

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

IPR2024-01131
Patent 7,266,801

DECLARATION OF ERIC BRETSCHNEIDER, PH.D.

TABLE OF CONTENTS

I. INTRODUCTION	1
II. BACKGROUND AND QUALIFICATIONS	2
III. THE '801 PATENT	10
IV. SUMMARY OF THE ALLEGED PRIOR ART	13
A. Overview of Kwak	13
B. Overview of Vaganov	21
C. Overview of Kim	25
D. Overview of Yamazaki ('336)	26
E. Overview of Zhang	31
F. Commentary on State of the Art	34
V. THE LEVEL OF ORDINARY SKILL IN THE ART	46
VI. APPLICABLE LEGAL STANDARDS	47
A. Burden of Proof	48
B. Date of Invention	48
C. Anticipation	48
D. Obviousness	48
E. Claim Construction	52
F. Section 112 Definiteness	54
G. Teaching Away	55
VII. CLAIM CONSTRUCTION	55
A. "layer"	56
B. "formed on"	60
VIII. Challenge 1: The Petition's Anticipation Theory Based on Kwak Fails to Disclose All Elements of Claim 9	62

A. Kwak Fails to Disclose a Predetermined Material Layer Formed on the First Substrate ([9b]) or an Organic Material Pattern Layer Formed on the Predetermined Material Layer ([9c])	62
B. Kwak Fails to Disclose a Predetermined Angle ([9c])	65
IX. Challenge 2: The Petition's Obviousness Theory Based on Kwak Fails.....	68
A. Kwak Fails to Render Obvious a Predetermined Material Layer Formed on the First Substrate ([9b])	68
B. Kwak Fails to Render Obvious a Predetermined Angle ([9c])	69
X. Challenge 3: The Petition's Obviousness Theory Based on Kwak and Vaganov Fails	69
A. Kwak and Vaganov Fails to Render Obvious a Predetermined Material Layer Formed on the First Substrate	69
B. No Motivation/Ability to Combine.....	69
XI. Challenge 4: The Petition's Obviousness Theory Based on Kwak and Kim Fails.....	71
A. Kwak and Kim Fails to Render Obvious a Predetermined Material Layer Formed on the First Substrate	71
B. No Motivation to Combine Kwak and Kim.....	71
XII. Challenge 5: The Petition's Obviousness Theory Based on Kwak and Yamazaki Fails.....	72
A. Kwak and Yamazaki Fails to Render Obvious a Predetermined Material Layer Formed on the First Substrate	72
B. No Motivation to Combine	73
XIII.Challenge 6: The Petition's Obviousness Theory Based on Zhang Fails	74
A. No Motivation to Combine Embodiments; Combination Made in Error	74
XIV. Challenge 7: The Petition's Obviousness Theory Based on Zhang and Vaganov Fails79	
A. Vaganov Fails to Cure Zhang's Deficiency Regarding Using an Organic Layer.....	79
B. No Motivation/Ability to Combine.....	80
XV. Challenge 8: The Petition's Obviousness Theory Based on Zhang and Yamazaki Fails.....	81
A. No Motivation to Combine	81
B. Yamazaki Fails to Cure Zhang's Deficiency Regarding Using an Organic Layer.....	82

XVI.	CONCLUSION.....	83
------	-----------------	----

I, Eric Bretschneider, declare as follows:

I. INTRODUCTION

1. I have been retained by counsel for Patent Owner Optronic Sciences LLC in this proceeding. My credentials are described in my curriculum vitae, which is Exhibit 2009. I offer this report in response to the Petition for Inter Partes Review, Case No. 2024-01131 regarding U.S. Patent No. 7,226,801 (the "'801 Patent"), filed by Petitioner Boe Technology Group Co., Ltd.

2. I have been asked by Patent Owner's counsel to offer technical opinions relating to the '801 Patent, the alleged prior art, and the arguments and opinions presented by Petitioner and its expert, Dr. Dean Neikirk.

3. I am being compensated at my standard consulting rate of \$500 an hour, plus out-of-pocket expenses. My compensation does not depend on the testimony that I express in this Declaration, or on the outcome of these cases.

4. I have reviewed the papers and exhibits filed in this proceeding as of the date my declaration is signed. I understand that Petition challenged the patentability of claims 1-6 and 8-14 of the '801 Patent (the "Challenged Claims"). Specifically, the Petition sets forth the following challenges:

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

5. After performing the analysis described herein and applying the standard outlined below, in my opinion, none of the grounds provide a basis for concluding that any of the claims of the '801 Patent should be found invalid. My opinions are based on the record evidence, my knowledge and experience in the field, and my opinion as to the level of ordinary skill in the art.

II. BACKGROUND AND QUALIFICATIONS

6. My complete qualifications and professional experience are described in my Curriculum Vitae, a copy of which is attached as Exhibit 2021.

7. I have over 30 years of experience with LEDs, displays, lighting fixtures, and lighting including a comprehensive background in a full range of LED technologies, including solid state lighting (SSL) fixture/lamp design, integration, and reliability, LED chip and package testing and reliability, fabrication, optical design, thermal management, and color conversion.

8. Throughout the course of my career, I have designed and transferred into manufacturing over 150 different LED-based lighting products, including LED lighting products designed to be installed in fixtures and in different lighting environments and applications. I have also designed and transferred into manufacturing dozens of different LED chips and packages for a variety of different applications with a particular focus on display applications and general lighting.

9. I am recognized as a leading expert in matters related to reliability for all types of LED technology and have consulted with numerous companies to help develop internal testing methods and reliability standards for evaluating their products.

10. I am currently the Chief Technology Officer at EB Designs & Technology. In that capacity, I am, among other things, responsible for the design of solid-state lighting technologies for clients ranging from startups to Fortune 100 companies.

11. I also served as a member of the University of Florida's Department of Chemical Engineering Advisory Board for 25 years, from 1998 until 2022. During my tenure on this Advisory Board, I served as Chair for a total of 8 years. I also served on the Dean's Advisory board for the College of Engineering at the University of Florida from 2007-2009 and 2017-2022. I have been a Conference Chair for LED Measurement and Standards. I am also a member of numerous professional

societies, including the International Society for Optics and Photonics (SPIE), Optica, the Society for Information Display (SID), the Materials Research Society (MRS), and the Illuminating Engineering Society (IES).

12. Inside the IES, I am a founding member of the Science Advisory Panel, which has oversight over all testing and technical committees and work groups inside the IES. I am also a full member of the Test Procedures Committee which develops test, measurement and reliability standards for LEDs and lighting fixtures. Inside the Test Procedures Committee, I serve as chair of the projections and reliability subcommittee which develops reliability standards for LED based lighting products including utilizing all forms of lighting technologies. I recently led the work group that revised TM-21 which is the internationally accepted standard for predicting reliability of LED packages. I also developed a new mathematical model that, for the first time, allows prediction of the color shift of an LED package over its time. This model is the basis for a new IES standard known as TM-35, which predicts the rate of color shift for LED products over time.

13. I joined the IES in 2006 and have been a member of the Test Procedures Committee since that time. As a result, I have been an active participant in the development of testing standards related and have helped to formalize the terminology for solid state lighting since the beginnings of the industry.

Additionally, I serve on the IES Color Committee and the IES Photobiology Committee.

14. I previously served as Chief Technology Officer at QuarkStar, LLC., from 2016 until 2023. QuarkStar is primarily a technology development company that is focused on new approaches to improving performance and efficiency of products that rely on LED light sources. In this role, I helped negotiate the company's first technology license to a European manufacturer of lighting fixtures. This technology has since be incorporated into one of their premium product lines. I also lead the efforts to transition products into manufacturing to produce fixtures for the Museum of Fine Arts, Houston (MFAH). These fixtures provide over 60% of the artificial lighting in a \$500 million expansion.

15. Prior to my position at EB Designs & Technology, I served as the Director of Engineering at HeathCo, LLC. In that capacity, I was responsible for advanced technology/product development related to solid-state lighting, sensors, notifications, and control products.

16. Prior to my position as Director of Engineering at HeathCo, I was at the Elec-Tech International Co., Ltd., where I held the positions of Chief Engineer, ETi Lighting Research Institute and VP of Research and Development, ETi Solid State Lighting. In my Elec-Tech capacities, my responsibilities included developing all technology and product roadmaps for markets in North America, China, Europe, and

Japan. I designed and developed LEDs, LED packages and LED based lighting products for all of these markets.

17. Between 2008 and 2011, I was at Lighting Science Group Corporation (LSG), first as a product development manager, and my responsibilities included developing solid state lighting products, then as VP of Research, and my responsibilities included developing advanced LED models for product development and production control. In these roles, I was involved in the design and manufacture of numerous LED-based lighting fixtures and products. The products I helped launch included LSG's C2D (Curb to Door) products. These products were designed to be installed in outdoor locations including wall packs, parking lots, and streetlights. These fixtures, particularly the wall pack fixtures, were also suitable for installation in public transportation areas.

18. Between 2004 and 2008, I was at Toyoda Gosei North America, where I was a sales manager, and my responsibilities included managing and developing LED die and package sales accounts from the eastern region of North America. I was also tasked with providing technical support for the entire western hemisphere. The support I provided included design of LED packages and design of lighting fixtures and products that incorporated LED packages. Notable successes at Toyoda Gosei included expanding market niches and applications for LED based backlights for LCD displays. I provided significant technical and design support to large

customers, including 3M, Global Lighting Technologies, Apple, Dell, and Hewlett Packard.

19. Between 2003 and 2004, I was at Beeman Lighting, where I was Director of Solid State Lighting Engineering, and my responsibilities included leading development of solid state lighting systems and materials.

20. Between 1998 and 2003, I was at Uniroyal Optoelectronics. Uniroyal Optoelectronics was a joint venture between Uniroyal Technology Corporation and Emcore Corporation which was initially focused on development and production of GaN-based and AlInGaP-based LED chips. Later, Uniroyal Optoelectronics expanded their scope to include LED packages. At Uniroyal Optoelectronics, I held a number of positions including Team Leader for the Epitaxial Growth and Materials Characterization areas, Sr. Epi Scientist, Director of Intellectual Property, University Relations and Government Contracts. My responsibilities included MOCVD hardware modification, epitaxial process development as well as design, development and testing of new LED chip structures for both AlInGaP and GaN-based material systems. I was also responsible for providing technical support and assistance to customers on topics related to use of LED chips, design of LED packages and design of LED based lighting products and systems. This support included both optical and thermal design of LED packages and LED lighting products. My work at Uniroyal included providing technical support and package

design for Kopin which resulted in the development of full color micro displays that were used as electronic viewfinders for Kodak digital cameras.

21. I have also authored and presented more than a total of 30 publications, presentations, and seminars, and I am a named inventor on over 65 issued patents and more than 25 pending patents.

22. I earned a bachelor's degree in Chemical Engineering from Tulane University in 1989.

23. I earned a Ph.D. in Chemical Engineering from the University of Florida in 1997, where my graduate work focused on development of optoelectronic devices, including novel silicon based visible LEDs and sulfide based TFELD structures and zinc selenide blue LEDs. As a graduate student, I was also an active participant in the Phosphor Technology Center of Excellence (PTCOE). The PTCOE was a large research consortium that was focused on technology development of display technology for electroluminescent (both alternating current and direct current) displays, field emission displays, and plasma displays.

24. In 1989 I worked for Shell Oil Corporation in Norco, LA. I was tasked with modeling heat exchanger performance for the crude oil distillation column in order to identify cost saving opportunities. I developed an improved model for determining the operating efficiency of heat exchange units that incorporated determined the economic impact on different operating conditions. The model was

designed to be compatible with all major operating units on site and resulted in costs savings of over \$20 million/year at the Norco Facility alone. My work was quickly adopted throughout the entire corporation and has resulted in sustained annual cost savings of approximately \$500 million/year.

25. Based on the above education and experience, I believe that I have a detailed understanding of the state of the art during the relevant period, as well as a sound basis for opining how persons of ordinary skill in the art at that time would understand the claim terms and technical issues in this case. I believe that I would have this understanding regardless of which definition of a “person of ordinary skill in the art” is adopted by the Board. I meet Petitioner’s proposed definition, which is “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,” because I have a B.S. and a Ph.D. in Chemical Engineering as well as over 30 years of experience in LED design, a subfield of optoelectronics.

26. The opinions stated in this declaration are based on my own personal knowledge and professional judgment; if called as a witness during any proceeding in this matter I am prepared to testify competently about them.

27. In forming my opinions, I have considered the materials discussed and cited herein, including the asserted patents, the prosecution histories of the patents,

and the prior art references discussed herein, and any other references referred to or cited in this declaration.

III. THE '801 PATENT

28. The '801 Patent discusses issues with thin film transistor (TFT) CLD devices, specifically that they may be sensitive to materials in the environmental, such as moisture, and that this sensitivity may adversely affect LCD performance and result in shortened lifetimes. Ex. 1001, 1:10-21 (“TFT LCD devices can suffer from degradation related to ambient environmental conditions such as moisture which may lead to performance loss, operational instability, poor color/emission accuracy, and shortened operational life. Specifically, water can cause crystallization and formation of organic solids, electrochemical reactions at the electrode organic layer interface, corrosion of metals and migration of ionic species. To minimize such degradation, a TFT LCD device must be properly encapsulated to prevent moisture migration. Typical encapsulation methods utilize a color filter substrate covering organic polymer areas with an adhesive sealant.”).

29. The '801 Patent also teaches that conventional encapsulation methods may exhibit a number of deficiencies. Ex. 1001, 1:22-25 (“[C]onventional encapsulation methods suffer from problems such as sealant peeling, uneven cell gaps, and formation of voids in the sealant regions during assembly.”).

30. The '801 Patent goes on to describe a new approach that remediates these issues using a combination of layers, forming saw tooth opening pattern in an organic material layer, and using a predetermined angle. *See* Ex. 1001, 1:32-46 (“The methods comprise providing a first substrate and a second substrate opposite thereto, forming a predetermined material layer on the first substrate, forming an organic material pattern layer having a saw tooth opening on the predetermined material layer. The saw tooth opening to expose the Surface of the predetermined material layer underneath and the surface of the predetermined material layer and the sidewall of the organic material pattern layer form a predetermined angle. A sealant region pattern is also disclosed. A saw tooth opening is formed in an organic material layer on a first substrate to expose a predetermined material layer underneath. The surface of the predetermined material layer and the sidewall of the organic material pattern layer form a predetermined angle.”).

