

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

BOE Technology Group Co., LTD.,
Petitioner

v.

Optronic Sciences LLC
Patent Owner

Inter Partes Review No.: IPR2024-01131

**DECLARATION OF DR. DEAN NEIKIRK IN SUPPORT OF PETITION
FOR INTER PARTES REVIEW OF U.S. PATENT NO. 7,226,801**

I hereby declare under penalty of perjury under the laws of the United States of America that the following is true and correct, and that all statements made of my own knowledge are true and that all statements made on information and belief are believed to be true. I understand that willful false statements are punishable by fine or imprisonment or both under Section 1001 of Title 18 of the United States Code.

July 12, 2014

Date



Dr. Dean Neikirk

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1001	U.S. Pat. No. 7,226,801 (“the 801 Patent”)
1002	File History of 7,226,801
1003	Declaration of Dr. Dean Neikirk
1004	Curriculum Vitae of Dr. Dean Neikirk
1005	U.S. Patent No. 7,538,488 (“Kwak”)
1006	Chinese Patent Publication CN 1538212A (“Zhang”)
1007	U.S. Patent No. 6,406,636 (“Vaganov”)
1008	U.S. Patent Publication 2003/0076452 (“Kim”)
1009	U.S. Patent No. 7,446,336 (“Yamazaki”)
1010	U.S. Patent Publication 2003/0209726 (“Shigeno”)
1011	U.S. Patent No. 7,786,496 (“Yamazaki 496”)
1012	U.S. Patent No. 6,147,722 (“Shimada 722”)
1013	U.S. Patent No. 5,907,376 (“Shimada 376”)
1014	U.S. Patent No. 6,734,935 (“Kim 935”)
1015	U.S. Patent No. 7,538,039 (“Sasagawa”)
1016	U.S. Patent No. 6,011,608 (“Tanaka”)
1017	U.S. Patent No. 7,342,619 (“Arakawa”)
1018	U.S. Patent No. 8,076,782 (“Asai”)
1019	U.S. Patent No. 7,696,100 (“Maekawa”)

CHART OF CLAIMS	
1pre	A method for forming a sealant region pattern of a liquid crystal display, comprising:
1a	providing a first substrate and a second substrate opposite thereto;
1b	forming a predetermined material layer on the first substrate; and
1c	forming an organic material pattern layer having a saw tooth opening on the predetermined material layer to expose the surface of the predetermined material layer underneath, wherein the surface of the predetermined material layer and the sidewall of the organic material pattern layer form a predetermined angle.
2	The method of claim 1, wherein the predetermined angle is less than about 60 degree.
3	The method of claim 1, wherein the predetermined angle ranges from about 20 degree to about 30 degree.
4	The method of claim 1, wherein the predetermined material layer comprises a passivation layer.
5	The method of claim 1, wherein the predetermined material layer comprises a metal electrode layer.
6a	The method of claim 1, wherein formation of the organic material pattern layer comprises: forming an organic material layer on the predetermined material layer; and patterning the organic material layer to form the saw tooth opening therein;
6b	wherein the organic material pattern layer comprises a plurality of segments adjacent to the saw tooth opening, and the respective height of the plurality segments gradually increases with respect to the distance from the saw tooth opening.
8	The method of claim 6, wherein the organic material layer comprises polymethyl methacrylate (PMMA) or photosensitive-methylsilsequiazane (PS-MSZ).
9pre	A sealant region pattern for a liquid crystal display, comprising:
9a	a first substrate and a second substrate opposite thereto;
9b	a predetermined material layer formed on the first substrate; and
9c	an organic material pattern layer having a saw tooth opening formed on the predetermined material layer to expose the surface of the predetermined material layer underneath, wherein the surface of the predetermined material layer and the sidewall of the organic material pattern layer form a predetermined angle.

10	The sealant region of claim 9, wherein the predetermined angle is less than about 60 degree.
11	The sealant region of claim 9, wherein the predetermined angle ranges from about 20 degree to about 30 degree
12	The sealant region of claim 9, wherein the predetermined material layer comprises a passivation layer.
13	The sealant region of claim 9, wherein the predetermined material layer comprises a metal electrode layer.
14	The sealant region of claim 9, wherein the organic material layer comprises polymethyl methacrylate (PMMA) or photosensitive-methylsilsesquiazane (PS-MSZ).

I. INTRODUCTION

I, Dean Neikirk, declare as follows:

1. My name is Dean Neikirk. I have been asked by Petitioner BOE Technology Group Co. Ltd. (“Petitioner”) to provide my expert opinions in support of the above-identified petition for *inter partes* review of claims 1-6 and 8-14 (“Challenged Claims”) of U.S. Patent No. 7,226,801 (“801 patent,” EX1001), owned by Optronic Sciences LLP (“PO”), pursuant to 35 U.S.C. §§311–19 and 37 C.F.R. §42.100.

2. I currently hold the opinions set forth in this declaration.

3. In summary, it is my opinion that the references cited below anticipate or render obvious the Challenged Claims. My detailed opinions on the claims are set forth below.

4. I am being compensated for my time at the rate of \$800 per hour. This compensation is not contingent upon my performance, the outcome of this matter, or any issues involved in or related to this matter.

II. BACKGROUND AND QUALIFICATION

5. My qualifications generally are set forth in my Curriculum Vitae, which is attached as EX1004 and also includes a list of the publications I have authored and a list of the other cases in which I have testified during the last four years.

6. I am currently an emeritus Professor in the Department of Electrical and Computer Engineering at the University of Texas at Austin, holding the Emeritus Cullen Trust for Higher Education Professorship in Engineering. I received a B.S. in Physics and Mathematics from Oklahoma State University in 1979, an M.S. in Applied Physics from the California Institute of Technology in 1981, and a Ph.D. in Applied Physics from the California Institute of Technology in 1984. Until January 2021, I was a tenured professor and endowed chair in the Cockrell School of Engineering at the University of Texas at Austin, where I have been a member of the engineering faculty since 1984. From 1992 to 2020 I held the Cullen Trust for Higher Education Professorship in Engineering at the University of Texas. From 2014 to 2020 I was the Associate Dean of Graduate Studies where I oversaw graduate student services for over 78 doctoral programs and 116 master's degree programs. I have also served as the Graduate Advisor of the Department of Electrical and Computer Engineering (ECE) at UT-Austin, an Associate Chairman of the ECE Department, the Chair of the UT-Austin Graduate Assembly, the Chair of the UT-Austin Faculty Council, and the Secretary of the General Faculty at UT-Austin.

7. In 1985, I established the Microelectronics Fabrication Teaching Laboratory at The University of Texas at Austin, which continues to this day to provide undergraduate and graduate students with hands-on experience in IC

fabrication. I have taught many courses in integrated-circuit fabrication, microwave devices, IC packaging, electromagnetics, computer aided design methods for circuit simulation, sensors of all sorts, and micro-electromechanical systems. In recognition of my research and classroom teaching accomplishments, I received the 1984-85 Engineering Foundation Faculty Award from the University of Texas at Austin Engineering Foundation Advisory Council, the 1985-90 General Motors Foundation Centennial Teaching Fellowship, the 1987 Award for Outstanding Engineering Teaching by an Assistant Professor, the 1990-1992 Temple Foundation Endowed Faculty Fellowship, the 1997 College of Engineering Award for Outstanding Teaching in the Department of Electrical and Computer Engineering, the 2003 Department of Electrical and Computer Engineering Gordon T. Lepley IV Endowed Memorial Teaching Award, and the 2007 Lockheed Martin Aeronautics Company Award for Excellence in Engineering Teaching. In recognition of my service to the University of Texas at Austin I also received the 2015 University of Texas at Austin Civitatis Award.

8. My research over the last thirty-five years has concentrated heavily in the areas of optical systems, microelectronics, semiconductor devices, IC fabrication, and new sensors. This research work has been funded by many agencies, focusing on the fabrication and modeling of semiconductor devices, microelectromechanical systems (MEMS), electromagnetic devices and detectors,

chemical sensors, temperature sensors, proximity sensors, and pressure sensors, as well as research on the high frequency properties of transmission lines, RF devices, and infrared to terahertz detectors for use in focal plane imaging arrays. Other aspects of my work involved Integrated Circuit (“IC”) packaging and encapsulating the IC within a “package,” such as by sealing the IC components between two opposing substrates. My research related to the development of new chemical sensors (an “electronic taste” sensor) was selected for a commercialization venture between The University of Texas and two outside start-up companies.

9. My earliest research was in the interaction of light with optically active materials, including color centers in crystals for use as light emitters. Each of my academic degrees involved significant studies in solid state physics, semiconductor devices, electrical engineering, electronic systems, electromagnetics, optics, radio frequency systems, and antennas. For example, courses relating to these fields that I took include two years of study in electromagnetics and optics, one year of study in solid state and semiconductor physics, as well as four years of graduate research in electronic devices, antenna design, antenna fabrication, and optical systems. My Ph.D. thesis was on the design and fabrication of high frequency electromagnetic detectors and quasi-optical imaging antenna arrays, including research on integrated-circuit fabrication,

semiconductor and MEMS devices, integrated circuits, antennas, sensors, and IC packaging. I designed and fabricated the first monolithic integrated-circuit imaging antenna array for use at wavelengths in the far infrared (sometimes referred to as the terahertz) region of the electromagnetic spectrum. For this work on the first high resolution focal plane antenna array for use at wavelengths between 0.1 mm and 1 mm I was awarded the 1984 Marconi International Fellowship Young Scientist Award “for contributions to the development of millimeter wave integrated circuits especially in the area of detectors and imaging arrays.” In recognition of my early research efforts, I received the 1985–1986 IBM Corporation Faculty Development Award, and the 1986 National Science Foundation Presidential Young Investigator Award.

10. As represented by the publications listed in my CV, I have extensive experience with microelectronics, semiconductors, and IC fabrication. My academic research has included a substantial body of work on new designs for imaging arrays, including the design and fabrication of arrays of pixels for use in the infrared spectrum. This work included new research on focal plane arrays made up of wavelength-selective pixels to allow for “color vision” in the infrared portion of the electromagnetic spectrum. In addition to optical sensing, my work also involved the growth of compound semiconductor materials used to generate

light in light emitting diodes. Later advances in these materials have led to their use in light emitting displays.

11. I am a senior member of the Institute of Electrical and Electronics Engineers (IEEE) and served as Associate Editor for Solid State and VLSI Electronics, IEEE Transactions on Education from March 1991 through October 1994.

12. Through my work on electronic systems and innovations in other related fields, I have been named an inventor on 17 U.S. patents. These are summarized in my curriculum vitae.

13. I have also co-authored over 250 technical papers in international journals and conferences and presented over 30 invited lectures and professional society presentations. My publications have addressed technologies such as integrated circuits for antenna arrays, multilayer interconnection lines for high speed digital integrated circuits, determining conductor loss in transmission lines, optical and electromagnetic devices for infrared detection, RF oscillator circuits, memory-switching double-barrier quantum-well diodes circuits, RF and infrared detection circuits, and other topics related to semiconductor and IC fabrication.

III. DOCUMENTS AND OTHER MATERIALS RELIED UPON

14. In forming the opinions set forth in this declaration, I have reviewed the documents in the following table:

Exhibit No.	Description
1001	U.S. Pat. No. 7,226,801 (“the 801 Patent”)
1002	File History of 7,226,801
1005	U.S. Patent No. 7,538,488 (“Kwak”)
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1008	U.S. Patent Publication 2003/0076452 (“Kim”)
1009	U.S. Patent No. 7,446,336 (“Yamazaki”)
1010	U.S. Patent Publication 2003/0209726 (“Shigeno”)
1011	U.S. Patent No. 7,786,496 (“Yamazaki 496”)
1012	U.S. Patent No. 6,147,722 (“Shimada 722”)
1013	U.S. Patent No. 5,907,376 (“Shimada 376”)
1014	U.S. Patent No. 6,734,935 (“Kim 935”)
1015	U.S. Patent No. 7,538,039 (“Sasagawa”)
1016	U.S. Patent No. 6,011,608 (“Tanaka”)
1017	U.S. Patent No. 7,342,619 (“Arakawa”)
1018	U.S. Patent No. 8,076,782 (“Asai”)
1019	U.S. Patent No. 7,696,100 (“Maekawa”)

15. Additionally, I have utilized my own experience and expertise, including regarding the knowledge and capabilities of a person of ordinary skill in the relevant art in the timeframe of the claimed priority date of the '801 patent.

IV. STATUTORY GROUNDS FOR CHALLENGE

16. In this declaration, I offer opinions on the following grounds that are the basis for this IPR proceeding:

Ground	Claims	Stat. Basis	Prior Art
1	9	35 U.S.C. § 102	Kwak
2	1-6, 8-14	35 U.S.C. § 103	Kwak
3	2, 3, 6, 10, 11	35 U.S.C. § 103	Kwak, Vaganov
4	2, 3, 6, 8, 10, 11, 14	35 U.S.C. § 103	Kwak, Kim
5	2, 3, 6, 10, 11	35 U.S.C. § 103	Kwak, Yamazaki

6	1-6, 9-13	35 U.S.C. § 103	Zhang
7	2, 3, 6, 10, 11	35 U.S.C. § 103	Zhang, Vaganov
8	2, 3, 6, 10, 11	35 U.S.C. § 103	Zhang, Yamazaki

V. RELEVANT PATENT LAW AND LEGAL STANDARDS

A. Date of Invention

17. I have been asked to use the date of the filing of the earliest application to which priority is claimed (i.e., June 27, 2005 for TW 94121405A) as the date of invention for purposes of my analysis.

B. Anticipation

18. I am informed and understand that a patent claim is invalid under 35 U.S.C. § 102 if a prior art disclosure teaches every element required by the claim, either expressly or inherently. The identical invention must be shown in as complete detail as is contained in the claim. When a claim covers several structures or compositions, either generically or as alternatives, the claim is deemed anticipated if any of the structures or compositions within the scope of the claim is known in the prior art.

C. Obviousness

19. I am informed and understand that a patent claim is invalid under 35 U.S.C. § 103 if the differences between the invention and the prior art are such that the subject matter as a whole would have been obvious at the time of the invention to a person having ordinary skill in the art to which the subject matter pertains.

Obviousness, as has been explained to me, is based on (i) the scope and content of the prior art, (ii) the differences between the prior art and the claim, (iii) the level of ordinary skill in the art, and (iv) any secondary indicia of non-obviousness (*e.g.*, “secondary considerations” such as commercial success in the marketplace of the claimed invention), to the extent that they exist.

20. I further understand that obviousness may be demonstrated by showing that it would have been obvious to combine the teachings of more than one item of prior art. In determining whether a piece of prior art could have been combined with other prior art or with other information within the knowledge of a person having ordinary skill in the art, the following are examples of approaches and rationales that may be considered:

- Combining prior art elements according to known methods to yield predictable results;
- Simple substitution of one known element for another to obtain predictable results;
- Use of a known technique to improve similar devices (methods, or products) in the same way;
- Applying a known technique to a known device (method or product) ready for improvement to yield predictable results;

- Applying a technique or approach that would have been obvious to try (choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success);
- Known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations would have been predictable to a person having ordinary skill in the art; and
- Some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention.

21. I further understand that an invention may be obvious if one of ordinary skill in the art, facing a wide range of needs created by developments in the field, would have seen an obvious benefit to the solutions tried by the applicant. When there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions, it may be obvious to a person of ordinary skill to try the known options. If a technique has been used to improve one device, and a person of ordinary skill in the art would recognize that it would improve similar devices in the same way, using the technique would have been obvious.

22. I further understand that a person of ordinary skill in the art is a hypothetical person who is presumed to be aware of all of the relevant art at the time of the invention. The person of ordinary skill may be able to fit together the teachings of multiple patents and/or printed publications employing ordinary creativity and the common sense that familiar items may have uses in another context or beyond their primary purposes.

23. I also understand that when considering the obviousness of a patent claim, one should consider whether a teaching, suggestion, or motivation to combine the references exists so as to avoid impermissibly applying hindsight when combining or modifying the prior art. I understand this test should not be applied rigidly, but that the test can be important to avoid such hindsight.

24. I also understand that one of ordinary skill in the art must have a reasonable expectation of success in combining or modifying prior art references.

25. I also understand that all elements of a claim must be considered in an obviousness analysis.

D. Claim Construction

26. I understand that claims are construed from the perspective of a person of ordinary skill as of the effective filing date of the patent application. A “person of ordinary skill in the art” is a hypothetical person who is presumed to have known the relevant art at the time of the invention.

27. I understand that persons of ordinary skill in the art are deemed to read the claims in the context of the entire patent, including the specification and prosecution history. In other words, the terms are not considered in a vacuum.

28. I understand that the claims define the invention and the terms used in the claims are generally given the plain and ordinary meanings they would have to a person of ordinary skill in the art at the time of the effective filing date of the application. The context of a claim can be particularly helpful, and other claims may inform the meaning of a term in a particular claim.

29. I understand that claim terms are normally used consistently throughout a patent. Thus, the meaning of a term may help inform the meaning of the same term in other claims. Differences between claims may also help define the terms, although this may not be the case where the specification or prosecution history indicate that such differences do not impact the scope of the claims.

30. I understand that a patentee can act as its own lexicographer by defining a term, in the patent specification, to have specific meaning. It is my understanding that statements made to the patent office by the patentee or its legal representative during prosecution can serve to illuminate, or possibly narrow the proper scope of claim terms, and that such statements must be considered when construing the claim terms. This is sometimes referred to as disclaimer. I have taken into account these principles in my analysis.

31. I understand that reference materials that were publicly available at the time that the patent application was filed, such as dictionaries, treatises or other technical references, may provide context and background for deciphering how one of ordinary skill in the art would have considered the terms used in the claims.

32. However, I understand that such references, as well as testimony (including this report) are generally known as “extrinsic evidence,” and are accorded less weight than evidence found within the patent and prosecution history. In addition, I understand that extrinsic evidence that is inconsistent with the claims, specification, or prosecution history should not be considered in the claim construction process.

E. Standard of Proof

33. I understand that the standard to prove unpatentability in an *inter partes* review proceeding is by a preponderance of the evidence, which means more likely than not.

VI. LEVEL OF ORDINARY SKILL IN THE ART

34. I have considered the level of ordinary skill in the art relevant to the '801 patent. I understand that factors such as the education level of those working in the field, the sophistication of the technology, the types of problems encountered in the art, the prior art solutions to those problems, and the speed at which innovations are made may help establish the level of skill in the art.

35. After reviewing the '801 patent, the relevant portions of the prosecution history of the '801 patent and its reexamination, and cited references, it is my opinion that the relevant art of the '801 patent is in the field of design and fabrication of electronic and optoelectronic devices.

36. Based upon my knowledge of this field, I conclude that a person of ordinary skill in the art ("POSITA") at the time of the alleged invention of the '801 patent (June 27, 2005), and for that matter, at all subsequent times through the present, would have had a Bachelors' degree in electrical or mechanical engineering or a comparable field of study, plus approximately two to three years of professional experience with electronic and optoelectronic device design or other relevant industry experience. Additional graduate education could substitute for professional experience, and significant experience in the field could substitute for formal education.

37. I am and was at the time of the earliest filing date at least a person of skill in the relevant art and I am able to provide insight and opinions into the understandings of such persons at all relevant times by virtue of my education, training and experience.

VII. THE '801 PATENT AND ITS PROSECUTION HISTORY

A. Overview of the '801 Patent

38. The '801 patent discloses a conventional sealant region used in the fabrication of liquid crystal displays that was already well-known in the art before June 27, 2005.

39. The '801 patent discloses conventional materials and layers used in LCD manufacture. For example, the '801 patent describes a first substrate, a predetermined material layer, an organic material pattern layer, and a second substrate. EX1003 Fig. 1C. The '801 patent does not require any specific material for any of these layers and describes different well-known materials that would be used for certain layers. For example, the '801 patent describes the predetermined material layer as a “passivation layer” that may comprise a “silicon nitride layer” as well as a “metal electrode layer” such as “Mo, Ti, Al, Ta, metal oxide, metal nitride, or a combination thereof . . .” *See, e.g., id.*, 2:46-55. Likewise, the organic material layer may comprise “polymethyl methacrylate (PMMA), photosensitive-methylsilsesquiazane (PS-MSZ), or the like.” *Id.*, 2:56-65. These disclosed materials and their uses were well-known at the time.

40. The '801 patent describes an opening in the organic layer to expose the underlying predetermined material layer as was used in conventional LCDs at the time. *See, e.g., id.* Figs. 1C, 2B, 2C. The patent describes forming these

opening using techniques and methods that were well-known in the art, such as etching and photolithography. *See, e.g., id.*, 2:31-36, 2:56-3:14.

41. The '801 patent also describes the conventional and well-known technique of forming these openings such that the sidewalls of the opening form a predetermined angle. *See, e.g., id.*, Figs. 1C, 2B, 2C. 3:15-21. The independent claims require only a “predetermined angle” and do not specify any specific numerical value. *Id.*, cls. 1, 9. The specification and claims describe a variety of example ranges, including “ranges from about 20 degree to about 60 degree, or about 50 degree to about 60 degree, or about 10 degree to about 20 degree, or about 30 degree to about 40 degree, or about 40 degree to about 50 degree, preferably about 20 degree to about 30 degree.” *Id.*, 3:15-21. Utilizing openings with these angles and others, including the methods and techniques for doing so, was well-known prior to the '801 patent.

42. The '801 patent describes the opening as being formed in a sawtooth pattern. *Id.* Figs. 1A, 1B. The '801 patent does not define “saw-tooth” or require any specific saw-tooth shape. And while the patent describes that the sealant “can be evenly distributed on both sides of a central axis S of the sealant region,” it does not teach or require the same distribution for the saw-tooth patterned opening. *See id.*, Fig. 2:17-24, 1B. Creating openings in sealant regions using a variety of saw-

tooth shaped patterns was well known at the time, as were the methods and techniques for doing so.

B. Overview of the 801 patent's File History

43. I have found at least the following from the file history relevant for the reasons noted elsewhere in this declaration.

44. On June 27, 2005, applicant filed Taiwanese Patent Application TW 94121405A. EX1001, cover.

45. On December 28, 2005, applicant filed U.S. Appl. No. 11/319,839. Id.

46. On October 6, 2006, the Examiner issued a non-final rejection, rejecting all claims on obviousness grounds. EX1002, 26-29¹ (Non-Final Rejection).

47. On January 5, 2007, applicant responded without amending any claims and stated that that the primary reference relied on by the Examiner was not prior art to the '801 patent. EX1002, 17-23 (Applicant Arguments/Remarks).

48. On April 3, 2007, the Examiner issued a notice of allowance.

49. On May 16, 2007, the '839 application issued as the '801 patent. EX1001, cover.

¹ For EX1002, I have cited to the pages of the PDF document where the cited office action is located.

VIII. CLAIM CONSTRUCTION

50. I have been asked to consider and apply the claim constructions discussed below. For all claim terms, I have applied their plain and ordinary meaning to a POSITA at the time of the '801 patent, and I have included below a discussion of the plain and ordinary meaning of certain terms.

1. “a predetermined angle” (all claims)

51. The '801 patent does not limit the claimed “predetermined angle” to any particular range of angles. Nor would one of ordinary skill in the art have understood the term to be limited to any particular range of angles. The plain and ordinary meaning of this term, as understood by a POSITA at the time, is not limited to any specific angle or range of angles.

52. For example, some dependent claims place restrictions on the range of the predetermined angle. A POSITA viewing these claims would have understood that the independent claim, which does not include the specific ranges, would include angles outside of those listed. *See* EX1001, claims 2 and 10 (“wherein the predetermined angle is less than about 60 degree”), claims 3 and 11 (“wherein the predetermined angle ranges from about 20 degree to about 30 degree”). Rather a POSITA would have understood a predetermined angle to at least allow for any predetermined angle between 0° and 180°, whether less than 90°, 90°, or greater than 90°.

53. This understanding is consistent with the specification's uses of the term "predetermined." In each case, the '801 patent describes a "predetermined" element and then provides examples of what the element may comprise. For example, the '801 patent describes a "predetermined material layer" followed by identifying specific materials the layer may comprise. *Id.*, 2:46-55 (describing how the predetermined material layer may comprise a "silicon nitride layer," "silicon oxynitride, silicon oxide, organic dielectric layer, or a combination thereof"), 2:27-30 (same). The specification also refers to "a predetermined pattern" (*Id.*, 2:56-65) and "a predetermined sealant" (*Id.*, 3:22-26) in the same manner. In the case of the "predetermined angle", the '801 patent first specifies an angle without identifying any numeric value and then provides various example numeric ranges for the angle. *Id.*, 3:15-21 (listing possible ranges for the predetermined angle).

54. The specification states that certain advantages may not be achieved by predetermined angles in excess of 60° (*id.*, 2:37-40 (describing voids or bubbles formed in the sealant)) and discloses various ranges of angles below 60°. *Id.*, 3:15-21. But these disclosed advantages are not claimed. Further, only a subset of the example ranges disclosed in the specification are claimed and only in certain dependent claims. The prosecution history does not provide any guidance on this issue. One of ordinary skill in the art would have understood that the independent claims must be broader, including allowing for angles greater than 60°.

IX. PRIOR ART REFERENCES

A. EX1005 – Kwak

55. U.S. Patent No. 7,446,336 (“Kwak”) was filed on 2/4/2005, published on 8/25/2005, and was granted on 5/26/2009. I understand that Kwak is prior art at least under 35 U.S.C. §§ 102(e).

56. Kwak teaches improving an LCD display using a specific “sealing function” to reduce “degradation caused by moisture.” EX1005, 2:53-56, 1:15-18. Kwak improves adhesion by creating holes that extend through the organic protective layer to the underlying inorganic layer. These openings allow the sealant to contact both the inorganic and organic layers, and the sealant bond with the multiple layers would help “compensate[] for any weakness in the adhesion between the sealant 810 . . . and the protection layer 180 . . .” EX1005, 9:58-10:4; *see also id.* 2:53-56. The sealant may have a lower bond with an organic layer versus an inorganic layer due to their chemical properties. By creating an opening for the sealant to contact layers below the organic layer, the bond is improved with the bond strength of the sealant and inorganic layer. Increasing the contact area between the sealant and layers would also improve the seal strength. *Id.*, 9:1-12, 9:58-10:4. Increasing the surface area of the openings “increases [] the adhesive strength between the [substrates].” EX1005, 10:50-53, Figs. 3A-C. for example, Kwak discloses openings of various depths, where a deeper opening would expose

more surface area for contact with the sealant. Kwak also teaches angled sidewalls on the openings, which would increase the surface area of the opening as well as the surface area of the sidewalls the sealant contacts. By increasing the surface area by implementing angled sidewalls as taught by Kwak, the bond strength can be enhanced.

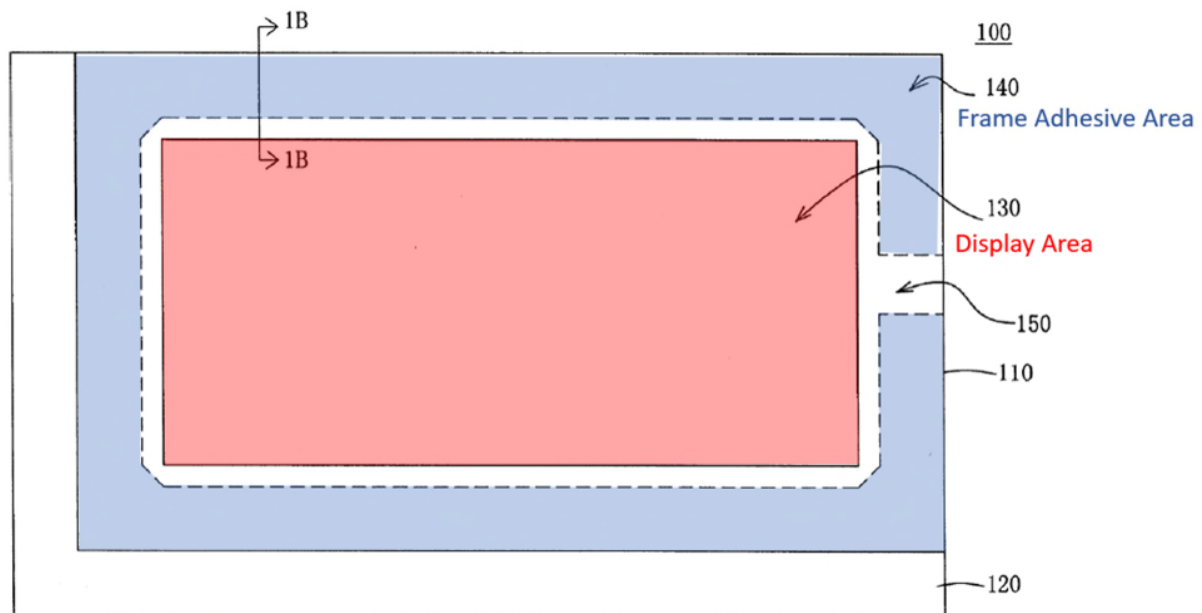
57. Kwak's openings would also "enhance[] protection against moisture infiltration." *Id.* at 11:46-53. First, the increased bond strength and contact with multiple layers would prevent delamination or intrusion between the layers. Kwak also teaches an angled opening on the outside periphery of the layers, such that the sealant is exposed to the outside elements rather than the various layers. *See, e.g., id.* Figs. 2B-D, 3A-C, 4A-C.

B. EX1006 – Zhang

58. Chinese Patent No. CN1538212A ("Zhang") was filed on 10/22/2003 and published on 10/20/2004. I understand that Zhang is prior art at least under 35 U.S.C. § 102(a).

59. Zhang teaches an LCD display implementing a "display panel frame adhesive structure with superior bonding strength." EX1006, 4. Figures 1A-B of Zhang depict a "conventional liquid crystal display panel" and Figures 2A-B depict "a conventional reflective liquid crystal display panel." EX1006, 4-6, 8.

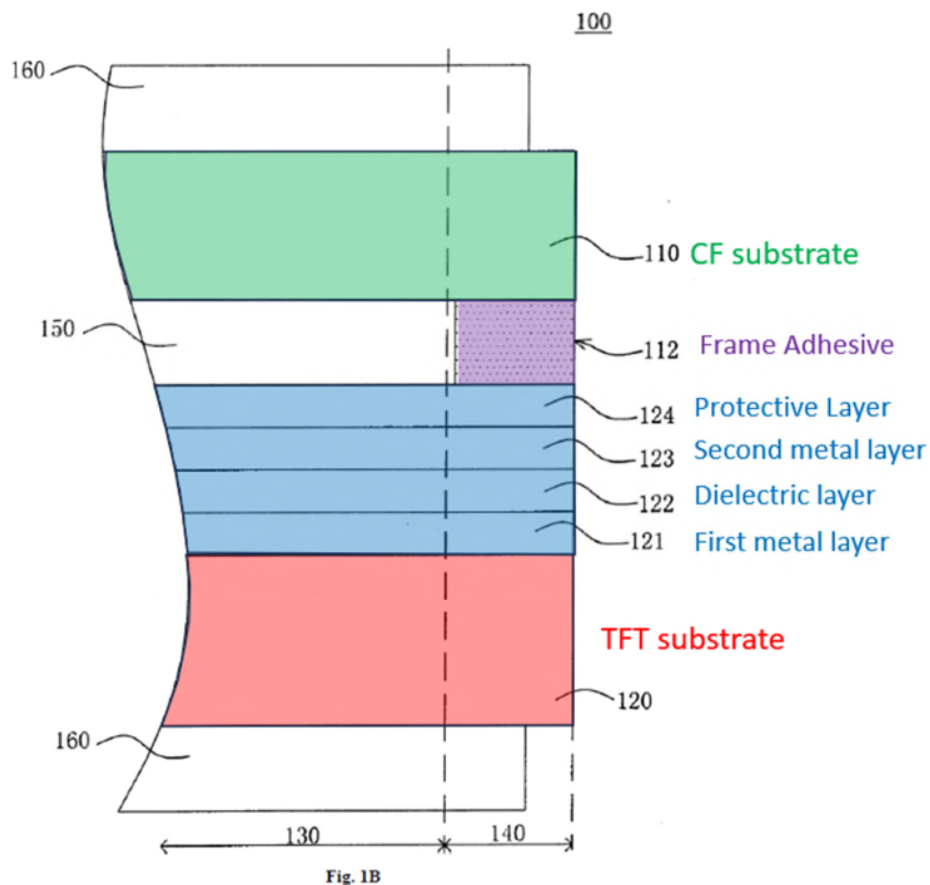
60. Figure 1A depicts a frame adhesive area 140 around the periphery of the display, as shown in the annotated figure below. EX1006, 4, Fig. 1A.



