UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO., LTD., SAMSUNG ELECTRONICS AMERICA, INC., SAMSUNG SEMICONDUCTOR, INC., and SAMSUNG AUSTIN SEMICONDUCTOR LLC,

Petitioner,

v.

W&WSENS DEVICES INC.,

Patent Owner.

Case PGR2025-00082
Patent No. 12,243,948

DECLARATION OF MICHAEL LEBBY, PH.D., IN SUPPORT OF PETITION FOR POST-GRANT REVIEW OF UNITED STATES PATENT NO. 12,243,948

TABLE OF CONTENTS

I. INTRODUCTION 1

II. SUMMARY OF OPINIONS 1

III. QUALIFICATIONS AND BACKGROUND 2

IV. MATERIALS CONSIDERED 11

V. LEGAL STANDARDS 15

A. Level of Ordinary Skill 16

B. Prior Art 17

C. Anticipation 17

D. Obviousness 18

E. Enablement 23

VI. TECHNOLOGY BACKGROUND 24

A. Photodetectors 24

B. Microstructure-Enhanced Photodetectors 25

C. Photodetectors and Processing Circuitry on a Single Substrate 28

VII. THE ’948 PATENT 34

A. Specification 34

B. Prosecution History 36

C. Claim Construction 36

VIII. SUMMARY OF THE PRIOR ART 38

A. *Kuboi* 38

B. *Vasylyev* 45

C. *Shinohara* 54

IX. LEVEL OF ORDINARY SKILL IN THE ART 57

X. GROUNDS OF UNPATENTABILITY 57

XI. THE CHALLENGED CLAIMS ARE UNPATENTABLE 58

A. Ground 1: Claims 1-3 and 7-12 Are Obvious over *Kuboi* 58

1. Independent Claim 1 58

a. [1(pre)] "An integrated structure comprising:" 58

b. [1a(1)] "an array of pillars comprising Si, Ge, and/or SiGe alloy semiconductor material," 59

c. [1a(2)] "wherein at least some of the pillars are configured to include photodetectors and have respective light-receiving surfaces and respective sides;" 62

d. [1b] "wherein at least some of the pillars comprise P-doped and N-doped regions and are configured to respond to illumination with light in selected visible and infrared wavelengths by generating electrical charge carriers;" 66

e. [1c] "one or more holes that are fabricated as recesses at or under the light-receiving surface of each of at least some of the pillars, have elongated or other shapes at or parallel to the light-receiving surfaces, extend into the pillars to a depth of 100 to 10000 nm, and are filled at least partly with solid dielectric material;" 72

f. [1d] "wherein at least some of the holes are elongated along the respective light-receiving surfaces;" 83

g. [1e] "side-isolation comprising solid material between at least portions of the sides of at least some of the pillars;" 84

h. [1f] “a solid dielectric material forming a base dielectric region for the array;” 86

i. [1g] “electrical contacts configured to provide electrical pathways coupled electrically to at least some of the photodetectors, including for selected reverse-biasing thereof;”.....91

j. [1h] “wherein the presence of said one or more holes increases by a factor of at least 1.1 the absorption of the light by at least some of the photodetectors relative to like photodetectors lacking said holes.”.....96

2. Claim 2.....119

a. “The integrated structure of claim 1, wherein the array is monolithically integrated with Si electronic devices.”.....119

3. Claim 3.....122

a. “The integrated structure of claim 1, wherein each of at least some of the pillars has a plurality of the elongated holes.”.....122

4. Claim 7.....123

a. “The integrated structure of claim 1, in which the electrical contacts are configured to selectively provide electrical fields across at least some of the photodetectors.”.....123

5. Claim 8.....128

a. “The integrated structure of claim 1, in which two or more of the photodetectors share one of the electrical contacts.”.....128

6. Claim 9.....131

a. “The integrated structure of claim 1, wherein the array is monolithically integrated with Si

electronic devices for signal processing and transmission." 131

7. Claim 10 134

a. "The integrated structure of claim 1, wherein the array is monolithically integrated with Si electronic devices for transmitting electrical signals related to accumulations of the charge carriers in at least some of the photodetectors." 134

8. Claim 11 135

a. "The integrated structure of claim 1, in which each of at least some of the photodetectors is configured such that the light passes through at least a part **of the one of** the P-doped region and N-doped region of the photodetector before reaching any part of the other doped region of the photodetector." 135

9. Claim 12 138

a. "The integrated structure of claim 1, in which the doped regions of each of at least some of the photodetectors are configured such that the light passes through at least a part of the P-doped region before reaching any part of the N-doped region." 138

B. Ground 2: Claims 4-6 and 13-16 Are Obvious over *Kuboi* in View of *Vasylyev* 140

1. *Kuboi* and *Vasylyev* Are Analogous Art to the '948 Patent 140

2. Motivation to Apply *Vasylyev*'s Teaching of a Single Light Input Port in Pairwise Optical Relationship with a Microlens to *Kuboi*'s Blue Pixel 53B 141

3. Motivation to Apply *Vasylyev*'s Teaching of a Light Input Port Extending Along a "Substantial Portion" of the Light-Receiving Surface to *Kuboi*'s Green and Red Pixels (53G, 53R) 154

4. Motivation to Additionally Incorporate a Single Light Input Port in the Blue Pixel 53B of the *Kuboi-Vasylyev-2* Imaging Device Based on *Vasylyev*'s Teaching 163

5. Claim 4 168

   a. "The integrated structure of claim 1, wherein each of at least some of the pillars has only one of the elongated holes." 168

6. Claim 5 173

   a. "The integrated structure of claim 1, in which the light-receiving surfaces have respective widths, and the elongated holes extend along less than the widths of the light-receiving surfaces of at least some of the pillars in which the holes are fabricated." 173

7. Claim 6 179

   a. "The integrated structure of claim 5 in which each of at least some of the elongated holes has at least one closed contour remote from respective side edges of the light-receiving surface in which the hole is fabricated. 179

8. Independent Claim 13 180

   a. [13(pre)] "An integrated structure comprising:" 180

   b. [13a(1)] "an array of pillars comprising Si, Ge, and/or alloyed SiGe semiconductor material," 181

   c. [13a(2)] "wherein at least some of the pillars have respective sides and respective light-receiving surfaces with selected widths and comprise at least one photodetector;" 181

   d. [13b] "wherein at least some of the pillars comprise P-doped and N-doped regions and are configured to respond to illumination with light in

selected visible and infrared wavelengths by generating electrical charge carriers;” 182

e. [13c] “one or more holes that are fabricated as recesses at or under the light-receiving surface of each of at least some of the pillars,” 183

f. [13d(1)] wherein each of the holes (i) has an elongated shape extending in length over less than the width of the light-receiving surface in which the hole is fabricated, (ii) has at least one closed contour at the light-receiving surface in which the hole is fabricated,” 183

g. [13d(2)] “([iii]) extends into the pillar in which the hole is fabricated to a depth of 100 to 10000 nm, and (iv) is filled at least partly with solid dielectric material;” 186

h. [13e] “side-isolation comprising solid material between at least portions of the sides of at least some of the pillars;” 187

i. [13f] “a solid dielectric material forming a base dielectric region for the array;” 187

j. [13g] “electrical contacts configured to provide electrical pathways coupled electrically to at least some of the photodetectors, including for selected reverse-biasing thereof;” 187

k. [13h] “wherein the presence of the one or more holes increases, by a factor of at least 1.1, absorption of the light by at least some of the photodetectors relative to like photodetectors lacking the holes; and” 188

l. [13i] “wherein the array is monolithically integrated with Si electronic devices for signal processing and transmission.” 188

9. Claim 14 188

a. "The integrated structure of claim 13, in which each of at least some of the pillars has only one of the elongated holes fabricated therein." 188

10. Claim 15 191

a. "The integrated structure of claim 13, in which each of at least some of the pillars has at least two of the elongated holes." 191

11. Claim 16 192

a. "The integrated structure of claim 13, in which each of at least some of the photodetectors includes at least one of the holes." 192

C. Ground 3: Claims 1-3 and 7-12 Are Obvious over *Kuboi* in View of *Shinohara* 193

1. *Kuboi* and *Shinohara* Are Analogous to the '948 Patent 193

2. Motivation to Apply *Shinohara*'s Monolithic Integration Teachings in *Kuboi* 194

3. Independent Claim 1 196

a. [1(pre)]-[1e], [1g]-[1h] 197

b. [1f] "a solid dielectric material forming a base dielectric region for the array;" 197

4. Claim 2 200

a. "The integrated structure of claim 1, wherein the array is monolithically integrated with Si electronic devices." 200

5. Claims 3 and 7-8 203

6. Claim 9 203

a. "The integrated structure of claim 1, wherein the array is monolithically integrated with Si

electronic devices for signal processing and transmission." 203

7. Claim 10 204

a. "The integrated structure of claim 1, wherein the array is monolithically integrated with Si electronic devices for transmitting electrical signals related to accumulations of the charge carriers in at least some of the photodetectors." 204

8. Claim 11 205

a. "The integrated structure of claim 1, in which each of at least some of the photodetectors is configured such that the light passes through at least a part **of the one of** the P-doped region and N-doped region of the photodetector before reaching any part of the other doped region of the photodetector." 205

9. Claim 12 205

a. "The integrated structure of claim 1, in which the doped regions of each of at least some of the photodetectors are configured such that the light passes through at least a part of the P-doped region before reaching any part of the N-doped region." 205

D. Ground 4: Claims 4-6 and 13-16 Are Obvious over *Kuboi* in View of *Vasylyev* and *Shinohara* 205

1. Motivation to Modify *Kuboi* in View of *Vasylyev* and *Shinohara* 205

2. Claims 4-6 208

3. Claim 13 209

a. [13(pre)]-[13e], [13g]-[13h] 209

b. [13f] 209

c. [13i] 209

4. Claims 14-16 210

E. Ground 5: Claims 1-16 Lack Enablement Under 35 U.S.C. § 112 210

1. The Claims Are Not Enabled If *Kuboi*'s Disclosure Is Deemed Insufficient 210

2. Because the Claims Cover Single-Hole Structures, the Full Scope of Claims 1, 4, 13, and 14 Is Not Enabled 211

3. Because the Claims Cover Millimeter-Sized Pillars, the Full Scope of Claims 1 and 13 Is Not Enabled 212

XII. CONCLUSION 214

XIII. DECLARATION 215

I. INTRODUCTION

1. I, Michael Lebby, Ph.D., have been retained as an independent expert by Samsung Electronics Co., Ltd.; Samsung Electronics America, Inc.; Samsung Semiconductor, Inc.; and Samsung Austin Semiconductor LLC ("Petitioner" or "Samsung") in connection with a post-grant review (PGR) of U.S. Patent No. 12,243,948 ("the '948 patent") (Ex. 1001). I have prepared this declaration in connection with Samsung's Petition for post-grant review.

2. Specifically, this document contains my opinions about the technology in claims 1-16 of the '948 patent and the grounds against these claims that have been asserted by Samsung. I was not asked to provide any opinions about the '948 patent that are not expressed herein.

II. SUMMARY OF OPINIONS

3. This declaration considers claims 1-16 of the '948 patent. Below, I set forth the opinions I have formed, the conclusions I have reached, and the bases for these opinions and conclusions. I believe the statements contained in this declaration to be true and correct to the best of my knowledge.

4. Based on my experience and knowledge of the art at the time of the applicable priority date (I was told to assume a priority date of May 22, 2013), it is my opinion that claims 1-16 of the '948 patent are unpatentable based on the asserted grounds discussed below.

5. I am being compensated for my time at my normal hourly rate. My compensation is in no way contingent upon the nature of my findings, the presentation of my findings in testimony, or the outcome of this proceeding.

III. QUALIFICATIONS AND BACKGROUND

6. I believe that I am well qualified to serve as a technical expert in this matter based upon my qualifications, discussed in detail below. A copy of my curriculum vitae is attached as Appendix A to this declaration.

7. Based on my education, research, and work experience, I am knowledgeable about the subject matter of the ’948 patent and the related prior art.

8. In what follows, I provide a short summary of my qualifications.

9. I am an engineer with a Ph.D. in Electrical and Electronic Engineering and have worked extensively with optoelectronics, photonics, electrical and electronic circuits, optical systems, as well as integrated circuit semiconductors for both optoelectronic and electronic solutions. Overall, I have approximately 40 years of experience working in industry to develop new electronic, photonic, display, and optics-based products, which I have taken from research to manufacturing.

10. I received a Bachelor of Engineering degree in Electrical and Electronic Engineering in 1984 from the University of Bradford, United Kingdom. I received a Ph.D. in Electrical and Electronic Engineering in 1987 from the

University of Bradford, United Kingdom. I also received a second doctorate degree: a Doctor of Engineering degree (D.Eng) in Electrical and Electronic Engineering in 2004 from the University of Bradford, United Kingdom.

11. I am currently Chief Executive Officer (CEO) and Chief Technology Officer (CTO) of GenusTechnik Inc., which is my consulting company, through which I engage in my expert witness work.

12. I recently retired in late 2024 as Chairman and CEO of Lightwave Logic Inc. (NASDAQ: LWLG), where I served as a Director of the Board of Directors since 2015.

13. I am a named inventor on over 225 U.S. utility patents. My work has also led to me either being an inventor or co-inventor in subjects such as semiconductors, electronics, optics, displays, high-frequency optical and electronic products such as lasers and light-emitting diodes (LEDs), as well as photonic integrated circuits. I am the author of more than 60 publications.

14. I am a Fellow grade of three professional organizations: IEEE (Institute of Electrical and Electronic Engineers), NAI (National Academy of Inventors), and Optica (Optical Society of America).

15. As described in this Section, and further detailed in my curriculum vitae (Appendix A) over the course of my 40-year career in electronics and optoelectronics, I have worked in nearly every aspect of the electronic,

semiconductor, and optoelectronics business, ranging from wafers to components, to modules, displays, optics, connectors, and cable technology. At the wafer level, I have experience in epitaxial wafer growth (compound semiconductors). I also have experience in electrical and optoelectronic device and circuit design, using modeling and simulation, electrical and optoelectronic device and component fabrication, testing, and qualification, implementation of devices such as laser diodes, light emitting diodes, photodetectors etc., into packages, connectors, and panels, both hermetic and non-hermetic, as well as analysis of package/panel materials such as plastics (including plastic housings such as resin-packaged lead frame housings), optical plastics, metallic-based packages, semiconductor-based packages, and ceramic-based packages for fiber optics, displays, and data-communications industries. I have also designed device packages (through-pin, surface mount, flip-chip, and various combinations thereof) for printed circuit board mounting as well as electrical and optical components for various industrial and environmental applications. Many of the designed components were implemented into technology applications both as manufactured products as well as components for testing, characterization, and analysis of qualified products for volume scaling. The components were designed to work at both optical and RF frequencies that include both optical and RF wireless as well as fiber-optics-based applications. I have also worked in commercially based industrial research-and-

development (R&D) laboratories to bring new high-performance optoelectronic- and photonic-based technologies from the research proof-of-concept phase through prototyping up to and including qualified manufacturing for volume release. This has included both transfer of as well as the design of optics and optical systems for various commercial systems.

16. I have been both an entrepreneur (e.g., Ignis Optics Inc., One Chip Photonics, Lightwave Logic Inc.), as well as an intrapreneur (e.g., Motorola, Intel, TE Connectivity (previously Tyco Electronics), AT&T Bell Labs), creating innovative new high-technology programs, both as venture-backed start-ups as well as corporate-funded divisions. I have built these entities to develop optical, electronic, optoelectronics, and photonics technology from the laboratory and fabrication clean room to production factories.

17. My career started in the late 1970s at the Ministry of Defense in the United Kingdom where I spent time at a number of their R&D facilities, including Malvern (RSRE – Royal Signals and Radar Establishment). There, I worked on electronic and optoelectronic semiconductor device design, as well as basic and high-frequency telecommunications and data-communications electronics for module, cable, connector, and circuit implementation. My research work in electronics then took me to AT&T Bell Laboratories in 1985, where I pursued research in novel electronic and optoelectronic semiconductor material systems

that included laser diodes, LEDs, photodetectors, optical waveguides, optics, and standard electronic devices as well as the processing and fabrication for such devices. The devices researched at Bell Labs became in part the subject of my Ph.D. thesis for which I was granted a doctoral degree in 1987.

18. I moved to Motorola in 1989 to further develop my skills in consumer commercial application of technology and focused on optoelectronics and semiconductor engineering and development. I became a Research and Development Manager at Motorola until I left the company in 1998. During my time at Motorola, I worked on many photonic, electronic, and optical technology projects that included projection, display, optics, LEDs, OLEDs, laser diodes, phosphors, and cameras as well as the packaging and reliability of mobile-product prototypes. At that time, I was particularly interested in miniaturization of electronics, optics, and optoelectronics, and worked on novel optical designs that included portable heads-up displays, optical heads for storage, and various light-based prototypes as well as advanced prototypes of futuristic communications and consumer hardware and cameras.

19. The research work at Motorola also included work on displays and, in particular, miniature displays, arrays, imagers, projection systems, and optics for pagers, clam-shell phones, and head-mounted displays that included mounting onto

eyeglasses (similar in concept to Google glass™) as well as techniques for electrical and optical connections in these applications.

20. I also initiated Motorola's work in optical interconnect (Optobus™) technology that incorporated both transfer and injection-molded optical parts, and included the design of electrical and optical connector technology. This project involved the research and development of a multi-channel electronic integrated circuit (IC) chip for parallel optical interconnects as well as optical simulations of performance.

21. I was one of Motorola's most prolific inventors, having over 150 issued utility patents as an inventor or a co-inventor by the late 1990s. Many of the photonics and optical prototypes with which I was involved were subject to reliability and stress testing as well as optical-measurement analysis. These consumer products all were driven using standard electronic ICs and electronic signaling where I had a role in design and simulation of these circuits.

22. Between 1998 and 1999, I worked as the Director of Technology/BD (Fiber Optics) for Tyco Electronics (previously AMP). I joined Tyco Electronics as a business development director and director of advanced technology for the telecommunications and data-communications industries. I was responsible for growing the optical and optoelectronic technology business through external

interactions that included mergers, acquisitions, strategic alliances, and technical strategic planning as well as leading new technology projects.

23. In 1999, I left Tyco and started employment at Intel. At Intel, I was involved heavily in photonic technology, especially technology that supported silicon photonic device platforms with different types of displays and optical systems. As a culmination of this work, I was one of Intel's founders of its silicon photonics division in the year 2000, and worked to set up a fabrication facility in South San Jose, California, USA. The work involved integrating silicon field-effect transistor (FET) electronics with optoelectronics and optics onto the same silicon semiconductor wafer. This included complementary metal-oxide semiconductor (CMOS) detectors and arrays. I was also part of Intel Capital's optical investment team and participated in over 30 photonics investment projects into photonics, optics, and optoelectronics. My focus included optical devices, packaging and modules for optical storage, and consumer applications such as displays, cameras, projection, communications, and sensing. The technologies that I investigated included lasers, LEDs, optics, liquid-crystal displays (LCDs), optical waveguides, cameras, imagers, and optical displays.

24. At the end of 2000, I left Intel and raised venture capital funding for a company called Ignis Optics Inc. The main goal of the company was to design and manufacture, in high volume, very high-performance optoelectronic modules.

These fiber optic transceiver modules have the capability of transmitting and receiving optical signals that are controlled using programmable electronics and packaged optoelectronics chips, such as laser diodes, optical lenses, and photodetectors.

25. In 2005, I took up employment for a trade association, based in Washington, D.C., called IEEE Optoelectronics Industry Development Association (OIDA). As head of this trade association, and with electronics, photonics, and optics manufacturers that included manufacturers of projection displays, optical systems, fiber optics, displays, and cameras, and sensing, defense, aerospace, LED lighting, and automotive vendors as members, I was responsible, in part, for industry-based technology roadmaps; and I implemented common industry roadmap methodologies with common features such as "Red Brick Walls" and transferred them into technology roadmaps for the industry in which displays, optics, optical sensors, telecommunications cables, fiber-optic cables, fiber, cameras, and their associated technology platforms were featured. OIDA roadmaps featured purple brick walls to show differentiation from the semiconductor industry.

26. In 2010, I became the General Manager and CTO of Translucent, Inc., a high-tech start-up company that developed and manufactured silicon and rare-earth oxide-based epitaxial semiconductor wafers. I patented a number of

optoelectronic and electronic device designs using rare-earth oxides and phosphors while employed at Translucent.

27. Throughout my career, I have also had an active role in a number of technical professional organizations, including, among others, IEEE Components, Packaging, and Manufacturing Technology (CPMT); IEEE Electronic Components and Technology Conferences (ECTC); IEEE TC-10 (Technical Committee on Optoelectronics); and IEEE Optoelectronics Industry Development Association (OIDA). Through these organizations, I have consistently been a part of committees, events, and workshops relating to semiconductors, optoelectronics, electronics, and packaging technology.

28. I also serve as a Technical Expert/Consultant for the European Commission. In my work at the European Commission, I review and advise on general optics, photonics, electronics, telecommunications, semiconductors, optoelectronics, imaging, sensing, cameras, display (e.g., LCD, LED, OLED, etc.), and related Information and Communications Technology (ICT).

29. A full list of my patents and journal publications in addition to my academic and industrial experience is further detailed in my curriculum vitae, which is attached to this declaration as Appendix A.

IV. MATERIALS CONSIDERED

30. In forming my opinions, I have analyzed the materials listed in the table below. My opinions are based on my experience, knowledge of the relevant art, the documents identified in the table below, as well as the documents directly cited to in this declaration.

Exhibit	Description
Ex. 1001	U.S. Patent No. 12,243,948 B2 to Wang et al. ("'948 patent").
Ex. 1003	Prosecution History of the '948 Patent (downloaded from Public PAIR).
Ex. 1004	U.S. Patent Application Publication No. 2012/0049044 A1 to Kuboi ("*Kuboi*").
Ex. 1005	U.S. Patent Application Publication No. 2012/0012741 A1 to Vasylyev ("*Vasylyev*").
Ex. 1006	U.S. Patent Application Publication No. 2012/0033119 A1 to Shinohara ("*Shinohara*").
Ex. 1007	European Patent Application EP 2 172 974 A1 to NXP B.V. ("*NXP*").
Ex. 1008	Zhihong Huang et al., *Microstructured silicon photodetector*, Applied Physics Letters, Vol. 89 (2006), pp. 033506-1 to -3.
Ex. 1009	Richard A. Myers et al., *Enhancing near-infrared avalanche photodiode performance by femtosecond laser microstructuring*, Applied Optics, Vol. 45, No. 35 (Dec. 2006), pp. 8825-31.
Ex. 1010	Abbas El Gamal et al., *CMOS Image Sensors*, IEEE Circuits & Devices Magazine (May/June 2005), pp. 6-20.
Ex. 1011	*Electrical Engineering Dictionary* – CRC*netBase 2000* (Phillip A. Laplante editor-in-chief, CRC Press LLC 2000), pp. 1-11.
Ex. 1012	S.M. Sze et al., *Semiconductor Devices - Physics and Technology* (John Wiley & Sons, Inc. 3d ed. 2012), pp. 6-9, 205-10, 325-30, 392-406, 416-17, 466-67.
Ex. 1013	John P. Uyemura, *CMOS Logic Circuit Design* (Kluwer Academic Publishers 2002), pp. 64, 74-102, 315-17, 458-60.

Exhibit	Description
Ex. 1014	Khalil Jumah Tawfiq Hamam, Organic Solar Cells Based on High Dielectric Constant Materials: An Approach to Increase Efficiency (June 2013) (Ph.D. dissertation, Western Michigan University), pp. 1-122.
Ex. 1015	P. Kalugasalam et al., *Dielectric and AC Conduction Studies of Lead Phthalocyanine Thin Film*, Chalcogenide Letters, Vol. 6, No. 9 (Sept. 2009), pp. 469-76.
Ex. 1016	Matthew Sauceda, *Porphyrin Thin Film Dielectrics*, SUNFEST Technical Report TR-CST01NOV04, Center for Sensor Technologies, Univ. of Pennsylvania, Philadelphia, PA (2004), pp. 181-98.
Ex. 1017	N. Venkatramaiah et al., *Spectroscopic and dielectric studies of meso-tetrakis(p-sulfonatophenyl) porphyrin doped hybrid borate glasses*, Journal of Alloys and Compounds, Vol. 509 (2011), pp. 2797-803.
Ex. 1018	Tom J. Savenije, *Photogeneration and transport of charge carriers in a porphyrin p/n heterojunction*, Physical Review B, Vol. 55, No. 15 (Apr. 1997), pp. 9685-92.
Ex. 1019	Ümit Salan et al., *Synthesis, characterization, electrical and dielectric permittivity measurements of 2,9,16,23-tetra(4-ferrocenylimino-3-nitrophenoxy)phthalocyanines*, Journal of Porphyrins and Phthalocyanines, Vol. 10 (2006), pp. 1263-70.
Ex. 1020	Teresa M. Figueira-Duarte et al., *Pyrene-Based Materials for Organic Electronics*, Chemical Reviews, Vol. 111 (2011), pp. 7260-314.
Ex. 1021	Jurgen Michel et al., *Advances in fully CMOS integrated photonic devices*, Proceedings of SPIE, Vol. 6477 (2007), pp. 64770P-1 to -11.
Ex. 1022	Mark Beals et al., *Process Flow Innovations for Photonic Device Integration in CMOS*, Proceedings of SPIE, Vol. 6898 (2008), pp. 689804-1 to -14.
Ex. 1023	Donald A. Neaman, *Semiconductor Physics and Devices – Basic Principles* (McGraw Hill 3d ed. 2003), pp. 247-50, 260-61.

Exhibit	Description
Ex. 1024	Laurent Frey et al., *Color filters including infrared cut-off integrated on CMOS image sensor*, Optics Express, Vol. 19, No. 14 (2011), pp. 13073-80.
Ex. 1025	U.S. Patent Application Publication No. 2012/0153124 A1 to Yu et al.
Ex. 1026	U.S. Patent No. 8,390,036 B2 to Goto.
Ex. 1027	U.S. Patent Application Publication No. 2008/0157141 A1 to Han.
Ex. 1028	Horst Zimmermann, *Integrated Silicon Optoelectronics* (Springer. 2d ed. 2010), pp. 1-7.
Ex. 1029	Ran Aharoni et al., *Basic model of absorption depth and injection levels in silicon under intermediate illumination levels*, Optics Communications, Vol. 291 (2013), pp. 1-6.
Ex. 1030	M.M. El-Nahass et al., *Structural and optical properties of Ni (II) tetraphenyl porphyrin thin films*, Eur. Phys. J. Appl. Phys., Vol. 57 (2012), pp. 30201-p1 to -p13.
Ex. 1031	Martin A. Green, *Self-consistent optical parameters of intrinsic silicon at 300K including temperature coefficients*, Solar Energy Materials & Solar Cells, Vol. 92, (2008), pp. 1305-10.
Ex. 1032	P.A. Lane et al., *Electroabsorption studies of phthalocyanine/perylene solar cells*, Solar Energy Materials & Solar Cells, Vol. 63 (2000), pp. 3-13.
Ex. 1033	Connie J. Chang-Hasnain et al., *High-contrast gratings for integrated optoelectronics*, Advances in Optics and Photonics, Vol. 4 (2012), pp. 379-440.
Ex. 1034	H.H. Li, *Refractive Index of Silicon and Germanium and Its Wavelength and Temperature Derivatives*, J. Phys. Chem. Ref. Data, Vol. 9, No. 3 (1980), pp. 561-658.
Ex. 1035	U.S. Patent No. 8,378,339 B2 to Nomura et al.
Ex. 1036	M.M. El-Nahass et al., *Structural and optical properties of thermally evaporated zinc phthalocyanine thin films*, Proc. 2nd Saudi Sci. Conf. (Mar. 2004), pp. 277-93.
Ex. 1037	M.E. Azim-Araghi et al., *Electrical and optical properties of an organic semiconductor metal-free phthalocyanine (C32H18N8)*, Eur. Phys. J. Appl. Phys., Vol. 58 (2012), pp. 30201-p1 to -p6.

Exhibit	Description
Ex. 1038	International Patent Publication No. WO 2011/085297 A1 to Han et al. ("*Han*").
Ex. 1039	J.S. Arney et al., *Color Properties of Specular Reflections*, IS&T's NIP20: 2004 International Conference on Digital Printing Technologies, pp. 445-49.
Ex. 1040	Andrew Blakers et al., *Thin Single Crystalline Elongate Silicon Solar Cells*, Energy Procedia, Vol. 15 (2012), pp. 58-66.
Ex. 1041	A. El Amrani et al., *Solar Module Fabrication*, International Journal of Photoenergy, Article ID 27610 (2007), pp. 1-5.
Ex. 1042	Ji-Tao Liu et al., *Curing Determination of EVA for Solar Panel Application by DSC*, Application Note, PerkinElmer (2010), pp. 1-3.
Ex. 1043	Chen ShuoFu et al., *A comprehensive consideration of bias voltage and temperature to extract the intrinsic frequency response of photodiodes*, Chinese Science Bulletin, Vol. 55, No. 32 (2010), pp. 3727-33.
Ex. 1044	Richard S. Quimby, *Photonics and Lasers - An Introduction* (John Wiley & Sons, Inc. 2006), pp. 249-79.
Ex. 1045	U.S. Patent No. 8,013,238 B2 to Hockaday.
Ex. 1046	A. Vandenbroucke et al., *Influence of temperature and bias voltage on the performance of a high resolution PET detector built with position sensitive avalanche photodiodes*, IOP Publishing for Sissa Medialab (2012), pp. 1-30.
Ex. 1047	U.S. Patent No. 8,274,122 B2 to Shimotsusa.
Ex. 1048	Renato Turchetta et al., *Introduction to CMOS Image Sensors*, Molecular Expressions™ Optical Microscopy Primer: Digital Imaging in Optical Microscopy (July 16, 2004), pp. 1-9, *available at* https://web.archive.org/web/20120508153832/https://micro.magnet.fsu.edu/primer/digitalimaging/cmosimagesensors.html
Ex. 1049	U.S. Patent Application Publication No. 2025/0194293 A1 to Wang et al. ("'948 Divisional").
Ex. 1050	Prosecution History of the '948 Divisional (downloaded from Public PAIR).

Exhibit	Description
Ex. 1051	Christopher Chase et al., *Size effect of high contrast gratings in VCSELs*, Optics Express, Vol. 17, No. 26 (Dec. 2009), pp. 24002-07.
Ex. 1052	Eric R. Fossum, *CMOS Image Sensors: Electronic Camera-On-A-Chip*, IEEE Transactions on Electron Devices, Vol. 44, No. 10 (Oct. 1997), pp. 1689-98.
Ex. 1053	U.S. Patent Application Publication No. 2008/0259981 A1 to Wang et al.
Ex. 1054	Sunetra Mendis et al., *CMOS Active Pixel Image Sensor*, IEEE Transactions on Electron Devices, Vol. 41, No. 3 (Mar. 1994), pp. 452-53.
Ex. 1055	U.S. Patent Application Publication No. 2008/0055432 A1 to Koseki.
Ex. 1056	Certified English translation of Japanese Published Unexamined Patent Application No. P2007-129024A to Hasegawa ("*Hasegawa*")

V. LEGAL STANDARDS

31. I am not a lawyer. My understanding of the legal standards to apply in reaching the conclusions in this declaration is based on discussions with counsel for Petitioner, my experience applying similar standards in other patent-related matters, and my reading of the documents submitted in this proceeding. In preparing this declaration, I have tried to faithfully apply these legal standards to the challenged claims.

32. I have been informed that there are two ways in which prior art may render a patent claim unpatentable. First, I have been informed that the prior art can "anticipate" a claim. Second, I have been informed that the prior art can render

a claim "obvious" to a person of ordinary skill in the art. I understand that a claim is patentable if it was not anticipated and would not have been obvious by the prior art at the effective filing date of the patent.

33. I have been informed that a dependent claim is a patent claim that refers back to another patent claim. I have been informed that a dependent claim includes all of the limitations of the claim to which it refers.

34. I have been asked to provide my opinions as to whether the cited prior art teaches or renders obvious claims 1-16 of the '948 patent from the perspective of a person of ordinary skill in the art at the '948 patent's earliest claimed priority date (May 22, 2013), as described in more detail below.

35. I have been informed that in post-grant review proceedings, such as this one, the party challenging the patent bears the burden of proving unpatentability by a preponderance of the evidence. I understand that a preponderance of the evidence means "more likely than not."

36. For purposes of this declaration, I have been asked to provide my opinions on issues regarding unpatentability. I have been informed of the following legal standards, which I have applied in forming my opinions.

A. Level of Ordinary Skill

37. I have been informed that a person of ordinary skill in the art is determined by considering several factors, including the (i) type of problems

encountered in the art; (ii) prior art solutions to those problems; (iii) rapidity with which innovations are made; (iv) sophistication of the technology; and (v) educational level of active workers in the field.

38. I have been instructed to assume that a person of ordinary skill in the art is not a specific real individual, but rather a hypothetical individual having the qualities reflected by the factors discussed above.

B. Prior Art

39. I have been advised and understand that the information used to evaluate whether an invention was new and not obvious when made is generally referred to as "prior art." I understand that prior art includes patents and printed publications that existed before the earliest claimed priority date or the earliest filing date of the patent (which I have been informed is also called the "effective filing date"). I have been informed and understand that a patent or published patent application is prior art if it was filed before the earliest filing date of the claimed invention and that a printed publication is prior art if it was publicly available before the earliest filing date.

C. Anticipation

40. I have been informed that under 35 U.S.C. § 102, a patent claim is unpatentable for anticipation if it is not novel, including if the claimed subject matter was patented or described in a printed publication before the effective filing

date of the claimed invention. I have been informed that this is referred to as unpatentability by anticipation. I have been informed that a patent claim is anticipated under § 102 if a single prior art reference discloses all limitations of the claimed invention.

D. Obviousness

41. I have been informed that under 35 U.S.C. § 103, a patent claim is unpatentable if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious to a person having ordinary skill in the art to which said subject matter pertains at the time the invention was made. I have been informed that this is referred to as unpatentability by obviousness.

42. I have been informed that a proper obviousness analysis includes the following:

a. Determining the scope and content of the prior art;

b. Ascertaining the differences between the prior art and the claims at issue;

c. Resolving the level of ordinary skill in the pertinent art; and

d. Considering evidence of secondary indicia of nonobviousness (if available). I am not aware of any evidence of secondary considerations that would support a determination of

nonobviousness of the claimed subject matter in the '948 patent.

43. I have been informed that the relevant time for considering whether a claim would have been obvious to a person of ordinary skill in the art is the time of invention. For my obviousness analysis, counsel for Petitioner instructed me to assume that the date of invention for the challenged claims is May 22, 2013. My opinions would not change if I assumed a later date of invention.

44. I have been informed that a reference may be modified or combined with other references or with a person of ordinary skill in the art's own knowledge if the person would have found the modification or combination obvious. I have also been informed that a person of ordinary skill in the art is presumed to know all the relevant prior art, and the obviousness analysis may take into account the inferences and creative steps that a person of ordinary skill in the art would employ.

45. I have been informed that whether a prior art reference renders a patent claim obvious is determined from the perspective of a person of ordinary skill in the art. I have also been informed that, while there is no requirement that the prior art contain an express suggestion to combine known elements to achieve the claimed invention, and while a suggestion to combine known elements to achieve the claimed invention may come from the prior art as a whole or

individually and may consider the inferences and creative steps a person of ordinary skill in the art would employ, as filtered through the knowledge of one skilled in the art, obviousness grounds cannot be sustained by mere conclusory statements and must include some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness.

46. In determining whether a prior art reference could have been combined with another prior art reference or other information known to a person having ordinary skill in the art, I have been informed that the following principles may be considered:

a. A combination of familiar elements according to known methods is likely to be obvious if it yields predictable results;

b. The substitution of one known element for another is likely to be obvious if it yields predictable results;

c. The use of a known technique to improve similar items or methods in the same way is likely to be obvious if it yields predictable results;

d. The application of a known technique to a prior art reference that is ready for improvement to yield predictable results;

e. Any need or problem known in the field and addressed by the reference can provide a reason for combining the elements in the manner claimed;

f. A person of ordinary skill often will be able to fit the teachings of multiple references together like a puzzle; and

g. The proper analysis of obviousness requires a determination of whether a person of ordinary skill in the art would have a "reasonable expectation of success"—but not "absolute predictability" of success—in achieving the claimed invention by combining prior art references.

47. I have been informed that, when a work is available in one field, design alternatives and other market forces can prompt variations of it, either in the same field or in another. I have been informed that if a person of ordinary skill in the art could have implemented a predictable variation and would have seen the benefit of doing so, that variation is likely to have been obvious. I have been informed that, in many fields, there may be little discussion of obvious combinations, and in these fields, market demand—not scientific literature—may drive design trends. I have been informed that, when there was a design need or market pressure and there are a finite number of predictable solutions, a person of

ordinary skill in the art would have had a good reason to pursue those known options.