31. Further, the '801 Patent teaches that issues with formation of voids or bubbles in prior art sealing processes is related to the sidewall angle of openings in which the sealing material is dispensed and that angles above 60° are disfavored. Ex. 1001, 2:31-40 (“An organic material layer 144 is formed on the silicon nitride layer 142. The organic material layer 144 is patterned by lithography. Saw tooth openings 134 shown in FIG. 1B are formed in the organic material layer 144 by etching, and sealant 146 is placed therein. Voids or bubbles 150 formed during

application of the sealant 146 occur due to angle θ between sidewall of saw tooth openings 134 and the surface of silicon nitride layer 142 exceeding 60 degrees.”).

32. The technology disclosed by the '801 Patent is important for reducing the width of the bezels of LCD displays. For general reference, I have provided an example of what a typical, pre-'801 Patent, LCD display looked like in the image below. Specifically, I note the large bezels that were required at the time for functionality and durability of the display.



Ex. 2014 (showing the date of first sale as Sept. 24, 2002).

33. By contrast, due in part to improvements such as those disclosed by the '801 Patent, LCD monitors today have a greatly reduced bezel size while maintaining functionality and durability. I have provided the exemplary image below, for reference, to show how bezels have changed over the years, consistent

with my memory of bezel sizes in general over the years.¹ Bezels have gotten thinner and narrower.



Ex. 2015.

IV. SUMMARY OF THE ALLEGED PRIOR ART

A. Overview of Kwak (Ex. 1005)

34. Kwak teaches that organic EL displays may be sensitive to moisture and are sealed using a substrate or metal cap. Ex. 1005, 1:45-50 (“However, in the organic EL display, organic layers including the organic light emitting layer are very vulnerable to moisture. Thus, in order to protect the organic light emitting layer from moisture and to protect a display area of the display from external shock, the layers are sealed using a substrate or a metal cap.”).

¹ I was not asked to provide an opinion on whether the AUO monitor practices the patent.

35. Kwak further teaches that sealing alone may not be sufficient to protect organic films from moisture in the environment and that additional materials are incorporated inside the sealed area to absorb moisture. Ex. 1005, 2:31-41 (“However, in the AM display described above, the protection layer is just a thin film, so internal devices are not protected sufficiently. In addition, there is a limit to the protection provided by the protection layer to the organic EL device, which should be protected completely from moisture. U.S. Pat. No. 5,882,761 refers to a display that further includes a drying substance in the metal cap or glass substrate in order to further protect the organic EL device from moisture. Moreover, the display having the thin protection layer cannot be a front-emission display or a dual-emission display, which form images in a direction of the sealing member.”).

36. Kwak seeks to improve adhesion and sealing performance by using a series of “penetration holes” and vias to increase contact area. Ex. 1005, 9:7-12 (“Thus, a chemical reaction between the sealant 810 and the driving power supply line 300 can be prevented, and if the layer has a smaller width than the driving power supply line 300, the contact area with the sealant 810 can be increased and the seal improved.”), 9:58-63 (“Referring to FIG. 2D, one or more via holes 811 are arranged on a portion of the protection layer 180 that overlaps the sealing portion 800 to increase the contact area of the sealant 810 with layers stacked on the substrate, thereby tightly sealing the substrate 110 and the encapsulation substrate 900.”),

10:50-53 (“When the depth of the via hole 811 is increased, the contact area with the sealing portion 810 increases and the adhesive strength between the substrate 110 and the encapsulation substrate 900 can be increased.”).

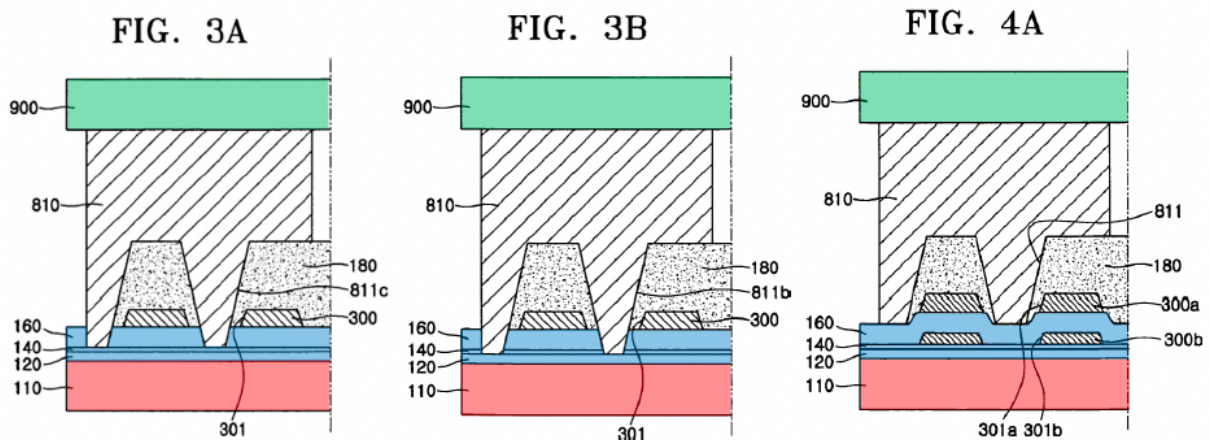
37. Kwak’s description of “penetration holes” is almost synonymous with vias and the two constructs are closely related. The difference between penetration holes and vias appears to be the diameter at the surface and the layers each penetrate through. Ex. 1005, 3:28-32 (“A position of the at least one penetration hole and a position of the at least one via hole preferably correspond to each other. A cross-section of the at least one via hole is smaller than that of a corresponding at least one penetration hole.”), 5:9-14, FIGS. 2A-B, 3A-C, 4A-C, 5A-E.

38. A POSITA would understand penetration holes and vias to be steep penetrating features in a thin film device. Vias are commonly used to provide electrically conductive paths between metallization layers in multilayer structures. A critical parameter for a via is the diameter at the bottom of the via—if the diameter is too small, it can lead to current crowding or overheating issues due to high electrical resistance.

39. Additionally, the primary use of a via is to provide an electrical path, a POSITA understood it is desirable for the side walls of a via to be as close to vertical as possible in order to minimize area requirements. Wide, shallow vias provide no operational or design benefit and in fact would impose design constraints due to

increased area requirements. As such, the diameter of a via is determined primarily by the ability of metals deposition processes to fill the via. In Kwak's case, a via is filled with sealant rather than with a conductor.

40. During deposition, Dr. Neikirk analogized creation of a via to pushing a thumbtack through several coatings on a wall, with the hole made by the thumbtack as being equivalent to a via. Ex. 2011 at 24:7–13 (“[I]f you picture multiple coatings of paint on a wall and you poke a thumbtack through that and pull that thumbtack out, the hole that you leave behind goes all the way through the paint to the sheetrock below it; and that hole, in some circumstances, would be what someone would refer to as the via.”). Kwak teaches using multiple layers, which may be used to increase the contact area of the via:



Ex. 1005, Fig. 3A, 3B, 4D (annotated by Petitioner).

41. This is consistent with the understanding of a POSITA with respect to via geometry as discussed above. Vias are generally steep features, but the emphasis

is on the depth and diameter at the bottom. While the angle of the sidewall is preferably close to vertical, it is certainly not a specific, predetermined angle unless such an angle is specifically called for. In my experience, the angle is not specifically defined, nor is it typically measured, and it may take a range of values that depend on other process parameters, the most critical parameter being the exposed area at the bottom of the via. After reviewing Kwak, it is clear that *the angles of the sidewall are not contemplated at all*. See Ex. 1005. Nothing discloses that the angle identified by Dr. Niekirk was predetermined, and a POSITA would not have understood them to be. In contrast, the depth of the via is predetermined. Ex. 1005 at 10:50–56 (“When *the depth* of the via hole 811 is increased, the contact area with the sealing portion 810 increases and the adhesive strength between the substrate 110 and the encapsulation substrate 900 can be increased. However, if the substrate 110 is exposed, it can receive stress, and thus *an appropriate depth* of the via hole should be determined in consideration of design specifications.”) (emphasis added).

42. Dr. Neikirk acknowledged that one of Kwak’s key teachings in increasing contact area to improve seal strength. Ex. 1003 ¶56 (“Increasing the contact area between the sealant and layers would also improve the seal strength. Increasing the surface area of the openings ‘increases the adhesive strength between the substrates.’ For example, Kwak discloses openings of various depths, where a

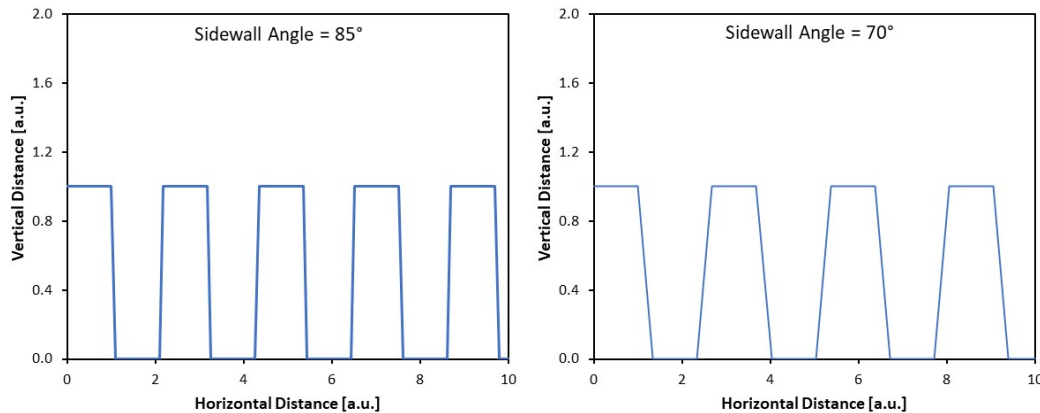
deeper opening would expose more surface area for contact with the sealant.”)
(cleaned up).

43. Dr. Neikirk also opined “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.” Ex. 1003 ¶56.

44. However, this opinion is plainly based on hindsight. Dr. Neikirk does not offer any support for this conclusory statement. An attempt to achieve a predetermined angle of Kwak’s via would reduce the angle, as the via would be intended to be nearly vertical. Even rudimentary analyses demonstrate that Kwak’s teaching of increasing surface area would not lead a POSITA to adjust the sidewall angles of the vias, as they would want the sidewalls as close to vertical as possible.

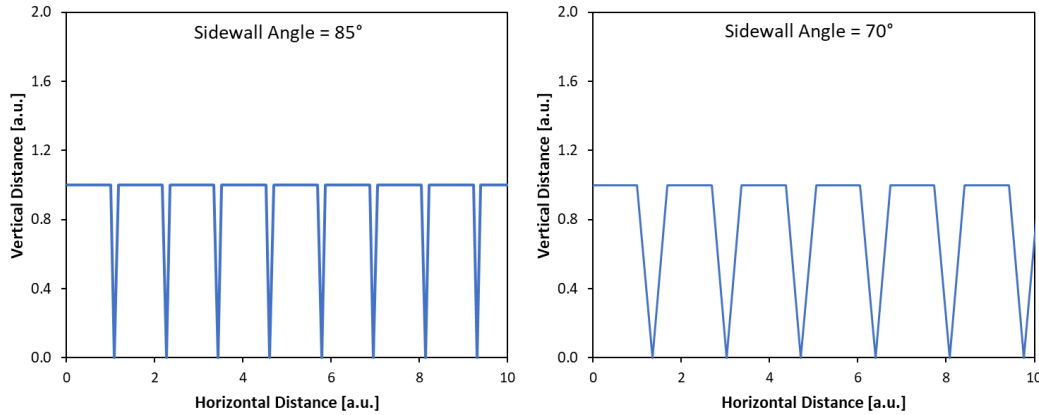
45. To illustrate, consider a one-dimensional analog of a series of vias. The mesa (flat, unetched region of film) and the valley (bottom of etched via) have a constant length of 1 unit. For simplicity, all vias are etched to the same depth. This simplified model allows calculation of the total length per unit length in the horizontal direction. The total length included the mesa and valley lengths as well as the length of the side walls.

46. The figures below show the scenario for side wall angles of 85° and 70° . By inspection, it is evident that the length of the sidewalls increases as the sidewall angle decreases, however, it is also evident that the distance between adjacent mesas and valleys increases.

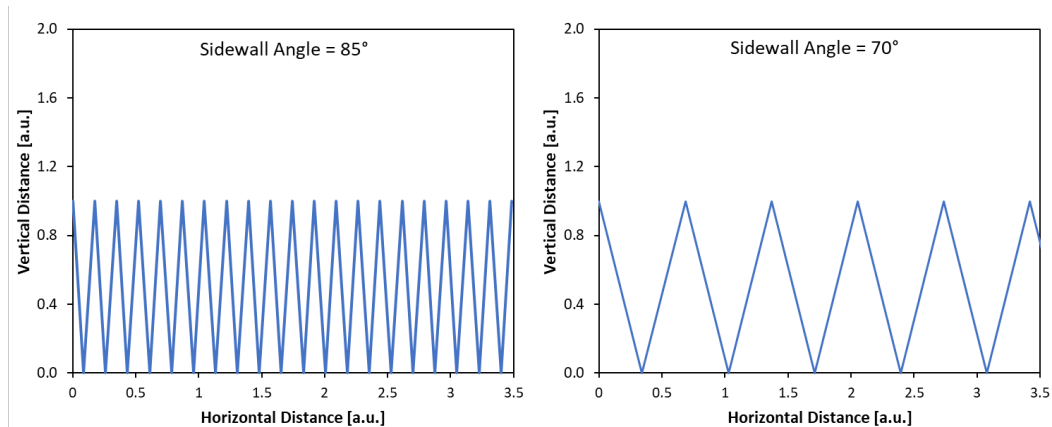


47. At a sidewall angle of 85° , the length ratio (total length/horizontal distance) is about 1.843, while at a side wall angle of 70° , the length ratio is smaller at about 1.533.

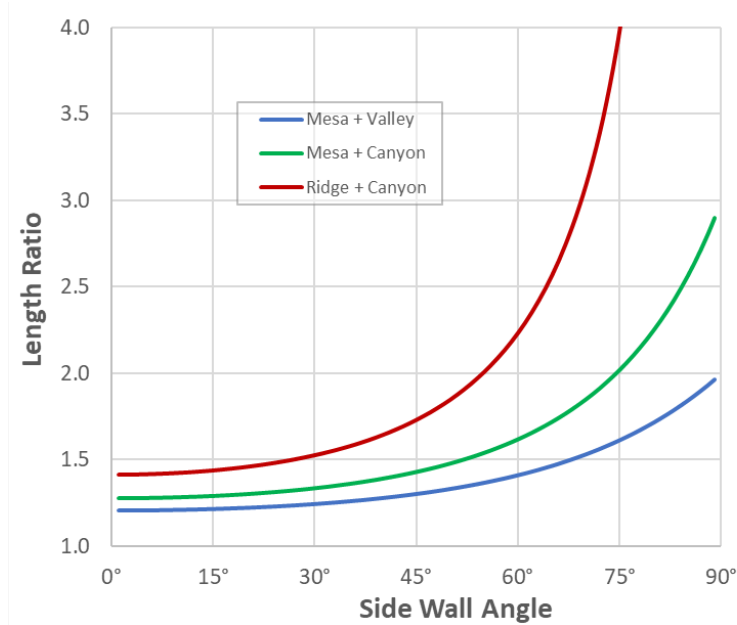
48. Repeating this exercise for a mesa + canyon configuration, one in which the bottom of the via just makes contact with the layer below yields the following images. The corresponding length ratios are 2.561 at a side wall angle of 85° and 1.849 at a side wall angle of 70° .