Zhang, Fig. 1A (annotated original)

61. Zhang teaches examples of conventional LCD's that included a TFT substrate (120 and 220) opposite a color filter substrate (110 and 210). EX1006, 4-6, Figs. 1B, 2B. Zhang also teaches conventional LCD's that comprise multiple layers between these substrates, including a first metal layer (121 and 221), a dielectric layer (122 and 222), a second metal layer (123 and 223), a protective layer (124 and 224), and, in the case of conventional reflective LCD's, an organic photoresist layer (225B). EX1006, 4-6, Figs. 1B, 2A-2B. These conventional LCDs included a frame adhesive (112 and 212B), as well as an optional opening

(2120) through the photoresist layer (225B) exposing the underlying protective layer (224) and filled with the frame adhesive. EX1006, 6, Figs. 2B. I have annotated certain figures from Zhang below that depict these teachings.



Zhang, Fig. 1B (annotated original)

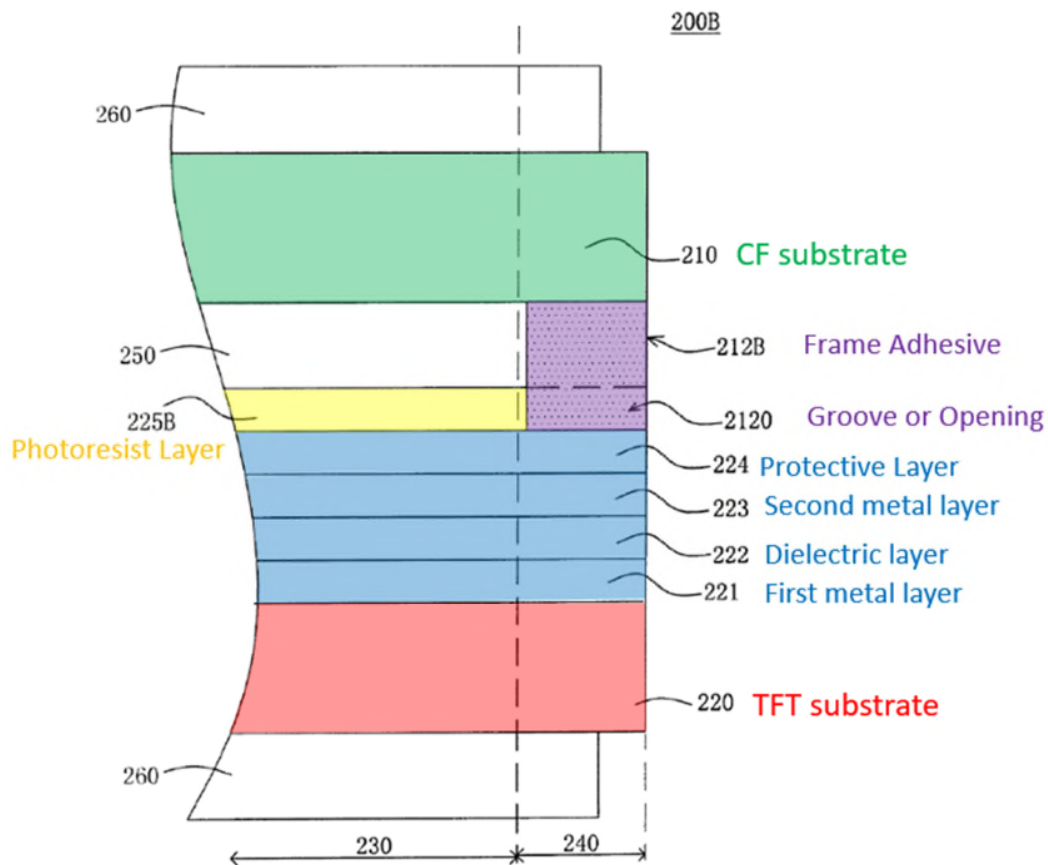
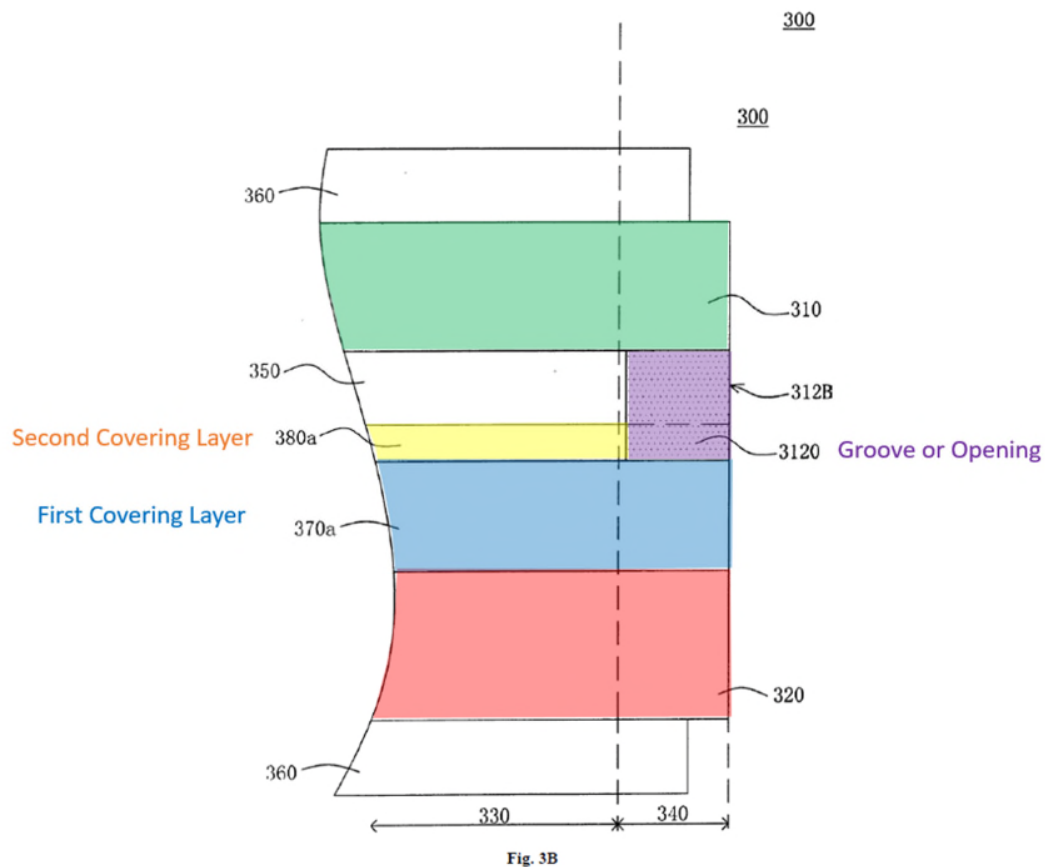


Fig. 2B

Zhang, Fig. 2B (annotated original)

62. The invention of Zhang describes a groove or opening in a second covering layer to expose an underlying first covering layer as depicted in Figure 3B. *See, e.g., id.* at cl. 1. I have annotated the image below to show this.



Zhang, Fig. 3B (annotated original)

63. Zhang discloses that the first covering layer and the second covering layer may each comprise a single layer. *See id.* Fig. 3B. The teachings of Zhang do not require that either of the first or second cover layers comprise specific material or specific types of layers. Instead, the specification provides examples of different combinations of layers that may comprise the first and second covering layers, including a protective layer, a dielectric layer, and one or more metal layers. EX1006, 9-10, Figs. 3C-3E. I have annotated certain figures below to demonstrate this.

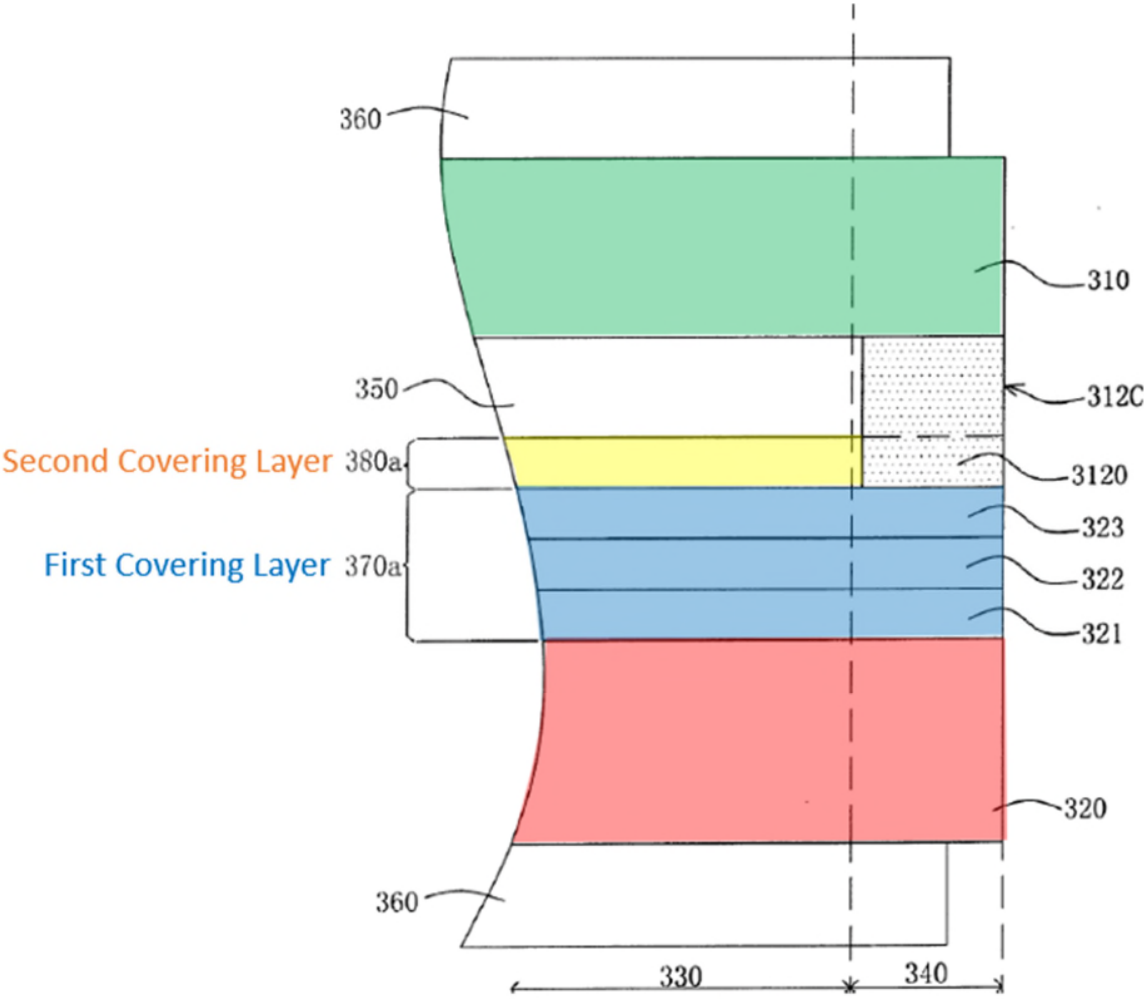


Fig. 3C

Zhang, Fig. 3C (annotated original)

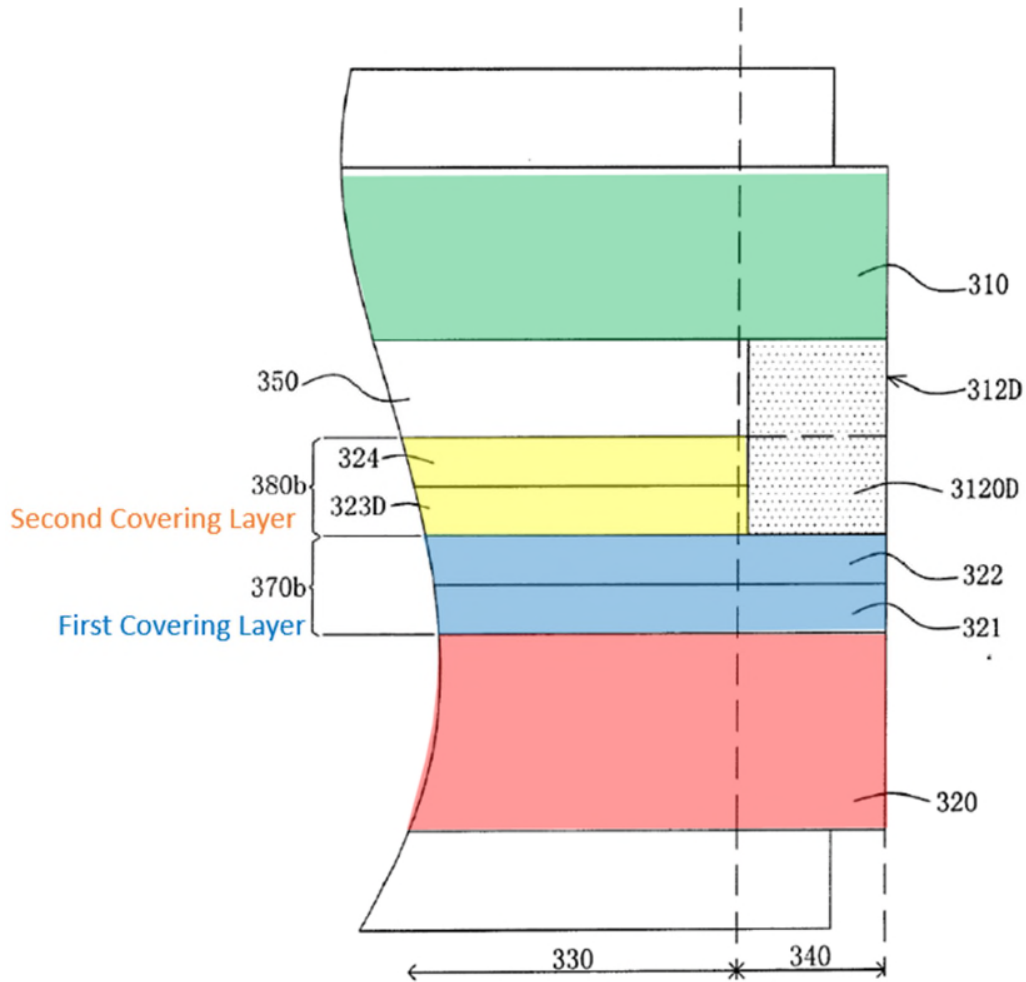


Fig. 3D

Zhang, Fig. 3D (annotated original)

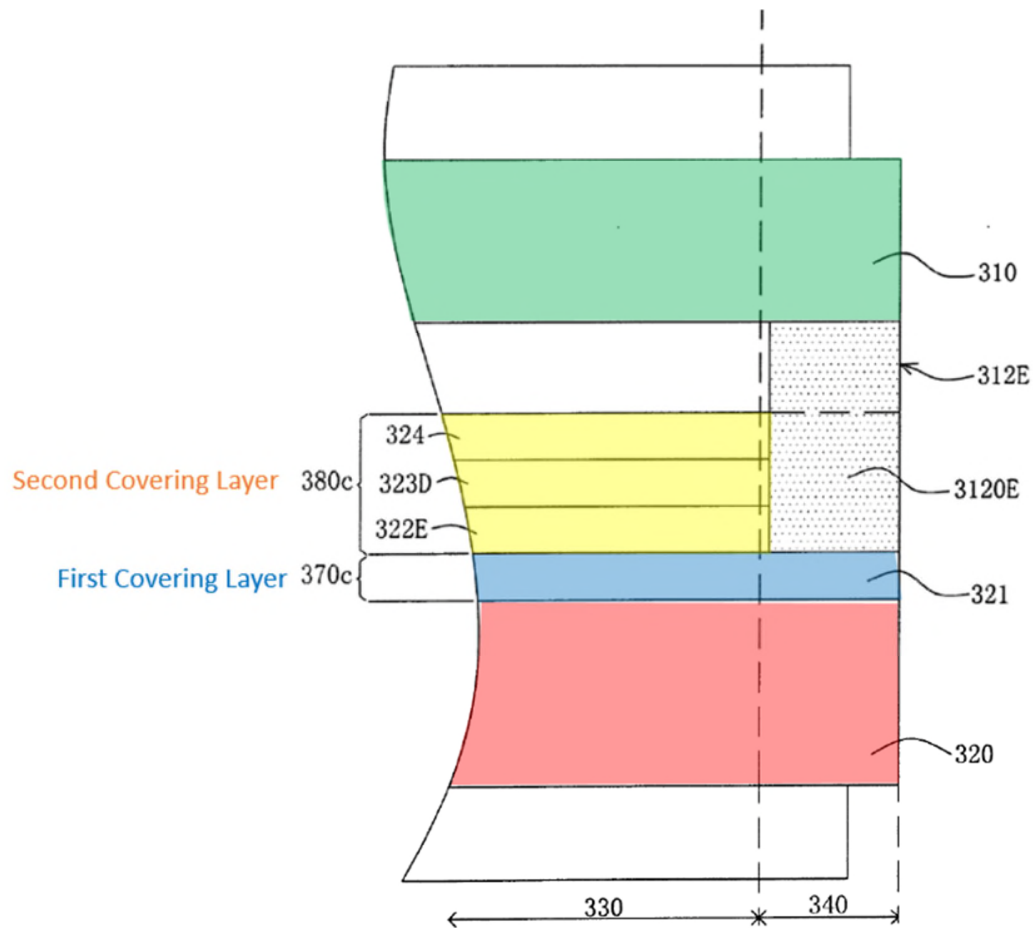
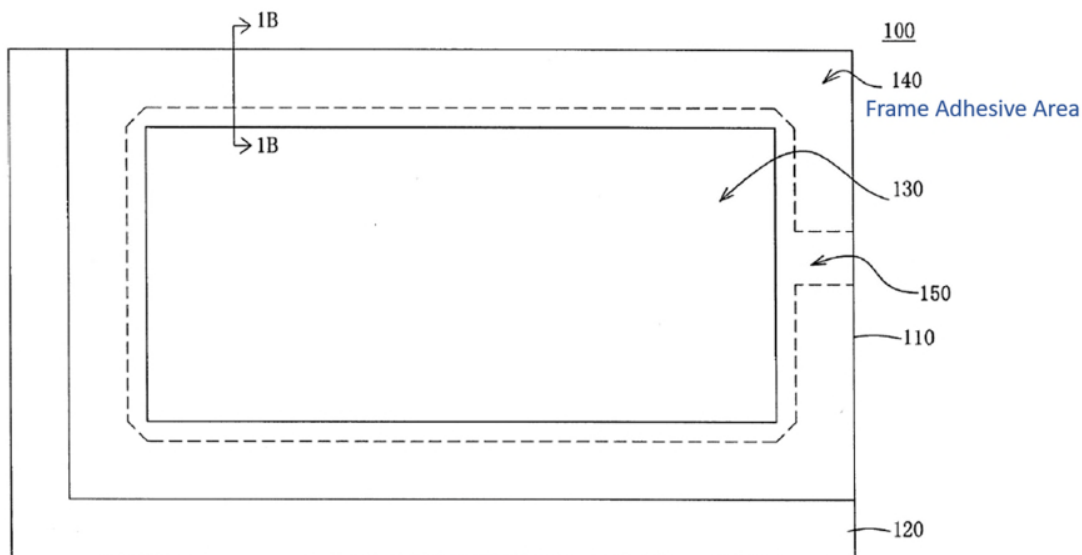


Fig. 3E

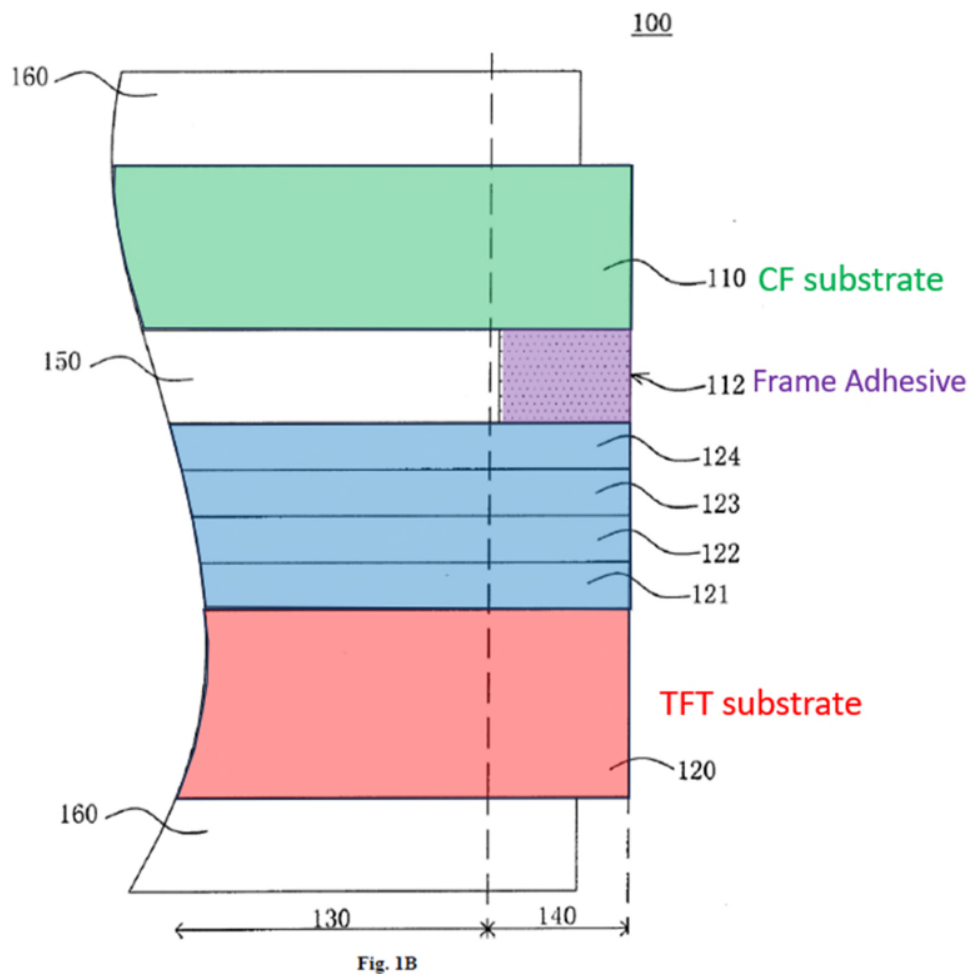
Zhang, Fig. 3E (annotated original)

64. Zhang teaches that “enlarging the openings successively to lower layers achieves the goal of increasing the contact area of the frame adhesive, enabling more adhesive to penetrate into the openings and thus enhancing the bonding strength between the [substrates].” EX1006, 9. Thus, creating an opening through the second covering layer, regardless of how many layers it comprises, would increase the bond strength.

65. Zhang also teaches that implementing these grooves or openings through the second covering layer may take many forms. See EX1006 11, Figs. 3A, 5A, 5B, cls. 5, 7, 8. Figure 1A of Zhang depicts a single flat frame adhesive area 140 on the periphery of the device. *Id.*, Fig. 1A. This frame adhesive area would reside between the color filter substrate 110 and TFT substrate 120 and would have a relatively uniform depth or thickness. Zhang teaches that conventional LCD's may include a single flat band of sealant between the two substrates, without any grooves, holes, or openings.



Zhang, Fig. 1A (annotated original)



Zhang, Fig. 1B (annotated original)

66. Zhang teaches implementing grooves or openings that extend below the conventional adhesive area depicted in Figure 1A and 1B. EX1006, 8-10, Figs. 2B, 3B-E. For example, the sealant fills both the conventional sealant area and the added grooves or openings. *See id.* Figs. 2B, 3B-E.

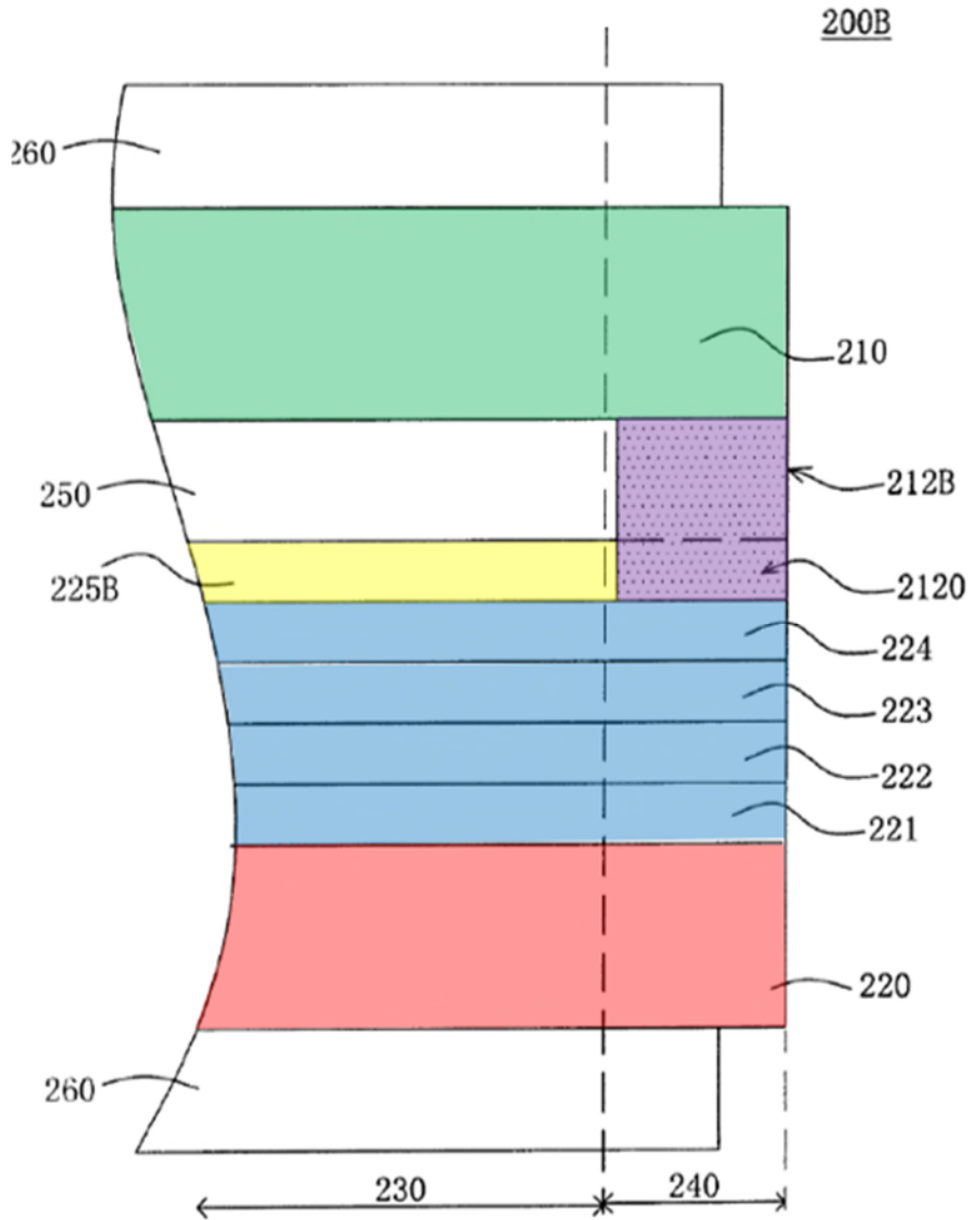


Fig. 2B

Zhang, Fig. 2B (annotated original)

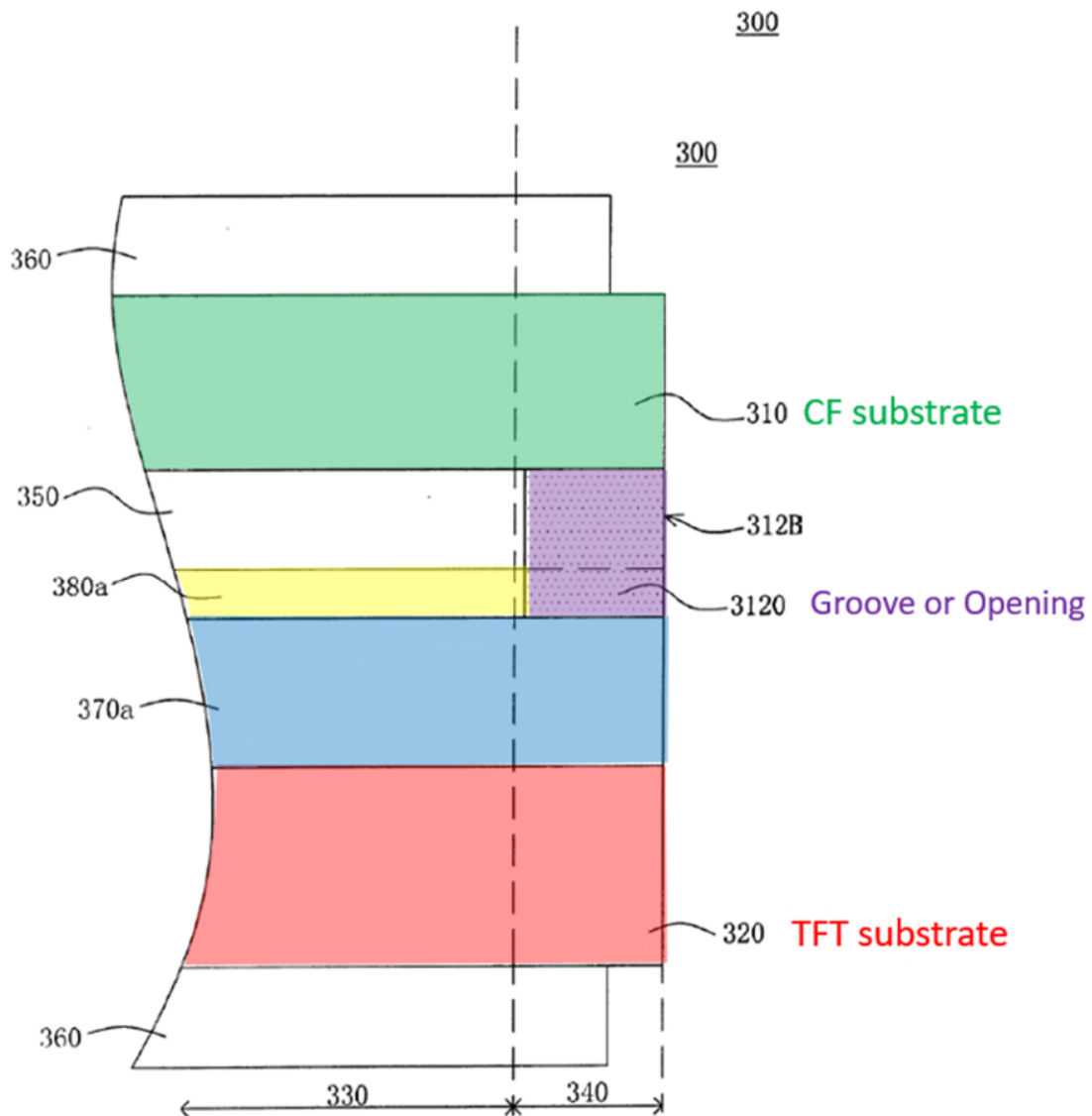
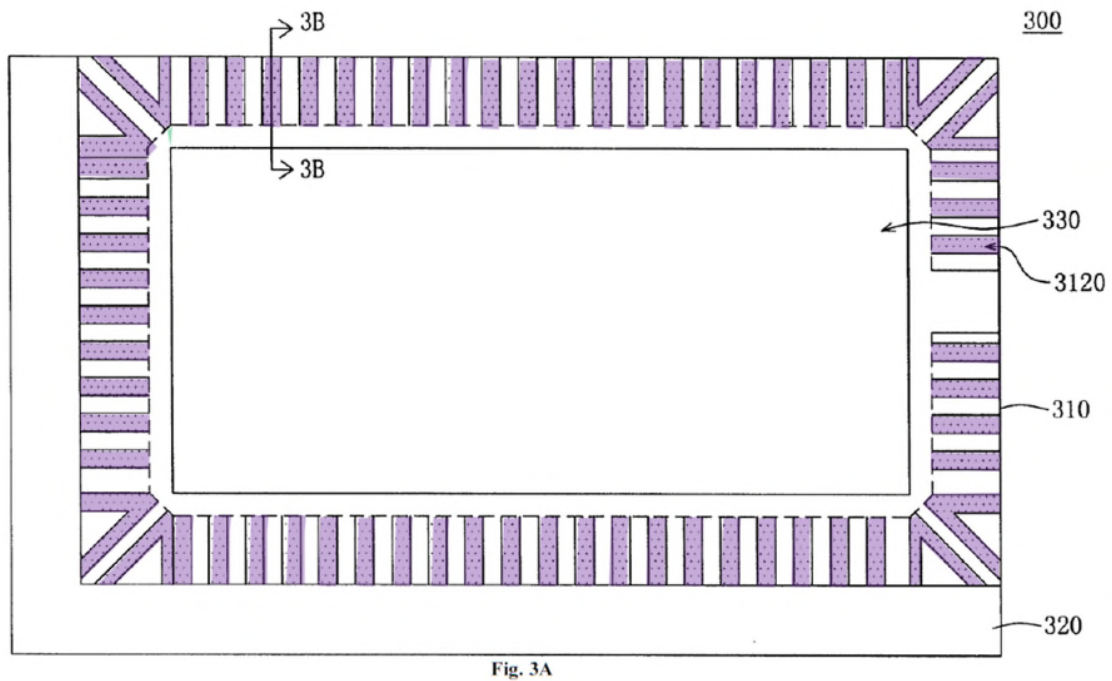


Fig. 3B

Zhang, Fig. 3B (annotated original)

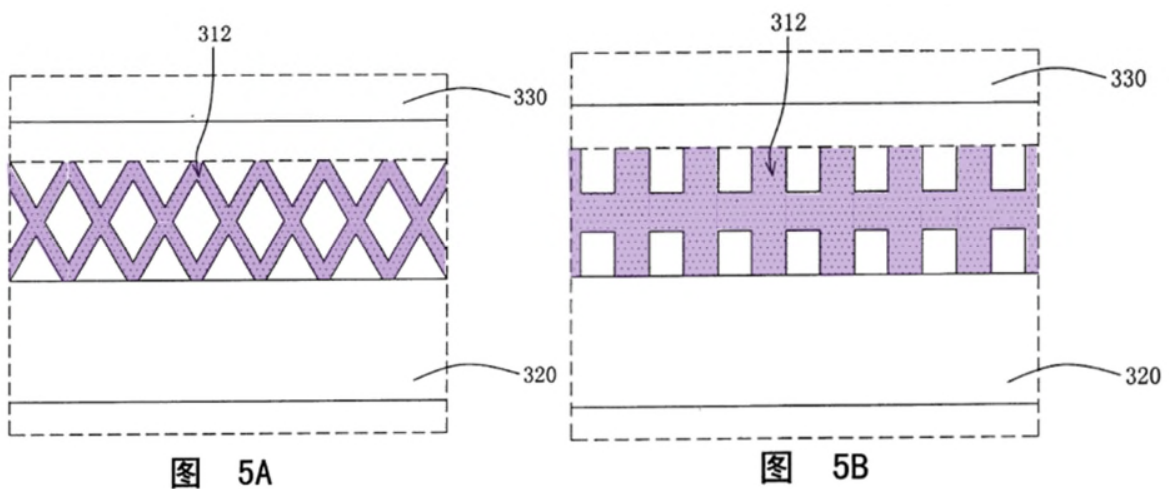
67. Zhang also teaches that these openings may be formed in a pattern.