48. I have been informed that the law permits the application of "common sense" in examining whether a claimed invention would have been obvious to a person skilled in the art. For example, I have been informed that combining familiar elements according to known methods and in a predictable way may suggest obviousness when such a combination would yield nothing more than predictable results. I understand, however, that a claim is not obvious merely because every claim element is disclosed in the prior art, and that a party asserting obviousness must still provide a specific motivation to combine or modify the references as recited in the claims and explain why one skilled in the art would have reasonably expected to succeed in doing so.

49. I have been informed that there is no rigid rule that a reference or combination of references must contain a "teaching, suggestion, or motivation" to combine references. But I also understand that the "teaching, suggestion, or motivation" test can be a useful guide in establishing a rationale for combining elements of the prior art. I have been informed that this test poses the question as to whether there is an express or implied teaching, suggestion, or motivation to combine prior art elements in a way that realizes the claimed invention, and that it seeks to counter impermissible hindsight analysis.

50. I have been informed that, in an obviousness analysis, prior art must be analogous prior art to the patent being considered. I have been informed that a prior art reference is considered to be analogous, or in the same field of art, if the reference is either (1) in the same field of endeavor as the challenged patent, regardless of the problems the challenged patent and the prior art address; or (2) reasonably pertinent to the particular problem being solved by the challenged patent.

E. Enablement

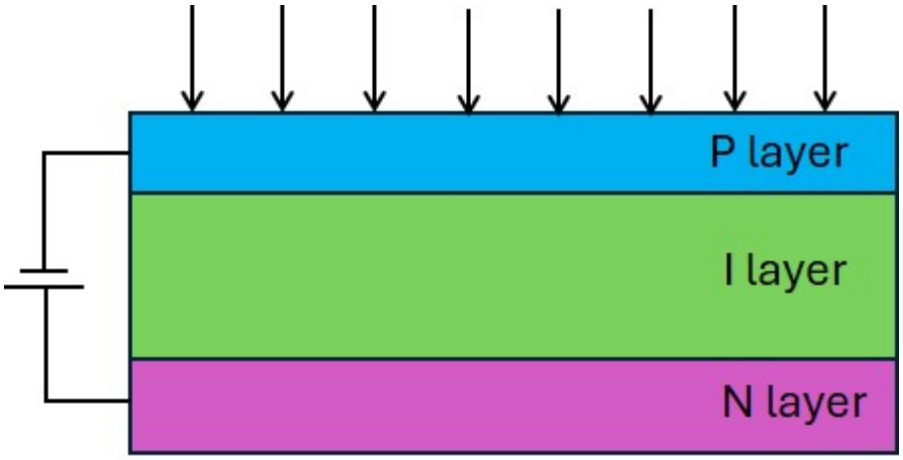
51. I have been informed that a patent must enable a skilled artisan to practice the claimed invention without undue experimentation under 35 U.S.C. § 112(a). I also understand that the enablement requirement is met only when a person of ordinary skill in the art, after reading the specification, could make and practice the claimed invention without undue experimentation. I have been advised that the full scope of the asserted invention must be enabled, meaning that the specification and drawings must teach a person of ordinary skill in the art how to make and use the invention as broadly as it is claimed. I also understand that the specification and drawings must demonstrate that the various embodiments covered by the full scope of the claim would work for the intended purpose described in the patent and/or the prosecution history.

52. I also understand that a patent is considered nonenabling if a person of ordinary skill in the art would be required to conduct "undue experimentation" in order to practice the invention. I have been informed that undue experimentation is determined based on a nonexclusive list of factors that are referred to as the *Wands* factors, including: (1) the quantity of experimentation necessary, (2) the amount of direction or guidance presented, (3) the presence or absence of working examples, (4) the nature of the invention, (5) the state of the prior art, (6) the relative skill of those in the art, (7) the predictability or unpredictability of the art, and (8) the breadth of the claims. I also have been informed that the analysis is case- and fact-specific, and all eight factors need not be analyzed in every case.

VI. TECHNOLOGY BACKGROUND

A. Photodetectors

53. A photodetector is a semiconductor device that transforms photons into electrical signals, enabling electrical circuits to detect and measure incident light. Various types of photodetectors exist, including photodiodes and avalanche photodiodes. A PiN photodetector is a specific type of photodiode characterized by an intrinsic (undoped) layer positioned between highly doped P-type and N-type semiconductor layers (hence the name "PiN"):



54. When light enters the photodetector, the intrinsic layer absorbs photons, generating electron-hole pairs. Applying a negative bias across the photodetector causes the separated electrons to move towards the N-type layer and the holes towards the P-type layer, producing a measurable photocurrent.

B. Microstructure-Enhanced Photodetectors

55. Conventional silicon photodetectors exhibit high responsivity at wavelengths of light less than about 850 nm. Ex. 1008, 1. The prior art recognized that tailoring silicon's microstructure extends photodetector operability to longer wavelengths. For instance, etching a silicon photodetector surface to create micron-sized pillars/grooves was known to enhance a photodetector's responsiveness at longer wavelengths. Ex. 1008, 1-2; Ex. 1009, 1-6. The images below illustrate photodiodes with laser-etched microstructures designed to enhance their responsiveness at longer wavelengths.

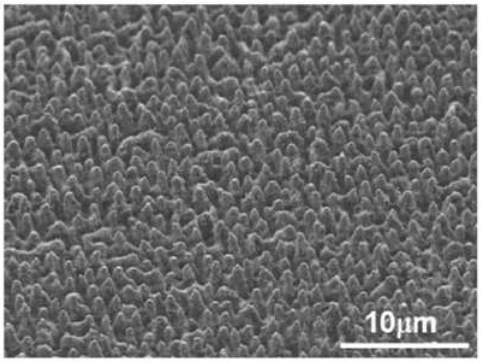


FIG. 1. Scanning electron micrographs of microstructured Si surface.

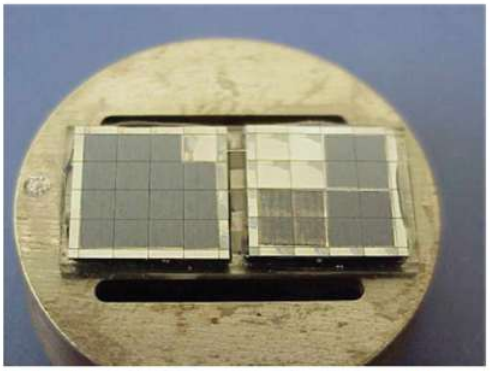


Fig. 1. (Color online) Picture of two microstructured APD arrays prior to packaging. Structuring was performed with an 800 nm fs laser operating at a fluence of 3.5 kJ/m^2 in an atmosphere of SF_6. The array on the right had four different structured regions with a pulse number ranging from 0 to 300. The shiny area is the bare silicon.

Ex. 1008, 1 (left); Ex. 1009, 2 (right).

56. Photodetectors featuring microstructures enhanced by etched holes were widely known and utilized well before the purported invention. For example, *NXP* (Ex. 1007) discloses a single-chip device 1300 where a silicon PiN photodiode is integrated with CMOS signal processing circuitry (not shown in Figure 13 below) on the same substrate 102. *NXP*, ¶¶[15], [32], [42], [85].

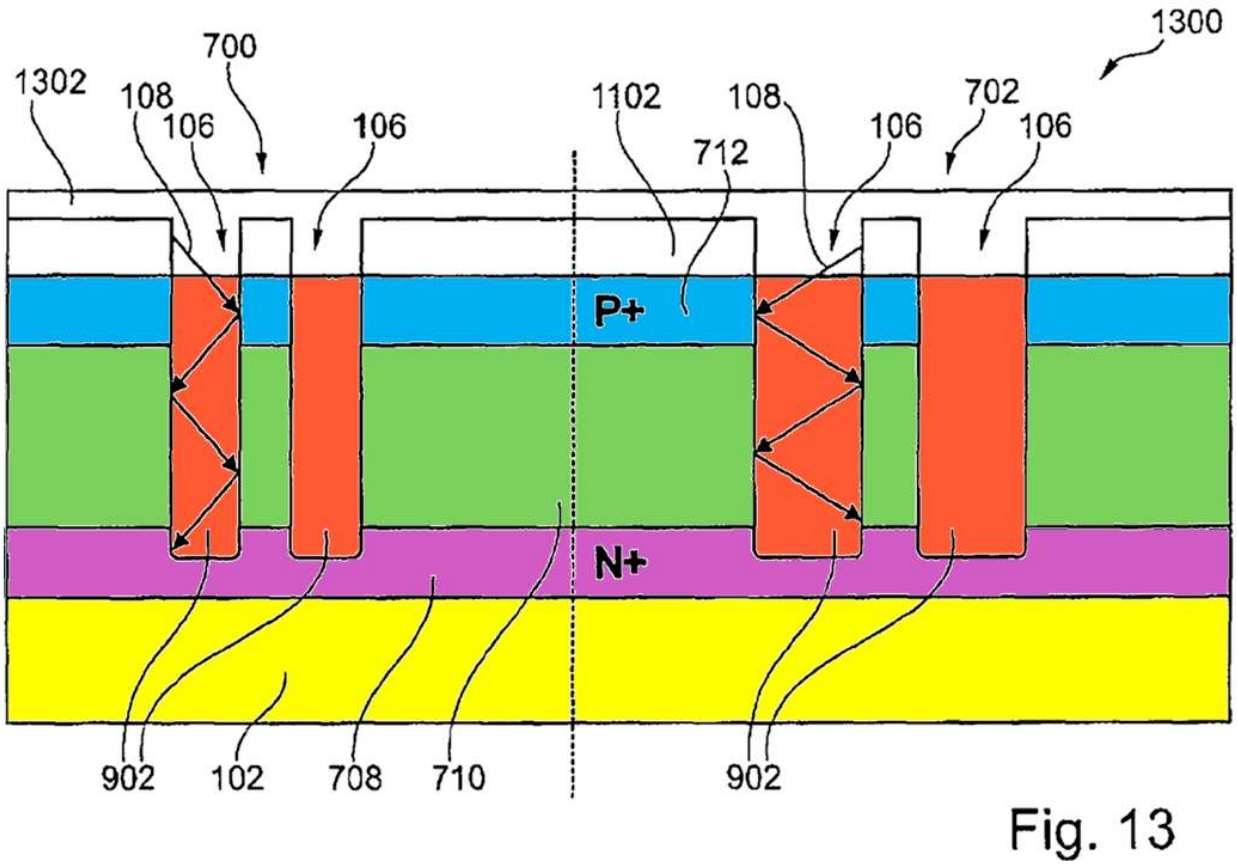


Fig. 13

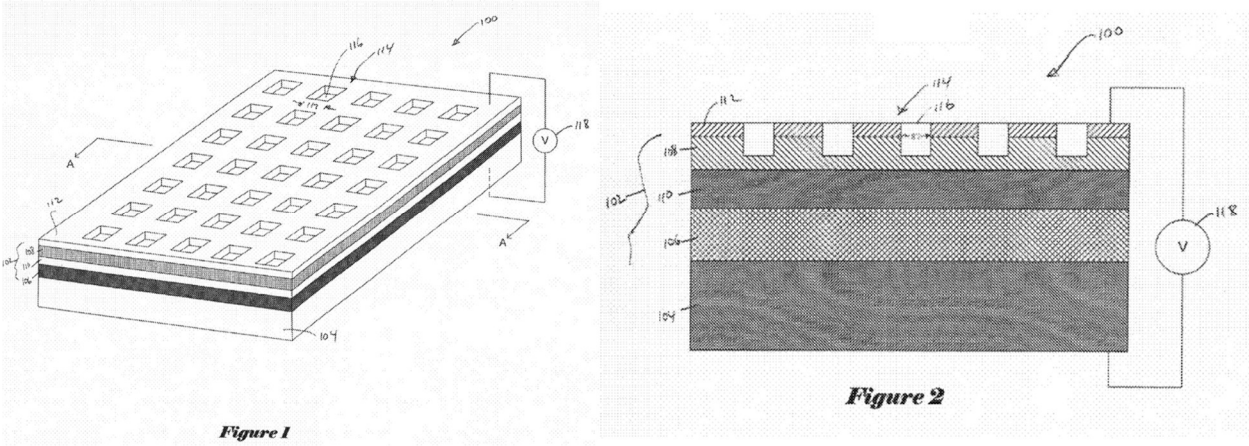
NXP, Fig. 13.[1]

57. The PiN photodiode above includes an intrinsic layer 710 disposed between an N^+ layer 708 and a P^+ layer 712 and holes or pores 106 formed on the PiN layers by etching. *NXP*, ¶¶[77]-[78]. *NXP* discloses that pores 106 increase the photodiode's quantum efficiency. *NXP*, ¶¶[13], [38]. Quantum efficiency is a

[1] I have added color and colored annotations in figures throughout my declaration to illustrate claimed features disclosed in the '948 patent as well as in the prior art references.

measure of how effectively the photodiode converts incoming optical energy into electrical signals. *See* Ex. 1010, 4; Ex. 1052, 4.

58. As another example, Ex. 1053 discloses a photonic device 100 comprising a PiN structure with a stacked p-semiconductor region 108, intrinsic semiconductor region 110, and an n-semiconductor region 106. *See* Ex. 1053, ¶[28], Figs. 1-2. A thin doped region 112 overlays the surface of the p-region 108, and a periodic array of holes or recesses 116 extends into the PiN structure through the overlying region 112. Ex. 1053, ¶¶[29]-[32].



Ex. 1053, Figs. 1, 2.

C. Photodetectors and Processing Circuitry on a Single Substrate

59. The integration of photodetectors and signal processing circuitry on a single substrate to form a single-chip device was known long before the purported invention date of the ’948 patent. Ex. 1010, 1-14; Ex. 1052, 1-8; Ex. 1054, 1-2. For instance, *NXP* teaches that integrating signal processing circuitry and the

photodiode on the same substrate "may be more reliable than a discrete solution" and result in a smaller package, which is advantageous for mobile applications. *NXP*, ¶¶[16], [32], [37].

60. Beginning in the late 1980s, advancements in CMOS technology enabled the fabrication of both photodetectors and signal processing electronics on the same substrate. Ex. 1010, 2-3, 10. For example, researchers at NASA's Jet Propulsion Laboratory developed the CMOS active pixel sensor (APS), which integrated a photodiode, amplifier, and signal processing circuitry within each pixel of an image sensor. Ex. 1010, 2-3. This allowed for on-chip conversion of light to electrical signals and immediate processing. Ex. 1010, 2-3; Ex. 1013, 4. This CMOS APS is shown below.

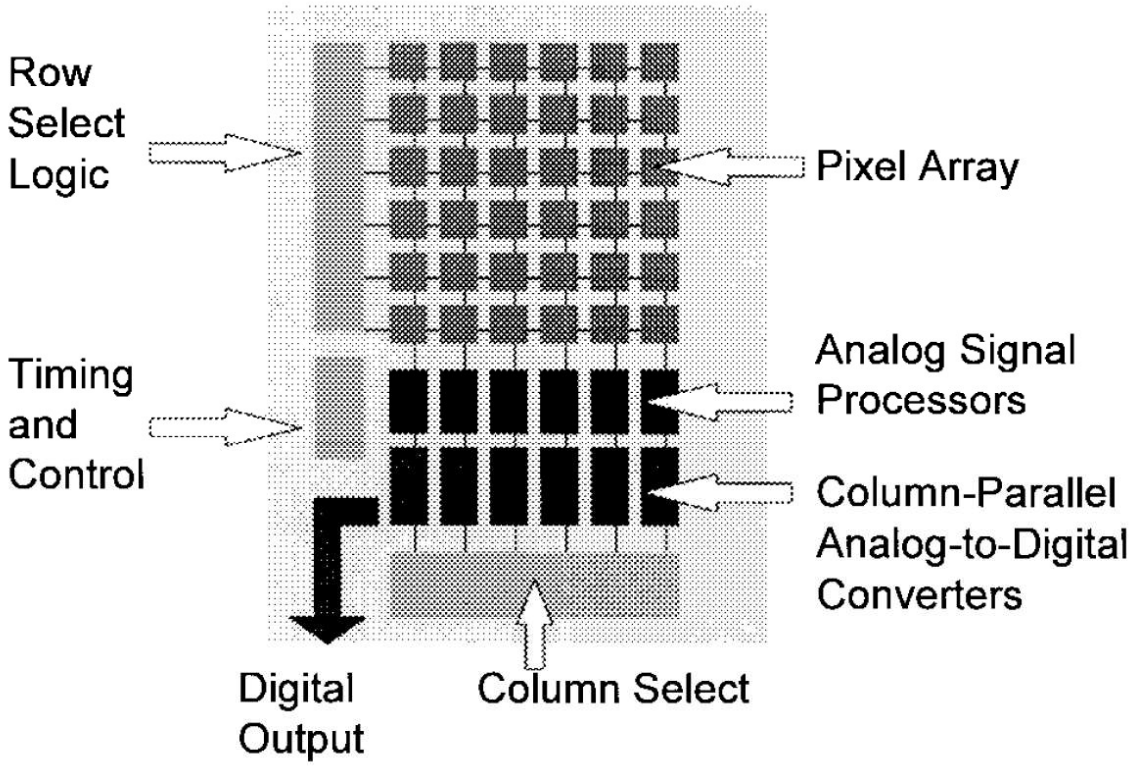
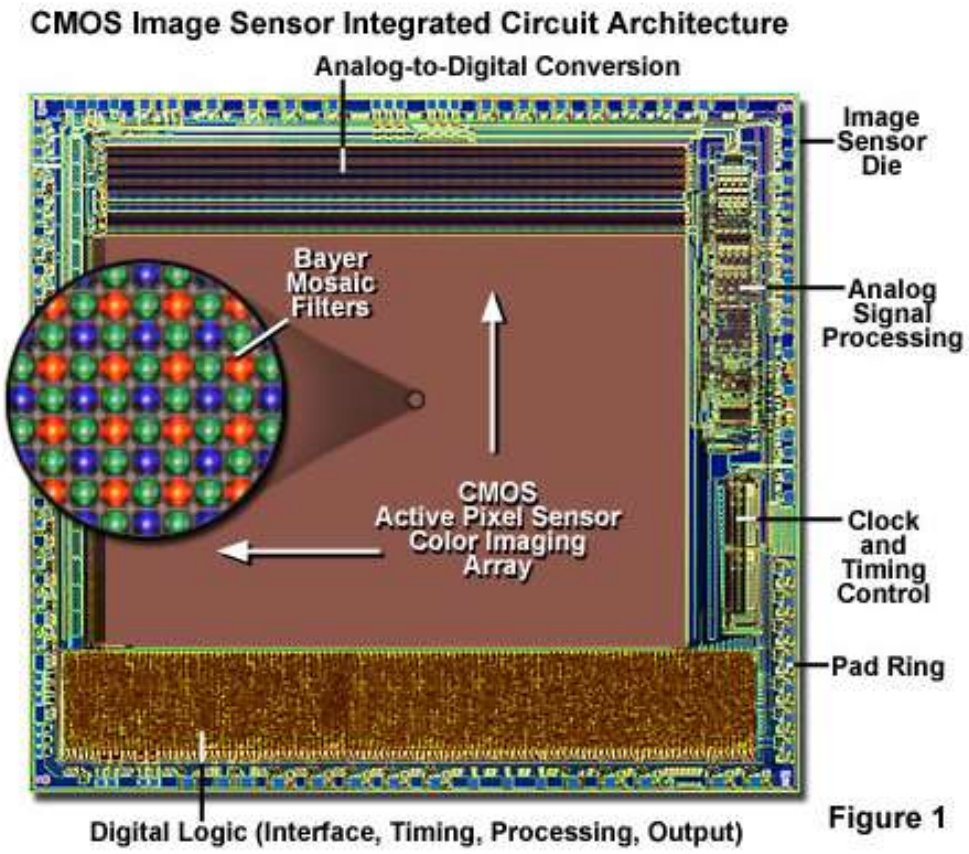


Fig. 2. CMOS APS integrates timing and control, ADC, and other circuitry on the same chip.

Ex. 1052, 3 (Fig. 2).

61. The integration of the photodiode and processing circuitry on the same chip reduced power consumption, lowered manufacturing costs, and allowed for smaller, more efficient imaging devices. Ex. 1010, 3, 10, 12; Ex. 1052, 8.

62. By the early 2000s, APS technology was prevalent in consumer electronics such as digital cameras, smartphones, and webcams. Ex. 1010, 1-3; Ex. 1048, 9. An image of a CMOS APS image sensor die is shown below.

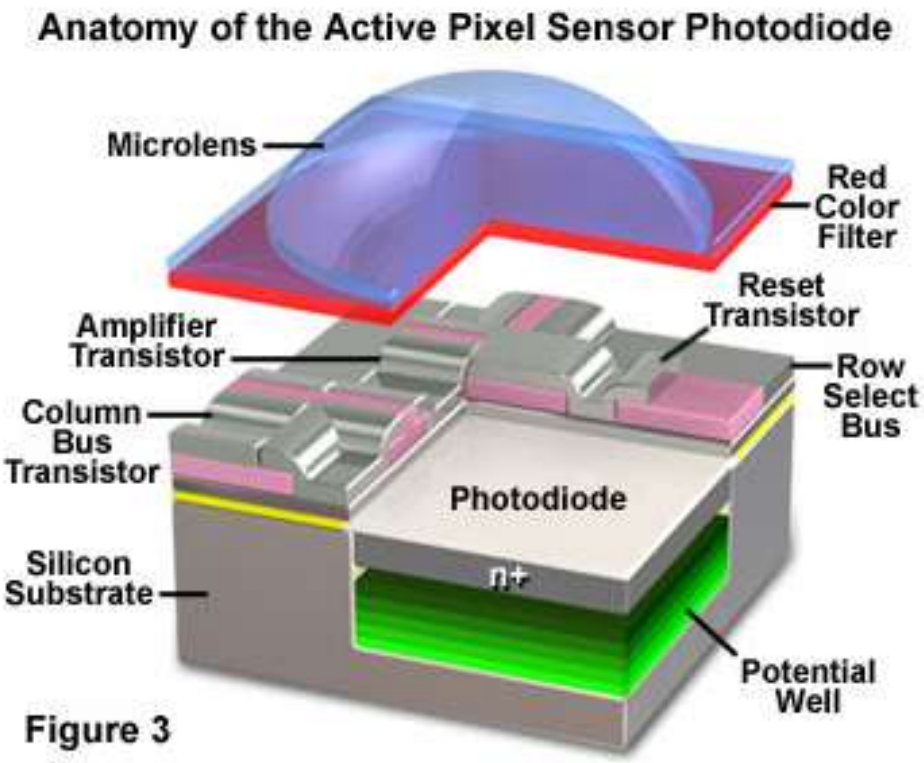


Ex. 1048, 1 (Fig. 1).

63. This image sensor die includes an array of photodiodes (640 x 480 pixels) located in the large reddish-brown central area of the chip and analog signal processing circuitry to collect and interpret the signals generated by the photodiode array. Ex. 1048, 2-3, Fig. 1.

64. A three-dimensional cutaway drawing of the above image sensor is shown below, illustrating a single photodiode and associated transistors that process the signals produced by the photodiode on a single substrate.

Ex. 1048, 3-5.



Ex. 1048, 3 (Fig. 3).

65. To focus the incident light on the photodiode, the photodiode is positioned beneath a microlens and a color filter to capture color information from the incident light. Ex. 1048, 3-4, Fig. 3.

66. Well before the purported invention date of the ’948 patent, numerous published references disclosed single-chip devices integrating photodetectors and signal processing circuitry on a single substrate. For example, *Kuboi* (Ex. 1004), discussed below, describes such a device. *Infra* VIII.A. *Shinohara* (Ex. 1006) discloses a similar single-chip device incorporating photodetectors and signal processing circuitry. *See Shinohara*, Figs. 1-2, ¶¶[51]-[63]; *infra* VIII.C.

FIG. 1

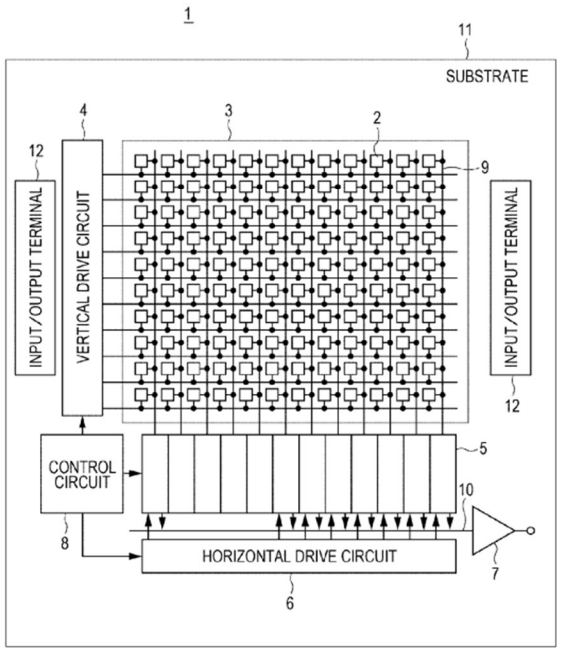
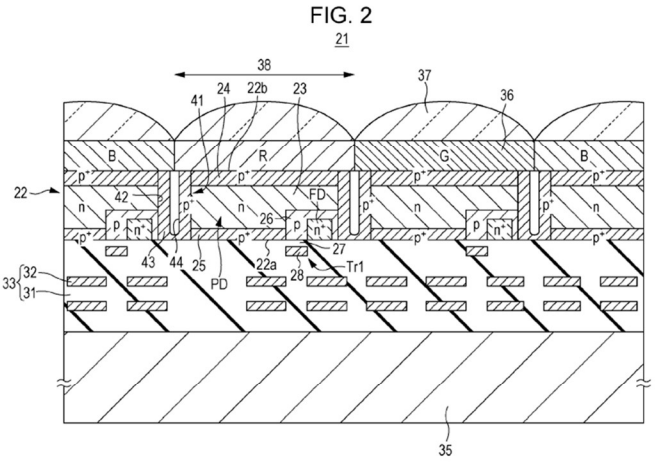


FIG. 2



Shinohara, Figs. 1, 2.

67. Like *Kuboi*'s imaging device 201 (*see Kuboi*, Fig. 5, ¶¶[48]-[54]), *Shinohara*'s imaging device 1 features a pixel region 3 with a two-dimensional pixel array 2 and a peripheral circuit portion integrated on the same semiconductor substrate 11. *See Shinohara*, ¶[51]; *infra* VIII.A, VIII.C. In *Shinohara*, each pixel 2 contains a photoelectric conversion portion and four pixel transistors, similar to *Kuboi*. *Shinohara*, ¶[51]; *see Kuboi*, ¶[48]; *infra* VIII.A, VIII.C. Additionally, similar to *Kuboi*, *Shinohara*'s peripheral circuit portion includes various logic circuits, such as a vertical drive circuit 4, a column signal processing circuit 5, a horizontal drive circuit 6, an output circuit 7, and a control circuit 8. *Shinohara*, ¶[52]; *see Kuboi*, ¶[49]; *infra* VIII.A, VIII.C. In *Shinohara*'s imaging device 1, the

photodiode-based photoelectric conversion portion and pixel transistors are formed on a single semiconductor substrate (substrate 22), along with the logic circuits of the peripheral circuit portion. *See Shinohara*, ¶¶[3]-[4], [58], [81].

VII. THE '948 PATENT

A. Specification

68. The '948 patent's photodetector includes microstructures to enhance photoabsorption. '948 patent, 2:41-42, 3:1-5, 4:1-8, 17:25-31. The photodetector includes a silicon substrate with a first layer (P^+ layer), a very low-doped N or P layer called the intermediate layer (i layer), and a second layer (N^+ layer) with holes etched in one or more of the PiN layers. '948 patent, 15:57-59, 16:9-36, 17:47-52. The photodetector (illustrated below) operates in reverse bias mode with negative voltage on the anode (P^+ layer) and positive voltage on the cathode (N^+ layer). '948 patent, 16:40-44, 11:45-51.

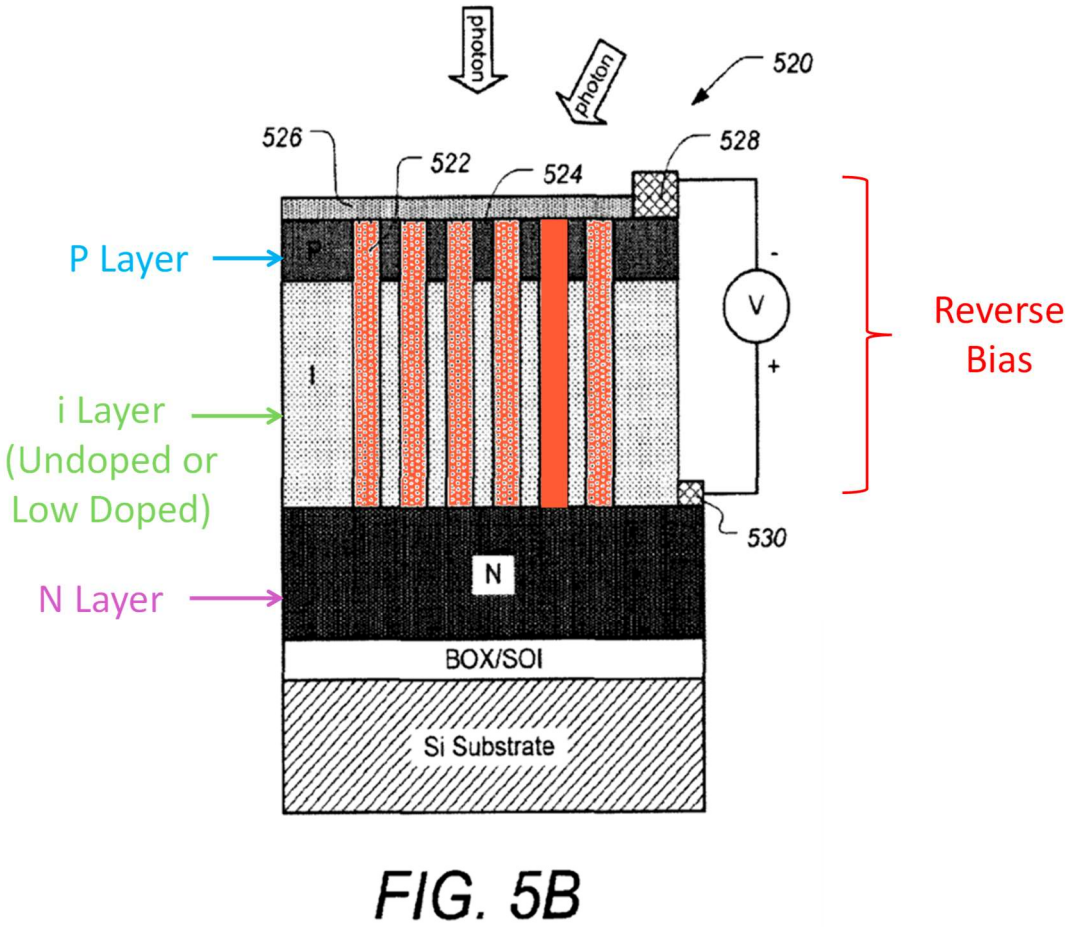


FIG. 5B

'948 patent, Fig. 5B.

69. The '948 patent discloses that optical signals or light can impinge on the light-receiving surface of the photodetector either perpendicular (normal) to the light-receiving surface or at an angle off normal. '948 patent, 16:48-49. The '948 patent discloses that one of the causes of enhancement of the absorption coefficient of the incident light includes high contrast grating (HCG) effects. '948 patent, 11:52-64. The '948 patent explains that its microstructured pillar-hole-void array can enhance the absorption coefficient of the incident light relative to the bulk

absorption coefficient by a factor of 1.1 to over 100 because of the HCG effect. ’948 patent, 12:49-54.

B. Prosecution History

70. During prosecution, independent claim 1 and several dependent claims were rejected as obvious over multiple references. *See* Ex. 1003, 348-351, 302-312. In response, Patent Owner amended independent claim 1 to further recite that “at least some of the holes are elongated along the respective light-receiving surfaces.” Ex. 1003, 249. Following this amendment, the claims were allowed. Ex. 1003, 18-23.

71. As detailed below, *Kuboi*—which was not considered during prosecution—discloses this limitation. Its teachings, when evaluated from the perspective of one skilled in the art, demonstrate that the allowed claims are obvious in light of *Kuboi*’s disclosure. Ex. 1003, 17-23.

C. Claim Construction

72. I have been instructed that the “intrinsic record” includes the ’948 patent itself, including the claims, description, and figures (Ex. 1001), and the ’948 patent’s prosecution history (Ex. 1003)—i.e., the record of proceedings at the U.S. Patent and Trademark Office (“Patent Office”) concerning the ’948 patent. I understand that, like the claims and written description, the prosecution history provides evidence to a person of ordinary skill in the art of how the inventor

intended his patent to be understood, and how the Patent Office understood the patent. I understand that the inventor is permitted to apply a special definition to the terms or to limit the scope of claim terms in his patent claims, which may differ from the term's plain and ordinary meaning. That special definition or limitation on scope may be provided in the patent's written description, the patent's prosecution history, or both.

73. I understand that claim interpretation may also be informed by "extrinsic evidence" (that is, evidence outside of the patent record itself). I have been informed that extrinsic evidence may include dictionaries, technical treatises, and other materials evidencing the meaning of a claim term and the understanding held by a person of ordinary skill in the art in the relevant time period.

74. I have been asked for purposes of this declaration to apply the plain and ordinary meaning of the claim terms as they would have been understood by a person of ordinary skill in the art at the earliest claimed priority date of the '948 patent. Based on my review of the materials and my personal knowledge and experience, I have considered each term of the '948 patent as it would have been understood by a person of ordinary skill in the art at the earliest claimed priority date of the '948 patent (May 22, 2013).

VIII. SUMMARY OF THE PRIOR ART

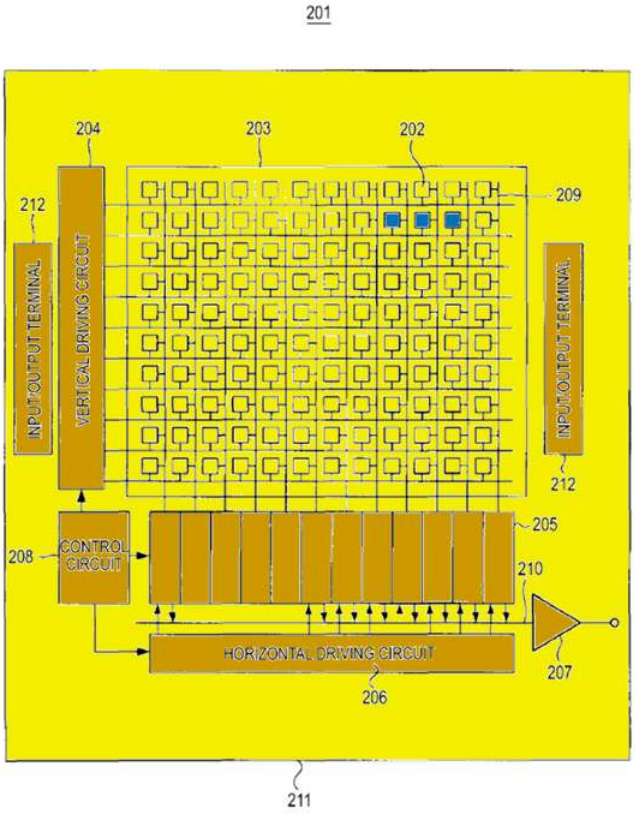
A. *Kuboi*

75. *Kuboi* is titled "Solid-State Imaging Device, Manufacturing Method Thereof, and Electronic Apparatus"; was filed on August 19, 2011; and published as U.S. Patent Application Publication No. 2012/0049044 A1 (Ex. 1004) on March 1, 2012. I understand that *Kuboi* is prior art to the '948 patent.

76. *Kuboi* is analogous art to the '948 patent because, like the '948 patent, *Kuboi* seeks to improve the light absorption efficiency of photoelectric devices. The '948 patent is directed to techniques for enhancing photon absorption. '948 patent, Abstract. Similarly, *Kuboi* is directed to a solid-state imaging device in which light absorption efficiency is increased to improve sensitivity. *Kuboi*, ¶[9].

77. *Kuboi* discloses a complementary metal oxide semiconductor (CMOS) imaging device 201 that includes a pixel region 203 and a peripheral circuit portion formed on a single semiconductor substrate 211. *Kuboi*, ¶[48], Fig. 15. *Kuboi*'s imaging device is illustrated below.

FIG.15



Kuboi, Fig. 15.