49. The images below show the scenario for a ridge + canyon or sawtooth scenario. Length ratios are 11.517 for side wall angles of 85° and 3.090 for side wall angles of 70° .



50. These results hold for all angles as shown below. The same type of trends will hold for two-dimensional scenarios as well. This is most easily understood by noting that as the side wall angle decreases, the side walls become more similar to horizontal, planar surfaces—at the limit of a 0° side wall angle, there would be no side walls, just a single plane.



51. In other words, *decreasing the angle of a via's sidewall reduces overall contact area*. Thus, a desire to increase surface area, as discussed below, would strongly motivate a POSITA not to adjust or otherwise attempt to predetermine the angle of the sidewall when making a via in order to maximize the total surface area.

52. As discussed below, Dr. Neikirk's opinions that a desire to maximize surface area would motivate a POSITA to decrease side wall angles as taught by the '801 Patent have no factual basis and are based solely on hindsight—the proposed combination simply would not accomplish his stated motivation to increase contact area.

B. Overview of Vaganov (Ex. 1007)

53. Vaganov is directed to the bonding of silicon and other wafer materials, or wafer-to-wafer bonding. Ex. 1007, 1:6-8 ("This invention relates to integrated

circuits, microsensors, and micromachining, and more particularly to bonding of silicon or other wafers.”). Wafer-to-wafer bonding is a different problem than LCD panel assembly.

54. A POSITA understood that the wafers of Vaganov are crystalline materials—more specifically, single crystal materials. In other words, Vaganov’s wafers are a single crystal material with no grain boundaries or amorphous regions. As such, this places significant limitations on the applicability of Vaganov’s teachings. This understanding is readily evident upon a review of Vaganov from the disclosure of the use of crystalline wafers and, in some cases, use of crystalline wafers of a particular orientation. *See* Ex. 1007, 2:63-64 (“For example, for silicon (100) crystalline orientation wafers”), 5:25-26 (“[F]or example by anisotropic etching of a (100) crystalline orientation silicon surface”), 10:23-26 (“The following describes various microstructures and etching processes for forming the above-described wafer bridges, pits, pyramids, etc., profiles, these processes are for monocrystalline silicon wafers”); *see also* Ex. 1007, 10:29-35, 10:36-43, 10:44-51, 10:54-59, 10:60-67, 11:1-8, 11:29-44, 11:57-12-5. The etches taught by Vaganov are specific to single crystal silicon materials. The rate at which these solutions etch silicon varies depending on the specific crystal plane exposed. More specifically, the etches of Vaganov are designed to be highly anisotropic and proceed very slowly on certain exposed crystal planes. If applied to amorphous or polycrystalline silicon,

the crystal planes would be randomly oriented meaning that the etch would produce random surfaces with different orientations to each other. As such, they would produce a random, textured surface in which the angle with respect to the substrate would vary tremendously over the etched surface and would have no fixed angle. A POSITA would be unable to predict or control the rate of etch on amorphous or polycrystalline silicon. The silicon etch chemistries of Vaganov work by first oxidizing an exposed silicon surface and then etching of the oxide by HF. These types of etches ***do not significantly attack organic films and are not compatible with such materials.*** A POSITA would be aware that such chemistries have little effect on organic films as organic films (i.e., photoresist materials) are used to mask portions of silicon wafers to protect those portions from being etched. I additionally note that Vaganov does not teach the etching of layers, but is rather directed to etching the wafer (substrate material).

55. A POSITA would also note that Vaganov emphasizes minimization of the area used for bonding. Ex. 1007 1:38-46 (“A major goal for bonding is minimizing the bonded area on the surface of the wafer. This goal is derived from the general strategy of microelectronics technology: minimizing area minimizes the manufacturing cost. In many cases, especially in sensor applications, the bonding area can be comparable or even larger than the active area of the sensor or

microelectronic device. Therefore, the need for decreasing this bonding area in order to decrease the cost of the IC or sensor die is clear.”)

56. The above passage further informs a POSITA that Vaganov is directed toward integrated circuit (IC) packaging which is a different field of endeavor from flat panel displays.

57. In my opinion, Dr. Neikirk misunderstand the teachings of Vaganov. Dr. Neikirk cited teachings in Vaganov for etching single crystal silicon substrates that resulted in angles of 90° , $54^\circ44'$, 45° , and $35^\circ16''$. Ex. 1003 ¶72. However, a POSITA would have understood that these examples were limited to single crystal silicon wafers and were, in part, dependent on the orientation (crystal plane associated with the primary face) of the wafer. In other words, the teachings of Vaganov could not be arbitrarily applied to any given material, as discussed above in ¶54.

58. Dr. Neikirk also cited a portion of Vaganov which he believes teaches a method for creating side wall angles of 21.8° . Ex. 1003, ¶73. The cited passage in Vaganov states “The 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. A typical depth of the trenches (or other microstructures) in wafer 10 in FIG. 4 is 5-15 μm ; a typical microstructure width at the widest point is 5 μm ; a typical minimum size would be 1 μm deep (or high) and

1 μm wide for any of the microstructures disclosed herein (this is however not limiting).” Ex. 1007, 5:14-22. Upon my review, the teaching of Vaganov is clear: the etch depth is 5-15 μm and the width at the widest point is 5 μm . The combinations are depth 5-15 μm with width of 5 μm and a minimum width or minimum depth of 1 μm . Nowhere does Vaganov teach or imply Dr. Neikirk’s example of a 5 μm feature with a depth of 1 μm .

59. Additionally, a POSITA would understand that whatever depth or width was used for a feature, the angles would be fixed by the etch method *and the crystalline orientation of the wafer* and not subject to the whims of a POSITA. Dr. Neikirk’s interpretation of the teachings of Vaganov are clearly and obviously the result of hindsight. In my opinion, the only way Dr. Neikirk could have reached his conclusion is if he formed his opinion prior to reviewing Vaganov and then modified his interpretation to conform to the presumed requirements.

C. Overview of Kim (Ex. 1008)

60. Kim is directed “to a contact structure for a semiconductor device as well as for a thin film transistor array substrate” for an LCD. Ex. 1008, ¶ [0002]. Nowhere does Kim describe sealing for an LCD. Kim is concerned with trying to avoid undercutting and enhancing wiring contacts. *Id.* ¶ [0045]. For example, as Petitioner’s own expert stated in his declaration, “Kim explains that creating openings with such angles allows for the smooth creation of later layers formed on

top of the organic layer. In this way, the organic insulating layer may remain sufficiently thick while simultaneously *allowing for better contacts through the openings.*” Ex. 1003, ¶ 157 (citations omitted) (emphasis added). Nothing in Kim concerns sealing or adhesion. Further, a POSITA would be aware that Kim does not teach a fixed or predetermined angle and rather teaches a wide range of acceptable angles. “[T]he side wall of the organic insulating layer defining the contact holes bearing an inclination degree of about 30-60°, and pixel electrodes formed on the organic insulating layer while being electrically connected to the drain electrodes.” Ex.1003, ¶[0010]. Moreover, Kim does not even teach planar sidewalls and instead teaches that a curved or gradual profile is desired. “[T]he organic insulating layer 75 is tapered at the contact area while bearing a gradual inclination degree. As the boundary of the protective layer 70 at the contact area agrees to that of the organic insulating layer 75, the pixel electrodes 82, the subsidiary gate pads 84 and the subsidiary data pads 88 have a gradual profile at the contract area while being prevented from being cut.” Ex. 1003, ¶[0063], *see also* Figs. 1D-G, 3, 9

D. Overview of Yamazaki ('336) (Ex. 1009)

61. Yamazaki teaches that many issues exist with respect to performance of organic electroluminescent (EL) devices. Ex. 1009 2:23-27 (“However, also in a light emitting device using an EL element, when an anode (or a cathode) is formed over an interlayer insulating film having unevenness, there is a possibility that short

is generated between the anode and the cathode since a layer containing an organic compound is thin.”).

62. Yamazaki also teaches that organic EL devices may display uneven luminescence (brightness) and may also suffer from rapid deterioration or lifetime. Ex. 1009 2:28-32 (“Further, an organic EL element using an organic material for an EL element has a problem that luminescence properties such as luminance or evenness of luminescence significantly deteriorate compared to an early period. The low reliability is a factor causing the practical application to be limited.”).

63. Despite listing many problems, Yamazaki only identifies addressing issues with reliability and points to moisture and oxygen as being problematic. Yamazaki further teaches that moisture in particular may penetrate from the outside environment or be trapped inside the device during manufacturing. Ex. 1009 1:66-2:3 (“As one factor of worsening reliability, moisture or oxygen which intrudes into the organic EL element from outside is given. In an EL display device (panel) using an EL element, moisture intruding inside cause a severe reliability lowering to generate a dark spot, shrink or luminance deterioration from the periphery of a light emitting display device. The dark spot is a phenomenon in which luminance deteriorates partly (including a pixel which does not emit light). The dark spot is generated when a hole emerges on an upper electrode, for example. Shrink is a phenomenon in which luminance deteriorates from an edge of a pixel.”), 2:33-44

(“Briefly, moisture which causes deterioration such as a dark spot intrudes into a display device after sealing in most cases. In addition, moisture or oxygen intrudes mainly through the sealant since an insulator and a covering material are made of metal or glass in most cases.”).

64. Yamazaki’s solution to moisture issues is an interlayer film that does not release after formation. Additionally, Yamazaki teaches that this interlayer film also acts as an effective barrier to moisture present in the environment. Ex. 1009, 3:34-38 (“In addition, the invention provides an interlayer insulating film which has sufficient planarity and insulation in an insulating film having planarity used for a semiconductor device and in which moisture content does not change even when a wet step is performed later.”), 3:51-56 (“After the formation, an edge portion or an opening portion is formed to have a tapered shape. Afterwards, distortion is given by adding an inert element with a comparatively large atomic radius to modify or densify a surface (including a side surface) for preventing the intrusion of moisture or oxygen.”).

65. Yamazaki’s interlayer film is densified by adding an inert element with a large atomic radius. Ex. 1009, 3:51-56 (“After the formation, an edge portion or an opening portion is formed to have a tapered shape. Afterwards, distortion is given by adding an inert element with a comparatively large atomic radius to modify or

densify a surface (including a side surface) for preventing the intrusion of moisture or oxygen.”).

66. Yamazaki lists various noble gases (inert elements), but points to Ar as being preferable due to its low cost and comparably large atomic radius. Ex. 1009, 5:3-10.

67. Yamazaki also lists desirable concentrations of inert elements as ranging from 1×10^{19} atoms/cm³ to 5×10^{21} atoms/cm³, with a typical range of 2×10^{19} atoms/cm³ to 2×10^{21} atoms/cm³. Ex. 1009, 5:38-42

68. A POSITA would have been aware that the typical density of photoresist materials is about 1.23 g/cm³. When this information is combined with Yamazaki's inert atom concentrations a POSITA would note that Yamazaki teaches 0.05% to 21.24% Ar by weight in the planarizing film. The corresponding typical Ar concentration is 0.11% to 9.74% by weight.

69. In order to achieve these high concentrations a POSITA understands that ion implantation would be the only feasible means of achieving these concentrations at any significant depth. Further, a POSITA would be aware that even at the low end, incorporating this concentration of an inert element would lead to substantial modification of the surface at the molecular level.

70. Yamazaki confirms this understanding. Ex. 1009, 12:36-42 (“The doping treatment may be performed by ion doping or ion implantation. Typically,

argon (Ar) is used as the inert element. Distortion is given by adding the inert element with a comparatively large atomic radius to modify a surface (including a side surface) or to highly densify for preventing the intrusion of moisture or oxygen.”).

71. A POSITA would know that the beam angles used for ion implantation are approximately perpendicular to the surface. Because of this, the penetration depth is highly dependent on the orientation of a film with respect to the ion beam.

72. Therefore, in order to achieve uniform ion implantation at the side surfaces of Yamazaki’s planarizing film, a taper (angle) would be required or else the side surfaces would be approximately parallel to the ion beam. At near parallel incidence such an ion beam would be highly likely to sputter or erode the surface of the film rather than penetrating. For this reason, a POSITA understands the purpose of Yamazaki’s tapered shapes are ion implantation—without this taper, those surfaces could not be doped.

73. Yamazaki explicitly teaches this. Ex. 1009, 12:42-47 (“The inert element contained in the highly densified part 20 is set Within the concentration range from 1×10^{19} atoms/cm³ to 5×10^{21} atoms/cm³, typically, from 2×10^{19} atoms/cm³ to 2×10^{21} atoms/cm³. In addition, the side surface of the high thermostability planarizing *film 16 is formed to have a tapered shape so as to be doped.*”) (emphasis added).

74. Yamazaki teaches that the tapered edge area *is not required* if plasma treatment is used to dope the film with inert atoms. Ex. 1009, 5:45-49 (“However, when the inert element is added by using plasma treatment or oblique doping, a side surface of the high thermostability planarizing film can be modified *without forming the edge portion to have a tapered shape.*”) (emphasis added).

75. For these reasons, a POSITA understands that Yamazaki’s use of tapered films is related to the process for adding an inert element to a film, more specifically, Yamazaki only teaches use of a tapered film in order to ion implant high doses of inert atoms in a film.

E. Overview of Zhang (Ex. 1006)

76. Zhang relates to display panels and, more specifically, to frame structures used to between substrates. Ex. 1006 at 4 (“The present invention relates to a display panel frame adhesive structure, and particularly to a display panel frame adhesive structure with superior bonding strength.”). I further note that the teachings of Zhang are directed towards LCD panels. Ex. 1006 at 1 (“For a general liquid crystal display (LCD) panel, it can be divided into a display area and a frame adhesive area located around the display area. In the frame adhesive area of a thin-film transistor liquid crystal display (TFT-LCD) panel, the thin-film transistor (TFT) substrate usually has multiple covering layers. From bottom to top, these layers typically include a scan line metal layer, a dielectric layer composed of a material

such as silicon nitride (SiNx), a data line metal layer, and a protective layer used to protect the transistor components. In addition, for reflective and semi-transmissive/semi-reflective TFT-LCD panels, apart from the aforementioned covering layers, there may sometimes be an additional layer of photoresist layer (PL) above the protective layer.”).