Figure 3A depicts one example of additional “elongated” grooves or openings 3120 in an alternating pattern around the periphery.



Zhang, Fig. 3A (annotated original)

“The shape of the groove or opening in the display panel of the present invention is not limited to a specific type” and “can also be X-shaped (as shown in Figure 5A) or matrix-shaped (as shown in Figure 5B).” EX1006, 11, Figs. 5A-B.



Zhang, Figs. 5A and 5B (annotated originals)

68. Zhang teaches a number of benefits from implementing its improvements. For example, it teaches “provid[ing] a display panel frame adhesive structure with greater bonding strength.” EX1006 7. “By increasing the contact area of the frame adhesive, more frame adhesive can penetrate into grooves or openings, thereby increasing the bonding strength between [substrates].” *Id.*; *see also id.* 1, 8, 9. Zhang taught increasing bond strength by increasing the surface area for sealant contact using vertical, angled openings through various layers. The increased frame adhesive “can prevent the occurrence of cracks at the interface between the [substrates] . . . , thereby effectively improving the quality of the panel.” *Id.* 1. This improvement “allows the structure to withstand greater external impact or vibration forces, avoiding the generation of damaging cracks between the CF substrate and the TFT substrate, thus affecting the display quality of the panel.” *Id.*, 7.

C. EX1007 – Vaganov

69. U.S. Patent No. 6,406,636 (“Vaganov”) was filed on 6/2/1999 and was granted and published on 6/18/2002. I understand that Vaganov is prior art at least under 35 U.S.C. §§ 102(a), (b), and (e).

70. Vaganov teaches techniques for increasing or enhancing bonding strength in the fabrication of microelectronics and IC packaging. Vaganov discusses, among other things, “increasing mechanical strength” by

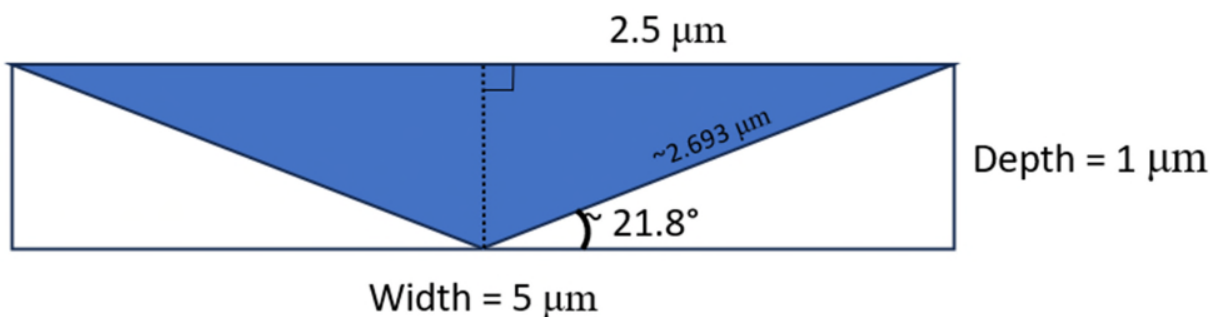
“microprofiling the bonding area,” “providing a larger bonding surface area,” and “increasing the bonding force due to the partial substitution for pull force of shear force.” EX1007 2:57-3:14.

71. Vaganov increases bonding strength by using microstructures with angled sidewalls in the bonded surfaces, which increases the bonding surface area and substitutes pull force for shear force. *See* EX1007 2:57-3:14, 3:29-33, 4:50-5:13, 5:31-39 (discussing replacing tensile stress with shear stress), 5:58-67 (“profiling of the bonding area . . . increases the bonding force and hermeticity due to a larger bonding surface, increases the bonding force due to the partial substitution of pull force by shear force, [and] increases uniformity of bonding”). Vaganov also teaches that microstructures with angled sidewalls can solve reliability issues stemming from “delamination due to insufficient adhesion, cracking or breakage.” *Id.* 6:1-16. Increasing the surface area and thus the amount of sealant between the substrates helps prevent the seal from breaking due to external forces. Increasing the sealant strength would also prevent moisture or other intrusions by increasing the hermeticity of the bond. *Id.* 3:29-33, 4:50-5:13.

72. Vaganov teaches examples of numerous techniques that were well-known in the art for creating different specific, predetermined angles, including methods resulting in angles of 90°, 54°44′, 45°, and 35°16′. *See* EX1007 10:23-12:42, 12:46-52, Figs. 36-55. Vaganov is clear that “[t]he dimensions (depth,

height, angle) of the ridges/ trenches or other microstructures are not critical but are determined by the associated etching processes and by design considerations.” *Id.*, 5:14-22; *see also id.* 2:57-3:14 (describing the various microstructures), 10:23-51, 12:46-53. Vaganov also provides examples of dimensions that would result in an angle less than 30°. *Id.*, 5:14-22. For example, Vaganov describes trenches and other microstructures with a depth ranging from 1-15 μm and a width between 1-5 μm . *Id.*

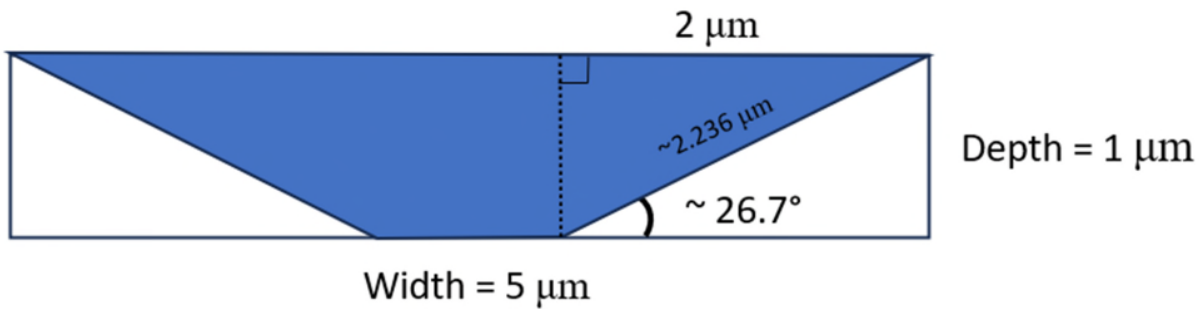
73. For example, an opening with a depth of 1 μm and a width of 5 μm , where both dimensions are within the range of those taught by Vaganov, would have an angle of $\sim 21.8^\circ$. *Id.*



Example of a “triangular” opening with dimensions as taught by Vaganov
The length of the sloped sidewall would be approximately 2.693 μm ($c = \sqrt{a^2 + b^2}$)
 $\rightarrow c = \sqrt{(1^2 + 2.5^2)} \rightarrow c = \sqrt{7.25} \rightarrow c = 2.6925824$). One can solve for the angle
using $\angle \alpha = \arcsin (a/c)$. This particular angle equals $\arcsin(1/2.6925824)$ or
approximately 21.801° . Additionally other forms of openings taught by Vaganov

and using the same dimensions would lead to sidewall angles less than 30° . *See id.*

Figs. 4, 7, 9, 16, 20, 21, 24, 30, 32; *see also id.* Figs. 27, 29, 45-46, 49-50, 52-55.



Example of a “trapezoidal” opening with dimensions as taught by Vaganov

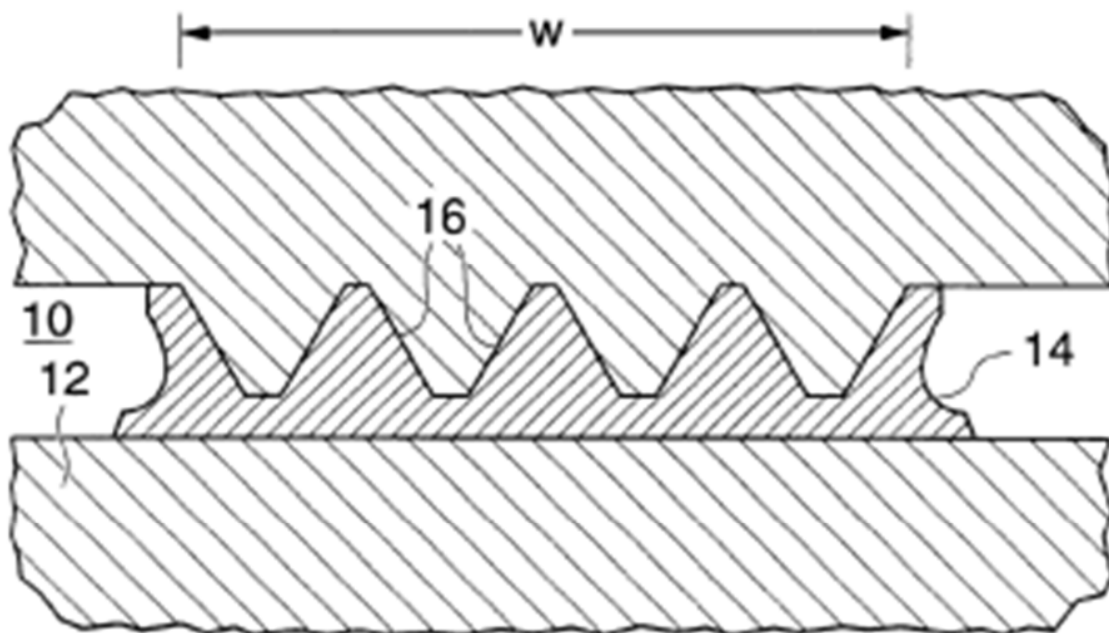


FIG. 4

Vaganov, Fig. 4 (original)

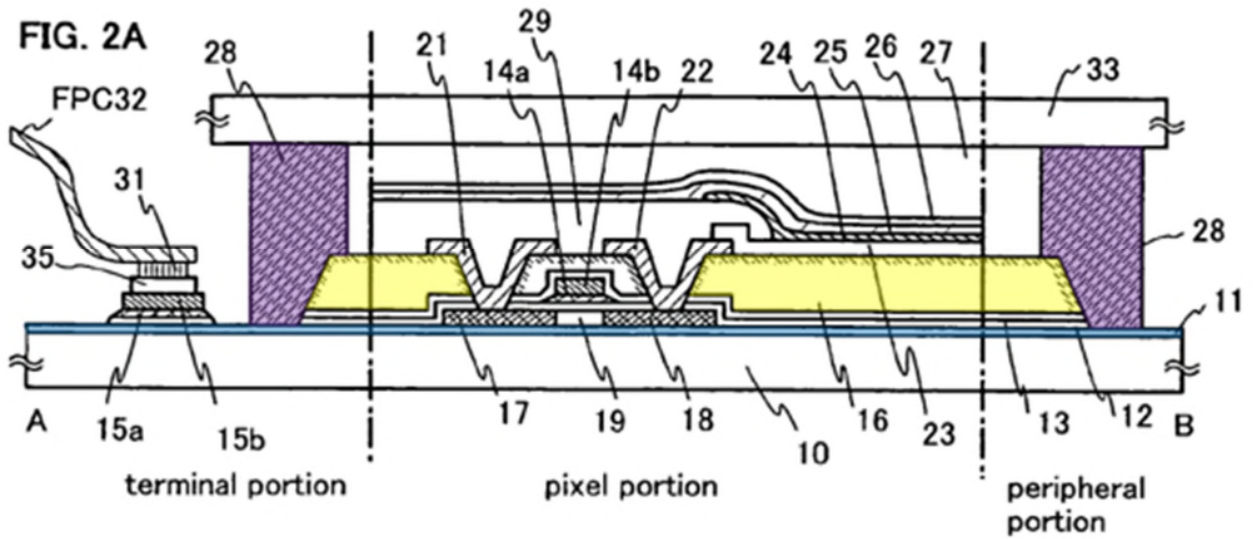
D. EX1008 – Kim

74. U.S. Patent Publication No. 2003/0076452 (“Kim”) was filed on 10/17/2002, published on 4/24/2003, and issued as U.S. Patent No. 7,271,867 on 9/18/2007. I understand that Kim is prior art at least under 35 U.S.C. §§ 102(a), (b), and (e).

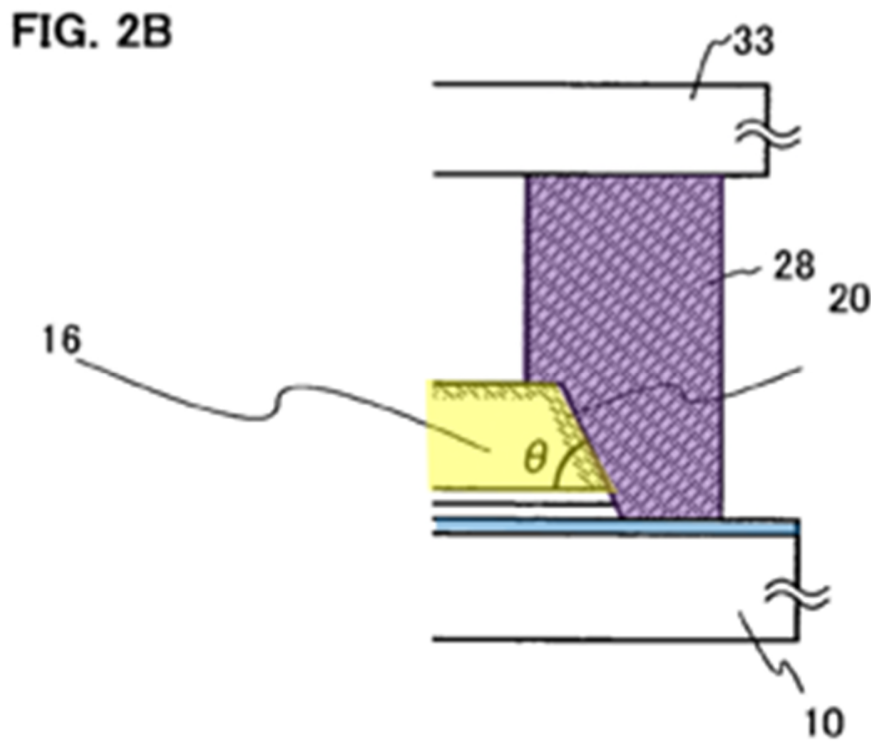
75. Kim describes forming openings in an organic layer comprising sidewall angles between 30-60° to expose multiple various underlying layers. *See, e.g.*, EX1008, 0010, 0055-0065, 0072, 0106, 0119, Figs. 3, 9, 11, 12, 21A. Creating openings with such angles helps to smoothly create overlying layers formed on top of the organic layer. EX1008, 0062, 0074, 0085. The lower angles allow the layer, including a sealant layer to more easily and evenly fill the opening or groove. Steeper angles may lead to the sealant not completely filling the opening. Kim’s method allows an overlay layer, such as an organic insulating layer, to remain sufficiently thick while simultaneously allowing for better contacts through the openings. *Id.*

E. EX1009 – Yamazaki

76. U.S. Patent No. 7,446,336 (“Yamazaki”) was filed on 8/26/2004, published on 3/3/2005, and issued on 11/4/2008. I understand that Yamazaki is prior art at least under 35 U.S.C. §§ 102(a) and (e).



Yamazaki, Fig. 2A (annotated original)



Yamazaki, Fig. 2B (annotated original)

77. Yamazaki discloses an LCD device with sealant (28) between two opposing substrates (10 and 33) where the sealant is formed on an angled opening in a planarizing film 16 to expose an underlying insulating layer 11. EX1009, Figs 2A-B, 3A-B, 8A-B, 9, 10A-B, 11. Yamazaki's sealant region comprises an organic planarizing film with an opening with an "angle θ more than 30° and less than 75° " that exposes the underlying insulating layers to the sealant. EX1009, 1:8-64, 4:1-20, 4:32--5:2, 5:43-49, 7:24-29, 8:28-33, 11:15-12:12, 12:45-48, 19:47-63, Figs 2A-B, 3A-B, 5A-C, 6, 8A-B, 9, 10A-B, 11. Yamazaki teaches that the "planarizing film is an SiO_x film containing an alkyl group," and the side of the planarizing film 16 "is formed to have a . . . taper angle θ more than 30° and less than 75° . *Id.*, 4:64, 5:2, 5:43-49, 7:24-29, 12:45-48, 15:10-11, Fig. 2B. The planarizing film described by Yamazaki comprises organic material. *See id.* 11:15-19 (planarizing film 16 serves as an interlayer insulating film), 4:48-5:2 (explaining that interlayer insulating film "has at least one kind of hydrogen, fluorine, an alkyl group or aromatic hydrocarbon as a substituent"), 11:20-12:12, Figs. 5A-C, 6. For example, the inclusion of hydrogen or an alkyl group in the planarizing film would indicate that the planarizing film is an organic layer. *See id.* Yamazaki thus teaches implementing an angled sidewall in the organic planarizing film 16 such that it forms an angle between 30° - 75° with the underlying insulating layers 11, 12 and 13. *Id.*

78. It is also apparent from the specification and common knowledge that the planarizing film of Yamazaki would be implemented in liquid crystal displays. *See, e.g., id.*, 1:8-64, 4:32-47, 8:28-33 (using planarizing film to prevent defects in a liquid crystal display), 19:47-63, Fig. 11.

79. Yamazaki teaches methods for preventing common issues with moisture or oxygen intrusion, thereby increasing the quality and reliability of display devices, such as traditional liquid crystal displays. *See e.g., id.*, 1:8-3:25, 2:66-3:25, 4:1-20, 19:9-14. For example, implementing a planarizing layer with a tapered slope in the sealant area would decrease moisture intrusion and chances of delamination in the display device. *Id.* 3:46-67. Yamazaki teaches covering the tapered edge of the planarizing film with sealant. EX1009, 4:5-20 (“[P]referably, the edge portion of the high thermostability planarizing film is covered with the sealant so as to overlap with the pattern of the sealant.”). Covering the side and edge of the planarizing film with sealant creates a barrier that shields against intruding moisture or oxygen and prevents deterioration. *Id.*, 5:50-59 (“When the sealant is arranged so as to cover the side surface of the . . . planarizing film, [a] display device with high reliability can be obtained by shielding intruding moisture or oxygen which causes deterioration”). Yamazaki also teaches adding material to the sidewall to increase its density and thus prevent moisture intrusion. *Id.*, 3:46-67, 4:1-20 (“Further, intrusion of moisture or oxygen is prevented by forming the

edge portion of the high thermostability planarizing film to have a tapered shape and adding an inert element there to highly densify”), 12:34-63. The angle of Yamazaki’s angled sidewall—between 30° and 75°—helps facilitate doping the sidewall with the inert element. *Id.*, 12:45-48, 12:60-63. For example, a sidewall with a lower angle, such as 30° would allow for the doping to be more easily applied and reduce areas having too little or too much of the inert element.

F. State of the Art

1. Implementing angled openings in an organic layer was well known at the time

80. Shigeno discloses an LCD device with sealant (105) between two opposing substrates (10 and 102) where the sealant enters into an opening (52) through an organic resin film (5) with an inner wall slope of about 45° and the opening exposes the underlying layer 31a. EX1010, 0071-0083, 0113, 0168, Fig. 4, 14, 32. This implementation would be utilized in liquid crystal display devices. See EX1010, 0005, 0011, 0024, 0089, 0106, 0124-125, 0212-213, cl. 5.

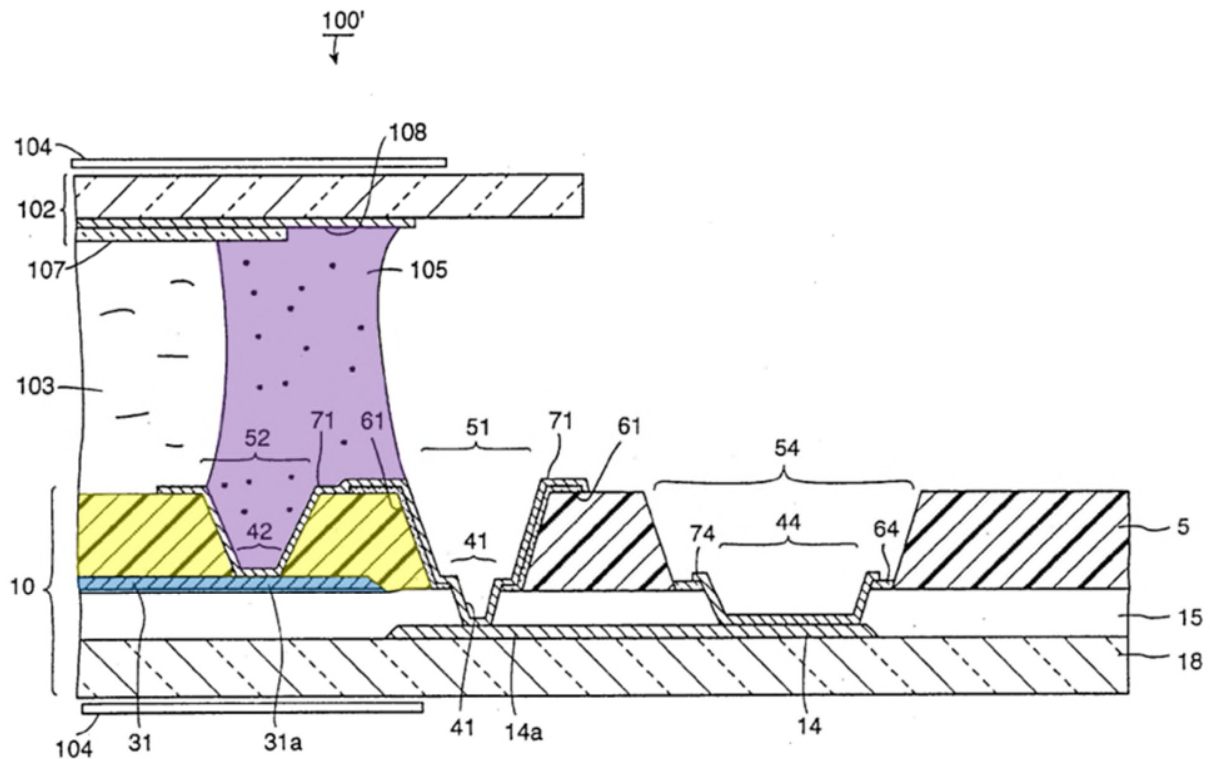
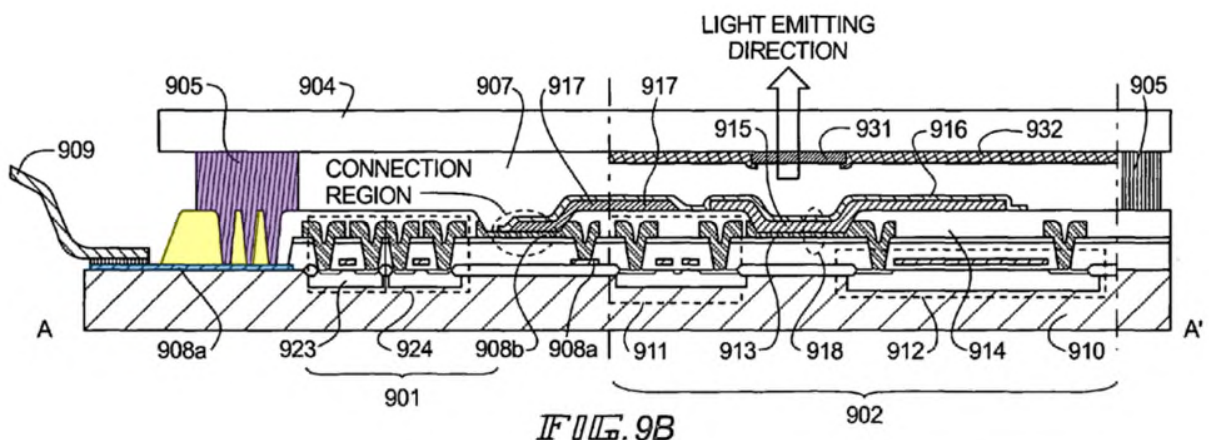


FIG.4

Shigeno, Fig. 4 (annotated original)

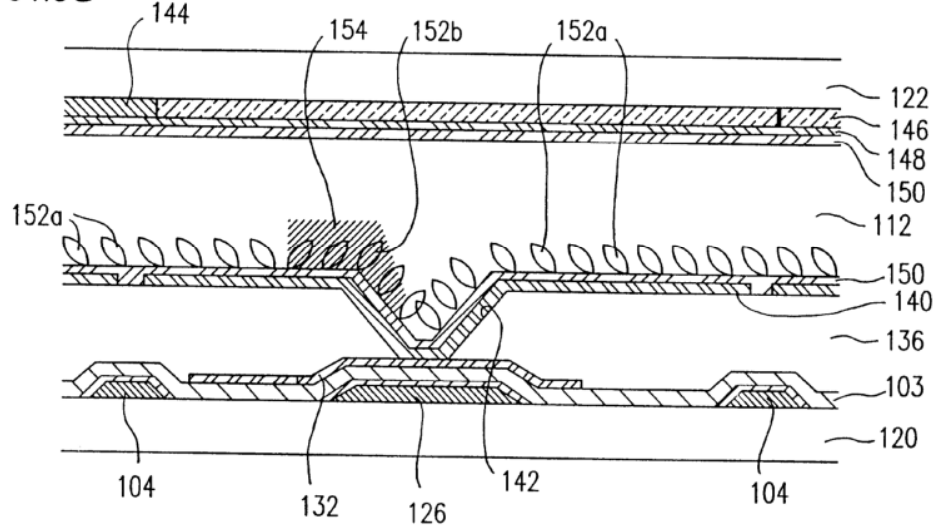
81. Yamazaki 496 discloses a display device with sealant (728) between the periphery of two opposing substrates (710 and 733) where the sealant enters into one or more angled openings in an insulation layer. EX1011, 19:16-21:33, Fig. 9B. The insulation layer taught by Yamazaki 496 may include “a photosensitive or non-photosensitive organic material (polyimide, acrylic, polyamide, polyimideamide, resist, or benzocyclobutene)” and have a “taper angle” from “35° to 55°.” *See id.*, 4:17-29, 8:43-53, 10:20-24, 15:3-13, 15:43-53, 16:23-39, 16:48-54.



Yamazaki 496, Fig. 9B (annotated original)

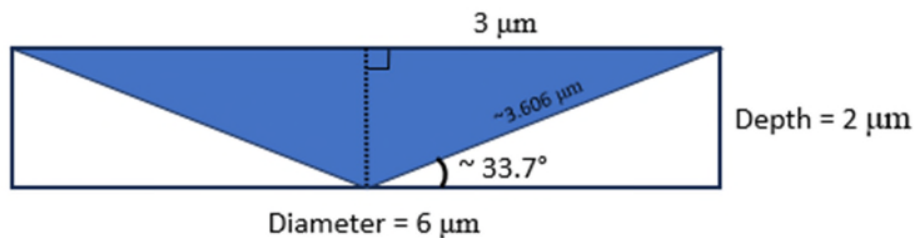
82. Shimada 722 discloses an LCD panel with openings formed in an acrylic resin interlaying insulating film 136 to expose the underlying layers where the “angle θ of an inclined inner wall of each contact hole 142 is preferably between about 45° or more and less than about 65° .” EX1012, 18:47-19:20, Figs. 2A, 11A, 14A, 17, 20, 23, 28. The interlayer insulating film comprising “acrylic resin or the like” indicates that the layer may comprise an organic layer. *Id.*, 10:50-54, 18:47-54.

FIG. 28

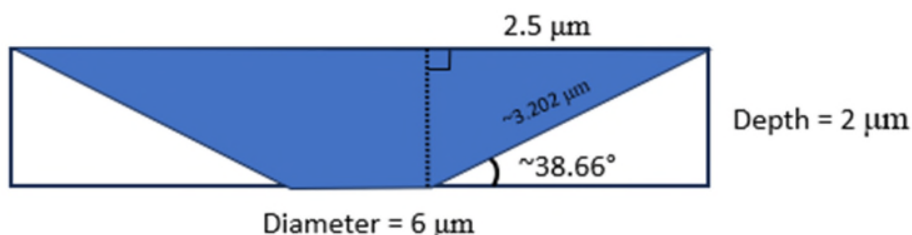


Shimada 722, Fig. 28

83. Shimada 722 describes an insulating film formed with a thickness approximately $2\text{-}4\mu\text{m}$ and contact holes with a diameter of $3.5\text{-}6\mu\text{m}$. *Id.* An embodiment with a hole diameter of $6\mu\text{m}$ (radius of $3\mu\text{m}$) and a depth of $2\mu\text{m}$ would result in an angle of approximately 33° . A trapezoidal opening with an upper diameter of $6\mu\text{m}$, an inner diameter of $1\mu\text{m}$, and a depth of $2\mu\text{m}$ would result in an angle of approximately 38.66° angle. Some examples are depicted below, and other examples would have been possible as well.



