SEL EXHIBIT 2012

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

IPR2013-00066

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

INNOLUX CORPORATION

Petitioner

v.

SEMICONDUCTOR ENERGY LABORATORY CO., LTD.

Patent Owner

CASE IPR 2013-00066

PATENT 7,876,413

DECLARATION OF MICHAEL J. ESCUTI, PHD

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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

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. 7,876,413 (the "'413 patent") (Ex.1001) and the scientific and technical subject matter at the time the '413 patent was filed. Appendix A lists the materials I reviewed.

3. My opinions and underlying reasoning for this opinion 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 '413 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 one book chapter. I have offered 23 invited research presentations. I am a named inventor on 5 issued and 10 pending United States and patent 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 I 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 '413 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 in 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 B. This includes a list of my patents and publications and 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 A.

II. LEGAL STANDARD OF PATENTABILITY

16. In forming my opinions and considering the patentability of the claims of the '413 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 '413 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 '413 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 '413 patent is based on series of continuation applications from an application (09/165,628) that was filed on October 1, 1998. I understand that the '413 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 '413 patent in 1997 would be aware of liquid crystal display structures, including techniques for providing connections therein and to circuits outside a sealant.

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)).

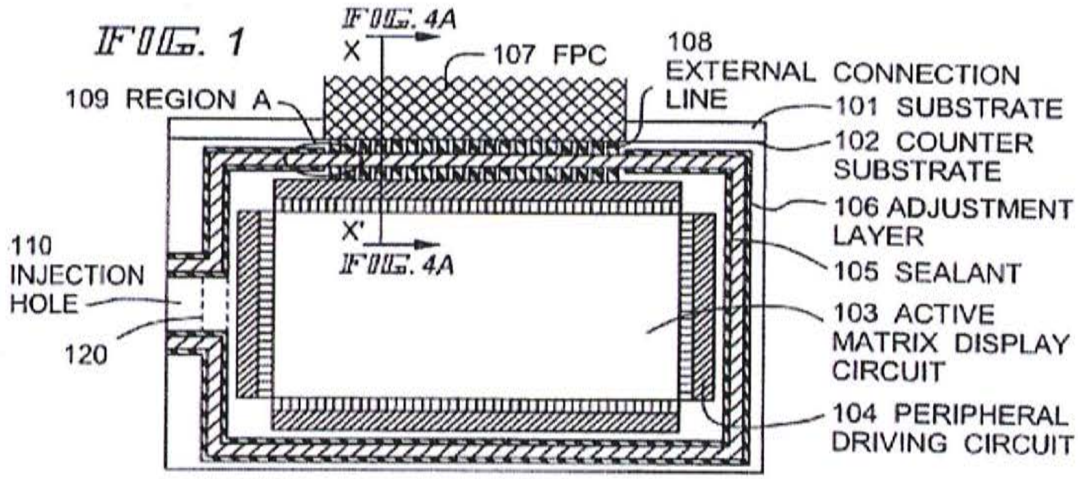
34. I understand that extrinsic evidence may be consulted for the meaning of a claim term as long as it is not used to contradict claim meaning that is unambiguous in light of the intrinsic evidence. *Phillips v. AWH Corp.*, 415 F.3d

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 '413 PATENT.

A. The Background Of The '413 Patent

35. The '413 patent relates to a display device such as a liquid crystal display ("LCD") device. LCD devices generally have two, parallel facing substrates that are mechanically connected by a sealant, and a liquid crystal material is located in a region circumscribed by the sealant. The substrates are generally called the substrate and the counter-substrate. Sometimes the counter-substrate is called the color filter substrate. FIG. 1 of the '413 patent shows general aspects of an LCD:

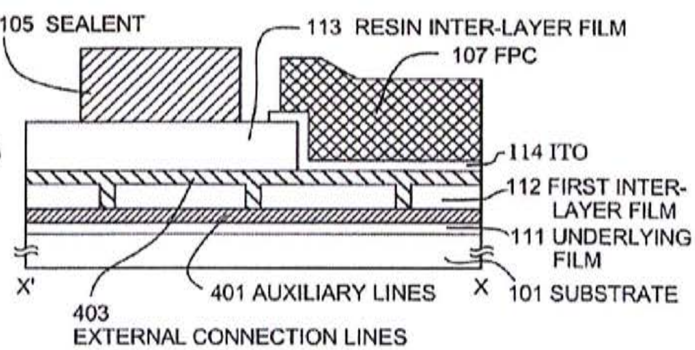


36. The sealant is used to define a region to contain liquid crystal between the two substrates. Thus, FIG. 1 of the '413 patent, shown above, indicates a substrate 101 and a counter-substrate 102. A sealant 105 is represented, and an injection hole 110 at the left side of FIG. 1 is where liquid crystal material is injected so that it becomes located between the substrates as constrained by the sealant. Then the hole is sealed. Inside the LCD are various microelectronic wirings and circuits that cause sections of the device called pixels to change their light transmittance or brightness. Wirings extend from an active area of the LCD (within the region circumscribed by the sealant 105) to the region outside the sealant. These include external connection lines 108 in FIG. 1.

37. The invention set forth in the claims relates more specifically to the embodiment illustrated in FIGS. 4A and 4B (reproduced below). The external connection lines in this embodiment are represented by reference 403. The

invention reduces the resistance of the electrical connection by using auxiliary lines 401, which lie beneath the external connection lines 403, and which correspond to a "first wiring" in the claims. (Ex. 1001, col. 8, ll. 42-50 and FIG. 4A). These two wirings are typically formed of a metal conductor. The external connection line 403 is referred to in some claims as a "second wiring," which is located above the first wiring in the whole region represented by FIG. 4A, from the "terminal region" on the right, to beneath the sealant region at the left. They are separated vertically by a first inter-layer film 112, which corresponds to a "first insulating film" in the claims.

FIG. 4A



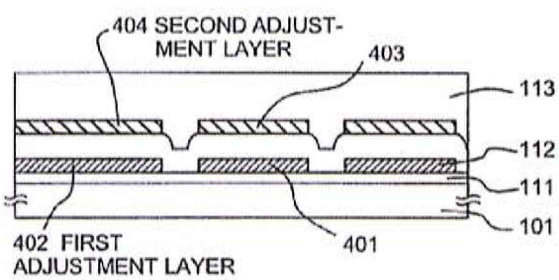


FIG. 4B

B. The Invention of the '413 Patent

38. All claims in the '413 patent require a contact hole ("an opening") through the first insulating film (between the two conducting lines) to allow electrical contact between them. The advantage of reduced electrical resistance, Ex. 1001, col. 8, ll. 42-51, results from the following limitations in claim 1 (and limitations in other contested claims):

> a sealant over the first wiring and a second region of the second wiring,
> wherein the second wiring overlaps at least part of the first wiring;
> wherein the first wiring and the second wiring are in electrical contact through an opening in the first insulating film.

39. Furthermore, in order to improve the reliability of an LCD by providing for the sealant 105 to have favorable adhesion, this invention provides a structure where the sealant 105 does not overlap the indium tin oxide ("ITO") film 114, which corresponds to a "transparent conductive layer" in the claims, and the sealant is in direct contact with the second insulating film (such as the resin inter-layer film 113). *Id.* at FIG. 4A. Generally, a sealant has poor adhesion to ITO. As shown in FIG. 4A of the '413 patent, the transparent conductive layer is over a "first region" of the second wiring, the sealant is over both the first wiring and a "second region" of the second wiring, and the sealant is in direct contact with the

second insulating film. This configuration provides favorable adhesion of the sealant. This advantage of favorable adhesion is achieved by the following limitations in claim 1 (and limitations in the other independent claims):

> a transparent conductive layer over a first region of the second wiring;
>
> a sealant over the first wiring and a second region of the second wiring,
>
> wherein the sealant is in direct contact with the second insulating film.

40. Additionally, independent claims 1, 7, 17, and 22 and dependent claims 15 and 29 of the '413 patent have the advantage of achieving a reliable connection with the flexible printed circuit 107 ("FPC"). First, a connection with high reliability can be achieved because the entire terminal portion region where the transparent conductive layer is formed can be used as the connection area for the FPC. For example, in FIG. 4A of the '413 patent, because resin inter-layer film 113 is formed before and located under the ITO layer 114, there will be no layer that blocks the ITO layer 114 from connecting with the FPC 107. That is, the entire area where the ITO layer 114 is formed corresponds to the region where the FPC 107 can be connected. Because the connection area is not obstructed by the resin-layer film 113, the connection reliability between the ITO layer 114 and the FPC 107 will increase.

41. Second, because no other layer is formed over the transparent conductive layer, the transparent conductive layer will not be damaged (such as if the properties of the layer change or the layer thinned by overetching) due to the deposition or etching process of any such other layer. Therefore, a more reliable connection with the FPC is achieved. As shown in '413 FIG. 4A, the transparent conductive layer 114 is formed over the second insulating film 113, and the second wiring 403 and the transparent conductive layer are in direct contact through an opening in the second insulating film. This advantage is achieved by the following limitations in claim 1 (with similar limitations in independent claims 7, 17, and 22 and dependent claims 15 and 29):

> wherein the second wiring and the flexible printed circuit are in electrical contact through the transparent conductive layer;
> wherein the second wiring and the transparent conductive layer are in direct contact through an opening in the second insulating film.

C. The Prosecution History of the '413 Patent

42. I was advised that the application which ultimately issued as the 413 patent was October 16, 2008, and 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 '413 patent also claims priority to a foreign patent, Japanese Patent Application No. JP 9-289160, filed on October 6, 1997. *See* Ex. 1001, '413 patent, at 1.

43. I understand the prosecution history of the '413 patent to be part of the intrinsic record of the '413 patent.

D. Claims of the '413 Patent

44. The '413 patent has six independent claims: claims 1, 7, 10, 17, 22, and 24. The following table has been provided to me to as a convenient way (using the numbered column at the far left of the table) to refer to various language contained in claim 1 and other claims:

#	Claim language	Corresponding element nos.
1.1	A ... display device comprising:	7.1, 10.1, 17.1, 22.1, 24.1
1.2	a first wiring over ... substrate	7.2, 10.2, 17.3, 22.3, 24.3
1.3	a first insulating film over the first wiring	7.3, 10.3, 17.4, 22.4, 24.4
1.4	a second wiring over the substrate and the first insulating film	7.4, 10.4, 17.5, 22.5, 24.5
1.5	a second insulating film over the second wiring	7.5, 10.5, 17.6, 22.6, 24.6
1.6	a transparent conductive layer over a first region of the second wiring;	7.6, 10.6, 17.7, 22.7, 24.7
1.7	a flexible printed circuit over the first wiring and the first region of the second wiring;	7.7, 10.7, 17.8, 22.8, 24.8
1.8	a sealant over the first wiring and a second region of the second wiring,	7.8, 10.8, 17.9, 22.9, 24.9

#	Claim language	Corresponding element nos.
1.9	wherein the sealant is in direct contact with the second insulating film;	7.9, 10.9, 17.11, 22.11, 24.11
1.10	wherein the second wiring overlaps ... the first wiring;	7.10, 10.10, 17.12, 22.12, 24.12
1.11	wherein the first wiring and the second wiring are in electrical contact through an opening in the first insulating film;	7.11, 10.11, 17.13, 22.13, 24.13
1.12	wherein the second wiring and the flexible printed circuit are in electrical contact through the transparent conductive layer;	7.12, 10.12, 17.14, 22.15, 24.15
1.13	wherein the second wiring and the transparent conductive layer are in direct contact through an opening in the second insulating film.	7.13, 17.16, 22.16

1. "First Wiring" and "Second Wiring"

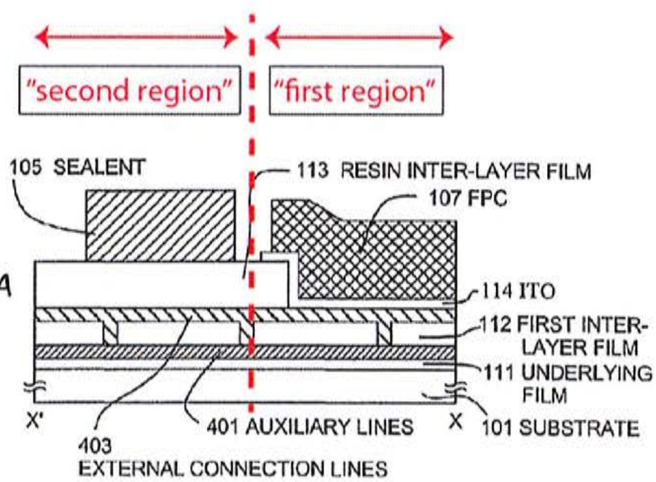
45. FIG. 4A of the '413 patent shows a first wiring 401 over a substrate 101, a first insulating film 112 over the first wiring 401, and a second wiring 403 over both the substrate 101 and the first insulating film 112. These first and second wirings are connected electrically because of contact holes or openings (not numbered) extending vertically through the first insulating film 112. This arrangement of first and second interconnected wirings reduces electrical resistance. Ex. 1001, col. 8, ll. 45-50.

2. "First Region" and "Second Region"

46. The second wiring is specified to have two regions that claim 1 calls "first" and "second" regions. I prepared an annotated version of FIG. 4A of the '413

patent (reproduced below with annotations) showing the claimed "first region" and "second region." A person of ordinary skill in the art would understand from claim element 1.8 that the second wiring extends under the sealant, and FIG. 4A shows one embodiment where it extends fully across the sealant region. The sealant could not reside over the second region of the second wiring, as the claim element recites, unless the second wiring is beneath the sealant. The sealant must also overlap the first wiring, as required by, *e.g.,* claim element 1.10.

FIG. 4A



47. It is clear that in the '413 patent, the transparent conductive layer 114 is formed after the second insulating film 113, as one horizontal portion of layer 114 lies on top of the upper surface of film 113. It is technically important that this portion of film 114 does not extend to the second region, *i.e.,* is separated from the sealant. This permits the sealant to make direct contact with film 113, and no part of the indium tin oxide ("ITO") film 114 extends beneath the sealant.

48. The '413 patent provides a structure where the sealant 105 and the transparent conductive layer 114 do not overlap each other, and the sealant is in direct contact with the second insulating film 113. Also, it provides a composite arrangement of a second wiring 403 overlying a first insulating film 112 overlying a first wiring 401 which both (i) extends beneath the transparent conductive layer 114 at the bottom of an opening (unnumbered) in the second insulating film 113 in a first region, and (ii) extends beneath the second insulating film 114 and the sealant 105.