78. According to *Kuboi*, and as shown in the above figure, pixel region 203 of substrate 211 includes a number of pixels 202 that are arranged in a two-dimensional array. *Kuboi*, ¶[48]. Each pixel 202 contains one photoelectric conversion portion (or a photodiode) and four pixel transistors. *Kuboi*, ¶[48]. *Kuboi* also discloses that the peripheral circuit portion includes logic circuits (such as a vertical driving circuit 204, column signal processing circuits 205, horizontal driving circuit 206, output circuit 207, and control circuit 208), which process the pixel's electrical signals and then output the processed electrical signals. *Kuboi*, ¶¶[49]-[54]. *Kuboi* discloses that the pixels and peripheral circuit portion are

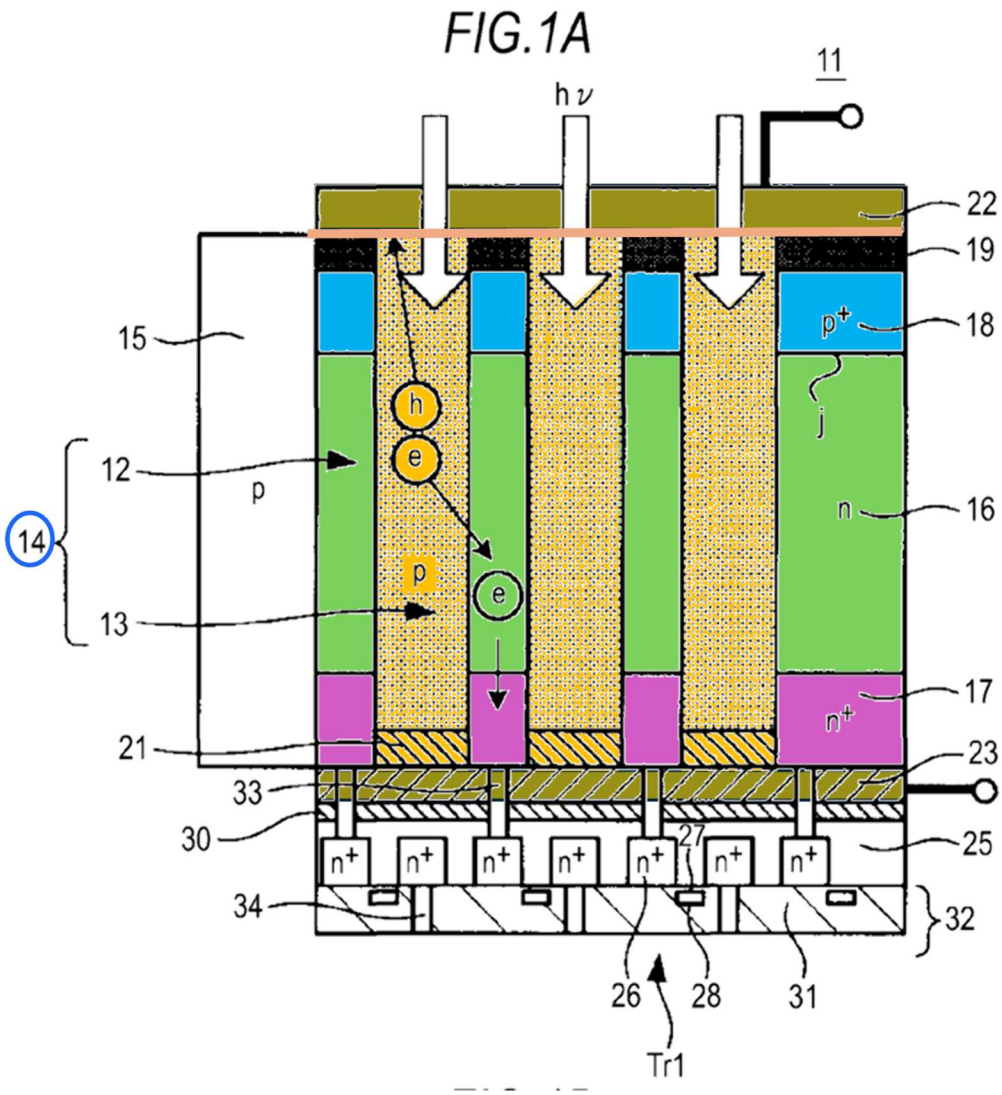
fabricated on one single substrate, the pixel transistors are fabricated on another substrate, and then two substrates are bonded together. *Kuboi*, ¶¶[62], [70], [78].

79. *Kuboi* describes photoelectric conversion portions suitable for use in the imaging device 201 shown in Figure 15. *Kuboi*, ¶[48]. For example, *Kuboi* discloses a basic pixel configuration for its imaging device with reference to Figures 1A/1B. *Kuboi*, ¶[55]. Similarly, *Kuboi* discloses a pixel configuration with reference to Figures 6A/6B, and explains that the disclosed red and green pixels 53R and 53G of Figures 6A/6B have a structure that is the same as the basic configuration of Figures 1A/1B. *Kuboi*, ¶¶[90], [95], [69]. *Kuboi* explains that Figure 13 includes pixels 53R, 53G, and 53B having configurations that are the same as the pixels of Figures 1A/1B. *Kuboi,* ¶[181]. Similarly, *Kuboi* describes its Figure 15 as being applicable to all of *Kuboi*'s pixel configurations. *Kuboi*, ¶¶[35], [48]. With reference to its Figures 4A-4F, *Kuboi* discloses a method of manufacturing the basic pixel configuration of Figures 1A/1B. *Kuboi*, ¶¶[69]-[76].

80. In my opinion, based on *Kuboi*'s disclosure, a person of ordinary skill in the art would have recognized that the different pixels described by *Kuboi* and illustrated in its Figures 1A/1B, 6A/6B, 13, and 15 all disclose the pixel configuration of the same imaging device. Further, in my opinion, Figures 4A-4F of *Kuboi* and the associated description disclose methods of manufacturing that same pixel configuration. Accordingly, throughout this declaration, references to

disclosures associated with Figures 1A/1B, 4A-4F, 6A/6B, 13, and 15 are deemed to be representative of the pixel configuration of the same imaging device 201. In addition, in my opinion, a person of ordinary skill in the art would have found it obvious to combine the elements illustrated and disclosed with Figures 1A/1B, 4A-4F, 6A/6B, 13, and 15.

81. *Kuboi* discloses that pixel 11, including photoelectric conversion portion 14, can be utilized in imaging device 201. *Kuboi*, ¶¶[48], [55]. Figure 1A of *Kuboi*, illustrating a photoelectric conversion portion 14 in a pixel 11, is shown below. *Kuboi*, ¶¶[48], [55]-[56].

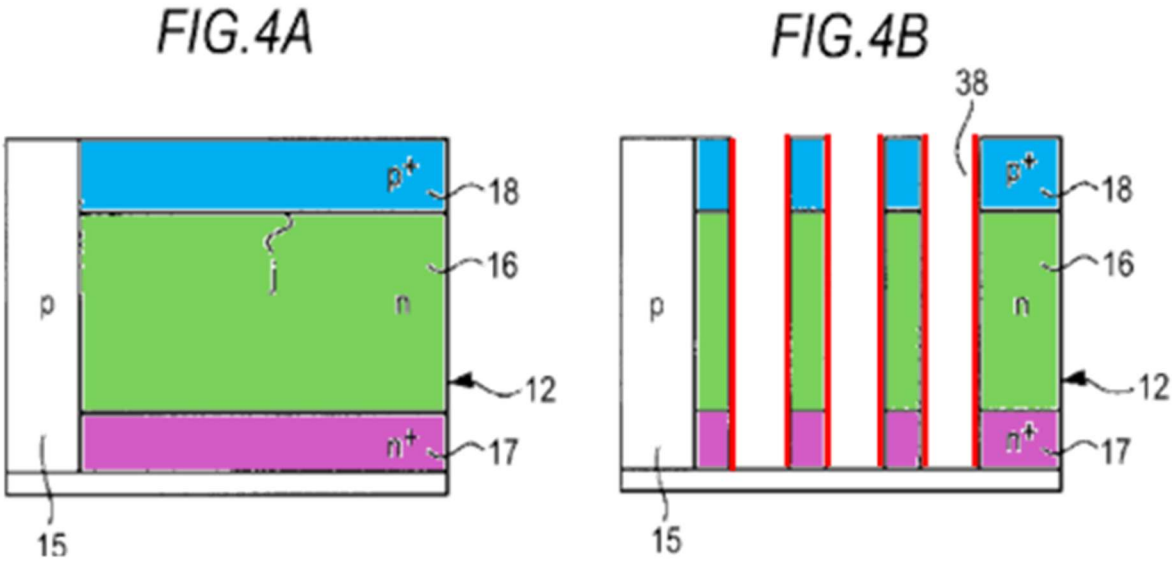


Kuboi, Fig. 1A.

82. Photoelectric conversion portion 14 comprises a silicon semiconductor layer 12 that includes multiple embedded organic photoelectric films 13. *Kuboi*, ¶[55], [57]. Silicon semiconductor layer 12 is implanted with different impurities (or doped) to form n-type semiconductor (or "intermediate") region 16 with p^+-type semiconductor region 18 on one side and n^+-type semiconductor region 17 on the opposite side (i.e., stacked PiN regions). *Kuboi*,

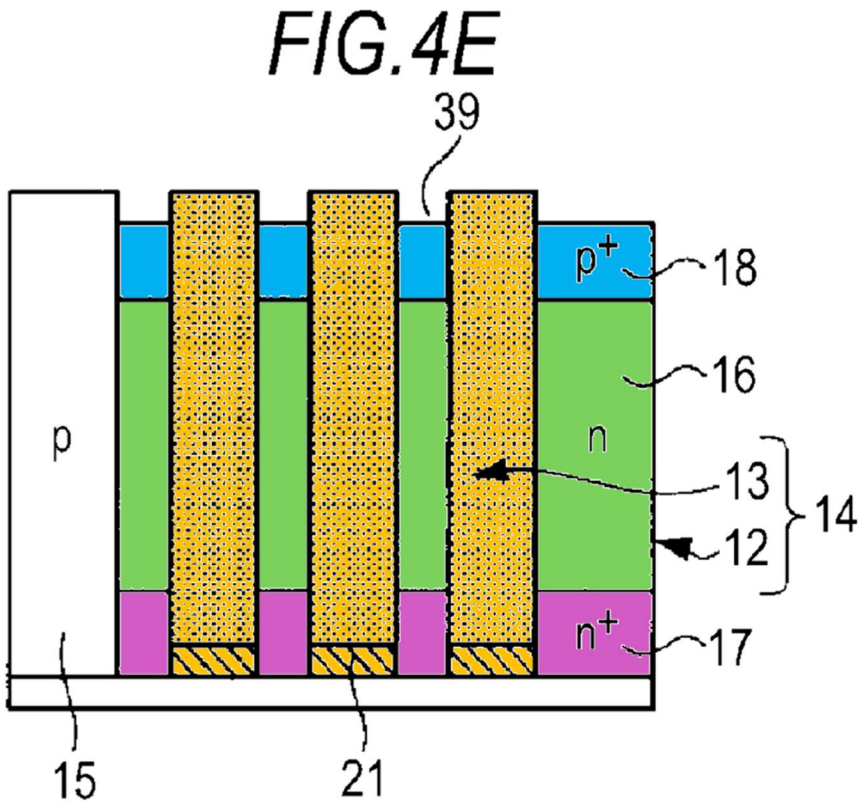
¶¶[56], [71]. *Kuboi* discloses that the doping of layer 12 is such that region 18 and region 17 have a higher concentration of impurities than region 16. *Kuboi*, ¶[56].

83. *Kuboi* explains that after forming regions 18, 16, and 17, vertical holes 38 extending from p^+-type region 18 to n^+-type region 17 are etched into the PiN regions (below, right). *Kuboi*, ¶¶[71]-[72].



Kuboi, Figs. 4A, 4B.

84. *Kuboi* further discloses that after forming holes 38, the organic material that forms photoelectric conversion film 13 is deposited in holes 38 (illustrated in *Kuboi*'s Figure 4E, below). *Kuboi*, ¶¶[72]-[73].



Kuboi, Fig. 4E.

85. A metal light shielding film 19 is then applied to region 18's surface such that only holes 38 containing films 13 are exposed to incident light (hν). *Kuboi*, ¶¶[59], [72]-[73], [76], Figs. 1A, 4F. An upper electrode 22 and a lower electrode 23 are formed on opposite sides of the PiN regions. *Kuboi*, ¶[60]. *Kuboi* discloses that a reverse bias is applied to electrodes 22 and 23. *Kuboi*, ¶[64]. Specifically, *Kuboi* discloses that a "necessary voltage is applied between the upper electrode 22 and the lower electrode 23 so that the upper electrode 22 has the negative potential, and the lower electrode 23 has the positive potential." *Kuboi*, ¶[64]. *Kuboi* explains that photoelectric conversion of the incident light (hν) occurs

within films 13 (inside holes 38) and results in generation of electron-hole pairs. *Kuboi*, ¶[64]. *Kuboi* discloses that the generated electrons move from the photoelectric conversion film 13 toward the depleted semiconductor layer 12 into a charge accumulation region 26 of the transfer transistor (Tr1) of the corresponding pixel 11 (via conductors 33). *Kuboi*, ¶¶[62], [64], [73]. *Kuboi* also discloses that the holes move toward upper electrode 22 through photoelectric conversion film 13. *Kuboi*, ¶[64]. *Kuboi* explains that after initial signal processing (e.g., amplification) by the pixel transistors, the electrical signals from the pixel 11 are sent to the peripheral circuits for further signal processing and output. *Kuboi*, ¶¶[48]-[49], [61]-[62].

B. *Vasylyev*

86. *Vasylyev*, titled "Light Harvesting System Employing Microstructures for Efficient Light Trapping"; was filed on July 12, 2011; and published as U.S. Patent Application Publication No. 2012/0012741 A1 (Ex. 1005) on January 19, 2012. I understand that *Vasylyev* is prior art to the '948 patent.

87. *Vasylyev* discloses a light harvesting system for "light detectors having light trapping microstructures … to improve absorption of light within the light sensitive layer." *Vasylyev*, ¶¶[6], [9], [16].

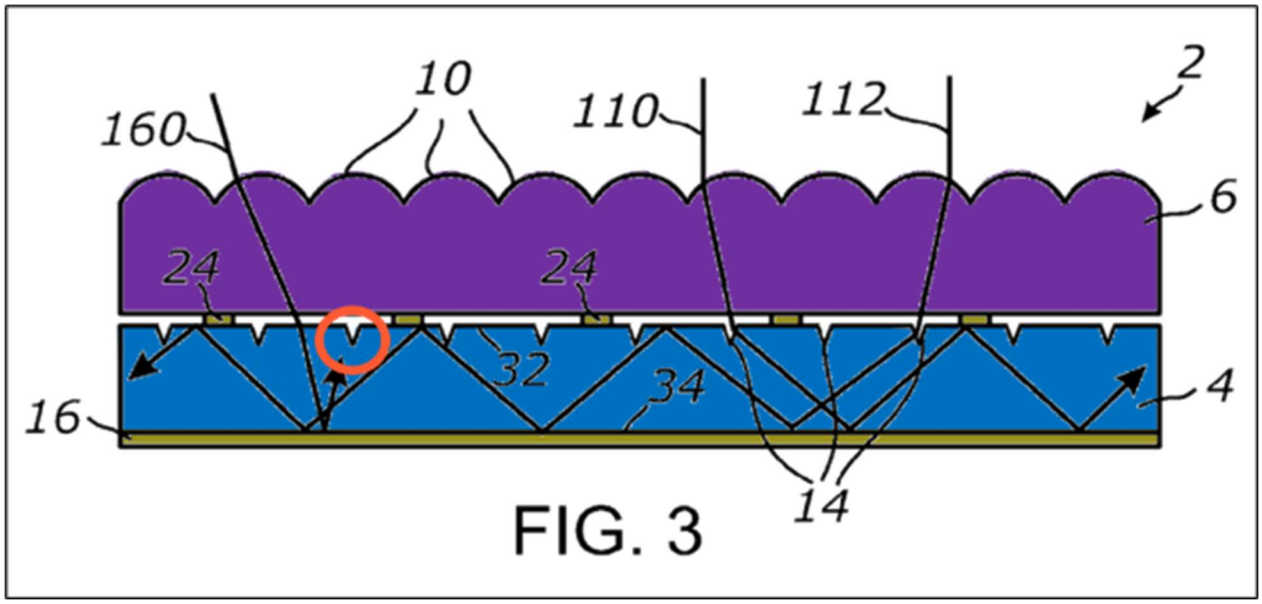


FIG. 3

Vasylyev, Fig. 3.

88. *Vasylyev* discloses that, in light harvesting system 2, a focusing array composed of microlenses 10 is disposed above a photo-responsive photovoltaic layer 4 to concentrate light onto layer 4. *Vasylyev*, ¶¶[65]-[67]. *Vasylyev* further discloses that photovoltaic layer 4 may incorporate any suitable structure capable of absorbing incident light and generating electrical charge carriers, and it may further include ohmic metallic or non-metallic electrodes—such as front electrodes 24 and back electrodes 16. *Vasylyev*, ¶¶[75], [80]. Like the semiconductor layer 12 of *Kuboi*'s blue pixel 53B, *Vasylyev*'s photovoltaic layer 4 may be formed of crystalline silicon and configured with a PiN architecture, wherein an intrinsic (i-type or undoped) layer is positioned between a p-type layer and an n-type layer. *Vasylyev*, ¶¶[76]-[77].

89. *Vasylyev* discloses that layer 4 further includes light input ports 14 formed in its front surface 32 that receive light from microlens 10. *Vasylyev*, ¶[83].

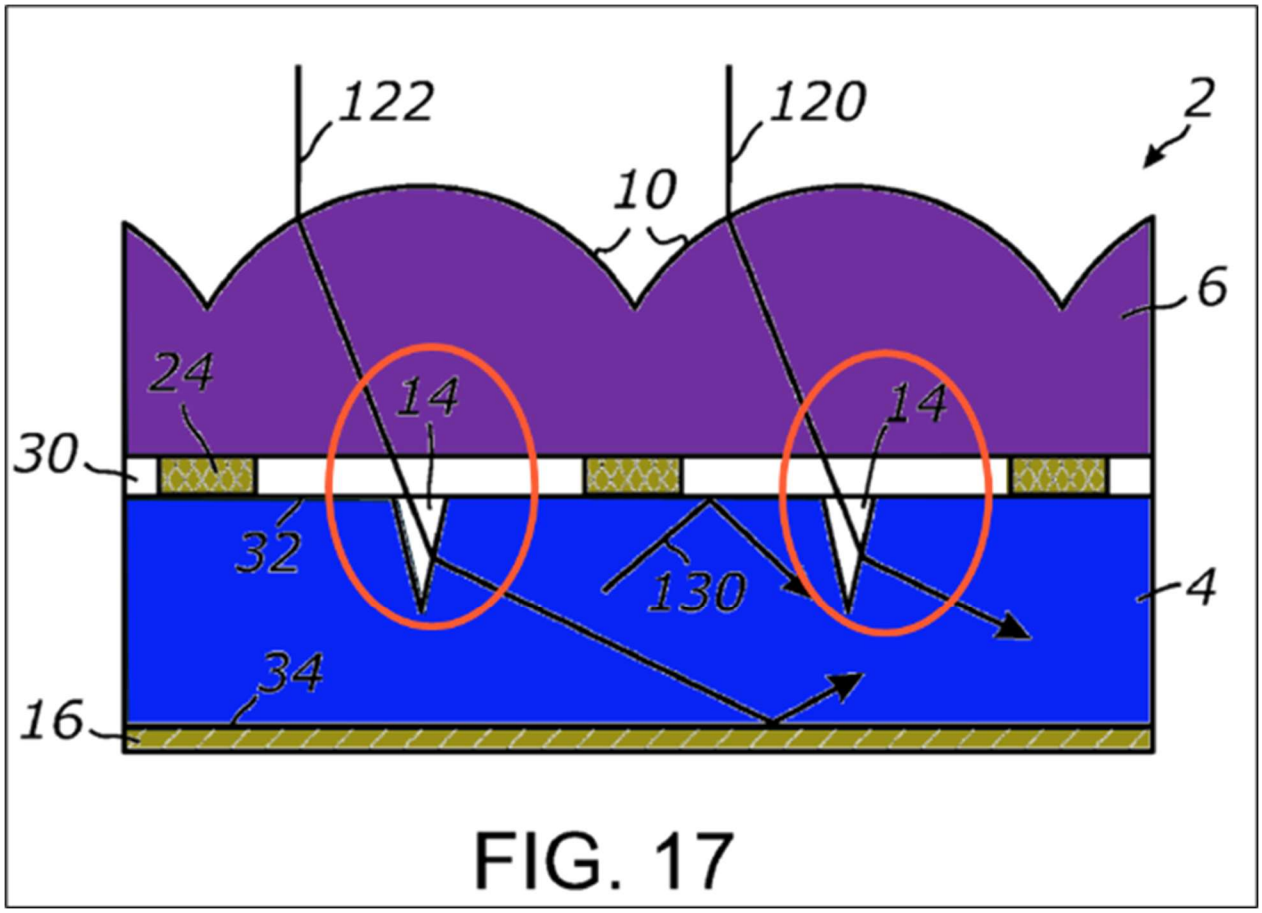


FIG. 17

Vasylyev, Fig. 17.

90. The number of light input ports 14 is equal to the number of lenses 10 positioned above photovoltaic layer 4. *Vasylyev*, ¶[84]. Importantly, ports 14 are spatially arranged on the light-receiving surface 32 of layer 4 such that there is a "pairwise optical relationship," or a one-to-one optical coupling, between each lens 10 and its associated port 14. *Vasylyev*, ¶[84]. *Vasylyev* discloses that the receiving aperture of each port 14 is centered with respect to the optical axis of the

associated lens 10. *Vasylyev*, ¶[85]. Accordingly, in *Vasylyev*'s system 2, a single port 14 is positioned beneath each lens 10.

91. *Vasylyev* explains that positioning a single port 14 beneath each lens 10 minimizes light reflection at the light-receiving surface 32 while enhancing light-coupling and light-trapping efficiency. *Vasylyev*, ¶¶[10]-[14], [63]-[64], [93]-[94]. *Vasylyev* explains that crystalline silicon—a conventional photovoltaic material—exhibits a relatively high refractive index, which contributes to poor light coupling efficiency due to significant reflection losses at the light-receiving surface. *Vasylyev*, ¶[12]. For instance, at a wavelength of 400 nm, crystalline silicon has a refractive index of 5.59, resulting in a Fresnel reflection of approximately 49% of the incident light. *Vasylyev*, ¶[12]. *Vasylyev* discloses that conventional techniques for mitigating surface reflection—such as antireflection coatings and surface microstructuring—suffer from various limitations. *See Vasylyev*, ¶[12]. For example, the formation of a microstructure array on the light-receiving surface 32, as illustrated below, can result in a significant portion of incident light escaping photovoltaic layer 4 without being absorbed. *Vasylyev*, ¶¶[63]-[64].

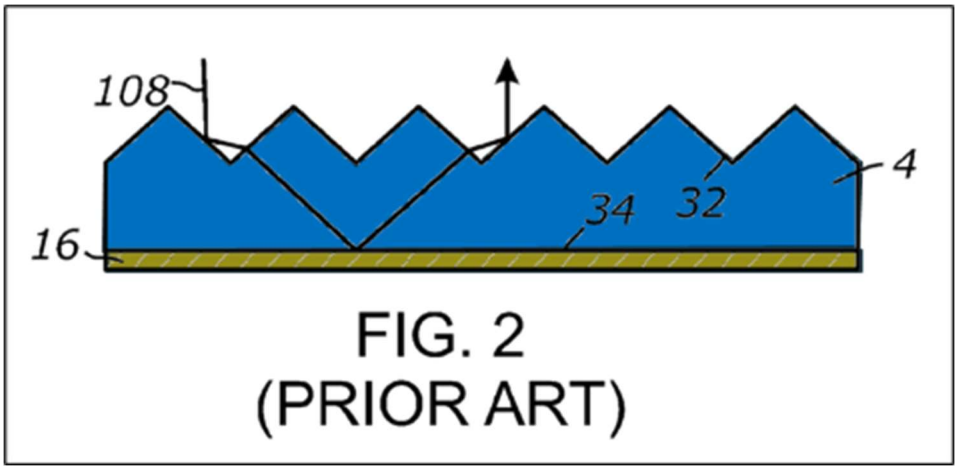


FIG. 2
(PRIOR ART)

Vasylyev, Fig. 2.

92. According to *Vasylyev*, although the above microstructure array enhances light coupling compared to a flat surface lacking microstructures, a light ray 108 entering photovoltaic layer 4 and reflecting from the back contact 16 may still escape the layer upon its next encounter with the front surface 32, resulting in poor light-trapping efficiency. *Vasylyev*, ¶[64].

93. To address this problem with the prior art, *Vasylyev* teaches positioning a single port 14 on surface 32 beneath each lens 10 to enhance both light coupling and light-trapping effectiveness. *Vasylyev*, ¶¶[93]-[94].

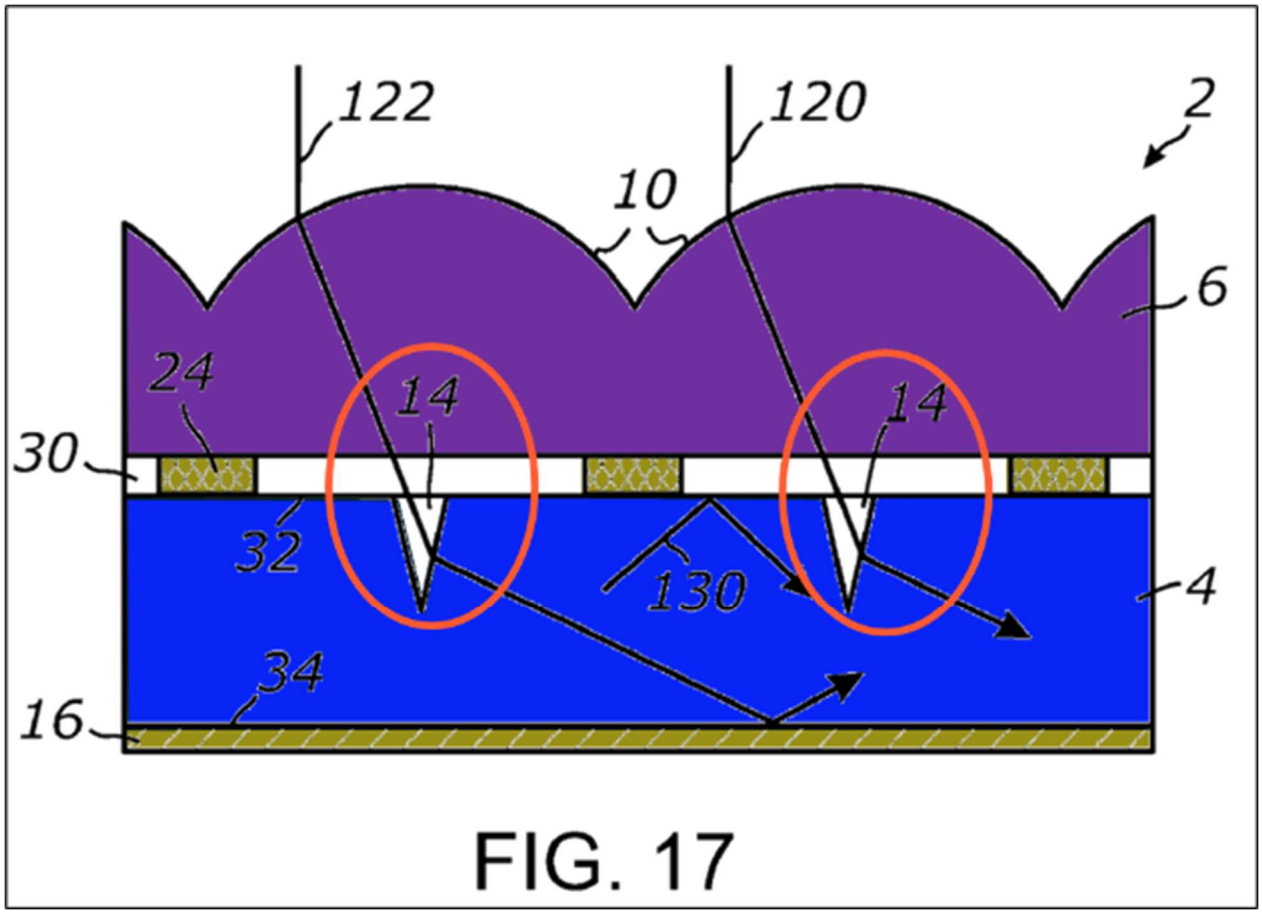


FIG. 17

Vasylyev, Fig. 17.

94. *Vasylyev* discloses that light ray 120 passing through lens 10 is directed onto corresponding port 14, where it undergoes refraction to enter photovoltaic layer 4 at an oblique angle, thereby enhancing light coupling efficiency. *Vasylyev*, ¶¶[93]-[94], [97]. Light introduced into photovoltaic layer 4 at an oblique angle becomes confined between its parallel surfaces, thereby extending the optical path length and resulting light absorption in layer 4, as illustrated by the trajectories of light rays 110 and 112 below. *Vasylyev*, ¶¶[64], [93].

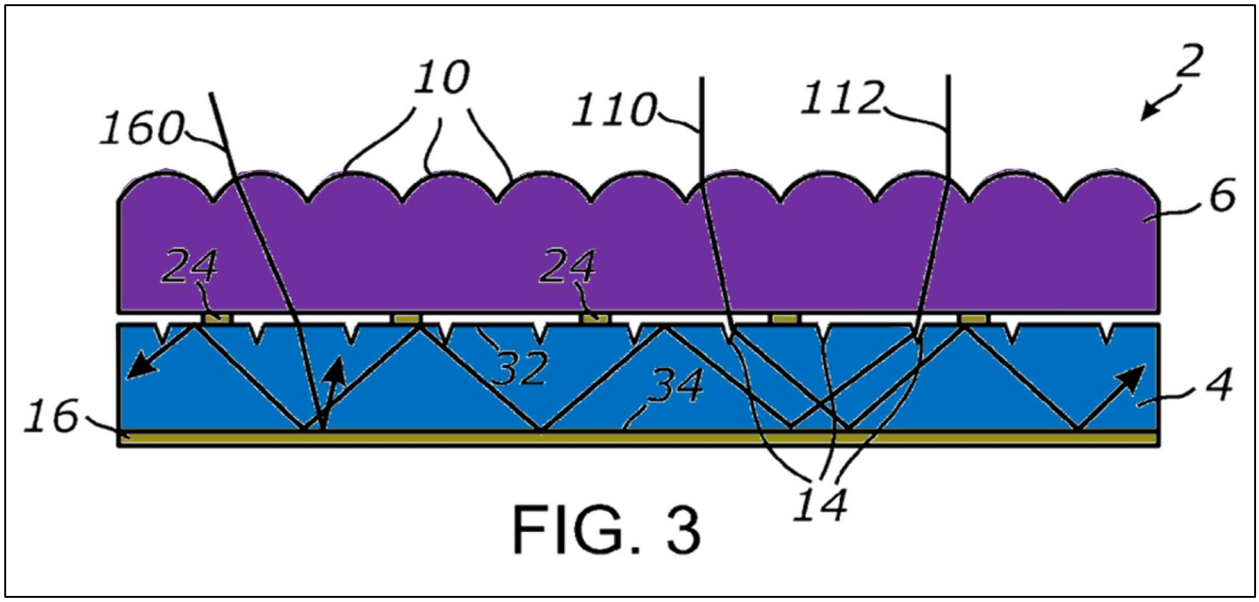
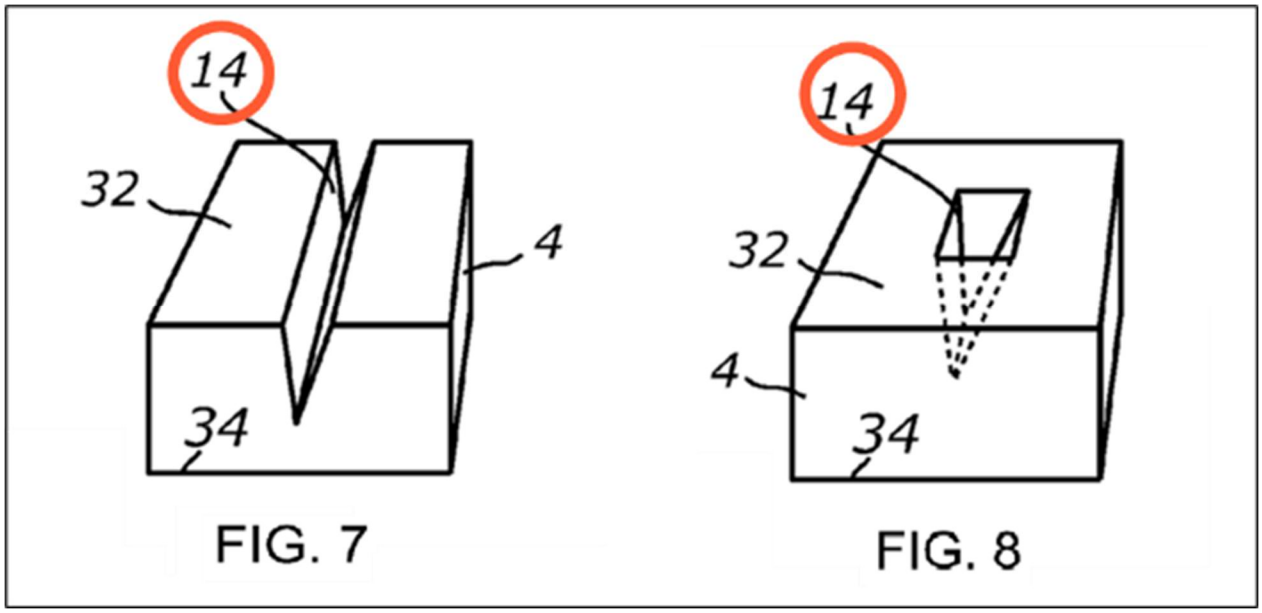


FIG. 3

Vasylyev, Fig. 3.

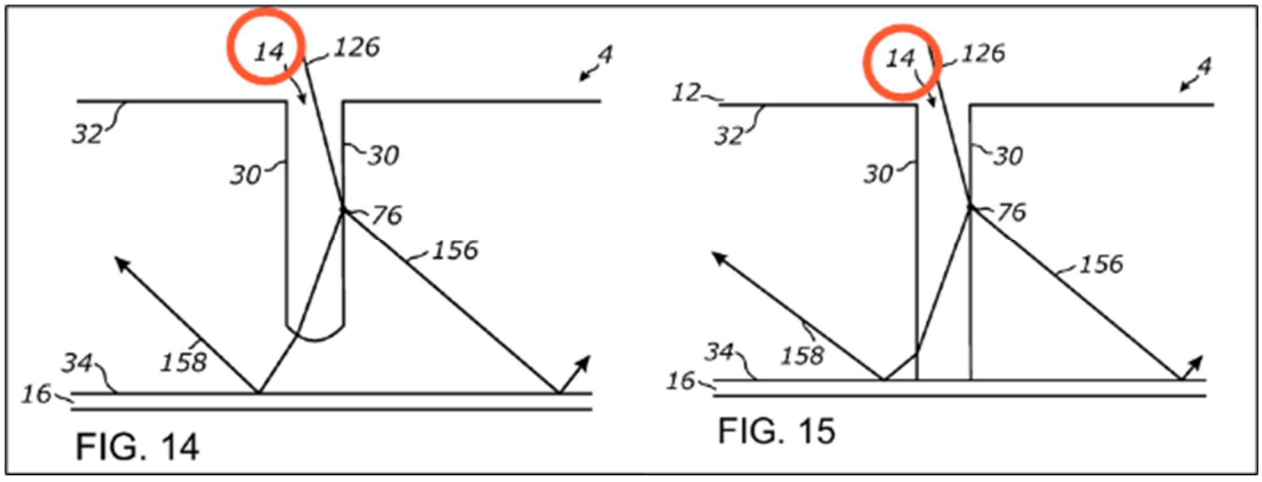
95. Accordingly, placing a single port 14 on the light-receiving surface 32 beneath each lens 10 enhances light coupling efficiency and facilitates the confinement of incident light within the silicon photosensitive layer, thereby extending the optical path length and improving both light absorption and energy conversion efficiency. *Vasylyev*, ¶[14].

96. *Vasylyev* discloses that port 14 may be any suitable microstructure, including "recesses, holes, [or] cavities," and may be fabricated on surface 32 using "chemical etching, ion beam etching, reactive ion etching, plasma etching[,] or any other known method." *Vasylyev*, ¶[83]. *Vasylyev* discloses that port 14 can have various shapes and profiles. *Vasylyev*, ¶[83].



Vasylyev, Figs. 7-8.

97. For example, port 14 may have an "elongated shape" on surface 32 and "can extend all the way along surface 32 or its substantial portion." *Vasylyev*, ¶[89]. Port 14 may also be configured as a relatively deep cavity formed in surface 32, with the cavity walls oriented either perpendicularly or at an inclined angle relative to surface 32. *Vasylyev*, ¶[90].



Vasylyev, Figs. 14-15.

98. *Vasylyev* discloses that ports 14 may be configured as "deep linear trenches or grooves" extending along surface 32, which may be fabricated by wet- or dry-etching techniques. *Vasylyev*, ¶[108].

99. In *Vasylyev*'s light harvesting system 2, a transparent buffer layer 30 is positioned between microlens array 10 and photovoltaic layer 4, serving to encapsulate layer 4 and protect its electrical contacts 24 from exposure to ambient air and moisture. *Vasylyev*, ¶[116].