77. Zhang’s goal is to improve the mechanical strength of a bond. Ex. 1006 at 8 (“By increasing the contact area of the frame adhesive, more frame adhesive can penetrate into grooves or openings, thereby increasing the bonding strength between the TFT substrate and the CF substrate. This 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.”).

78. “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 the CF substrate.” Ex. 1006 at 9.

79. “The main approach of the present invention is to increase the contact area of the frame adhesive, allowing more adhesive to penetrate into the groove or opening, thereby enhancing the bonding strength between the TFT substrate and the CF substrate. As the first covering layer 370a and the second covering layer 380a

consist of four layers in total, 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 TFT substrate and the CF substrate.” Ex1006 at 10.

80. “[I]t is evident that the display panel completed by bonding after assembly is achieved by increasing the space occupied by the frame adhesive through the groove or opening, allowing more adhesive to penetrate into the groove or opening successively, effectively enhancing the bonding strength between the TFT substrate and the CF substrate.” Ex. 1006 at 12.

81. Beyond this “main approach,” however, is a crucial distinction that Dr. Neikirk does not seem to have recognized. As part of its improvement over the prior art, Zhang teaches not to use an organic layer, as the prior art does, but instead teaches using an inorganic layer. Zhang discloses an organic material pattern layer as part of the *conventional LCD*, an “photoresist layer 225 can be composed of an organic material.” Ex. 1006 at 6. Then Zhang describes his own invention (improving the conventional LCD) by teaching that the frame adhesive may be applied to a groove or opening, including an opening in a “V-shaped manner.” *Id.* at 12. However, **Zhang explicitly teaches that for the embodiments where the frame adhesive is applied to a groove or opening, there is no organic layer.** Specifically, the corresponding layer is changed to an *inorganic* material. *Id.* at 10

(teaching “the protective layer 324 is composed of silicone dioxide . . . or silicon nitride.”), 7 (“*the bonding strength of the assembled liquid crystal display panels 100, 200A, and 200B is insufficient*. During reliability tests or drop tests, the panels are prone to developing cracks at the contact interface between the TFT substrate and the CF substrate due to impact or vibrational forces.”). Put simply, a POSITA understood that organic layers are soft and squishy and inorganic layers are hard and durable—an adhesive applied to a hard layer is more durable than if it is applied to a soft and squishy layer. Thus, a POSITA understood Zhang’s substitution of an organic layer for an inorganic layer was part of the design that improved durability.

F. Commentary on State of the Art

82. A review of Dr. Neikirk’s “state of the art” opinions and conclusions provides strong additional evidence of his pervasive use of hindsight in forming his opinions. Dr. Neikirk repeatedly misinterprets and misstates clear teachings of prior art references. In my opinion, it is not a coincidence that every misinterpretation or misstatement is cited as evidence supporting his opinions of obviousness or anticipation—it is clear evidence of hindsight.

83. **Shinego:** As an example, Dr. Neikirk states that Shinego teaches an organic resin film with side wall slopes of about 45°. Ex. 1003 ¶(14 last paragraph). However, a review of the cited passages of Shinego reveals that Shinego fails to

disclose any angles of side walls through organic resin films. *See* Ex. 1010, ¶¶0071-0083.

84. Moreover, the discussions and descriptions of a 45° angle are for an oxide layer that is etched using a buffered hydrofluoric acid (BHF) etch solution. Ex. 1010, ¶ [0113] (“Next, an etching solution of buffered hydrofluoric acid (BHF: hydrofluoric acid-ammonium fluoride buffered solution) is sprayed to necessary portions for a period of 120 sec. at a temperature of 28° C., for example. ***The etching solution removes the gate insulation film 15 at the bottom region of the upper contact hole 51*** to expose the upper surface of the connecting lines 14a of the connecting pads 14. The buffered hydrofluoric acid solution includes, for instance, 6% hydrofluoric acid and 30% ammonium fluoride. The etching time is determined to avoid excessive side-etching and to make the inner wall slope of the lower contact hole 41 at an angle of about 45°.”) (emphasis added).

85. “Next, an etching solution of BHF (hydrofluoric acid-ammonium fluoride buffer Solution) is sprayed to necessary portions for a period of 120 sec. at a temperature of 28° C., for example. ***The etching solution removes the interlayer and gate insulation films 4 and 15 or the interlayer insulation film 4 at the bottom region of the upper contact holes 51, 52 and 53*** to expose the lower metal layer. The buffered hydrofluoric acid solution includes, for instance, 6% hydrofluoric acid and 30% ammonium fluoride. The etching time is determined to avoid excessive

side-etching and to make the inner wall slope of the lower contact holes 41, 42 and 43 at an angle of about 45°.” Ex. 1010, ¶ [0168] (emphasis added).

86. In both examples, the films being etched are the silicon oxide or silicon nitride, not organic films. *See* Ex. 1010, ¶ [0140] (“The wet-etching solution fulfils the etching of the interlayer insulation film 4 made of silicon nitride and the gate insulation film 15 made of Silicon oxide to make the lower contact hole 41 perforated through the interlayer and gate insulation films 4 and 15.”). In addition, a POSITA would be aware that HF based etchant solutions do not attack or etch organic films. For this reason alone, it is my opinion that Dr. Neikirk failed to perform an adequate review of the actual teachings of the Shigeno reference. Nowhere does Shigeno teach or disclose a specific sidewall angle for any organic film.

87. In the annotated version of Fig. 4 of Shigeno, reproduced below, I have highlighted the resin insulating film 5 in green, the gate insulating film 15 in tan, and the sealant 105 in pink. ***I have also indicated the etch features identified to have a 45° side wall in dashed red lines.***

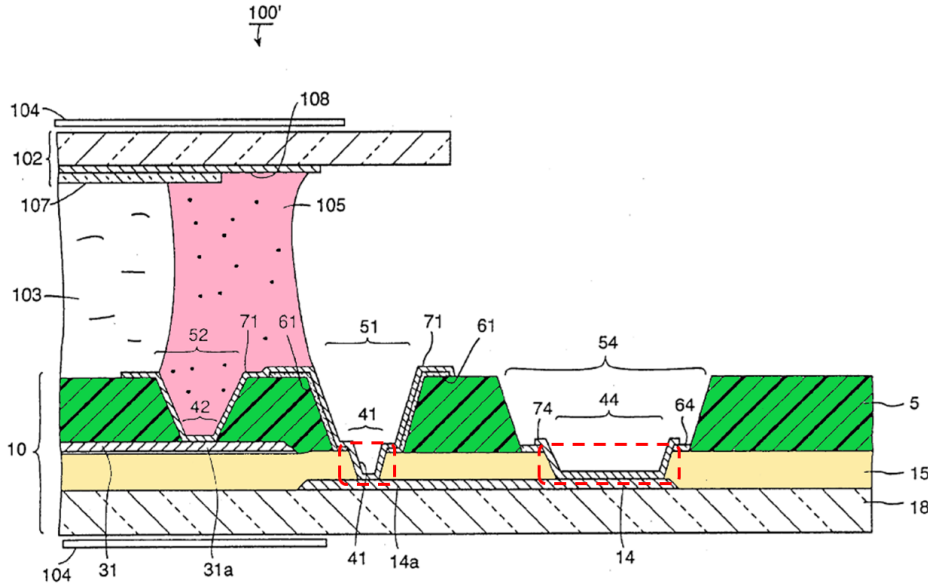
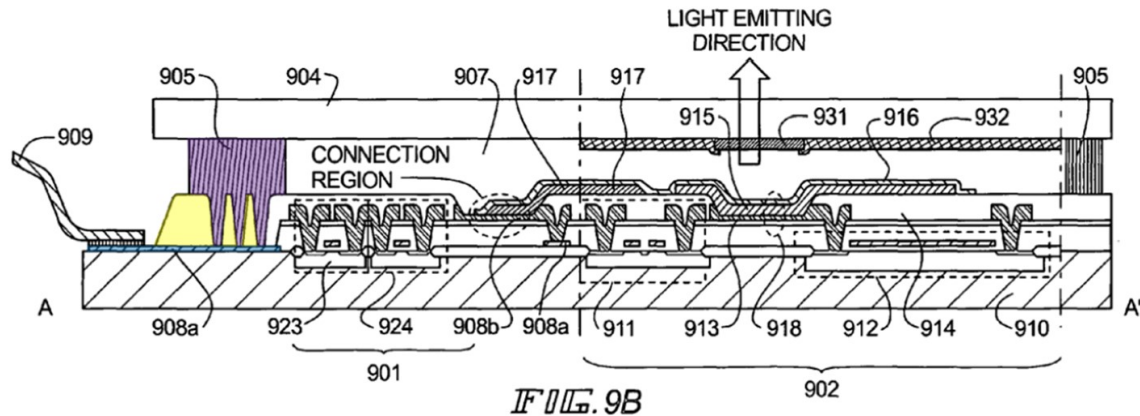


FIG.4

88. By inspection, it is evident that, contrary to Dr. Neikirk's opinion, "Shigeno discloses an LCD device with sealant (105) between two opposing substrates (10 and 102) where the sealant enters into an opening (52) through a thick organic resin film (5) where the inner wall slope of the opening is about 45° to expose the underlying layer 31a." Ex. 1003 ¶(bottom of page 13). Shigeno's sealant is not even applied over the etch features in Shigeno's gate insulation film 15. Dr. Neikirk's opinion misstates the actual content and teachings of the Shigeno reference and indicates a reliance on hindsight.

89. **Yamazaki 496:** Dr. Neikirk’s analysis of the Yamazaki 496 reference bears similar signs of his reliance on hindsight. Dr. Neikirk opines, “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.” Ex. 1003, ¶81. Dr. Neikirk includes an annotated version of Fig. 9B of Yamazaki 496, which I have reproduced below.



90. The sealant of Yamazaki 496 is highlighted in purple. Nowhere does Yamazaki describe the features highlighted in yellow. As such, it is improper to assume that Yamazaki 496 teaches any predetermined angle. Further, an unbiased POSITA would understand that the features are a series of vias whose sidewalls would be formed as close to vertical as possible but not at any particular, predetermined angle.

91. Dr. Neikirk cites portions of Yamazaki 496 that discuss forming a taper angle in organic layers. Ex. 1003, ¶81 (“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°”).

92. The only angles taught by Yamazaki 496 are unrelated to sealant. The “insulation layer” with angles from 35° to 55° (45° +/- 10°) is designated with

numeral 19 in Figure 1A and is described in Col. 9:66–10:24, which is a location completely different from that shown in Petitioner's annotated figure.

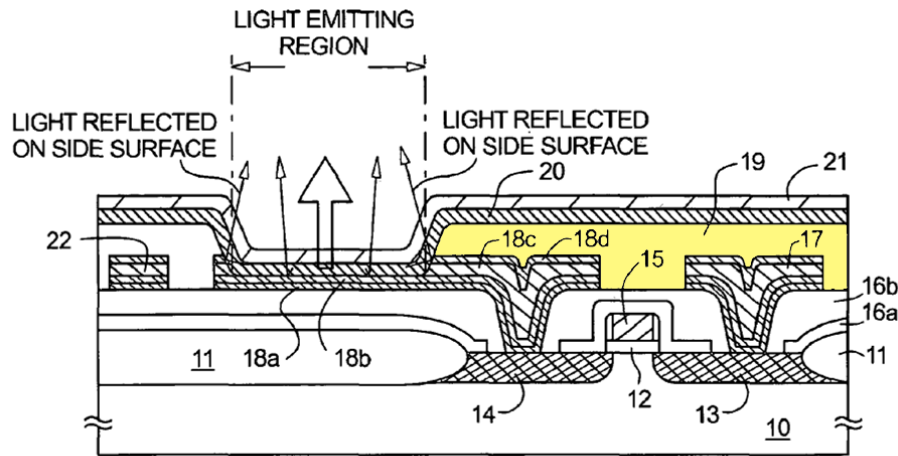


FIG. 1A

93. Yamazaki 496 teaches curved surfaces and angles of 35° to 55° for deposition of thin film layers in regions between pixels. Ex. 1011 4:13-25 (“Also, the invention contrives a configuration of insulations (called bank, partition, barrier, or the like) provided between respective pixels in order to eliminate failure in coverage when an organic chemical compound layer composed of a high polymer is formed by means of a coating method. The respective configurations has a feature in that upper ends of the insulations have a curved surface, of which a radius of curvature is 0.2 μm to 3 μm . Also, the taper angle of the insulations suffices to be 35° to 55°. The radius of curvature is provided to make favorable a covering quality for the stepped portion, so that deposition can be made even when a layer formed later and containing an organic chemical compound is very thin.”). This teaching is restricted to the interior of the device between pixels.

94. In fact, Yamazaki 496 repeatedly emphasizes the importance of angled reflective surfaces in order to control light. Ex. 1011, Abstract (“A FET is formed on a semiconductor substrate, a curved surface having a radius of curvature is formed on an upper end of an insulation, a portion of a first electrode is exposed corresponding to the curved surface to form an inclined surface, and a region defining a luminescent region is subjected to etching to expose the first electrode. Luminescence emitted from an organic chemical compound layer is reflected by the inclined surface of the first electrode to increase a total quantity of luminescence taken out in a certain direction.”), 3:9-13 (“According to the invention, an inclined surface formed on a stepped portion of the first electrode reflects or collects lateral emission to increase a quantity of light taken out in a certain direction (direction passing through the second electrode).”); *see also* 3:49-60, 4:26-34, 5:38-43, 6:1-6.

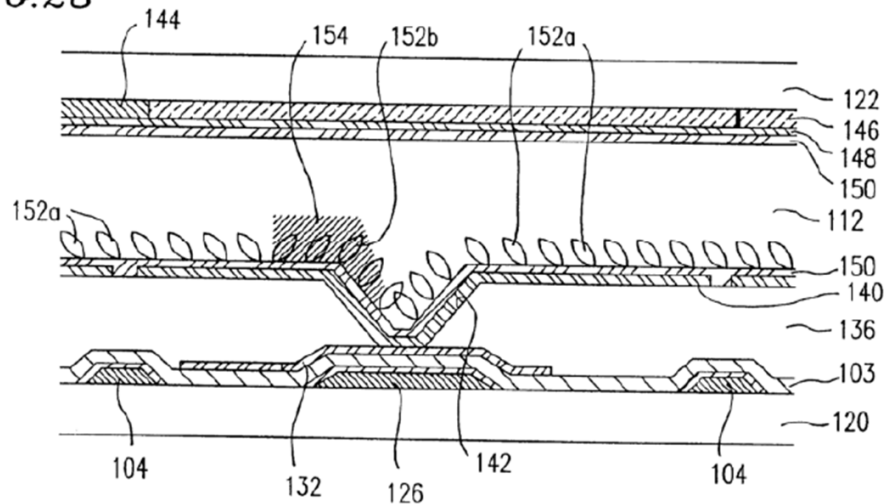
95. In order to serve the desired reflective functions of Yamazaki 496, side wall angles need not be precise or repeatable, but may instead be any value over a wide range provided that the light is reflected toward the center of the pixel. Therefore, a POSITA reviewing Yamazaki 496 would understand the discussion of a taper angle are specifically related to this reflective function. In my opinion, there is no support in Yamazaki 496 for Dr. Neikirk’s assumption of a sealant dispersed in one or more angled openings in an insulation layer. *See* Ex. 1003, ¶81.