Example of a “triangular” opening with dimensions as taught by Shimada 722

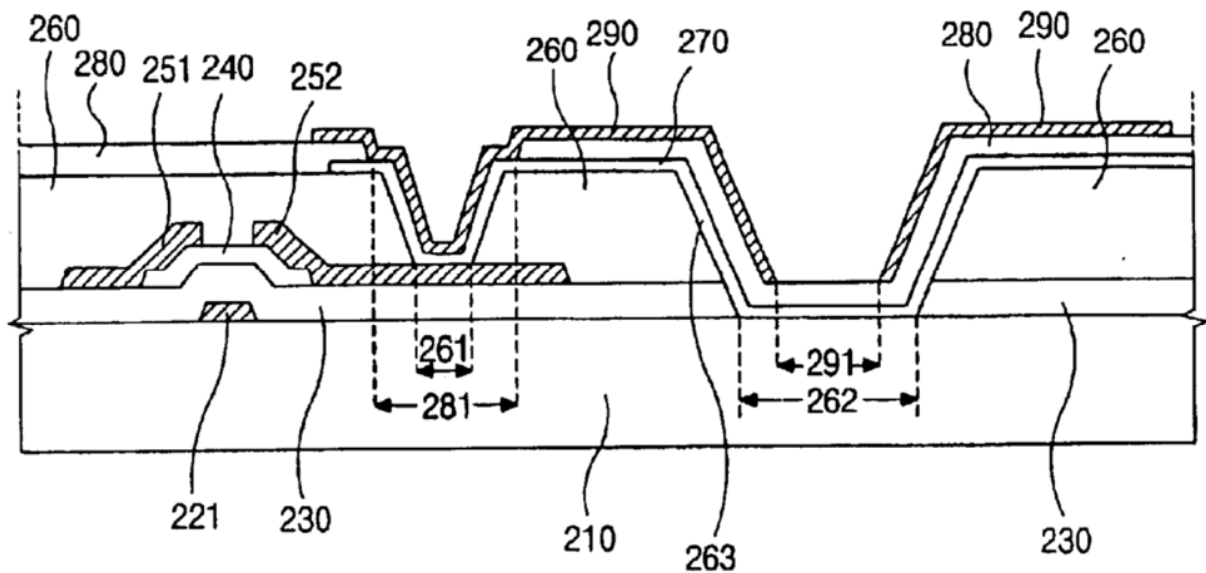


Example of a “trapezoidal” opening with dimensions as taught by Shimada 722

84. Shimada 376 discloses an LCD comprising a photo-sensitive acrylic resin inter-layer insulating film 9 with contact holes 10 that expose the underlying layers. EX1013, 1:52-60, 4:51-5:25, 7:52-59, 8:30-36, 8:61-66, Figs. 3, 5, 10. The disclosure of an acrylic resin layers and layers made of “benzocyclobutene” indicates that the insulating film likely would comprise an organic layer. *See e.g., id.*, 8:30-36 (“photosensitive acrylic resin diluted with a solvent (diethylene glycol ethyl methyl ether) was used as a material for the inter-layer insulating film”), 8:61-9:2 (same as well as “benzocyclobutene”), cl. 2; *See also* Yamazaki 496 (“a photosensitive or non-photosensitive organic material (polyimide, acrylic, polyamide, polyimideamide, resist, or benzocyclobutene)”). Shimada 376 teaches contact holes with sidewalls that are typically between 45° and 60°. *Id.* 1:52-60, 4:51-5:25, 7:52-59, 8:30-36, 8:61-66, Figs. 3, 5, 10. Shimada 376 also explains that smaller angles are possible by modulating the temperature gradient (Table 1) and/or pre-baking temperature (Table 2). *Id.*, 6:4-60, 8:25-60. It would have been readily apparent from Shimada 376’s teachings that the application of these various

temperature variables would result in different predetermined angles, including those of 30° or smaller.

85. Kim 935 discloses an LCD device comprising opposing substrates (10 and 30), and an interlayer/passivation layer formed from a photosensitive resin and including openings that expose the underlying layers, such as a transparent electrode. EX1014, 5:23-57, 7:41-8:30, Figs. 2, 5, 7-10. The sidewalls of the openings form an angle “within a range of about 20 to 110 degrees.” *Id.* 6:22-28, 6:49-53, 9:5-16; *see generally id.*, 8:35-9:57. The disclosure of a passivation layer comprising a photosensitive acrylic resin or benzocyclobutene indicates that the passivation layer likely would be an organic layer. *Id.*, 5:31-33, 6:28-29 (“The first passivation layer includes one of a benzocyclobutene (BCB) and a photosensitive acrylic resin”), 6:53-54, 8:1-3, 9:40-45, 10:6-14, 10:58-67, cl. 5; *See also* Yamazaki 496 (“a photosensitive or non-photosensitive organic material (polyimide, acrylic, polyamide, polyimideamide, resist, or benzocyclobutene”).



Kim 935, Fig. 7

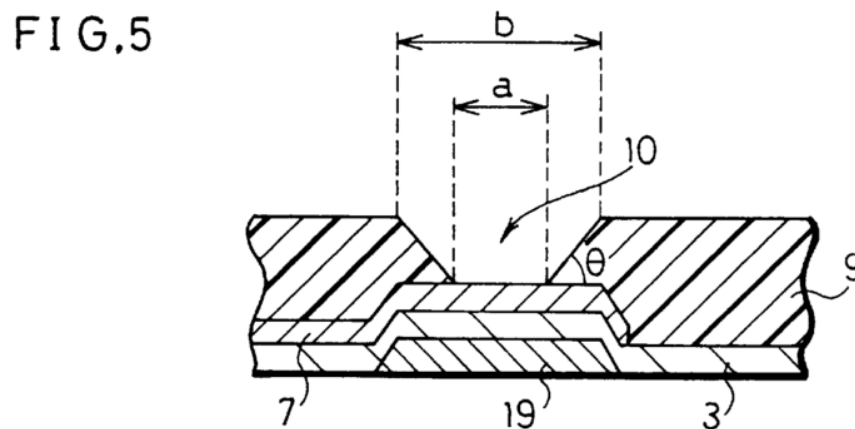
2. Many techniques for creating openings with specific angles were known at the time

86. Vaganov describes known etching techniques, such as anisotropic etching, reactive ion etching, isotropic plasma etching, sidewall masking, and combinations of the same. See EX1007 10:23-12:42, Figs. 36-54. These techniques were well-known and widely used at the time, including for use in fabrication of display panels, semiconductors, and IC's. It was also well known that these techniques were capable of creating a variety of predetermined angles, including 90°, 54°44'', 45°, and 35°16'' depending on variable including the technique used and material being etched. See *id.* Vaganov admits that these "standard etching processes [are] of types well known in the art" and explained that those of ordinary

skill in the art would have already known how to implement these methods.

EX1007 12:46-52, Figs. 36-55.

87. In other references well-known and widely used photolithography methods are used to create a mask pattern with a tapered side edge angle between 50° to 80°. See EX1015, 6:23-41; EX1008, 0132 (referring to using a mask and slit pattern to form angled openings in an underlying organic layer).



Kim, Fig. 5

TABLE 1

Temperature gradient [° C./minute]	Tilt angle θ [degree]	b/a
5	55	2.3
10	45	2.8
15	35	3.6

Kim, Table 1

TABLE 2

Pre-baking temp. [° C.]	Tilt angle θ [degree]
90	50
95	45
100	35

Kim, Table 2

3. The various benefits of utilizing predetermined angles were well known at the time

88. For example, Tanaka describes removing an organic insulating film from the sealant area using “obtuse angles” of the opening to “ensure good adhesion” between substrates. EX1016, 1:49-53, Fig. 7, 8; *see also id.* 2:43-60, cl. 9. Tanaka explains that the “the end surface of each organic insulating film is formed so as to make an obtuse angle with respect to the surface of the array substrate, facilitating contact between the end surface of each organic insulating film and the sealant.” EX1016, 6:60-67. The use of angle openings in an organic layer, like those taught by Tanaka, provide multiple benefits including allowing a more smooth and more uniform application of sealant and to provide barriers or walls that stabilize the sealant within the trench as opposed to the sealant spreading outside of the sealant area. *See* EX1016, 1:65-67, 2:43-60, 6:50-67; 7:13-17.

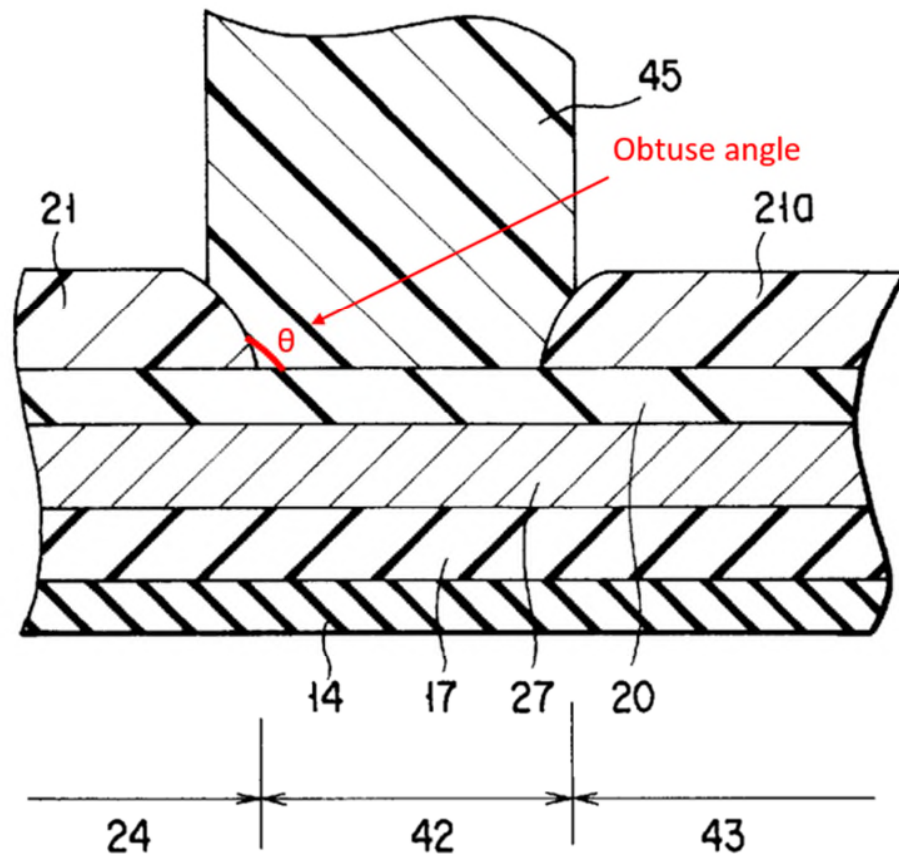


FIG. 7

Tanaka, Fig. 7 (annotated to identify the “obtuse” angle of Tanaka)

89. Miyoshi teaches that angles below 60° and as low as 30° provide benefits such as ensuring a more uniform application of the overlying layer. Miyoshi describes how angles larger than 60° may cause the upper layers “to be thin at the boundary (i.e., the end) of the insulation layer.” EXMIYOSHI 29:42-60. Miyoshi provides test results indicating the benefits of taper angles less than 60° and as low as 30°. *Id.* Table 1.

4. PMMA was a well-known and commonly used component in LCD manufacture

90. Polymethyl methacrylate (“PMMA”) was a well-known and widely used material well before the ’801 patent. PMMA was widely used in the manufacture of electronics and displays. To clarify, PMMA was known by many different names, including generic names such as “acrylic” or “acrylic resin” and trade or brand names such as Plexiglass, Acrylite, Lucite, and various others. PMMA is strong, lightweight, low cost, and moderate impact strength. PMMA is used in a variety of applications including as a glass substitute in outdoor devices and aquariums. In the fabrication of semiconductors and microelectronics, PMMA may serve to assist in the etching or lithography processes. For example, a surface may be coated with a layer of PMMA and then patterns can be etched into the PMMA layer using electron beams, UV light, or X-rays. PMMA is a versatile and easily handled material that allows for complex and detailed patterns to be created.

91. Numerous references and documents indicate the widespread use of PMMA or “acrylic” as it was more commonly called. For example, U.S. Patent No. 7,342,619 to Arakawa et al. discusses LCD panels using “acrylic resins such as polymethyl methacrylate (PMMA).” EX1017, 14:59-63, 14:10-13. U.S. Patent No. 8,076,782 to Asai et al. describes “acrylic resin such as PMMA (polymethyl methacrylate).” EX1018, 18:38-44, 25:31-36. U.S. Patent No. 7,696,100 to

Maekawa describes “a thermoplastic resin . . . such as poly(methyl methacrylate) (PMMA)” and using “PMMA for the insulating film.” EX1019, 4:59-5:3.

X. GROUND 1: CLAIM 9 IS ANTICIPATED BY KWAK

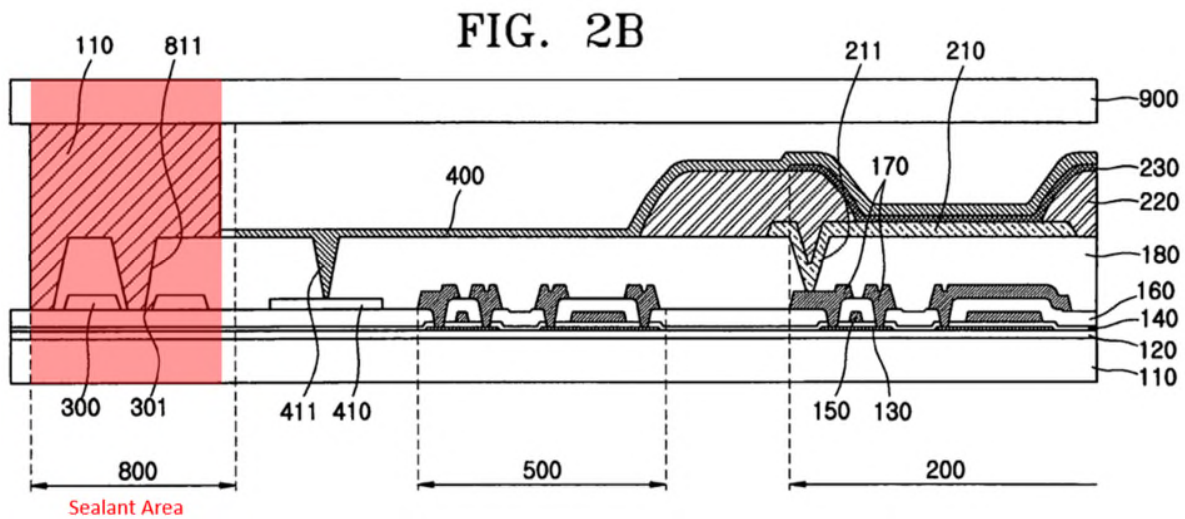
A. Claim 9

92. Kwak anticipates Claim 9.

1. [9pre]

93. To the extent that the preamble is limiting, Kwak discloses “[a] sealant region pattern for a liquid crystal display [*liquid crystal display panel 300*].”² EX1005, 11:30-38, Figs. 1B, 2A-D, 3A-C, 4A-C, 5A-E; *see also id.*, 2:53-3:22, 3:54-5:2, 5:38-52, 8:21-10:4, 10:21-36, 11:56-69, cls. 1, 10-15, 22, 25-26. Kwak discloses a “flat panel display” that comprises “a sealing portion 800 applied to an outer edge of the display area 200 to seal the [substrates].” *Id.*, 6:46-60. The patent also states that its embodiments “can be applied to other types of flat panel displays, such as liquid crystal displays (LCDs).” *Id.*, 11:30-38.

² Throughout this declaration, I have included italicized text within square brackets for certain quotations. To be clear, the text encased in a square bracket within a quote does not appear in the quoted text. Likewise, the italicized text within the square brackets are not part of the quoted text.



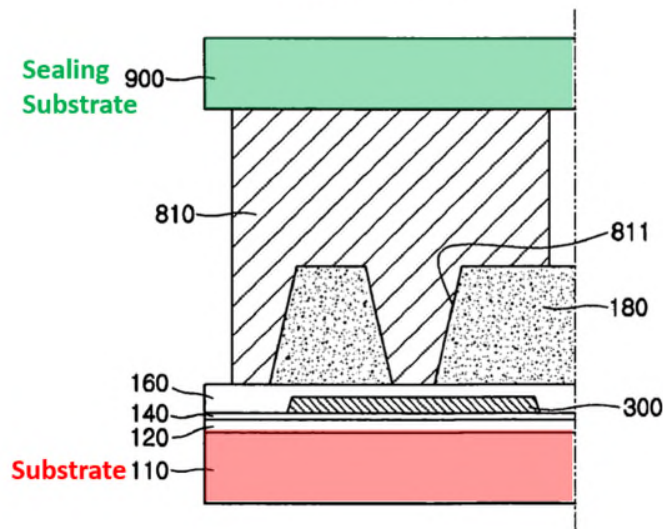
Kwak, Fig. 2 (annotated original)

2. [9a]

94. Kwak discloses “a first substrate [substrate 110] and a second substrate [sealing/encapsulation substrate 900] opposite thereto.” EX1005, 6:52-60, Figs. 2B-D, 3A-C, 4A-C; *see also id.*, 9:58-10:4, 10:36-62, cls. 1, 10-15, 22, 25-26. Substrate 110 and sealing substrate 900 are opposite of one another within the display. *See id.*

³ Figure 2B of Kwak contains a typographical error in which sealant 810 is given the same moniker (110) as substrate 110. All other figures and the specification correctly label sealant 810.

FIG. 2D

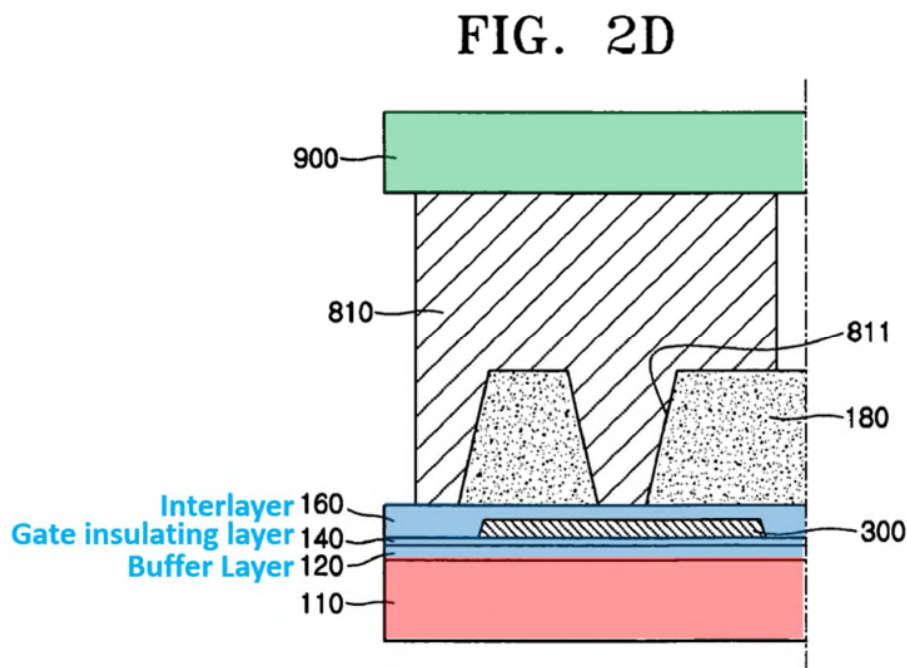


Kwak, Fig. 2D (annotated original)

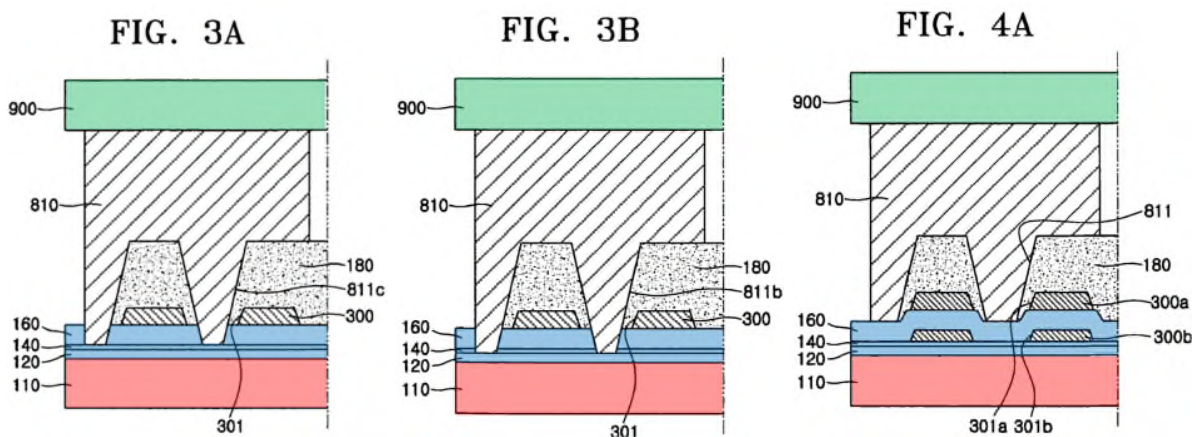
3. [9b]

95. Kwak discloses “a predetermined material layer [*interlayer 160, gate insulating layer 140, and/or buffer layer 120*] formed on the first substrate [*substrate 110*].” EX1005, 6:52-60, Figs. 2B-D, 3A-C, 4A-C. Kwak discloses that the disclosed buffer layer, gate insulating layer, and interlayer may be comprised of inorganic material. *See* EX1005, 3:9-3:49, 3:66-30, 4:54-5-8, 5:15-32, 5:54-6:6, 9:58-10:4, 10:21-62, 11:46-53, cls. 5-7, 10-15, 17-19, 22, 25-28. Kwak further discloses “a gate insulating layer 140 [comprising] SiO₂” and an “interlayer 160, which can be a single layer or a double layered structure [] formed of a material, such as SiO₂ or SiN_x.” *Id.*, 7:3-24, 10:21-36. The predetermined material layer disclosed by Kwak may also include combinations of interlayer 160, gate

insulating layer 140, and/or buffer layer 120, such as interlayer 160, interlayer 160 with insulating layer 140, or interlayer 160 with insulating layer 140 and buffer layer 120. *See id.* Figs. 2D, 3A-B, 4A.



Kwak, Fig. 2D (annotated original)



Kwak, Figs. 3A-B, 4A (annotated originals, showing different opening structures)

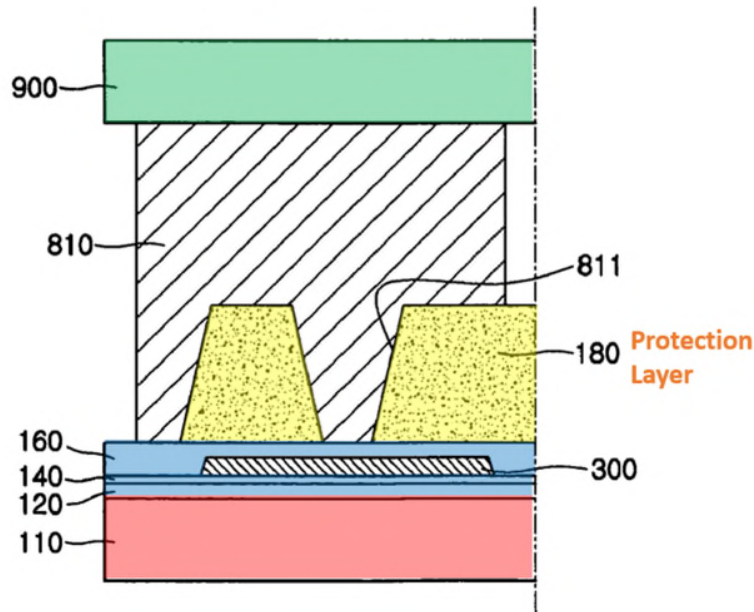
4. [9c]

96. Kwak discloses “an organic material pattern layer [*protection layer 180*] having a saw tooth opening [*e.g., opening or grooves in a saw-tooth pattern, such as in Fig. 5D*] formed on the predetermined material layer [*interlayer 160, gate insulating layer 140, or buffer layer 120*] to expose the surface of the predetermined material layer underneath [*e.g., via opening 811 extends through the protection layer 180 and exposes the underlying predetermined material layer, as shown in Figs. 2A-D, 3A-C, 4A-C*], wherein the surface of the predetermined material layer [*interlayer 160, gate insulating layer 140, or buffer layer 120*] and the sidewall of the organic material pattern layer [*protective layer 180*] form a predetermined angle [*e.g., angled openings as shown in Figs. 2B-D, 3A-C, 4A-C*].”

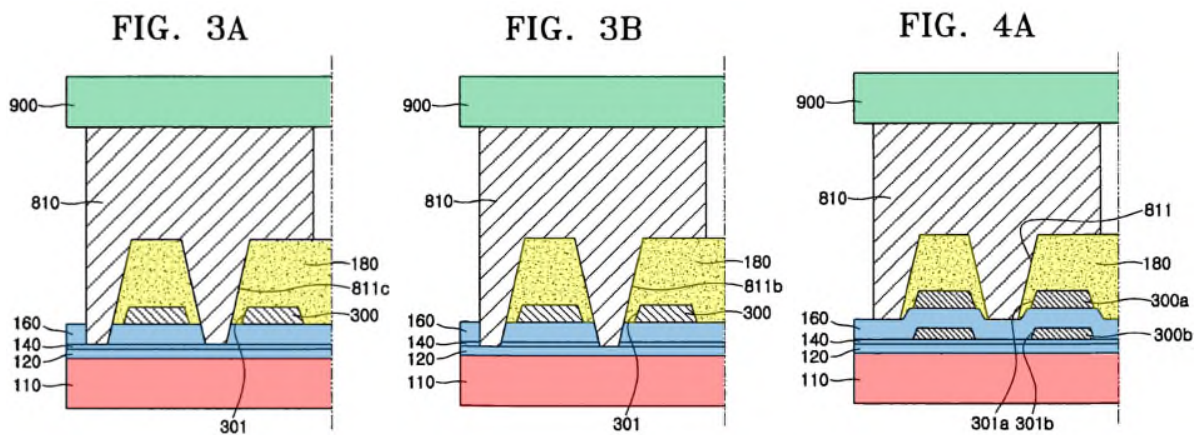
97. Kwak discloses “an organic material pattern layer . . . on the predetermined material layer.” Kwak discloses a “protection layer [*a passivation layer and/or planarization layer*] 180.” EX1005, 7:24-33, Figs. 2B-D, 3A-C, 4A-C. “The protection layer 180 can be formed of . . . an organic material . . . such as a benzocyclobutene or acryl upper layer, or a multilayered structure.” *Id.*, 7:24-33; *see also id.*, 5:3-4, 9:58-10:4 (same), 11:47-53 (“organic protection layer”), cls. 2, 16. The protection layer 180 is formed on the underlying layers, including interlayer 160, gate insulating layer 140, and/or buffer layer 120. *See, e.g., id.*, 3:9-

22 (“an inorganic layer under the protection layer”), 3:66-4:31, 4:54-5:2, 5:53-6:2, 9:58-7:4, 11:46-53, cls. 1, 10-15, 22, 25-28.

FIG. 2D



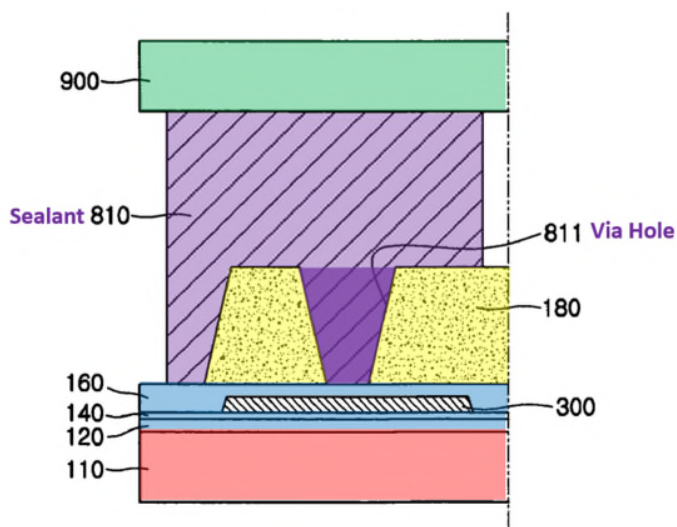
Kwak, Fig. 2D (annotated original)



Kwak, Figs. 3A-B, 4A (annotated originals, showing different opening structures)

98. Kwak's organic protective layer 180 comprises an "opening [*e.g., via hole 811*] . . . to expose the surface of the predetermined material layer [*interlayer 160, gate insulating layer 140, or buffer layer 120*] underneath [*e.g., via hole 811 extends through the protection layer and exposes the underlying layer*]." Kwak teaches a "via hole 811" in the organic protective layer 180 and "at the bottom of the via hole 811 is an inorganic layer [*interlayer 160, gate insulating layer 140, and/or buffer layer 120*] under the protection layer 180." EX1005, 9:58-10:4; see *e.g., id.*, 3:9-22, 3:66-4:31, 4:54-5:2, 5:53-6:2, Figs. 2B-D, 3A-C, 4A-C.

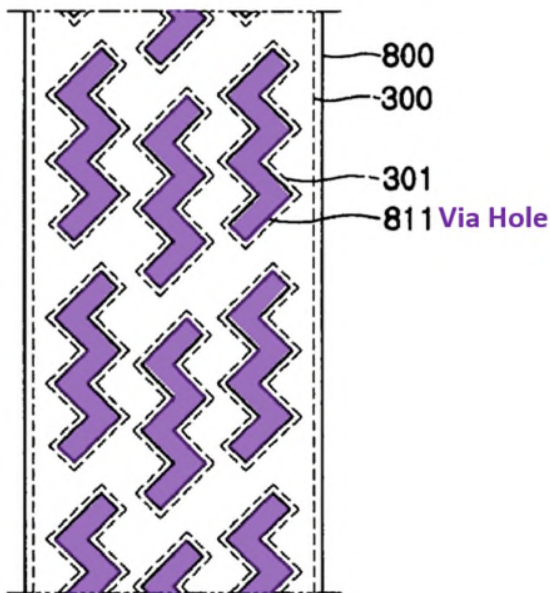
FIG. 2D



Kwak, Fig. 2D (annotated original)

99. Kwak's opening in the protective layer 180 is a "sawtooth opening". "Via hole 811 formed in the protection layer 180, can be formed in various shapes." EX1005, 11:4-29. Figures 5A-E depict different shapes that the openings

811 may take. Kwak discloses a “sawtooth” opening 811, as displayed in Figure 5D, that includes indentions and protrusions evenly distributed across a central axis. EX1005, Fig. 5D.



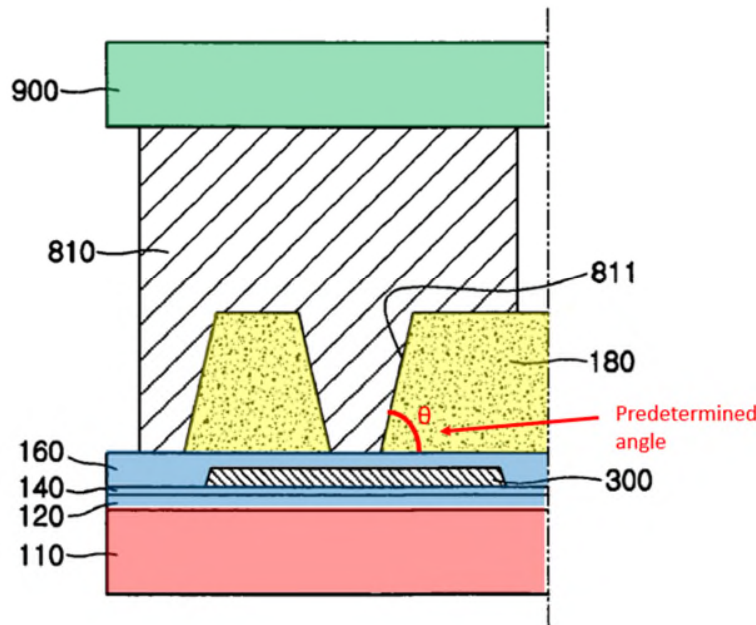
Kwak, Fig. 5D (annotated original)

100. Kwak discloses an opening where “the surface of the predetermined material layer and the sidewall of the organic material pattern layer form a predetermined angle.” *See, e.g.*, EX1005, Figs. 2B-D, 3A-C, 4A-C. The surface of the predetermined material layer (interlayer 160, gate insulating layer 140, and/or buffer layer 120) and the sidewall of the organic material pattern layer (protective layer 180) form a predetermined angle. *Id.* Kwak consistently discloses

implementing openings with the same, less-than-90° angle across its embodiments.