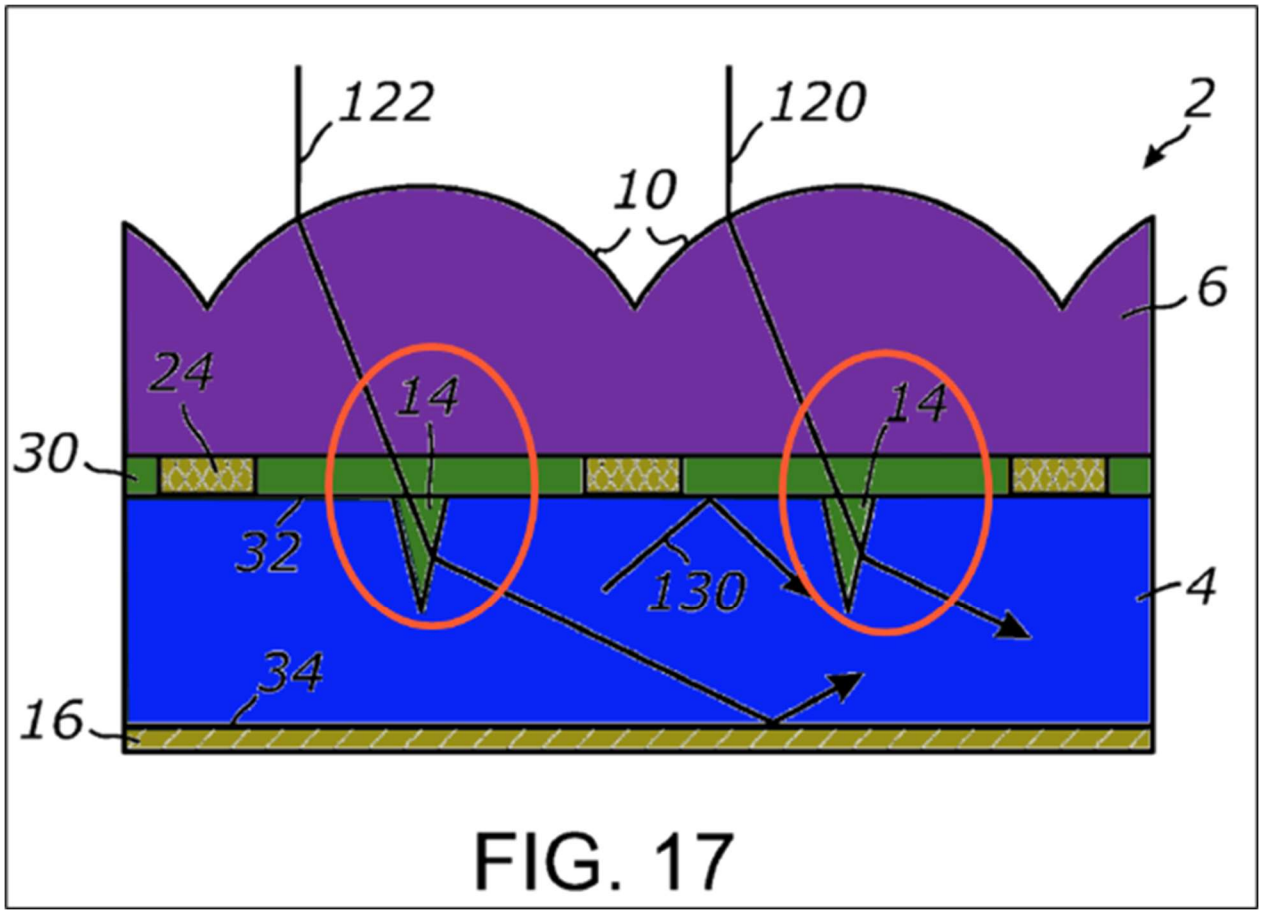


FIG. 17

Vasylyev, Fig. 17.

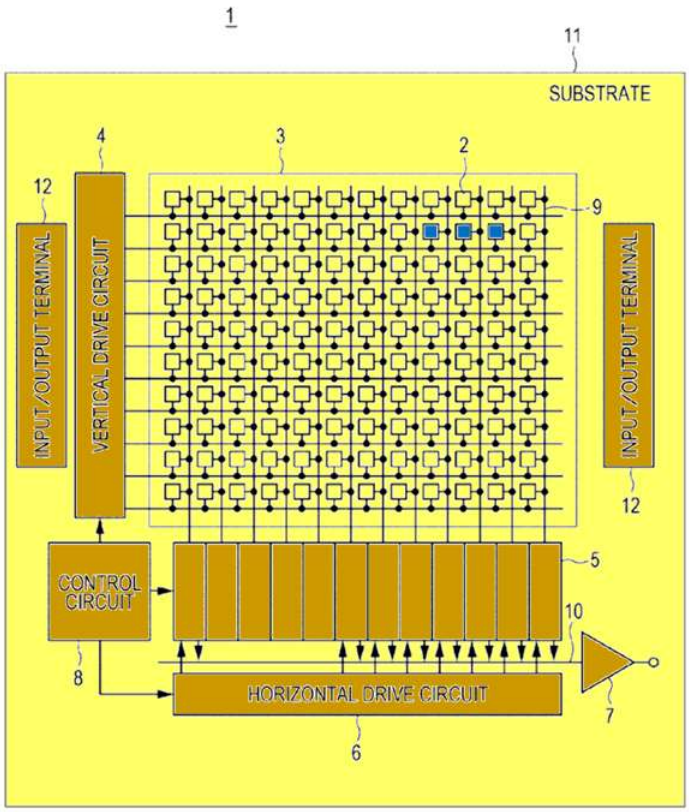
100. Buffer layer 30 may be a conventional encapsulating material such as ethylene vinyl acetate (EVA) or optically clear silicone. *Vasylyev*, ¶[111].

C. *Shinohara*

101. *Shinohara* is titled "Solid-State Imaging Device, Manufacturing Method Thereof, and Electronic Apparatus"; was filed on August 2, 2011; and published as U.S. Patent Application Publication No. 2012/0033119 A1 on February 9, 2012. I understand that *Shinohara* is prior art to the '948 patent.

102. *Shinohara* discloses "a solid-state imaging device which suppresses the generation of white spots and dark current and the occurrence of color mixture and which improves the sensitivity." *Shinohara*, ¶¶[13], [51]. Specifically, *Shinohara* discloses a solid-state imaging device 1 that includes a pixel region (so-called imaging region) 3 and a peripheral circuit portion. *Shinohara*, ¶[51]. *Shinohara* explains that in its pixel region, a plurality of pixels 2 are arranged in a semiconductor substrate 11, such as a silicon substrate, in a two-dimensional matrix. *Shinohara*, ¶[51]. *Shinohara* also discloses that each of its pixels 2 includes a photoelectric portion. *Shinohara*, ¶[51]. Further, *Shinohara* discloses that the peripheral circuit portion includes "logic circuits, such as a vertical drive circuit 4, a column signal processing circuit 5, a horizontal drive circuit 6, an output circuit 7, and a control circuit 8." *Shinohara*, ¶[52]. *Shinohara*'s imaging device including these features is illustrated below.

FIG. 1



Shinohara, Fig. 1.

103. *Shinohara* discloses that its photodiode PD includes a first conductivity type that functions as both photoelectric conversion and charge storage. *Shinohara*, ¶[58]. *Shinohara* explains that the first conductivity type can be an n-type charge storage region 23. *Shinohara*, ¶[58]. *Shinohara* discloses that its PD also includes second conductivity types, for example, p-type semiconductor regions 25 and 24. *Shinohara*, ¶[58].

104. *Shinohara* also discloses a method for manufacturing the imaging device on a p-type silicon semiconductor substrate 22. *Shinohara*, ¶[68]. For example, *Shinohara* discloses forming an n-type semiconductor region 52, in a

region corresponding to the pixel region, by ion-implanting an n-type impurity 51. *Shinohara*, ¶[69]. *Shinohara* discloses forming a trench 42 corresponding to the element isolation region and filling trench 42 with a p-type semiconductor region by epitaxial growth so as to form void 44 in trench 42. *Shinohara*, ¶[71]. *Shinohara* also discloses filling void 44 with an insulating film 69. *Shinohara*, ¶[91].

105. *Shinohara* discloses forming the p-type semiconductor well region 26 in a part of the n-type semiconductor region 52 at a surface side corresponding to each pixel isolated by the element isolation region 41. *Shinohara*, ¶[81]. Further, *Shinohara* discloses forming the floating diffusion portion FD in the p-type semiconductor well region 26 by an n-type semiconductor region. *Shinohara*, ¶[81]. *Shinohara* also discloses forming the transfer gate electrode 28, transfer transistor Tr1, and other pixel transistors, such as a reset transistor Tr2, an amplification transistor Tr3, and a selection transistor Tr4, in the p-type semiconductor well region 26. *Shinohara*, ¶[81].

106. *Shinohara* discloses forming the multilayer wiring layer 33 with a plurality of layers of the wires 32 disposed with at least one interlayer insulating film 31 on the surface of the semiconductor substrate 22. *Shinohara*, ¶[82]. Subsequently, the rear surface 22b of the semiconductor substrate 22 is formed as a light-receiving surface, and the p-type semiconductor region 24, which forms the

photodiode PD, is formed in the rear surface 22b. *Shinohara*, ¶[85]. In my opinion, a person of ordinary skill in the art would have understood from *Shinohara*'s disclosure that the pixel region, the multilayer wiring, and the pixel transistors in *Shinohara*'s imaging device are monolithically formed on a single substrate.

IX. LEVEL OF ORDINARY SKILL IN THE ART

107. A person of ordinary skill in the art would have had at least a master's degree in electrical engineering or a similar field and at least five years of experience working with semiconductor systems and semiconductor devices. Additional relevant work experience can compensate for less education and vice versa.

X. GROUNDS OF UNPATENTABILITY

108. Based on my review of the materials set forth above, including my application of the knowledge of a person of ordinary skill in the art, it is my opinion that claims 1-16 of the '948 patent would have been obvious or lack enablement to one of ordinary skill in the art.

109. In particular, it is my opinion that claims 1-16 of the '948 patent would have been obvious to a person of ordinary skill in the art based on the prior art shown below or lack of enablement.

Ground	Challenged Claims	Basis	Prior Art/Further Detail
1	1-3 and 7-12	§ 103	*Kuboi*

2	4-6 and 13-16	§ 103	*Kuboi* and *Vasylyev*
3	1-3 and 7-12	§ 103	*Kuboi* and *Shinohara*
4	4-6 and 13-16	§ 103	*Kuboi*, *Vasylyev*, and *Shinohara*
5	1-16	§ 112	Lack of enablement

XI. THE CHALLENGED CLAIMS ARE UNPATENTABLE

A. Ground 1: Claims 1-3 and 7-12 Are Obvious over *Kuboi*

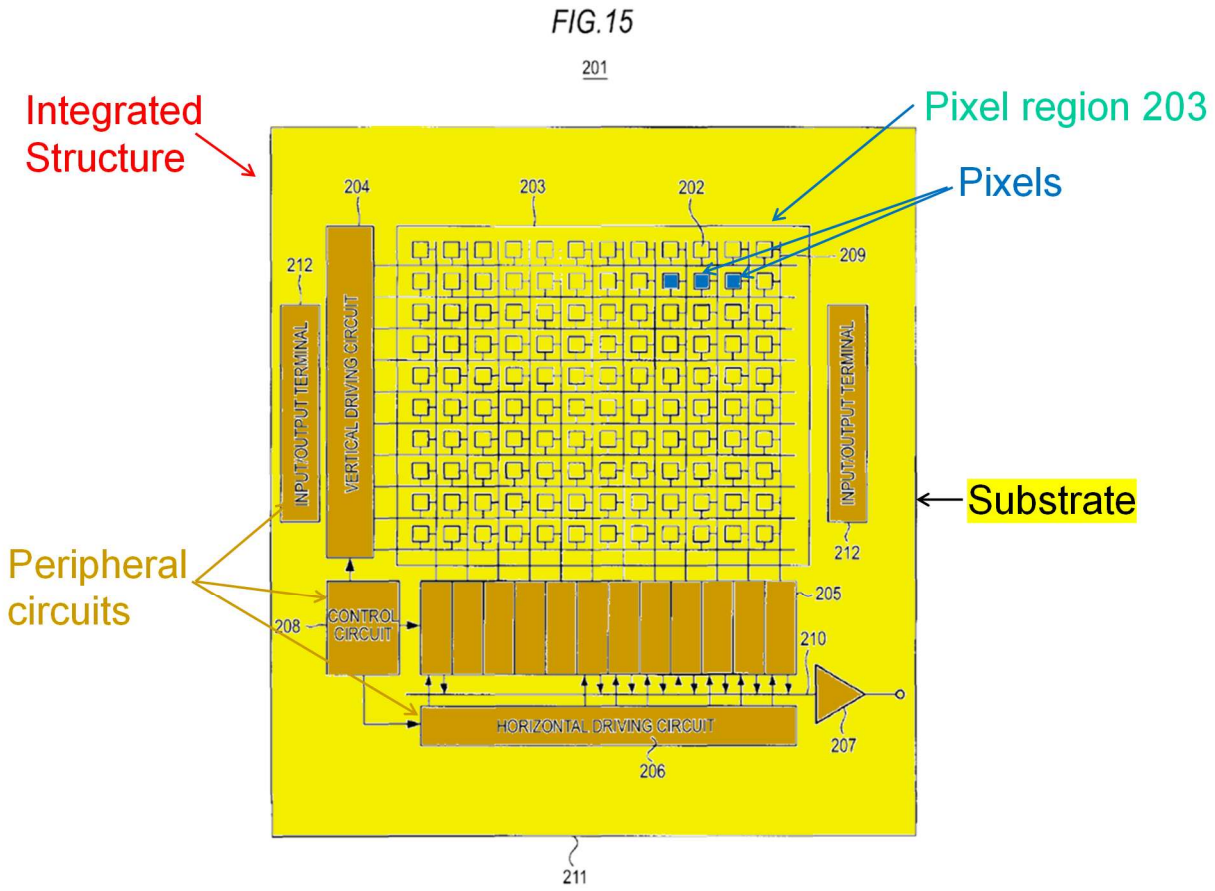
1. Independent Claim 1

a. [1(pre)] "An integrated structure comprising:"

110. In my opinion, to the extent the preamble is limiting, *Kuboi* discloses it.

111. *Kuboi*'s CMOS imaging device 201 includes pixel region 203 and a peripheral circuit portion on a single semiconductor substrate 211. *Kuboi*, ¶[48]. *Kuboi* discloses that substrate 211's pixel region 203 comprises a plurality of pixels 202, each of which contains a photoelectric conversion portion. *Kuboi*, ¶[48]. *Kuboi* also discloses that the pixels and peripheral circuit portion are fabricated on a single substrate. *Kuboi*, ¶¶[70], [78].

112. *Kuboi*'s imaging device is an "integrated structure" because it combines structures, including, for example, pixels with photoelectric conversion portions and peripheral electric circuits. *Kuboi*'s integrated structure is shown below.

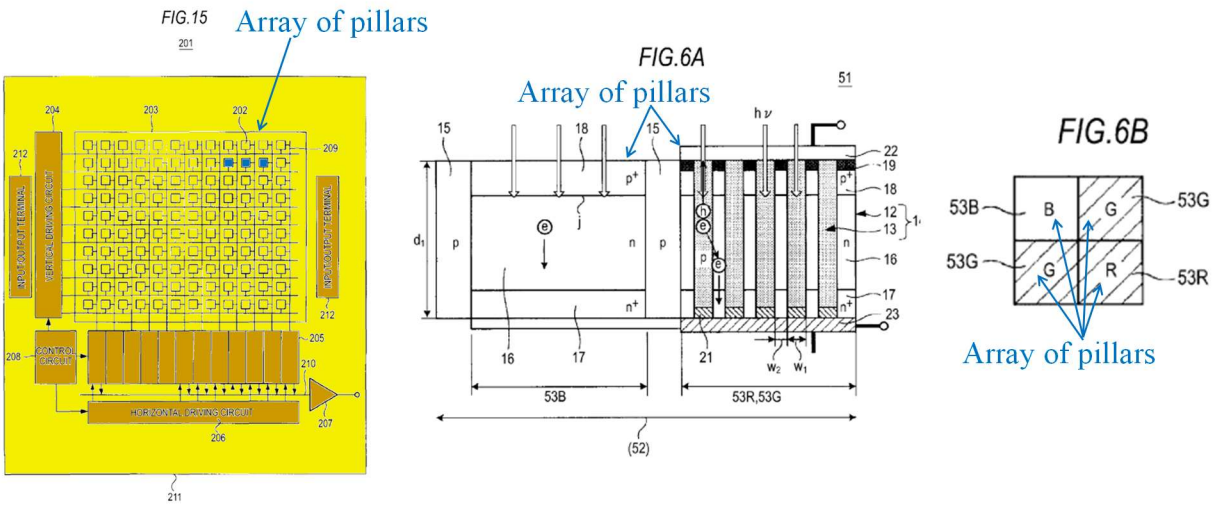


Kuboi, Fig. 15.

b. [1a(1)] "an array of pillars comprising Si, Ge, and/or SiGe alloy semiconductor material,"

113. In my opinion, *Kuboi* discloses this limitation.

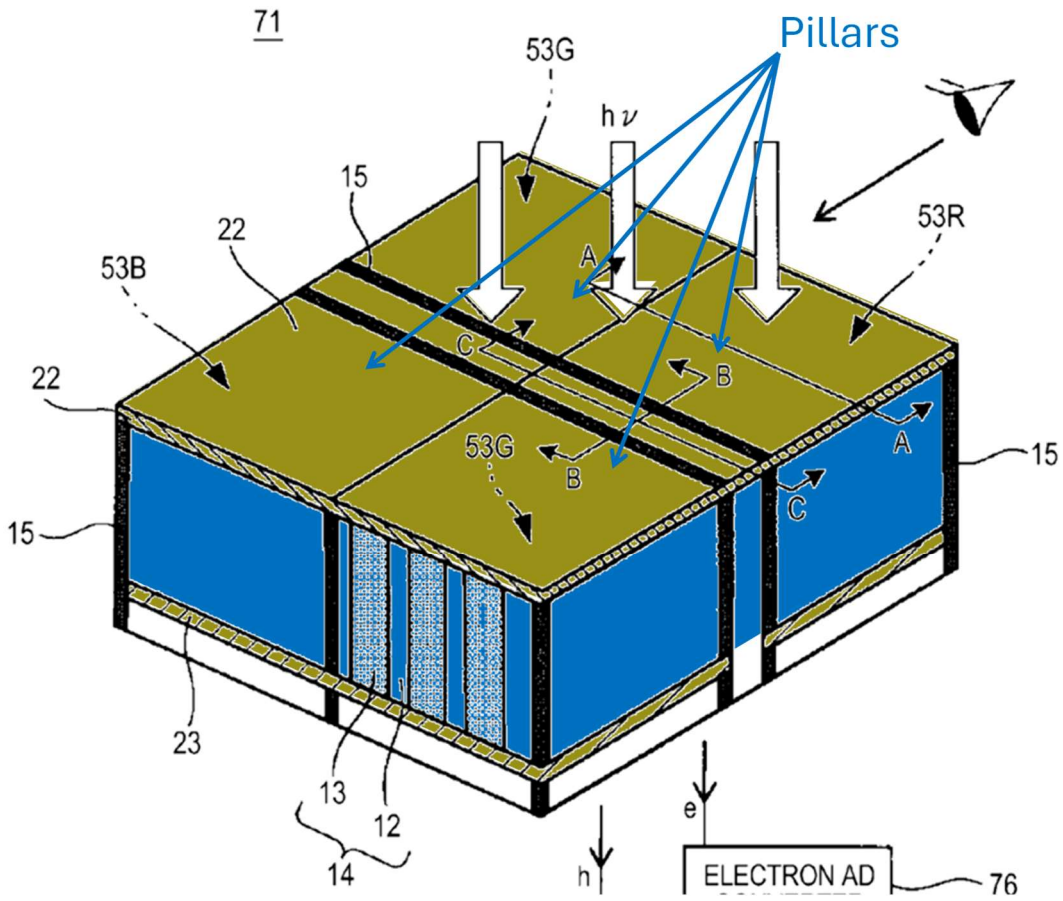
114. *Kuboi* discloses that the pixel region 203 of its imaging device 201 includes "a plurality of pixels 202 which include a photoelectric conversion portion and which are regularly arranged in a two-dimensional array." *Kuboi*, ¶[48]. *Kuboi* discloses that its imaging device includes "red, blue, green, and green pixels … arranged in a two-dimensional array." *Kuboi*, ¶¶[90], [181].



Kuboi, Figs. 15 (left), 6A (center), 6B (right).

115. In my opinion, one skilled in the art would have understood that *Kuboi*'s array of pixels constitutes an array of pillars and each pixel in the array is a pillar. Figure 13 below provides a perspective view highlighting the pillar-like structure of red 53R, green 53G, and blue 53B pixels arranged in a Bayer configuration. *Kuboi*, ¶¶[180]-[181]. A Bayer configuration is "a sequential pattern of red, green, and blue filters that are arranged in a mosaic pattern." Ex. 1048, 2.

FIG.13



Kuboi, Fig. 13 (cropped).

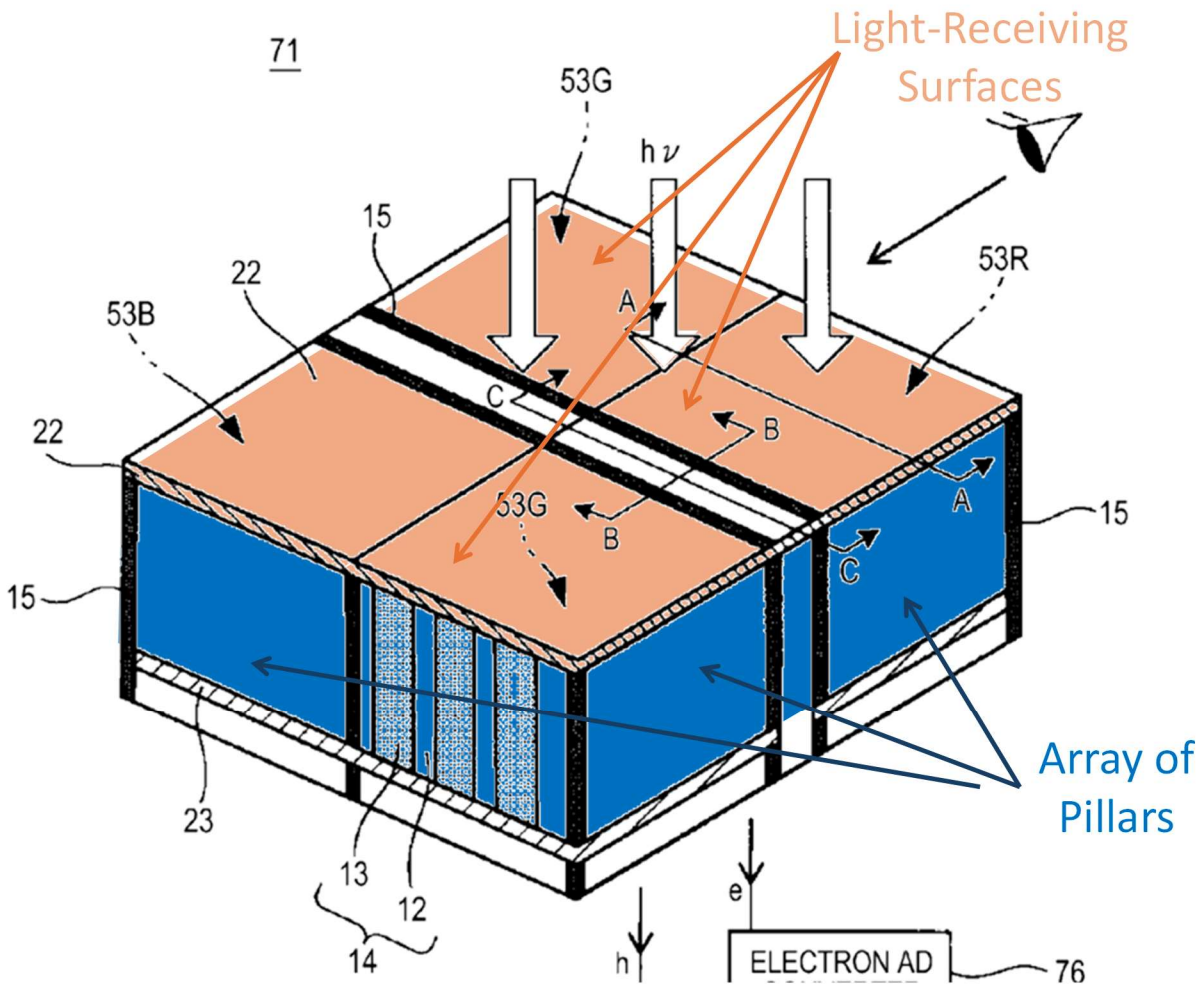
116. *Kuboi* explains that "**silicon** semiconductor layer 12" is divided into respective pixels. *Kuboi*, ¶[91] (emphasis added). In my opinion, one skilled in the art would have known that because *Kuboi*'s pixels are formed in a silicon (or Si) semiconductor layer, *Kuboi*'s pixels (i.e., pillars) comprise Si.

c. [1a(2)] "wherein at least some of the pillars are configured to include photodetectors and have respective light-receiving surfaces and respective sides;"

117. In my opinion, *Kuboi* discloses this limitation. *Kuboi* discloses that the pixel region of its "imaging device" includes "a plurality of pixels 202 which include a photoelectric conversion portion and which are regularly arranged in a two-dimensional array." *Kuboi*, ¶[48]. *Kuboi* discloses that the imaging device includes "red, blue, green, and green pixels … arranged in a two-dimensional array." *Kuboi*, ¶¶[90], [181].

118. *Kuboi* also discloses that "[l]ight hν enters the p-type organic photoelectric conversion films 13" of *Kuboi*'s pixels. *Kuboi*, ¶¶[186], [64]. *Kuboi* discloses that the "upper electrode 22 on the light incident side is formed of a transparent electrode." *Kuboi*, ¶[93]. Because electrode 22 is *on* the light incident side, one skilled in the art would have understood that the light incident side (i.e., "light-receiving surfaces") of *Kuboi*'s pixels (i.e., pillars) would be located on the lower surface of upper electrode 22. As illustrated in the figures below, in my opinion, each pixel constitutes a pillar in the two-dimensional array, and light hν is incident on and enters via each pixel's light-receiving surface.

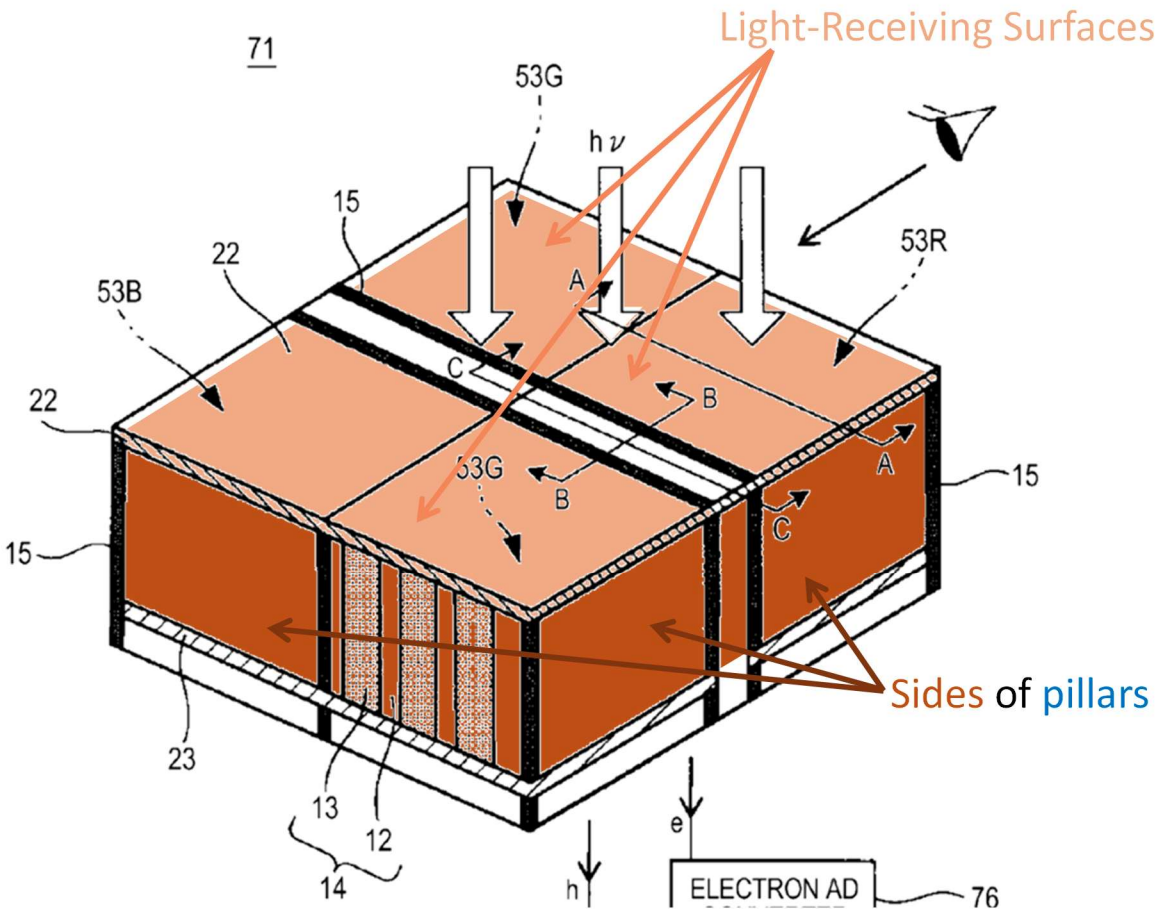
FIG.13



Kuboi, Fig. 13 (cropped).

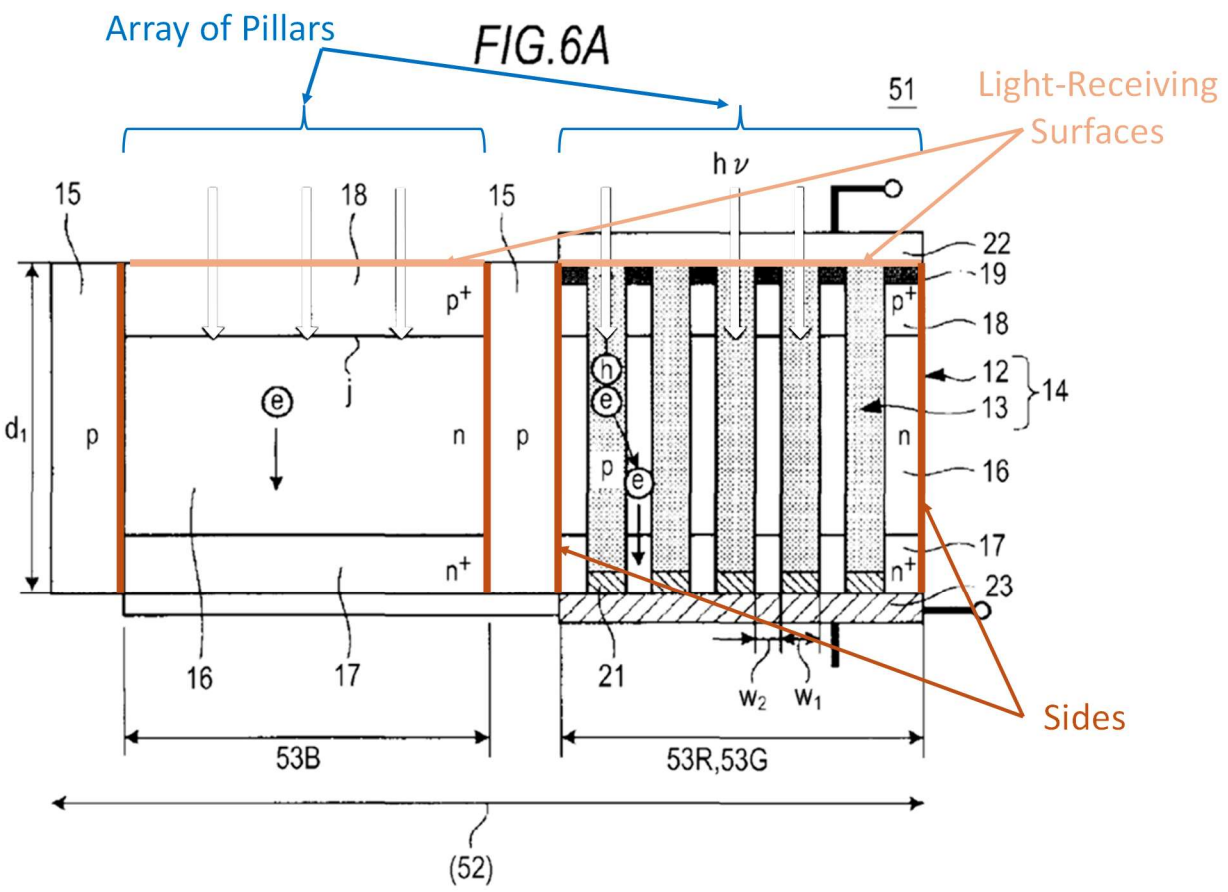
119. As further illustrated below, one skilled in the art would have understood that *Kuboi*'s pixels (i.e., pillars) have sides.

FIG.13



Kuboi, Fig. 13 (cropped).

120. A cross-sectional view of *Kuboi*'s array of pillars illustrating these features is shown below.



Kuboi, Fig. 6A.

121. *Kuboi* discloses that the "blue pixel 53B is formed by a photoelectric conversion portion which is formed of a photodiode PD formed in a silicon semiconductor region, and the red pixel 53R, the green pixel 53G, and the green pixel 53G are formed by the hybrid photoelectric conversion portion 14 shown in FIGS. 1A and 1B." *Kuboi*, ¶[90]; *see also Kuboi*, ¶¶[48], [55], [69]-[71], [79]-[80], [91], [108], [181]. In my opinion, one skilled in the art would have understood that *Kuboi*'s blue pixel 53B is a photodetector because it includes a photoelectric conversion portion.

122. Further, regarding red pixel 53R and green pixels 53G, *Kuboi* discloses that "[l]ight hν passes through the on-chip microlens to enter the p-type organic photoelectric conversion film 13 [embedded in these pixels], in which the light is subjected to photoelectric conversion, whereby electron-hole pairs are generated." *Kuboi*, ¶[64]. Accordingly, in my opinion, one skilled in the art would have recognized that photoelectric conversion portions 14 of red and green pixels (53R, 53G) are also photodetectors because they generate electric charges by photoelectric conversion of received light. Thus, it is my opinion that one skilled in the art would have understood that *Kuboi*'s pixels are photodetectors because these pixels detect light by absorbing light photons and generating electric charge carriers.

d. [1b] "wherein at least some of the pillars comprise P-doped and N-doped regions and are configured to respond to illumination with light in selected visible and infrared wavelengths by generating electrical charge carriers;"

123. In my opinion, *Kuboi* discloses and/or renders obvious this limitation.

124. As I discussed above, *Kuboi*'s imaging device includes an array of pixels, each of which is a pillar. *Supra* XI.A.1.b (claim [1a(1)]); *Kuboi*, ¶[90]. *Kuboi* discloses that, in the blue pixel 53B (i.e., a pillar), "a p^+-type semiconductor region 18, an n-type semiconductor region 16, and a[n] n^+-type semiconductor region 17 are formed in that order from the light incident surface of the

semiconductor layer 12 toward the opposite surface." *Kuboi*, ¶[91]; *see also Kuboi*, ¶¶[71], [181]. Similarly, *Kuboi* discloses that, in red pixel 53R and green pixels 53G, "the same p^+-type semiconductor region 18, n-type semiconductor region 16, and n^+-type semiconductor region 17 are formed." *Kuboi*, ¶[91]. Thus, *Kuboi* discloses that the red, blue, and the green pixels of its imaging device have a p^+-type region 18, an n-type region 16, and an n^+-type region 17.

125. *Kuboi*'s silicon "semiconductor layer 12 is implanted with impurities … [to form] a[n] n^+-type semiconductor region 17 having higher concentration [of impurities] than the n-type semiconductor region 16, and a [p^+-type] semiconductor region 18 of second conductivity type (for example, p^+ type) having higher concentration [of impurities] than the n-type semiconductor region 16." *Kuboi*, ¶¶[55]-[56]; *see also Kuboi*, ¶¶[111], [151], [7]. In my opinion, one skilled in the art would have understood that the process of implanting impurities into silicon is known as "doping." This is supported by prior art references that would have been known to one skilled in the art.