49. 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 '413 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 standard practice for one of ordinary skill in the art 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.

50. One of ordinary skill in the art would understand a required positional relationship between the sealant and the transparent conductive layer from the other features recited in the original claims. Claim element 1.6 requires that the transparent conductive layer is over a first region of the second wiring. Claim element 1.8 requires that the sealant is over a second region of the second wiring. Claim element 1.9 requires that the sealant is in direct contact with the second insulating film. Therefore, these three claim elements clearly tell one of ordinary skill in the art that the sealant does not overlap the transparent conductive layer.

51. A structure where the sealant does not overlap the transparent conductive layer is shown in FIG. 4A of the '413 patent wherein the sealant (105) does not overlap the transparent conductive layer (114). This structure is advantageous to improve the reliability of an electronic apparatus by providing for the sealant (105) to have favorable adhesion to the second insulating film. This is accomplished in the '413 patent by having the sealant (105) and transparent conductive layer (114)

not overlap each other and by having the sealant (105) in direct contact with the second insulating film (113), as in FIG. 4A. One of ordinary skill in the art would have understood in 1997 that, in general, a sealant has poor adhesion to a transparent conductive layer made of ITO.

3. "Contact Through An Opening In An Insulating Film"

52. Two of the elements of claim 1 (and other claims) refer to "contact through an opening in (an) insulating film." *See* claim elements 1.11 ("electrical contact through an opening in the first insulating film") and 1.13 ("direct contact through an opening in the second insulating film.") Similar recitals appear in claims 7, 10, 17, 22, and 24. This phrase of "contact through an opening in (an) insulating film" is used routinely in the LCD art and has a very clear meaning that is reflected in FIG. 4A of the '413 patent and the patent specification.

53. As can be seen in FIG. 4A of the '413 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." All of the claims in the '413 patent require such an opening through the first insulating film to allow contact between these first and second wirings. *Id.* at col. 8, ll. 46-50 and FIG. 4A. This form of connection is routine in the microelectronics fabrication art to connect one layer or structure that is located

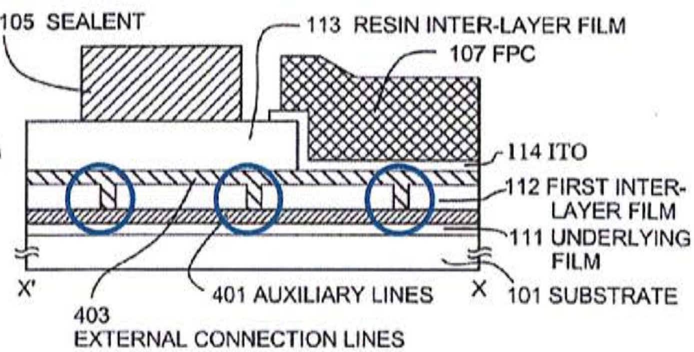
above an insulating film to another layer or structure that is located below the insulating film. To permit such contact to occur, the fabrication process establishes holes in the insulation film before the upper layer or structure is added. Then, when the upper layer or structure is added, often by 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."

54. 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, and had that meaning in 1997. It still has that meaning today. Often, these openings have been called "contact holes."

55. This phrase is used in precisely that way in the '413 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

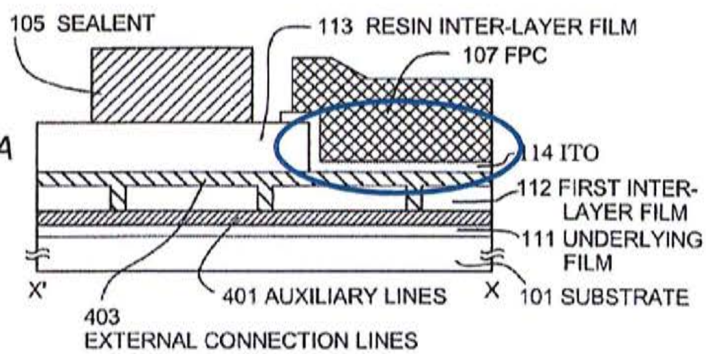


56. One reason for, and result of, electrically connecting the auxiliary lines 401 to the external connection lines 403 is to lower electrical resistance. As explained in the '413 patent specification, even when the second wiring is made from a metal, the wiring faces a problem of high line resistance, 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. *Id.* at col. 8, l. 61 - col. 9, l.

11. The above configuration in the patent reduces this electrical resistance. *Id.* at col. 8, ll. 42-50 and FIG. 4A).

57. 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



58. 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 '413 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. 1003, 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. 2022, 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 '413 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. 2024, 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 '413 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."

59. 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 '413 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.

60. 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 '413 claims. In connection with that, I have examined the

Declaration of Miltiadis Hatalis, PhD (Ex. 1005), and I note that at ¶ 28, he states, "Instead, the claim terms are used in their ordinary and customary sense as one skilled in the relevant field would understand them." Ex. 1005, ¶ 28. I agree to that extent. However, Dr. Hatalis then uses two <u>different</u> meaning for the phrase.

61. First, in ¶ 113, Dr. Hatalis applies claim element 1.11 ("...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.

62. However, Dr. Hatalis uses a completely different meaning in ¶ 122 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 he applied it with respect to the Sukegawa reference, and I believe that his understanding implicit in ¶ 122 is technically incorrect and contrary to how one of ordinary skill in the LCD art in 1997 (and today) would understand the phrase.

63. The interpretation applied by Dr. Hatalis in ¶ 122 is unreasonably broad. While Dr. Hatalis does not expressly state in his declaration that "contact (of two

layers) through an opening in an 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 ¶ 122. However, in my opinion, one of ordinary skill in the art who sees this phrase in the claims of the '413 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.

64. 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 '413 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.

65. Specifically, in Sukegawa (Ex. 1003) Figure 1B and 2C, ITO layer 8 lies on top of (and directly contacts) metal wiring 7 over the broad area where these two layers are coextensive. An insulating film 9 has been established subsequently on the top surface of ITO layer 8, and an opening has been established in film 9 above the already-contacting layers 7 and 8. No one of ordinary skill in the art in 1997 would understand that layers 7 and 8 are in contact "through" the opening in insulating film 9. They would understand that the contact resides "under" the opening, and elsewhere. From reading the '413 patent, they would conclude that Sukegawa does *not* disclose layer 8 contacting wiring 7 through the opening in insulating film 9. They would reject the hypothesis that layer 8 contacts wiring 7 "through" the opening in film 14, and they would regard it as extremely unreasonable and reject it out of hand.

66. 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.

67. In the field of integrated circuit (and LCD) fabrication, "contact through an opening in an insulator" is an idiomatic phrase which has the single meaning that

corresponds to the meaning which the Board adopted as the first part of the claim construction.

68. I have studied Sukegawa (Ex. 1003) extensively, and it is clear to me that layers 7 and 8 do not have contact with one another through any contact opening in layer 9. No person of ordinary skill in the art of microelectronics or LCD fabrication in 1997 (or at present) would reasonably understand such contact to occur through the opening 14, in my opinion.

69. I disagree with Dr. Hatalis that in Sukegawa, layers 7 and 8 are in contact through an opening in insulating film 9. The only way to read the claim as to the relative arrangement of structures making contact corresponds to FIG. 4A of the '413 patent. Dr. Hatalis addressed the question of the relative sequence of layers during his deposition and conceded that virtually all of the layers are in a specified relationship. Ex. 2011, Hatalis Dep., at pp. 46-60. He testified, however, that as to claim element 1.13, the claim language did not imply the relative location of the three structures mentioned there: the transparent conductive layer, the second wiring, and the second insulating film. But this position is impossible, in light of the whole claim.

70. I recognize only six different ways to stack three layers. If the layers were called A, B, and C, the six possible combinations would be: ABC, ACB, BAC, BCA, CAB, and CBA.

71. My examination of the various provisions of claim 1 compels the conclusion that the transparent conductive layer must be formed after the second insulating film (which overlies the second wiring), and an opening in the second insulating film allows the transparent conductive layer to pass through the opening in the second insulating film to contact the second wiring, as illustrated in '413 FIG. 4A. This analysis applies to all of the claims which call for the second wiring (or language calling for the upper wiring) to be in direct contact with the transparent conductive layer through an opening in the second insulating film.

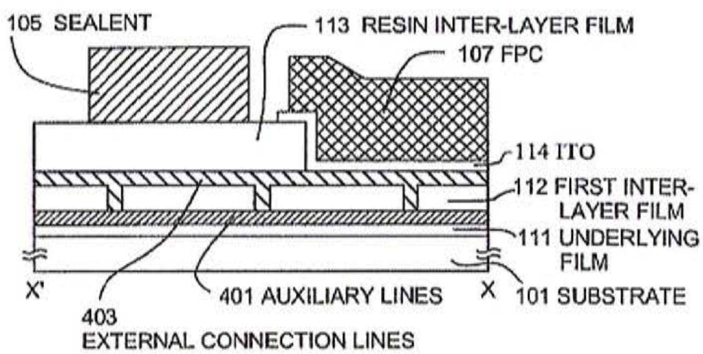
72. Claim element 1.5 requires that the second insulating film must be located over the second wiring. (The claim language at 1.5 states: "a second insulating film over the second wiring.") Also, claim element 1.6 specifies that the transparent conductive layer is located over (a first region of) the second wiring. (The claim language at 1.6 states: "a transparent conductive layer over a first region of the second wiring.") Either of these two claim elements clearly tells the one of ordinary skill in the art that the second wiring *cannot* be the top structure.

73. Since *both* the second insulating film and the transparent conductive layer must be located above the second wiring, this means that the second wiring must be the bottommost of these three structures and of the three, must be the one that is formed before the other two. Hence the last one of these three layers is necessarily (but tentatively) either transparent conductive layer or the second insulating film.

74. The claim language provides further information that resolves this question for one of ordinary skill in the art in 1997 (and today). Claim element 1.13 requires that the second wiring must directly contact the transparent conductive layer through an opening in the second insulating film. (The claim language at 1.13 states: "wherein the second wiring and the transparent conductive layer are in direct contact through an opening in the second insulating film.") The person of ordinary skill in the art would understand from this language that the second insulating film must be the second one of the three layers to be formed and that an opening in the second insulating film permits the contact to occur. With the second insulating film as the second-formed layer (of these three), the last layer of the three to be formed must be either the transparent conductive layer or the second wiring. Since the second wiring cannot be the last-formed layer due to claim elements 1.5 or 1.6, as explained above, this means that the last-formed layer of the three *must* be the transparent conductive layer, formed on top of the second insulating film. The second wiring must be located beneath the second insulating film. This all follows from the claim language as one of ordinary skill in the art would have understood it in 1997 (and today). Accordingly, the claim language tells the person of skill in the art in 1997 that before the transparent conductive layer is formed, the second insulating film is formed and an opening is formed in

that film. Further, before these are formed, the second wiring is formed. This sequence is clear from the language of claim 1.

75. I find that this corresponds to the structure shown at the middle portion of FIG. 4A (reproduced below): a horizontal portion of the transparent conductive layer 114 lies on top of the second insulating film 113 (indicating that it was formed after film 113), and the second wiring 403 lies immediately beneath film 113.



76. Additionally, claim element 1.13 calls for direct contact of the transparent conductive layer with the second wiring through an opening in the second insulating film. One of ordinary skill in the art would understand that this means that the opening in the second insulating film allows the transparent conductive layer to extend through that opening and make contact with the second wiring.

77. In fact, this corresponds to the structure shown at the right portion of '413 FIG. 4A which shows an opening in second insulating film 113 over which the transparent conductive layer has been added so that a horizontal portion of it is

located on the underlying second insulating film 113, a vertical portion of it is shown along the edge of the opening in insulating film 113, and the major horizontal portion of it is located at the bottom of the opening in the insulating film 113. At the bottom of that opening, the transparent conductive film 114 makes direct contact with the upper surface of the second wiring 403.

78. Claim element 1.9 requires the sealant to be "in direct contact" with the second insulating film. This necessarily means that although the transparent conductive layer is the last one of the three structures that is formed, it cannot cover the whole (if any) upper surface of the second insulating film but must be confined in location so that the sealant makes direct contact with the second insulating film. An illustration of this is shown in the left portion of '413 Fig 4A, where sealant 105 lies directly on top of the exposed portion of second insulating film 113.

79. Additionally, I note that "through" is used also in claim element 1.12, which specifies that "the second wiring and the flexible printed circuit are in electrical contact through the transparent conductive layer." The usage of "through" in this claim language also means that the electrical contact is made between the second wiring and the flexible printed circuit *by virtue of* and *because of* the transparent conductive layer. This usage is fully consistent with the meaning I explained above for contact through an opening (in an insulating film). In all cases, the

contact occurs *by virtue of* the opening or the layer, or *because of* the opening or wiring.

80. Still further, claims 17, 22, and 24 call for items to be "connected … *through* (a wiring)." This further usage of "through" in claim language has the very same meaning to a person ordinarily skilled in the art – namely, that the connection occurs *by virtue of* and *because of* the wiring specified in the claim.

81. For these reasons, one of ordinary skill in the art as of 1997 would not accept that "contact through an opening [in an insulating film]" could mean merely "contact which occurs between the vertical limits of the opening" in the abstract. The contact must occur by virtue of and because of the opening.

IV. THE PRIOR ART

82. I have been asked to consider the patentability of the claims over Sukegawa (Ex. 1003) in light of Nakamoto (Ex. 1004). I understand that the relevant portion of the Petition (that is, the second combination) relies principally on Sukegawa FIG. 2C and not the subsequent figures in Sukegawa other than infrequent references to FIGS. 3C and 3D. *See* Ex. 1005, Hatalis, Decl., at ¶¶ 35, 37, 45, and 48.

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

83. Sukegawa addresses a corrosion problem in the terminal portion of an LCD where a tape carrier package connects to one of the two opposing LCD substrates.