96. **Shimada 722:** Dr. Neikirk offers similar opinions about Shimada 722.

Ex. 1003 ¶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°.”) However, Dr. Neikirk ignores the explicit teachings of Shimada 722, which are similar to those of Yamazaki 496. That is, *Shimada 722 teaches use of angled reflectors for light control*. Ex. 1012 18:55-67 (“The contact holes 142 are formed at predetermined position through the interlayer insulating film 136 by a predetermined method. An angle θ of an inclined inner wall of each contact hole 142 is preferably between about 45° or more and less than about 65°. A diameter ϕ of the contact hole 142 is preferably in the range of about 3.5 μm to about 6 μm , typically about 4 μm . With the above settings, the storage capacitor electrode 126 can effectively prevent light leakage from the reverse tilt domain 154 as described above. Thus, in the liquid crystal display device of this embodiment, the line width of the storage capacitor electrode 125 can be minimized and a high aperture ration can be maintained.”).

97. Dr. Neikirk includes a reproduction of Fig. 28 of Shimada 722 which clearly shows that contact holes are flat bottomed features. I have reproduced this image below.

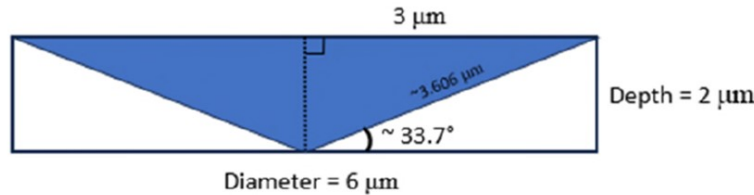
FIG. 28



Shimada 722, Fig. 28

98. Even absent this image, a POSITA would understand that contact holes would be expected to have a flat bottom in order to ensure that adequate and repeatable electrical contact could be made. Additionally, a POSITA would note that these features contain liquid crystal materials and, as such, ***could not be used for any sealing function***—they are literally filled with a liquid. Despite this clear teaching and the understanding of a POSITA, Dr. Neikirk determines an angle measurement for a hypothetical contact hole of Shimada 722. See Ex. 1003 ¶83 (“Shimada 722 describes an insulating film formed with a thickness approximately 2-4 μ m and contact holes with a diameter of 3.5-6 μ m. *Id.* An embodiment with a hole diameter of 6 μ m (radius of 3 μ m) and a depth of 2 μ m would result in an angle of approximately 33°. A trapezoidal opening with an upper diameter of 6 μ m, an inner diameter of 1 μ m, and a depth of 2 μ m would result in an angle of approximately

38.66° angle.”). Dr. Neikirk included a visual image of this hypothetical embodiment which I have reproduced below. Ex. 1003, ¶83:



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

99. At issue is that Shimada 722 does not teach a “triangular opening”. As discussed above, a POSITA would not expect a contact hole to be triangular. If such a structure were used, all of the current would pass through a point contact—this would be subject to failure due to high current densities. The area at the contact would be essentially zero, so any current would result in unsafe and unsustainable current densities through the point contact. Further, any minor variations in the process would result in variations in the actual contact area that would range from zero (meaning the feature did not penetrate the layer) to a small, but finite area. Contact holes that did not penetrate the insulating film would fail and variations in penetration would lead to enormous variations in performance as the current densities would range from very high to infinite. As such, Shimada 722 does not disclose the angles that Dr. Neikirk surmises. In my opinion, Dr. Neikirk’s reliance on hindsight is so pervasive that he failed to realize that his hypothetical triangular

opening resulted in angles outside the range of those taught by Shimada 722 as being useful for reflection.

100. Further, Shimada 722 does not disclose that the insulating film is an organic layer. *See* Ex. 1012. I note that Dr. Neikirk simply interprets Shimada 722's the word "or the like" as something that "*indicates* that the layer *may*" comprise an organic layer with no reasoning behind this speculation upon speculation (emphasis added). Ex. 1003, ¶ 44. This further supports my conclusion that Dr. Neikirk relied on hindsight in shaping his opinion.

101. **Shimada 376** is similar to Shimada 722 and also is directed towards using angled reflectors to control light and to prevent light leakage. *See* Ex. 1013 at 2:9–18, 36–45. Shimada 376's angled reflectors have nothing to do with sealing.

102. **Kim 935**: Similarly, Dr. Neikirk opines that Kim 935 teaches openings with specific angles. Ex. 1003, ¶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. The sidewalls of the openings form an angle 'within a range of about 20 to 110 degrees.'") (citations omitted). Kim 935 describes angled reflectors and does not even mention sealing. *See* Ex. 1014.

103. **Tanaka**: Dr. Neikirk's reliance on hindsight is further evident from his opinions with respect to Tanaka. Dr. Neikirk relies on Tanaka to support his

hindsight opinion that the benefits of utilizing predetermined angles were well known at the time. *See* Ex. 1003, ¶88.

104. This is a truly remarkable conclusion, as Tanaka does not teach any specific predetermined angle. Rather, Tanaka teaches “It is preferable that each of those end surfaces of the organic insulating film formed over the display area and the organic insulating film formed over the peripheral area which abut against the seal area be formed to make an obtuse angle with respect to the surface of the array substrate. This ensures good contact between the sealant and the organic insulating film.” Ex. 1016 2:54-60. Tanaka is clear that each end surface of the organic insulating film should form an obtuse angle with respect to the surface of the substrate. Tanaka’s requirement means that ***any etch process that does not produce an undercut would suffice*** and that the acceptable angle θ between the side surface and the substrate surface is $90^\circ < \theta < 180^\circ$.

105. Tanaka then relaxes this restriction and notes only one end surface needs to make contact with the sealant so the actual requirement is that only one end surface meet the angular condition of $90^\circ < \theta < 180^\circ$. *See* Ex. 1016 6:65-67 (“Even if the sealant is brought into contact with the end surface of either the organic insulating film 21 or the organic insulating film 21a, the same advantage will result.”).

106. In my opinion, a POSITA would not understand the background teachings² as being relevant in the manner Dr. Neikirk is asserting, and Dr. Neikirk minimizes the inventive concept of the '801 Patent. Rather, he appears to be relying on hindsight, as he cited art that discloses various angles without regard for what the references themselves actually teach.

V. THE LEVEL OF ORDINARY SKILL IN THE ART

107. I have been informed that my analysis of the Challenged Claims should be viewed from the perspective of a person of ordinary skill in the art (POSITA) as the earliest claimed priority date, which I have been informed is December 28, 2005.

108. I understand that a POSITA is a hypothetical person presumed to have known the relevant art at the time of the invention. I have been informed that in determining the level of ordinary skill in the art the following factors may be considered none of which is predominant: (1) type of problems encountered in the art; (2) prior art solutions to those problems; (3) rapidity with which innovations are made; (4) sophistication of the technology; and (5) educational level of active workers in the field.

109. I understand that Dr. Neikirk has opined that a POSITA “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

² I was not provided with the Miyoshi reference and have no opinion about Miyoshi.

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.” Neikirk Decl. at ¶36.

110. In my opinion, the field of “electronic and optoelectronic device design” is too broad. A POSITA of the Asserted Patents, around the time of each patent’s filing, has at least a Bachelors’ degree in a field of engineering or physics and at least two to three years of professional experience related to the design and manufacture of the relevant aspects of flat panel displays. Additional graduate education related to relevant semiconductor manufacturing or flat panel display technology could reduce but not eliminate the time requirement for professional experience. Nevertheless, the proposed definitions of a POSITA by me and by Dr. Neikirk are not outcome determinative. Thus, for the purposes of this IPR proceeding, I will use Dr. Neikirk’s proposed construction.

111. Through my education and work experience during the relevant timeframe, I believe myself to have at least ordinary skill in the art. I am also familiar with the knowledge and capabilities of one of skill in the art as of 2005.

VI. APPLICABLE LEGAL STANDARDS

112. I am not a lawyer and offer no legal opinions. My analysis and opinions are based on my expertise in this technical field and on the instruction that counsel

has given me for the legal standards outlined in the rest of this section. These principles are summarized below.

A. Burden of Proof

113. I understand that the petitioner must prove invalidity of a patent claim by a preponderance of the evidence, that is, the evidence must be sufficient to show that a fact or legal conclusion is more likely than not.

B. Date of Invention

114. I have been asked to use the date of the filing of the earliest application to which priority is claimed as the date of invention for purposes of my analysis.

C. Anticipation

115. I understand that a claim may be anticipated if a prior art disclosure teaches each and 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.

116. I understand that, once the claims of a patent have been properly construed, the next step in determining anticipation of a patent claim requires a comparison of the properly construed claim language to the prior art on a limitation-by-limitation basis.

D. Obviousness

117. I understand that even if a patent claim is not anticipated, it may still be invalid if the differences between the claimed subject matter and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person of ordinary skill in the pertinent art.

118. I also understand that a patent may be rendered obvious based on an alleged prior art reference or a combination of such references plus what a person of ordinary skill in the art would understand based on his or her knowledge and the references. It is also my understanding that in assessing the obviousness of claimed subject matter one should evaluate obviousness over the prior art from the perspective of one of ordinary skill in the art at the time the invention was made (and not from the perspective of either a layman or a genius in that art).

119. I understand that a patent claim composed of several elements is not proved obvious merely by demonstrating that each of its elements was known in the prior art. There must be a reason for combining the elements in the manner claimed. That is, there must be a showing that a person of ordinary skill in the art at the time of the invention would have thought of either combining two or more references or modifying a reference to achieve the claimed invention.

120. I understand that an obviousness determination includes the consideration of the following factors: (1) the scope and content of the prior art, (2) the differences between the prior art and the claims at issue, (3) the level of ordinary

skill in the art, and (4) 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. I understand that the following are examples of approaches and rationales that may be considered:

121. Combining prior art elements according to known methods to yield predictable results;

122. Simple substitution of one known element for another to obtain predictable results;

123. Use of a known technique to improve similar devices (methods, or products) in the same way;

124. Applying a known technique to a known device (method or product) ready for improvement to yield predictable results;

125. 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);

126. 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

127. 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. I am further informed that when a prior art reference teaches away from the claimed invention, that is a factor in determining obviousness.

128. I understand that the burden is on the petitioner to explain how an invention is 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. I further understand 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.

129. I understand that the burden is on the petitioner to explain how specific references could be combined, which combinations of elements in specific references would yield a predictable result, and how any specific combination would operate or read on the claims. I further understand that the petitioner cannot rely on conclusory statements but must instead provide a reasoned explanation supported by evidence. I also understand that obviousness does not exist where the prior art

discourages or teaches away from the claimed invention. I also understand that even if a reference does not teach away, its statements regarding preferences are relevant to a finding whether a person skilled in the art would be motivated to combine that reference with another reference.

130. 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.

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

132. I understand that it is impermissible to use hindsight to arrive at the claimed invention. My understanding is that the inventor's own path never leads to a conclusion of obviousness. I also understand that, when assessing whether there was a motivation to combine references to teach a claim element, defining the problem in terms of its solution reveals improper hindsight.

E. Claim Construction

133. 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.

134. 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.

135. I understand that the claims define the invention and the terms used in the claims are generally given their 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.

136. 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.

137. I understand that a patentee can act as its own lexicographer by defining a term, in the patent specification, to have a 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 a disclaimer. I have taken into account these principles in my analysis.

138. 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.

139. 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.

F. Section 112 Definiteness

140. I understand that, under 35 U.S.C. § 112 ¶ 2, “[t]he specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.”

141. I understand that that claims must be definite. This means that the claims must particularly point out and distinctly claim the subject matter that the applicant regards as her invention. I understand that indefiniteness is evaluated from the perspective of a person of ordinary skill in the art at the time of a patent’s filing. I understand that a patent claim is indefinite if the claim, when read in light of the specification and the prosecution history, fails to inform, with reasonable certainty,

a person of ordinary skill in the art of the scope of the invention. Absolute or mathematical precision in claim language is not required and even if more than one interpretation is presented for a claim term, the term may still be definite if an informed and confident choice is available among the contending alternative definitions.

G. Teaching Away

142. I understand that a prima facie case of obviousness may be rebutted by showing that the art, in any material respect, teaches away from the claimed invention. I understand that a known or obvious composition does not become patentable simply because it has been described as somewhat inferior to some other product for the same use.

VII. CLAIM CONSTRUCTION

143. I understand that in *Inter Partes* review, claims “shall be construed using the same claim construction standard that would be used to construe the claim in a civil action under 35 U.S.C. 2282(b), including construing the claim in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent.” 37 C.F. R. § 42.100(b). This is also referred to as the *Phillips* standard as explained in the Case *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005). I have applied this standard in rendering my opinions herein.

A. “layer”

144. In my opinion, the term “layer should be afforded its plain and ordinary meaning, which is a “film of a material created during manufacturing.”

