. Escuti, "Liquid Crystal Display Technology", in *Encyclopedia of Imaging Science and Technology*, ed. J.P. Hornak, (John Wiley & Sons, Inc., 2002).

MICHAEL JAMES ESCUTI

North Carolina State University
Department of Electrical and Computer Engineering
2410 Campus Shore Dr, Box 7914
Raleigh, NC 27695

(919) 274-7508 (mobile)
(919) 513-7363 (office)
mjescuti@ncsu.edu
go.ncsu.edu/oleg

Professional Preparation

2002 PhD in Electrical Engineering, Brown University
Dissertation: "Structured Liquid Crystal/Polymer Composites as Photonic Crystal Switches and LCD Innovations" – *Advisor*: Dr. Gregory P. Crawford
1999 MSc in Electrical Engineering, Brown University
1997 BS (magna cum laude) in Electrical & Computer Engineering, Drexel University

Professional Experience

2010-present	Associate Professor, Dept. Electrical & Computer Engineering, NC State Univ
2005-present	Chief Science Officer, ImagineOptix Corporation
2004-2010	Assistant Professor, Dept. Electrical & Computer Engineering, NC State Univ
2002-2004	Post-Doc, Dept. Functional Polymers, Eindhoven Univ of Tech (Netherlands)

Honors and Awards

2011 Presidential Early Career Award for Scientists and Engineers (PECASE)
2011 Alcoa Foundation Engineering Research Achievement Award, NC State Univ
2010 Faculty Early Career Development (CAREER) Award, National Science Foundation
2004 Glenn Brown Award for Outstanding PhD Dissertation, International Liquid Crystal Soc
2003 First Prize – Art & Liquid Crystals Competition, European Conf. Liquid Crystals
2002 OSA/New Focus Student Award, Top Winner, CLEO/QELS Conference
2001 Graduate Student Silver Award, Materials Research Soc. Fall Meeting
2001 Sigma Xi Outstanding Graduate Student Research Award, Brown University
2000 Citation of Excellence in Science Education, RI House of Representatives
1999 Best Student Paper Award, Society for Information Display, International Symposium
1997 Citation of Excellence in Engineering Design, Drexel University

Publications and Patents Summary

Inventor on 5(10) US patents issued(pending), and 6 additional foreign patents and applications. Authored 33 journal articles, 57 refereed conference proceedings, 23 invited research presentations, and 1 book contribution. As of April 2013 per ISI Web of Knowledge™ (across journal papers): Accumulated Citations 647, and h-index 14

External and Internal Sponsored Research Activities

External Funding: ~ $ 5M (overall), ~ $ 3.7M (to NCSU), ~ $ 3.5M (as PI/co-PI)
Prime Sponsors (Gov't): Natl Science Foundation, NASA, US Air Force Research Lab, DARPA
Industry Partners, Sponsors: Raytheon, SAIC, Boulder Nonlinear Sys, ImagineOptix, Teledyne

Expert Witness Experience

Ongoing: Patent dispute, before District Court of New Jersey (Civil Action No. 12-952)
Technology: Optical Data Storage, CD/DVD/Blueray-Disc, Holograms
Supporting: Samsung et al (Defendants) v Voxpath RS LLC
Role: Wrote expert report, anticipate addl report, deposition, testimony at trial
Firm: Greenberg Traurig

Closed 2012: Patent dispute, before US International Trade Commission (ITC No. 337-TA-836)
Technology: LCD system technologies
Supporting: LG Electronics et al (Respondents) v Graphics Properties Holdings
Firm: Greenberg Traurig
Role: Expert reports, witness statements, extensive lab testing, deposition; settlement prior to hearing

Closed 2012: Patent dispute, before US International Trade Commission (ITC No. 337-TA-805)
Technology: LCD backlights
Supporting: LG Display, LG Electronics et al (Respondents) v Ind Tech Res Instr
Firm: Steptoe & Johnson
Role: Expert reports, witness statements, deposition, extensive lab testing, testified at hearing