126. For example, doping of semiconductors by implanting impurities has been well known in semiconductor fabrication since at least the early 1960s, and doping has been a major element of semiconductor manufacturing since then and even today. Ex. 1012, 4 (noting use of diffusion using diffusion techniques to alter the type of conductivity in silicon patented in 1952, and development of ion

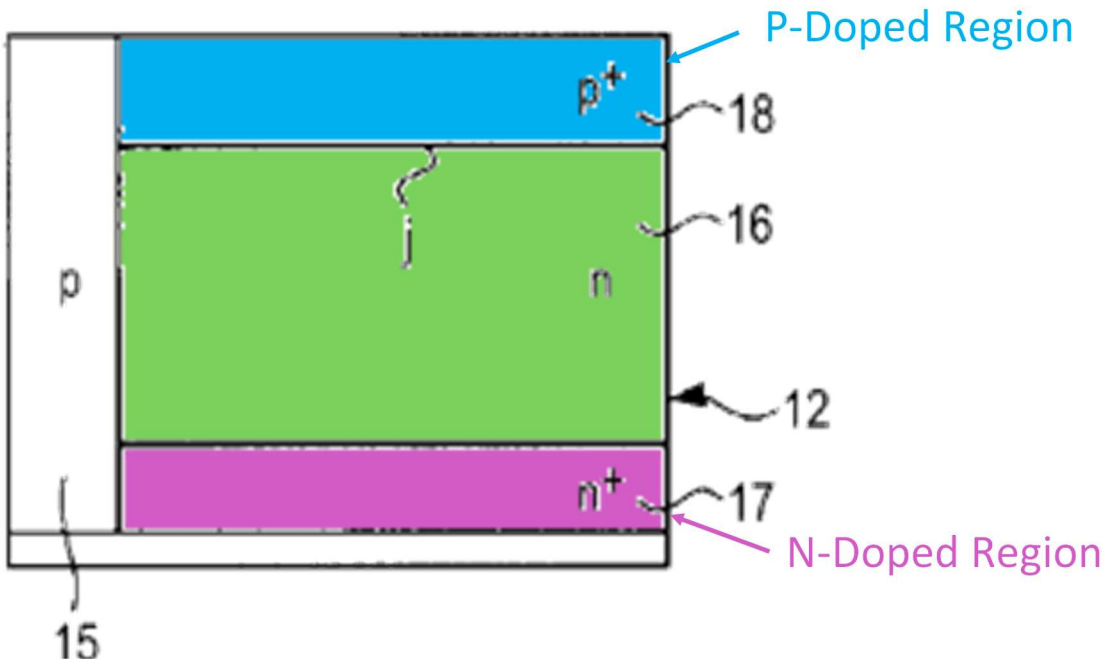
implantation for doping semiconductors in 1958). Similarly, Ex. 1012 discloses that "[i]mpurity doping is the introduction of controlled amounts of impurity dopants into semiconductor materials." Ex. 1012, 37. And Ex. 1013 explains that "[a] doped region is simply a section of the silicon into which impurity atoms have been purposely added to alter the electrical properties." Ex. 1013, 4. Moreover, "doping" is defined as "the process of introducing impurity atoms into pure silicon to change its electrical properties." Ex. 1011, 5.

127. *Kuboi* discloses that implanting impurities in *Kuboi*'s semiconductor layer 12 forms "a[n] n^+-type semiconductor region 17 having higher concentration [of impurities] than the n-type semiconductor region 16." *Kuboi*, ¶[56]. Similarly, implanting impurities in *Kuboi*'s semiconductor layer 12 forms "a semiconductor region 18 of second conductivity type (for example, p^+ type) having higher concentration [of impurities] than the n-type semiconductor region 16." *Kuboi*, ¶[56]; *see also Kuboi*, ¶¶[111], [151], [7]. In my opinion, one skilled in the art would have understood that as a result of implanting impurities (i.e., doping), *Kuboi*'s p^+-type semiconductor region 18 is a "P-doped" region, and its n^+-type semiconductor region 17 is an "N-doped" region, as claimed. Further, in my opinion, because region 16, which *Kuboi* refers to as "an intermediate region," is positioned between region 18 and region 17, and has a lower concentration of

impurities than the n^+-type region 17 and p^+-type region 18, it corresponds to the intermediate region (or "i" region) of *Kuboi*'s PiN photodetector.

128. Therefore, it is my opinion that one skilled in the art would have known that *Kuboi*'s p^+-type region 18 is the claimed "P-doped" region, and its n^+-type region 17 is the claimed "N-doped" region.

FIG.4A



Kuboi, Fig. 4A.

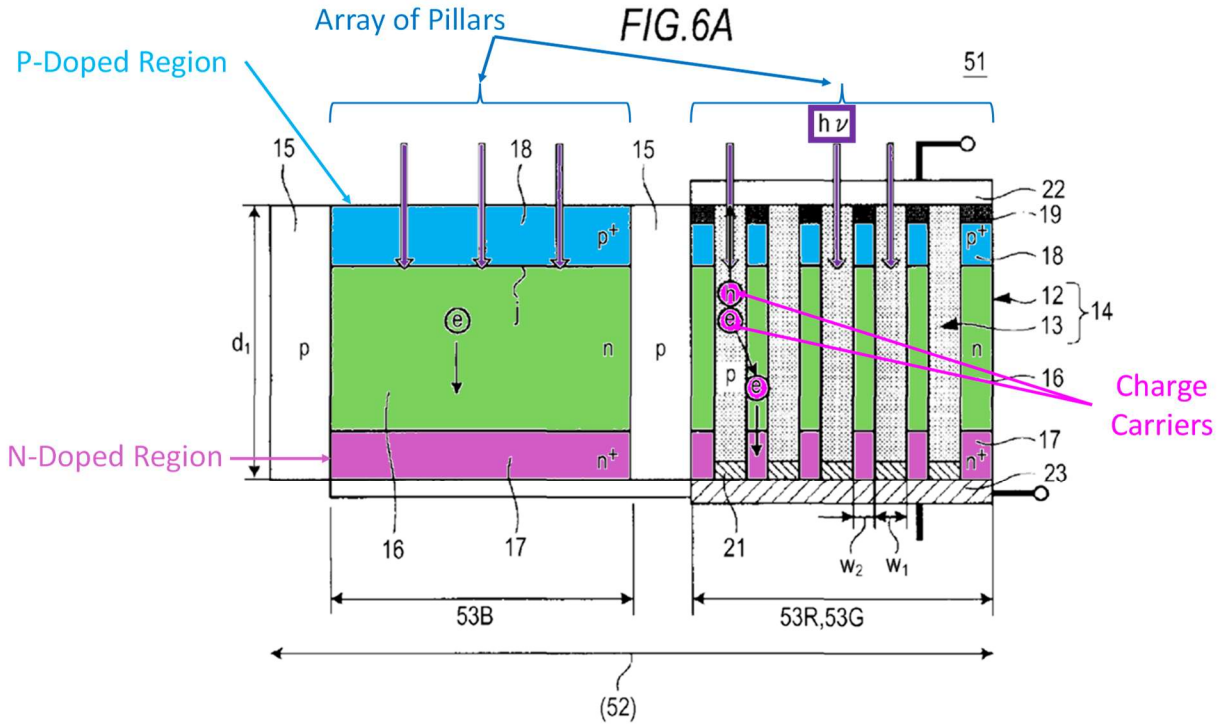
129. *Kuboi*'s imaging device includes a pixel group composed of blue pixel 53B, red pixel 53R, and green pixels 53G, arranged in a two-dimensional Bayer configuration with corresponding color filters. *Supra* XI.A.1.c (claim [1a(2)];

Kuboi, ¶[90]. As I explained above for claim [1a(2)], *Kuboi* discloses that blue pixel 53B is formed by a photoelectric conversion portion comprising a photodiode (PD), while red pixel 53R and green pixels 53G are formed using the photoelectric conversion portion 14. *Kuboi*, ¶[90]; *supra* XI.A.1.c.

130. *Kuboi* discloses that pixel 11's hybrid photoelectric conversion portion 14 includes organic photoelectric conversion film 13 embedded in holes etched in the semiconductor layer 12. *Kuboi*, ¶¶[55], [67], [91], [181]. *Kuboi* also explains that light (hν) passes through the on-chip microlens and color filter to enter the organic photoelectric conversion film 13 of pixel 11, where it undergoes photoelectric conversion to generate electron-hole pairs (or charge carriers). *Kuboi*, ¶¶[64], [90], [93]. Therefore, in my opinion, *Kuboi*'s pillars are configured to generate electron-hole pairs (charge carriers) when illuminated with light hν incident on the array of pillars. *Kuboi*, ¶¶[87], [107].

131. *Kuboi* discloses that the silicon photodiode that comprises the blue pixel 53B also generates "charge carriers" when illuminated with light. *Kuboi*, ¶¶[6], [149]. Thus, in my opinion, one skilled in the art would have understood that *Kuboi*'s blue pixel 53B, red pixel 53R, and two green pixels 53G ("pillars") generate "charge carriers" when illuminated with light (hν). *Kuboi*, ¶¶[87], [107].

132. *Kuboi*'s photodetector pillars, including the P-doped regions (i.e., region 18), N-doped regions (i.e., region 17), and the photo-generated charge carriers, are illustrated below.



Kuboi, Fig. 6A.

133. *Kuboi*'s imaging device can be used in the visible light region and in other wavelength bands, including infrared. *Kuboi*, ¶[190]. *Kuboi* discloses that its organic material is sensitive to (i.e., generates electric charge carriers in response to) "visible light," but that compounds sensitive to infrared rays can also be used. *Kuboi*, ¶[58]. In my opinion, one skilled in the art would have understood from *Kuboi*'s disclosure that by selecting a suitable organic material, *Kuboi*'s photodetector pillars would be able to respond to light in a wavelength range

selected from the visible and/or the infrared light spectrum. One skilled in the art would also have had a reasonable expectation of success in modifying *Kuboi*'s imaging device to respond to light in a wavelength range selected from the visible and/or the infrared light spectrum. This is because *Kuboi* already discloses selecting the material of the organic photoelectric films in its pixels to detect light in selected visible and/or infrared wavelength ranges. *Kuboi*, ¶[58].

e. [1c] "one or more holes that are fabricated as recesses at or under the light-receiving surface of each of at least some of the pillars, have elongated or other shapes at or parallel to the light-receiving surfaces, extend into the pillars to a depth of 100 to 10000 nm, and are filled at least partly with solid dielectric material;"

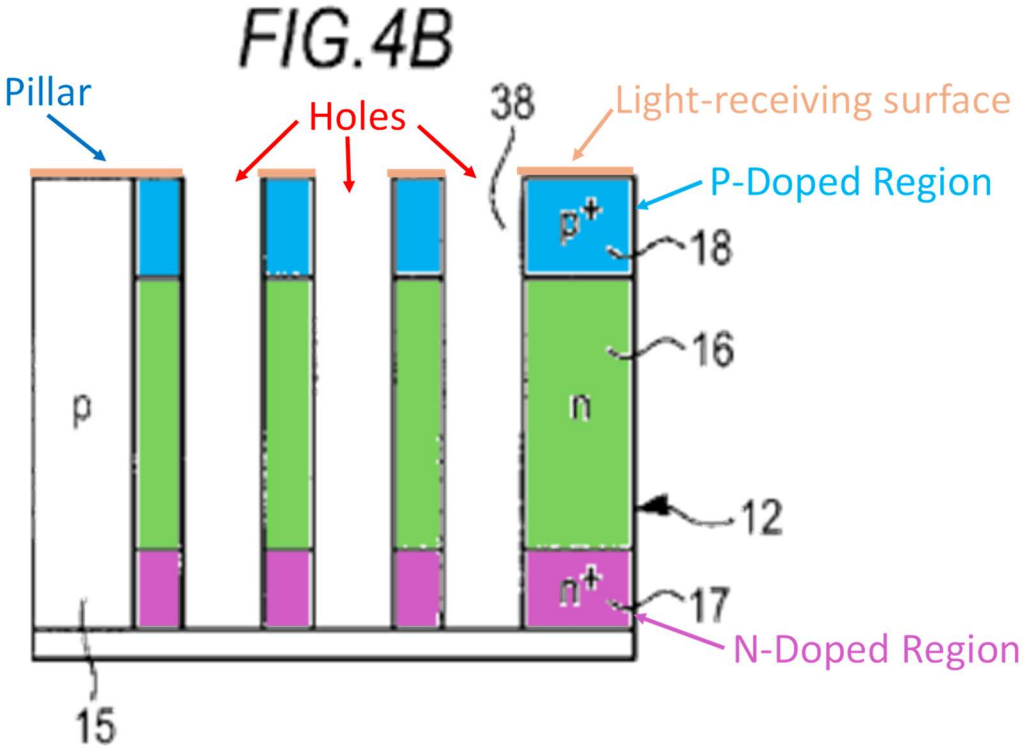
134. In my opinion, *Kuboi* discloses this limitation.

135. *Kuboi* discloses that "hole 38 such as a trench or a via extending from the p^+-type semiconductor region 18 to the n^+-type semiconductor region [17] is formed in a region of the semiconductor layer 12 corresponding to one pixel by dry-etching." *Kuboi*, ¶[72]; *see also Kuboi*, ¶¶[13]-[14], [95].

136. *Kuboi* also discloses that a "plurality of vertical holes 38 are formed at necessary intervals." *Kuboi*, ¶[72].

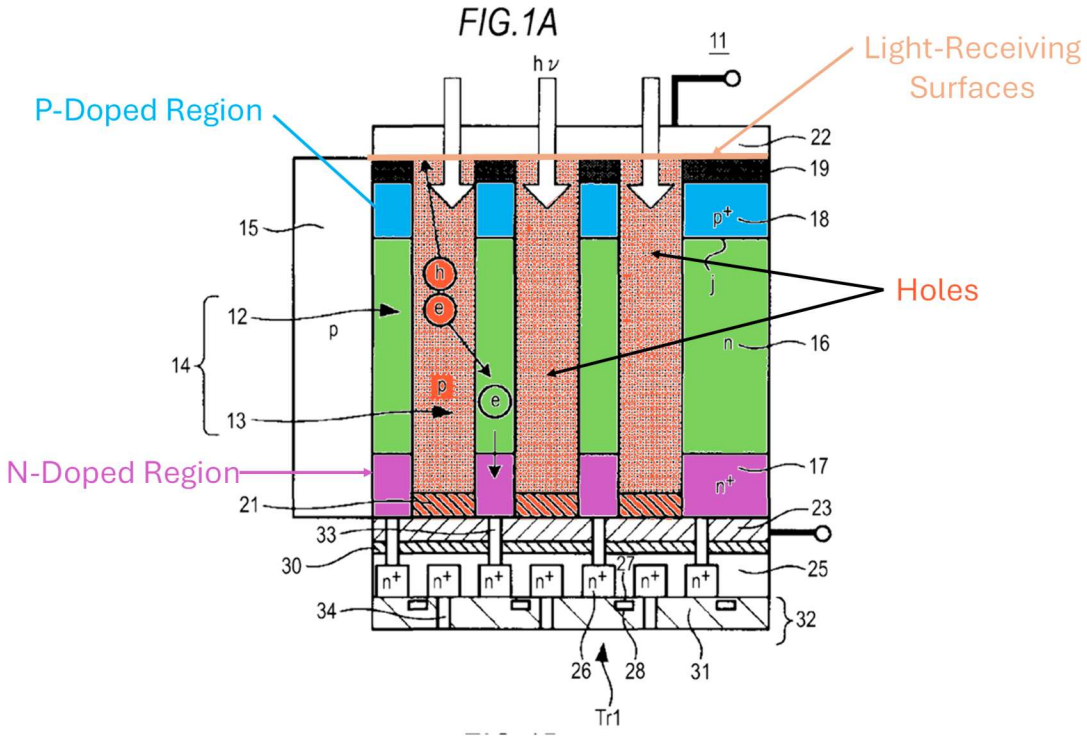
137. *Kuboi* also discloses that the holes 38 extending through the PiN regions of its pixels may be dry-etched "using a CCP (Capacitive Coupled Plasma) etching apparatus" or other apparatuses. *Kuboi*, ¶¶[72], [95]. In my opinion,

because holes 38 are etched using a CCP apparatus, one skilled in the art would have understood that these holes 38 are "fabricated" as claimed.

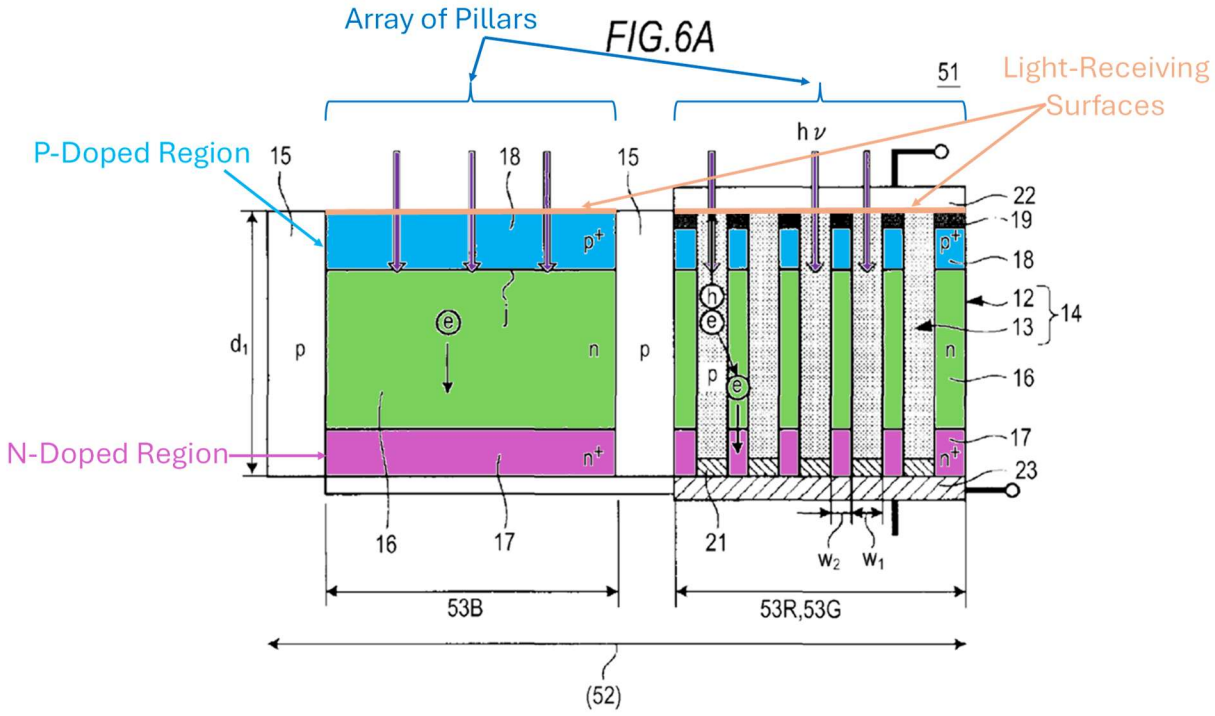


Kuboi, Fig. 4B.

138. One skilled in the art would have also understood that because holes 38 extend from region 18 (i.e., P-doped region), they are formed in the light-receiving surfaces located between region 18 and electrode 22. *Kuboi*'s holes formed in its light-receiving surfaces are illustrated below.

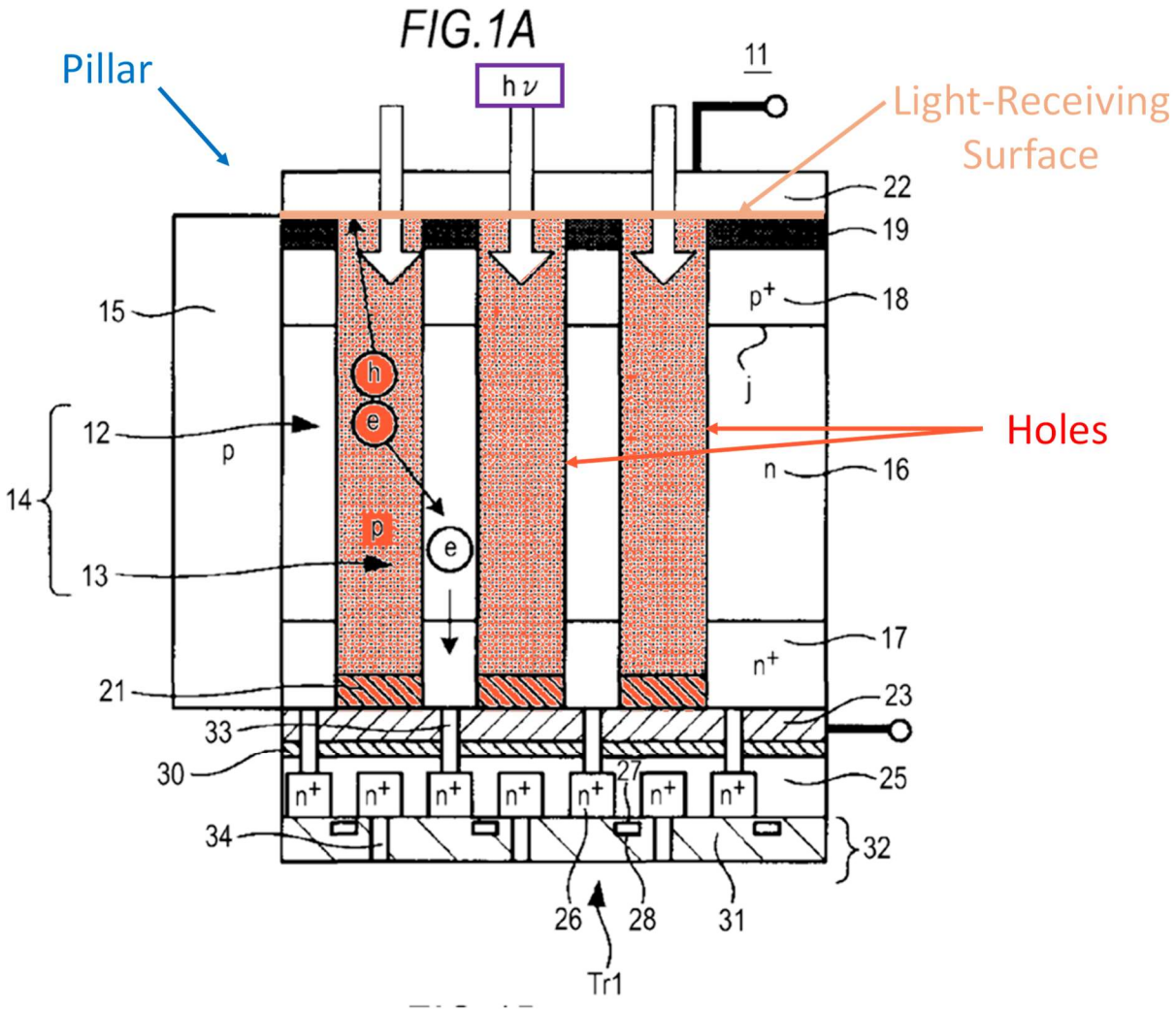


Kuboi, Fig. 1A.



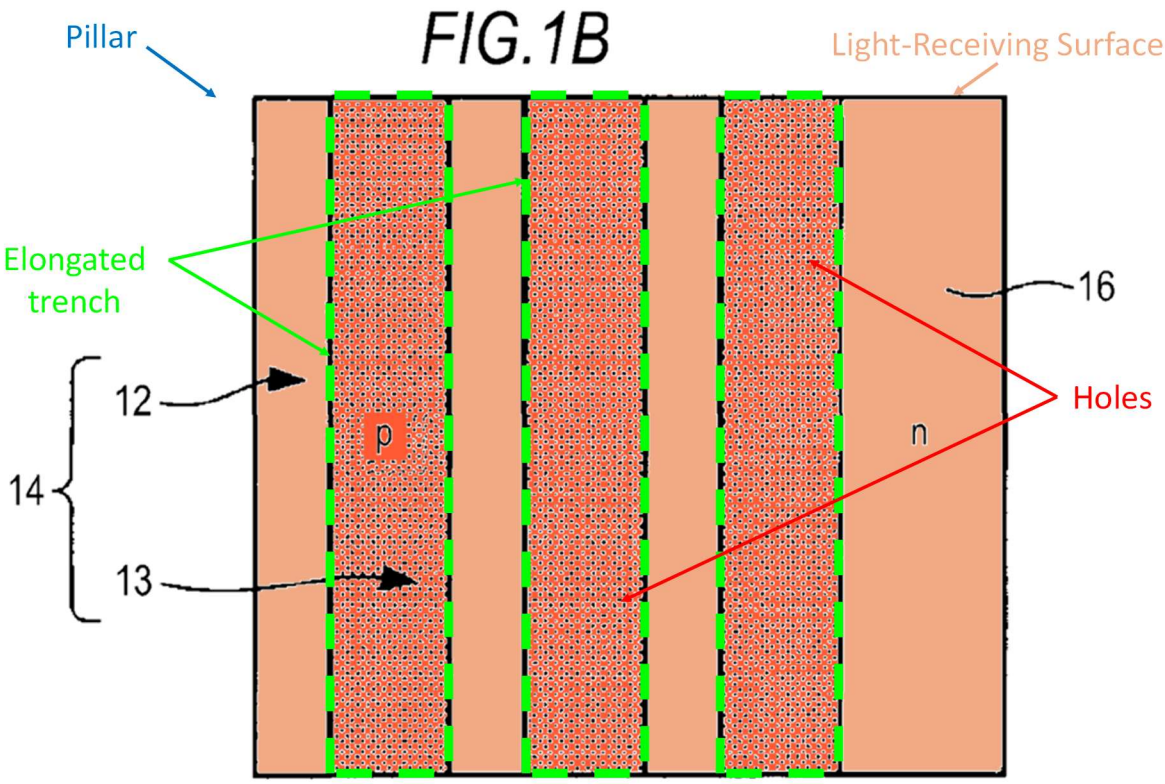
Kuboi, Fig. 6A.

139. *Kuboi* describes its vertical holes as "so-called … trench[es]." *Kuboi*, ¶[67]. *Kuboi* also discloses with reference to its Figure 1A that "the vertical holes 38 are formed in a stripe shape as seen in a planar view." *Kuboi*, ¶[72].



Kuboi, Fig. 1A.

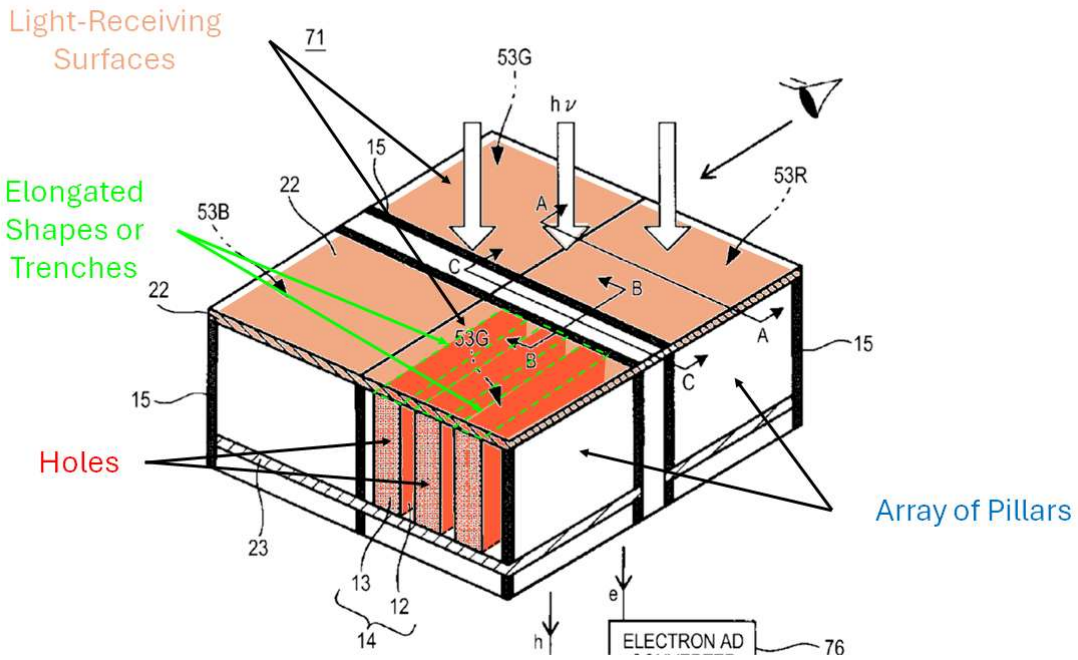
140. Figure 1B of *Kuboi*, which is the planar view of Figure 1A, showing the stripe shape of vertical holes 38 is illustrated below.



Kuboi, Fig. 1B.

141. A perspective view of *Kuboi*'s holes (or trenches) having elongated shapes at the light-receiving surfaces is illustrated below.

FIG.13



Kuboi, Fig. 13 (cropped).

142. *Kuboi* explains that "an organic photoelectric conversion film 13 is deposited so as to be embedded in the vertical holes 38." *Kuboi*, ¶[73]. *Kuboi* explains that "as shown in FIG. 1B [above], the plurality of organic photoelectric conversion films 13 are formed in a stripe shape so as to divide the semiconductor layer 12 into a plurality of parts as viewed from the upper surface." *Kuboi*, ¶[57].

143. As can be seen in the above Figure 1B, holes 38 and films 31 deposited in those holes have elongated shapes at the light-receiving surfaces of *Kuboi*'s pixels (or pillars), which include photodetectors. *Supra* XI.A.1.c (claim [1a(2)]). In my opinion, one skilled in the art would have understood from these disclosures that *Kuboi*'s stripe shape represents the shape of a trench. One

skilled in the art would have further understood from the above figures that a stripe- or trench-shaped hole would have an elongated shape.

144. Although Figures 1A and 1B illustrate only one pixel (i.e., pillar), as discussed for claim [1a(1)], *Kuboi*'s imaging device includes an array of pixels (53B, 53R and 53G). *Supra* XI.A.1.b. *Kuboi* discloses that pixels 53R and 53G have structures similar to the pixel of Figures 1A-1B. *Kuboi*, ¶[90]. Thus, in my opinion, a person skilled in the art would have understood that *Kuboi*'s imaging device has a plurality of pixels 53R and 53G (i.e., "pillars"), including multiple holes fabricated as recesses at the light-receiving surfaces of these pixels, and that the holes in each of these pixels have an elongated shape parallel to the pixel's light-receiving surface.

145. *Kuboi* also discloses that "an electron blocking film 21 having a thickness of several tens of nm, for example[,] is formed on the bottom portions of the vertical holes 38." *Kuboi*, ¶¶[73], [91]. *Kuboi* explains that "film 21 is formed by an insulating film such as, for example, a silicon nitride (Si_3N_4) film[or] a silicon [oxide] (SiO_2) film." *Kuboi*, ¶[73].

146. In my opinion, one skilled in the art would have understood that silicon nitride (Si_3N_4) and silicon oxide (SiO_2) are solid dielectric materials. This is supported by prior art that would have been known to one skilled in the art. For example, Ex. 1013 discloses that "[c]lassically, silicon dioxide (generically called

oxide here) has served as the insulating dielectric." Ex. 1013, 34. Further, Ex. 1013 discloses that silicon nitride is "an insulator." Ex. 1013, 35. As another example, Ex. 1012 discloses "[d]ielectric layers such as silicon dioxide and silicon nitride." Ex. 1012, 20.

147. In my opinion, one skilled in the art would have further understood that *Kuboi*'s silicon dioxide or silicon nitride film would be made of solid material. This is because thermal oxides like silicon dioxide are formed during semiconductor fabrication processes by oxidizing the solid silicon material. For example, Ex. 1012 discloses the formation of a silicon oxide by a "thermal oxidation" process in which oxygen is supplied for oxidizing solid silicon wafers in a furnace. Ex. 1012, 20-21. One skilled in the art would also have understood that an insulating film formed by oxidation of silicon would have an amorphous structure, which is characteristic of a solid material. Ex. 1012, 23 ("When silicon is thermally oxidized, the silicon dioxide structure is amorphous."). In my opinion, one skilled in the art would have recognized that because the thermally oxidized silicon dioxide is amorphous, it would be a solid material.

148. Similarly, a skilled artisan would have recognized that in semiconductor fabrication, silicon nitride is deposited via a chemical vapor deposition (CVD) process. Ex. 1012, 33. Further, one skilled in the art would have understood that such CVD deposition of silicon nitride would produce a solid layer

of silicon nitride. Ex. 1012, 30 ("Chemical vapor deposition (CVD) is a method of forming a thin solid film on a substrate.").

149. In my opinion, therefore, one skilled in the art would have understood that *Kuboi*'s film 21 would be made of a solid dielectric material.

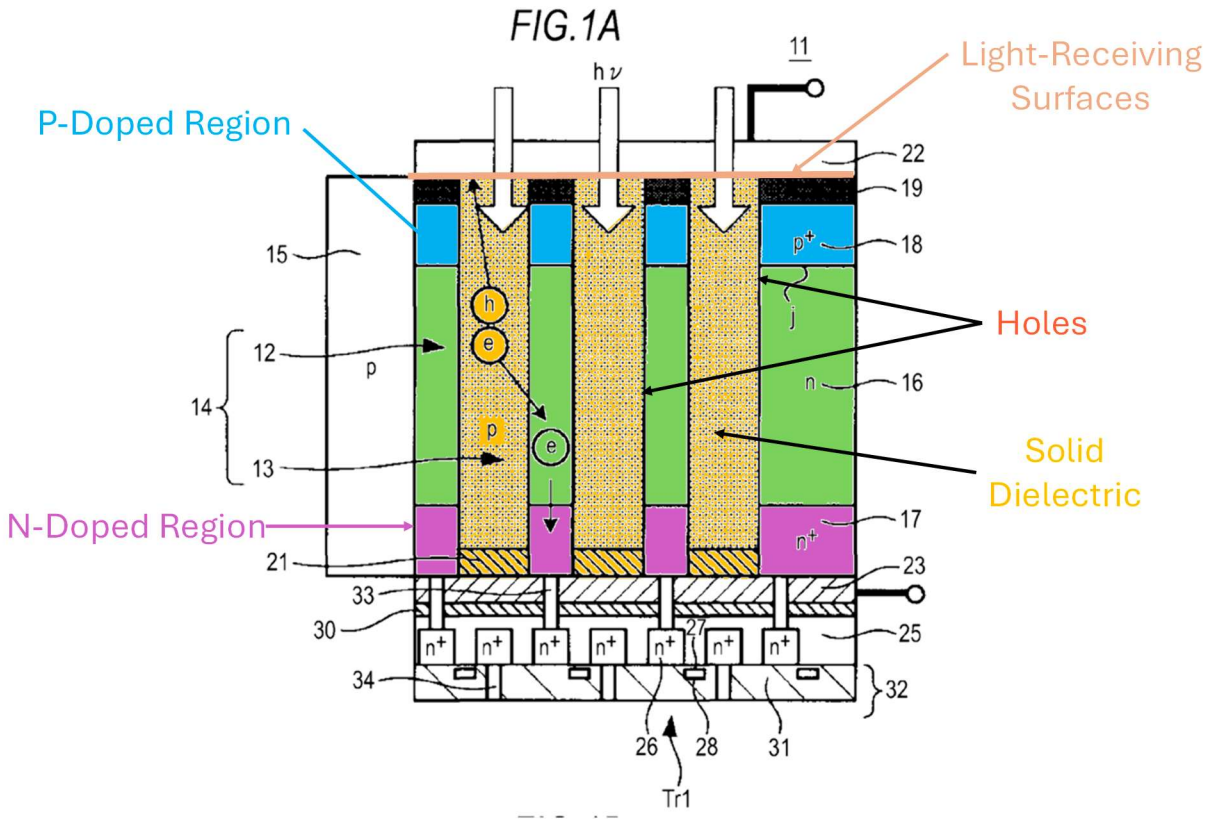
150. *Kuboi* also discloses that an organic material is deposited to fill portions of the holes, thereby forming organic photoelectric conversion films 13 embedded within the hole. *Kuboi*, ¶¶[73], [58], [85], Fig. 4C. *Kuboi* discloses that as the p-type organic material is sensitive to a visible light region, "perylene-based compounds, phthalocyanine compounds, quinacridone compounds, porphyrin compounds, merocyanine compounds, and the like can be used, for example." *Kuboi*, ¶[58]. This is consistent with the description in the '948 patent indicating that its microstructured pillar and hole arrays can include "polymer, glass, oxides, nitrides, … [and] organic conducting and non conducting polymers." '948 patent, 50:13-17.

151. In my opinion, one skilled in the art would have recognized that phthalocyanine compounds, perylene-based compounds, and porphyrin compounds function as dielectric materials. Various prior art references examine their dielectric properties and behavior in optoelectronic devices. For instance, Ex. 1014 discusses the dielectric characteristics of phthalocyanine and perylene compounds used in organic solar cells. Ex. 1014, 3, 17, 47, 52-56. Additionally, Ex. 1015, 1-4,

7, explores the dielectric behavior of phthalocyanine compounds, noting that their dielectric constant decreases with increasing frequency and rises with increasing temperature. Ex. 1016, 4-11, presents experimental studies on porphyrin as a dielectric material, while Ex. 1017, 1-6, details dielectric investigations of porphyrin compounds used in optical devices. Ex. 1018, 1-6, discusses the measurement of photocurrents generated by illuminating a porphyrin compound, alongside its dielectric property evaluations. Ex. 1019, 1, explains that the dielectric properties of phthalocyanine compounds increase with temperature and decrease with frequency. Lastly, Ex. 1020, 1-5, describes perylene compounds as organic dielectric materials with "high photoluminescence efficiency," employed in solar cells.