In that terminal portion, the prior art had already included an upper layer metal wiring 7 (of chromium or the like; *see* Ex. 1003, Sukegawa, at col. 3, l. 16) that overlies a lower layer metal wiring 2 (also chromium or the like; *id.* at col. 3, line 11) with an interlayer insulating film 3 (typically silicon oxide and silicon nitride; *id.* at col. 3, lines 12-13) between them. The lower layer metal wiring 2 and upper layer metal wiring 7 contact one another because of contact holes 6 in insulator 3. That is, contact holes 6 lie over upper surface portions of wiring 2. When the metal to form wiring 7 is added, parts of that metal (7) extend <u>through</u> the openings 6 to establish direct contact between layers 7 and 2. This is the normal usage of "contact through an opening in an insulation layer." Sukegawa uses the equivalent phrase, "connected … by way of ... contact holes." Ex. 1003, Sukegawa, at col. 4, ll. 60-61.

84. Sukegawa also shows a layer 8 of transparent conductive film (indium tin oxide – ITO) that covers an upper layer metal wiring 7 in the terminal portion 100. Dr. Hatalis explained that the purpose of the ITO layer 8 is to protect against corrosion (not to lower resistance). Ex. 2011, Hatalis Dep., at p. 123, ll. 4-10. The ITO layer 8 protects the metal wiring 7 during assembly of the FPC and for testing before installing silicone resin 13 to plug the gap left open for probe testing.

85. Above the ITO layer 8, Sukegawa provides a protective insulating film 9 made of silicon nitride. Ex. 1003, Sukegawa, at col. 3, ll. 19-20. An opening in

protective insulating film 9 is represented in the plan view FIG. 1A and is shown in sectional view in Ex. 1003, Sukegawa, at FIGS. 1B, 2A, 2B, and 2C.

86. In Sukegawa, a tape carrier package 300 having a flexible wiring substrate 31 becomes connected to the terminal portion of 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 intentionally not completely covered by the tape carrier package 300 having a flexible wiring substrate 31, as FIGS. 2A, 2B, 2C and several subsequent figures depict.

87. Sukegawa addresses the problem that a pinhole defect in transparent conductive film 8 could develop because ITO is chemically stable, but generally is not applied in thick layers; also ITO is not very moisture-resistant. *Id.* at col. 3, ll. 36-42. If a pinhole develops in layer 8 to expose wiring 7 beneath the pinhole before a silicone resin 13 is applied (see FIG. 2C) after the probe test, then corrosion 12 could result in not only wiring 7 but also the underlying wiring 2. FIG. 2B depicts such corrosion 12 from such a pinhole 11. Sukegawa's solution was to remove the upper layer metal wiring 7 at the probe test region 14 (labeled in FIG. 3E) so that even if a pinhole develops in the ITO layer 8 or moisture penetrates it where it traverses region 14, no corrosion would result because only insulating film 3 would be exposed by the pinhole or to the moisture. Further,

Sukegawa protected the upper layer metal wiring 7 by double coverage with the transparent conductive film 8 and either the protective insulating film 9 or the anisotropic conductive film 10, because the protective function of the transparent conductive film 8 to the upper layer metal wiring 7 is not very effective. *Id.* at col. 3, ll. 36-42. Sukegawa suggests that the transparent conductive film 8 cannot be made thick in order to ensure transparency, thereby allowing pinholes to be formed in the film. These pinholes will allow corrosion to occur on the upper layer metal wiring 7, which is formed under the transparent conductive film 8. *Id.* at col. 1, ll. 39-49. In order to resolve this defect, Sukegawa teaches forming the protective insulating film 9 or the anisotropic conductive film 10 over the transparent conductive film 8. *Id.* at col. 3, ll. 37-53 and col. 6, ll. 9-20. Ex. 2023, Hatalis Dep., at p. 104, l. 14 – p. 105, l. 2. With this double coverage structure, the metal wiring 7 will not be exposed to the external air and will be protected against corrosion, even when the pinholes are formed in the transparent conductive film 8. Ex. 1003, Sukegawa, col. 6, ll. 22-26. The transparent conductive film 8 is formed after upper layer metal wiring 7 is formed and protects the wiring 7 during assembly of the FPC and for testing before installing silicone resin 13 to plug the gap left open for probe testing. *See id.* at col. 2, ll. 13-28; FIG. 3E. That is, in Sukegawa, transparent conductive film 8 needs to be formed over the upper layer metal wiring 7 and under the protective insulating film 9, thereby ensuring sufficient protection against corrosion (oxidation) on the upper layer metal wiring 7.

88. Sukegawa also addresses a "peeling off" problem during a potential repair operation of the terminal portion of the LCD. The same solution already described for the pinhole problem also has the advantage that a restored electrical connection can be more easily established if the upper conductors in the terminal portion "peel off" during a repair procedure, as discussed further below. Ex. 1003, Sukegawa, at col. 6, l. 39-col. 7, l. 15.

89. Sukegawa fails to show the location of a sealant between the active matrix substrate 100 and the counter-substrate or color filter substrate 200. Persons of ordinary skill in the LCD fabrication art in 1997 would have understood that a sealant is required and present, though not illustrated, in Sukegawa's LCD structure. They also understood that this sealant is ordinarily near the edge of the counter substrate, but with some offset from the counter substrate edge (as shown Ex. 1004, Nakamoto, at FIGS. 5 and 9).

90. I understand that at his deposition of July 1, 2013, Dr. Hatalis drew on FIG. 2C of Sukegawa to indicate where he thought the ordinarily skilled artisan would locate the sealant and that the resulting drawing was marked as Ex. 2010, which is reproduced below:

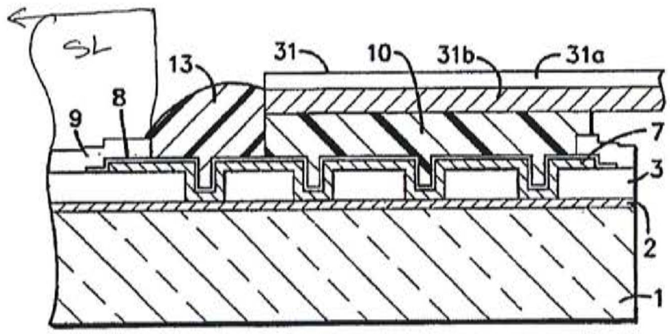


FIG. 2C
PRIOR ART

91. I disagree with that placement for several reasons. First, Sukegawa teaches away from this placement in FIG. 2C. 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. To the extent that there is any teaching at all about the position of the sealant, one of ordinary skill in the art could only identify it as somewhere near the left boundary of FIG. 3D, offset leftward from the edge of the counter substrate (*e.g.*, Ex. 1004, Nakamoto, at FIGS. 5 and 9). This region would be beyond the left edge of the illustration in FIG. 2C of Sukegawa, which, in my opinion, is why the sealant is not illustrated in any of the terminal portion figures.

92. Second, I disagree with Dr. Hatalis' sealant placement in FIG. 2C, because this would overlie the region where all three conductive layers (*i.e.*, 2, 7, and 8) extend from each terminal, which has a substantial height difference relative to the non-terminal portions under the sealant (*e.g.*, adjacent to the terminal portion), and a much larger height difference than when only one conductor (*i.e.*, 2) extends under the sealant as explicitly disclosed in Sukegawa. One of ordinary skill in the art would not place a sealant in Sukegawa FIG. 2C directly next to the 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 '413 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 '413 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 therebetween. **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, '413 Patent, at col. 2, ll. 51-59 (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 overlie only the uniform surface of protective insulating film 9 and not metal wiring 7 or transparent conductive film 8.

93. Third, I disagree with Dr. Hatalis' sealant placement because the counter substrate would then interfere with the checking terminal, making it difficult or impossible to probe the checking terminal. A person of ordinary skill in the art would have understood that the best adhesion was obtained when the sealant was offset from the edge of the counter substrate (*e.g.,* Ex. 1004, Nakamoto, at FIGS. 5 and 9). I have prepared an illustration (below) showing an example of this, based on Dr. Hatalis' annotated FIG. 2C of Sukegawa. Placing a substrate this close to the flexible wiring substrate 31, or even at the edge of the hypothetical sealant, would block the probe from accessing the ITO layer 8 in the opening portion (which is unnumbered in this figure below the silicone resin 13). It would also make the application of the silicone resin 13 after a successful terminal connection check difficult or impossible.

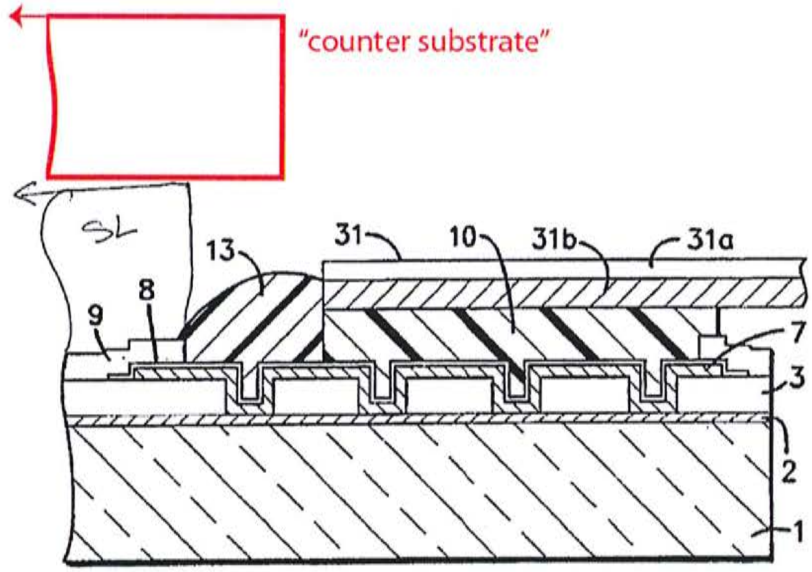


FIG. 2C
PRIOR ART

B. Nakamoto

94. With respect to Nakamoto (Ex. 1004), Dr. Hatalis noted in his deposition that he relies on Nakamoto only for placement of the sealant. Ex. 2011, Hatalis, Dep., at p. 158. He does not rely on Nakamoto to show the first and second regions of the second wiring, as set forth in the claims.

95. Nakamoto discloses an LCD device and shows a sealant marked as "SL" in FIGS. 5 and 9. FIG. 9 shows a gate wiring g1 of metal and an overlying transparent conductive layer d1 extending beneath the sealant SL. Other conductive lines DL, d2, and d3 all extend from the right-hand side of FIG. 9 (from the active matrix area) and terminate beneath the sealant SL as FIG. 9 shows. Dr.

Hatalis agreed. But crucially, Nakamoto does not disclose in any way two stacked conductive lines separated by insulator passing beneath the sealant.

V. THE PATENTABILITY OF THE '413 PATENT

96. Neither Sukegawa nor Nakamoto teaches or suggests extending Sukegawa's composite arrangement of an upper layer metal wiring 7 overlying insulation 3, which in turn overlies lower layer metal wiring 2, so that this composite arrangement extends from the tape carrier connection region to the region beneath the sealant.

97. Also, neither of these references teaches or suggests that the transparent conductive layer (ITO) should be applied after the second insulating film or after Sukegawa's protective insulating film 9.

98. As to whether the ITO 8 should be confined to a region relative to the sealant, Sukegawa is silent, since the location of the sealant is not disclosed. It must be somewhere beyond the left side of the structure shown in Sukegawa FIG. 2C, far to the left of silicone resin 13 (which is not the sealant between the two opposing substrates of an LCD device). Nevertheless, in Sukegawa, it is understood that the ITO film 8 is added on top of upper layer metal wiring 7 before insulating film 9 is deposited because parts of the insulating film 9 overlie and rest upon the upper surface of transparent conductive film 8. *See* Ex. 1003, Sukegawa, at FIG. 2C.

A. Sukegawa and Nakamoto fail to disclose that "First Wiring" and Overlying "Second Wiring" Would Extend to the "Second Region"

99. One question I have been asked to consider is whether one of ordinary skill in the art as of 1997, in light of both Sukegawa and Nakamoto, would have located both first *and second* wirings, the second wiring overlapping the first wiring (separated by first insulating film but electrically connected together), beneath the sealant (*e.g.,* claim elements 1.2-1.4, 1.8, 1.10 and 1.11).

100. As to this question, Sukegawa FIG. 2C discloses a second wiring 7 overlying a first wiring 2 but it is only *in a terminal region* of an LCD. Dr. Hatalis reasoned that extending Sukegawa's first and second wirings to under the sealant would have created a more reliable connection and provided a reduced resistance as compared to extending just one wiring layer.

101. In my opinion, one of ordinary skill in the art, at the time of the invention, would not have modified Sukegawa to achieve the claimed structure, for several reasons. First, the terminal region of an LCD is where unusual stresses occur due to connection because of a flexible printed circuit (FPC). It is in that particular region that a fortified structure is advantageous, which cannot be tolerated in the LCD as a whole. A person of ordinary skill in the art would *not* have thought to extend the wiring arrangement from there to beneath the sealant because the

mechanical and environmental stresses do not call for it, and putting a double (actually, a triple layer when counting the first insulating film) layer under the sealant introduces or worsens the problem of thickness variations.

102. Second, as for the advantage of lowering resistance, it is true that resistance would be lowered. However, Sukegawa chose <u>not</u> to make such an extension and instead terminated the two-wiring arrangement in the terminal region so the two wiring arrangement does not reach the sealant but instead is confined to the area outside the sealant-enclosed area, leaving only lower layer metal wiring 2 to extend beneath the sealant. In my opinion, the question of lowering resistance would not have led one of ordinary skill in the art in 1997 to make this extension.

103. Third, if the two-wiring arrangement of Sukegawa were to be extended so that the second wiring extends to beneath an area appropriate for the sealant location, the transparent conductive layer 8 of ITO would be extended at the same time. The explicit disclosure of Sukegawa is always that the ITO 8 extends beyond and terminates the upper layer metal wiring 7 on all sides (*e.g.*, Ex. 1003, at FIGS. 1, 2, 3A, 3B, 3E, 4, and 5). This hypothetical modification would still not satisfy claim 1 or other claims of the '413 patent because the claim language implies clearly that the transparent conductive layer is formed *after* the second insulating film is formed. However, in Sukegawa, the opposite sequence and structure are used. Specifically, Sukegawa's insulating film 9 is formed on top of the ITO layer

8 (the transparent conductive layer). Consequently, this hypothetical arrangement would have to be modified even further to locate the ITO layer 8 above the insulating film 9.

104. Fourth, extending the upper layer metal wiring 7 along with the underlying insulating film 3 over lower layer metal wiring 2 to beneath the sealant would create unevenness in the interval (*i.e.,* gap) between the two substrates, leading to the problems described in the '413 patent (*see* Ex. 1002, '413 patent, at col. 2, ll. 51-59), and discussed previously. A person of ordinary skill in the art would have known this causes "distortion of the counter substrate" and "unevenness in the color and brightness" clearly observable by a viewer, and would have strong motivation to avoid it. *Id.* at col. 2, ll. 59-61.