Closed 2011: Patent dispute, before US International Trade Commission (ITC No. 337-TA-749)
Technology: LCD optics, viewing angle compensation
Supporting: Thomson (Complainants) v Chimei Innolux, AU Optronics, et al
Firm: Kirkland & Ellis
Role: Expert reports, witness statements, deposition, tutorial, testified at hearing

Teaching and Mentoring Experience

I have previously graduated 5 PhD and 3 MST students as Chair, and currently advise 3 PhD and 0 MST students. I have directed 16 undergraduate researchers, and mentor 2 Post-Docs. Classes Taught: ECE-200 (Intro to Electrical Circuits, Signals, Sys), ECE-303 (Electromagnetic Fields), ECE-492K (Optical Communications), ECE-492S (Organic Electronics & LCDs)

Professional Memberships

SPIE – International Society for Optical Engineering (2000-present), IEEE – Institute of Electrical and Electronics Engineers (1996-present), ILCS – International Liquid Crystal Society (2002-present), SID – Society for Information Display (1999-2002, 2006-present), OSA – Optical Society of America (2000-present), MRS – Materials Research Society (2001-2005)

Journal Publications (peer-reviewed)

1) R.K. Komanduri, K.F. Lawler, and M.J. Escuti, " Multi-twist retarders: broadband retardation control using self-aligning reactive liquid crystal layers", *Optics Express*, **vol. 21**, no. 1, pp. 404-420, 2013.
2) Y. Li, J. Kim, M.J. Escuti, "Orbital angular momentum generation and mode transformation with high efficiency using forked polarization gratings," *Applied Optics*, **vol. 51**, no. 34, pp. 8236-8245, 2012.
3) M.W. Kudenov, M.N. Miskiewicz, M.J. Escuti, and E. Dereniak, "Spatial heterodyne interferometry with polarization gratings", *Optics Letters*, **vol. 37**, no. 21, pp. 4413-4415, 2012.
4) J. Kim, R.K. Komanduri, K.F. Lawler, D.J. Kekas, and M.J. Escuti, "Efficient and monolithic polarization conversion system based on a polarization grating", *Applied Optics*, **vol. 51**, no. 20, pp. 4852-4857, 2012.
5) M. Kudenov, M.J. Escuti, N. Hagen, E. Dereniak, and K. Oka, "Snapshot imaging Mueller matrix polarimeter using polarization gratings," *Optics Letters*, **vol. 37**, no. 8, pp. 1367-1369, 2012.
6) J. Kim, C. Oh, S. Serati, and M.J. Escuti, "Wide-angle, nonmechanical beam steering with high throughput utilizing polarization gratings," *Applied Optics* **50**, no. 17, pp. 2636-2639, 2011.