145. Claim 9 uses the term in its plain and ordinary meaning to refer to single layers of materials, such as a “predetermined material layer” and an “organic material pattern layer.” In my opinion, this is consistent with how a POSITA would understand that modern electronic circuits are built using “successive layers of insulating, conducting, and semiconducting material.” Ex. 2010 at 467-68 (Sze is a seminal textbook for how to build modern electronic circuits). Each layer is individually built according to the intended purpose of the layer, such as using a layer of SiO₂ if an insulating layer is desired. A simple manufacturing process for a MOS capacitor is described on pages 469-70 of Ex. 1010 and summarized in the following figure:

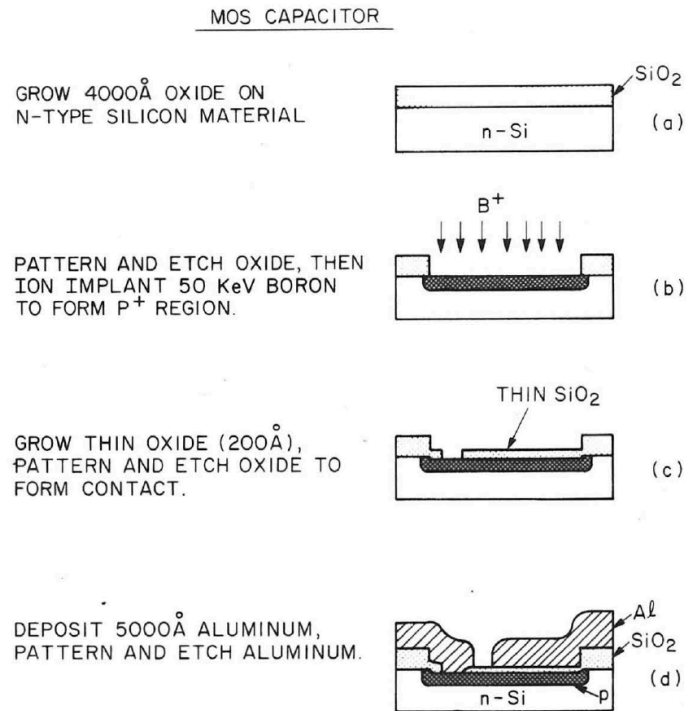


FIGURE 2.
Steps to form an MOS capacitor.

146. A simple capacitor is formed through laying of materials, doping, and etching. “The capacitor that results from this sequence of steps will only work properly if the individual layers are isolated from each other except where an intentional contact is made.” *Id.* at 470. This can be seen where the aluminum layer (shown in Fig. 2(d)) is only allowed to contact the conductor (the doped part of the n-type silicon material layer). The remainder of the aluminum layer is insulated from the conductor by the layer of insulting SiO₂ material.

147. In my opinion, the dependent claims of the '801 patent also support this construction. Dependent claims 12 and 13 further refine the “predetermined material layer” to having a particular purpose, such as a passivation layer (relating to

insulation and shielding of lower layers from environmental effects) or a metal electrode layer. Dependent claim 14 further refines “organic material pattern layer” to using either a polymethyl methacrylate or a photosensitive-methylsilsequiazane.

148. Further, the specification similarly uses “layer” in its plain and ordinary sense to refer to a single film of material created during manufacturing using techniques similar to those described in *Size*. For example, the specification describes forming silicon nitride layer 242 on substrate 232, and then forming organic material 244 on top of that:

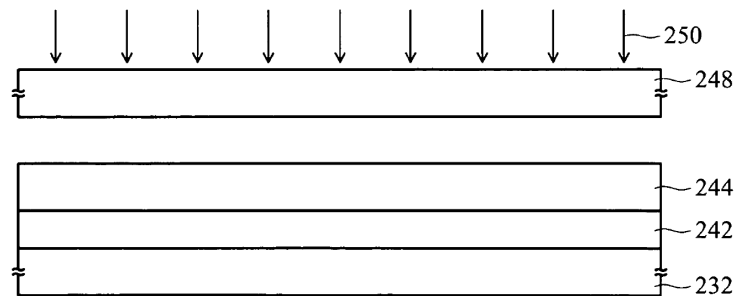


FIG. 2A

149. Ex. 1001 at Fig. 2A, 2:46-65. A similar usage of layers is shown in Fig. 1C and the related specification description (Ex. 1001 at 2:25-33). In my opinion, nothing in the file histories is inconsistent with this construction.

150. Additionally, another of Petitioner’s experts in related IPR2024-01133 testified generally (i.e., not specific to the '801 Patent) that his understanding of layer supports this construction. See IPR2024-01133, Ex. 2028 at 164:21-168:1 (testifying about the ordinary meaning of layer; for example, “[b]ut if they’re

different materials, they're different layers"); 180:21-24 ("Q Would you consider SE1, SE2 and SE3 to be different layers? A They may be the same material, but they're different places in the process, so yes.").

151. In my opinion, a POSITA would understand that the "predetermined material layer" cannot be "one or more layers." The term "a" can be understood as "one or more" unless the claim language suggests a different construction to a POSITA. In the context of the intrinsic evidence, a POSTIA would not understand the "predetermined material layer" to actually be multiple layers. In claim 1, only a single layer can be formed "on the first substrate." Subsequent layers would be formed on previous predetermined materials layer. Claims 4 (the predetermined material layer is a passivation layer) and 5 (the predetermined material layer is a metal electrode layer) similarly would inform a POSITA that the predetermined material layer is a single layer given the dependent claims' reference to a specific function. The specification similarly discloses embodiments where the predetermined material layer is a single layer. Ex. 1001 at Figs. 1C, 2A-2C, 2:27-33, 2:46-65. In my opinion, the proposal that "layer" could mean multiple layers is counterintuitive to a POSITA and would make the meaning of the term arbitrary—it would allow layers of different materials and properties to be considered a single layer.

152. In my opinion, nothing in the '801 Patent changes the plain and ordinary meaning of the term “layer.” Accordingly, the term “layer” should be construed under its plain and ordinary meaning, which is a “film of a material created during manufacturing.”

B. “formed on”

153. Patent Owner respectfully submits that the term “formed on” be given its plain and ordinary meaning, which is which is “forming in a manner directly touching the below layer or substrate.”

154. As described above in §VII.A, a POSITA would have understood the relevant manufacturing process. This process involves building layers of materials and doing other processes to create the sought after functionality. Each layer is “formed on” the next. Dr. Neikirk’s understanding of the plain and ordinary meaning of the term is consistent with this understanding. Nothing in the '801 Patent alters the plain and ordinary meaning of the term “formed on.”

155. Claim 9 is written consistent with this plain and ordinary meaning. The predetermined material layer is “formed on” the first substrate, and the organic material pattern layer is then “formed on” the predetermined material layer. Nothing in the claim language supports BOE’s apparent argument that “formed on” should be read as formed “above” regardless of the contact between the layers.

156. The specification is similar, discussing layers being formed on another layer to result in a structure where the various layers are touching. For example, this is demonstrated in Fig. 1C, and the various layers are described at 2:27-33:

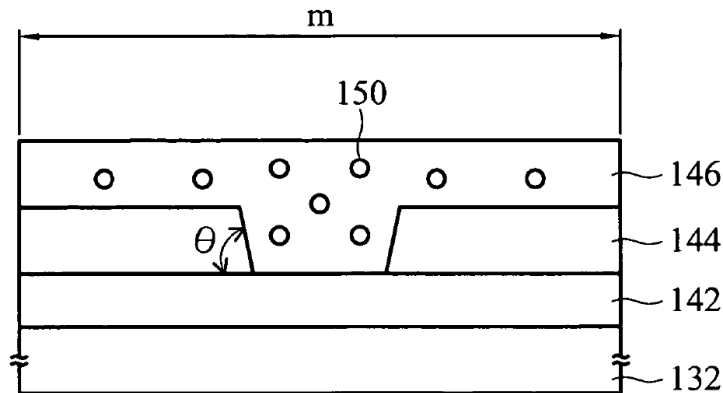


FIG. 1C

157. Fig. 2C and its related description includes a similar disclosure:

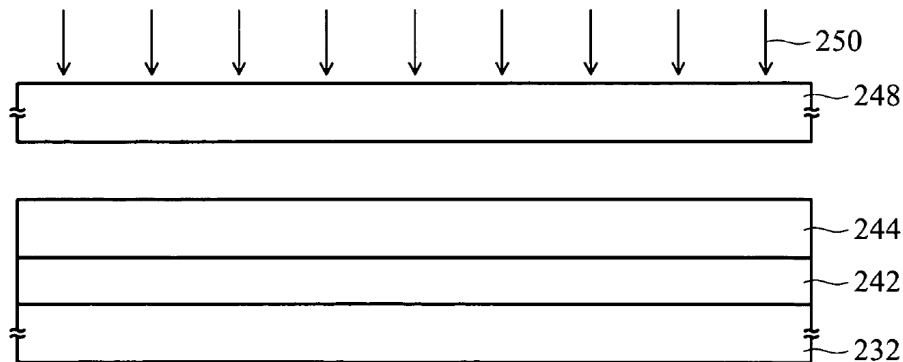


FIG. 2A

158. Ex. 1001 at Fig. 2A, 2:46-65. The specification is therefore consistent with “formed on” referring to layers directly formed on the preceding layer. In my opinion, nothing in the file history changes this construction.

159. Accordingly, “formed on” should be given its plain and ordinary meaning, which is “forming in a manner directly touching the below layer or substrate.”

VIII. Challenge 1: The Petition’s Anticipation Theory Based on Kwak Fails to Disclose All Elements of Claim 9

A. Kwak Fails to Disclose a Predetermined Material Layer Formed on the First Substrate ([9b]) or an Organic Material Pattern Layer Formed on the Predetermined Material Layer ([9c])

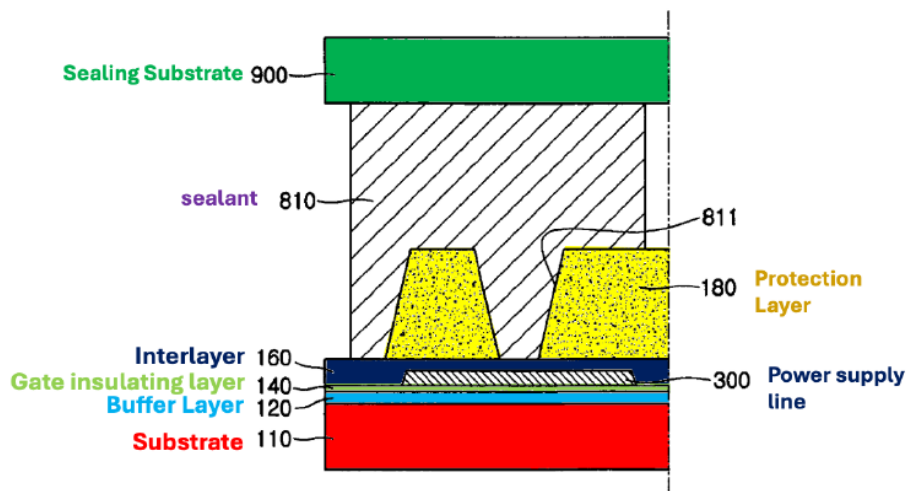
160. Dr. Neikirk fails to identify the predetermined material layer in Kwak. Instead, Dr. Neikirk identifies a plethora of layers. *See* Ex. 1003, ¶95 (“Kwak discloses ‘a predetermined material layer [interlayer 160, gate insulating layer 140, and/or buffer layer 120] formed on the first substrate [substrate 110].’”) (alteration in original). Dr. Neikirk offers that Kwak’s layer 160 alone; a combination of 160, 140, and 120; or a combination of 160 and 140 are the claimed predetermined layer. A POSITA understood that layers 160, 140, and 120 were formed during different manufacturing steps. Thus, a combination of 160, 140, and 120 would not be a “layer” because they are films formed at different manufacturing steps.

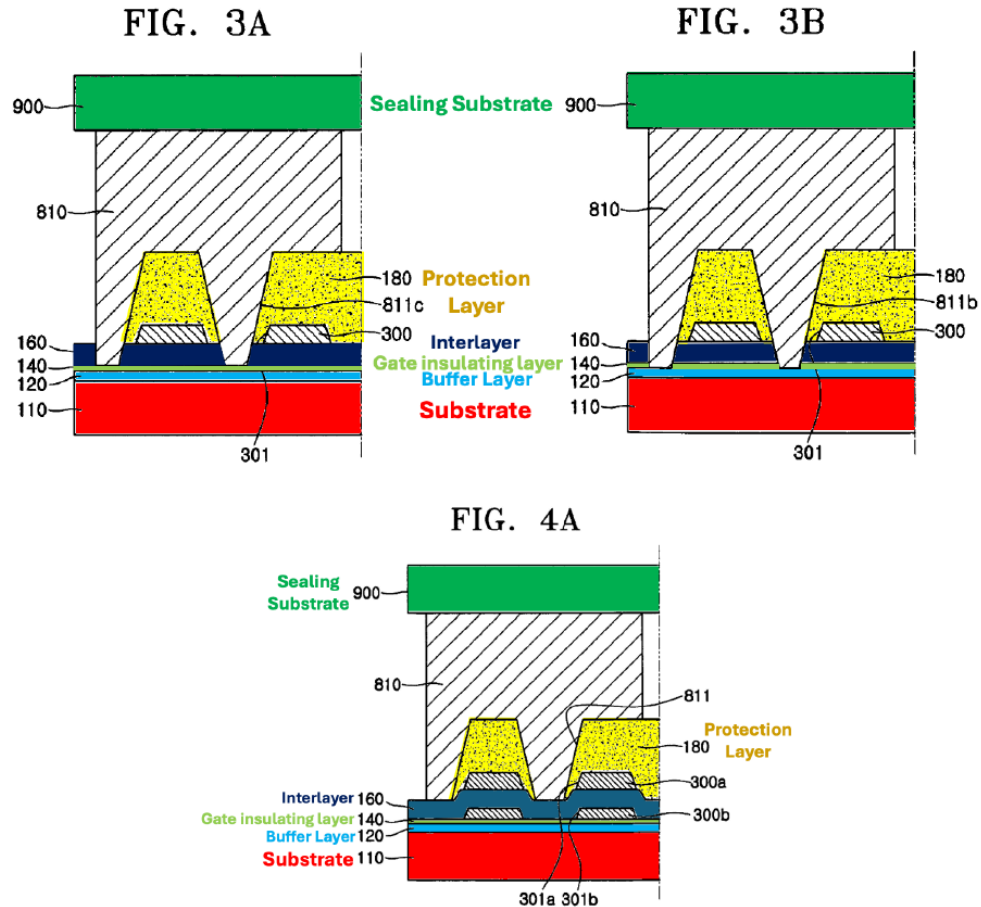
- a. **160 alone** (all embodiments of Kwak shown below): Layer “160 alone” is not “formed on” the substrate under Patent Owner’s construction of “formed on.” Layer 160 is plainly “formed on” layer 140 and driving

power supply line 300 under the plain and ordinary meaning of the term. *See* §**Error! Reference source not found.**, *supra*.

- b. **A layer comprising 160, 140 and 120** (all embodiments shown below): Petitioner improperly points to three distinct layers that are successively formed on each other as the claimed “predetermined material layer.” A POSTIA would have understood that layers 160, 140, and 120 are formed at different manufacturing steps. Specifically, interlayer 160 is a film of a material created during manufacturing that is formed on gate insulating layer 140 *and* driving power supply line 300. Likewise, gate insulating layer 140 is a film of a material created during manufacturing that is on buffer layer 120. Buffer layer 120, in turn, is a film of a material created during manufacturing that is formed on substrate 110.
- c. **A layer comprising 160 and 140** (Figures 3A/B): Petitioner’s position that layers 160 and 140 correspond to the claimed predetermined layer is wrong because it is not a “layer” under the plain and ordinary meaning of the term. As noted above, layers 120 and 140 are different films that were created during different manufacturing steps and cannot be the claimed “predetermined layer.”
- d. **No other combination of layers or single layer meets the claim language.**

FIG. 2D





(from the POPR at 10–11).