See, e.g., EX1005, Figs. 2B-D, 3A-C, 4A-C.

FIG. 2D



Kwak, Fig. 2D (annotated original, showing predetermined angle)

XI. GROUND 2: CLAIMS 1-6 AND 9-14 ARE OBVIOUS OVER KWAK

A. Claim 9

101. Kwak in view of the knowledge of a POSITA renders obvious Claim 9.

1. [9pre]

102. For the same reasons discussed under Ground 1, Kwak alone and in view of the knowledge of a POSITA discloses preamble 9pre. *See* Ground 1

(Kwak), 9[pre]. Kwak renders this limitation obvious at least because it anticipates this limitation.

2. [9a]

103. For the same reasons discussed under Ground 1, Kwak alone and in view of the knowledge of a POSITA discloses limitation 9a. *See* Ground 1 (Kwak), 9[a]. Kwak renders this limitation obvious at least because it anticipates this limitation.

3. [9b]

104. For the same reasons discussed under Ground 1, Kwak alone and in view of the knowledge of a POSITA discloses limitation 9b. *See* Ground 1 (Kwak), 9[b]. Kwak renders this limitation obvious at least because it anticipates this limitation.

4. [9c]

105. For the same reasons discussed under Ground 1, Kwak alone and in view of the knowledge of a POSITA discloses limitation 9c. *See* Ground 1 (Kwak), 9[c]. Kwak renders this limitation obvious at least because it anticipates this limitation.

106. To the extent that Kwak does not explicitly disclose a “saw tooth opening,” a POSITA would have had the knowledge, skill, and motivation to modify Kwak to comprise “saw tooth”-shaped embodiments. Kwak explained that

the shape of the opening “can be formed in various shapes,” such as “square,” “circular,” or “rhombic” shapes. EX1005, 11:4-29. A POSITA would have been motivated to try different shaped openings, including those with additional surface area, at least because Kwak teaches improving sealant bond by enlarging the contact area with the underlying inorganic layer. EX1005, 10:58-11:4, 11:47-53. A POSITA would have understood that the organic layer of Kwak would have easily been formed or patterned to include a sawtooth shaped opening.

107. For example, a POSITA viewing the patterns of Figures 5B and 5E would have understood that these patterns would easily be modified to into other shapes, including sawtooth-like shapes as depicted below. One of skill would have understood that the openings along the center axis of Figure 5B could have been replaced with similar openings on either side of the central axis, creating sawtooth shaped openings.

FIG. 5B

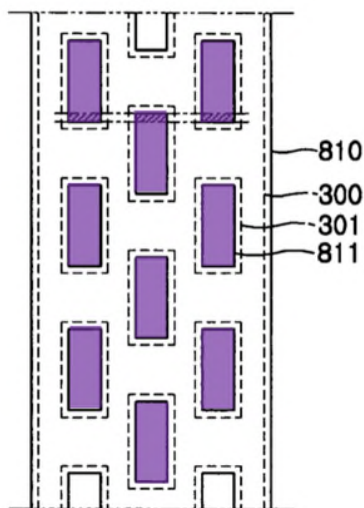
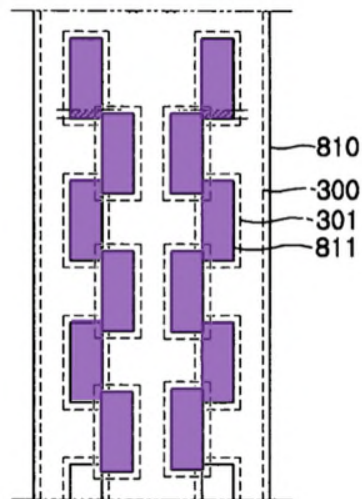


FIG. 5B



Kwak, Fig. 5B (left, annotated original), Kwak, Fig. 5B (right, modified)

FIG. 5E

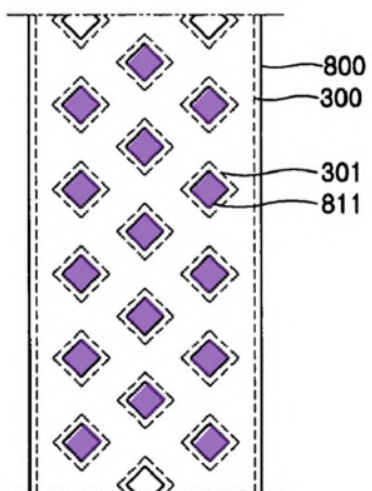


FIG. 5E

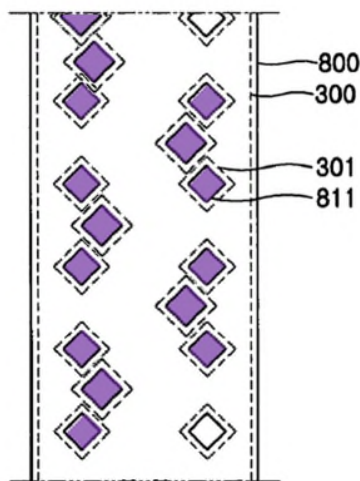
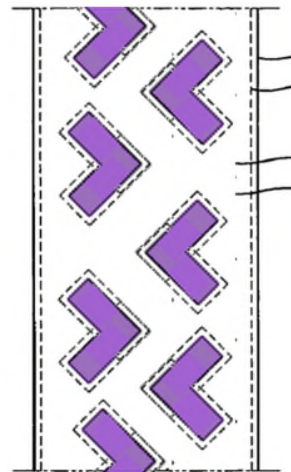


FIG. 5E



Kwak, Fig. 5E (left, original), Fig. 5E (center, modified), Fig. 5E (right, modified)

One of skill would have understood that the openings along the center axis of
Figure 5B could have been replaced with similar, alternating openings on either

side of the central axis, creating sawtooth shaped openings. A POSITA would have also understood this pattern to be refined into chevron or sawtooth shaped openings on either side of the central axis.

108. A POSITA would have been motivated to try these and other pattern variations to increase the contact area between the sealant and the underlying inorganic layer and thus increase the bond strength. A POSITA would have understood it to merely require implementing known methods to achieve expected results with a reasonable expectation of success.

109. To the extent that Kwak does not explicitly disclose that “the surface of the predetermined material layer and the sidewall of the organic material pattern layer form a predetermined angle,” it would have been obvious to a POSITA that the angle of Kwak’s opening would be intentional (i.e., be predetermined) based on design choices, including the etching method employed and related variables such as time and concentration.

110. Kwak discloses the use of a consistent, less-than-90° angle without providing a specific numerical value for the angle. EX1005, Figs. 2B-D, 3A-C, 4A-C. Even without a specific numerical value, a POSITA would have understood that how to create such angled openings, including openings with angles less than 30° or 60°, using techniques known in the art and using that these known techniques would result in a predetermined angle. *See id.*

111. A POSITA would have understood that utilizing angled openings within sealant areas in LCD screens was known—as was shown in various prior art references—, would have known the methods for doing so, and would have understood that doing so merely involved applying known techniques to achieve expected results, such as improving bond strength and seal. *See* IX.E (Yamazaki), IX.F (State of the Art).

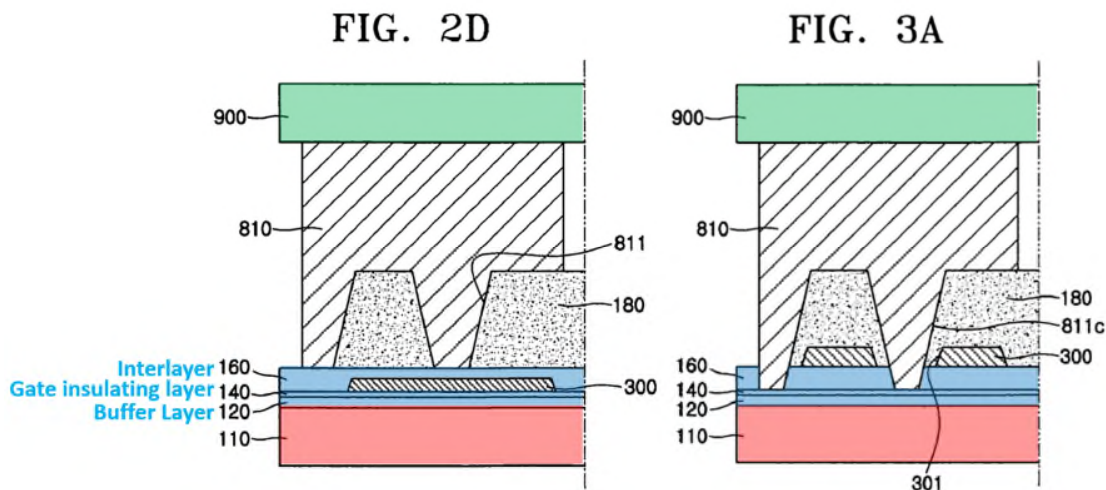
112. Further, various well-known and conventional techniques existed in the art that would form a V-shaped opening comprising predetermined angles less than 90° as described in at least the Vaganov, Sasagawa, and Kim prior art references. *See* IX.C (Vaganov), IX.F (State of the Art).

113. Thus, one of skill would have understood that the angles disclosed by Kwak likely would have been created using these known techniques to achieve known and expected results, particularly to create corresponding predetermined angles. A POSITA would have understood that the angled openings of Kwak would take many forms, ranging from substantially 90° to less than 30° angles and that there were known methods for creating these various angles of the openings in an organic layer. As explained here and in the prior art references such as Vaganov, implementing these known methods to achieve openings with a predetermined angle would have been within a POSITA's knowledge and skill and a POSITA would have a reasonable expectation of success in doing so.

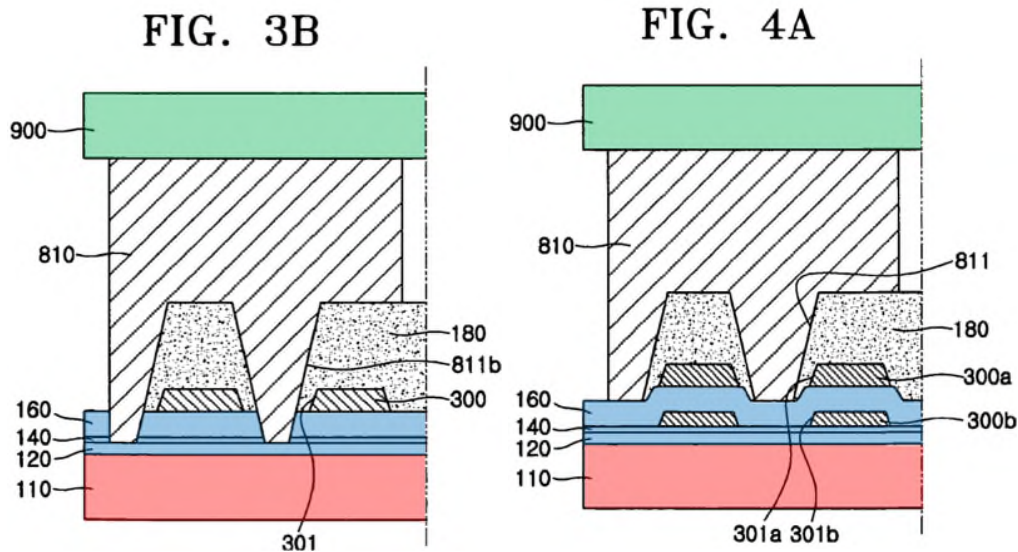
B. Claim 10

114. Kwak alone and in view of the knowledge of a POSITA discloses “[t]he sealant region of claim 9, wherein the predetermined angle is less than about 60 degree.” *See* (Ground 1 – Kwak), claim 9.

115. Kwak discloses an opening 811 that extends through the protective layer 180 to expose the inorganic layer below (i.e., interlayer 160, gate insulating layer 140, and/or buffer layer 120). *See* EX1005, 9:58-10:4; *see e.g., id.*, 3:9-22, 3:66-4:31, 4:54-5:2, 5:53-6:2, Figs. 2B-D, 3A-C, 4A-C.



Kwak, Figs. 2D and 3A (annotated original)



Kwak, Figs. 3B, and 4A (annotated original)

116. Kwak does not identify a numerical value for its angles, but it would have been obvious to a POSITA that the use of common manufacturing methods and the design choices would create openings with an angle less than 60° and even less than 30° . A POSITA would have understood, as demonstrated by the state of the art disclosed in prior art references, that the openings in Kwak's protective layer would utilize an angle less than 60° and even as low as 20° - 30° . *See IX.C (Vaganov), IX.D (Kim), IX.E (Yamazaki), IX.F (State of the Art).*

117. When implementing the teachings of Kwak, a POSITA would have been motivated to apply these known methods to create an opening with an angle below 60° and even less than 30° at least because a POSITA would have understood that these methods and angles would provide the same benefits sought by Kwak. One benefit described by Kwak includes how the opening through the

organic protective layer to expose the underlying inorganic layer can “compensate[] for any weakness in the adhesion between the sealant 810 . . . and the protection layer 180 . . .” EX1005, 9:58-10:4; *see also id.* 2:53-56, 9:1-12 (“the contact area with the sealant 810 can be increased and the seal improved”). “This improves the seal and enhances protection against moisture infiltration.” *Id.* at 11:46-53. Kwak’s angled openings offer the benefits of increasing sealant strength by increasing the contact area between the sealant and the various layers and by improving reliability by preventing moisture infiltration. *See id.*, 2:53-56, 9:1-12, 9:58-10:4, 11:46-53.

118. The benefits of implementing angled openings, and specifically angled openings less than 60° and as small as 20°-30° were well known in the art. *See IX.F (State of the Art)*. Vaganov describes using angled openings in a sealant region to increase the surface area for sealant contact and thus increasing the strength of the seal and preventing cracks and breakage. *See IX.C (Vaganov)*. Tanaka describes creating a sealant region with an opening where the top of the opening is wider than the base of the opening. *See Section IX.F (State of the Art)*. Tanaka teaches implementing these “obtuse angles” such that the sidewalls slope away from the center of the opening leading to improved adhesion between the substrates. *Id.* Miyoshi teaches away from angles above 60° as they may cause the

upper layers to be thin at the boundary or corner and provides test results indicating the benefits of angles as low as 30. *See* Section IX.F (State of the Art).

119. For at least these reasons, one of skill in the art would have understood and would have been motivated to create the angled openings disclosed by Kwak using known techniques that would result in acute angles less than 60° and as low as 20° to 30° and would have a reasonable expectation of success doing so.

C. Claim 11

120. Kwak alone and in view of the knowledge of a POSITA discloses claim 11 for the same reasons explained above. *See* Ground 2 (Kwak), claims 9 and 10.

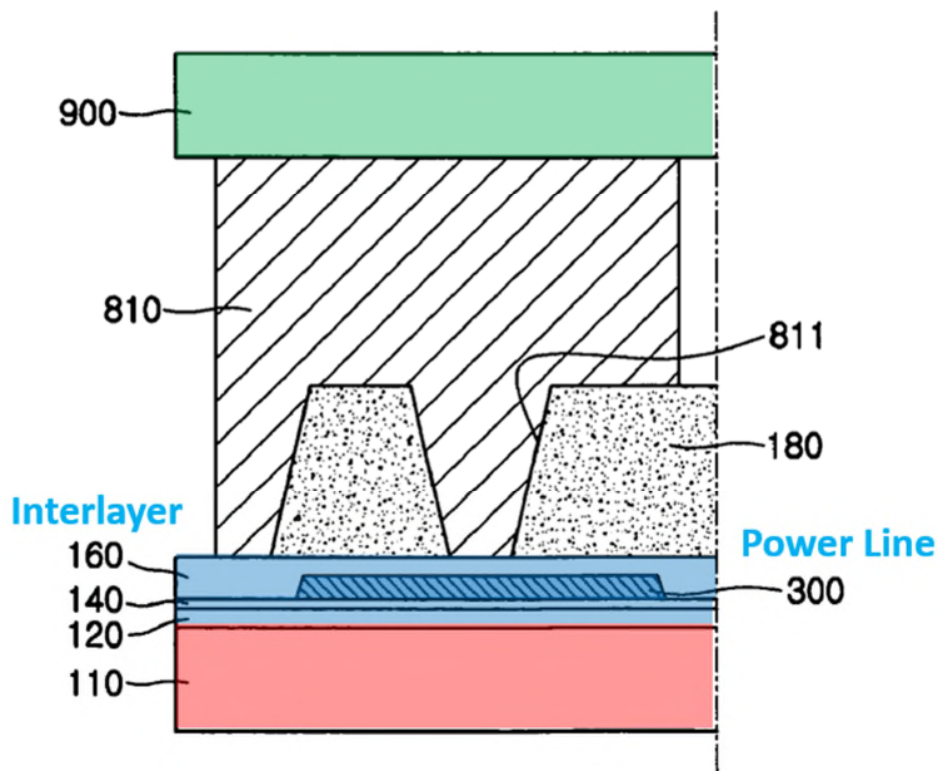
D. Claim 12

121. Kwak alone and in view of the knowledge of a POSITA discloses “[t]he sealant region of claim 9, wherein the predetermined material layer comprises a passivation layer.” Kwak teaches that “interlayer 160, [] can be a single layer or a double layered structure [] formed of a material, such as SiO₂ or SiN_x.” EX1005., 7:3-24, 10:21-36. A POSITA would have understood that Kwak’s silicon nitride interlayer would act as a passivation layer. Even the ’801 patent describes a “predetermined material layer such as a silicon nitride layer 242 . . . serving as a passivation layer.” EX1001, 2:27-30, 2:46-55.

E. Claim 13

122. Kwak alone and in view of the knowledge of a POSITA discloses “[t]he sealant region of claim 9, wherein the predetermined material layer comprises a metal electrode layer.” Kwak teaches that “at least one conductive layer is preferably arranged between the inorganic layer at the bottom of the at least one via hole and the protection layer and includes a layer of the same material as that of a gate electrode on the display area.” EX1005, 5:20-23, 9:1-12, Fig. 2D, 4A-C. “In FIG. 2D, the driving power supply line is the layer 300b formed of the same material as the gate electrode 150.” *Id.*, 10:1-3; *see also* 9:17-22 (“As shown in FIG. 4A, the driving power supply line 300 can include the first conductive layer 300a formed of the same material as the source? drain electrode 170, and the second conductive layer 300b formed of the same material as the gate electrode 150.”), .

FIG. 2D



Kwak, Fig. 2D (annotated original)

123. A POSITA would have understood Kwak to disclose a predetermined material layer (interlayer 160) comprising a conductive metal driving layer (driving power supply line 300).

F. Claim 14

124. Kwak alone and in view of the knowledge of a POSITA discloses “[t]he sealant region of claim 9, wherein the organic material layer comprises polymethyl methacrylate (PMMA) or photosensitive-methylsilsesquiazane (PS-MSZ).”

125. Kwak discloses that protection layer 180 can be formed of . . . an organic material . . . such as a benzocyclobutene or acryl upper layer, or a multilayered structure.” *Id.*, 7:24-33; *see also id.*, 5:3-4, 9:58-10:4 (same), 11:47-53 (“organic protection layer”), cls. 2, 16.

126. A POSITA would have understood that the “acryl” organic material would refer to a form of PMMA. *See IX.F (State of the Art)*. A POSITA would have understood that Kwak’s acryl organic material would be another generic term, like acrylic or acrylic resin, used to refer to PMMA. Kwak’s acrylic organic layer would refer to an organic layer formed of PMMA. A POSITA would have been motivated to use PMMA for the acryl organic layer of Kwak at least because it merely involved application of a known material (PMMA) in a known manner (organic layer) to achieve expected results with a reasonable expectation of success.

G. Claim 1

127. Kwak alone and in view of the knowledge of a POSITA discloses claim 1. *See Grounds 1 and 2 (Kwak)*, claim 9. Claim 1 claims a method of “providing” and “forming” the elements of apparatus claim 9 without further specificity and, therefore, is rendered obvious by Kwak alone and in view of the knowledge of a POSITA. *See Ground 2 (Kwak)*, 9.

1. [1pre]

128. To the extent the preamble is limiting, Kwak alone and in view of the knowledge of a POSITA discloses “A method for forming a sealant region pattern of a liquid crystal display” for the same reasons discussed above regarding claim 9. *See* Grounds 1 and 2 (Kwak), claim 9pre.

2. [1a]

129. Kwak alone and in view of the knowledge of a POSITA discloses “providing a first substrate and a second substrate opposite thereto,” for the same reasons discussed above regarding claim 9. *See* Grounds 1 and 2 (Kwak), claim 9a.

3. [1b]

130. Kwak alone and in view of the knowledge of a POSITA discloses “forming a predetermined material layer on the first substrate,” for the same reasons discussed above regarding claim 9. *See* Grounds 1 and 2 (Kwak), claim 9b.

4. [1c]

131. Kwak alone and in view of the knowledge of a POSITA discloses “forming an organic material pattern layer having a saw tooth opening on the predetermined material layer to expose the surface of the predetermined material layer underneath, wherein the surface of the predetermined material layer and the sidewall of the organic material pattern layer form a predetermined angle” for the

same reasons discussed above regarding claim 9. Grounds 1 and 2 (Kwak), claim 9c.

H. Claim 2

132. Kwak alone and in view of the knowledge of a POSITA discloses claim 2 for the same reasons discussed above. *See* Ground 2 (Kwak), claim 10.

I. Claim 3

133. Kwak alone and in view of the knowledge of a POSITA discloses claim 3 for the same reasons discussed above. *See* Ground 2 (Kwak), claim 11.

J. Claim 4

134. Kwak alone and in view of the knowledge of a POSITA discloses claim 4 for the same reasons discussed above. *See* Ground 2 (Kwak), claim 12.

K. Claim 5

135. Kwak alone and in view of the knowledge of a POSITA discloses claim 5 for the same reasons discussed above. *See* Ground 2 (Kwak), claim 13.

L. Claim 6

136. Kwak alone and in view of the knowledge of a POSITA discloses claim 6.

1. Claim [6a]

137. Kwak alone and in view of the knowledge of a POSITA discloses “The method of claim 1, wherein formation of the organic material pattern layer comprises: forming an organic material layer on the predetermined material layer;

and patterning the organic material layer to form the saw tooth opening therein.”

See Ground 2 (Kwak), claims 9 and 1. Kwak alone and in view of the knowledge of a POSITA discloses “The method of claim 1 (see claim 1, 9), wherein formation of the organic material pattern layer comprises: forming an organic material layer on the predetermined material layer (see [1b-c], [9b-c]); and patterning the organic material layer to form the saw tooth opening therein (see [1c]. [9c]).” See Ground 2 (Kwak), 9 and 1. Kwak discloses these steps to a POSITA by disclosing Kwak’s organic layer 180 is formed on the predetermined material layer (160, 140, and/or 120) and that Kwak’s sawtooth opening (pattern) is created by making “holes” 811 in the organic layer 180. See EX1005, 7:16-8:2. Kwak does not explicitly disclose the precise technique for creating the sawtooth pattern, but the claim is not limited to any particular technique. In the alternative, this claim would have been obvious to a POSITA in light of their knowledge. The lack of description of a precise patterning technique in Kwak would have motivated a POSITA to use a known technique within their knowledge and skill, any one of which would satisfy this claim. See Section IV.C-F (discussing known techniques for forming angled openings in organic layers). A POSITA would have had a reasonable expectation of success in using known techniques to pattern the holes 811 in organic layer 180 for the predictable result of patterning. Specific examples of techniques disclosed

in Vaganov, Kim and Yamazaki for particular angles are incorporated herein by reference. *See* Grounds 3-5; IV.C-F.

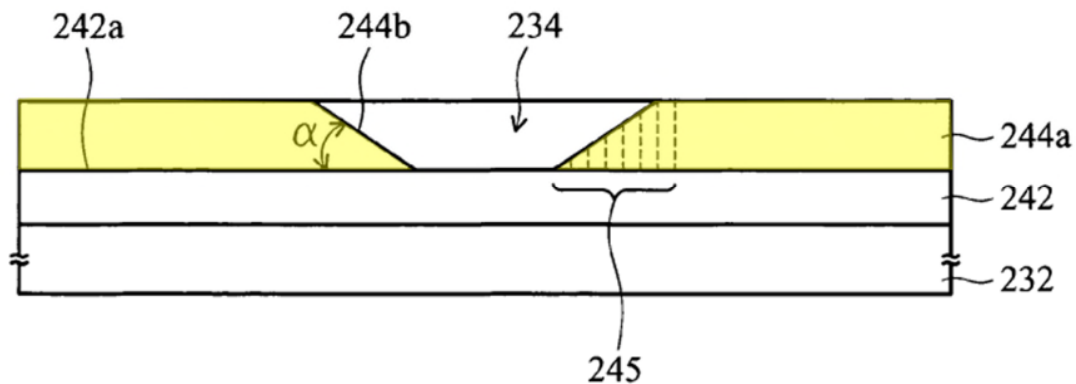
2. Claim [6b]

138. Kwak alone and in view of the knowledge of a POSITA discloses “wherein the organic material pattern layer comprises a plurality of segments adjacent to the saw tooth opening, and the respective height of the plurality segments gradually increases with respect to the distance from the saw tooth opening.”

139. As explained above, Kwak discloses an opening with angled sidewalls such that the height of the segments gradually increases as they move away from the center of the opening. *See* Ground 2 (Kwak), claims 9b, 10, 1b, 2.

140. Claim 6 of the '801 patent requires an opening with a sloping sidewall with an angle less than 90°. Independent claims 1 and 9 of the '801 patent require a “predetermined angle,” which includes a range of angled openings including angles that are substantially 90°. Dependent claims 2, 3, 10, and 11 require that the angle be less than 90°. Claim 6, similar to the other dependent claims, requires that the sidewalls that form either a stepped pattern (potentially with 90° angles) or a continuous slope with an angle less than 90°. The plain language of the claim requires “a plurality of segments adjacent to the saw tooth opening” where the height of each segment gradually increases as it moves away from the opening.

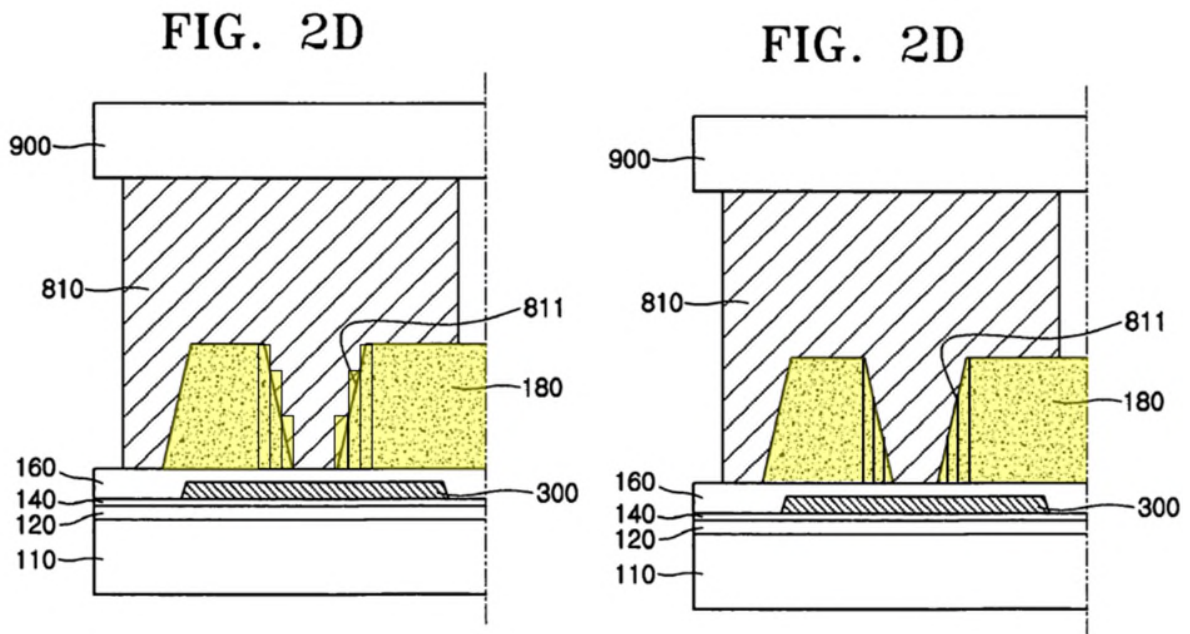
The '801 patent depicts a plurality of segments 245 as a continuous slope with an angle less than 90° as it moves away from the center of the opening. EX1001, Fig. 2B-C.



'801 patent Fig. 2B

141. Kwak teaches a similar opening with an angled slope. A POSITA would have understood that the angled opening of Kwak would include a plurality of segments forming the angled sidewalls. Further, a POSITA would have been motivated to implement gradually increasing segments. For example, a POSITA would have understood that the initial opening may be formed in layers with a step-like side wall. When etching the opening to form the angled sidewall, a POSITA would understand that they only need to etch the incremental edges of the various segments rather than the entire opening, thus reducing cost and increasing efficiency. A POSITA would have been motivated to explore such an

implementation at least because it would merely require applying known techniques to achieve expected results with a reasonable expectation of success.



Kwak, Fig. 2D (left, modified), 2D (right, annotated original)

142. Kwak discloses this limitation at least to the same extent and scope as it is disclosed in the '801 patent.

M. Claim 8

143. Kwak alone and in view of the knowledge of a POSITA discloses Claim 8. See Ground 2 (Kwak), claims 6 and 14.

XII. GROUND 3: CLAIMS 2-3, 6, AND 10-11 ARE OBVIOUS OVER KWAK IN VIEW OF VAGANOV

A. Combination Rationale

144. It would have been obvious to a POSITA to combine Kwak's teachings related to increasing the bonding strength and improving the quality of the LCD panel by preventing moisture degradation with Vaganov's teachings of increasing bonding strength in semiconductors which also increases reliability by reducing cracking or breakage.

145. Kwak teaches angled openings in the sealant region to increase the contact area between the sealant and the various layers, thus increasing the bond strength and improving reliability by preventing moisture infiltration. *See IX.A (Kwak)*. Kwak explains adhesion can be improved by implementing one or more holes that extend through the organic protective layer to the underlying inorganic layer. By allowing the sealant to contact both the inorganic and organic layers, the design of Kwak "compensates for any weakness in the adhesion" between the sealant and the organic layer alone. EX1005, 9:58-10:4, 2:53-56. Kwak also explains that increasing the contact area between the sealant and the layers in general also improves the seal strength. *Id.*, 9:1-12, 9:58-10:4. Widening and/or deepening Kwak's openings "increases [] the adhesive strength between the [substrates]." *Id.*, 10:50-53, Figs. 3A-C. Further, Kwak's openings also "enhance[]"

protection against moisture infiltration.” *Id.* at 11:46-53. Specifically, Kwak teaches a sealant layer around the periphery of the display that protects the layers, such as the organic and inorganic layers, from exposure to moisture and oxygen. Kwak recognized that angled openings in the sealant region would increase the contact area between the sealant and the various layers, thus increasing the bond strength and improving reliability by preventing moisture infiltration.

146. Vaganov is directed to increasing bonding strength by implementing microstructures with angled sidewalls in the bonded surfaces to increase the surface area exposed to the sealant and the volume of sealant that is possible to fit between the substrates. *See* IX.C (Vaganov). The angled sidewalls of Vaganov’s microstructures have the additional benefit of reducing the stress on the seal from external forces by exchanging at least some of the pull force for shear force. *See* EX1007, 2:57-3:14, 3:29-33, 4:50-5:13, 5:31-39 (discussing replacing tensile stress with shear stress), 5:58-67 (“profiling of the bonding area . . . increases the bonding force and hermeticity due to a larger bonding surface, increases the bonding force due to the partial substitution of pull force by shear force, [and] increases uniformity of bonding”). Vaganov also describes how microstructures, including those with angled sidewalls, may solve reliability issues stemming from “delamination due to insufficient adhesion, cracking or breakage,” such as what may occur if the adhesive only contacts the uppermost organic layer. *Id.* 6:1-16.