7) M. Kudenov, M.J. Escuti, E. Dereniak, and K. Oka, "White light channeled imaging polarimeter using broadband polarization gratings" *Applied Optics* **50**, no. 15, 2283-2293, 2011.
8) E. Nicolescu, C. Mao, A. Fardad, and M.J. Escuti, "Polarization-independent variable optical attenuator using liquid crystal polarization gratings," *IEEE Journal of Lightwave Technology*, **vol. 28**, no. 21, pp. 3121-3127, 2010.
9) E. Nicolescu and M.J. Escuti, "Polarization-independent tunable optical filters using bilayer polarization gratings," *Applied Optics*, **vol. 49**, no. 20, pp. 3900-3904, 2010.
10) C. Packham, M. Escuti, J. Ginn, C. Oh, I. Quijano, and G. Boreman, "Polarization Gratings: A Novel Polarimetric Component for Astronomical Instruments," *Publications of the Astronomical Society of the Pacific*, **vol. 122**, no. 898, pp. 1471-1482, 2010.
11) C. Oh, J. Kim, J.F. Muth, S. Serati, and M.J. Escuti, "High-Throughput, Continuous Beam Steering Using Rotating Polarization Gratings", *IEEE Photonics Technology Letters*, **vol. 22**, no. 4, pp. 200-202, 2010.
12) R.K. Komanduri and M.J. Escuti, "Highly Efficient Reflective Liquid Crystal Polarization Gratings," *Applied Physics Letters*, **vol. 95**, art. num. 091106, 2009.
13) P.F. McManamon, P.J. Bos, M.J. Escuti, J. Heikenfeld, S. Serati, H. Xie, and E.A. Watson, "A Review of Phased Array Steering for Narrowband Electro-Optical Systems," *Proceedings of the IEEE*, **vol. 97**, no. 6, pp. 1078-1096, 2009.
14) C Oh and MJ Escuti, "Achromatic diffraction from polarization gratings with high efficiency," *Optics Letters*, **vol. 33**, pp. 2287-2289, 2008.
15) C. Sanchez, F. Verbakel, M.J. Escuti, C.W.M. Bastiaansen, and D.J. Broer, "Printing of Monolithic Polymeric Micro-Structures using Reactive Mesogens," *Advanced Materials*, **vol. 20**, no. 1, pp. 74-78, 2008.
16) C. Oh and M.J. Escuti, "Numerical Analysis of Polarization Gratings Using the Finite-Difference Time-Domain Method," *Physical Review A*, **vol. 76**, no. 4, num. 043815, 2007.
17) R.K. Komanduri and M.J. Escuti, "Elastic Continuum Analysis of the Liquid Crystal Polarization Grating," *Physical Review E*, **vol. 76**, no. 2, num. 021701, 2007.
18) R.K. Komanduri, W.M. Jones, C. Oh, and M.J. Escuti, "Polarization-Independent Modulation for Projection Displays Using Small-Period LC Polarization Gratings," *Journal of the Society for Information Display*, **vol. 15**, no. 8, pp. 589-594, 2007.
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Invited Research Presentations

1) 2013 *American Chemical Society* at New Orleans (LA), "On patterning liquid crystal monomers into perfect geometric phase holograms," in Liquid Crystals and Polymers Session
2) 2012 *OSA Frontiers in Optics* at Rochester (NY), "Geometric Phase Holograms - Fabricating Generalized Polarization Gratings Enabling Arbitrary Wavefront Control with Perfect Efficiency," in Optical Design and Unconventional Polarization Session
3) 2012 *Microsoft Research* in Redmond (WA), "Polarization gratings & multi-twist retarders: 'perfect' wavefront manipulation & 'fully' tailorable broadband retardation control"
4) 2012 *European Patent Office in Munich* (Germany), "Innovation and Success in University/Industry Partnership: the technology and story of commercialization of functional polymer optics"
5) 2012 *St. Petersburg State University, Invited Research Seminar,* in St. Petersburg (Russia), "Liquid Crystal Polarization Gratings as 'perfect' diffractive elements via the geometric

phase: fundamental insights, novel photonic devices, and commercialization", Physics Department