161. Further, claim element [9c] recites “an organic material pattern layer . . . formed on the predetermined material layer to expose the surface of the predetermined material layer underneath.” I note that under my proposed construction of “layer” and “formed on,” Kwak does not disclose this element. All the figures relied on in Kwak show that protection layer 180 is not formed on buffer layer 120. Likewise, protection layer 180 is formed on interlayer 160, but interlayer 160 is not formed on the substrate 110. For this to meet claim element 9[c], interlayer 160, gate insulating layer 140, buffer layer 120 (as well as the layers

between them, including semiconductor layer 130, gate electrode 150, and power supply line layer 300) must collectively considered to be a single layer that meets the “predetermined layer” requirement from claim [9b]. Under the proposed construction I have provided, these are several different layers and cannot meet the claimed “predetermined material layer.” Accordingly, Kwak fails to render disclose organic material pattern layer formed on the predetermined material layer and does not anticipate claim element [9c].

162. Dr. Neikirk again demonstrates a reliance on hindsight, as despite his acknowledgement that Kwak fails to teach a predetermined material layer, he clearly opines that any arbitrary combination of layers will suffice. In my opinion a POSITA would not have done this.

B. Kwak Fails to Disclose a Predetermined Angle ([9c])

163. As discussed above in §IV.A, a POSITA understood that Kwak fails to disclose the angle for any opening of any embodiment. In fact, Kwak never even uses the word “angle”. As such, it is my opinion that Kwak does not anticipate this claim element—I have reviewed Kwak and there is no disclosure of an angle, let alone predetermining an angle. Dr. Neikirk simply points to the Figures of Kwak images and assumes that an angle shown in the Kwak’s Figs. 2B-D, 3A-C, 4A-C were predetermined but he does not, and cannot, identify anywhere that Kwak discloses a predetermined angle. *See* Ex. 1003, ¶100.

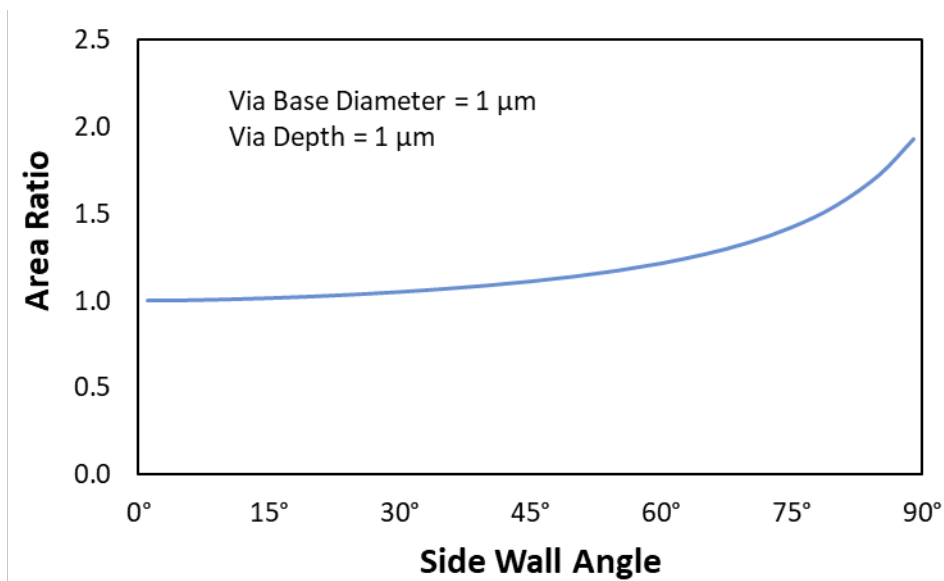
164. Further, Dr. Neikirk references Kwak's teachings of via holes in an effort to overcome this deficiency. *See* Ex. 1003, ¶98 ("Kwak's organic protective layer 180 comprises an 'opening [e.g., via hole 811] . . . to expose the surface of the predetermined material layer [interlayer 160, gate insulating 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.'").

165. However, via holes do not require or disclose predetermined angles of the sidewall. As discussed above in §IV.A, during deposition Dr. Neikirk described vias as essentially vertical holes that extend through one or more layers, similar to if a thumbtack were pushed through several coatings on a wall. Ex. 2011 at 24:7–13. The crux of the via is the depth, not a particular angle of the sidewall. Unless there is a call to create a specific angle, the angle of the sidewall is simply a by-product and is not predetermined.

166. Additionally, as discussed above, one of Kwak's primary teachings is improving seal performance by increasing contact area, and did not discuss or suggest that the use of particular angles may reduce the formation of voids or bubbles in the sealant. Previously, I used a one-dimensional demonstrative to show that this

would motivate a POSITA to create vias without altering or predetermining the angle of the sidewalls, as maximizing the surface area requires the sidewall to be as close to vertical as possible.

167. Extending that analogy to a circular via in a 1 μm thick film with a constant base diameter of 1 μm shows the same type of trend. Here the Area Ratio is defined as the total surface area of a via structure compared to the area of a circle with the same diameter as the top of the via. The plot below clearly demonstrates that the maximum increase in surface area occurs for side walls that are nearly perpendicular to the substrate.



168. Kwak discloses increasing the contact area by increasing the *depth* of the via. *See* Ex. 1005, 10:50–55 (“When the depth of the via hole 811 is increased, the contact area with the sealing portion 810 increases and the adhesive strength between the substrate 110 and the encapsulation substrate 900 can be increased.

However, if the substrate 110 is exposed, it can receive stress, and thus an appropriate depth of the via hole should be determined . . .”). For all the reasons above, Kwak does not disclose a predetermined angle. Rather, Kwak was specifically focused on the appropriate depth of via holes.

169. Other Claims

- a. Claim 10: for the reasons stated above in §IV.F, none of the cited art reference are relevant for creating angled sidewalls in the organic layer of Kwak’s via.
- b. Claim 11: is not obvious for the same reasons as claim 10.
- c. Claims 12, 13, and 14 depend from claim 9 and are not obvious for at least the same reasons.
- d. Claim 1 recites similar elements to claim 9 and is not obvious for the same reasons as claim 9.
- e. Claims 2, 3, 4, 5, 6, and 8 depend from claim 1 and are not obvious for at least the same reasons.

IX. Challenge 2: The Petition’s Obviousness Theory Based on Kwak Fails

A. Kwak Fails to Render Obvious a Predetermined Material Layer Formed on the First Substrate ([9b])

170. As discussed above in relation to Challenge 1, Dr. Neikirk failed to identify a predetermined material layer formed on the first substrate. Moreover, a review of Kwak revealed that Kwak teaches multiple layers rather than a

predetermined layer. As such, it necessarily follows that Kwak fails to render this claim limitation obvious.

B. Kwak Fails to Render Obvious a Predetermined Angle ([9c])

171. For the reasons discussed above in relation to Challenge 1, it is my opinion that Kwak fails to render obvious this claim limitation.

X. Challenge 3: The Petition's Obviousness Theory Based on Kwak and Vaganov Fails

A. Kwak and Vaganov Fails to Render Obvious a Predetermined Material Layer Formed on the First Substrate

172. As discussed above, Kwak fails to disclose or render obvious a “predetermined material layer formed on the first substrate” under the plain and ordinary meaning of the terms “layer” and “formed on” discussed above, and Vaganov does not cure this deficiency. Indeed, Petitioner makes no assertion that Vaganov does so. Indeed, as discussed above, Vaganov teaches etching of the wafer (substrate) as opposed to a layer deposited on the substrate. Thus, Vaganov does not cure the deficiencies of Kwak and the combination cannot render the '801 Patent obvious.

B. No Motivation/Ability to Combine

173. As discussed above, Kwak and Vaganov are not in the same field of art. More specifically, a POSITA seeking to address the problems of the '801 Patent or Kwak would not understand Vaganov to be relevant.

174. Importantly, for the reasons discussed above, the teachings of Vaganov are specific to the use of single crystal wafers which are incompatible with the substrates of the '801 Patent and Kwak. I further reiterate that Vaganov's field of art is integrated circuits, microsensors, and micromachining. *See* Ex. 1007 1:6-8 This is a distinct field and different from that of thin film displays.

175. Further, as the methods of Vaganov are specific to single crystal wafers, a POSITA would have no reasonable expectation of success even if they were to attempt to apply those methods and teachings to the field of the '801 Patent or Kwak. Specifically, the etches taught by Vaganov are specific to single crystal silicon materials. The rate at which these solutions etch silicon varies depending on the specific crystal plane exposed. More specifically, the etches of Vaganov are designed to be highly anisotropic and proceed very slowly on certain exposed crystal planes. If applied to amorphous or polycrystalline silicon, the crystal planes would be randomly oriented meaning that the etch would produce random surfaces with different orientations to each other. A POSITA would be unable to predict or control the rate of etch on amorphous or polycrystalline silicon. The silicon etch chemistries of Vaganov work by first oxidizing an exposed silicon surface and then etching of the oxide by HF. These types of etches ***do not significantly attack organic films and are not compatible with such materials.*** Indeed, organic films in the form of photoresists are used to protect portions of the wafer from the etches of Vaganov.

176. For these reasons as well as the reasons discussed above in relation to Challenge 1, it is my opinion Kwak and Vaganov cannot be combined and/or it would not be obvious to combine their teachings. As such, the combination of Kwak and Vaganov does not render obvious at least 9b and 9c of the '801 Patent.

XI. Challenge 4: The Petition's Obviousness Theory Based on Kwak and Kim Fails

A. Kwak and Kim Fails to Render Obvious a Predetermined Material Layer Formed on the First Substrate

177. As discussed above, Kwak fails to disclose or render obvious a “predetermined material layer formed on the first substrate” under the plain and ordinary meaning of the terms “layer” and “formed on” discussed above, and Kim does not cure this deficiency. Indeed, Petitioner makes no assertion that Kim does so. Thus, Kim does not cure the deficiencies of Kwak, and the combination cannot render the '801 Patent obvious.

B. No Motivation to Combine Kwak and Kim

178. As discussed above in §IV.C, Kim's teachings of inclined side walls is restricted to contact holes and a desire to ensure adequate electrical contact is made to the layer at the bottom of a via. These vias would be in the central region of a display and a POSITA would not be motivated to use them in place of Kwak's vias as they serve distinctly different functions. Put another way, Kim is not concerned with sealing and focuses on forming better electrical contacts.

179. More importantly, as discussed above, Kwak emphasizes increasing contact area to improve sealant performance by changing the depth of a via. Kim's teachings of inclined side walls in via structures directly opposes this goal of Kwak's. Kim's contact vias would *reduce* area whereas Kwak teaches to increase area, as mathematically demonstrated above.

180. In my opinion, a POSITA would have understood that the goals of Kwak and Kim are contradictory and could not be combined without the use of hindsight.

181. For these reasons as well as the reasons discussed above in relation to Challenge 1, it is my opinion that the combination of Kwak and Kim fails to render obvious at least claim elements 9b and 9c of the '801 Patent.

XII. Challenge 5: The Petition's Obviousness Theory Based on Kwak and Yamazaki Fails

A. Kwak and Yamazaki Fails to Render Obvious a Predetermined Material Layer Formed on the First Substrate

182. As discussed above in §IV.C, Kwak fails to disclose or render obvious a "predetermined material layer formed on the first substrate" under the plain and ordinary meaning of the terms "layer" and "formed on" discussed above, and Yamazaki does not cure this deficiency. Indeed, Petitioner makes no assertion that Yamazaki does so. Thus, Kim does not cure the deficiencies of Yamazaki and the combination cannot render the '801 Patent obvious.

183. Moreover, as discussed above, Yamazaki's use of angled side walls is for a specific embodiment and is a necessary condition for successful ion implantation of inert atoms. Yamazaki does not teach or suggest use of angled side walls for any other purpose and explicitly states that no angle is required if the ion implantation method is not used. *See* Ex. 1009 5:43-49.

B. No Motivation to Combine

184. As discussed above, a POSITA understood that Yamazaki's inclined side walls are necessary for *ion implantation treatment*. Further, Yamazaki states that if ion implantation is not used then no angling of side walls is required. *See* Ex. 1009, 5:43-49. Nothing in Kwak does not suggests using ion implantation in Kwak's vias. *See* Ex. 1005. Thus, there is no motivation to combine Yamazaki's taper with Kwak's via's.

185. Additionally, and as discussed above, a POSITA would be aware that angling the side walls of Kwak would *decrease* rather than increase the contact area if used in the peripheral areas where sealant is dispersed, which is contrary to the teachings of Kwak. The object of Yamazaki was "to provide a high reliable EL display device and a manufacturing method thereof by shielding intruding moisture or oxygen . . . without enlarging the EL display device." Ex. 1009 at abstract. Adding a taper to the vias of Kwak would have to enlarge the device, as reducing

the angles of Kwak's via (without adjusting the depth) requires more lateral space. Further, adding angles would reduce the surface area of Kwak.

186. Accordingly, a POSITA would understand that Yamazaki's angled side walls are contradictory to Kwak's teaching of increasing contact area. Thus, a POSITA would not be motivated to and would not seek to combine Kwak and Yamazaki.

XIII. Challenge 6: The Petition's Obviousness Theory Based on Zhang Fails

A. No Motivation to Combine Embodiments; Combination Made in Error

187. As discussed above in § IV.E, Zhang teaches improving the mechanical strength of a bond by increasing surface area and using *an inorganic layer* to adhere to. *See* Ex. 1006 at 10 (teaching "the protective layer 324 is composed of silicone dioxide . . . or silicon nitride."), 7 ("*the bonding strength of the assembled liquid crystal display panels 100, 200A, and 200B is insufficient*". During reliability tests or drop tests, the panels are prone to developing cracks at the contact interface between the TFT substrate and the CF substrate due to impact or vibrational forces.").

188. Further, Dr. Neikirk admits that Zhang teaches almost any arbitrary layer rather than a predetermined layer. He states, "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.’ 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.” Ex. 1003 ¶186 (citations omitted). As such, Dr. Neikirk has granted himself the leeway to point to almost any layer/combination of layers in Zhang’s structure as the requisite “predetermined layer.”

189. Additionally, Dr. Neikirk fails to identify any teaching of a predetermined angle by Zhang. Indeed, the term “angle” is not used by Zhang anywhere. For this reason alone, a POSITA would understand that Zhang does not teach “a predetermined angle.” Although Zhang does teach using a V-shaped structure, Petitioner relies on hindsight to for the teachings of Zhang. Specifically, the claim requires “an organic material pattern layer” having an opening.