Vaganov describes creating these angled openings using any one of numerous well-known techniques for creating a variety of predetermined angles of below 60°. *See* IX.C (Vaganov). Such techniques include, but are not limited to, anisotropic etching, reactive ion etching, isotropic plasma etching, sidewall masking, and combinations of the same, which would create a variety of corresponding predetermined angles, including 90°, 54°44'', 45°, and 35°16''. *Id.*, 10:23-12:42, 2:46-52, Figs. 36-55. These techniques, how to implement them, and the specific angles they would produce were well known in the art. *Id.*, 12:46-52, Figs. 36-55. Vaganov explains, and a POSITA would have known, that the specific dimensions and angles of any specific opening would be determined by design considerations and the processes chosen by the implementer and would easily result in angles at or below 30°. *Id.*, 2:57-3:14, 5:14-22, 10:23-51, 12:46-53; *See* IX.C (Vaganov).

147. Kwak and Vaganov are in the same field of endeavor (i.e., disclosing methods for manufacturing electronic devices) and describe implementing their improvements in similar structures. *See* IX.A (Kwak), IX.C (Vaganov), Ground 2 (Kwak) at claims 9 and 10; *see also* EX1005, 11:30-38, Figs. 1B, 2A-D, 3A-C, 4A-C, 5A-E; EX1007, 1:5-61, 3:33-44, 4:50-67, 14:27-35, 14:58-63.

148. A POSITA would have recognized the similar structures, materials, methods, and goals between the two references and would have found it routine

and straightforward to combine Vaganov's specific angled opening with Kwak's angled opening with a reasonable expectation of success. Both references teach methods for improving the sealing bond when encapsulating components between two opposing substrates. Both references teach increasing the surface area for sealant contact by implementing angled opening in the layers. Kwak discloses an organic layer (protective layer 180) that rests above a predetermined material layer (interlayer 160, gate insulating layer 140, or buffer layer 120) and has an angled opening (811) in the organic layer to expose the underlying layers. Kwak describes and depicts openings with various angles, but it does not identify a specific numeric value for implementation. Vaganov discloses numerous methods for creating openings in similar materials that result in specific angles, including 90°, 54°44'', 45°, 35°16'', and less.

149. Both references teach similar improvements that provide similar benefits. Kwak is directed to increasing the contact area for the adhesive, which improves the bond strength. *See IX.A (Kwak)*. The angled sidewalls and increased bond strength have the additional benefit of reducing damage to the seal that might allow for moisture intrusion. *Id.* Vaganov describes techniques for creating openings with angled sidewalls to increase the contact area between the sealant and various layers. *See IX.C (Vaganov)*. A stronger bond would also improve the reliability by preventing intrusion from moisture and oxygen and thus reducing

delamination. *See* EX1007, 1:28-37 (“Bonding also should provide a certain level of hermeticity (airtightness) or permeability”), 1:62-2:27, 2:56-3:4, 3:29-33, 7:6-9. One of skill in the art, recognizing the similar structures and materials, would have found it obvious to combine Vaganov’s teaching of etching methods and a specific angle with Kwak’s angled opening at least because they are directed to solving the same and similar problems (increasing bond strength and decreasing moisture intrusions) and would have merely required implementing known techniques (known etching techniques and specific angles) to achieve predictable results with a reasonable expectation of success.

B. Overview and Incorporation of Grounds 1 and 2

150. Ground 3 relies on everything in Grounds 1 and 2, including the teachings of Kwak, Vaganov, and the knowledge of a POSITA, which are incorporated herein by reference. Ground 3 additionally relies on the explicit combination of Kwak and Vaganov, including the discussions above regarding the motivation to combine, for the claims below.

C. Claim 10

151. Kwak in view of Vaganov discloses claim 10 for at least the same reasons discussed above. *See* Ground 2 (Kwak), claim 10.

D. Claim 11

152. Kwak in view of Vaganov discloses claim 11 for at least the same reasons discussed above. *See* Ground 2 (Kwak), claim 11.

E. Claim 2

153. Kwak in view of Vaganov discloses claim 2 for at least the same reasons discussed above. *See* Ground 2 (Kwak), claim 2.

F. Claim 3

154. Kwak in view of Vaganov discloses claim 3 for at least the same reasons discussed above. *See* Ground 2 (Kwak), claim 3.

G. Claim 6

155. Kwak in view of Vaganov discloses claim 6 for at least the same reasons discussed above. *See* Ground 2 (Kwak), claim 6; IV.C-F.

XIII. GROUND 4: CLAIMS 2-3, 6, 8, 10-11, AND 14 ARE OBVIOUS OVER KWAK IN VIEW OF KIM

A. Combination Rationale

156. A POSITA would have found it obvious to combine Kwak's teachings related to increasing the bonding strength and improving the quality of the LCD panel with Kim's teachings regarding creating openings with a gradual incline in an organic polymer layer to expose underlying layers.

157. Both references describe similar improvements in similar structures to obtain similar benefits. Both references describe sealant techniques used in liquid

crystal displays. Kwak teaches angled openings in the sealant region to increase the contact area between the sealant and the various layers, thus increasing the bond strength, and to improve reliability by providing a barrier between the layers and outside elements and preventing moisture infiltration. *See* IX.A (Kwak), Ground 2 (Kwak). Kim describes forming openings in an organic layer comprising sidewall angles between 30°-60° to expose multiple various underlying layers. *See, e.g.*, EX1008, 0010, 0055-0065, 0072, 0106, 0119, Figs. 3, 9, 11, 12, 21A. Kim explains that creating openings with such angles allows for the smooth creation of later layers formed on top of the organic layer. *Id.*, 0062, 0074, 0085. In this way, the organic insulating layer may remain sufficiently thick while simultaneously allowing for better contacts through the openings. *Id.*; *See* IX.D (Kim). One of skill in the art, recognizing the similar structures and materials, would have found it obvious to combine Kim's teaching of a specific angle with Kwak's angled opening at least because they are directed to solving the same and similar problems (increasing bond strength and decreasing moisture intrusions) and would have merely required implementing known techniques (known etching techniques and specific angles) to achieve predictable results with a reasonable expectation of success.

158. A POSITA would have been motivated to implement Kwak using the methods of Kim, at least as they pertain to Kim's methods for creating an opening

in the organic layer at specific angles and would have had a reasonable expectation of success. Both references describe creating an opening in an organic layer overlaying metal and passivation layers. Kwak discloses an opening with angled sidewalls but does not identify a specific numeric value for the angle. Kim describes known methodologies for creating an angled opening in an organic insulating layer that would be implemented to create predetermined sidewall angles between 30-60°. More specifically, Kwak is directed to increasing the contact area for the adhesive and a POSITA would have understood that the gradually inclined sidewalls of Kim would also serve to increase the contact area, such as the area that would contact an overlying sealant layer. A POSITA would also have understood that a smooth, uniform application of sealant, which would result from using the teachings of Kim, would increase contact between sealant and the surfaces, thereby helping to reduce moisture infiltration and degradation.

B. Overview and Incorporation of Grounds 1 and 2

159. Ground 4 relies on everything in Grounds 1 and 2, including the teachings of Kwak, Kim, and the knowledge of a POSITA, which are incorporated herein by reference. Ground 4 additionally relies on the explicit combination of Kwak and Kim, including the discussions above regarding the motivation to combine, for the claims below.

C. Claim 10

160. Kwak in view of Kim discloses “The sealant region of claim 9, wherein the predetermined angle is less than about 60 degree” for at least the same reasons discussed above regarding claim 10. *See* Ground 2 (Kwak), claim 10.

D. Claim 11

161. Kwak in view of Kim discloses “The sealant region of claim 9, wherein the predetermined angle ranges from about 20 degree to about 30 degree” for at least the same reasons discussed above regarding claim 11. *See* Ground 2 (Kwak), claim 11. Specifically, Kim discloses a tapered angle as small as “about 30°” and the claim requires an angle between 20° and “about 30 degree[s].” EX1008, 0010, 0072, 0106, 0119, cl. 20. Thus, Kim discloses the claimed predetermined angle.

162. A POSITA would have been motivated to implement Kim’s 30° angle at least because it would increase surface area, and thus increase adhesion, and smaller angles would provide for a more even application of sealant.

E. Claim 14

163. Kwak in view of Kim discloses “[t]he sealant region of claim 9, wherein the organic material layer comprises polymethyl methacrylate (PMMA) or photosensitive-methylsilsesquiazane (PS-MSZ)” for at least the same reasons discussed above regarding claim 14. *See* Ground 2 (Kwak), claim 14.

164. Kim further discloses “an organic insulating layer 75 is formed on the protective layer 70 with a low dielectric acryl-based organic material.” EX1008, 0062. As explained above, a POSITA would have understood that the acryl-based organic material would comprise PMMA. *See* IX.F (State of the Art), Ground 2 (Kwak), claim 9.

F. Claim 2

165. Kwak in view of Kim discloses “The method of claim 1, wherein the predetermined angle is less than about 60 degree” for at least the same reasons discussed above regarding claim 2. *See* Ground 2 (Kwak), claim 2.

G. Claim 3

166. Kwak in view of Kim discloses “The method of claim 1, wherein the predetermined angle ranges from about 20 degree to about 30 degree” for at least the same reasons discussed above regarding claim 3. *See* Ground 2 (Kwak), claim 3.

H. Claim 6

167. Kwak in view of Kim discloses claim 6 for at least the same reasons discussed above. *See* Ground 2 (Kwak), claim 6; IV.C-F.

I. Claim 8

168. Kwak in view of Kim discloses “[t]he method of claim 6, wherein the organic material layer comprises polymethyl methacrylate (PMMA) or

photosensitive-methylsilsequiazane (PS-MSZ).” *See* Ground 2 (Kwak), claim 14, 8; Ground 4 (Kwak with Kim), claim 14.

XIV. GROUND 5: CLAIMS 2-3, 6, AND 10-11 ARE OBVIOUS OVER KWAK IN VIEW OF YAMAZAKI

A. Combination Rationale

169. A POSITA would have found it obvious to combine Kwak’s teachings related to increasing the bonding strength and improving the quality of the LCD panel with Yamazaki’s teachings regarding creating sealant regions including an organic layer with an angled slope to improve the seal and reliability by preventing moisture and oxygen intrusion.

170. Kwak teaches angled openings in the sealant region to increase the contact area between the sealant and the various layers, thus increasing the bond strength, and improving reliability by preventing moisture infiltration. *See* IX.A (Kwak). Kwak explains adhesion can be improved by implementing one or more holes that extend through the organic protective layer to the underlying inorganic layer. By allowing the sealant to contact both the inorganic and organic layers, the design of Kwak “compensates for any weakness in the adhesion” between the sealant and the organic layer alone. EX1005, 9:58-10:4, 2:53-56. Kwak also explains that increasing the contact area between the sealant and the layers in general also improves the seal strength. *Id.*, 9:1-12, 9:58-10:4. Widening and/or

deepening Kwak's openings "increases [] the adhesive strength between the [substrates]." *Id.*, 10:50-53, Figs. 3A-C. Further, Kwak's openings also "enhance[] protection against moisture infiltration." *Id.* at 11:46-53. Specifically, Kwak teaches a sealant layer around the periphery of the display that protects the layers, such as the organic and inorganic layers, from exposure to moisture and oxygen. Kwak recognized that angled openings in the sealant region would increase the contact area between the sealant and the various layers, thus increasing the bond strength and improving reliability by preventing moisture infiltration.

171. Yamazaki discloses an LCD device with a sealant region comprising an organic layer (planarizing film 16) with openings that expose the underlying insulating layers (insulating layers 11, 12, and 13), where the sidewalls of the opening have an "angle θ more than 30° and less than 75° ." *See* IX.E (Yamazaki); *see generally* EX1009, 1:8-64, 4:1-20, 4:32--5:2, 5:43-49, 7:24-29, 8:28-33, 11:15-12:12, 12:45-48, 19:47-63, Figs 2A-B, 3A-B, 5A-C, 6, 8A-B, 9, 10A-B, 11. The reference teaches that traditional liquid crystal displays had issues with moisture or oxygen intrusion. *See e.g., id.*, 1:8-3:25, 19:9-14. Yamazaki 366's solution includes the use of "a high thermostability planarizing film, typically, an interlayer insulating film" where an "edge portion or an opening portion is formed to have a tapered shape." *Id.* 3:46-67. Implementing a planarizing layer with a tapered slope in the sealant area would have decreased moisture intrusion and chances of

delamination in the display device. “[P]referably, the edge portion of the high thermostability planarizing film is covered with the sealant so as to overlap with the pattern of the sealant.” *Id.*, 4:5-20. “When the sealant is arranged so as to cover the side surface of the . . . planarizing film, [a] display device with high reliability can be obtained by shielding intruding moisture or oxygen which causes deterioration . . .” *Id.*, 5:50-59. “[A]dding an inert element” to the sidewall will create a high density surface “for preventing the intrusion of moisture or oxygen.” *Id.*, 3:46-67, 4:1-20 (“Further, intrusion of moisture or oxygen is prevented by forming the edge portion of the high thermostability planarizing film to have a tapered shape and adding an inert element there to highly densify.”), 12:34-63. Yamazaki teaches the use of a taper angle between 30° and 75°, which helps to facilitate doping the sidewall with the inert element. *Id.*, 12:45-48, 12:60-63.

172. Kwak and Yamazaki are in the same field of endeavor, including disclosing methods for manufacturing liquid crystal displays, and describe implementing their improvements in similar structures to achieve similar benefits. See IX.A (Kwak), IX.E (Yamazaki), Ground 2 (Kwak), claim 9; *see also* EX1005, 11:30-38, Figs. 1B, 2A-D, 3A-C, 4A-C, 5A-E; EX1009, 1:8-64, 4:32-47, 8:28-33, Fig. 11.

173. Both references describe an organic layer overlaying an underlying layer and an opening through the former to expose the latter. Kwak discloses an

organic layer (protective layer 180) that rests above a predetermined material layer (interlayer 160, gate insulating layer 140, or buffer layer 120) and has an angled opening (811) in the organic layer to expose the underlying layers. Kwak describes openings with a consistent angle, but it does not identify a numerical value for its angle. Yamazaki discloses an organic layer (planarizing film 16) that rests above a predetermined material layer (insulating layers 11, 12, and 13) and comprises openings in the organic layer to expose the underlying layers where the opening sidewalls have a predetermined angle between 30°-75°.

174. A POSITA implementing the teachings of Kwak would have been motivated to use the techniques and methods of Yamazaki with reasonable expectation of success, at least as they pertain to its methods for creating an opening with specific angles in the protective layer of the sealant region.

175. A POSITA would have understood that both Kwak and Yamazaki teach similar improvements that provide similar benefits. Kwak is directed to increasing the contact area for the adhesive to improve bond and reliability. *See* IX.A (Kwak). The increased bond strength has the additional benefit of reducing damage or cracks in the sealant that might allow for intrusion of moisture. *Id.* Yamazaki describes angled sidewalls that would also increase the contact area between the sealant and various layers. *See* IX.E (Yamazaki). The sealant area of Yamazaki also creates a more reliable product by preventing intrusion from

moisture and oxygen and thus reducing the likelihood of delamination or degradation. *Id.*

176. One of skill in the art, recognizing the similar structures and materials, would have found it obvious to combine Yamazaki's teaching of a specific angle with Kwak's angled opening at least because they are directed to solving the same and similar problems (increasing bond strength and decreasing moisture intrusions) and would have merely required implementing known techniques (known etching techniques and specific angles) to achieve predictable results with a reasonable expectation of success.

B. Overview and Incorporation of Grounds 1 and 2

177. Ground 5 relies on everything in Grounds 1 and 2, including the teachings of Kwak, Yamazaki, and the knowledge of a POSITA, which are incorporated herein by reference. Ground 5 additionally relies on the explicit combination of Kwak and Yamazaki, including the discussions above regarding the motivation to combine, for the claims below.

C. Claim 10

178. Kwak in view of Yamazaki discloses claim 10 for at least the same reasons discussed above regarding claim 10. *See* Ground 2 (Kwak), claim 10.

D. Claim 11

179. Kwak in view of Yamazaki discloses claim 11 for at least the same reasons discussed above regarding claim 11. *See* Ground 2 (Kwak), claim 11.

E. Claim 2

180. Kwak in view of Yamazaki discloses claim 2 for at least the same reasons discussed above regarding claim 2. *See* Ground 2 (Kwak), claim 2.

F. Claim 3

181. Kwak in view of Yamazaki discloses claim 3 for at least the same reasons discussed above regarding claim 3. *See* Ground 2 (Kwak), claim 3.

G. Claim 6

182. Kwak in view of Yamazaki discloses claim 6 for at least the same reasons discussed above. *See* Ground 2 (Kwak), claim 6; IV.C-F.

XV. GROUND 6: CLAIMS 1-6 AND 9-13 ARE OBVIOUS OVER ZHANG

A. Claim 9

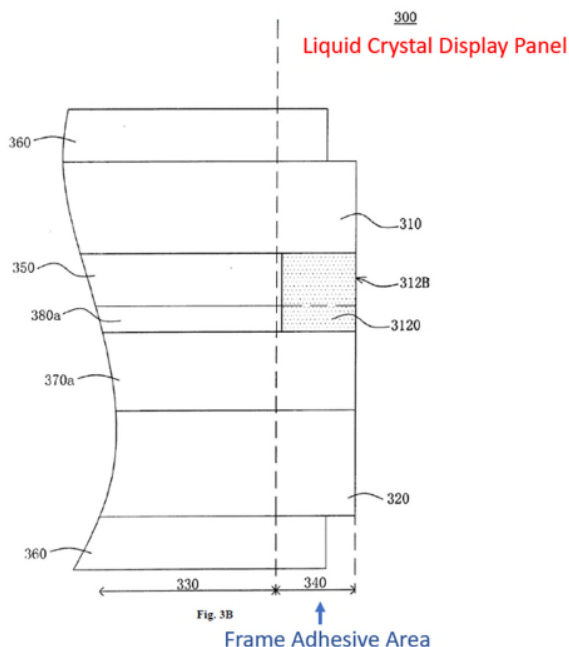
183. Zhang in view of the knowledge of a POSITA renders obvious Claim 9.

1. [9pre]

184. To the extent the preamble is limiting, Zhang discloses “[a] sealant region pattern for a liquid crystal display [*liquid crystal display panel 300*].”

EX1006, 4; *see also id.*, 7-11 (describing the patent figures), Figs. 1A-B, 2A-B, 3A-E, 4, 5A-B, and 6A-B; IX.B (Zhang). Zhang discloses a “liquid crystal display

panel 300” comprising a “a frame adhesive area 340.” *Id.*, 8. Zhang discloses a method for forming a sealant region pattern in the frame adhesive area including creating openings in various layers and the assembly process of injecting liquid crystal (350), adding sealant (312B), “pressing” the substrates together, and “bak[ing] in an oven.” *Id.*, 8-10, Figs. 3A-E.

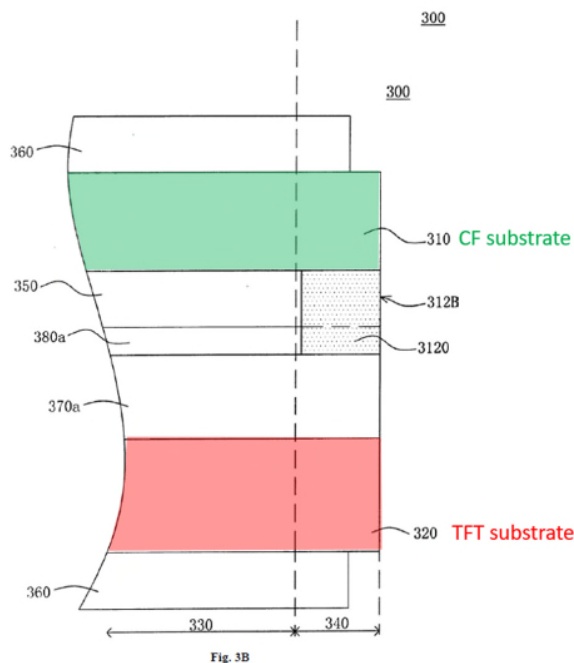


Zhang, Fig. 3B (annotated original)

2. [9a]

185. Zhang discloses “a first substrate [*lower substrate 320*] and a second substrate [*upper substrate 310*] opposite thereto.” EX1006, 8. TFT substrate 320 and CF substrate 310 are opposite of one another within the LCD. *See id.*, 8-10, Figs. 3A-E; *see also id.* Figs. 1B, 2A-B. Zhang also discloses polarizing plates 160

opposite each other on the outer sides of the two substrates. *See, e.g., id.* at 8, Fig. 3B.



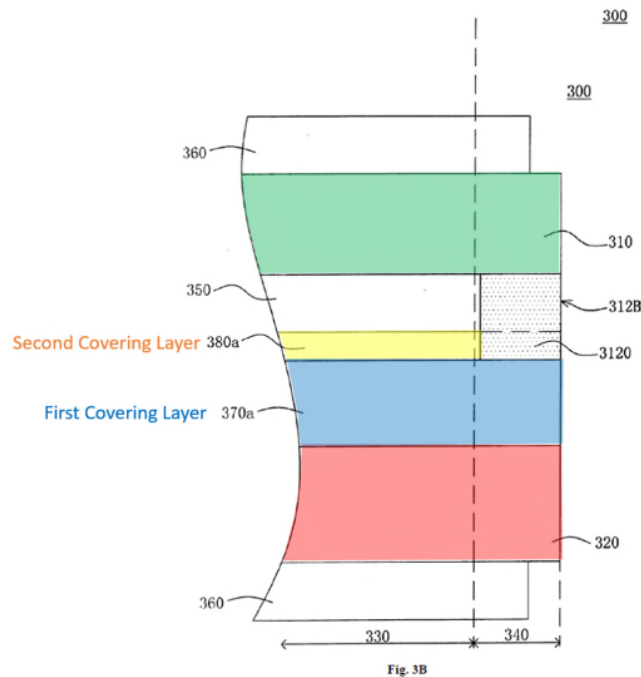
Zhang, Fig. 3B (annotated original)

3. [9b]

186. Zhang discloses “a predetermined material layer [*first cover layer 370*] formed on the first substrate [*TFT substrate 320*].” “In the frame adhesive area 340, the TFT substrate 320 also includes the two covering layers 370a and 380a extending from the display area 330.” EX1006, 8; *see also id.*, 7, 9-10, Figs. 1B, 2A-B, 3B-E, 6A-B, cls 1-4. The first covering layer may comprise a single layer (such as Fig. 3B) or a combination of layers (such as Figs. 3C-E), including a

first metal layer, a dielectric layer, a second metal layer, and/or a protective layer.

Id.



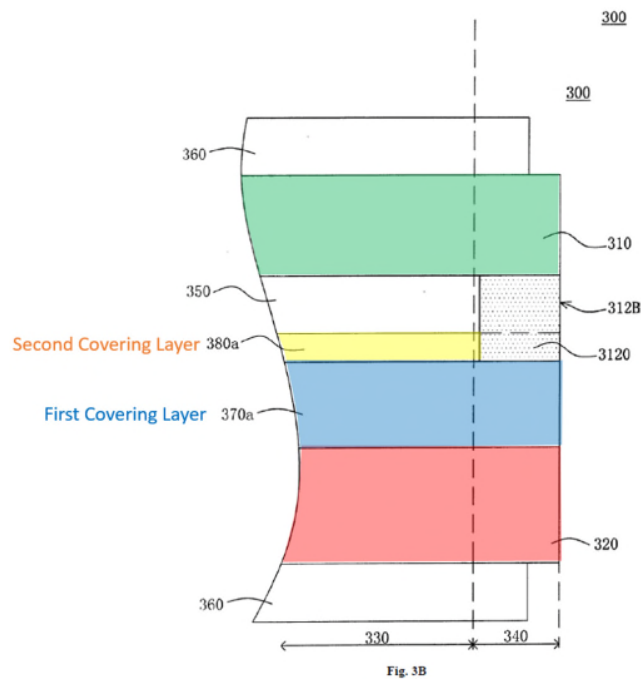
Zhang, Fig. 3B (annotated original)

4. [9c]

187. Zhang alone and in view of the knowledge of a POSITA discloses “an organic material pattern layer [second covering layer 380a, which Zhang discloses or renders obvious would have comprised photoresist layer 225B] having a saw tooth opening [e.g., opening or grooves in elongated, X-shaped, matrix-shaped patterns, or other openings and shapes, such as in figures 3A, 5A-B and discussed below] formed on the predetermined material layer [first covering layer 370, which may comprise one or more of protective layer 224, second metal layer 223,

dielectric layer 222, and first metal layer 221] to expose the surface of the predetermined material layer underneath [e.g., opening 2120 that exposes at least a portion of protective layer 224, and which can optionally be extended further (i.e., opening 3120) to expose additional underlying layers], wherein the surface of the predetermined material layer [first covering layer 370] and the sidewall of the organic material pattern layer [second covering layer 380, which may comprise photoresist layer 225B] form a predetermined angle [e.g., a substantially 90° angle, such as those in Figs. 3B-E, 6B, or a V-shaped groove or opening, such as in Fig. 6A].”

188. Zhang discloses “an organic material pattern layer . . . on the predetermined material layer.” Zhang discloses a “second covering layer 380a positioned above the first covering layer 370a.” *See, e.g.*, EX1006, 8. Zhang’s second covering layer is not limited to any specific layer or combination of layers. *See* EX1006, 8-9, cl. 1. “In Figure 3B, both the first covering layer 370a and the second covering layer 380a on the TFT substrate 320 are single-layer structures.” EX1006, 9.

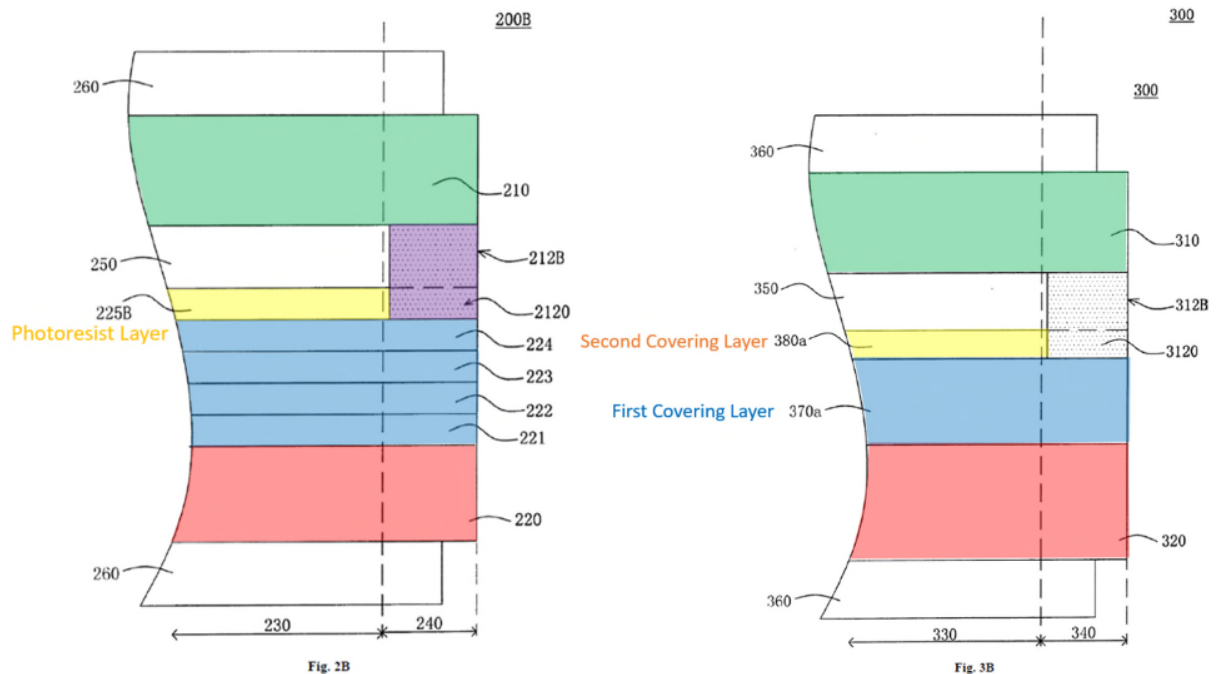


Zhang, Fig. 3B (annotated original)

189. As noted above, Zhang explains that conventional reflective LCD panels may include an organic layer, such as photoresist layers 225A and 225B. EX1006 at 4-6, Figs. 2A-B; IX.B (Zhang). The disclosed organic layer “covers” the other layers, including “the protective layer 224.” The sealant would contact organic layer 225B via opening 2120 or the second covering layer 380 via opening 3120. *Id.*, 5-6, Figs. 2A-B. Thus, Zhang discloses a second covering 380a that, when implemented in a conventional reflective LCD, would comprise at least organic layer 225B, and would optionally include additional underlying layers such as protective layer 224. *See, e.g., id.*, 11 (“Any variations or modifications to the embodiments described above that fall within the essential spirit of the present

invention will be within the scope of the claims of the present invention”), Figs. 2B, 3B.

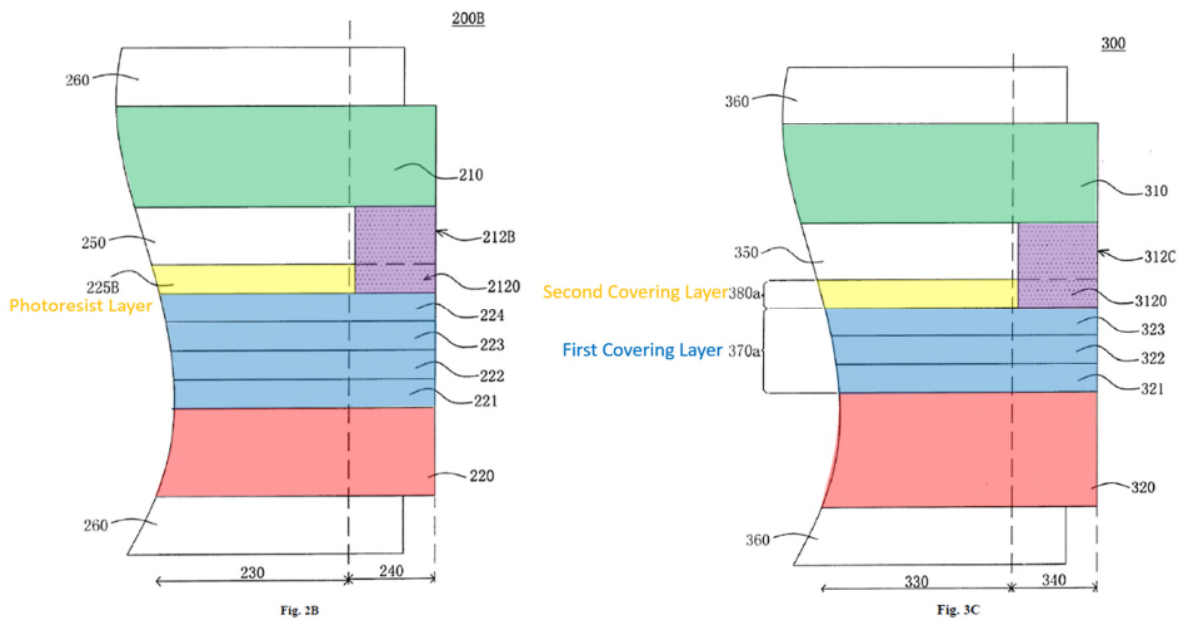
190. A POSITA would have understood Zhang to teach that the second covering layer 380a would, when implemented in conventional reflective LCD’s, consist of or comprise organic photoresist layer 225B. *See id.*, 5-6, 11 (“[T]hose skilled in the art should understand that . . . various changes and modifications may be made [] without departing from the scope of the present invention”), Figs. 2A-B, 3B-E.