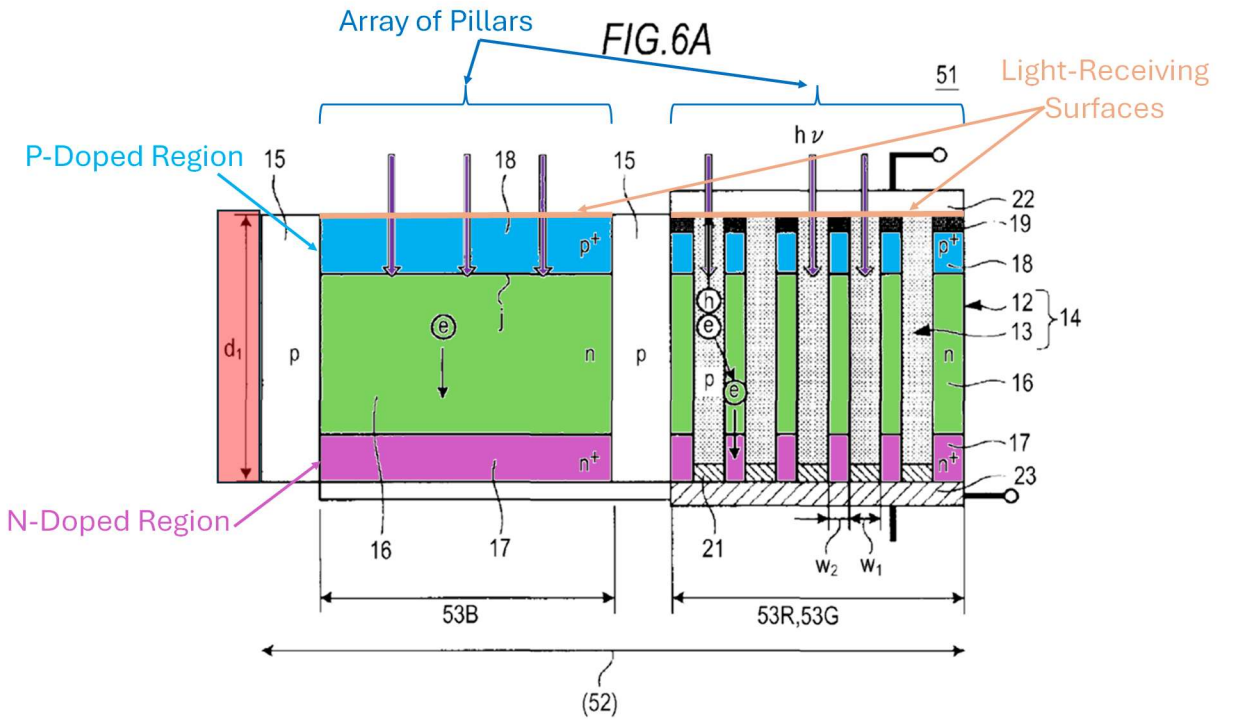
152. Thus, both electron blocking film 21 and photoelectric conversion film 13 together entirely fill the holes of photoelectric conversion portion 14 and are solid dielectric materials. Thus, in my opinion, one skilled in the art would have understood that the elongated holes in pixels 53G and 53R ("pillars") of *Kuboi*'s imaging device "are filled at least partly with solid dielectric material" as claimed.

153. *Kuboi*'s fabricated holes filled with solid dielectric material are illustrated below.



Kuboi, Fig. 1A.

154. *Kuboi* discloses that holes 38 extending from region 18 to region 17 are "formed in a region of the semiconductor layer 12 corresponding to one pixel by dry-etching." *Kuboi*, ¶¶[72], [13]-[14], [67], [95]. In my opinion, one skilled in the art would have understood that *Kuboi*'s holes extend into the photoelectric conversion portions (photodetectors) of its pixels. *Supra* XI.A.1.c (claim [1a(2)]). Furthermore, referencing Figures 6A and 6B, *Kuboi* discloses that the thickness d_1 of semiconductor layer 12 is "set to about 1.4 μm." *Kuboi*, ¶[94]. *Kuboi*'s holes extending through thickness d_1 of semiconductor layer 12 are illustrated below.



Kuboi, Fig. 6A.

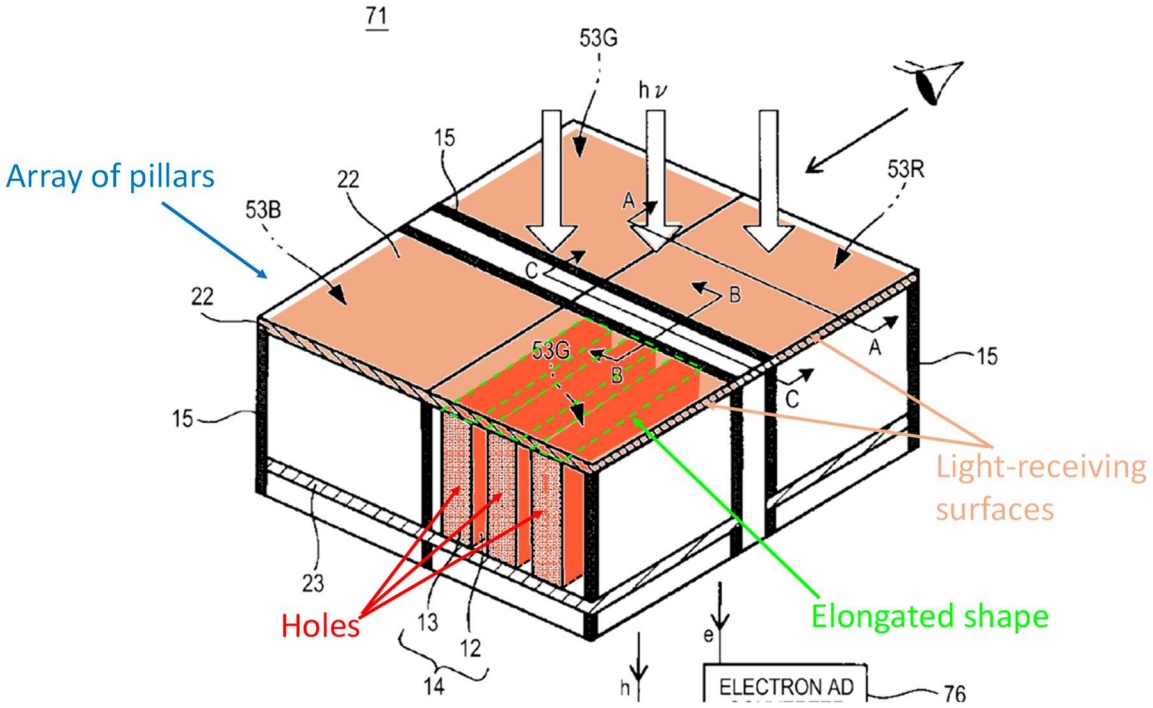
155. *Kuboi* discloses that semiconductor layer 12's thickness d_1 is "about 1.4 μm," which equals 1400 nm. *Kuboi*, ¶[94]. Because each hole in *Kuboi* extends over the thickness d_1 of the semiconductor layer 12 of *Kuboi*'s pixels 53G and 53R, in my opinion, one skilled in the art would have understood that *Kuboi*'s holes have a depth d_1 = 1.4 μm (i.e., 1,400 nanometers), which falls within the claimed range of 100-10,000 nanometers.

f. [1d] "wherein at least some of the holes are elongated along the respective light-receiving surfaces;"

156. In my opinion, *Kuboi* discloses this limitation. As I explained above for claim [1c], *Kuboi*'s imaging device includes multiple holes fabricated as recesses at the light-receiving surfaces of pixels 53R and 53G, and that these holes

have an elongated shape parallel to the pixel's light-receiving surface. *Supra* XI.A.1.e; *Kuboi*, ¶¶[11], [57], [72].

FIG.13



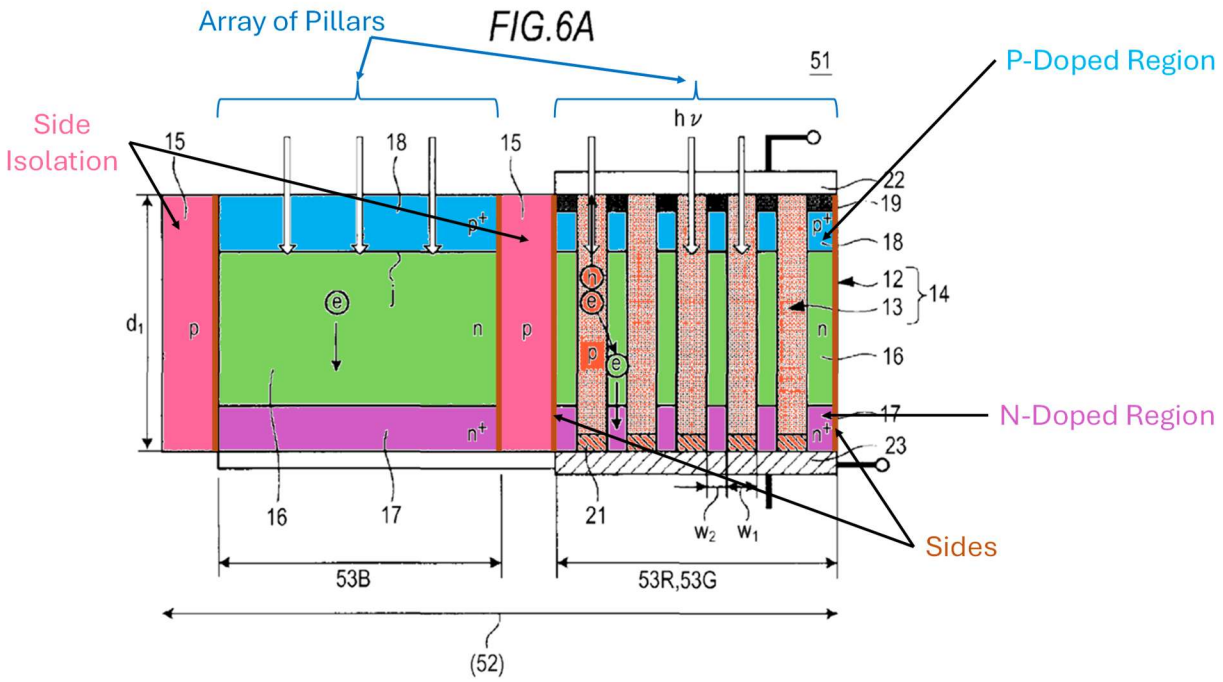
Kuboi, Fig. 13 (cropped).

g. [1e] "side-isolation comprising solid material between at least portions of the sides of at least some of the pillars;"

157. In my opinion, *Kuboi* discloses this limitation.

158. *Kuboi* discloses that its "silicon semiconductor layer 12 is divided into respective pixels by an element separation region 15 which [can be] formed by a p-type semiconductor region." *Kuboi*, ¶¶[91], [55]-[56], [71], [182]. *Kuboi* also discloses that "pixel 11 is *separated* by an element separation region 15." *Kuboi*,

¶[55] (emphasis added). In my opinion, one skilled in the art would have understood that element separation region 15 provides side-isolation because it separates adjacent pixels, which each include photoelectric conversion portions. *Supra* XI.A.1.c (claim [1a(2)]). *Kuboi* discloses that element separation region 15 is a region of *silicon* semiconductor layer 12. *Kuboi*, ¶[71]. One skilled in the art would have known that silicon is a solid semiconductor material. In my opinion, one skilled in the art would have understood that, because *Kuboi*'s p-type semiconductor region—including element separation region 15—is part of silicon semiconductor layer 12, element separation region 15 is a solid material. Thus, in my opinion, in *Kuboi*'s imaging device, side-isolation is provided by element separation region 15 between at least portions of the sides of at least some of *Kuboi*'s pixels (pillars) as illustrated below.



Kuboi, Fig. 6A.

h. [1f] "a solid dielectric material forming a base dielectric region for the array;"

159. In my opinion, *Kuboi* discloses or renders obvious this limitation.

160. *Kuboi* discloses a "CMOS solid-state imaging device" in which "pixel transistors constituting one pixel are formed in a semiconductor region 25 formed of silicon which is disposed on the front surface side of the semiconductor layer 12, namely[,] under the lower electrode 23 with an insulating film 30 disposed therebetween." *Kuboi*, ¶¶[55], [61], [69]. *Kuboi* also discloses a semiconductor substrate on which the semiconductor region 25 having pixel transistors, the multilayer wiring layer 32, and the lower electrode 23 are formed.

Kuboi, ¶[69]. *Kuboi* explains that multilayer wiring layer 32 includes a plurality of layers of wiring with an interlayer insulating film 31 disposed therebetween. *Kuboi*, ¶[62]. In my opinion, *Kuboi*'s insulating film 30 and/or interlayer insulating film 31 constitutes the claimed base dielectric region. This is because, as I explain below, both these layers are made of dielectric material and are located at the base of *Kuboi*'s pillars.

161. Although *Kuboi* does not disclose the material of insulating films 30 or 31, *Kuboi* uses "insulating film" to refer to films made of dielectric materials such as silicon nitride (Si_3N_4), silicon oxide (SiO_2) film, or similar materials. *See Kuboi*, ¶[59]. In my opinion, one skilled in the art would have understood that *Kuboi*'s insulating film 30 that insulates lower electrode 23 from the pixel transistors and is part of a CMOS device would constitute a film of silicon oxide or silicon nitride or at least would have been motivated to use silicon oxide or silicon nitride. This is because silicon oxide or silicon nitride films can be fabricated using standard silicon fabrication processes. Ex. 1012, 4-5, 20 (stating that "thermal oxidation … is a key process in modern silicon integrated-circuit technology"). Moreover, silicon oxide or silicon nitride provide good barriers to impurity and moisture diffusion. Ex. 1012, 4 ("[A]n oxide layer can prevent most impurity atoms from diffusing through it."), 5, 34 ("The plasma-deposited nitride provides

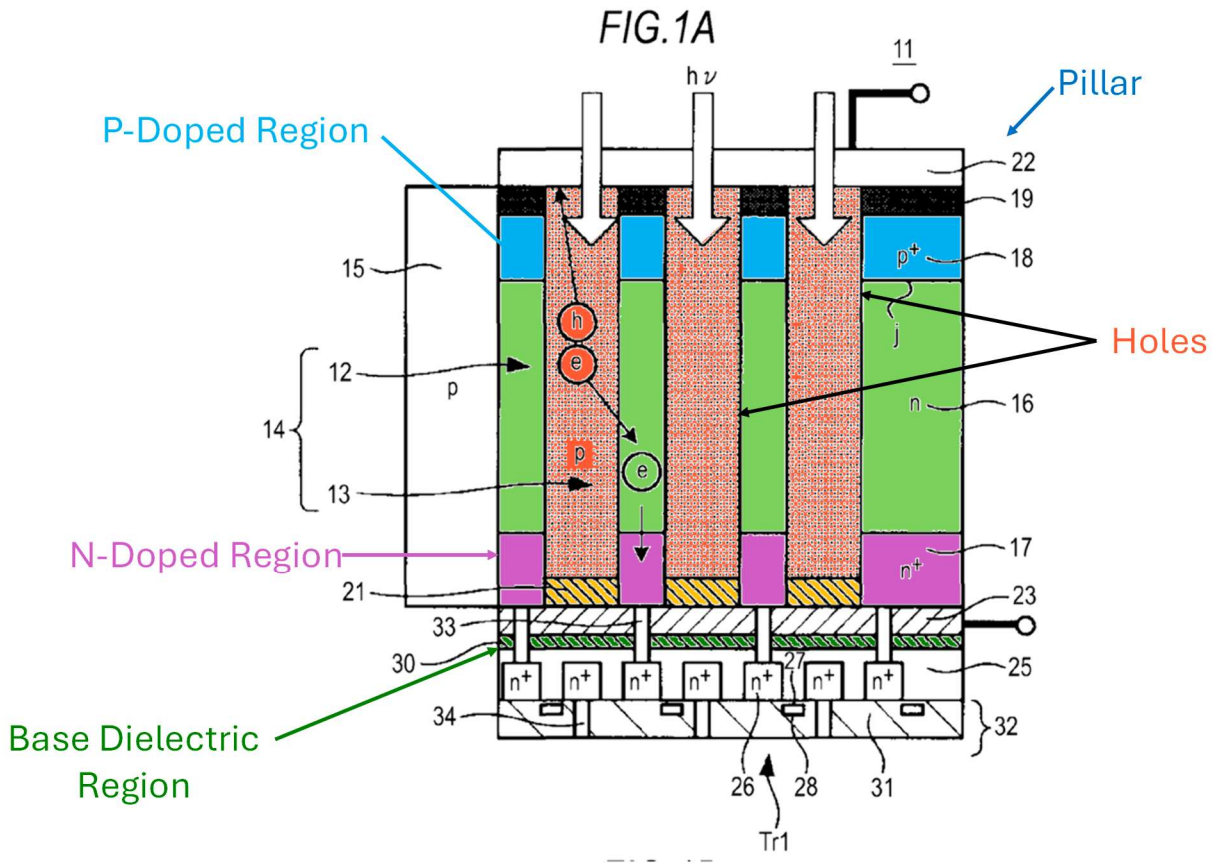
excellent scratch protection, serves as a moisture barrier, and prevents sodium diffusion.").

162. Similarly, one skilled in the art would have understood that *Kuboi*'s interlayer insulating film 31 that insulates wiring layers from each other would constitute a film of silicon oxide or silicon nitride, or at least would have found this configuration obvious, there being a motivation for it and a reasonable expectation of success in achieving it. This is supported by other prior art that would have been known to one skilled in the art. Ex. 1027, ¶¶[13], [14] (disclosing "a method of manufacturing a CMOS device" in which "first insulating film 102 may be composed of [a] silicon oxide film (SiO_2) or an aluminum oxide film"); Ex. 1013, 9-14 (describing the use of dielectric films to separate metal electrically conducting traces in CMOS circuits); Ex. 1013, 34 ("Classically, silicon dioxide (generically called oxide here) has served as the insulating dielectric"); Ex. 1013, 35 (disclosing silicon nitride as "an insulator"); Ex. 1026, 26:7-14 (disclosing that "it is preferable that the material of the interlayer insulating film used for the multi-layer wiring of the lower layer is used so as to form the film, from the viewpoint of reliability and manufacturing cost," and that "silicon oxide, silicon nitride, silicon nitride oxide[,] or laminated films thereof are generally used"); Ex. 1012, 20 (disclosing that many different kinds of thin films, including thermal oxides, are used to fabricate discrete devices and integrated circuits), 34 ("The plasma-deposited nitride

provides excellent scratch protection, serves as a moisture barrier, and prevents sodium diffusion."). One skilled in the art would have also understood that both silicon dioxide and silicon nitride are solid materials, and that both are dielectric or insulating materials. *Supra* XI.A.1.e (claim [1c]).

163. Indeed, *Kuboi* uses "insulating film" to refer to films made of dielectric materials such as silicon nitride (Si_3N_4), silicon oxide (SiO_2) film, or similar materials. *See Kuboi*, ¶[59]. Thus, in my opinion, one skilled in the art would have found it obvious to form *Kuboi*'s insulating film 30 or 31 (i.e., base dielectric material) of a solid dielectric material like silicon oxide or silicon nitride. One skilled in the art would also have had a reasonable expectation of success in forming insulating film 30 or 31 using a solid dielectric material because methods for fabricating such films using dielectric materials were well known in the art.

164. As I explained above, in my opinion, a skilled artisan would have understood that *Kuboi*'s insulating films 30 or 31 made of silicon dioxide or silicon nitride would be made of solid material. *Kuboi*'s insulating films 30 and/or 31 (i.e., base dielectric region) for *Kuboi*'s pixel array (i.e., array of pillar) are illustrated below.



Kuboi, Fig. 1A.

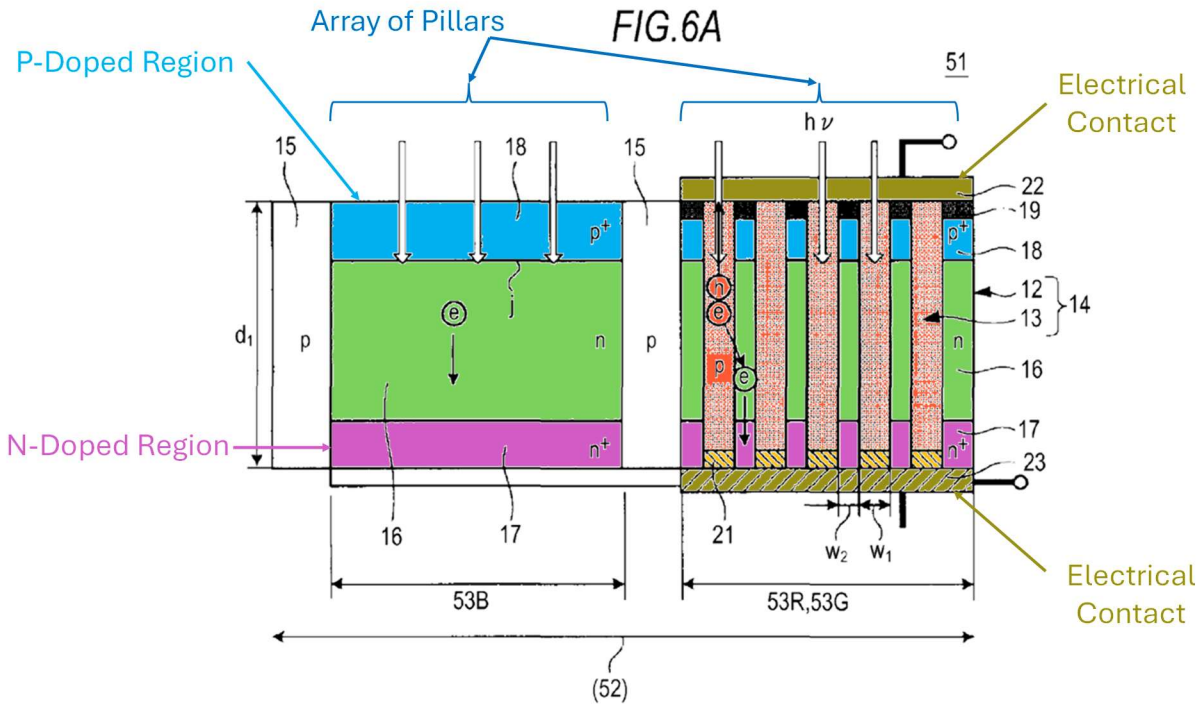
165. As seen in the above figure, both of *Kuboi*'s insulating films 30 and 31 are disposed below *Kuboi*'s pixel (i.e., pillar). Although Figure 1A illustrates only one pixel, as I discussed for claim [1c], *Kuboi*'s imaging device includes a plurality of pixels (i.e., 53B, 53R, and 53G) arranged as an array of pixels. *Supra* XI.A.1.e. *Kuboi* discloses that pixels 53R and 53G have structures similar to the Figure 1A pixel. *Kuboi* ¶[90]. Moreover, one skilled in the art would have understood that *Kuboi*'s multilayer wiring board with insulating film 31 would be disposed below *Kuboi*'s array of pillars (i.e., below the array of pixels

including 53B, 53R, and 53G). *Kuboi*, ¶[70] ("[A] silicon semiconductor substrate for pixels is bonded to the semiconductor substrate on which the semiconductor region 25, the multilayer wiring layer 32, the lower electrode 23, and the like are formed."). In my opinion, one skilled in the art would therefore have understood that Figure 1A's base dielectric region would be a base dielectric region for *Kuboi*'s array of pixels.

i. [1g] "electrical contacts configured to provide electrical pathways coupled electrically to at least some of the photodetectors, including for selected reverse-biasing thereof;"

166. In my opinion, *Kuboi* discloses this limitation.

167. As I explained above for claim [1a(2)], the photoelectric conversion portions of *Kuboi*'s pixels (including pixels 53B, 53G, and 53R) are photodetectors. *Supra* XI.A.1.c. *Kuboi* discloses that "electrodes 22 and 23 [are] formed on the entire rear and [front] surfaces of the semiconductor layer 12" of the photoelectric conversion portions. *Kuboi*, ¶¶[60], [77], [93], [103]. *Kuboi* explains that "upper electrode 22 on the rear surface side is formed by a transparent electrode formed of a transparent conductive film." *Kuboi*, ¶[60]. *Kuboi* further explains that "lower electrode 23 is formed of metal exhibiting ohmic properties." *Kuboi*, ¶[60]. *Kuboi*'s electrodes, which are electrical contacts to its photoelectric conversion portions, are illustrated in the figure below.



Kuboi, Fig. 6A.

168. *Kuboi* discloses that "an organic photoelectric conversion film 13 is deposited so as to be embedded in the vertical holes 38." *Kuboi*, ¶¶[73], [91]. *Kuboi* explains that "[l]ight hν passes through the on-chip microlens to enter the p-type organic photoelectric conversion film 13, in which the light is subjected to photoelectric conversion, whereby electron-hole pairs are generated." *Kuboi*, ¶[64].

169. *Kuboi* discloses that a "necessary voltage is applied between the upper electrode 22 and the lower electrode 23." *Kuboi*, ¶[64]. *Kuboi* discloses that "electrons e serving as signal charges move from the organic photoelectric conversion film 13 through the interface toward the semiconductor layer 12 depleted by the applied bias voltage," and "hole h moves toward the upper

electrode 22 through the organic photoelectric conversion film 13 and is discharged through the upper electrode 22." *Kuboi*, ¶[64]. In my opinion, one skilled in the art would have understood that *Kuboi*'s electrodes 22 and 23 provide electrical pathways to the photoelectric conversion portions (which are photodetectors, *supra* XI.A.1.c (claim [1a(2)])) of at least to some of *Kuboi*'s pixels. This is because the holes generated in the photoelectric conversion film 13 of the photoelectric conversion portions move through electrodes 22, and the electrons e generated in the photoelectric conversion film 13 move toward semiconductor layer 12 due to a bias voltage applied between electrodes 22 and 23.

170. In my opinion, one skilled in the art would have understood that, because the holes move through electrodes 22, and because the electrons (e) move into semiconductor layer 12 due to a bias voltage applied between electrodes 22 and 23, these electrodes provide electrical pathways to the photoelectric conversion portions (photodetectors) of at least some of *Kuboi*'s pixels.

171. *Kuboi* discloses that "[a] necessary bias voltage is applied between the upper electrode 22 and the lower electrode 23 so that the upper electrode 22 has the negative potential, and the lower electrode 23 has the positive potential." *Kuboi*, ¶[64]. The "necessary bias voltage" is applied between electrodes 22 and 23 so that p^+-type region 18 of the photoelectric conversion portion is at a negative potential and n^+-type region 17 is at a positive potential. *Kuboi*, ¶[64]. A person skilled in

the art would have understood that applying a positive voltage to n^+-type region 17 with respect to p^+-type region 18 constitutes reverse-biasing the photoelectric conversion portion. This is supported by prior art that would have been known to one skilled in the art. For example, Ex. 1023 explains that reverse bias is "[t]he condition in which a positive voltage is applied to the n region with respect to the p region of a pn junction." Ex. 1023, 3-5, 8.

172. Because *Kuboi* allows for applying the reverse biasing to particular pixels and further allows for selection of the *necessary* voltage for reverse biasing, in my opinion, one skilled in the art would have understood that *Kuboi* discloses that its electrical contacts (i.e., electrodes 22 and 23) are configured to provide electrical pathways for selected reverse biasing as claimed.

173. In my opinion, one skilled in the art would have understood that *Kuboi*'s imaging device selects the bias voltage for the level of reverse biasing needed to maintain performance under changing operating conditions. This is supported by prior art that would have been known to one skilled in the art. Ex. 1046 explains that "[i]t is well known that the behavior … [of photodiodes] are strongly dependent on both bias voltage and temperature." Ex. 1046, 4-29. Ex. 1032 discloses that "[t]he electric field is proportional to the applied bias voltage in devices." Ex. 1032, 1, 4-6 (plotting a "linear dependence of the internal electric field on applied bias"), 10. Ex. 1043 demonstrates that the intrinsic frequency

response—which determines the upper bandwidth limit of a photodiode—is significantly influenced by both reverse bias voltage and temperature. Ex. 1043, 1-6. By applying a physical model and analyzing experimental data, this reference shows that increasing the reverse bias voltage widens the depletion region, thereby reducing junction capacitance and enhancing response speed. This effect is especially beneficial in low-light conditions where fast and sensitive detection is critical. Additionally, this study explores how temperature variations impact carrier mobility and transit time, further affecting the photodiode's dynamic behavior. Together, these findings underscore the importance of carefully tuning bias voltage to optimize photodiode performance across different operating environments. *See* Ex. 1044, 4-17. Thus, in my opinion, one skilled in the art would have understood that by selecting the "necessary voltage" based on ambient conditions, *Kuboi* enables stable operation across varied operating conditions.

174. Accordingly, one skilled in the art would have known that since *Kuboi* allows reverse biasing of particular pixels and allows for selection of *necessary* voltage for reverse biasing, its electrical contacts (electrodes 22 and 23) are configured to provide electrical pathways for selected reverse biasing as claimed.

j. [1h] "wherein the presence of said one or more holes increases by a factor of at least 1.1 the absorption of the light by at least some of the photodetectors relative to like photodetectors lacking said holes."

175. In my opinion, *Kuboi* discloses or at least renders this limitation obvious in view of the knowledge of a person of ordinary skill in the art.

176. First, a skilled artisan would have found this limitation disclosed in view of the skilled artisan's knowledge of the state of the art before the priority date of the '948 patent. In my opinion, a skilled artisan would have understood that the intensity I_d of light at a depth "d" in a material is governed by the Lambert-Beer expression $I_d = I_0 e^{-\alpha d}$, where I_0 is the intensity of incident light and α is the absorption coefficient of the material. Ex. 1028, 23. A skilled artisan would have also understood that the amount of incident light entering a material would be $I_0 \times A$, where A is the cross-sectional area available for light to enter the material (i.e., area of light incidence). Ex. 1028, 25. Further, the skilled artisan would have understood that the amount of light exiting the material of depth d would be $(I_0 e^{-\alpha d}) \times A$. Ex. 1028, 25. A skilled artisan would therefore have understood that the amount of incident light absorbed by a material of depth d (P_{abs}) would be $I_0 (1- e^{-\alpha d}) \times A$, based on the Lambert-Beer expression. Ex. 1028, 22-25; Ex-1029, 2-5.

177. *Kuboi* discloses that the organic photoelectric conversion film 13 in the red pixel 53R, which is sensitive to the red light wavelength band, can include

"phthalocyanine compounds." *Kuboi*, ¶[92]. Red light wavelengths range between about 620 to 750 nm. *Yu*, ¶[23]. Further, *Kuboi* discloses that the organic photoelectric conversion film 13 in the green pixel 53G, which is sensitive to the green light wavelength band, can include "porphyrin compounds." *Kuboi*, ¶[92]. Green light wavelengths range between about 495 to 570 nm. *Yu*, ¶[23]. *Kuboi* also discloses that "the organic photoelectric conversion film has a greater optical absorption coefficient than silicon." *Kuboi*, ¶¶[4], [12], [92]. As I explain below, the higher absorption coefficient of *Kuboi*'s organic photoelectric conversion film provides a greater than 10% increase in light absorption over a comparable photodetector that does not include holes.

178. Ex. 1032 provides a graph showing the absorption coefficients for phthalocyanine compounds over a range of wavelengths. Ex. 1032, 3, Fig. 1. Ex. 1030 similarly provides a graph showing the absorption coefficients for porphyrin compounds over a range of wavelengths. Ex. 1030, 7, Fig. 6. I have reproduced these graphs below.

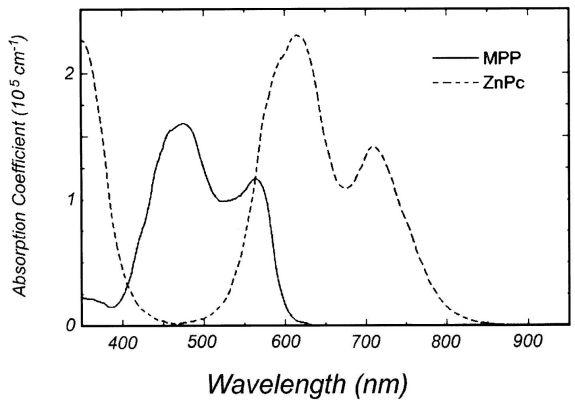


Fig. 1. The absorption spectra of ZnPc (dashed line) and MPP (solid line).

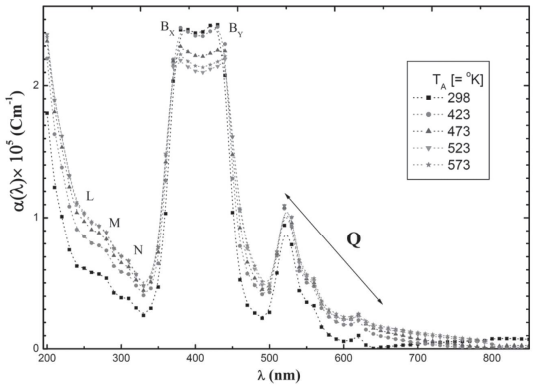


Fig. 6. (Color online) The optical absorption coefficient, $\alpha(\lambda)$, versus wavelength, λ, for as-deposited and annealed NiTPP thin films.

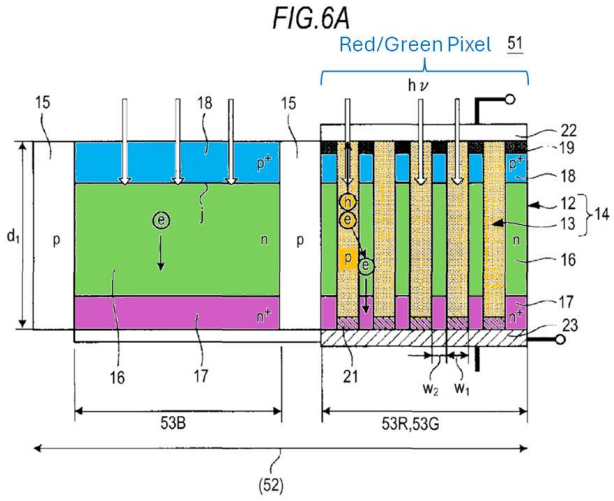
Ex. 1032, 3 (Fig. 1). Ex. 1030, 7 (Fig. 6).

179. Ex. 1031 provides a table of the absorption coefficients of silicon. Ex. 1031, 2-4 (Table 1). In Table A below, I have listed the absorption coefficients for the phthalocyanine and porphyrin organic materials that I extracted from the above figures and compared them with the absorption coefficient for silicon for the green and red light wavelength ranges. As seen from the table below, the absorption coefficient of the porphyrin organic materials is greater than silicon in the green light wavelength range of 510 to 580 nm. Similarly, the absorption coefficient of the phthalocyanine organic materials is ten times greater than silicon for the red light wavelength range of 620 to 750 nm.

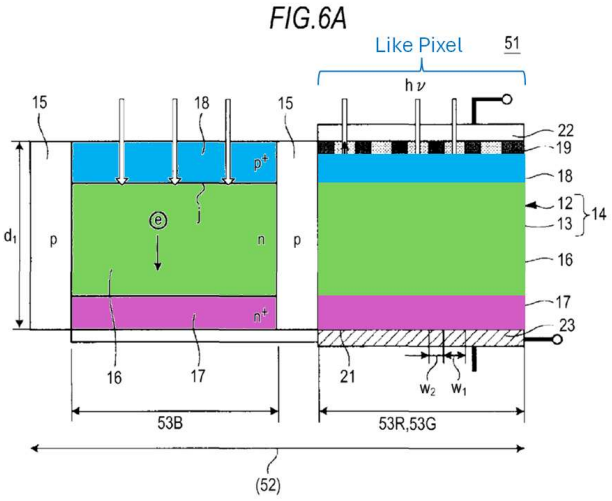
Table A			
Wavelength (nm)	**Absorption coefficient α (cm^{-1})**		
	Silicon (Ex. 1031)	**Porphyrin (Ex. 1030)**	**Phthalocyanine (Ex. 1032)**
490	12600	22000	
500	11100	27000	
510	9700	57600	
520	8800	93400	
530	7850	79000	
540	7050	44000	
550	6390	35000	
560	5780	31400	
570	5320	15800	
580	4880	10000	
620	3520		228000
630	3280		216000
640	3030		188000
650	2790		147000
660	2570		122000
670	2390		111000
680	2200		110000
690	2040		120000
700	1890		133000
710	1780		142000
720	1680		135000
730	1540		119600
740	1420		101000
750	1310		83000

180. Claim [1h] recites "increases by a factor of at least 1.1 the absorption of the light by at least some of the photodetectors relative to otherwise ***like*** photodetectors lacking said holes" (emphasis added). As I discussed above for

claim [1a(2)], the photoelectric conversion portions of *Kuboi*'s pixels are photodetectors. *Supra* XI.A.1.c. Below, I have illustrated the structure of *Kuboi*'s red or green pixels (or photodetectors) 53R or 53G (left) and the structure of a ***like*** pixel or photodetector (right) that does not have holes. As is apparent from the below figures, a ***like*** pixel would include silicon in place of the organic film in *Kuboi*'s holes. Further, as illustrated in the figures below, both *Kuboi*'s 53R or 53G pixel and the ***like*** pixel would include *Kuboi*'s light shielding film 19. Thus, light is incident over the same area, defined by the openings in the light shielding film, at the light-receiving surface for both cases.