190. Zhang discloses an organic material pattern layer as part of the *conventional LCD*, an “photoresist layer 225 can be composed of an organic material.” Ex. 1006 at 6. Then Zhang describes the invention (improving the sealing of the conventional LCD) by teaching that the frame adhesive may be applied to a groove or opening, including an opening in a “V-shaped manner.” *Id.* at 12. However, **Zhang explicitly teaches that for the embodiments where the frame adhesive is applied to a groove or opening, there is no organic layer.**

Specifically, the corresponding layer is changed to be an *inorganic* material. *Id.* at 10 (teaching “the protective layer 324 is composed of silicone dioxide . . . or silicon nitride.”).

191. A POSITA would have understood the difference in the material properties between an organic layer and an inorganic layer that makes an inorganic material more desirable for adhesion. Put plainly, organic materials are soft and squishy and inorganic materials, such as silicon nitride, are hard and durable. As Dr. Neikirk puts it, one of the benefits Zhang discloses is that the “increased bond strength has the additional benefit of reducing damage or cracks in the sealant that might allow for intrusion of moisture.” Ex. 1003, ¶ 255. Using an organic material where Zhang explicitly teaches a change to use an inorganic material would hamper the durability of the adhesive because the sealant would be more against a hard, inorganic material than a soft, organic material.

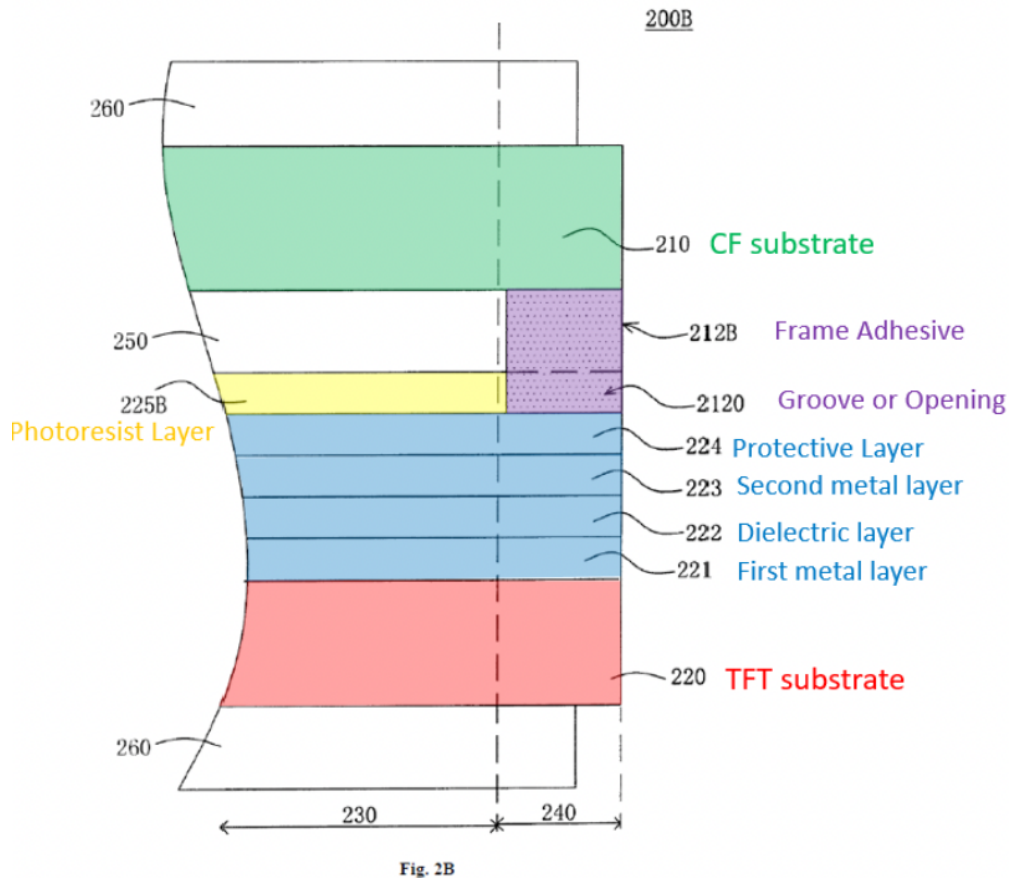
192. Thus, it is my opinion that a POSITA understood Zhang to teach away from the use of an organic layer when creating an opening for sealant. In my opinion, a POSITA would have had no motivation to use an *organic* photoresist layer with a reasonable expectation of success based on the teachings of Zhang due to the inherent properties of the materials themselves and Zhang’s disparagement of the conventional LCD approach. *See* Ex. 1006 at 7 (“the bonding strength of the assembled liquid crystal display panels 100, **200A**, and **200B is insufficient**. During

reliability tests or drop tests, the panels are prone to developing cracks at the contact interface between the TFT substrate and the CF substrate due to impact or vibrational forces. This results in damage to the display panel, significantly affecting the quality of the display panel.”). Indeed, Dr. Neikirk can identify no reason that a POSITA would apply only half of the teachings of Zhang based on the teachings of Zhang. *See* Ex. 1003, ¶192. In my opinion, such a proposal is based on hindsight. Despite what Dr. Neikirk argues, simply changing the material of one layer to be either organic or silicon nitride would not increase the contact area of that layer.

193. For at least these reasons as well as the reasons discussed above, it is my opinion that Zhang fails to render obvious at least claim elements 9b and 9c of the '801 Patent.

194. Further, Zhang has too many layers. Under the construction of the term “layer,” which is a “film of a material created during manufacturing,” the figures 2A/B of Zhang plainly includes too many layers to be the claimed “predetermined material layer.” Also, under the construction of “formed on,” which is “forming in a manner directly touching the below layer or substrate,” figures 2A/B of Zhang show that photoresist layer 225B is formed on protective layer 224, and that protective layer 224 is formed on second metal layer 223. Thus, protective layer 224 cannot be the claimed “predetermined material layer” because is not formed on the substrate as required by claim [9b]. Alternatively, claim [9c] is not satisfied

because only first metal layer 221 is formed on the substrate and the photoresist layer 225B is not formed on the first metal layer. The first metal layer 221 cannot be the “predetermined material layer.”



Ex. 1006 at Fig. 2B.

195. None of the claims are obvious:

- a. Claim 9 is not rendered obvious by Zhang for the reasons discussed above.
- b. Claim 10 is not rendered obvious because it depends from claim 9 and further because Petitioner has provided no reasoning that a POSITA would have used a predetermined angle less than about 60 degree but rather states generally that angled openings less than 60 degrees were known in the art. Petition at 68. As explained throughout, none of the references Petitioner has identified are for sealing. *See, e.g.,* § **Error!**

Reference source not found., *supra*. Specifically, Vaganov is related to wafer to wafer bonding of specific crystalline structures; Kim 452 is related to allowing a better contact structure and does not mention sealing; Yamazaki 336 discloses tapering for ion doping, not sealing. Further, (1) Shinego does not teach an angle in an organic layer as claimed, (2) Yamazaki 496 discloses angles for reflecting light, not for sealing, (3) Shimada 722 similarly teaches using angles to reflect light, not for sealing, (4) Shimada 376 also teaches using angles to reflect light, not for sealing, (5) Kim 935 teaches using angles to reflect light, not for sealing, (6) Tanaka teaches that using any etch process that does not result in an undercut, and (7) Miyoshi is not in evidence. Thus, claim 10 is not rendered obvious by Zhang.

- c. Claim 11 is not obvious for at least the same reasons as claim 10.
- d. Claim 12 depends from claim 9 and is not obvious over Zhang for at least the same reasons.
- e. Claim 13 depends from claim 9 and is not obvious over Zhang for at least the same reasons.
- f. Claim 1 recites similar elements to claim 9 and is not obvious for the same reasons as claim 9.
- g. Claim 2 depends from claim 1 and is not obvious for the same reasons.
- h. Claim 3 depends from claim 1 and is not obvious for the same reasons.
- i. Claim 4 depends from claim 1 and is not obvious for the same reasons.
- j. Claim 5 depends from claim 1 and is not obvious for the same reasons.
- k. Claim 6 depends from claim 1 and is not obvious for the same reasons.

XIV. Challenge 7: The Petition's Obviousness Theory Based on Zhang and Vaganov Fails

A. Vaganov Fails to Cure Zhang's Deficiency Regarding Using an Organic Layer

196. As discussed above, Zhang fails to disclose or render obvious using an organic layer. Nothing in Vaganov cures this deficiency and Dr. Neikirk makes no assertion that it does so. Indeed, as discussed above, Vaganov only teaches etching of inorganic single crystal materials and does not teach or suggest use of any organic

films to improve adhesion. In my opinion, Zhang and Vaganov do not render the '801 Patent obvious.

B. No Motivation/Ability to Combine

197. For similar reasons to those discussed above in relation to Challenge 3, it is my opinion that a POSITA would not seek to combine Zhang and Vaganov as they represent different fields of endeavor. More specifically, the teachings of Vaganov are directed specifically to inorganic single crystal wafers and are incompatible with the substrates of Zhang. I further reiterate that Vaganov's field of art is integrated circuits, microsensors, and micromachining. *See* Ex. 1007 1:6-8. This is a distinct field and different from that of thin film displays.

198. As the methods of Vaganov are specific to single crystal wafers, a POSITA would have no reasonable expectation of success even if they were to attempt to apply the teachings of Vaganov to the polycrystalline and amorphous films of Zhang. Specifically, Vaganov's wafers are a single crystal material with no grain boundaries or amorphous regions. As such, this places significant limitations on the applicability of Vaganov's teachings. This understanding is readily evident upon a review of Vaganov from repeated examples of use of crystalline wafers and in some cases use of crystalline wafers of a particular orientation. *See* Ex. 1007 2:63-64 ("For example, for silicon (100) crystalline orientation wafers"), 5:25-26 ("[F]or example by anisotropic etching of a (100) crystalline orientation silicon surface"),

10:23-26 (“The following describes various microstructures and etching processes for forming the above-described wafer bridges, pits, pyramids, etc., profiles, these processes are for monocrystalline silicon wafers”); *see also* Ex. 1007 10:29-35, 10:36-43, 10:44-51, 10:54-59, 10:60-67, 11:1-8, 11:29-44, 11:57-12-5. The etches taught by Vaganov are specific to single crystal silicon materials. The rate at which these solutions etch silicon varies depending on the specific crystal plane exposed. More specifically, the etches of Vaganov are designed to be highly anisotropic and proceed very slowly on certain exposed crystal planes. If applied to amorphous or polycrystalline silicon, the crystal planes would be randomly oriented meaning that the etch would produce random surfaces with different orientations to each other. A POSITA would be unable to predict or control the rate of etch on amorphous or polycrystalline silicon. The silicon etch chemistries of Vaganov work by first oxidizing an exposed silicon surface and then etching of the oxide by HF. These types of etches *do not significantly attack organic films and are not compatible with such materials.*

199. For these reasons as well as the reasons discussed above in Challenge 6, it is my opinion that the combination of Zhang and Vaganov fails to render obvious at least claim elements 9b and 9c of the ‘801 Patent.

XV. Challenge 8: The Petition’s Obviousness Theory Based on Zhang and Yamazaki Fails

A. No Motivation to Combine

200. In my opinion, Dr. Neikirk misleadingly states that Yamazaki teaches “creating sealant regions including an organic layer with an angled slope to improve the seal and reliability by prevent [sic] moisture and oxygen intrusion.” Ex. 1003, ¶251. As I explained above, Yamazaki discloses using ion doping or ion implantation, which is the reason Yamazaki suggests using tapered shapes. *See* Ex. 1009, 12:42-47 (“ . . . the side surface of the high thermostability planarizing *film 16 is formed to have a tapered shape so as to be doped.*”) (emphasis added). Indeed, Yamazaki explicitly teaches that the tapered shape is not required if methods other than ion implantation are used. *See* Ex. 1009, 5:45-49 (“However, when the inert element is added by using plasma treatment or oblique doping, a side surface of the high thermostability planarizing film can be modified *without forming the edge portion to have a tapered shape.*”). Thus, a POSITA would not have been motivated to implement the teachings of Yamazaki.

B. Yamazaki Fails to Cure Zhang’s Deficiency Regarding Using an Organic Layer

201. Dr. Neikirk again mischaracterizes Zhang, stating that “Zhang discloses an organic layer . . . that rests above a predetermined material layer.” *Id.*, ¶254. As discussed above in Challenge 6, this is based on an incorrect interpretation of what Zhang teaches. Dr. Neikirk states that “Yamazaki discloses an LCD device with a sealant region comprising an organic layer with openings that expose the underlying insulating layers.” Ex. 1003, ¶253. Dr. Neikirk does not, and cannot, identify any

reason to modify Zhang to include the organic layer of Yamazaki, as this goes against the express teachings of Zhang. Ex. 1006 at 10 (teaching “the protective layer 324 is composed of silicone dioxide . . . or silicon nitride.”).

202. Further, and as I explain in §IV.D, Yamazaki explicitly teaches tapering for ion implantation, and that if ion implantation is not necessary, then the taper is not necessary. Ex. 1009, 12:42-47 (“The inert element contained in the highly densified part 20 is set Within the concentration range from 1×10^{19} atoms/cm³ to 5×10^{21} atoms/cm³, typically, from 2×10^{19} atoms/cm³ to 2×10^{21} atoms/cm³. In addition, the side surface of the high thermostability planarizing *film 16 is formed to have a tapered shape so as to be doped.*”) (emphasis added), 5:45-49 (“However, when the inert element is added by using plasma treatment or oblique doping, a side surface of the high thermostability planarizing film can be modified *without forming the edge portion to have a tapered shape.*”). Zhang does not call for ion implantation. See Ex. 1006. Thus, a POSITA would not have been motivated to combine Yamazaki and Zhang.

203. Thus, a POSITA would not be motivated to combine the teachings of Zhang and Yamazaki. For at least these reasons, it is my opinion that the combination of Zhang and Yamazaki fails to render obvious at least claim elements 9b and 9c of the ‘801 Patent.

XVI. CONCLUSION

204. In signing this Declaration, I understand that the Declaration will be filed as evidence in contested cases before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I acknowledge that I may be subject to cross-examination in this case and that cross examination will take place within the United States. If cross examination is required of me, I will appear for cross examination within the United States during the time allotted for cross examination.

205. I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the '801 Patent.

Executed on May 7, 2025 at Flower Mound, TX.

A handwritten signature in black ink, appearing to read "Eric Bretschneider", is written over a horizontal line.

Eric Bretschneider, Ph.D.