Zhang, Fig. 2B (left, annotated original), 3B (right, annotated original)

191. Zhang discloses an “opening” in the organic layer “to expose the surface of the predetermined material layer underneath.” Figure 2B depicts a

conventional reflective LCD with an opening (2120) in the organic photoresist layer (225B) to expose the underlying layers (e.g., protective layer 224). EX1006, 5-6, Figs. 2A-B. Figure 3B of Zhang depicts opening 3120 in the second covering layer 380a to expose the underlying first covering layer 370a. EX1006 8-10, Figs. 3A-3E. Opening 3120 may extend through the second covering layer (comprising at least an organic layer, such as 225B, and optionally additional underlying layers, such as protective layer) to expose the underlying layers. *Id.* When implemented in a conventional reflective LCD, Zhang's second covering 380a would comprise organic layer 225B as well as protective layer 224 and opening 3120 would extend through one or both. *See, e.g., id.*, 11, Figs. 2B, 3B. The conventional reflective LCDs of Zhang would include an opening (opening 2120) in the organic layer (photoresist layer 225B) to expose an underlying predetermined layer (protective layer 224). Zhang also discloses an opening (opening 3120) in the organic material layer (second covering layer 380a comprising at least organic photoresist layer 225B and potentially other layers) to expose an underlying predetermined material layer (first covering layer 370a).

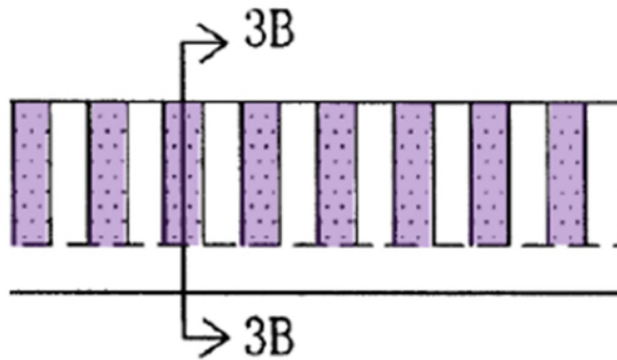


Zhang, Fig. 2B (left, annotated original), 3C (right, annotated original)

192. To the extent Zhang does not explicitly disclose that the second covering layer would include organic photoresist layer 225B and optionally protective layer 224, a POSITA would have understood that the teachings of Zhang, as depicted in Figures 3A-3E, would be applied to conventional reflective LCDs with an organic photoresist layer to obtain similar improvements in adhesion and would have had a reasonable expectation of success doing so. For example, Zhang teaches both an opening through an organic photoresist layer (e.g., Figs. 2A-B) as well as an opening through second covering layer (e.g., Figs. 3B-E)—which may include one or more layers, such as a photoresist layer and optionally a protective layer—to expose the underlying layers. A POSITA implementing Zhang's teachings would have been motivated to apply them to conventional

reflective LCD structures to create a stronger bond by increasing the contact area and allowing more sealant to penetrate the groove or opening.

193. Zhang discloses a “sawtooth opening”. Zhang explains that the groove or opening may be an “elongated shape,” “matrix-shaped,” or “X-shaped” but “the shape of the groove or opening . . . is not limited to a specific type.” EX1006 at 1, cls. 5, 7, 8, Figs. 3A, 5A-B. Figure 3A of Zhang depicts a “groove or opening 3120” similar to the teeth of a saw. See EX1006 8, Fig 3; IX.B (Zhang).

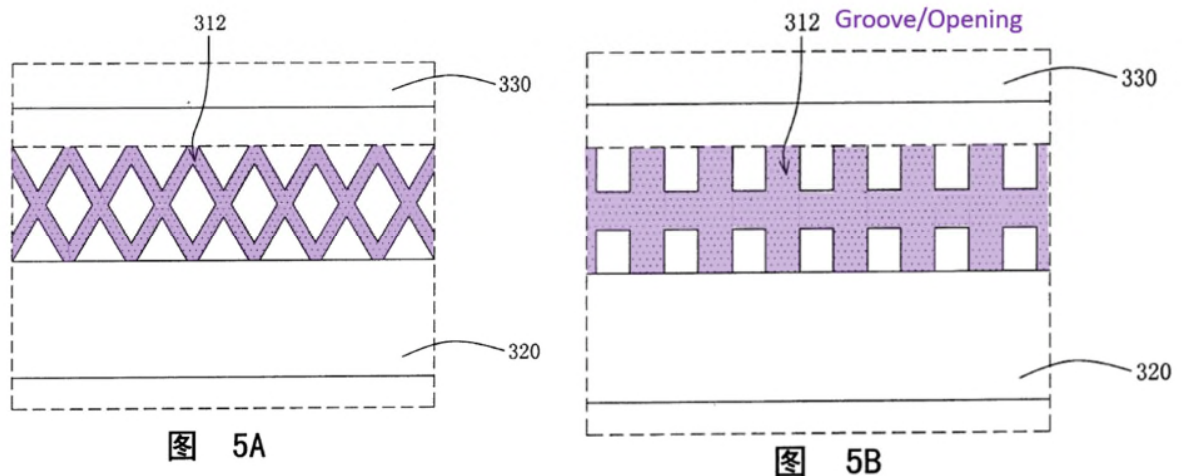


Zhang, Fig. 3A (annotated excerpt of original)

194. Zhang explains that “the second covering layer 380a has a groove or opening 3120 exposing a portion of the first covering layer 370a.” EX1006 at 8. One of skill in the art would have understood that the Zhang’s teachings of various shapes for the groove or opening, as depicted in Figures 3A and 5A-B, would be applied to conventional reflective LCDs with an organic photoresist layer such that the elongated, X-shaped, or matrix-shaped openings in the second covering layer

380 would be formed on at least the organic photoresist layer and optionally additional underlying layers.

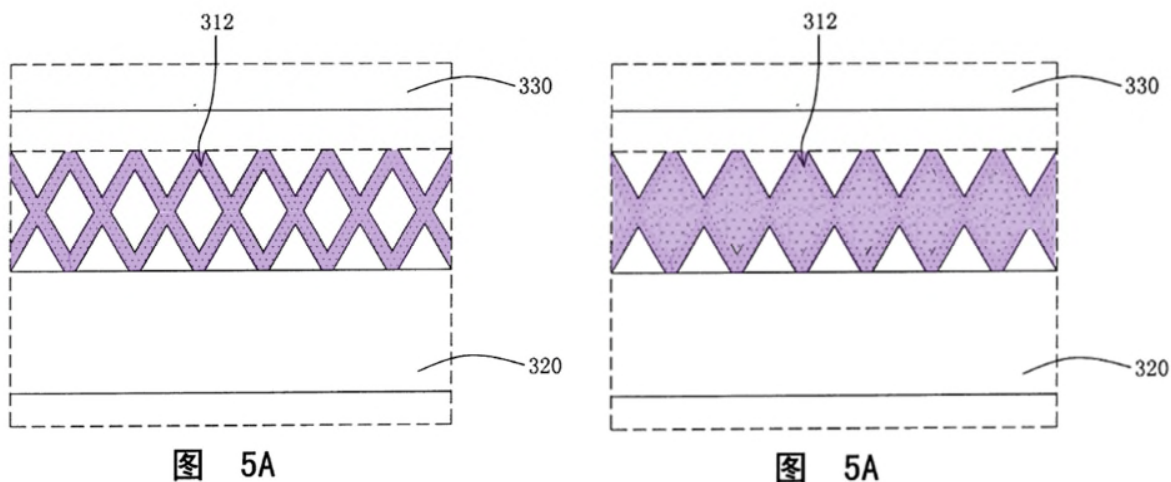
195. Zhang discloses various “saw tooth”-shaped openings with indentions and protrusions evenly distributed on either side of a central axis, including the “X-shaped” opening of Fig. 5A and the saw tooth opening of Fig. 5B. See EX1006 11, Fig 5A.



Zhang, Fig. 5A (annotated original), 5B (annotated original)

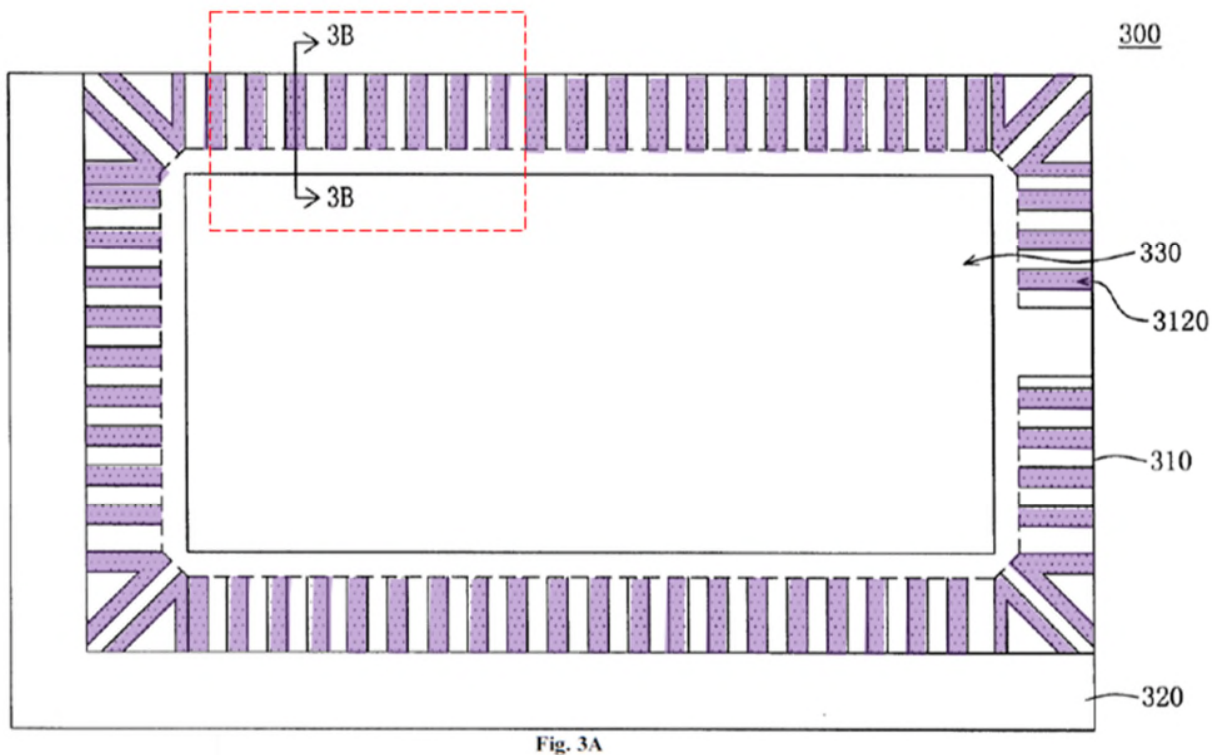
196. A POSITA would have found it obvious that the teachings of Zhang could be modified to comprise other “saw tooth”-shaped embodiments. Zhang’s opening “is not limited to a specific type. EX1006 1. I have included depictions of various sawtooth shaped patterns that would have been obvious derivations of the patterns explicitly taught by Zhang.

197. The X-shaped grooves of Figure 5A could be modified to remove the interior islands, forming a different saw-tooth pattern.

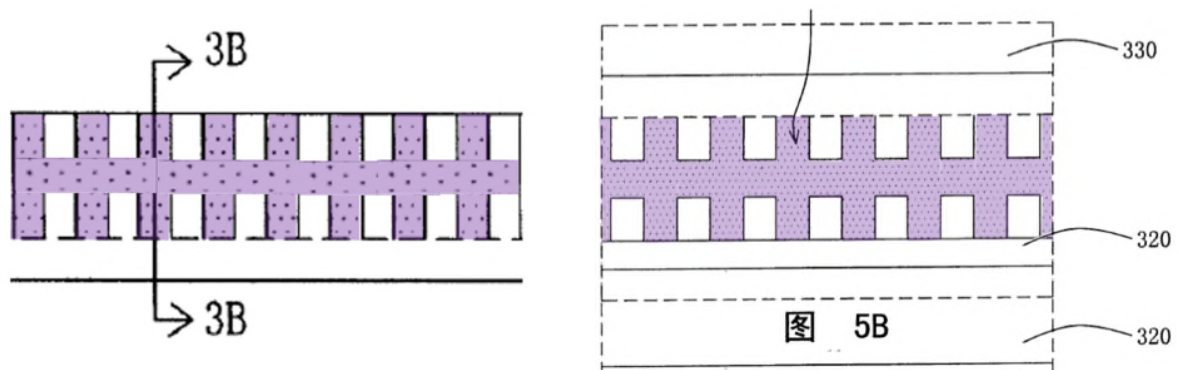


Zhang, Fig. 5A (left, annotated original), 5A (right, modified)

198. Likewise, the matrix-shaped grooves of Figure 5B can be derived from the elongated grooves of Figure 3A by extending the groove down the center axis.

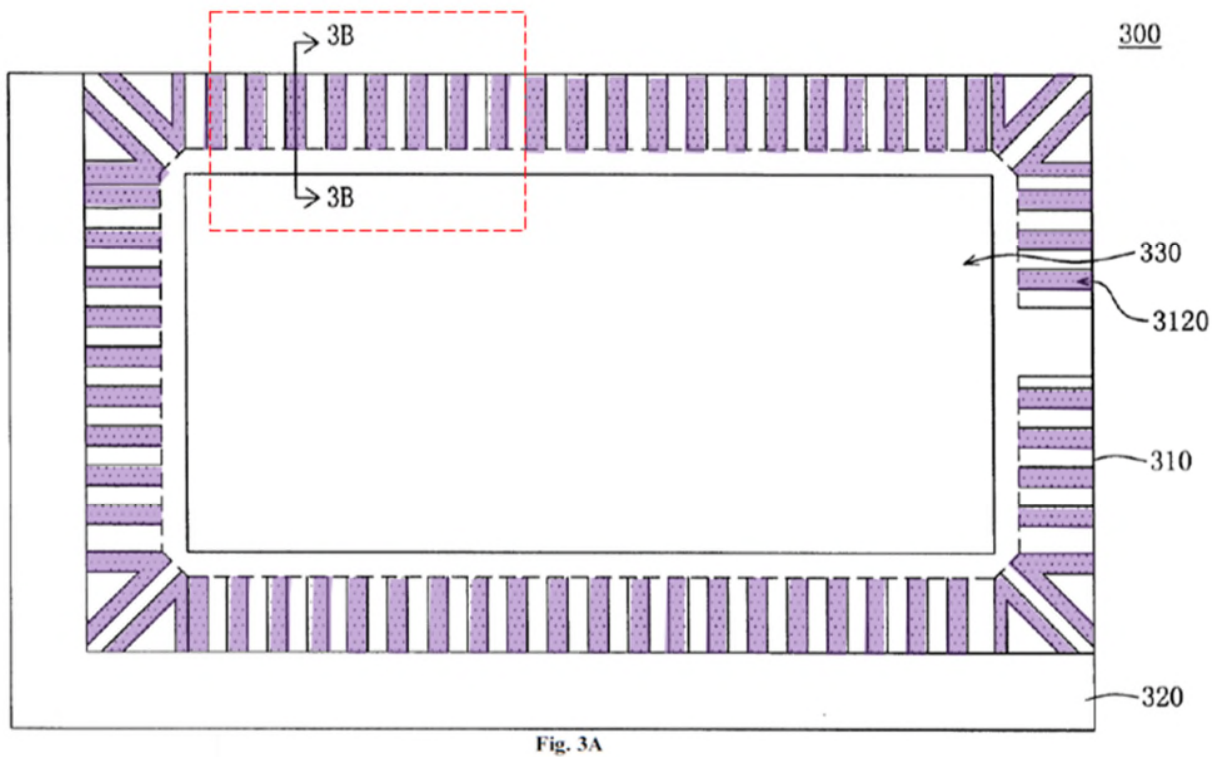


Zhang, Fig. 3A (annotated original, red box indicating area excerpted below)

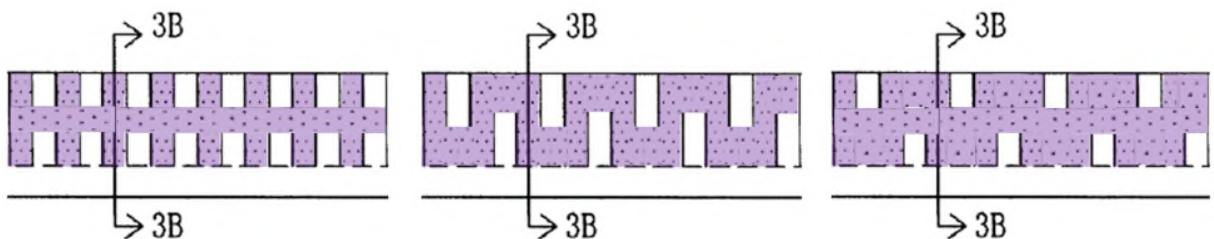


Zhang, Fig. 3A (left, modified excerpt), 5B (right, annotated original)

199. A POSITA would have also understood that the groove patterns disclosed by Zhang could be modified to form alternative groove patterns in other sawtooth-like shape, including those shown below.



Zhang, Fig. 3A (annotated original, red box indicating area excerpted below)



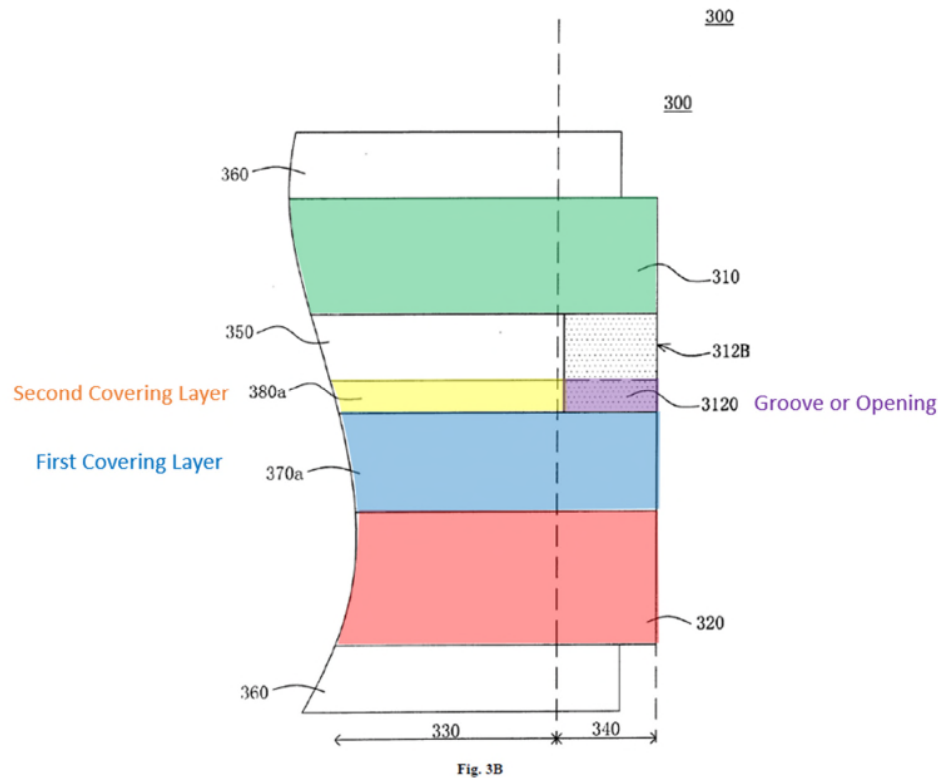
Zhang, Fig. 3A (modified excerpts)

200. A POSITA would have been motivated to try these different options and other similar options at least because they are mere derivations of Zhang's explicit teachings, and they increase the surface area for adhesive contact which Zhang teaches may improve the sealant bond by allowing more sealant to penetrate into the groove or opening. EX1006, 9. A POSITA would have had a reasonable

expectation of success implementing these variations and others. When describing Figures 3A and 3B, Zhang teaches that “the main purpose of this embodiment is to increase the contact area of the frame adhesive, allowing more adhesive to penetrate into the grooves/openings, thereby enhancing the bonding strength between the TFT substrate and CF substrate.” EX1006 at 8, *see also id.* at 1, 9. A POSITA would have been motivated to try these other obvious groove pattern variations to increase the amount of adhesive that enters the opening and thus increase the bond strength.

201. Zhang discloses an opening such that “the surface of the predetermined material layer and the sidewall of the organic material pattern layer form a predetermined angle.” Zhang describes prior art including an opening (opening 2120) where the surface of the predetermined layer (protective layer 224) and the sidewall of the organic material pattern layer (photoresist layer 225B) form a substantially 90° angle. Zhang also teaches an opening 3120 where the surface of the predetermined material layer (first covering layer 370a) and the sidewall of the organic material pattern layer (second covering layer 380a comprising at least organic layer 225B and optionally additional layers such as protective layer 224) form a substantially 90° angle. *See* EX1006, Figs. 3B-E, 6B; *see also id.* 5-6, Figs. 2A-2B. A POSITA would have understood Zhang’s substantially 90° angle to be

intentional (i.e., be predetermined) based on design choices, including the use of various etching methods known in the art.

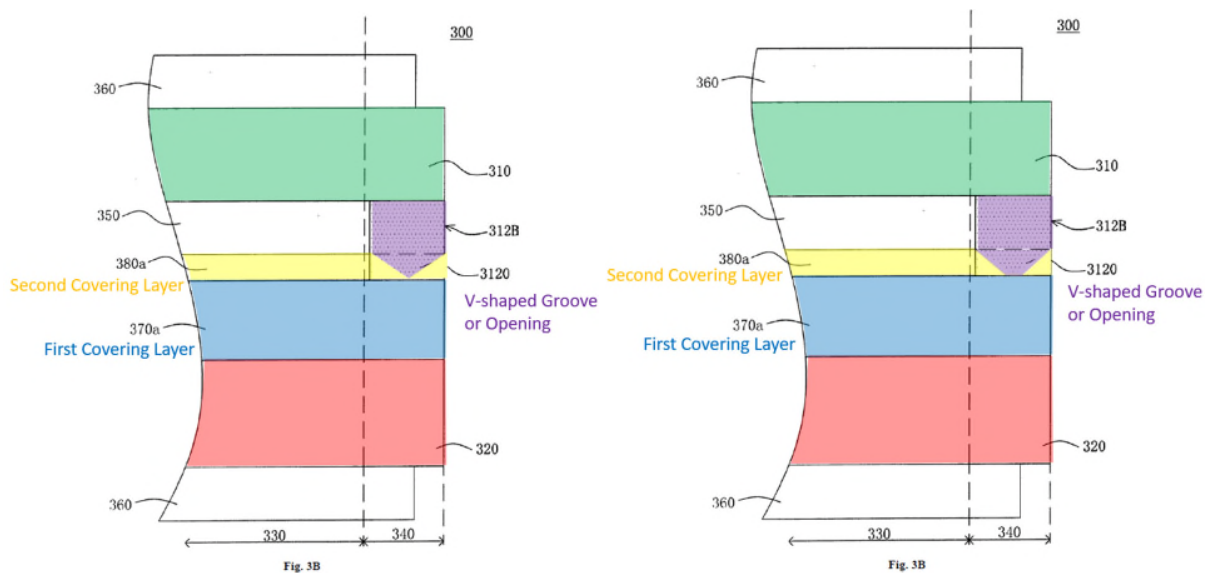


Zhang, Fig. 3B (annotated original)

202. Zhang also describes a “V-shaped” groove or opening where the surface of the predetermined material layer and the sidewall of the organic layer form an angle less than 90°. EX1006 at 1, 11, Fig. 6A, cls. 9, 17. Zhang’s V-shaped opening would be implemented in a conventional reflective LCD such that it would extend through at least the organic photoresist layer and optionally extend through additional layers, such as protective layer, to expose the predetermined material layer beneath. *See, e.g., id.*, 5-6, 8-9, Figs. 2B, 3B-E, 6B. A POSITA

would have understood Zhang's V-shaped angle to be intentional (i.e., be predetermined) based on design choices, including the use of various known etching methods in the art.

203. Zhang's V-shaped opening may extend through one or more layers. EX1006, 3A-3E, cl. 9. Figure 3B describes a single-layer first covering layer 370a, a single-layer second covering layer 380a, and a groove or opening through the second covering layer to expose the first covering layer. See EX1006 at 8-9, Fig. 3B. This opening may be "V-shaped." EX1006, 7-10, cl. 1, 9.



Zhang, Fig. 3B (left, modified with triangular opening), Fig. 3B (right, modified with trapezoidal opening)

Likewise, the V-shaped opening may extend through the other layers of the second covering. See EX1006 at 8-10, Figs. 3C-E, cl. 9; *see also id.* at Fig. 6A.

204. A POSITA would have understood that the V-shaped opening of Zhang would be created using well-known methods and techniques and that using these techniques would result in “a predetermined angle.” Zhang discloses angled openings but does not identify a numeric value for its angle. EX1006, 9-10, cl. 9. Methods for creating the substantially 90° angle or V-shaped angle of Zhang were well known and would result in a predetermined angle. *See* EX1006, Fig. 2B, 3B.

205. A POSITA would have understood that utilizing angled openings within sealant areas in LCD screens was known and understood, as was shown in various prior art references. *See* IX.E (Yamazaki), IX.F (State of the Art).

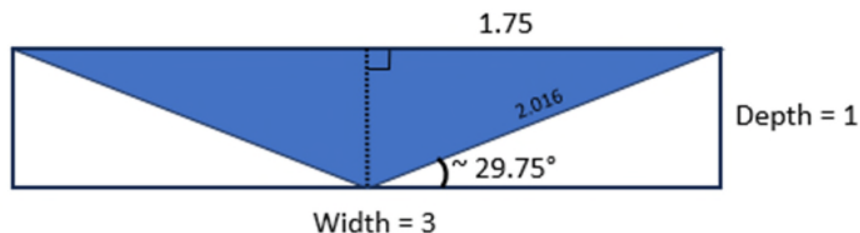
206. Further, various well-known and conventional techniques existed in the art that would form a V-shaped opening comprising predetermined angles less than 90°. *see* IX.C (Vaganov), IX.F (State of the Art).

207. A POSITA would have understood that the angles disclosed by Zhang would have been created using known techniques resulting in predetermined angles and would have been motivated to do so with a reasonable expectation of success. Zhang discloses implementing different angled openings, from substantially 90° to angles between 20° to 30°, as explained below regarding claim 10. *See* Ground 6 (Zhang), claims 9 and 10. A POSITA would have the knowledge and skill to implement these various methods to create openings in an organic with a specific, intentional angle.

B. Claim 10

208. Zhang alone and in view of the knowledge of a POSITA discloses “[t]he sealant region of claim 9, wherein the predetermined angle is less than about 60 degree.”

209. Zhang discloses a V-shaped “groove or opening” that extends through the second covering layer, comprising at least the organic photoresist layer and optionally additional layers such as the protective layer, to expose a predetermined material layer below. See EX1006 at 8-9, Figs. 2A-B, 3B-E. While the figures of Zhang may not be to scale, they depict to a POSITA a frame adhesive area 340 with a width approximately 3.5-times greater than the height of the protective layer 380a. A POSITA, reviewing Zhang, would have understood its teachings to disclose dimensions that would result in an angle well below 60° and approximately equal to or less than 30° . I have included annotated figures and diagrams of my own making below to illustrate this point.



Example of a “triangular” opening as taught by Zhang

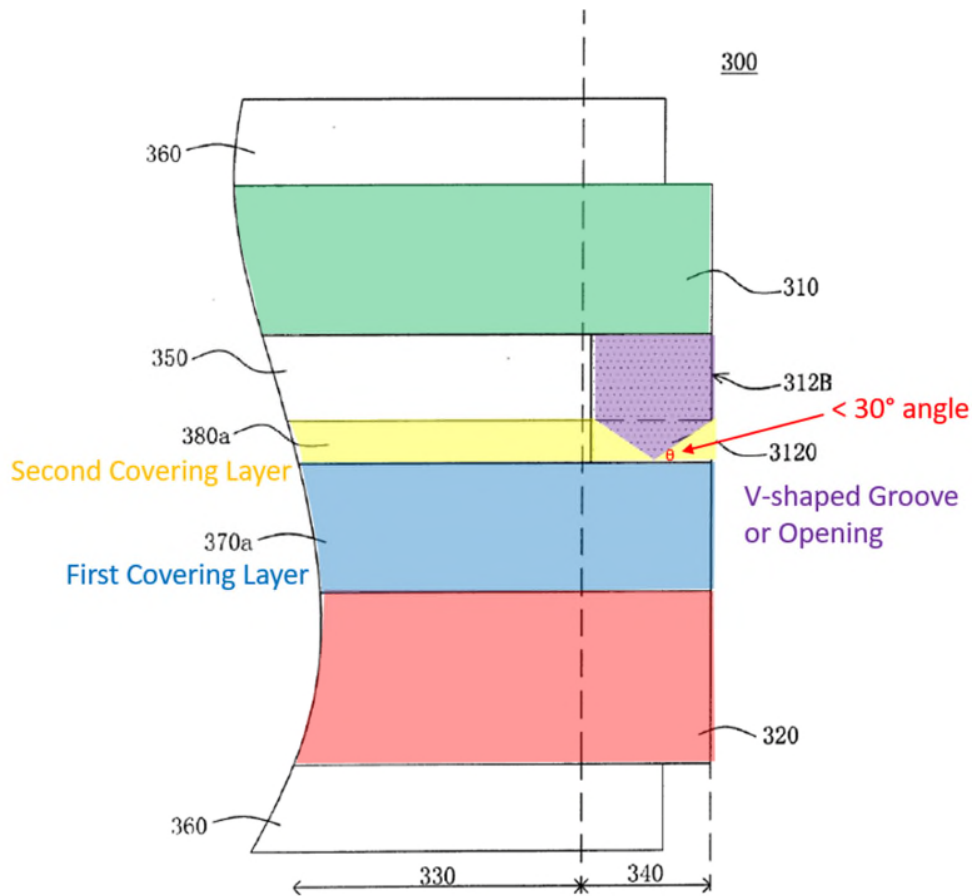
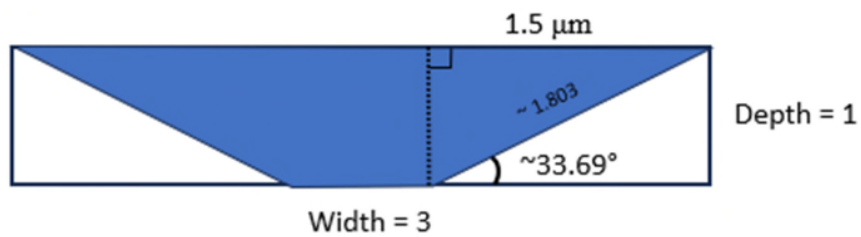
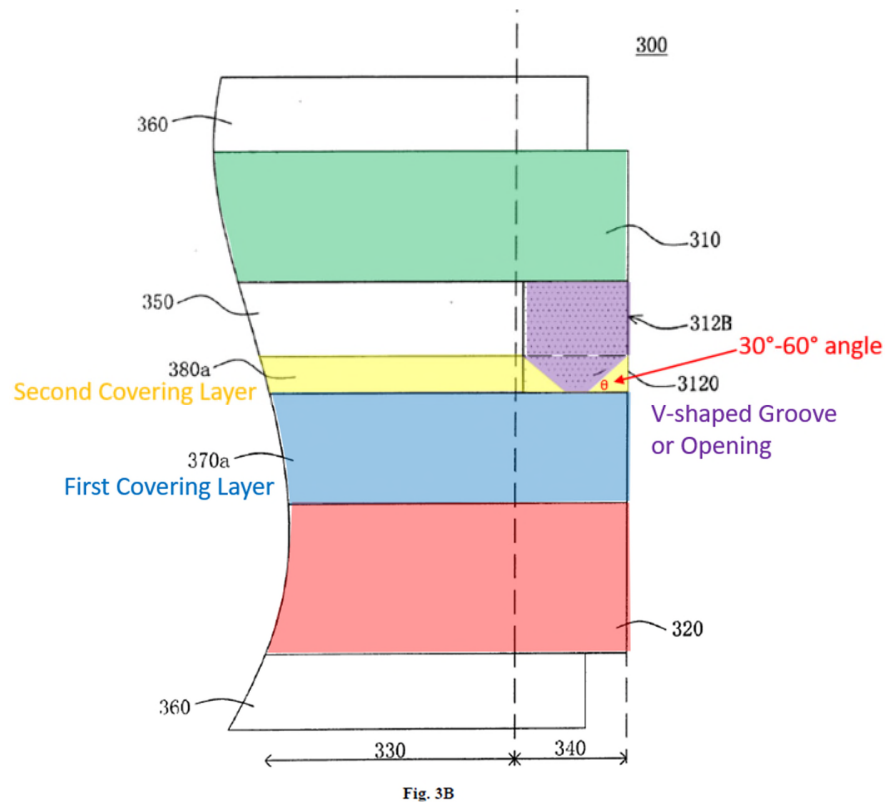


Fig. 3B

Zhang, Fig. 3B (modified with triangular opening and $\theta < 30^\circ$)



Example of a “trapezoidal” opening as taught by Zhang



Zhang, Fig. 3B (modified with trapezoidal opening and $30^\circ < \theta < 60^\circ$)

210. A POSITA would have knowledge of common manufacturing methods and the design choices involved in creating similar openings and would have understood that openings with an angle less than 60° and even less than 30° were possible and would have the knowledge and skill to implement those methods with a reasonable expectation of success.