6) 2012 *NCSU, Physics Department Colloquium* in Raleigh (NC), "Polarization gratings and beyond: how liquid crystals + holography = 'perfect' wavefront manipulation"
7) 2012 *US Air Force Research Laboratory (AFRL)* at Dayton (OH), "Liquid Crystal Polarization Gratings – review and prospects of their use in visible thru infrared applications".
8) 2012 *SPIE Photonics West* at San Diego (CA), "Liquid Crystals in Diffraction Gratings Review" Liquid Crystals Session
9) 2011 *SPIE Defense, Security, & Sensing* at Orlando (FL), "A liquid crystal shutter for unpolarized broadband light," Acquisition, Tracking, Pointing, and Laser Systems Technologies Session
10) 2011 *SPIE Defense, Security, & Sensing* at Orlando (FL), "LC polarization gratings: performance review and prospects for visible through longwave infrared applications," Acquisition, Tracking, Pointing, and Laser Systems Technologies Session
11) 2010 *University of Arizona Invited Research Seminar* at Tucson (AZ), "Polarization Gratings – Novel Efficient Optical Elements," College of Optical Sciences
12) 2010 *SPIE Optics & Photonics* at San Diego (CA), "Liquid Crystal Polarization Gratings With Large Diffraction Angles - Efficiency and Polarization Trends and Compensation," Liquid Crystal Switches, Modulators, Lasers Session
13) 2008 *SPIE Optics & Photonics* at San Diego (CA), "Polarization Freedom For Liquid Crystal Devices," Liquid Crystal Switches, Modulators, Lasers Session
14) 2007 *SPIE Optics & Photonics* at San Diego (CA), "DAZLE: A New Approach to Adaptive Imaging", Atmospheric and Space Optical Systems Session
15) 2006 *International Liquid Crystal Conference* at Keystone (CO), "Polarization-Independent Modulation and Simplified Spectropolarimetry Using LC Polarization Gratings", Novel Devices and Applications Session
16) 2006 OSA/SPIE *Optics in the Southeast Conference* at Charlotte (NC), "Anisotropic Gratings for Polarization-Independent Modulation & Simplified Spectropolarimetry", Micro- and Nano-Optics Section
17) 2006 *Brown University Invited Seminar* at Providence (RI), "Polarization-Independent Modulation and Other Tricks with LC Polarization Gratings"
18) 2006 *Kent State University, Liquid Crystal Institute Invited Seminar* at Kent (OH), "Reactive and Switchable LC Polarization Gratings"
19) 2005 *North Carolina Photonics Consortium* at Raleigh (NC), "Polarization Gratings in Photonics: the Hidden uncovered by the Asymmetric"
20) 2004 *International Liquid Crystal Conference* at Ljubljana (Slovenia), Invited ILCS Award Talk: "Structured LC/Polymer Composites as Tunable Photonic Crystals"
21) 2002 *American Chemical Society Annual Meeting* at Boston (MA), "Switchable Photonic Lattices with Polymer Dispersions of Liquid Crystals"
22) 2002 *Josef Stefan Institute Invited Seminar, Univ of Ljubljana* (Slovenia), "Holographic-PDLCs and Novel Structures from Reactive Mesogens"
23) 2000 *Brownbag Research Seminar, NASA Glenn Research Center* at Cleveland (OH), "Investigations into Bulk and Polymer Dispersed Liquid Crystals in Microgravity"

Patents Issued (US & Foreign)

1) *US Patent No. 8,339,566* (issued 2013), "Low-Twist Chiral Nematic Liquid Crystal Polarization Gratings and Related Fabrication Methods", M.J. Escuti, C. Oh, and R. Komanduri.
2) *US Patent No. 8,358,400* (issued 2013), "Methods of Fabricating Liquid Crystal Polarization Gratings on Substrates and Related Devices", M.J. Escuti.
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5) *US Patent No. 7,006,747* (issued 2006), "Optical devices incorporating photo reactive polymers", M.J. Escuti, G.P. Crawford, and R.C. Allen.
6) *European Patent No. EP2350736* (issued 2013), "Polarization-Independent Liquid Crystal Display Devices Including Multiple Polarization Grating Arrangements and Related Devices", M.J. Escuti, C. Oh, R. Komanduri, B.L. Conover, and J. Kim.
7) *European Patent No. EP2137571* (issued 2013), "Methods of Fabricating Liquid Crystal Polarization Gratings", M.J. Escuti.
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9) *European Patent No. WO2006041278* (issued 2006), "Waveguide Comprising An Anisotropic Diffracting Layer", C. Sanchez, C. Bastiaansen, D.J. Broer, M.J. Escuti, and C. van Heesch.