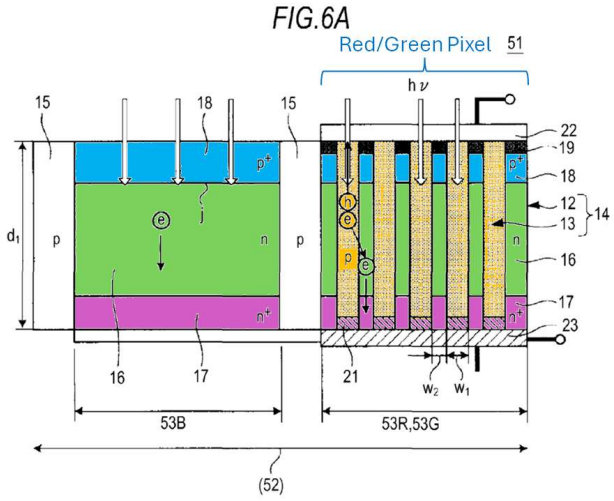
Kuboi, Fig. 6A (53R/53G pixel with organic material in the holes).



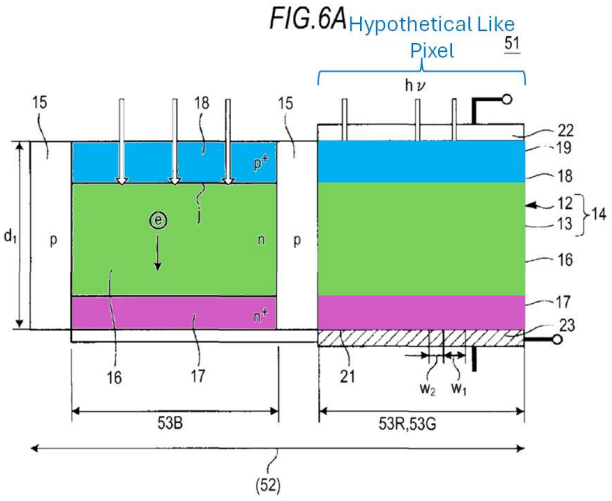
Kuboi, Fig. 6A (***like*** pixel without holes).

181. It is instructive to also consider the configuration in which a *hypothetical like* pixel does not include the holes and the light shielding film.

Below, I have illustrated the structure of *Kuboi*'s red or green pixels (or photodetectors) 53R or 53G (left) and the structure of a *hypothetical like* pixel or photodetector (right) that does not have the holes and also does not include the light shielding film.



Kuboi, Fig. 6A (53R/53G pixel with organic material in the holes).



Kuboi, Fig. 6A (*hypothetical like* pixel without holes and no light shield).

182. *Kuboi* discloses a hole width of 200 nm, at least five holes in its red and green pixels, and a 1.4 μm by 1.4 μm pixel area. *Kuboi*, ¶[94], Fig. 6A. Thus, the area of the organic film on which light is incident in *Kuboi*'s red or green pixels (53R or 53G), as defined by the openings in the light shielding film, is about 1.4 μm^2 (i.e., 5 × 0.2 μm × 1.4 μm). In contrast, the area on which light would be incident on a *hypothetical like* pixel that does not have the light shielding film is

about 1.96 μm^2 (i.e., 1.4 μm × 1.4 μm). Thus, the area on which light is incident in *Kuboi*'s green and red pixels is about 71% of the total pixel area.

183. As I discussed above for claim [1c], *Kuboi* discloses holes filled with the organic material and having a depth of 1.4 μm. *Supra* XI.A.1.e; *Kuboi*, ¶[94]. Table B below shows the ratio $P_{abs\text{-}organic}$ / $P_{abs\text{-}silicon}$ for a *like* pixel (second column) for the green light wavelength range of 490-580 nm. In the table, $P_{abs\text{-}organic}$ is the amount of light absorbed in porphyrin organic material (for green pixel 53G), $P_{abs\text{-}silicon}$ is the amount of light absorbed by a *like* pixel having no holes, and both $P_{abs\text{-}organic}$ and $P_{abs\text{-}silicon}$ are obtained using the Lambert-Beer expression. The ratio $P_{abs\text{-}organic}$ / $P_{abs\text{-}silicon}$ for the *hypothetical like* pixel (Table B, third column) is obtained by scaling the values of $P_{abs\text{-}organic}$ / $P_{abs\text{-}silicon}$ for the *like* pixel (Table B, second column) by 71% to account for the smaller area of light incidence on the organic material in the green pixel as compared to the area of light incidence on the *hypothetical like* pixel.

Table B		
Wavelength (nm)	**$P_{abs\text{-}organic}$ / $P_{abs\text{-}silicon}$**	
	***Like* Pixel**	***Hypothetical Like* Pixel (without light shielding film)**
490	1.2	0.8
500	1.2	0.9
510	1.3	1.0
520	1.4	1.0
530	1.5	1.1
540	1.6	1.1
550	1.7	1.2
560	1.8	1.3
570	1.7	1.2
580	1.5	1.1

184. The ratio $P_{abs\text{-}organic}$ / $P_{abs\text{-}silicon}$ in Table B is illustrated in chart form in Figure A below. As illustrated in Figure A, the ratio $P_{abs\text{-}organic}$ / $P_{abs\text{-}silicon}$ is greater than or equal to 1.1 (shown by the dashed black line) for the entire green light wavelength range for the *like* pixel. That is, the amount of light absorbed by *Kuboi*'s green pixel with holes filled with porphyrin organic material is at least 1.1 times that absorbed by a *like* pixel without holes. Furthermore, the ratio $P_{abs\text{-}organic}$ / $P_{abs\text{-}silicon}$ is greater than or equal to 1.1 (shown by the dashed black line) for the 540-570 nm wavelength range for the *hypothetical like* pixel. That is, the amount

of light absorbed by *Kuboi*'s green pixel with holes filled with porphyrin organic material is at least 1.1 times that absorbed by a *hypothetical like* pixel without holes and without the light shielding film for the 540-570 nm wavelength range.

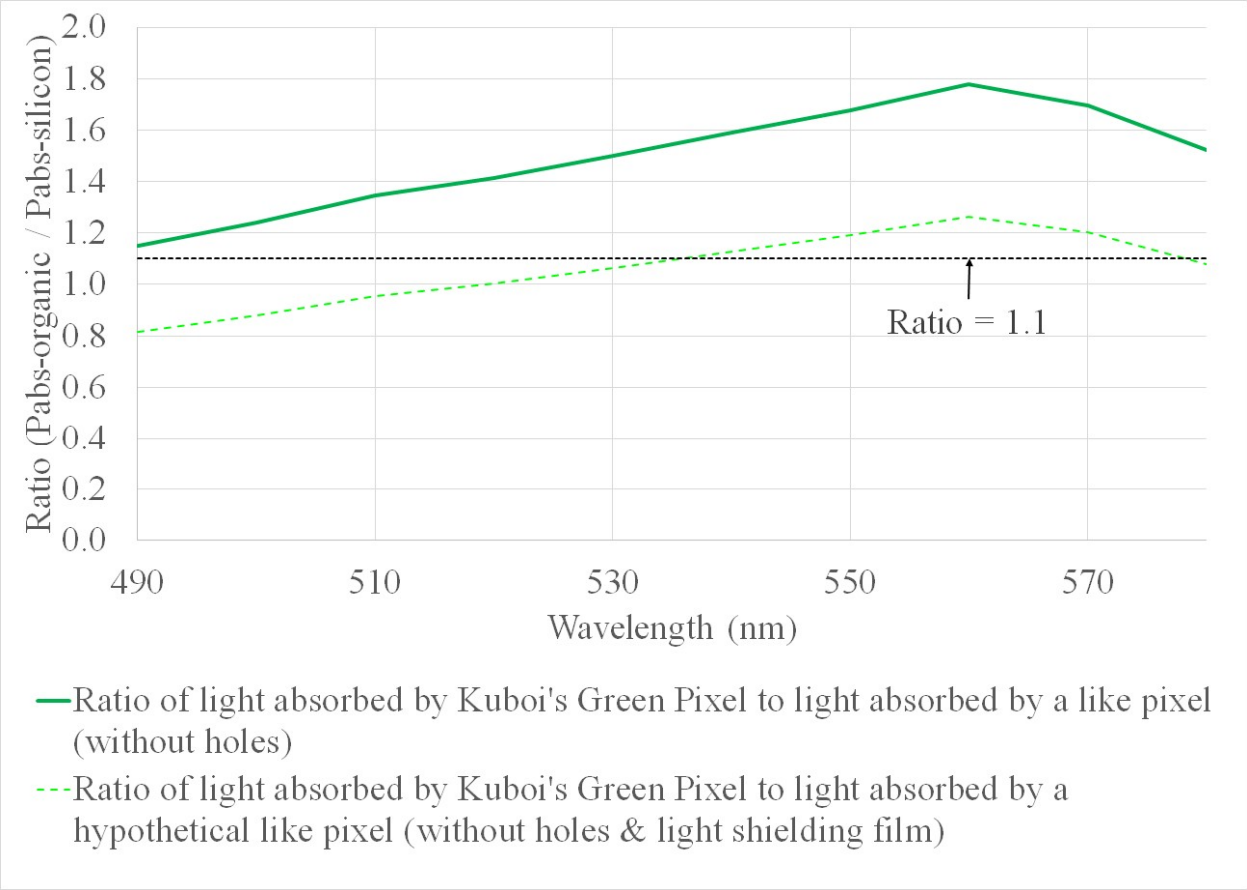


Figure A.

185. Table C below shows the ratio $P_{abs\text{-}organic}$ / $P_{abs\text{-}silicon}$ for a *like* pixel (second column) for the red light wavelength range of 620-780 nm. In the table, $P_{abs\text{-}organic}$ is the amount of light absorbed in phthalocyanine organic material (for red pixel 53R) and is obtained using the Lambert-Beer expression. The ratio $P_{abs\text{-}organic}$ / $P_{abs\text{-}silicon}$ for the *hypothetical like* pixel (Table C, third column) is

obtained by scaling the values of $P_{abs\text{-}organic}$ / $P_{abs\text{-}silicon}$ for the *like* pixel (Table C, second column) by 71% to account for the smaller area of light incidence on the organic material in the red pixel as compared to the area of light incidence on the *hypothetical like* pixel.

Table C		
Wavelength (nm)	**$P_{abs\text{-}organic}$ / $P_{abs\text{-}silicon}$**	
	***Like* Pixel**	***Hypothetical Like* Pixel (without light shielding film)**
620	2.6	1.8
630	2.7	1.9
640	2.9	2.1
650	3.1	2.2
660	3.3	2.3
670	3.5	2.5
680	3.8	2.7
690	4.0	2.9
700	4.3	3.1
710	4.5	3.2
720	4.8	3.4
730	5.2	3.7
740	5.5	3.9
750	6.0	4.2
760	6.5	4.6
770	7.0	5.0
780	7.4	5.2

186. The ratio $P_{abs\text{-}organic}$ / $P_{abs\text{-}silicon}$ in Table C for the *like* pixel is illustrated in chart form in Figure B below. As illustrated in Figure B (and in Table C, column two), the ratio $P_{abs\text{-}organic}$ / $P_{abs\text{-}silicon}$ is greater than or equal to 1.1 (shown by the

dashed black line) for the entire red light wavelength range for the *like* pixel. That is, the amount of light absorbed by *Kuboi*'s red pixel with holes filled with phthalocyanine organic material is at least 1.1 times that absorbed by a *like* pixel without holes. Furthermore, the ratio $P_{abs\text{-}organic}$ / $P_{abs\text{-}silicon}$ is greater than or equal to 1.1 (shown by the dashed black line) for the entire red light wavelength range for the *hypothetical like* pixel. That is, the amount of light absorbed by *Kuboi*'s red pixel with holes filled with phthalocyanine organic material is at least 1.1 times that absorbed by a *hypothetical like* pixel without holes and without the light shielding film.

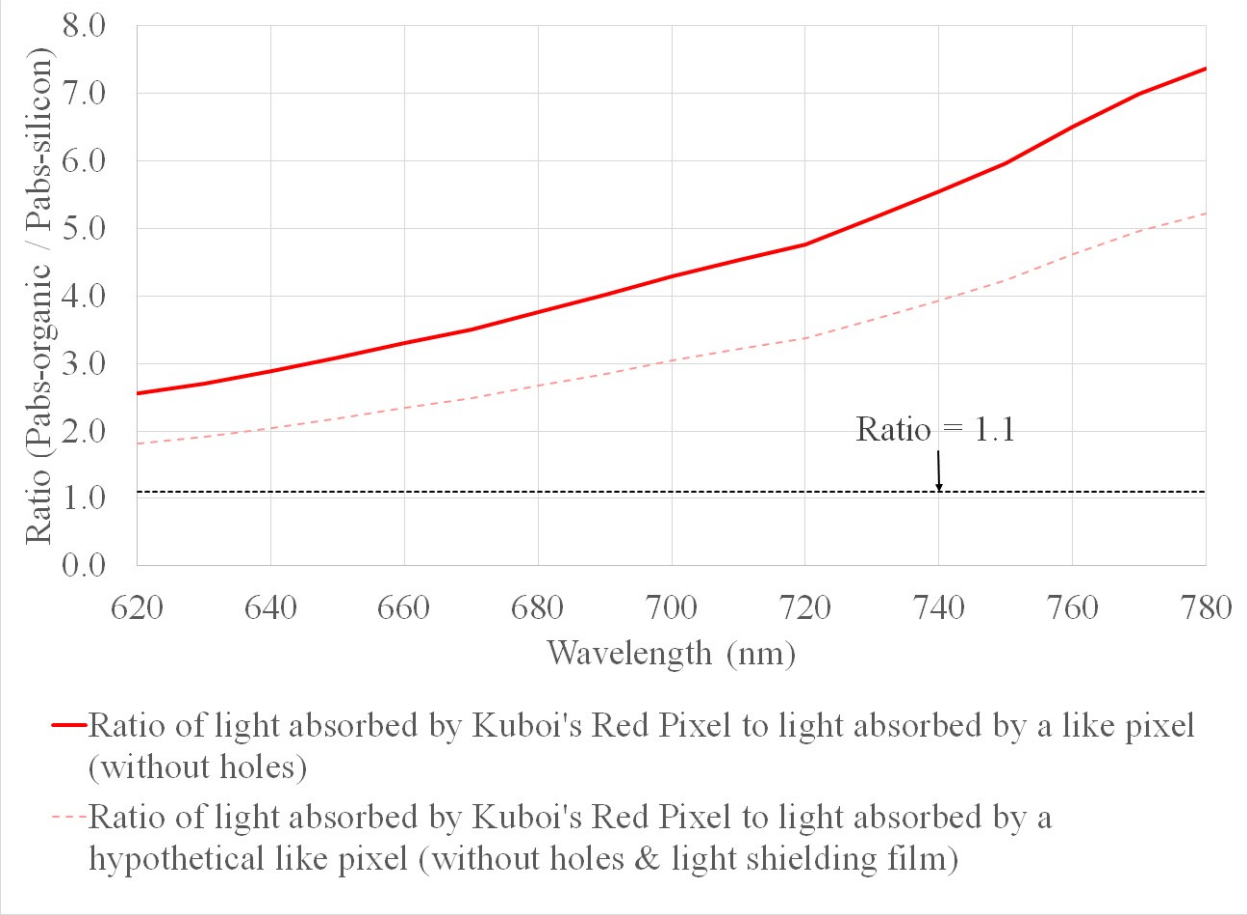


Figure B.

187. In my opinion, therefore, one skilled in the art would have understood that *Kuboi*'s photodetectors with organic material in their holes would increase the absorption of the light (at selected visible and infrared wavelength ranges) in at least some of *Kuboi*'s photodetectors by at least 1.1 times compared to *like* photodetectors lacking said holes.

188. Second, in my opinion, one skilled in the art would have also found claim [1h] disclosed based on Patent Owner's statements in the '948 patent. Patent

Owner represents in the ’948 patent that an imaging device having the structure disclosed in *Kuboi* would improve photon absorption by at least 10%.

189. The ’948 patent details the cause or causes of the enhancement of the absorption coefficient. Specifically, the ’948 patent explains:

> The cause or causes of the enhancement of the absorption coefficient are believed to include one or more of the following: an increase in optical field concentration, resonance effects, constructive and destructive optical interferences (amplitude and phase) effects, scattering, and *high contrast grating (HCG) effects*. [*See, e.g.*,] Chang-Hasnain et al[.], High contrast gratings for integrated optoelectronics, Advances in Optics and Photonics 4, 379-440 (2012), hereinafter “Chang-Hasnain.” The HCG effects are at the near-wavelength regime ([*see*] Chang-Hasnain) where the optical wavelength in the material of the grating and the optical wavelength in the surrounding material of the grating is the range of the period of the grating.

’948 patent, 11:52-64 (emphasis added). A skilled artisan would have understood from the above-excerpted disclosure that one cause of enhancement of photon absorption is due to effects produced by a high contrast grating (HCG).

190. The ’948 patent further explains that “[t]he period of the 3D pillar/hole microstructured array can be seen as a 3D high contrast grating, whose

period of the grating Λ can lie between λ/n_1 where n_1 is the optical refractive index of material M_1 and λ/n_2 where n_2 is the optical refractive index of material M_2." '948 patent, 12:14-18. Further, "[i]f $n_1>n_2$ then $\lambda/n_1<\Lambda<\lambda/n_2$." '948 patent, 12:18-19. A skilled artisan would have understood from this disclosure that a structure that includes holes in the pillars of an imaging device would behave like an HCG if the pitch between the holes satisfies the condition $\lambda/n_1<\Lambda<\lambda/n_2$, when $n_1>n_2$.

191. The '948 patent confirms this, explaining that the HCG effect may explain the high absorption coefficient of semiconductors with holes that satisfy the relationship $\lambda/n_1<\Lambda<\lambda/n_2$. Specifically, the '948 patent states:

> The HCG effect that may explain the high enhancement of the absorption coefficient of the bulk material is that a single or multiple HCG layer (or a single microstructured pillar/hole array layer) due to its resonance effects and/or due to a varying of the microstructured pillar/hole period spacing, the optical signal resonating in the HCG/microstructured pillar-hole array can be directed to propagate in the plane of the HCG/microstructured pillar-hole array rather than normal to the surface. Together with resonance and in-plane propagation this can greatly increase the absorption path length in the HCG/microstructured pillar-hole array.

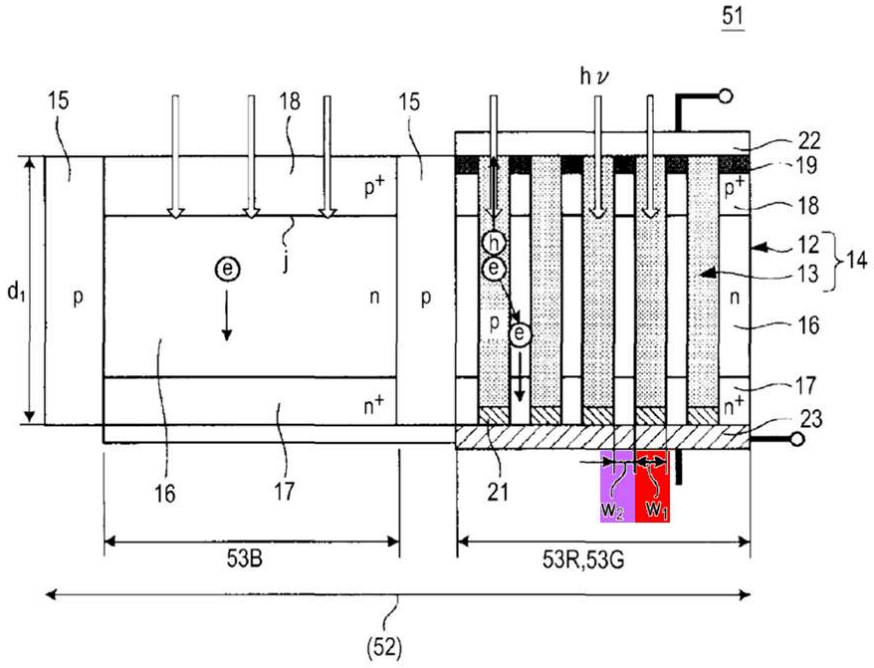
’948 patent, 12:35-45. The ’948 patent goes on to say that “[u]sing the phenomenon of near-wavelength and also deep-wavelength where the HCG period is much less than the optical wavelength, and the diffraction regime where the HCG period is greater than the optical wavelength ([*see*] Chang-Hasnain)[,] the microstructured pillar-hole-void array can have enhanced absorption coefficient over the bulk absorption coefficient by a factor of 1.1 to over 100.” ’948 patent, 12:49-55.

192. In my opinion, one skilled in the art would have understood these disclosures of the ’948 patent as representations made by Patent Owner that a microstructured pillar hole array having microstructure period Λ (i.e., pitch of the holes) and satisfying the relationship $\lambda/n_1<\Lambda<\lambda/n_2$ forms a high contrast grating (HCG). In my opinion, one skilled in the art would have further understood Patent Owner as representing that if the microstructured pillar hole array forms an HCG, then the physical phenomenon of near-wavelength and deep-wavelength would result in an enhanced absorption coefficient of 1.1 to 100 times the bulk absorption coefficient associated with a structure that does not have the microstructured pillar hole array.

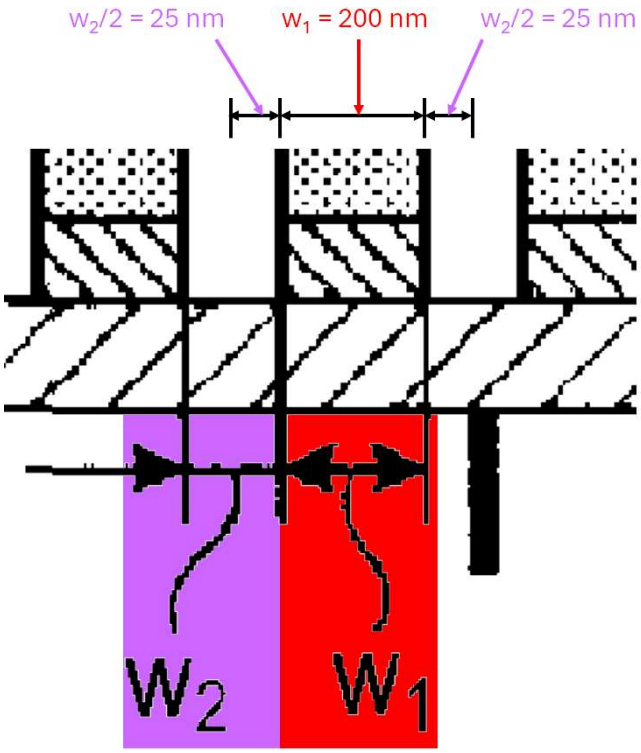
193. As I have discussed, *Kuboi* discloses an imaging device that has an array of pillars with holes. *Supra* XI.A.1.b-XI.A.1.e (claims [1a(1)]-[1c]). Furthermore, *Kuboi* discloses a microstructured pillar hole array where the period

Λ or center-to-center distance between holes is about 250 nanometers. For example, *Kuboi* discloses that the width w_1 of photoelectric conversion films 13 is 200 nm and width w_2 of semiconductor layer 12 between the photoelectric conversion films is 50 nm. *Kuboi*, ¶[94]. *Kuboi*'s Figure 6A, below, illustrates these dimensions. Additionally, I have provided a magnified view of Figure 6A to illustrate that the period Λ or center-to-center distance between holes in that figure would be 250 nm. Specifically, the period Λ would be $w_2/2 + w_1 + w_2/2 = 25$ nm + 200 nm + 25 nm = 250 nm.

FIG.6A



Kuboi, Fig. 6A.



Kuboi, Fig. 6A (cropped and magnified).

194. One skilled in the art would have understood that visible light has a wavelength range of 400 nm -700 nm and infrared light has a wavelength range of 750 nm to 1,000 μm or even 2,000 μm. Ex. 1010, 4 (disclosing wavelengths "typically in the 400-700 nm range of visible light"); Ex. 1025, ¶[23] (disclosing "IR light (light of wavelengths from about 0.78 to about 1000 microns"). Further, one skilled in the art would have understood that the refractive index n_1 of silicon ranges between about 3.0 to 5.9 (Ex. 1047, 9:43-47, Fig. 4) and varies with wavelength. Ex. 1034, 48. For example, the refractive index n_1 of silicon is about

5.8 for light of wavelength 400 nm, 3.7 for light of wavelength 700-750 nm, and about 3.5 for light of wavelength 1,000 nm. Ex. 1034, 48.

195. *Kuboi* discloses that the organic photoelectric conversion films in its holes may include materials such as "perylene-based compounds, phthalocyanine compounds, quinacridone compounds, porphyrin compounds, [and] merocyanine compounds." *Kuboi*, ¶[58]. One skilled in the art would have understood that the refractive index n_2 of such organic materials ranges between 1.5 and 3.0. Ex. 1035, 86:35-48 (disclosing porphyrin compounds as photoelectric conversion material), 142:18-25 (disclosing refractive index of photoelectric conversion material); Ex. 1030, 6, Fig. 5 (disclosing refractive index of porphyrin compounds ranging from 1.5 to 2.8 for wavelengths of 400-700 nm); Ex. 1036, 13, Fig. 7 (disclosing refractive index of phthalocyanine compounds ranging from 1.5 to 2.8 for wavelengths of 400-700 nm); Ex. 1037, Abstract (disclosing refractive index of phthalocyanine compounds ranging from 2.03 to 2.48).

196. Below, I have provided Table D showing calculated values of λ/n_1 and λ/n_2 for *Kuboi*'s green pixels with porphyrin for visible light wavelengths 400 nm and 700 nm, and near infrared wavelengths of greater than 700 nm wavelength. I obtained values of λ/n_1 and λ/n_2 in Table D, using values of n_1 of silicon for different wavelengths from Ex. 1034, page 48, Table A-1, and values of n_2 of porphyrin compounds at different wavelengths from Ex. 1030, Fig. 5. As seen

from the values in Table D, *Kuboi*'s hole pitch of 250 nm falls in the range λ/n_1 to λ/n_2 for at least part of the visible light spectrum (400-700 nm wavelengths) and at least part of the near infrared light spectrum (>700 nm wavelengths). For example, for the 550 nm green light wavelength, λ/n_1 (550/4.5 = 123) < Λ (250 nm) < λ/n_2 (550/2.0 = 275).

Table D

λ (nm)	**n_1 (Silicon)**	**n_2 (Porphyrin)**	**λ/n_1(nm)**	**λ/n_2 (nm)**
400	5.8	1.7	68	235
550	4.5	2.0	123	275
700	3.7	1.6	188	438
750	3.7	1.8	203	417

197. Below, I have provided Table E showing calculated values of λ/n_1 and λ/n_2 for *Kuboi*'s red pixels with porphyrin for visible light wavelengths 400 nm and 700 nm, and near infrared wavelengths of greater than 700 nm wavelength. I obtained values of λ/n_1 and λ/n_2 in Table E, using values of n_1 of silicon for different wavelengths from Ex. 1034, page 48, Table A-1, and values of n_2 of phthalocyanine compounds at different wavelengths from Ex. 1036, page 13, Fig. 7. As seen from the values in Table E, *Kuboi*'s hole pitch of 250 nm falls in the range λ/n_1 to λ/n_2 for at least part of the visible light spectrum (400-700 nm wavelengths) and at least part of the near infrared light spectrum (>700 nm

wavelengths). For example, for the 650 nm red light wavelength, λ/n_1 (650/3.9 = 168) < Λ (250 nm) < λ/n_2 (650/2.1 = 302).

Table E				
λ (nm)	**n_1 (Silicon)**	**n_2 (Phthalocyanine)**	**λ/n_1(nm)**	**λ/n_2 (nm)**
400	5.8	1.9	68	211
650	3.9	2.1	168	302
700	3.8	1.8	186	389
750	3.7	2.3	203	326

198. In my opinion, therefore, one skilled in the art would have understood that the stated period of *Kuboi*'s hole array falls within the λ/n_1 to λ/n_2 range for light in selected visible and infrared wavelength ranges.

199. Further, one skilled in the art would have understood based on Patent Owner's representations that *Kuboi*'s hole structure would form an HCG. One skilled in the art would have also understood based on Patent Owner's representations that such an HCG would produce an enhanced absorption coefficient of 1.1 to 100 times the bulk absorption coefficient based on the near-wavelength and deep-wavelength phenomena. In my opinion, therefore, one skilled in the art would have understood that *Kuboi*'s photodetectors with organic material in their holes would increase the absorption of the light (at selected visible and

infrared wavelength ranges) in at least some of *Kuboi*'s photodetectors by at least 1.1 times compared to *like* photodetectors lacking said holes.

200. Third, in my opinion, one skilled in the art would have found that Patent Owner's representations were consistent with those of other prior art teachings. For example, according to *Han* (Ex. 1038), "[t]o obtain the same ultimate efficiency as a standard 300 micrometer crystalline silicon wafer, nanohole arrays require less silicon by mass." *Han*, Abstract, 2:4-5. *Han* discloses that "nanoholes can be sized to substantially trap incident light." *Han*, 3:2-3. As shown in Figure 4 of *Han* below, the ultimate efficiency for a device having a semiconductor thickness of about 1.4 μm without nanoholes is approximately 0.12, whereas the ultimate efficiency for a similar device having nanoholes is approximately 0.22. *Han*, Fig. 4. In my opinion, based on a skilled artisan's knowledge of the state of the art before the '948 patent's priority date, the skilled artisan would have understood that nanohole depths of 1.4 μm would increase light absorption by a factor of 1.8 (0.22/0.12 = 1.8), which is significantly higher than a factor of 1.1.

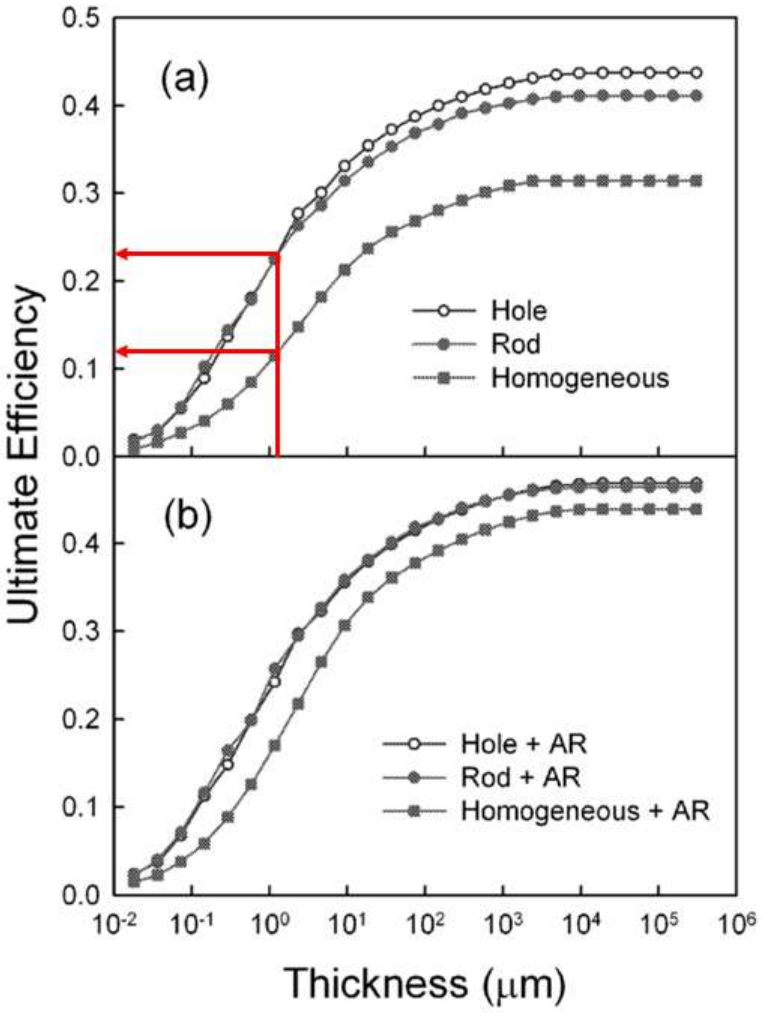


FIG. 4

Han, Fig. 4.

201. In my opinion, therefore, based on a skilled artisan's knowledge of the state of the art before the '948 patent's priority date, the skilled artisan would have understood that *Kuboi*'s 1.4 μm hole depth would increase by a factor of at least 1.1 the absorption of the light by at least some of *Kuboi*'s photodetectors relative to otherwise like photodetectors lacking said holes, and even if not readily understood, one skilled in the art would have found such a result not only obvious

but also one having a reasonable expectation of success in achieving this increase because *Kuboi* discloses forming nanoholes of 1.4 μm depth.

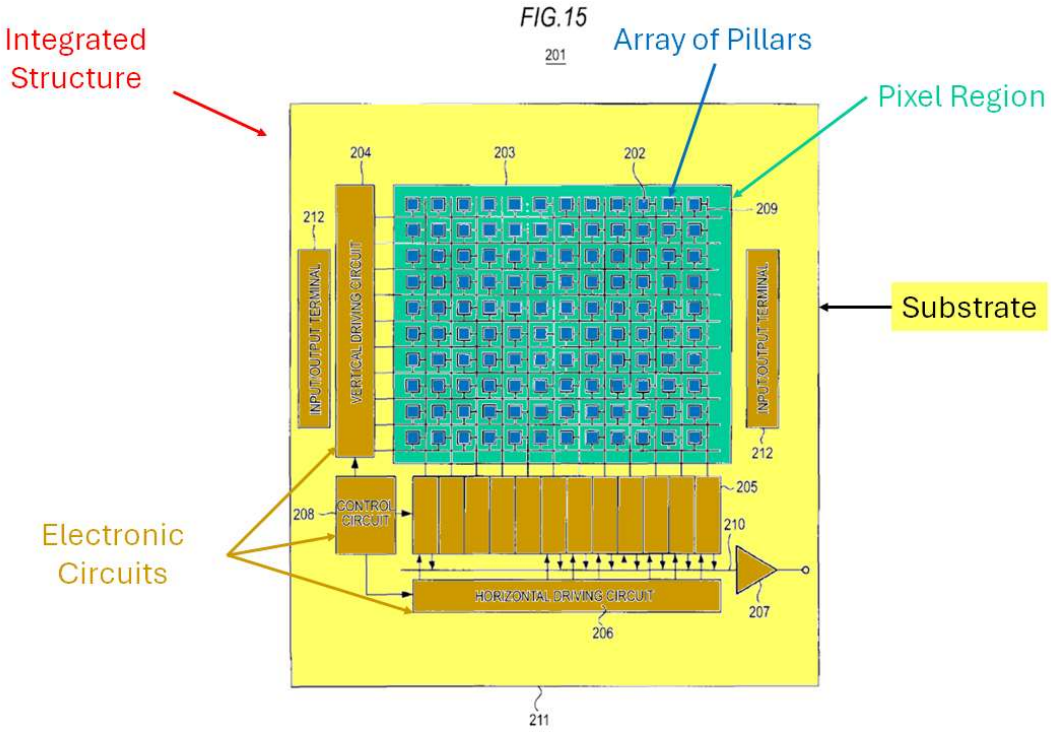
2. Claim 2

a. "The integrated structure of claim 1, wherein the array is monolithically integrated with Si electronic devices."

202. In my opinion, *Kuboi* discloses these additional limitations.

203. *Kuboi* discloses "a simplified exemplary configuration of a CMOS solid-state imaging device." *Kuboi*, ¶[48]. *Kuboi*'s imaging device 201 "include[s] a pixel region (so-called … imaging region) 203 and a peripheral circuit portion which are provided on a semiconductor substrate 211 (i.e., a silicon substrate)." *Kuboi*, ¶[48]. *Kuboi*'s "pixel [region] and logical circuit portion *may be created in advance* and be bonded to the semiconductor substrate on which the semiconductor region 25 having the pixel transistors, the multilayer wiring layer 32, the lower electrode 23, and the like are formed." *Kuboi*, ¶[78] (emphasis added). *Kuboi* also discloses that its logical circuit portion includes vertical driving circuit 204, column signal processing circuits 205, horizontal driving circuit 206, output circuit 207, and control circuit 208. *Kuboi*, ¶[49]. One skilled in the art would have understood that each of circuits 204-208 would include electronic devices. Ex. 1011, 3 (defining circuit as "a physical device" that may be constructed, for example, by "interconnecting [devices such as] a resistor and a capacitor to a

voltage source"). In my opinion, one skilled in the art would have understood *Kuboi* as teaching that the pixel region (including the array of pillars) is monolithically integrated with the logical circuit portion. *Kuboi*, ¶¶[48]-[49]. *Kuboi*'s monolithically integrated structure is shown below.



Kuboi, Fig. 15.