105. The "second region" is an essential feature of the claimed "second wiring." The "first region" of the second wiring (the upper wiring) is mentioned in claim element 1.6. Claim elements 1.8, 7.8, 10.8, 17.9, 22.9, and 24.9 contain recitals about the second region ("a sealant over…a second region of the second wiring"). The Petition relies on Sukegawa to show the claimed "first region" (*e.g.,* Petition, at p. 37, element 1.6).

106. Because the first wiring and the second wiring are required to be in electrical contact and to extend under the sealant, the electrical resistance of wiring for transmitting signals between the flexible printed circuit and the other circuit can be

reduced ("a sealant over the first wiring and a second region of the second wiring" and "wherein the first wiring and the second wiring are in electrical contact through an opening in the first insulating film"). Because of the way these two wirings are electrically connected, they are overlapped with each other, and it is a fundamental property of circuits that the resistance must be lower than either one individually. This arrangement would allow a more narrow wiring from the terminal portion to the display portion as seen from the plan-view, as compared to a single wiring with the equivalent resistance, and this would enable a closer packing of the terminals. The '413 patent explains another reason to minimize line resistance: "A high line resistance causes delay and deterioration of the propagation of high frequency signals such as clock and video signals to disallow preferable display." Ex. 1001, '413 patent, at col. 9, ll. 2-5.

107. I have been asked to consider whether the claimed "second region" (over which the sealant must be located according to claim element 1.8) is disclosed or suggested in Sukegawa FIGS. 2C and 3D, and the Petition claiming that the color filter substrate 200 is "fitted just outside the flexible wiring circuit 31," along with Nakamoto. Petition, at 37-39. Even if Sukegawa discloses a lower layer metal wiring 2 as "first wiring" that extends under a sealant, Sukegawa's upper layer metal wiring 7, corresponding allegedly to the "second wiring" of the '413 claims, is confined to the terminal region and does not extend to beneath the sealant. These

references do not show, teach, suggest, or motivate one of ordinary skill in the art to modify Sukegawa to extend the composite stacked structure of wiring 2, insulator 3, and overlying wiring 7 in that relationship from the terminal region to the region beneath the sealant.

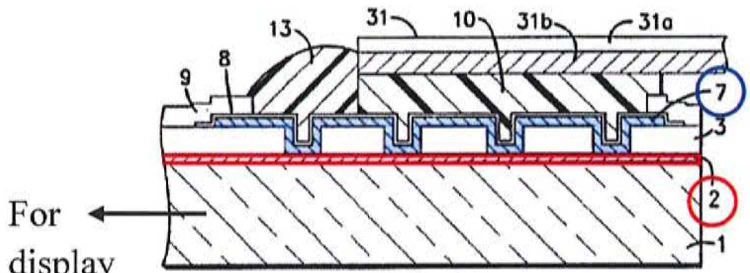


FIG. 2C
PRIOR ART

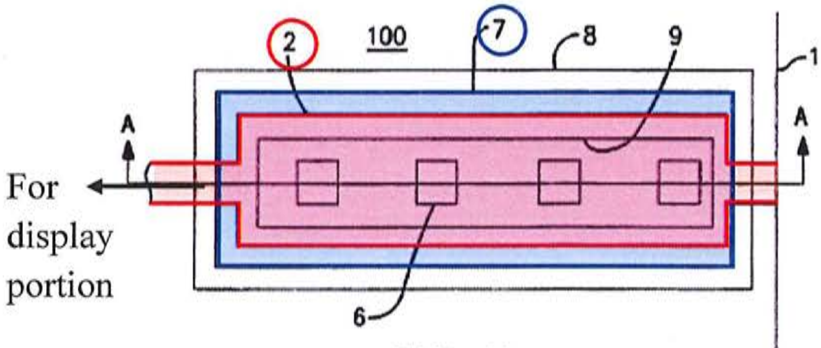


FIG. 1A
PRIOR ART

108. As shown in Sukegawa FIG. 2C (reproduced above with annotations) and FIG. 1A (reproduced above with annotations), which is a top view representation of FIG. 2C, the upper layer metal wiring 7 (blue region) is formed only at the terminal portion in an island-shape as opposed to the lower layer metal wiring 2 (red region) which extends to the display portion. This structure shows that the

upper layer metal wiring 7 is formed to transmit signals from the FPC (flexible wiring substrate 31) to the lower layer metal wiring 2 because of the anisotropic conductive film 10, transparent conductive film 8, and then upper layer metal wiring 7. On the other hand, the lower layer metal wiring 2 extends away from the terminal portion to the display portion, so that the lower layer metal wiring 2 transmits signals to the display portion. The upper layer metal wiring 7 in all the plan views of the terminal region in Sukegawa that include that element (*i.e.,* FIGS. 1A, 3A, and 4A) are shown to be rectangular in shape, merely extending slightly under the opening in the insulator 9, without the thin strips extending left and right that are present in the lower layer metal wiring 2. This clearly shows to a person of ordinary skill in the art that the disclosure of Sukegawa is that the upper layer metal wiring 7 is intended to be located within only the terminal region, for the purposes of the terminal connection.

1. Sukegawa and Nakamoto Do Not Suggest Extending The Second Wiring Under the Sealant

109. On the question of whether it would have been obvious to extend the second wiring from its position in the terminal region so that it also extends beneath the sealant, I have been asked to consider Dr. Hatalis' Declaration (Ex. 1005) at ¶¶ 98-101, and 144. Dr. Hatalis' statements are incorrect.

110. In Ex. 1005, Hatalis Decl., at ¶ 98, Dr. Hatalis simply recites the language of claim element 1.8 (and parallel provisions in other claims).

111. In ¶ 99, Dr. Hatalis makes several assertions. He cites Sukegawa as explaining that a multilayer wiring structure for providing an external connection, including first and second wiring over a substrate, provides lower resistance as well as a more secure connection. He states that "lower resistance" can be achieved with the "multilayer wiring structure" comprising lower layer metal wiring 2 and upper layer metal wiring 7. *Id.* He also states that Sukegawa also places the color filter substrate "just outside of the connection to the flexible wiring circuit" and cites Sukegawa FIG. 3D. I will address these in order.

112. The upper layer metal wiring 7 is formed to transmit signals from the flexible wiring substrate 31 to the lower layer metal wiring 2 in a vertical direction, which does not have a purpose to lower the wiring resistance between the flexible wiring substrate 31 and display portion. To a person of ordinary skill in the art, there is an important distinction between the resistance of the external connection to the terminal region (*i.e.,* from the FPC 31 to the lower layer metal wiring 2 directly below) as opposed to the resistance along the wiring from the terminal region into the display region. This distinction enables one of ordinary skill in the art to employ structures in the former, which would have a different, and sometimes opposite, effect in the latter. For example, in Sukegawa the terminal region includes both a lower layer metal wiring 2 and an upper layer metal wiring 7 (among other layers), even though this pair presents a higher resistance from the

FPC 31 to the lower layer metal wiring 2 than if only the lower layer metal wiring 2 were directly and fully available for contact to the FPC 31. In simple terms, the resistances are in series, and adding any non-zero resistance must increase the total. Notwithstanding, this multi-conductor structure in Sukegawa is useful in the terminal region because it increases the reliability of the connection. Ex. 1003, Sukegawa, col. 2, ll. 21-24. However, as the '413 patent discloses, when this pair of wirings is extended from the terminal region into the display region, the resistance between these two regions is reduced as compared to just having one wiring. In simple terms, the resistances are in parallel, and adding any non-zero resistance must decrease the total.

113. In any event, to the extent that lowering the electrical resistance may be disclosed in Sukegawa, this would merely be a reduction in electrical resistance with a structure in which upper layer metal wiring 7 is formed between the transparent conductive film 8 and lower layer metal wiring 2. Ex. 1003, Sukegawa, col. 7, ll. 16-21. It does not suggest any extension of upper layer metal wiring 7 from the terminal region to under the sealant. The function of Sukegawa's upper layer metal wiring 7 is merely to transmit signals from flexible wiring substrate 31 to the lower layer metal wiring 2 that is located vertically below wiring 7.

114. If one of ordinary skill in the art wanted to reduce wiring resistance from the terminal portion to the display portion, other options are available rather than

forming the upper layer metal wiring 7 and lower layer metal wiring 2 in parallel to the display portion. A person of ordinary skill in the art would consider widening the width of the lower layer metal wiring 2 to lower the resistance rather than extending the upper layer metal wiring 7 to the display portion, because the upper layer metal wiring 7 is disclosed as a wiring that could easily corrode. The upper layer metal wiring 7 is disclosed as easily corroding because it is one of the upper layers in the terminal region, where it is more exposed to humidity and oxygen, which tend to degrade the metal. The lower layer metal wiring 2 is not so exposed, either in the terminal or display regions, because it is a lower layer. Therefore, the standard technique, well-known to one of ordinary skill in the art, to lower the resistance from the terminal region to the display region for a connection as disclosed in Sukegawa is to widen the lower layer metal wiring 2. Notice in all the plan view figures in Sukegawa (*i.e.,* FIGS. 1A, 3A, 4A, and 5A) that the lower layer metal wiring 2 extending from the terminal region to the display region is illustrated as having a much narrower width than the terminal region. This is typical.

115. Addressing the "more secure connection" language, Dr. Hatalis states in Ex. 1005, Hatalis Decl., at ¶ 99, that a multilayer wiring structure in Sukegawa provides a more secure connection, referring to Sukegawa col. 6, ll. 9-20. Although ¶ 99 refers to first and second wirings over a substrate, this Sukegawa

passage cited in ¶ 99 is directed to a different multilayer structure than what Dr. Hatalis claims. In this passage, Sukegawa is not discussing a more secure connection by virtue of providing first and second wirings. Instead, the passage of Sukegawa cited by Dr. Hatalis indicates that a secure connection can be realized when upper layer metal wiring 7 is covered by transparent conductive film 8 and protection film 9, or when upper layer metal wiring 7 is covered by transparent conductive film 8 and anisotropic conductive film 10. This structure seeks to prevent corrosion of upper layer metal wiring 7. This is possible and preferred in the "first region" because these layers 8 and 9 act as barrier layers, preventing environmental damage on the vulnerable upper layer metal wiring 7 from moisture and oxygen at the terminal. A person of ordinary skill in the art would understand that this corrosion prevention is already accomplished for the lower layer metal wiring 2 in the "second region" because it is always covered by at least two insulators (*e.g.*, 3 and 9), and, therefore, there is no need for a "more secure connection."

116. For at least these reasons, Dr. Hatalis' "resistance" and "more secure connection" arguments in Ex. 1005, ¶ 99 do not provide a basis to conclude that one of ordinary skill in the art in 1997 would have extended the upper layer metal wiring 7 of Sukegawa to reach beneath the sealant region.

117. In Ex. 1005, Hatalis Decl., at ¶ 99, Dr. Hatalis added an arrow to Sukegawa FIG. 3D (reproduced below) to point to the gap between the tape carrier package 300 and the color filter substrate 200, as follows:

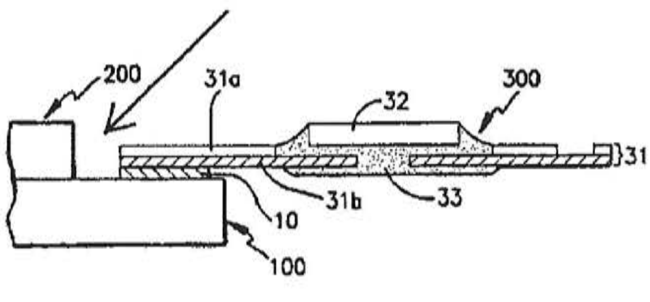


FIG. 3D

118. At ¶ 99, Dr. Hatalis also states that the color filter substrate 200 is sealed with the active-matrix substrate 100. While the color filter substrate is sealed somewhere at the left side of FIG. 3D, the assertion that the color filter substrate is "fitted just outside of the connection to the flexible wiring circuit" invites a serious misunderstanding. In fact, the gap which Dr. Hatalis' arrow (above) points to is orders of magnitude larger than the dimensions being discussed. An ordinarily skilled artisan would know that around 1997 this gap would be on the order of at least a millimeter, while the thicknesses of the anisotropic conducting film 10 and the insulating film 31a are one or more orders of magnitude smaller (*i.e.,* typically tens of microns at most). Extending the wirings 2 and 7 from beneath the tape carrier package 300 all the way to the left in FIG. 3 to the sealant (not shown)

would have not have been a routine matter for one of ordinary skill in the art in 1997.

119. If the sealant were to be placed immediately next to the silicone resin 13 as Dr. Hatalis drew it on Ex. 2010, there would be (a) a risk in not being able to perform a checking test with a probe since the counter substrate would extend toward the checking terminal area, and (b) a risk that the exposed terminal portion where the test probe contacts the transparent conductive film 8 would not be properly covered with silicone resin 13.

120. Because it is commonly known that a sealant is formed *inward* of the counter substrate edges, if a counter substrate is formed in the structure drawn in Ex. 2010 by Dr. Hatalis, the edge of the counter substrate will necessarily invade the area where the check probe is applied, *i.e.,* the region below silicone resin 13 (before it is added). That is, the edge of the counter substrate will cover the checking terminal. Sukegawa's checking terminal is applied with a measuring probe to check whether the tape-carrier package and the terminal portion are connected electrically as desired. Ex. 1003, Sukegawa, at col. 3, ll. 27- 36 and col. 6, ll. 26-38. Thus, if the sealant were formed immediately next to the silicone resin 13, the counter substrate formed over the sealant will prevent the probe from reaching the checking terminal. Therefore, Dr. Hatalis' hypothetical structure in Ex. 2010 is unworkable, and a person of ordinary skill would reject it.

121. Moreover, spacers affect the uniformity of the gap between the substrates, and the spacers are commonly included in the sealant even at the time of the invention of the '413 patent. The presence of such spacers 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. 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, '413 patent, at col. 2, ll. 56-59. Accordingly, one of ordinary skill in the art would not form the sealant over the upper layer metal wiring 7 and transparent conductive film 8, but rather one of skill would form the sealant farther away from the terminal so that the sealant would overly only the uniform surface of protective insulating film 9.