Patent Applications Pending (US & Foreign)

1) *US Patent Appl. No. 13/646,166*, "Multi-Twist Retarders for Broadband Polarization Transformation and Related Fabricated Methods", M.J. Escuti, R.K. Komanduri, and K.F. Lawler.
2) *US Patent Appl. No. 13/387,942*, "Beam Steering Using Stacked Liquid Crystal Polarization Gratings", M.J. Escuti, J. Kim, C. Oh, and S. Serati.
3) *US Patent Appl. No. 13/122,244*, "Polarization-Independent Liquid Crystal Display Devices Including Multiple Polarization Grating Arrangements and Related Devices", M.J. Escuti, C. Oh, R. Komanduri, B.L. Conover, and J. Kim.
4) *US Patent Appl. No. 12/596,176*, "Multi-Layer Achromatic Liquid Crystal Polarization Gratings and Related Fabrication Methods", M.J. Escuti and C. Oh.
5) *US Provisional Appl. No. 61/784,683*, K. Gundogdu, B. Gokce, Y. Li, and M.J. Escuti.
6) *US Provisional Appl. No. TBA*, M.J. Escuti, J. Kim, R.K. Komanduri, and E. Clark.
7) *US Provisional Appl. No. 61/713,770*, M.J. Escuti, M.N. Miskiewicz, and J. Kim.
8) *US Provisional Appl. No. 61/796,974*, M.W. Kudenov and M.J. Escuti.
9) *US Provisional Appl. No. 61/629,655*, M.W. Kudenov and M.J. Escuti.
10) *US Provisional Appl. No. 61/544,888*, M.J. Escuti, R.K. Komanduri, J. Kim, and K.F. Lawler.
11) *International Appl. No. WO2006064431*, "Porous holographic film", C. van Heesch, C. Sanchez, M.J. Escuti, C. Bastiaansen, and D.J. Broer.
12) *International Appl. No. WO2006088369*, "Luminescent Object And Utilisation Thereof", M.G. Debije, C. Bastiaansen, D.J. Broer, M.J. Escuti, and C. Sanchez.

Invited Book Chapter

1. G.P. Crawford and M.J. Escuti, "Liquid Crystal Display Technology", in *Encyclopedia of Imaging Science and Technology*, ed. J.P. Hornak, (John Wiley & Sons, Inc., 2002).

APPENDIX B

Materials considered by Michael Escuti

Exhibit No.	Reference
1001	U.S. Patent No. 8,068,204 to Hirakata et al.
1002	Prosecution history of application 13/009,980, which matured into the '204 patent.
1003	U.S. Patent No. 5,684,555 to Shiba et al.
1004	U.S. Patent No. 5,504,601 to Watanabe et al.
1005	U.S. Patent No. 5,636,329 to Sukegawa et al.
1007	Declaration of Miltiadis Hatalis, Ph.D.
Paper No. 1	Petition for Inter Partes Review
Paper No. 6	Preliminary Response of the Patent Owner
Paper No. 7	Decision, Institution of Inter Partes Review
Paper No. 15	Patent Owner Request for Rehearing
Paper No. 22	Decision, Request for Rehearing
2008	Display search Laboratory website material
2009	Sukegawa FIG. 1B marked by Dr. Hatalis at deposition to show vertical and horizontal limits of the opening in insulation film 9
2010	Sukegawa FIG. 2C marked by Dr. Hatalis at deposition to show hypothetical placement of a sealant
2012	Deposition transcript of Miltiadis Hatalis, Ph.D dated July 1, 2013, for No. IPR2013-00066
2013	Deposition transcript of Miltiadis Hatalis, Ph.D dated July 2, 2013

CERTIFICATE OF SERVICE

I certify that the foregoing DECLARATION OF MICHAEL J. ESCUTI was served on the Petitioner by Federal Express Standard Overnight at the following addresses on July 24, 2013.

Scott A. McKeown
Oblon, Spivak, McClelland, Maier & Neustadt, L.L.P.
1940 Duke Street
Alexandria, VA 22314

Gregory S. Cordrey
Jeffer Mangels Butler & Mitchell LLP
3 Park Plaza, Suite 1100
Irvine, CA 92614-2592

Stanley Gibson
Jeffer Mangels Butler & Mitchell LLP
3 Park Plaza, Suite 1100
Irvine, CA 92614-2592