211. A POSITA would have known and understood, as demonstrated by the state of the art disclosed in prior art references, that the openings in Zhang's organic layer would utilize an angle less than 60° and even as low as 20° - 30° . *See* IX.C (Vaganov), IX.D (Kim), IX.E (Yamazaki), IX.F (State of the art). The

benefits of implementing angled openings, and specifically angled openings less than 60° and as small as 20° - 30° were also well known to a POSITA. *see* IX.C (Vaganov), IX.D (Kim), IX.E (Yamazaki), IX.F (State of the art).

212. A POSITA would have been motivated to apply these known methods to Zhang to create an opening with an angle less than 60° and as low as 20° - 30° at least because these methods and angles provide the same benefits sought by Zhang. *See* Ground 6 (Zhang), claim 9; IX.B (Zhang), IX.C (Vaganov), IX.D (Kim). Zhang purports describes improving the bonding strength in a display panel and reducing cracks and damage by increasing the contact area for the adhesive. *See* IX.B (Zhang).

213. The state of the art—as evidenced by references such as Vaganov, Tanaka, Miyoshi—recognized that angles below 60° and as low as 20° - 30° would improve bond strength and reliability and reduce cracks, breaks, and moisture intrusion. *See* IX.C (Vaganov), IX.F (State of the art).

214. For at least these reasons, one of skill in the art would have understood and would have been motivated to use known techniques to implement the angled openings of Zhang with angles less than 60° and as low as 20° to 30° with a reasonable expectation of success.

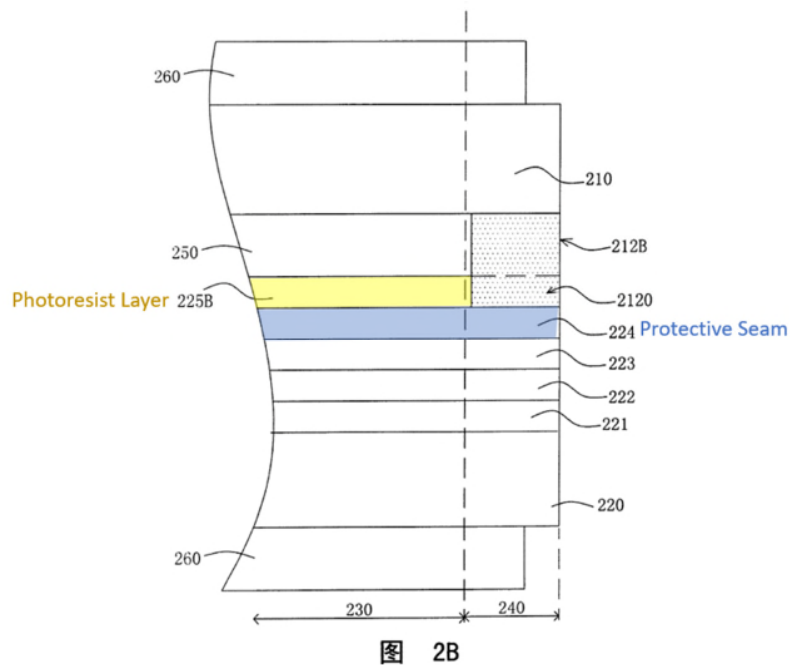
C. Claim 11

215. Zhang alone and in view of the knowledge of a POSITA discloses “[t]he sealant region of claim 9, wherein the predetermined angle ranges from about 20 degree to about 30 degree” for the same reasons explained above regarding claims 9 and 10. *See* Ground 6 (Zhang), claims 9 and 10.

D. Claim 12

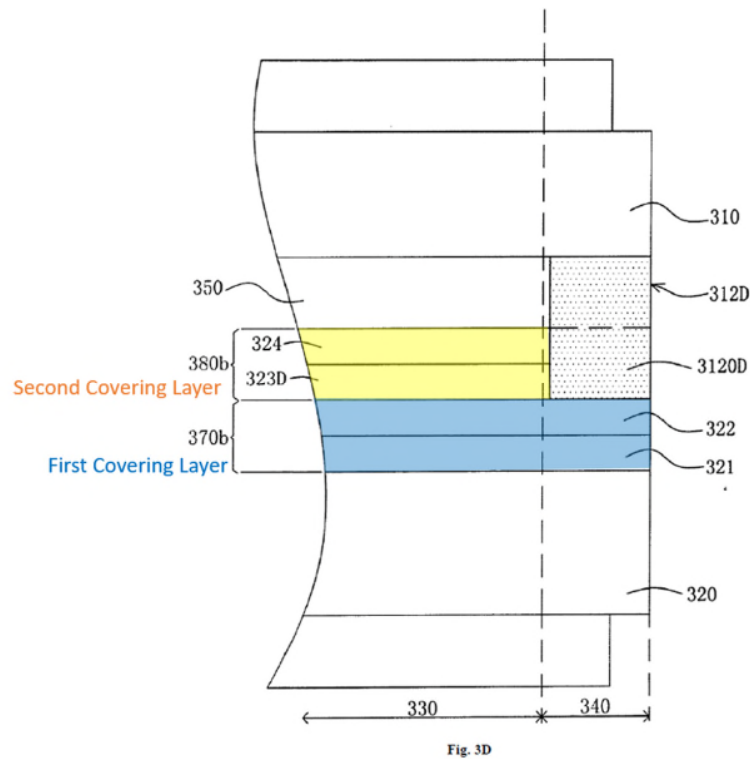
216. Zhang alone and in view of the knowledge of a POSITA discloses “[t]he sealant region of claim 9, wherein the predetermined material layer comprises a passivation layer.” *See* Ground 6 (Zhang), claim 9.

217. Zhang’s conventional reflective LCD display would include at least an organic photoresist layer 225B with an opening 2120 that exposes a protection layer 224 (predetermined material layer) comprised of silicon dioxide (SiO_2) or silicon nitride (Si_3N_4). *Id.*, 6, Fig. 2B, cl. 6.



Zhang, Fig. 2B (annotated original)

218. Zhang also discloses a second covering layer comprising an organic layer as well as additional layers, such as protective layer 324 and second metal layer 323, covering a first covering layer comprising other layers, including a dielectric layer 322 that can be “composed of a material such as silicon nitride (SiN_x).” EX1006 4, 5, 6, 9, 10, Figs. 3B-E.



Zhang, Fig. 3D (annotated original)

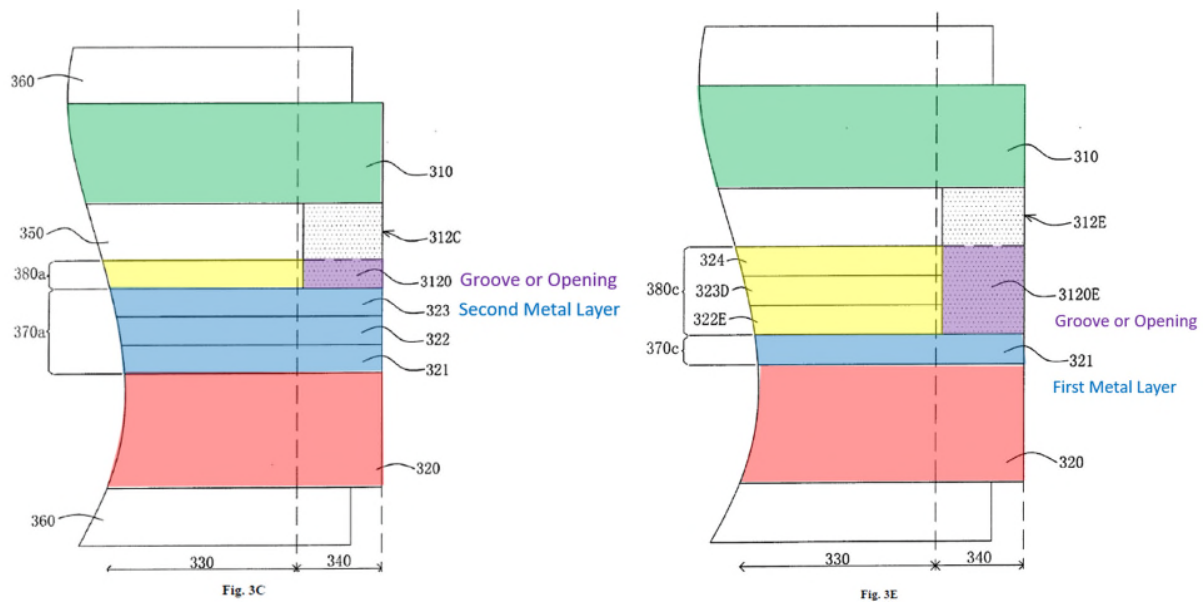
219. The '801 patent describes a “predetermined material layer such as a silicon nitride layer 242 . . . serving as a passivation layer.” EX1001 at 2:46-55. Both the protective layer and the first covering of Zhang, like the passivation layer of the '801 patent, may comprise a silicon nitride passivation layer. Further, one of skill in the art would have understood the dielectric layer within the first covering of Zhang to also refer to a passivation layer.

E. Claim 13

220. Zhang alone and in view of the knowledge of a POSITA discloses “[t]he sealant region of claim 9, wherein the predetermined material layer

comprises a metal electrode layer.” See Ground 6 (Zhang), claim 9. The first covering layer 370 of Zhang comprises a first metal layer 321 and a second metal layer 323. EX1006 9, 10, Figs. 3A-3E, cls. 2-6; *see also id.* 4-7. The metal layers of Zhang may serve as scan lines or data lines. *Id.* at 4. The ’801 patent describes a “predetermined material layer [that] may further comprise [various metal compounds] or a combination thereof, serving as a metal electrode layer.” EX1001 at 2:46-55. One of skill in the art would have understood the metal layers within the first covering of Zhang to refer to metal electrode layers like those described in the ’801 patent.

221. Zhang discloses creating a groove or opening in the second covering layer 380 to expose the metal layers 321 and/or 323 of first covering layer 370. EX1006, 9-10, Figs. 3C-E, cls. 1-6. For example, in Figure 3C “the groove or opening 3120 exposes portion of the second metal layer 323,” and in Figure 3E “the groove or opening 3120 exposes portion of the second metal layer 323.” EX1006 9-10, Figs. 3C-E. This groove structure allows the “frame adhesive [to] . . . penetrat[e] into the opening 3120 and mak[e] contact with the surface of the [first or second metal layer].” EX1006 9-10.



Zhang, Figs. 3C and 3E (annotated originals)

F. Claim 1

222. Zhang alone and in view of the knowledge of a POSITA discloses claim 1 for the same reasons discussed above. See Ground 6 (Zhang), claim 9. Claim 1 claims a method of “providing” and “forming” the elements of apparatus claim 9 without further specificity and, therefore, is rendered obvious by Zhang alone and in view of the knowledge of a POSITA. See Ground 6 (Zhang), 9.

1. [1pre]

223. To the extent the preamble is limiting, Zhang alone and in view of the knowledge of a POSITA discloses “A method for forming a sealant region pattern of a liquid crystal display” for the same reasons discussed above. See Ground 6 (Zhang), claim 9pre.

2. [1a]

224. Zhang alone and in view of the knowledge of a POSITA discloses “providing a first substrate and a second substrate opposite thereto” for the same reasons discussed above. *See* Ground 6 (Zhang), claim 9a.

3. [1b]

225. Zhang alone and in view of the knowledge of a POSITA discloses “forming a predetermined material layer on the first substrate” for the same reasons discussed above. *See* Ground 6 (Zhang), claim 9b.

4. [1c]

226. Zhang alone and in view of the knowledge of a POSITA discloses “forming an organic material pattern layer having a saw tooth opening on the predetermined material layer to expose the surface of the predetermined material layer underneath, wherein the surface of the predetermined material layer and the sidewall of the organic material pattern layer form a predetermined angle” for the same reasons discussed above. *See* Ground 6 (Zhang), claim 9c.

G. Claim 2

227. Zhang alone and in view of the knowledge of a POSITA discloses “[t]he method of claim 1, wherein the predetermined angle is less than about 60 degree” for the same reasons discussed above. *See* Ground 6 (Zhang), claim 10.

H. Claim 3

228. Zhang alone and in view of the knowledge of a POSITA discloses “[t]he method of claim 1, wherein the predetermined angle ranges from about 20 degree to about 30 degree” for the same reasons discussed above. *See* Ground 6 (Zhang), claim 11.

I. Claim 4

229. Zhang alone and in view of the knowledge of a POSITA discloses “[t]he method of claim 1, wherein the predetermined material layer comprises a passivation layer” for the same reasons discussed above. *See* Ground 6 (Zhang), claim 12.

J. Claim 5

230. Zhang alone and in view of the knowledge of a POSITA discloses “[t]he method of claim 1, wherein the predetermined material layer comprises a metal electrode layer” for the same reasons discussed above. *See* Ground 6 (Zhang), claim 13.

K. Claim 6

231. Zhang alone and in view of the knowledge of a POSITA discloses claim 6.

1. Claim [6a]

232. Zhang alone and in view of the knowledge of a POSITA discloses “The method of claim 1, wherein formation of the organic material pattern layer comprises: forming an organic material layer on the predetermined material layer; and patterning the organic material layer to form the saw tooth opening therein.” See Ground 6 (Zhang), claims 9 and 1. Zhang alone and in view of the knowledge of a POSITA discloses “The method of claim 1 (see claim 1, 9), wherein formation of the organic material pattern layer comprises: forming an organic material layer on the predetermined material layer (see [1b-c], [9b-c]); and patterning the organic material layer to form the saw tooth opening therein (see [1c]. [9c]).” See Ground 6 (Zhang), 9 and 1. Zhang discloses these steps to a POSITA by disclosing Zhang’s organic layer is formed on the predetermined material layer and that Zhang’s sawtooth opening is created by making openings in the organic layer. Zhang does not explicitly disclose the precise technique for creating the sawtooth pattern, but the claim is not limited to any particular technique. In the alternative, this claim would have been obvious to a POSITA in light of their knowledge. The lack of description of a precise patterning technique in Zhang would have motivated a POSITA to use a known technique within their knowledge and skill, any one of which would satisfy this claim. See Section IV.C-F (discussing known techniques for forming angled openings in organic layers). A POSITA would have

had a reasonable expectation of success in using known techniques to pattern the openings in Zhang's organic layer for the predictable result of patterning. Specific examples of techniques disclosed in Vaganov, Kim and Yamazaki for particular angles are incorporated herein by reference. *See* Grounds 7-8; IV.C-F.

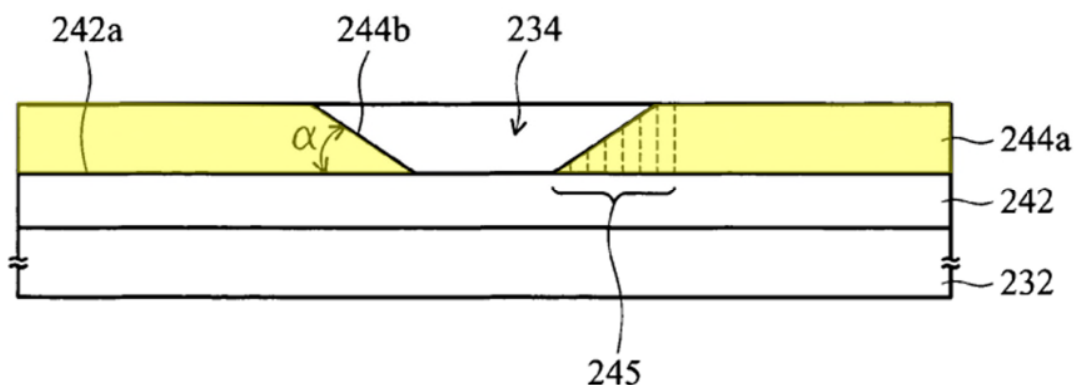
2. Claim [6b]

233. Zhang alone and in view of the knowledge of a POSITA discloses “wherein the organic material pattern layer comprises a plurality of segments adjacent to the saw tooth opening, and the respective height of the plurality segments gradually increases with respect to the distance from the saw tooth opening.”

234. For example, as explained above, Zhang discloses that the groove or opening may be V-shaped such that the height of the segments gradually increases as they move away from the center of the opening. *See* Ground 6 (Zhang), claims 1b, 2, 9b, 10.

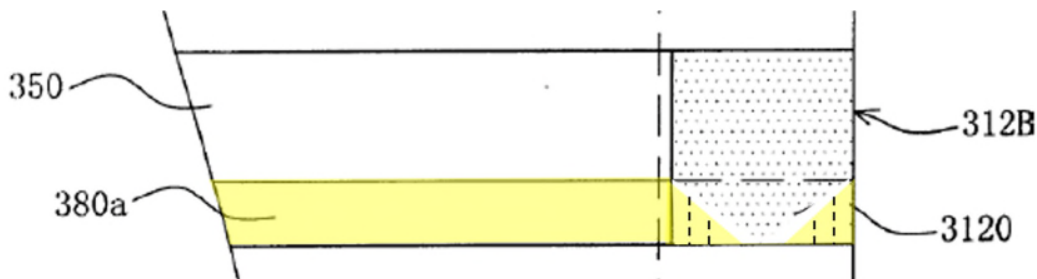
235. Claim 6 of the '801 patent requires an opening with a sloping sidewall with an angle less than 90°. Independent claims 1 and 9 of the '801 patent require a “predetermined angle,” which includes a range of angled openings including angles that are substantially 90°. Dependent claims 2, 3, 10, and 11 require that the angle be less than 90°. Claim 6, similar to the other dependent claims, requires that the sidewalls that form either a stepped pattern (potentially with 90° angles) or a

continuous slope with an angle less than 90° . The plain language of the claim requires “a plurality of segments adjacent to the saw tooth opening” where the height of each segment gradually increases as it moves away from the opening. The '801 patent depicts a plurality of segments 245 as a continuous slope with an angle less than 90° as it moves away from the center of the opening. EX1001, Fig. 2B-C.



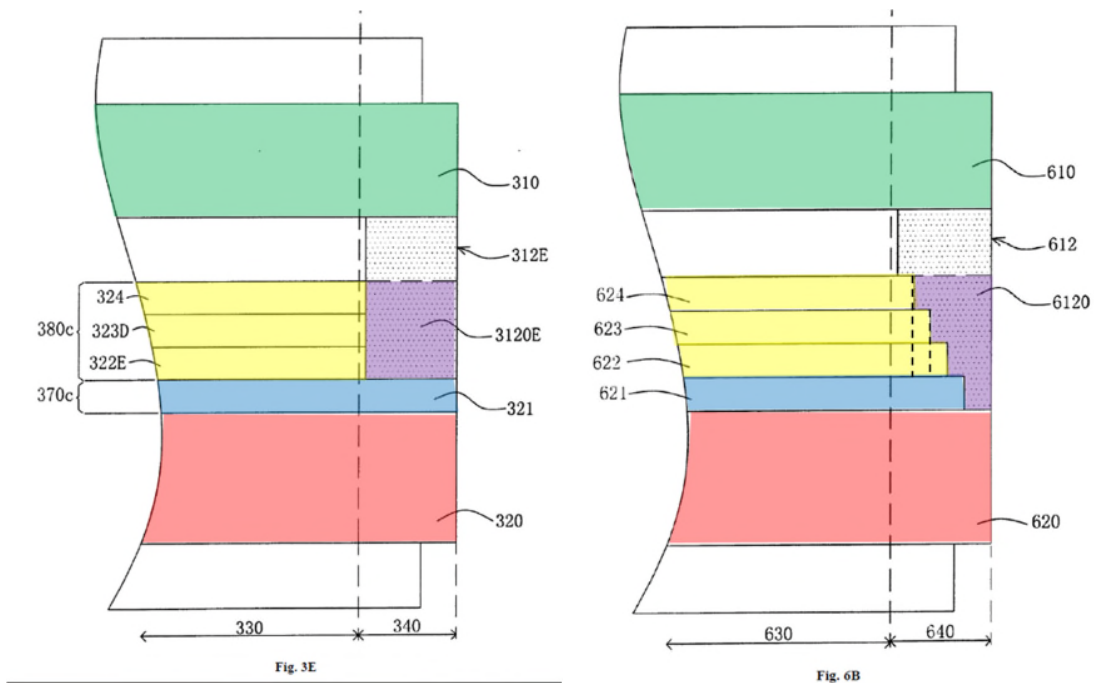
'801 patent Fig. 2B

236. Similarly, Zhang teaches a V-shaped opening with a similarly angled slope as that taught by the '801 patent.



Zhang Fig. 3B (modified excerpt)

237. To the extent the claims require explicit and separate segments, Zhang discloses this. For example, Zhang discloses embodiments in which the second covering, including an organic layer, comprises multiple layers. See Ground 6 (Zhang), 9, 13, 1, 5. Zhang discloses a “groove or opening . . . distributed in a stepped manner, as shown in Figure 6B.” EX1006, 11, Fig. 6B. Similarly, the embodiment using a V-shaped groove as shown in Figure 6A includes separate segments at each level that satisfy this claim. *Id.*, 11, Fig. 6A. As established above, Zhang discloses, or at least renders obvious, that the multi-layered second covering layer would have included an organic layer for reflective LCDs. See Ground 6 (Zhang) claims 9, 13, 1 and 5. A POSITA would have understood that the multi-layered second covering layer, including an organic layer, would be formed in the same stepped manner. EX1003, ¶234, Figs. 3B-E, 6B. Thus, one of skill would have understood that one technique for forming the opening of Zhang would begin with the stepped segments and would have a reasonable expectation of success doing so. *Id.* Similar to Zhang’s disclosure of a v-shaped opening in the second covering layer, a POSITA would have understood that the opening (3120) in the organic layer (second covering layer) as depicted in Figs. 3B-3E would be formed in the same manner as the stepped opening (6120) of Fig. 6B.



Zhang, Figs. 3E and 6B (annotated originals)

238. One of skill also would have understood that further etching or treatment would be applied to a stepped openings to form the angled V-shaped slopes of Zhang. A POSITA would have understood that one technique for forming the opening of Zhang would begin with the stepped segments. One of skill would have understood that it was a design choice regarding whether to use the initial stepped opening as depicted in Fig. 6B (and sacrifice some volume for additional adhesive material) or continue treating the opening to create angled slopes to form the V-shaped angles, such as those in Fig. 6A. Further, creating an initial opening with stepped sides and then etching only the stepped sides would reduce cost and

improve efficiency. A POSITA implementing these techniques would have had a reasonable expectation of success in doing so.

XVI. GROUND 7: CLAIMS 2-3, 6, AND 10-11 ARE OBVIOUS OVER ZHANG IN VIEW OF VAGANOV

A. Combination Rationale

239. It would have been obvious for a POSITA to combine Zhang's teachings related to increasing the bonding strength in the manufacture of LCD's and improving the quality of the panel by preventing moisture degradation with Vaganov's teachings of increasing bonding strength in semiconductor and chip manufacture and increasing the reliability by reducing cracking or breakage.

240. Zhang is directed improving the quality and bond strength of display panels by increasing the contact area of openings in the layers to allow more adhesive to penetrate the openings and come into contact with the various layers.

See IX.B (Zhang)

241. Vaganov is directed to bonding strength by using microstructures with angled sidewalls in the bonded surfaces to increase the bonding surface area and volume of sealant. *See IX.C (Vaganov)*. Vaganov's angled sidewalls also improve reliability and prevent "delamination due to insufficient adhesion, cracking or breakage." EX1007, 6:1-16. Vaganov describes well-known techniques for creating a variety of predetermined angles of below 60°. *See IX.C (Vaganov)*. The

specific dimensions and angles are determined by design considerations and the processes used and would result in angles at or below 30° . EX1007, 2:57-3:14, 5:14-22, 10:23-51, 12:46-53; *See* IX.C (Vaganov).

242. Zhang and Vaganov are in the same field of endeavor, including disclosing methods for manufacturing electronic devices, such as LCD's and integrated circuits, and describe implementing their improvements in similar structures. *See* IX.B (Zhang), IX.C (Vaganov).; *see also* EX1006, 7-11, Figs. 1A-B, 2A-B, 3A-E, 4, 5A-B, and 6A-B; EX1007, 1:5-8, 1:11-36, 1:38-61, 3:33-44, 4:50-67, 14:27-35, 14:58-63, Figs. 1.

243. Both references teach methods for improving the sealing bond when encapsulating components between two opposing substrates. Both references teach increasing the surface area for sealant contact by implementing angled opening in the layers. Zhang discloses an organic layer (second covering 380 comprising at least photoresist layer 225 and optionally other layers) that covers a predetermined material layer (first covering 370) and has an angled (V-shaped) opening to expose the underlying layers. While Zhang describes and depicts openings with various angles (including substantially 90° and less), Zhang does not identify a numerical value for its angle. Vaganov discloses methods for creating openings in similar materials that result in specific angles, including 90° , $54^{\circ}44''$, 45° , and $35^{\circ}16''$. A POSITA would have recognized the similar structures and materials and would

have found it routine and straightforward to combine Vaganov's teaching of a specific angle with Zhang's angled opening.

244. A POSITA implementing Zhang would have been motivated to use the methods of Vaganov, at least as they pertain to creating an opening with a specific angle and would have a reasonable expectation of success. A POSITA would have understood that Zhang and Vaganov teach similar improvements that provide similar results. Zhang is directed to increasing the contact area for the adhesive to improve bond and reliability. The increased bond strength has the additional benefit of reducing damage or cracks in the sealant that might allow for intrusion of moisture. Vaganov describes techniques for creating openings with angled sidewalls that would also increase the contact area between the sealant and various layers. The sealant area of Vaganov would improve the reliability by preventing intrusion from moisture and oxygen and thus reducing the likelihood of delamination or degradation. See EX1007, 1:28-37, 1:62-2:27, 2:56-3:4, 3:29-33, 7:6-9.

B. Overview and Incorporation of Ground 6

245. Ground 7 relies on everything in Ground 6, including the teachings of Zhang and Vaganov and the knowledge of a POSITA, which are incorporated herein by reference. Ground 7 additionally relies on the explicit combination of

Zhang and Vaganov, including the discussions above regarding the motivation to combine, for the claims below.

C. Claim 10

246. Zhang in view of Vaganov discloses claim 10 for at least the same reasons discussed above. *See* Ground 6 (Zhang), claim 10.

D. Claim 11

247. Zhang in view of Vaganov discloses claim 11 for at least the same reasons discussed above. *See* Ground 6 (Zhang), claim 11.

E. Claim 2

248. Zhang in view of Vaganov discloses claim 2 for at least the same reasons discussed above. *See* Ground 6 (Zhang), claim 2.

F. Claim 3

249. Zhang in view of Vaganov discloses claim 3 for at least the same reasons discussed above. *See* Ground 6 (Zhang), claim 3.

G. Claim 6

250. Zhang in view of Vaganov discloses claim 6 for at least the same reasons discussed above. *See* Ground 6 (Zhang), claim 6; IV.C-F.

**XVII. GROUND 8: CLAIMS 2-3, 6 AND 10-11 ARE OBVIOUS OVER
ZHANG IN VIEW OF YAMAZAKI**

A. Combination Rationale

251. It would have been obvious for a POSITA to combine the Zhang's teachings related to increasing the bonding strength and reliability with Yamazaki's teachings regarding creating sealant regions including an organic layer with an angled slope to improve the seal and reliability by prevent moisture and oxygen intrusion.

252. Zhang is directed improving the quality and bond strength of display panels by increasing the contact area of openings in the layers to allow more adhesive to penetrate the openings and come into contact with the various layers. *See IX.B (Zhang).*

253. Yamazaki discloses an LCD device with a sealant region comprising an organic layer with openings that expose the underlying insulating layers, where the sidewalls of the opening have an "angle θ more than 30° and less than 75° ." *See IX.E (Yamazaki).* Yamazaki's tapered slope would have decreased moisture intrusion and chances of delamination in the display device. *Id.*

254. Zhang and Yamazaki are in the same field of endeavor, including disclosing methods for manufacturing liquid crystal displays, and describe implementing their improvements in similar structures and products to achieve

similar benefits. EX1006, 7-11, Figs. 1A-B, 2A-B, 3A-E, 4, 5A-B, and 6A-B; EX1009, 1:8-64, 4:32-47, 8:28-33, Fig. 11. Both references describe an organic layer overlaying an underlying layer and an opening through the former to expose the latter. Zhang discloses an organic layer (second covering 380 comprising at least photoresist layer 225 and optionally including additional layers, such as a protective layer) that rests above a predetermined material layer (first covering 370) and has an angled (V-shaped) opening in the organic layer to expose the underlying layers. Zhang describes openings with various angles (including substantially 90° and less) but does not identify a numerical value for its angle. Yamazaki discloses an organic layer (planarizing film 16) that rests above a predetermined material layer (insulating layers 11, 12, and 13) and has an angled (30°-75°) sidewall or opening in the organic layer to expose the underlying layers. One of skill in the art would have recognized the similar structures and materials and would have found it routine and straightforward to combine Yamazaki's teaching of a specific angle with Zhang's angled opening.

255. A POSITA implementing Zhang would have been motivated to use the methods of Yamazaki and would have a reasonable expectation of success of doing so, at least as they pertain to creating an opening with specific angles. A POSITA would have understood that both Zhang and Yamazaki teach similar improvements that provide similar results, and thus would have been obvious to

combine. Zhang is directed to increasing the contact area for the adhesive to improve bond and reliability. The increased bond strength has the additional benefit of reducing damage or cracks in the sealant that might allow for intrusion of moisture. Yamazaki describes angled sidewalls that would also increase the contact area between the sealant and various layers. The sealant area of Yamazaki also creates a more reliable product by preventing intrusion from moisture and oxygen and thus reducing the likelihood of delamination or degradation.

B. Overview and Incorporation of Ground 6

256. Ground 8 relies on everything in Ground 6, including the teachings of Zhang, Yamazaki, and the knowledge of a POSITA, which are incorporated herein by reference. Ground 8 additionally relies on the explicit combination of Zhang and Yamazaki, including the discussions above regarding the motivation to combine, for the claims below.

C. Claim 10

257. Zhang in view of Yamazaki discloses claim 10 for at least the same reasons discussed above. *See* Ground 6 (Zhang), claim 10.

D. Claim 11

258. Zhang in view of Yamazaki discloses claim 11 for at least the same reasons discussed above. *See* Ground 6 (Zhang), claim 11. Specifically, Yamazaki discloses a taper angle “more than 30° and less than 75°.” EX1009, 5:43-45, 12:47-

48. A POSITA would have understood that an angle “more than 30°” could also be “about 30 degree.” Further, as explained above, techniques for creating an opening with angled sidewalls of “about 30 degree” were well known. A POSITA would have been motivated to implement Yamazaki’s angle of approximately 30 degrees in Zhang because the smaller angle would allow for more surface area, more sealant, and, thus, a stronger bond.

E. Claim 2

259. Zhang in view of Yamazaki discloses claim 2 for at least the same reasons discussed above. *See* Ground 6 (Zhang), claim 2.

F. Claim 3

260. Zhang in view of Yamazaki discloses claim 3 for at least the same reasons discussed above. *See* Ground 6 (Zhang), claim 3.

G. Claim 6

261. Zhang in view of Yamazaki discloses claim 6 for at least the same reasons discussed above. *See* Ground 6 (Zhang), claim 6; IV.C-F.

XVIII. SUMMARY OF OPINIONS

262. The Challenged Claims of the ’801 patent are anticipated and/or rendered obvious by these prior art references.