122. In Ex. 1005, Hatalis Decl., at ¶ 100 (first sentence), Dr. Hatalis notes that Nakamoto shows an LCD with wirings extending to an external tape carrier package and wirings extending under sealant SL. However, his next sentence is quite misleading when it refers to GTM as first wiring and DTM as second wiring. These are *orthogonal* wirings, on different sides of the substrate. Indeed, Dr. Hatalis' mark up of Nakamoto FIG. 5 in ¶ 100 shows that the GTM lines extend horizontally across a vertical section of the sealant SL, while the DTM lines extend vertically across a horizontal section of the sealant SL. These do not form a

composite stack of first and second electrically connected wirings, separated by a first insulating film, with the second wiring overlying that first insulating film, so that both of them extend beneath the same sealant location. *See, e.g.*, Ex. 1001, '413 patent, claim 1, elements 1.3, 1.4, 1.8, and 1.10 ("overlaps"). The supposed first and second wirings of Nakamoto are remote from one another, and they are not "in electrical contact [with each other] through an opening in the first insulating film" as claim element 1.11 (and many others) require. I understand that these two lines should *not* be connected directly together because the TFT would not operate. Nakamoto's second wiring does *not* overlap the first wiring beneath the sealant, and therefore is not "second wiring" as required by the '413 claims.

123. Ex. 1005, Hatalis Decl., at ¶ 100, includes a copy of Nakamoto FIG. 9. However, that figure also fails to show that sealant SL lies over a composite two-level wiring arrangement with an insulator in-between as claimed in the '413 patent and discussed above. Nakamoto only discloses that a terminal portion consists of silicon oxide SIO formed on the substrate SUB 1, conductive film g1 formed on the SIO, ITO d1 formed on the conductive film g1, and protective film PSV1 formed over the ITO d1. *See, e.g.*, Ex. 1004, Nakamoto, at FIG. 9.

124. In ¶ 101 of Ex. 1005, Dr. Hatalis asserts that Nakamoto shows the placement of an LCD sealant "near close" to the connection to the tape carrier package, the placement of the sealant over first and second wirings extending outside the sealant

was known, and only ordinary skill would have been required to configure the sealant over first and second wirings. I believe that ¶ 101 is misleading.

125. While Nakamoto does indeed show that it was known for different, unconnected wirings DTM and GTM to cross under *different sections* of the sealant, it nowhere suggests that a composite arrangement of a "first wiring" overlapped by a "second wiring," electrically connected together because of openings in insulation between them, would routinely have been located under the sealant or that only ordinary skill in the art was required to provide such a configuration.

126. Turning to the "near close" assertion, Nakamoto FIG. 5 contradicts this assertion. It shows that the sealant is not at all "near" or "close" to the edge of the counter substrate. There does not appear to be any recital in Nakamoto declaring such a relationship, and Dr. Hatalis does not point one out in his declaration. Nakamoto FIG. 9 further contradicts this assertion by Dr. Hatalis, because the epoxy resin EXP element is arranged at the edge of the counter substrate, for the purpose of protecting the sealant SL. Ex. 1004, Nakamoto, at ¶ 127.

127. Dr. Hatalis' declaration at ¶144 repeats his belief that only ordinary skill would have been required to adopt the various configurations of wiring structures where the sealant is over the multilayer wiring of Sukegawa in the way shown by Nakamoto. He continues that placing the sealant in close proximity to the

multilayer terminal portion was well known to conserve space and result in a small system size with reduced parasitic wiring resistance.

128. However, extending the multilayer wiring arrangement (2, 7) of Sukegawa to the sealant was not contemplated by Nakamoto. While Nakamoto contemplated running two different, independent wirings beneath orthogonal, spaced-apart sections of sealant, it contains no suggestion of running the multilayer wiring arrangement, as specified in the '413 claims, beneath the sealant. And, FIG. 9 of Nakamoto contemplated running a multi-conductor wiring from the terminal portion into the display portion, formed by metal g1 and transparent conducting layer (ITO) d1, but there is no suggestion of adding a second metal wiring or insulating films in between any of them.

129. Indeed, there are strong reasons why it would not have been the application of routine skill in the art to adopt such a configuration. One major problem is creating unevenness in the sealant topography and a gap difference, resulting in catastrophic defects in the LCD performance.

130. The problem of the corrosion was addressed above and is another reason why ordinarily skilled artisans would not extend the double wiring arrangement from the terminal region all the way to the sealant region.

131. Furthermore, Sukegawa was addressing corrosion problems resulting from a pinhole defect in transparent conductive film 8 of ITO, which is chemically stable

but not very moisture-resistant and generally not applied in thick layers. Ex. 1003, Sukegawa, at col. 1, ll. 28-49 and col. 3, ll. 37-42. 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. Sukegawa's solution was to *remove the upper layer metal wiring 7* at the probe test region 14 (FIG. 3E and FIG. 4B). *Id.* at col. 6, ll. 9-38, col. 7, ll. 35-57, FIGS. 3E and 4B. Sukegawa actually teaches *not* to extend the upper layer metal wiring 7 to the probe test region 14.

132. A person of ordinary skill in the art in 1997 would not have combined Sukegawa with Nakamoto for at least the following reasons: (1) Sukegawa and Nakamoto are directed to solving different problems; (2) Nakamoto is merely a representative example of using a sealant; and (3) Nakamoto does not disclose elements that would motivate one of ordinary skill in the art to combine it with Sukegawa. Regarding Nakamoto, the relevant issue is where the sealant is located relative to the second wiring, but in Nakamoto, there is no second wiring as defined in the '413 claims, no second insulating film, and no insulating film between the two wirings. I disagree with Dr. Hatalis' characterization of FIG. 5 of Nakamoto. That is, FIG. 5 does not show a sealant over the "first wiring" and "second region of the second wiring" because what Dr. Hatalis defines as the first and second wiring in FIG. 5 does not meet the claim limitations for those features.

B. Sukegawa and Nakamoto Fail to Disclose The Claimed "Second Wiring Making Direct Contact With the Transparent Conductive Layer Through an Opening in the Second Insulating Film" (claim element 1.13)

1. Sukegawa Does Not Disclose The Limitation "wherein the second wiring and the transparent conductive layer are in direct contact through an opening in the second insulating film" (claim element 1.13)

133. I have been asked to consider whether Sukegawa FIG. 3B shows ITO layer 8 making contact with wiring 7 "through an opening" because of supposed contact "between the vertical limits of the opening in the second insulating film 9…." It does not. For reasons explained above, the proposed reading of Sukegawa FIG. 3B is unreasonable and does not show contact through the opening in the protective insulating film 9. That opening is not the cause of the contact of upper layer metal wiring 7 and the transparent conductive layer 8. The contact does not occur by virtue of the opening. Transparent conductive layer 8 and upper layer metal wiring 7 were already in direct contact with one another prior to the formation of insulating film 9 or the opening in that film 9 on top of the already-contacting layer and wiring. Persons of ordinary skill in the LCD art or even the microelectronics art as of 1997, and as of today, would <u>not</u> consider that the contact between upper layer metal wiring 7 and transparent conductive layer 8 is "contact through [the] opening in the … insulating film" 9 of Sukegawa.

134. I have been asked to consider whether Sukegawa FIG. 2C and the Hatalis Declaration, Ex. 1005, ¶¶ 121-123 show claim element 1.13. Independent claims 1, 7, 17, and 22 and dependent claims 15 and 29 recite that "the second wiring and the transparent conductive layer are in direct contact ***through*** an opening in the second insulating film" (claim elements 1.13, 7.13, 17.16, and 22.16; emphasis added.) As described in the '413 patent, "...external connection lines 403 are electrically connected to an FPC (flexible printed circuit) 107 *through* contact holes provided in the resin inter-layer film 113 through an ITO (indium tin oxide) film 114." Ex. 1001, '413 patent, at col. 8, ll. 52-55 (emphasis added).

135. The Petition contains the following drawing as an annotated FIG. 2C of Sukegawa, (*see* left). I have been asked to consider whether the area below the horizontal red arrow corresponds to the "opening" recited in the claims. *See* Pet., at 22 and 23. The red markings are alleged to designate an opening in the protective insulating film 9.

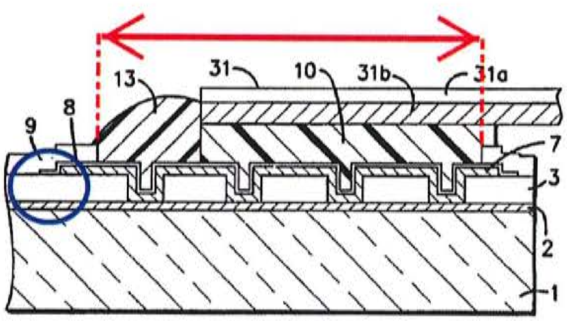


FIG. 2C
PRIOR ART

136. In independent claims 1, 7, 17, and 22 and dependent claims 15 and 29 of the '413 patent, the second insulating film is established and an opening is made so that a *subsequently-added* transparent conductive layer will extend into the opening and make direct contact with the second (upper) wiring. This leads to a

different structure which presents different problems and advantages that are completely unrecognized in the prior art, and in my opinion are nonobvious over the art. Based on its claimed structure, the '413 patent achieves at least the following advantageous effects (a) and (b).

137. (a) Placing the transparent conductive layer on top of the second conductive film leads to a high reliability connection between the FPC and the transparent conductive layer (and, thus, the second wiring). This is because the entire region at the terminal portion where the transparent conductive layer is formed can be used as the connection area with the FPC. For example, in FIG. 4A (reproduced below), because the resin inter-layer film 113 is located under the ITO film 114, there will be no layer that blocks the ITO film from contacting with the FPC. The entire area where the ITO film remains after etching corresponds to the region where FPC can be located. That area can be bigger than the area of the opening in the second insulating film, which means that the connection area is larger. Because the connection area is larger, the connection reliability between ITO film and the FPC will increase. This advantageous effect is achieved by the following claim limitation: "wherein the second wiring and the transparent conductive layer are in direct contact through an opening in the second insulating film" (claim element 1.13 and others).

138. (b) Because no other layer will be deposited over the transparent conductive layer during the terminal portion fabrication, the transparent conductive layer will not be exposed to damage from further processing steps (which might, for example, cause a change of film properties or thinning) due to the deposition or etching process of any subsequent layer. In contrast, such damage may occur in Sukegawa's structure when insulating layer 9 is deposited on top of the ITO layer 8 and then etched. Those steps can damage the ITO, which has a particularly porous film structure and etches quickly, as compared to the insulator and metal materials elsewhere in the active-matrix substrate, and leads to high resistance, pinhole defects, and weak adhesion. Therefore, according to the claimed invention of the '413 patent, a reliable connection with the FPC can be achieved.

139. On the other hand, one of the advantageous effects of Sukegawa is to reduce the electrical resistance in the vertical direction between the transparent conductive film 8 (transparent conductive layer) and the lower layer metal wiring 2 (first wiring), which is different from the advantageous effect of the '413 patent of reducing the electrical resistance of wirings for transmitting signals between the flexible printed circuit and another circuit. That is, a person of ordinary skill in the art would not extend the upper layer metal wiring 7 under the sealant in order to achieve the effect (a) above. In addition, the transparent conductive film 8 is formed under the protective insulation film 9 (the second insulating film). As

shown in FIG. 3A of Sukegawa below, the portion where tape-carrier package 300 (flexible printed circuit FPC) can contact with the transparent conductive film 8 (red area in the figure below) is small compared to the area where transparent conductive film 8 is formed (blue area). Further, because the protective insulation film 9 is formed over the transparent conductive film 8, the area where tape-carrier package 300 can connect with the transparent conductive film 8 is limited. In addition, 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 insulation film 9 formed between them. From these two FIGS. 3A and 3E, it is apparent that the transparent conductive film 8 cannot maximize its area available for connection with the tape-carrier package 300 because the protective insulation film 9 overlies and masks most of it from the tape-carrier package 300. For the foregoing reasons, the structure in Sukegawa cannot achieve the '413 patent's effects (a) and (b).

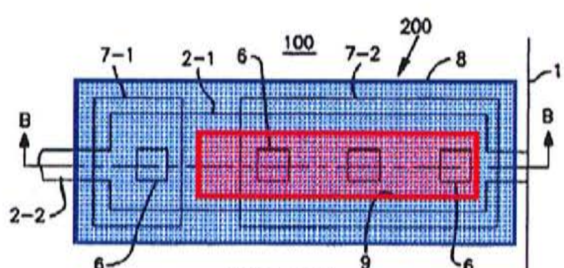


FIG. 3A

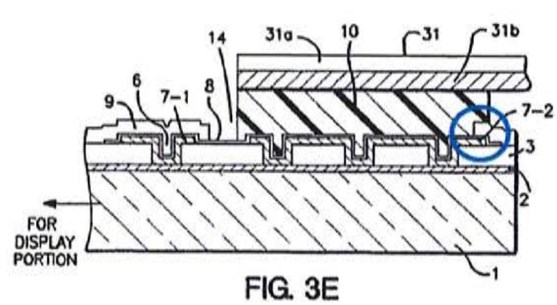


FIG. 3E

140. As discussed above, under the broadest definition of "through," as this claim language would be understood by persons of ordinary skill in the art, the opening

in protective insulating film 9 does not cause or permit transparent conductive film 8 to make direct contact with upper layer metal wiring 7. Such direct contact would exist regardless of whether protective insulating film 9 exists or not and whether protective insulating film 9 has an opening or not. Dr. Hatalis agreed. Ex. 2011, Hatalis Dep., at p. 60, ll. 12-25. Thus, the upper layer metal wiring 7 is not connected to the transparent conductive film 8 *because of or by virtue of* an opening in the protective insulating film 9 according to the Board's first meaning of "through." My opinion is that no one of ordinary skill in the art would understand the phrase "contact through an opening in an insulator film" to mean that the insulator film and the opening therein lie *above* the two layers or structures *already* making contact. I cannot agree scientifically (or otherwise) that there is "no discernible difference" between how Sukegawa's transparent conductive layer 8 contacts the second wiring 7 and how ITO layer 114 contacts the external connection lines 403 in the '413 patent.

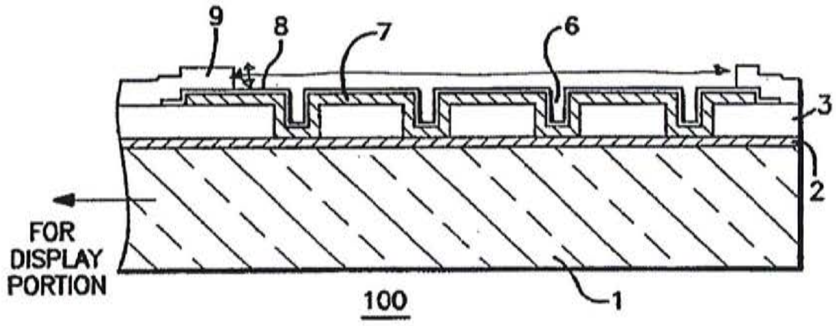
141. Furthermore, Sukegawa explained that the upper layer metal wiring 7 is protected by double coverage provided by the transparent conductive film 8 and the insulating film 9 or the anisotropic conductive film 10, because the transparent conductive film 8 is not very effective in protecting the upper layer metal wiring 7. Sukegawa suggests that the transparent conductive film 8 cannot be made thick in order to ensure transparency, and pinholes are easily formed in the thin film.

These pinholes will allow corrosion to occur on the upper layer metal wiring 7, which is located under the transparent conductive film 8. Ex. 1003, 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. *Id.* at 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 pinholes are formed in the transparent conductive film 8. *Id.* col. 6, ll. 22-26. That is, in Sukegawa, transparent conductive film 8 needs to be formed under the insulating film 9, thereby ensuring sufficient protection against corrosion (oxidation) on the upper layer metal wiring 7. As such, it would not have been obvious to form the transparent conductive layer *over* the second insulating film, which the '413 claims require.

2. Even Under Another Definition, Sukegawa is Deficient To Show Claim Element 1.13

142. I have been asked to consider Sukegawa in light of an alternate interpretation of the language of claim element 1.13 where the contact through an opening means within the vertical limits of the opening. I find that Sukegawa still fails to show this feature.

143. In his deposition, Dr. Hatalis marked a copy of Sukegawa FIG. 1B (Ex. 2009) to show the horizontal and vertical limits of the opening, represented by double headed arrows:



144. FIG. 1B is the precursor to FIG. 2C. In FIG. 1B, the terminal portion of the LCD is already formed. Upper layer metal wiring 7 and transparent conductive film 8 are already in place, in direct contact with one another. Insulating film 9 has already been added and its opening (delineated by the two double-headed arrows drawn by Dr. Hatalis) has been created. This structure is ready for the addition of the tape carrier portion 31 and the silicone resin 13, which are depicted in FIG. 2C. No manufacturing steps that occur between FIGS. 1B and 2C redefine the opening in film 9.

145. Dr. Hatalis' testimony regarding Exhibit 2009 shows that the point of contact between films 7 and 8 resides ***below*** the vertical limits of the opening in film 9. I agree. As such, even under this alternate definition, Sukegawa fails to show direct contact of the transparent conductive layer and the second wiring

"through" an opening in the second insulating film, as required by the last element of claim 1 and all other challenged claims.

146. Sukegawa itself does not declare that the contact of layers or films 7 and 8 occurs "through" the opening in insulating film 9. Nor would one of ordinary skill in the art characterize or describe the depicted connections that way.

147. Contrary to Dr. Hatalis' assertion of no discernible differences, FIG. 2C of Sukegawa is distinctly different from FIG. 4A of the '413 patent, where the opening in resin inter-layer film 113 (second insulating film) allows the ITO film 114 (transparent conductive layer) to contact the external connection lines 403 (second wiring). The connection is made *possible by* (or by virtue of) the opening. The connection is *because of* the opening. Thus, unlike Sukegawa, the '413 patent discloses that the second wiring is in direct contact with the transparent conductive layer *because of* the opening in the second insulating film. The claim recital corresponds to this configuration.

148. For these reasons, Sukegawa's structure of FIG. 2C does not satisfy the claim limitation "*through* an opening in the second insulating film," as required by the claim elements 1.13, 7.13, 17.16, and 22.16, and dependent claims 15 and 29.

3. Sukegawa FIG. 3B/3E Are Deficient

149. Sukegawa FIG. 3B and FIG. 3E are very similar. FIG. 3E simply adds the tape carrier connection (flexible wiring 31) to the structure of FIG. 3B because of the anisotropic conductive film 10.

150. FIGS. 3B and 3E fare no better than FIGS. 1B and 2C because contact is not made from the transparent conductive layer 8 to the upper wiring 7 because of or by virtue of the opening 14 in the protective film 9. Just as with FIG. 2C, the contact would exist without the opening, so the opening cannot be the source of the contact. The contact does not occur *through* the opening, as a person of ordinarily skill in the art would understand the phrase in light of the '413 patent.

151. Even using a definition where the contact occurs "between" vertical limits of the opening, the "opening" is irregular because film 9 has one elevation on one side of the opening and a different elevation on the opposite side of the opening. I have been asked to consider a suggestion that the opening is therefore slanted downward, and whether by this reasoning, a small bit of the contacting faces between layer 8 and wiring 7 might be said to be within the "vertical limits" of this irregularly-shaped opening and therefore the contact is supposedly "through" the opening. I disagree, and in my opinion, no one of ordinary skill in the art today or in 1997 would reach that conclusion. Also, no one of ordinary skill in the art

would conclude that the contact of layer 8 to wiring 7 is because of or by virtue of the opening in film 9. Therefore, it cannot be "through" the opening.

152. It can just as well be said that the opening in FIG. 3B is disjointed in elevation, and where wiring 7 has been removed from the structure, the opening is at a lower elevation. Where wiring 7 still exists, however, the opening in film 9 is at a higher elevation. At all times, the opening is above the layer immediately beneath where film 9 had been located. As such, the interface between layer 8 and wiring 7 is still below the vertical limits of the opening.

4. Reconnecting After "Peel-Off" Does Not Suggest the Claimed Element 1.13

153. I have been asked to consider the "peel-off" provisions of Sukegawa as meeting the "contact through an opening in the … insulation" aspect of claim 1 and the same or similar recitals in other claims. Decision, at 19-20.

154. Sukegawa noted that in some test and fault situations, the tape-carrier package 300 (the same as the FPC in the '413 patent) is peeled away from the active matrix substrate 100 and the transparent conductive layer 8 along with wiring 7-2 may be peeled off. Sukegawa states that the FPC can be reconnected to the substrate.

155. A question I have been asked to consider is whether one of ordinary skill in the art as of 1997 would have recognized that new upper layer metal wiring 7 and

transparent conductive layer 8 sections could have been provided because of the opening in the film 9 following a "peeling off" as related in Sukegawa.

156. Any proposed remanufacturing of metal wiring 7 after a "peel off" incident is a misreading of Sukegawa and would *not* have been what one of ordinary skill in this art would (or could) do. The reconnecting relates not to creating new layers 7 or 8 on the substrate but instead to using a new anisotropic conductive film 10.

157. Dr. Hatalis has misstated the extent of Sukegawa's specification and teachings, especially about the peeling off operation. Sukegawa writes in col. 6, line 39 to col. 7, line 15:

> **If it is found upon checking** that no sufficient electric connection is obtained between both of them, the tape-carrier package 300 connected by way of the anisotropic conductive film 10 in **the terminal portion is peeled off** from the active matrix substrate 100 and then bonded again as repairing operation. In the peeling step, not only the anisotropic conductive film 10 **but also the underlying transparent conductive film 8 and the upper layer metal wiring 7-2 may also be peeled together sometimes** from the active matrix substrate 100. **In this embodiment, not only the upper layer metal wiring 7-2 but also the upper layer metal wiring 7-1 so are also formed and they are connected respectively by way of the through holes 6 to the lower layer metal wiring 2.** Accordingly, if the copper foil wirings 31b of the tape carrier package 300 and the transparent conductive film 8 in the terminal portion of the active matrix substrate 100 are **connected again by a new anisotropic conductive film 10** upon repairing operation, **a conduction path connected by way of the upper layer metal wiring 7-1 to the lower layer metal wiring 2 can be ensured** at least in the same manner as that before the

repairing operation and a region usable as the checking terminal can be maintained.

Further, in this embodiment, 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 65 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. That is, the upper layer metal wirings 7-1 and 7-2 are electrically connected with the lower layer metal wiring 2 by way of the through holes 6 at several positions. **In the structure connected with the through holes disposed at several positions, the upper layer metal wiring is fastened to the lower layer metal wiring and can be made less peeling as compared with the structure connected by way of a single and a large diameter size through hole.** Namely, also after the peeling step after the checking, the upper layer metal wiring 7-2 can be made less peeling from the active matrix substrate 100. Further, since the peripheral length for the opening portion of the through holes is made longer, the upper layer metal wiring is less disconnected in the through holes thereby enabling to provide more reliable connection between the upper layer metal wiring and the lower layer metal wiring.

158. I note that Sukegawa is explaining one of the key aspects of this first embodiment: Since peeling-off can occur, he introduces a new structure (FIG. 3B) that goes beyond the prior art (FIG. 2C), where a portion of the upper layer metal wiring 7 is removed from the terminal checking portion. FIG. 3B shows the improved initial structure, *not the repaired structure*, followed by the application of the FPC 300 in FIG. 3D. Then the electrical connection is checked, and if not

good, the FPC 300 is peeled off and sometimes the upper layer metal wiring 7-2 and transparent conducting film 8 comes off with the ACF 10.

159. When Sukegawa writes, "In this embodiment, not only the upper layer metal wiring 7-2 but also the upper layer metal wiring 7-1 are also formed and they are connected respectively by way of the through holes 6 to the lower layer metal wiring 2…." this refers to how 7-1 and 7-2 are initially formed, not repaired. It is an observation about 7-1 and 7-2, explaining in this section one reason why or how the wiring 7 was split during their original fabrication (not repair).

160. If we keep reading (see FIG. 3D), Sukegawa then explains that, "… if the *copper foil wirings 31b* of the tape carrier package 300 and the *transparent conductive film 8* in the terminal portion of the active matrix substrate 100 are *connected again by a new anisotropic conductive film 10 upon repairing operation, a conduction path connected by way of the upper layer metal wiring 7-1 to the lower layer metal wiring 2 can be ensured…"*. This leads to two questions: "What could this repairing operation consist of?" and "What are the possible structures Sukegawa is referring to, after this repair?"

161. I have considered the question, "What could this repairing operation consist of?" In conjunction with this question, I reviewed and considered several teachings from the art about apparatus used in fabricating LCDs. Copies of these resources are provided with this declaration:

a. Ex. 2013 is from the **LG website <TFT process>**. This exhibit provides a summary of standard, well-known LCD fabrication processes, both now and at the priority date. One common process not mentioned is wet etching, but that does not imply much. It is the option of the manufacturer to use wet or dry or both etching. This material shows a typical TFT manufacturing process in the section titled "What is TFT process." The flowchart shows that the deposition or etching process is performed on a single substrate. According to the description, a CVD apparatus or sputtering apparatus is used for the deposition, and a dry etching apparatus is used for the etching. I understand from the material that the single substrate would be placed into a CVD apparatus/sputtering apparatus and a dry etching apparatus, which contradicts the idea that a completed LCD panel would be placed into a deposition or etching apparatus.

b. Ex. 2014 is from the **CPT website <TFT process>**. This exhibit also refers to standard processes. It includes sealant printing, which can be screen-printed or syringe-printed and includes ACF and TAB install steps discussed in prior art and the '413 patent. This material shows a typical TFT manufacturing process in the section titled "Array Engineering." The flowchart of Array Engineering shows that the deposition or etching process is performed on a single substrate. It also shows that a CVD apparatus is used for the deposition and a wet / dry etching apparatus is used for the etching. I understand from the material that the single substrate would be placed into a CVD apparatus and a wet / dry etching apparatus, which contradicts the idea that a completed LCD panel would be placed into a deposition or etching apparatus.

c. Ex. 2015 is from the **ShinMaywa website <evaporator>**. This exhibit provides standard process description of (mainly) sputtering, for metals. An evaporation method is shown in Chart A. The object shown in Chart A is a single substrate. I understand from the material that the single substrate would be placed into an evaporator apparatus, which contradicts the idea that a completed LCD panel would be placed into a deposition apparatus.

d. Ex. 2016 is from the **Pascal website <laser deposition>**. This exhibit concerns laser molecular beam epitaxy ("laser MBE"), a kind of pulsed laser deposition (PLD) technique. An ultra-high vacuum environment is essential, which should include both the substrate and a target of the deposition material. A laser beam hits a target material, but not the substrate. The layer deposition thickness on the substrate is sensed by an electron-beam, not a laser. Usually, the substrate is heated to 100s of °C. Usually for oxides, but also semiconductors. The PLD process is explained in FIG. 1. In FIG. 1, a single substrate is shown. I understand from the material that the single substrate would be placed into a laser assisted deposition apparatus, which contradicts the idea that a completed LCD panel would be placed into a deposition apparatus.

e. Ex. 2017 is from the **MicroTec website <screen printing>**. This exhibit describes one kind of standard screen-printing tool/process used in LCD fabrication. At pages 5 and 6, screen printing is described, and a single substrate is shown in the figures. I understand from the material that the single substrate would be placed into a screen printing apparatus, which contradicts the idea that a completed LCD panel would be placed into a deposition apparatus.

f. Ex. 2018 is from the **ULVAC website <laser ablation>**. This exhibit provides a description of a standard tool used for laser ablation in LCD fabrication, usually for removal and etching patterns of ITO, instead of using a chemical etching process. This is removal, not deposition. The material recites on the first page that "[t]his system is a single-substrate laser scribing system that is used to remove the transparent electrode (TCO) films formed on the glass substrate by the laser ablation method using the near-infrared wavelength pulse oscillating laser." I understand from the material that the single substrate would be placed into a laser ablation removing apparatus, which contradicts the idea that a completed LCD panel would be placed into an etching apparatus.

g. Ex. 2019 is from the **MicroFab website <ion beam etch technology>**. This exhibit provides a description of a standard tool used for ion-beam etching, an anisotropic process for removing thin-film layers with high precision control over depth and side-wall control. Figure 1 describes an ion beam etching apparatus and Figure 2 shows an ion beam etching process. I understand from the figures that the single substrate would be placed into an ion beam etching apparatus, which contradicts the idea that a completed LCD panel would be placed into an etching apparatus.

h. Ex. 2020 is from the **SIJ website <inkjet>**. This exhibit provides a description of an inkjet deposition system that can be used for patterned deposition of many material types, including conductive paste, biological materials, semiconducting organic materials, and polymers. I am not aware of any use of this type of tool by 1997 in LCD terminal fabrication or repair, nor can I find any patent, conference, or journal literature suggesting it. As shown in the material's Technology section, inkjet technology allows wirings to be formed without using either deposition or etching apparatus. However, the technology is still in the research phase and yet to be applied to LCD's actual wiring formation process. Examples of applications of inkjet apparatus are shown in the material's Product section. I understand from the application examples that a single substrate would be placed into an inkjet apparatus, which contradicts the idea that a completed LCD panel would be placed into a deposition or etching apparatus.

i. Ex. 2021 is from the **Henley SID DIGEST OF TECHNICAL PAPERS 1994.** This exhibit is a conference paper in 1994 discussing the issues in test and repair of LCDs. It includes mention of the importance of "various laser functions of welding, ablating, cutting and wiring." Note that FPC (or TCP or TAB) components are added at the module stage. No module repair is mentioned (which would include the FPC), only module inspection. Plate and cell repairs (and inspection) are detailed. It identifies two types of repair systems and strategies: (i) deposition/cutting" systems, only for "plate repair stage" (*i.e.,* before the cell or module, see Fig 1), since the deposition processes would damage the cell and module; and (ii) "cut/weld" systems, potentially for "plate and cell repair" (*i.e.,* before the module), since deposition is not necessary in these cases – it uses the materials already deposited to fix incorrect short or open circuits in wiring.

162. Terminal checking occurs in the last step of the fabrication, after substrate fabrication, after joining substrates into a cell and applying all optical films, and after adding on the FPC, etc., in the module assembly. At this stage, no deposition or repair process with high temperatures and/or low pressures could possibly be applied because these would catastrophically damage the liquid crystal module.

The sealant would easily delaminate, the liquid crystal would leak out, the polarizer and optical films would yellow, and the other electrical connections would fail. Furthermore, the only repair technique that I am aware of that might be used is the laser welding technique in the last paper (and elsewhere). But this does not involve deposition of new materials, but rather, modification of layers already present.

163. It is precisely this situation that motivates Sukegawa's invention. Repairs to the terminal are nearly impossible at the checking stage, so his invention is a specialized terminal with redundancy. It has multiple layers and structures engineered to withstand the potential peeling and allow for a second attempt at connection with a new anisotropic conductive film if the first attempt fails and peels away some of the structures.

164. It is important to note:

a. The only thing "new" or explicitly referred to as repaired in Sukegawa is the "new anisotropic conductive film 10 upon repairing operation" (col. 6, ll. 55-56).

b. At col. 6, lines 39-60, Sukegawa does not describe or contemplate wiring 7 and film 8 being separated from one another. Instead, Sukegawa states that wiring 7 and film 8 are either both separated from ACF 10 or they both are separated from the substrate 100. In either case, the only repair disclosed in

Sukegawa is that "the copper foil wirings 31*b* of the tape carrier package 300 and the transparent conductive film 8 ... are connected again by a new anisotropic conductive film 10 upon [a] repairing operation," *See Id.* at col. 6, ll. 52-56. There is no disclosure of repairing or replacing wiring 7 and film 8. Instead, Sukegawa is merely adding new anisotropic conductive film in place of the peeled off wiring 7 and film 8.

c. The transparent conductive film 8 is mentioned in this same sentence, but one of ordinary skill in the art understands that this refers to the original ITO that remains either fully intact, partially intact when some peels off, and/or the ITO that remains in the checking portion (to the left of the anisotropic conductive film in FIG. 3E (et al.) and where the label 8 is located

d. The person of ordinary skill would not understand Sukegawa here to be disclosing that the transparent conductive film 8 is re-deposited or re-applied, since that would require high temperatures (and low pressures) that would damage the rest of the module, including the LC+substrates cell and the other FPC connections that are not defective. I am not aware of any process (especially in 1997 and before) that can deposit LCD-quality ITO without temperatures and pressures severe enough to cause significant damage to the cell or module.

e. Finally, I note that the upper layer metal wiring 7-2 is never spoken of in the Sukegawa patent as being re-deposited or repaired. In the invention of Sukegawa, instead of repairing upper layer metal wiring 7-2, which would be impossible due to the processing temperatures and pressures, Sukegawa designs it originally to be robust to this repair operation when peeled off. The text says that a "conduction path… can [still] be ensured" to upper layer metal wiring 7-1 (on the left side and when needed is the data/signal line extending into the display) even when the upper layer metal wiring 7-2 is peeled off, "by way of" lower layer metal wiring 2. This would presumably include any part of ITO layer 8 that remains.

165. I have also considered the other question, "What are the possible structures Sukegawa is referring to, after this repair?"

a. Same as FIG. 3E, where the only thing new is the ACF 10.

b. Begin with FIG. 3E, but without some or all of the ITO 8 under the ACF 10.

c. Begin with FIG. 3E, but without some or all of the ITO 8 and the upper layer metal wiring 7-2 under the ACF 10.

166. In all these cases, the new anisotropic conductive film 10 will have a good connection to the lower layer metal wiring 2, and via this wiring, to upper layer metal wiring 7-1. As the specification says, "at least in the same manner as that

before the repairing operation and a region usable as the checking terminal can be maintained."

167. It is my opinion that Sukegawa categorically does *not* teach one of ordinary skill in the art that the upper metal and ITO are to be re-deposited in the terminal portion, through the opening in insulator 9, during the repair operation. If that were possible, it would negate the primary value of Sukegawa's invention and explicit embodiments.

168. As I explain above, it is technically improper to read Sukegawa as teaching or suggesting the supposed connection of second wiring and a transparent conductive layer through the opening in Sukegawa's insulating film 9 after the "peeling off." It is unnecessary to repeat that explanation again. In sum, persons skilled in the art in 1997 would not have reconnected the FPC after a "peeling off" by remanufacturing either of the upper layer metal wiring 7 or transparent conductive layer 8 lost in the peel-off.

C. The limitation of the Sealant in "Direct Contact With the Second Insulating Film" is not obvious

169. I have been asked to consider the feature of placing the sealant in direct contact with the second insulating film in combination with other features of the claims. In FIG. 4A of the '413 patent, the sealant 105 lies on top of the resin inter-layer film 113 (which is a second insulating film). Claim element 1.8 (along with

parallel recitals in claims 7, 10, 17, 22, and 24) recites that the sealant is located "over the first wiring and a second region of the second wiring," and claim element 1.9 (along with parallel recitals in claims 7, 10, 17, 22, and 24) recites that "the sealant is in *direct contact* with the second insulating film" (emphasis added). Also according to the claims, the transparent conductive layer must provide the electrical contact between the flexible printed circuit (*e.g.,* claim element 1.12), and the second wiring must make direct contact to the transparent conductive layer through an opening in the second insulating film (*e.g.,* claim element 1.13). The claims call for the transparent conductive layer to be formed after the second insulating film, as I have already explained in this declaration.

170. I understand that Sukegawa FIG. 2C is alleged to show that an insulating film 9 may be a top layer and that Nakamoto FIGS. 5 and 9 show a sealant SL in direct contact with a second insulating film PSV1. I have reviewed Ex. 1005, Hatalis Decl. ¶¶ 105-108, 144 in the context of whether it was known from these references to provide regions under a sealant with a second insulating film in direct contact with the sealant to protect the wirings under the sealant.

171. Even if it were accepted that in an LCD, a sealant may rest upon an insulator that overlies and protects wiring under the sealant, this fails to address the '413 structure which results from forming the transparent conductive layer *after* the claimed second insulating film. That is, in Sukegawa, the formation order of the

final two layers is reversed from the '413 patent. In Sukegawa, the transparent conductive layer 8 is deposited on top of the upper layer metal wiring 7 and etched before the second insulating film 9 is deposited, as is evident from examining Figures 1B, 2B, or 2C and as I have explained above in this declaration. In the '413 claims, however, the second insulating film is established and an opening is made so that a subsequently-added transparent conductive layer will extend into the opening and make direct contact with the second (upper) wiring.

172. It is known that generally a transparent conductive layer (typically ITO) and sealant have poor adhesion with each other. If the transparent conductive layer failed to achieve good adhesion, the seal could be corrupted and the LCD could fail. I addressed sealant adhesion properties above.

173. The '413 patent achieves the advantages of placing the transparent conductive layer above the second insulating film while avoiding the problem of poor adhesion of the sealant with the transparent conductive layer by restricting the structure so that the transparent conductive layer does not extend to and lie beneath the sealant. As a result, the sealant makes direct contact with the second insulating film, despite the sequence that is implicit in the claims where the second insulating film is not the last layer to be formed before placement of the sealant, and good adhesiveness of the sealant is nevertheless achieved. For example, in FIG. 4A of the '413 patent, the ITO 114 and sealant 105 are spatially separated so that the

adhesiveness of the sealant 105 with respect to the underlying insulating film 113 is preserved. This feature is expressed in the claim element 1.9 in combination with the other claim elements 1.8, 1.12 and 1.13, along with parallel claim features in the other claims. Considering Sukegawa, even if the transparent conductive film 8 could hypothetically be formed over the protective insulation film 9 and over the lower layer metal wiring 2 and the upper layer metal wiring 7, and even if these wirings could be extended to the display portion together with the transparent conductive film 8, Sukegawa does not suggest that the transparent conductive film 8 should be patterned before it reaches the sealant or confined to positions outside the sealant area.

174. To the contrary, Sukegawa discloses that upper layer metal wiring 7 is *always* covered by the transparent conductive film 8 and protective insulation film 9 in order to achieve secure connection (col. 6, ll. 9-20). Consequently, to the extent that the upper layer metal wiring 7 might hypothetically be extended to beneath the sealant, the transparent conductive layer 8 would also continuously be extended along with the wiring 7 so that it continues to cover and shield it. As a result, the structure in Sukegawa suggests that the transparent conductive film may overlap the sealant, resultsing in poor adhesion. Further, assuming that the overlying transparent conductive film 8 in this hypothetical modification of Sukegawa extends beyond the sealant to the display portion, then the structure

would contradict the '413 claim element (1.9 and parallel claim elements) "wherein the sealant is in direct contact with the second insulating film."

175. For these reasons, it is my opinion that the combination represented by each of the claims at issue solves multiple variables with unique and unexpected advantages in a manner that is clearly not contemplated by the prior art. The modifications that would have to be made to the prior art to arrive at the claimed structures are substantial and certainly not matters of applying routine skill of the art as of 1997.

VI. SHIBA

176. I have been asked to review U. S. Patent No. 5,684,555 ("Shiba"; Ex. 2022) which is cited in IPR2013-00068. Shiba does not disclose the claimed transparent conductive layer of the '413 patent. Shiba only discloses the common pad 751 which is formed in the same step of forming the data lines Xi or the scanning lines Yi. *See, ,e.g,*, Ex. 2022, Shiba, at FIG. 4, col. 6, ll. 25-36. Shiba also states that transparent conductive layers such as ITO are used to form a pixel electrode and counter electrode. *Id.* at col. 1, ll. 36-39, col. 4, ll. 42-44, col. 5, ll. 24-28. That is, Shiba fails to disclose or teach that the transparent conductive layer is formed over the common pad 751.

177. Further, if a transparent conductive layer were to be added over the common pad 751 in Shiba, it would require additional steps or changes in the manufacturing

process. This is because, in Shiba, the pixel electrode 251 is formed under the source electrode 231. As shown in Figure A (Schematic View of Figure 4 of Shiba), Shiba 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. 2022, Shiba, at col. 4, ll. 24-33.

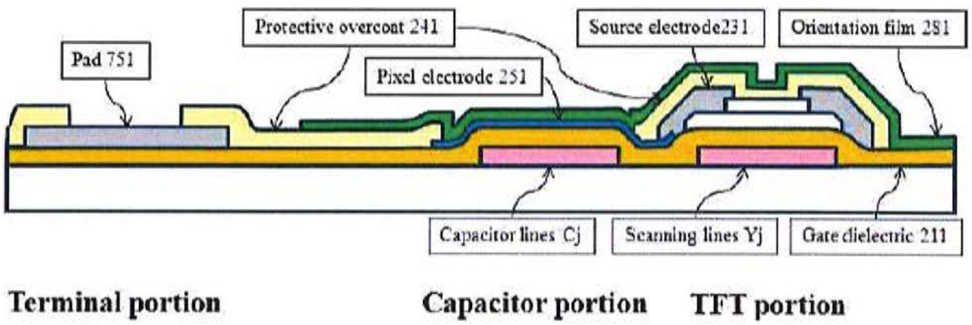


Figure A (Schematic View of Figure 4 of Shiba)

178. Thus, Shiba would require additional steps or changes in the manufacturing process in order for the transparent conductive layer to be formed as the top layer.

179. However, adding manufacturing steps is generally undesirable, and Shiba teaches not to "increase the number of manufacturing steps." Ex. 2022, Shiba, at col. 6, ll. 25-35.

180. By changing the structure and manufacturing process, it would be possible to form a transparent conductive layer, such as ITO, as the uppermost layer of pad 751 in Shiba, to form the pixel electrode 251 after forming the protective overcoat 241, without adding manufacturing steps. However, if the pixel electrode 251 is formed after forming the protective overcoat 241, the storage capacitor comprising

gate dielectric 211 would be seriously damaged by the etching performed for forming the opening in the protective overcoat 241 because there is no layer, such as pixel electrode 251, that could function as a barrier layer.

181. Therefore, since adding or changing process steps is to be avoided, one skilled in the art would not have adopted such a modification in Shiba.

182. Shiba does not teach the claimed sequence of the transparent conductive layer and the second insulating film. This is significant because Shiba cannot achieve the advantageous effects of the '413 patent, namely, making a more reliable connection between the transparent conductive layer and the FPC, and not damaging the transparent conductive layer due to the deposition or etching process of any overlying layer, as explained above.

183. Furthermore, the transparent conductive layer of the '413 claims would not have been obvious in view of Shiba in combination with Sukegawa. As discussed above, Sukegawa's transparent conductive film 8 must be formed under the protective insulation film 9 to protect against corrosion (oxidation) on the upper layer metal wiring 7. In light of this object of Sukegawa, if the transparent conductive layer is formed in the terminal portion of Shiba, the transparent conductive layer would need to be provided under the protective overcoat 241, not over the protective overcoat 241.

184. Because Shiba does not disclose the claimed transparent conductive layer, it does not disclose the positional relationship between the sealant and the transparent conductive layer. This is significant because Shiba then cannot achieve the favorable adhesion between the sealant and second insulting film, which is one of the advantageous effects of the '413 patent, as explained above.

185. Therefore, Shiba also fails to disclose and teach each and every limitation of the claims of the '413 patent and would not have rendered those claims obvious.

Conclusion

Even if the references were combined, several claim elements of each of the challenged claims of the '413 patent are absent from the cited art. Extending Sukegawa's upper layer metal wiring 7 would, according to the teaching in Sukegawa, also call for extending the overlying transparent conductive layer, which lies under the second insulating film, contrary to the present claims. One of ordinary skill in the art would not only have to extend wiring 7 but also delete the layer 8 and place it elsewhere, resulting in process changes and structure changes that are clearly not obvious. Also, the claimed invention achieves unique advantages which the cited art does not achieve. The prior art fails to teach, suggest, or motivate one to combine the art to arrive at the combinations specified in the claims of the '413 patent. For these reasons, together with the reasons expressed in this declaration, it is my opinion that claims 1-2, 4-7, 9-11, 13-18, 20-

22, 24-25, or 27-29 of the ’413 patent would not have been arrived at by the application of mere ordinary skill in the art as of 1997.

APPENDIX A

Materials considered by Michael Escuti

Exhibit No.	Reference
1001	U.S. Patent No. 7,876,413 to Hirakata et al.
1002	Prosecution history of application 12/252,793, which matured to the '413 patent.
1003	U.S. Patent No. 5,636,329 to Sukegawa et al.
1004	JP Publication No. H08-160446 with translation
1005	Declaration of Miltiadis Hatalis, Ph.D.
Paper No. 2	Petition for Inter Partes Review
Paper No. 9	Preliminary Response of the Patent Owner
Paper No. 10	Decision, Institution of Inter Partes Review
Paper No. 18	Patent Owner Request for Rehearing
Paper No. 23	Decision, Request for Rehearing
Ex. 2009	Sukegawa FIG. 1B marked by Dr. Hatalis at deposition to show vertical and horizontal limits of the opening in insulation film 9
Ex. 2010	Sukegawa FIG. 2C marked by Dr. Hatalis at deposition to show hypothetical placement of a sealant
Ex. 2011	Dr. Hatalis deposition transcript, July 1, 2013
Ex. 2013	materials from LG website <TFT process>
Ex. 2014	materials from CPT website <TFT process>
Ex. 2015	materials from ShinMaywa website <evaporator>

Ex. 2016	materials from Pascal website <laser deposition>
Ex. 2017	materials from MicroTec website <screen printing>
Ex. 2018	materials from ULVAC website <laser ablation>
Ex. 2019	materials from MicroFab website <ion beam etch technology>
Ex. 2020	materials from SIJ website <inkjet>
Ex. 2021	Henley_SID DIGEST OF TECHNICAL PAPERS 1994
Ex. 2022	Shiba, US Patent No. 5,684,555, IPR2013-00068, Ex. 1003.
Ex. 2023	Dr. Hatalis deposition transcript, July 2, 2013, for No. IPR2013-00068
Ex. 2024	Watanabe, US 5,504,601

APPENDIX B

Curriculum Vitae of Michael J. Escuti

Including a list of prior testimony

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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

MICHAEL JAMES ESCUTI

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.
19) C. Oh and M.J. Escuti, "Time-domain analysis of periodic anisotropic media at oblique incidence: an efficient FDTD implementation," *Optics Express*, **vol. 14**, no. 24, pp. 11870-11884, 2006.
20) B.-J. de Gans, C. Sánchez, D. Kozodaev, M.J. Escuti, C. Bastiaansen, D.J. Broer, and U.S. Schubert, "Optimizing photo-embossed gratings: A gradient library approach," *Journal of Combinatorial Chemistry*, **vol. 8**, no. 2, pp. 228-236, 2006.
21) C. Sanchez, M.J. Escuti, C. van Heesch, C. Bastiaansen, and D.J. Broer, "TiO_2 nanoparticle-photopolymer composites for volume holographic recording," *Advanced Functional Materials*, **vol. 15**, no. 10, pp. 1623-1629, 2005.
22) C. Sanchez, M.J. Escuti, C. van Heesch, C. Bastiaansen, and D.J. Broer, "An efficient illumination system for LCDs incorporating an anisotropic hologram," *Applied Physics Letters*, **vol. 87**, no. 9, art. no. 094101, 2005.
23) C. Sánchez, B.-J. de Gans, D. Kozodaev, A. Alexeev, M.J. Escuti, C. van Heesch, T. Bel, U.S. Schubert, C. Bastiaansen, and D.J. Broer, "Photoembossing of periodic relief structures using polymerization induced diffusion: A combinatorial study," *Advanced Materials*, **vol. 17**, no. 21, pp. 2567-2571, 2005.
24) M.J. Escuti and G.P. Crawford, "Holographic Photonic Crystals," *Optical Engineering*, **vol. 43**, no. 9, pp. 1973-1987, 2004.
25) M.J. Escuti and G.P. Crawford, "Mesoscale three-dimensional lattices formed in polymer dispersed liquid crystals: a diamond-like face centered cubic," *Molecular Crystals and Liquid Crystals*, **vol. 421**, pp. 23-36, 2004.

26) M.J. Escuti, J. Qi, and G.P. Crawford, "A tunable face-centered-cubic photonic crystal formed in holographic-polymer dispersed liquid crystals," *Optics Letters*, **vol. 28**, no. 7, pp. 522-524, 2003. Highlighted in the "News" section of the July 2003 issue of *Scientific American*.
27) M.J. Escuti, J. Qi, G.P. Crawford, "Two-dimensional tunable photonic crystal formed in a liquid crystal/polymer composite: threshold behavior and morphology," *Applied Physics Letters*, **vol. 83**, no. 7, pp. 1331-1333, 2003. Selected to appear in the *Virtual Journal of Nanoscale Science & Technology*.
28) M.J. Escuti and G.P. Crawford, "Polymer Dispersed Liquid Crystals as Tunable Photonic Crystals," *Polymer News*, **vol. 28**, pp. 205–212, 2003.
29) M.J. Escuti, D.R. Cairns, and G.P. Crawford, "Optical-strain characteristics of anisotropic polymer films fabricated from a liquid crystal diacrylate," *Journal of Applied Physics*, **vol. 95**, no. 5, pp. 2386-2390, 2004.
30) M. Vilfan, B. Zalar, A. K. Fontecchio, M. Vilfan, M.J. Escuti, G.P. Crawford, and S. Zumer, "Deuteron NMR study of molecular ordering in a holographic-polymer-dispersed liquid crystal," *Physical Review E*, **vol. 66**, no. 2, 021710, 2002.
31) M.J. Escuti, P. Kossyrev, G.P. Crawford, T. Fiske, J. Colegrove, and L. Silverstein, "Expanded viewing-angle reflection from diffuse holographic-polymer dispersed liquid crystal films," *Applied Physics Letters*, **vol. 77**, no. 26, pp. 4262-4264, 2000.
32) M.J. Escuti, C.C. Bowley, G.P. Crawford, and S. Zumer, "Enhanced dynamic response of the in-plane switching liquid crystal display mode through polymer stabilization," *Applied Physics Letters*, **vol. 75**, no. 21, pp. 3264-3266, 1999.
33) M.J. Escuti, C.C. Bowley, G.P. Crawford, and S. Zumer, "A model of the fast-switching polymer-stabilized in-plane-switching configuration," *Journal of the SID*, **vol. 7**, no. 4, pp. 285-288, 1999.

Conference Proceedings (peer-reviewed)

1) F. Snik, G. Otten, M. Kenworthy, M.N. Miskiewicz, M.J. Escuti, C. Packham, and J. Codona, "The vector-APP: a broadband apodizing phase plate that yields complementary PSFs," *Proc. SPIE - Modern Technologies in Space- and Ground-based Telescopes and Instrumentation II*, **vol. 8450**, art. no. 84500M, 2012.
2) J Buck, S Serati, L Hosting, R Serati, H Masterson, MJ Escuti, J Kim, and MN Miskiewicz, "Polarization gratings for non-mechanical beam steering applications," *Proc. SPIE - Acquisition, Tracking, Pointing, and Laser Systems Technologies XXVI*, **vol. 8395**, art. no. 83950F, 2012.
3) M.N. Miskiewicz, J. Kim, Y. Li, R.K. Komanduri, and M.J. Escuti, "Progress on large-area polarization grating fabrication," *Proc. SPIE - Acquisition, Tracking, Pointing, and Laser Systems Technologies XXVI*, **vol. 8395**, art. no. 8395-15, 2012.
4) M.N. Miskiewicz, P.T. Bowen, and M.J. Escuti, "Efficient 3D FDTD analysis of arbitrary birefringent and dichroic media with obliquely incident sources," *Proc. SPIE - Physics and Simulation of Optoelectronic Devices XX*, **vol. 8255**, art. no. 82550W, 2012.
5) J. Kim, R.K. Komanduri, and M.J. Escuti, "A compact holographic recording setup for tuning pitch using polarizing prisms," *Proc. SPIE - Practical Holography XXVI: Materials and Applications*, **vol. 8281**, art. no. 82810R, 2012.
6) Y. Li, J. Kim, and M.J. Escuti, "Broadband orbital angular momentum manipulation using liquid crystal thin films," *Proc. SPIE - Complex Light and Optical Forces VI*, **vol. 8274**, art. no. 827415, 2012.
7) R.K. Komanduri, J. Kim, KF Lawler, and M.J. Escuti, "Multi-twist retarders for broadband polarization transformation," *Proc. SPIE - Emerging Liquid Crystal Technologies VII*, **vol. 8279**, art. no. 82790E, 2012.
8) M.W. Kudenov, M.J. Escuti, E.L. Dereniak, and K. Oka, "Spectrally broadband channeled imaging polarimeter using polarization gratings," *Proc. SPIE – Polarization Science and Remote Sensing*, **vol. 8160**, art. no. 816031, 2011.

9) E. Seo, H.C. Kee, Y. Kim, S. Jeong, H. Choi, S. Lee, J. Kim, R.K. Komanduri, and M.J. Escuti, "Polarization Conversion System Using A Polymer Polarization Grating," *SID Symposium Digest*, **vol. 42**, pp. 540-543, 2011.
10) Y. Li, J. Kim, M.J. Escuti, "Experimental realization of high-efficiency switchable optical OAM state generator and transformer," *Proc. SPIE - Laser Beam Shaping XII*, **vol. 8130**, art. no. 813015, 2011.
11) (invited) R.K. Komanduri, K.F. Lawler, and M.J. Escuti, "A liquid crystal shutter for unpolarized broadband light," *Proc. SPIE – Acquisition, Tracking, Pointing, and Laser Systems Technologies XXV*, **vol. 8052**, art. no. 805227, 2011.
12) J. Kim, M.N. Miskiewicz, S. Serati, and M.J. Escuti, "Demonstration of large-angle nonmechanical laser beam steering based on LC polymer polarization gratings," *Proc. SPIE – Acquisition, Tracking, Pointing, and Laser Systems Technologies XXV*, **vol. 8052**, art. no. 805229, 2011.
13) J. Kim and M.J. Escuti, "High-efficiency quasi-ternary design for nonmechanical beam-steering utilizing polarization gratings," *Proc. SPIE – Advanced Wavefront Control: Methods, Devices, and Applications VIII*, **vol. 7816**, art. no. 781614, 2010.
14) Y. Li and M.J. Escuti, "Orbital angular momentum controlling using forked polarization gratings," *Proc. SPIE – Laser Beam Shaping XI*, **vol. 7789**, art. no. 778914, 2010.
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.
16) C. Oh, J. Kim, J.F. Muth, and M.J. Escuti, "A New Beam Steering Concept: Risley Gratings," *Proc. SPIE - Advanced Wavefront Control: Methods, Devices, and Applications VII*, **vol. 7466**, art. no. 746619, 2009.
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.
19) C. Oh, R.K. Komanduri, B.L. Conover, and M.J. Escuti, "Polarization-Independent Modulation Using Standard Liquid Crystal Microdisplays and Polymer Polarization Gratings," *International Display Research Conference*, **vol. 28**, pp. 298-301, 2008.
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.

27) E. Nicolescu and M.J. Escuti, "Polarization-Independent Tunable Optical Filters Based On Bilayer Polarization Gratings," *Proceedings of the SPIE - Optics & Photonics Conference*, **vol. 7050**, art. no. 705018, 2008.
28) R.K. Komanduri, C. Oh and M.J. Escuti, "Reflective Liquid Crystal Polarization Gratings With High Efficiency And Small Pitch," *Proc. SPIE - Liquid Crystals XII*, **vol. 7050**, art. no. 70500J, 2008.
29) R.K. Komanduri, C. Oh, M.J. Escuti, and D.J. Kekas, "Late-News Paper: Polarization-Independent Liquid Crystal Microdisplays," *Society for Information Display Symposium Digest*, **vol. 39**, pp. 236-239, 2008.
30) E. Nicolescu and M.J. Escuti, "Portable Spectrophotometer Based on Polarization Independent Tunable Optical Filters," *Proceedings of the SPIE - Optics & Photonics Conference*, **vol. 6661**, art. no. 666105, 2007.
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.
32) R.L. Kellogg and M.J. Escuti, "DAZLE: A New Approach to Adaptive Imaging," *Proceedings of the SPIE - Optics & Photonics Conference*, **vol. 6714**, art. no. 67140H, 2007.
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.
43) W.M. Jones, B.L. Conover, and M.J. Escuti, "Evaluation of projection schemes for the liquid crystal polarization grating operating on unpolarized light," *Society for Information Display Symposium Digest*, **vol. 37**, pp. 1015-1018, 2006.
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.

45) C. Sanchez, B.J. de Gans, D. Kozodaev, A. Alexeev, M.J. Escuti, C. van Heesch, T. Bel, U.S. Schubert, C. Bastiaansen, and D.J. Broer, "Polymerization-induced diffusion as a tool to generate periodic relief structures: a combinatorial study," *Proceedings of the SPIE*, **vol. 6136**, art. no. 61360H, 2006.
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"

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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).

CERTIFICATE OF SERVICE

I certify that the foregoing DECLARATION OF MICHAEL J. ESCUTI, PHD was served on the Petitioner by electronic mail on July 24, 2013.

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