204. *Kuboi* discloses a manufacturing method that forms the pixel region and the logical circuit portion on the same substrate. For example, *Kuboi* discloses a method of forming the pixel region by first forming an element separation region 15 on a silicon semiconductor layer 12. *Kuboi*, ¶[71]. *Kuboi* further discloses that an "n^+-type semiconductor region 17 (corresponding to the front surface side), a[n] n-type semiconductor region 16 (corresponding to an intermediate region), and a

p^+-type semiconductor region 19 (corresponding to the rear surface side) are formed in that order" in the region corresponding to one pixel divided by the element separation region 15. *Kuboi*, ¶[71]. *Kuboi* also discloses that subsequently "a vertical hole 38 such as a trench or a via extending from the p^+-type semiconductor region 18 to the n^+-type semiconductor region is formed in a region of the semiconductor layer 12 corresponding to one pixel by dry-etching." *Kuboi*, ¶[72]. *Kuboi* explains that a plurality of such holes are formed at necessary intervals. *Kuboi*, ¶[72].

205. *Kuboi* discloses forming electron blocking film 21 on the bottom of the vertical holes 38 and depositing an organic photoelectric conversion film 13 in the vertical holes 38. *Kuboi*, ¶[73]. *Kuboi* discloses forming an upper electrode on the upper surface of semiconductor layer 12 and a lower electrode on its lower surface. *Kuboi*, ¶[77]. Further, *Kuboi* discloses that "the pixel and logical circuit portion may be created in advance" on substrate 12. *Kuboi*, ¶¶[78], [48]-[49]. And as I discussed above, one skilled in the art would have understood *Kuboi*'s logical circuit portion as including a plurality of electronic devices. Ex. 1011, 3. In my opinion, because substrate 12 is a silicon substrate, one skilled in the art would have understood that the electronic devices in *Kuboi*'s logical circuit portion (circuits 204-208) would be fabricated in silicon, i.e., they would be Si electronic devices. Further, in my opinion, one skilled in the art would have understood from

Kuboi's disclosures that *Kuboi*'s manufacturing method would result in monolithically integrating the array of pillars (i.e., pixel region) with electronic circuits that include active elements for signal processing and transmission (i.e., control circuit 208 and output circuit 207). A skilled artisan would have understood that forming the pixel region (including an array of pillars) and logical circuits (including CMOS devices) on the same substrate would result in monolithically integrating *Kuboi*'s array of pillars (i.e., pixel region) with Si electronic devices that include CMOS devices.

206. Thus, in my opinion, a person skilled in the art would have understood that *Kuboi*'s disclosure, including Figure 15 and its method of fabrication, show that the array of pillars (pixel region) and the Si electronic devices of the logical circuit portion are monolithically integrated on a single substrate, substrate 211. *Kuboi*, ¶¶[70]-[78], [48]-[49].

3. Claim 3

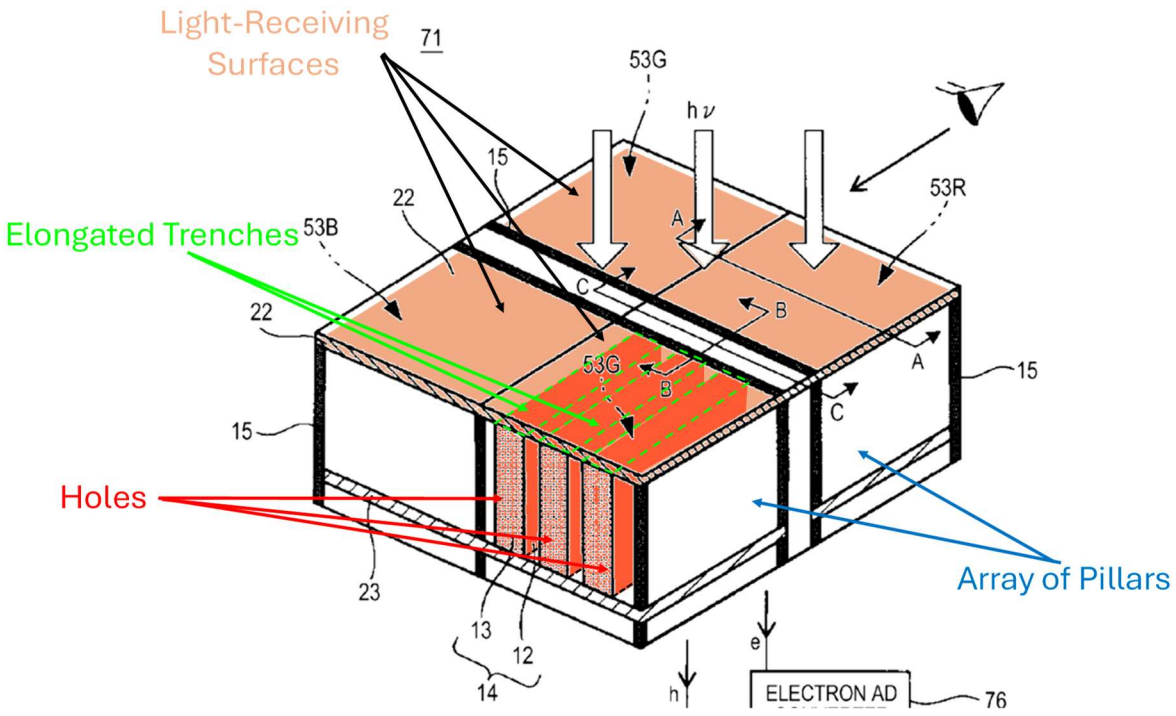
a. "The integrated structure of claim 1, wherein each of at least some of the pillars has a plurality of the elongated holes."

207. In my opinion, *Kuboi* discloses this additional limitation.

208. As explained above for claims [1c] and [1d], in *Kuboi*'s imaging device, each of pixels 53R and 53G has multiple holes 38 that are elongated (i.e., trenches) along the light-receiving surface of that pixel. *Supra* XI.A.1.e, XI.A.1.f.

Thus, in my opinion, in *Kuboi*'s imaging device, each pillar of at least some of the pillars (53R and 53G) has a plurality of the elongated holes.

FIG.13



Kuboi, Fig. 13 (cropped).

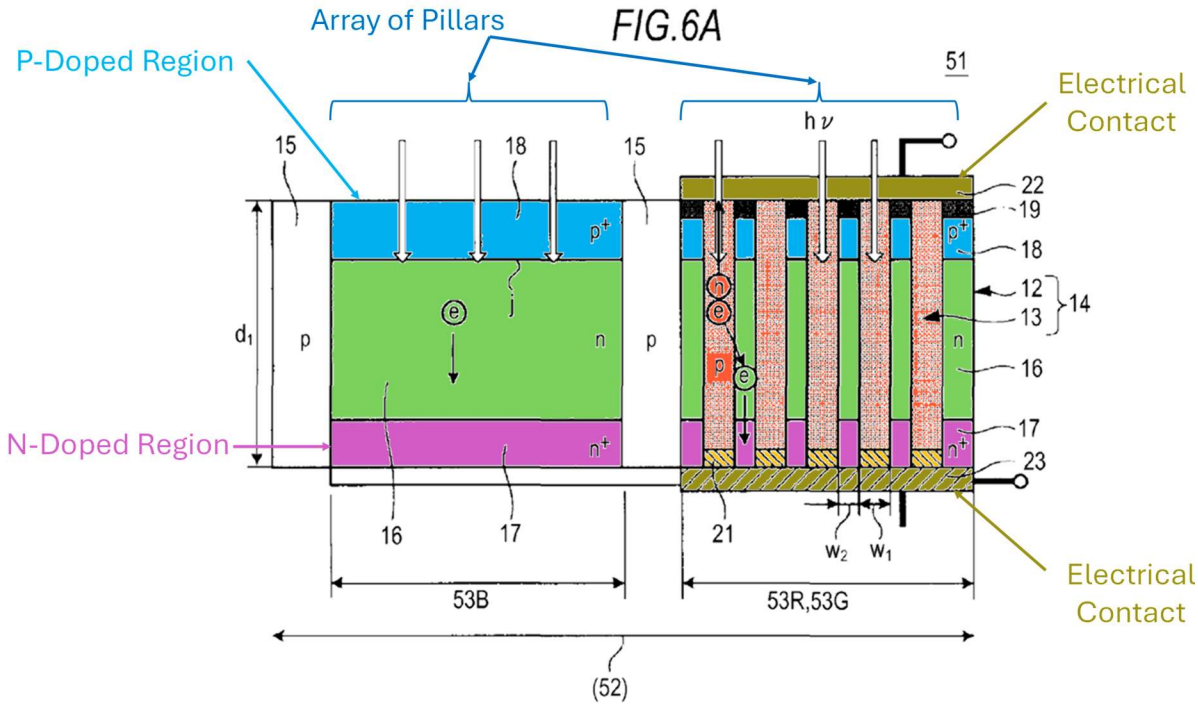
4. Claim 7

a. "The integrated structure of claim 1, in which the electrical contacts are configured to selectively provide electrical fields across at least some of the photodetectors."

209. In my opinion, *Kuboi* discloses this additional limitation.

210. As I explained for claim [1g], *Kuboi*'s electrodes 22 and 23 are "electrical contacts." *Supra* XI.A.1.i. *Kuboi* discloses that a "necessary voltage" is applied between upper and lower electrodes 22, 23 so that p^+-type region 18 is at a

negative potential and n^+-type region 17 is at a positive potential. *Kuboi*, ¶[64]. In my opinion, because electrodes 22 and 23 are positioned on opposite sides of photoelectric conversion portions 14 (photodetectors) of pixels (53G, 53R) as shown below, one skilled in the art would have known that the voltage applied between electrodes 22, 23 provides an electric field across those photodetectors. *Supra* XI.A.1.i (claim [1g]).



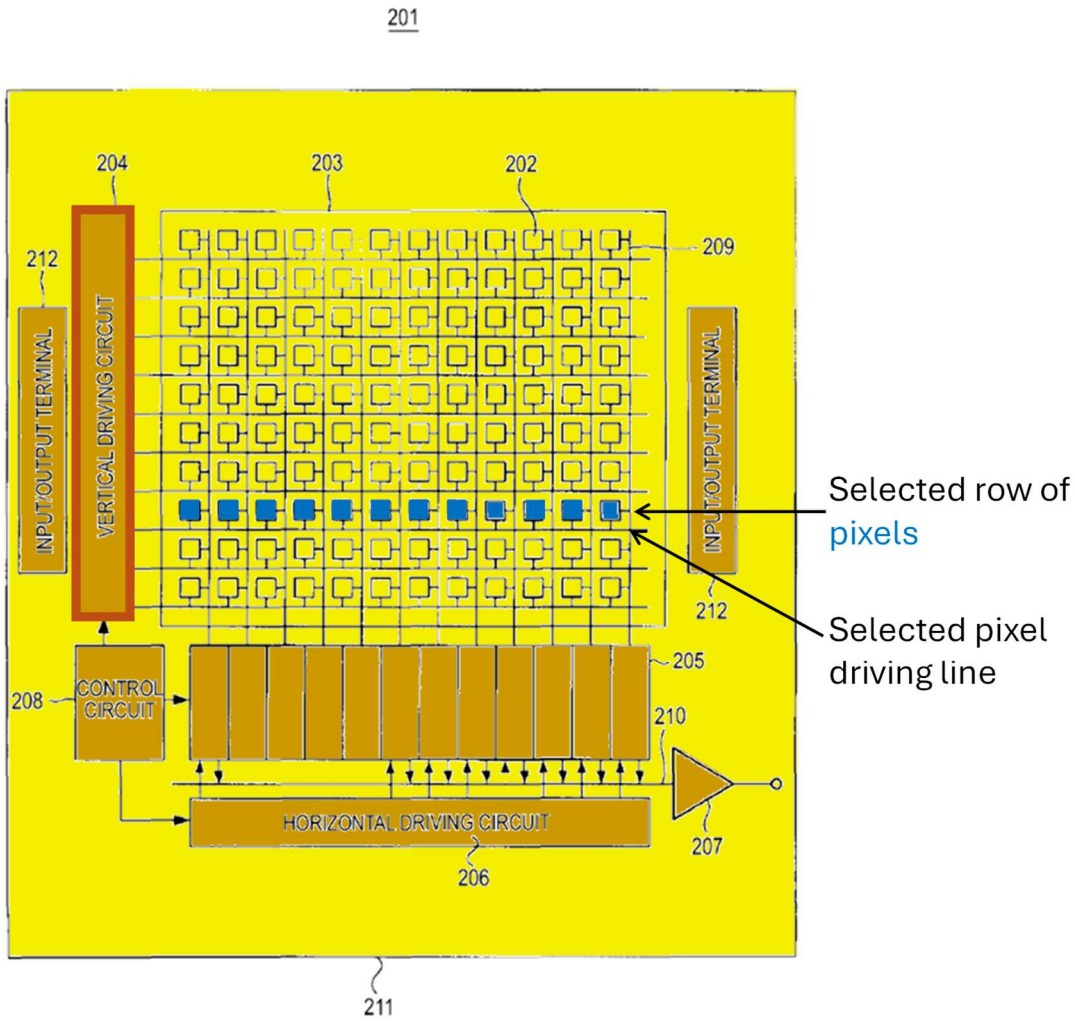
Kuboi, Fig. 6A.

211. As I also explained for claim [1g], in *Kuboi*, the "necessary voltage" applied for reverse biasing is selected based on operating conditions. *Supra* XI.A.1.i. In my opinion, one skilled in the art would have understood that varying

the bias voltage alters the strength of the electric field generated within the device. For instance, a higher reverse bias intensifies the electric field, while lower bias weakens it. As Ex. 1032 explains, "[t]he electric field is proportional to the applied bias in devices." Ex. 1032, 1; *see also* Ex. 1032, 4-6, 10. Thus, one skilled in the art would have known that, by applying a "necessary voltage" for biasing, *Kuboi*'s electrodes 22 and 23 are arranged to selectively provide electric fields across at least some of the photodetectors.

212. Additionally, *Kuboi* discloses that its vertical driving circuit 204 activates a selected row of pixels by selectively applying voltage pulses to the upper and lower electrodes 22, 23 of pixels 202 in the selected row through the "selected pixel driving line," thereby establishing a reverse bias and generating an electric field across just those pixels. *Kuboi*, ¶¶[51], [64]. For example, by selectively applying a voltage pulse to the "selected pixel driving line" identified in the figure below, a reverse bias is applied and an electric field is generated across only the selected row of pixels identified in the figure below.

FIG.15



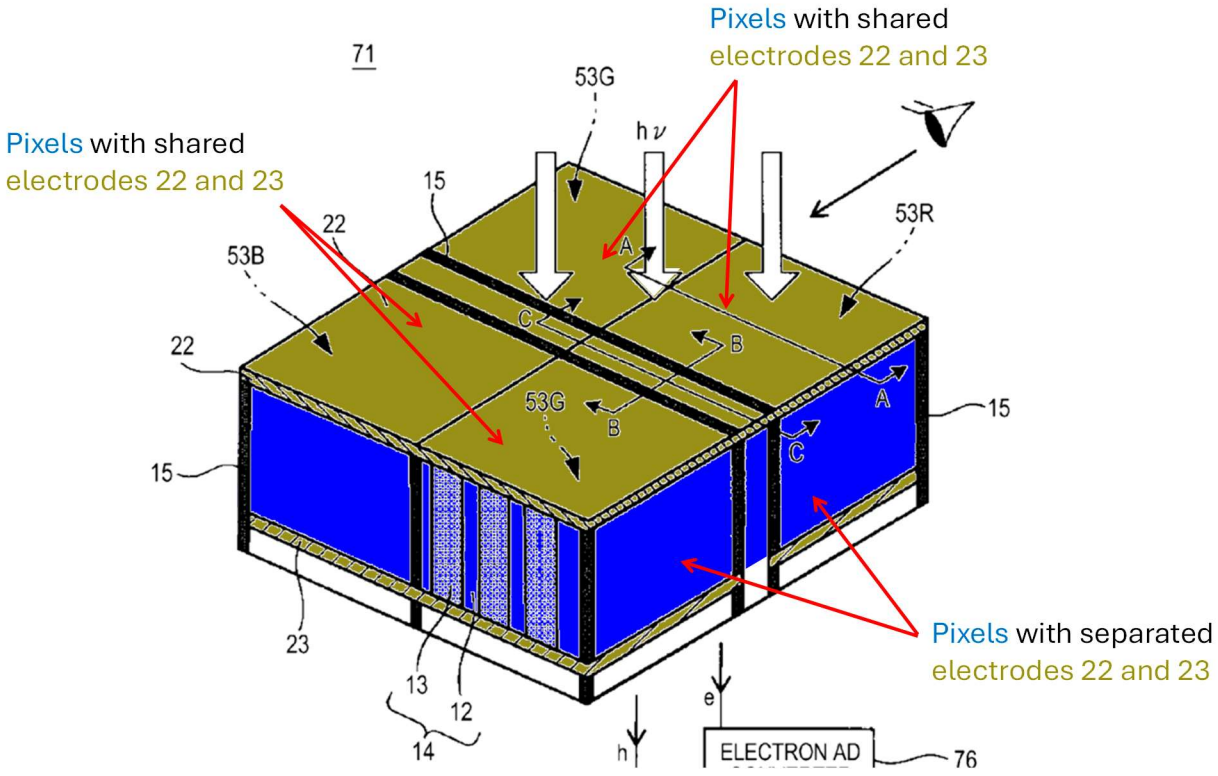
Kuboi, Fig. 15.

213. The concept of selectively applying reverse bias to specific pixel rows aligns with established CMOS image sensor design practices, which commonly incorporate row-level control to manage dynamic range, reduce power consumption, and enhance signal fidelity. For instance, a 2008 patent publication by the same assignee as *Kuboi* (Ex. 1055) describes a CMOS image sensor architecture similar to that disclosed in *Kuboi*'s Figure 15. In particular, Ex. 1055,

¶[78], explains that to achieve high-speed pixel signal readout, the pixel cells arranged in a two-dimensional array are accessed row by row. During vertical scan-and-read, all pixels in one selected row are accessed in parallel, and their analog signals are read via corresponding vertical signal lines. This row-wise access mechanism inherently supports selective control—such as reverse biasing—at the row level. *Kuboi*'s disclosure builds upon these foundational principles, and its selective biasing approach reflects broader industry trends toward more granular pixel-level control.

214. To enable this selective application of voltage pulses to only the pixels in a selected row, *Kuboi* illustrates a pair of adjacent pixels (53B and 53G in the figure below) as sharing their upper and lower electrodes 22 and 23 and separated from the electrodes 22 and 23 of an adjacent pair of pixels (53G and 53R in the figure below).

FIG.13



Kuboi, Fig. 13 (cropped).

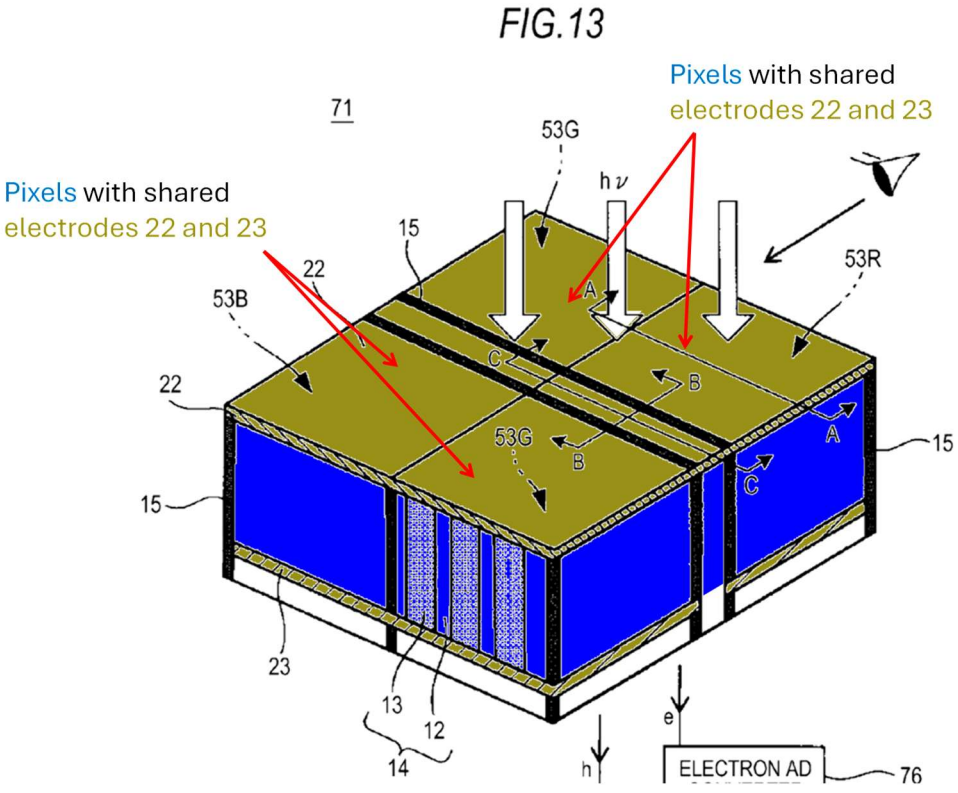
215. In my opinion, one skilled in the art would have understood that because *Kuboi* allows selective reverse biasing of pixels in a selected row, electrodes 22 and 23 (electrical contacts) are configured to selectively provide electrical fields across the photoelectric conversion portions of the selected row of pixels.

5. Claim 8

a. "The integrated structure of claim 1, in which two or more of the photodetectors share one of the electrical contacts."

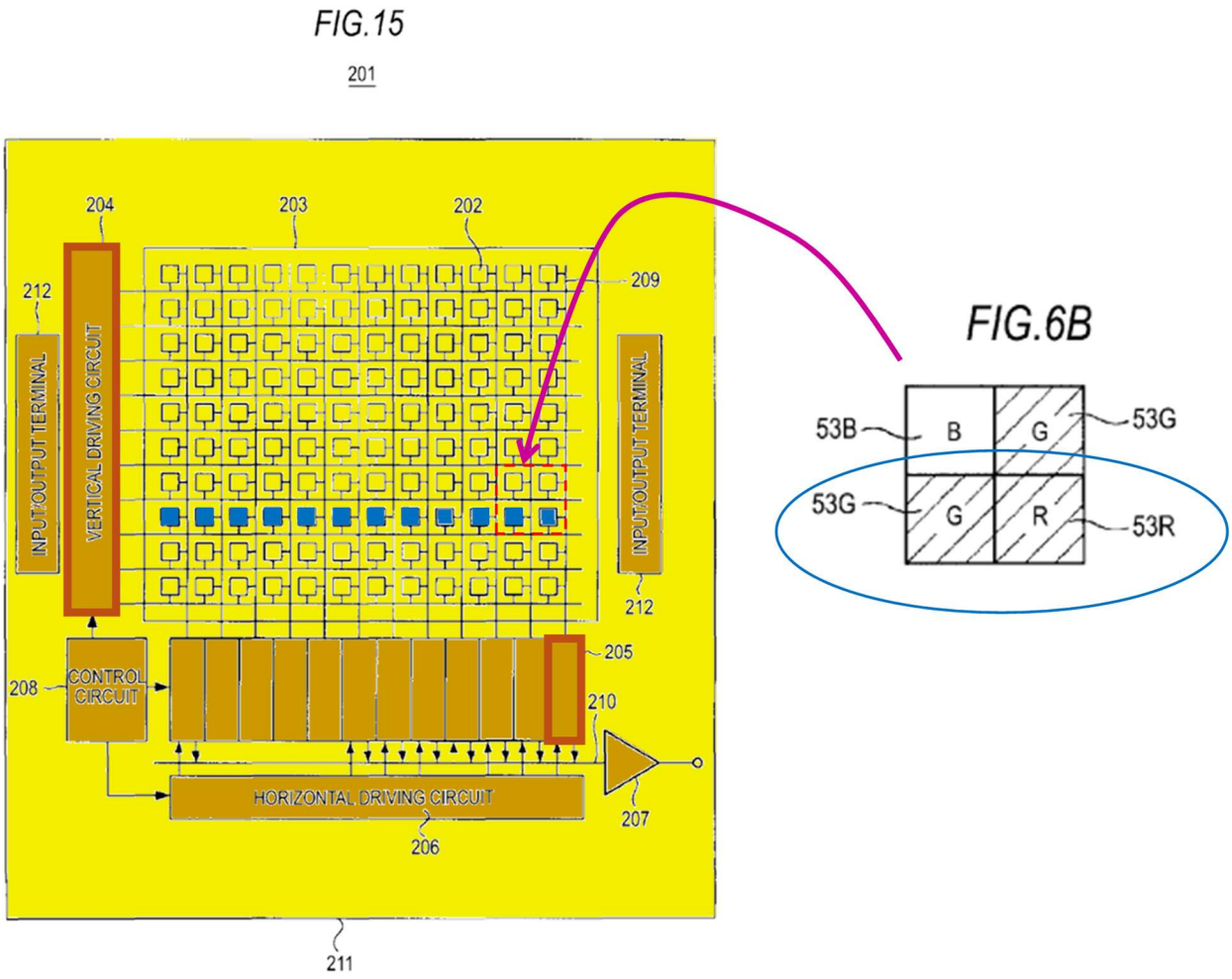
216. In my opinion, *Kuboi* discloses this additional limitation.

217. As I explained for claim [1g], *Kuboi*'s electrodes 22 and 23 are "electrical contacts." *Supra* XI.A.1.i. As I also explained for claim 7, *Kuboi* illustrates a pair of adjacent pixels 53B and 53G sharing their upper electrodes 22 and lower electrodes 23, and another pair of adjacent pixels 53G and 53R as sharing their electrodes 22, 23. *Supra* XI.A.4.a. In my opinion, one skilled in the art would have known that the photoelectric conversion portions (photodetectors) of pixels 53B and 53G share their upper electrodes 22 and lower electrodes 23, and the photoelectric conversion portions (photodetectors) of pixels 53G and 53R share their upper electrodes 22 and lower electrodes 23.



Kuboi, Fig. 13 (cropped).

218. Moreover, as I explained for claim 7 (*supra* XI.A.4.a), vertical driving circuit 204 activates a selected row of pixels by simultaneously applying voltage pulses to the upper and lower electrodes 22 and 23 of all the pixels 202 in the selected row. *Kuboi*, ¶¶[51], [64].



Kuboi, Figs. 15, 6B.

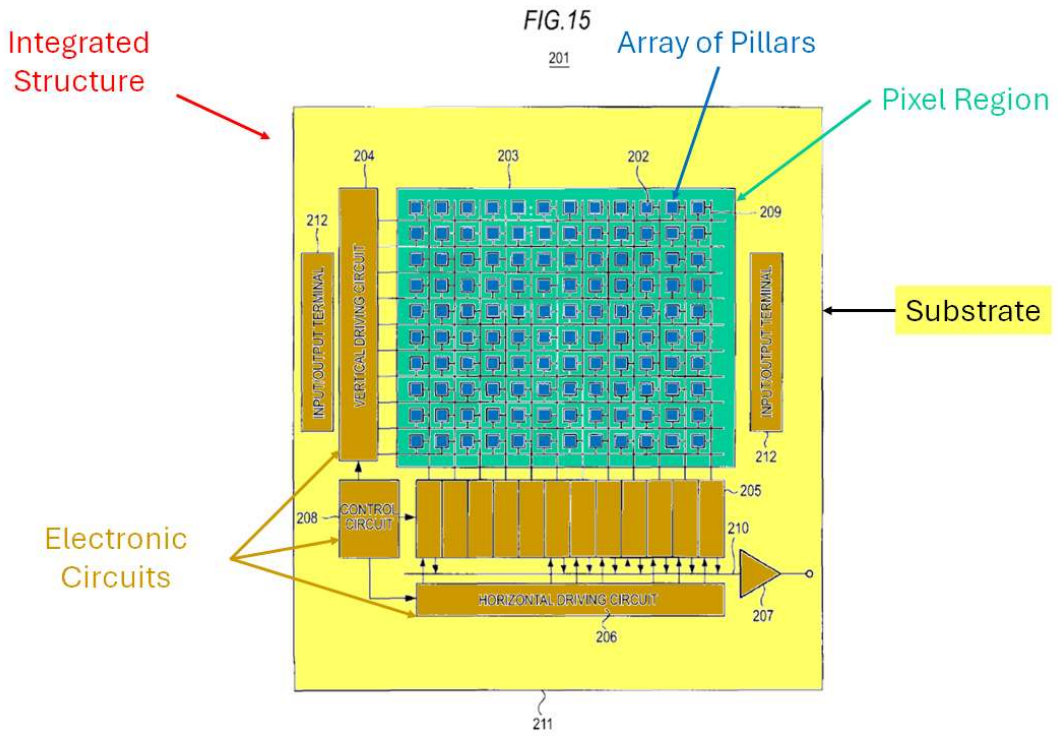
219. One skilled in the art would have understood that, when the group of pixels of Figures 6A-6B are incorporated into imaging device 201 (as illustrated above), all pixels 202 in the selected row—including pixels 53G and 53R circled in

Figure 6B above—would share common upper electrodes 22 and lower electrodes 23. *Supra* VIII.A. One skilled in the art would have recognized that this shared configuration of the electrodes 22 and 23 enables vertical driving circuit 204 to apply a voltage bias simultaneously across the selected row of pixels. *Kuboi*, ¶[51].

6. Claim 9

a. "The integrated structure of claim 1, wherein the array is monolithically integrated with Si electronic devices for signal processing and transmission."

220. *Kuboi* discloses this additional limitation. As explained for claim 2 (*supra* XI.A.2.a), *Kuboi*'s pixel region 203 (i.e., array of pillars) is monolithically integrated with the peripheral circuit portion (including logical circuits 204-208 with Si electronic devices) on silicon substrate 211. *Kuboi*, ¶¶[48]-[49]. *Kuboi* also discloses that the "peripheral circuit portion is configured to include so-called logical circuits, for example, a vertical driving circuit 204, column signal processing circuits 205, a horizontal driving circuit 206, an output circuit 207, a control circuit 208, and the like," such as input/output terminal 212. *Kuboi*, ¶[49].



Kuboi, Fig. 15.

221. *Kuboi* discloses that, within the peripheral circuit portion, column signal processing circuits 205 "perform signal processing such as noise removal" on the signals received from pixels 202. *Kuboi*, ¶[52]. *Kuboi* further discloses that the resulting signals are then forwarded to output circuit 207, which performs additional signal processing "and outputs the processed signals." *Kuboi*, ¶¶[49], [53]-[54]. As I also discussed above, *Kuboi*'s circuits 204-208 would include Si electronic devices. *Supra* XI.A.2.a (claim 2); Ex. 1011, 3. In my opinion, one skilled in the art would have understood that *Kuboi*'s column signal processing circuits would constitute the claimed electronic devices for signal processing. This is supported by other prior art that would have been known to one skilled in the art.

For example, Ex. 1011 discloses that signal processing is "a generic term that refers to any technique that manipulates the signal, including but not limited to signal averaging, signal conditioning[,] and signal recognition." Ex. 1011, 10. Thus, because column signal processing circuits 205 include devices that process signals by removing noise, one skilled in the art would have understood that *Kuboi*'s circuits 205 would include devices for signal processing.

222. *Kuboi* also discloses that output circuit 207 outputs the processed signals and that "input/output terminal 212 exchanges signals with an external device." *Kuboi*, ¶[54]. In my opinion, one skilled in the art would have understood that *Kuboi*'s output circuit and input/output terminal would include devices for signal transmission. This is supported by other prior art that would have been known to one skilled in the art. For example, Ex. 1011 discloses that transmission is "the act of sending information from one location to another." Ex. 1011, 11. Because *Kuboi*'s output circuit and input/output terminal send signals out from *Kuboi*'s imaging device, one skilled in the art would have understood these circuits as including devices for signal transmission. As I explained above, *Kuboi*'s output circuit and input/output terminal would include Si electronic devices because the electronic devices in the output circuit and input/output terminal are formed on a silicon substrate. *Supra* XI.A.2.a (claim 2).

223. Thus, in my opinion, in *Kuboi*, the array of pixels is monolithically integrated with Si electronic devices for signal processing and transmission.

7. Claim 10

a. "The integrated structure of claim 1, wherein the array is monolithically integrated with Si electronic devices for transmitting electrical signals related to accumulations of the charge carriers in at least some of the photodetectors."

224. *Kuboi* discloses this additional limitation. As explained for claim 9 (*supra* XI.A.6.a), *Kuboi*'s array of pixels is monolithically integrated with Si electronic devices for signal processing and transmission. *Kuboi*, ¶¶[48]-[54]. In my opinion, one skilled in the art would have recognized that the processed signals output by output circuit 207 are processed electrical signals related to the accumulations of charge carriers in the photoelectric conversion portions (photodetectors) of the pixels. *Supra* XI.A.1.d (claim [1b]).

225. *Kuboi* discloses that incident light enters the photoelectric conversion films 13 within the photoelectric conversion portion (photodetector) of a pixel, where it undergoes photoelectric conversion to generate electron-hole pairs (charge carriers). *Kuboi*, ¶[64]. The electrons (e) from these pairs, which function as signal charges, accumulate in a charge accumulation region of the pixel. *Kuboi*, ¶[64]. *Kuboi* discloses that vertical driving circuit 204 then transfers the accumulated pixel signal to the corresponding column signal processing circuit 205, which

performs noise reduction on the received signal. *Kuboi*, ¶¶[51]-[52]; *supra* XI.A.6.a (claim 9). *Kuboi* further discloses that the processed signal is subsequently sent to output circuit 207 for further processing and final output. *Kuboi*, ¶¶[53]-[54].

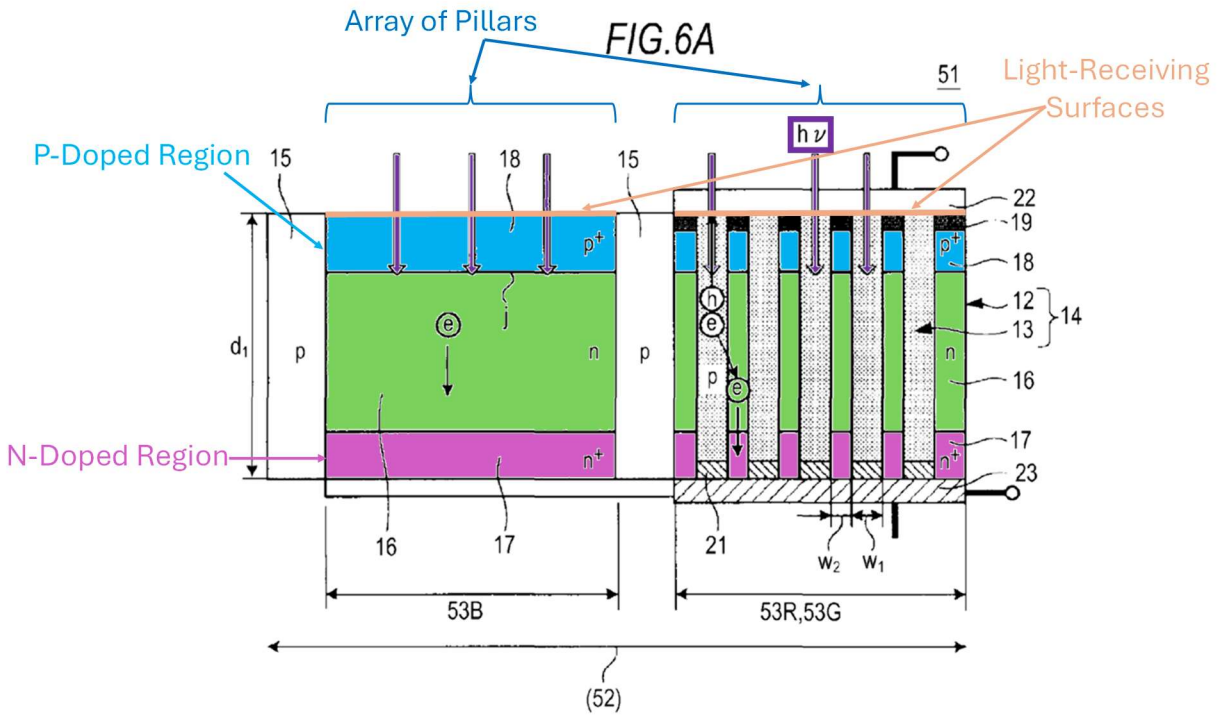
226. As I explained previously for claim 2, circuits 204, 205, and 207 are logic circuits of the peripheral circuit portion that are monolithically integrated with the array of pixels on a single substrate 211. *Supra* XI.A.2.a; *Kuboi*, ¶¶[48]-[49]. Thus, in my opinion, in *Kuboi*, the array of pixels (pixel region 203) is monolithically integrated with Si electronic devices for transmitting electrical signals related to accumulations of the charge carriers in the photoelectric conversion portions of at least some of the pixels.

8. Claim 11

a. "The integrated structure of claim 1, in which each of at least some of the photodetectors is configured such that the light passes through at least a part of the one of the P-doped region and N-doped region of the photodetector before reaching any part of the other doped region of the photodetector."

227. In my opinion, *Kuboi* discloses this additional limitation.

228. As I explained for claim [1b], in *Kuboi*'s semiconductor layer 12, p^+-type region 18 is the "P-doped" region and n^+-type region 17 is the "N doped" region. *Supra* XI.A.1.d; *Kuboi*, ¶¶[55]-[56]. This is illustrated below.



Kuboi, Fig. 6A.

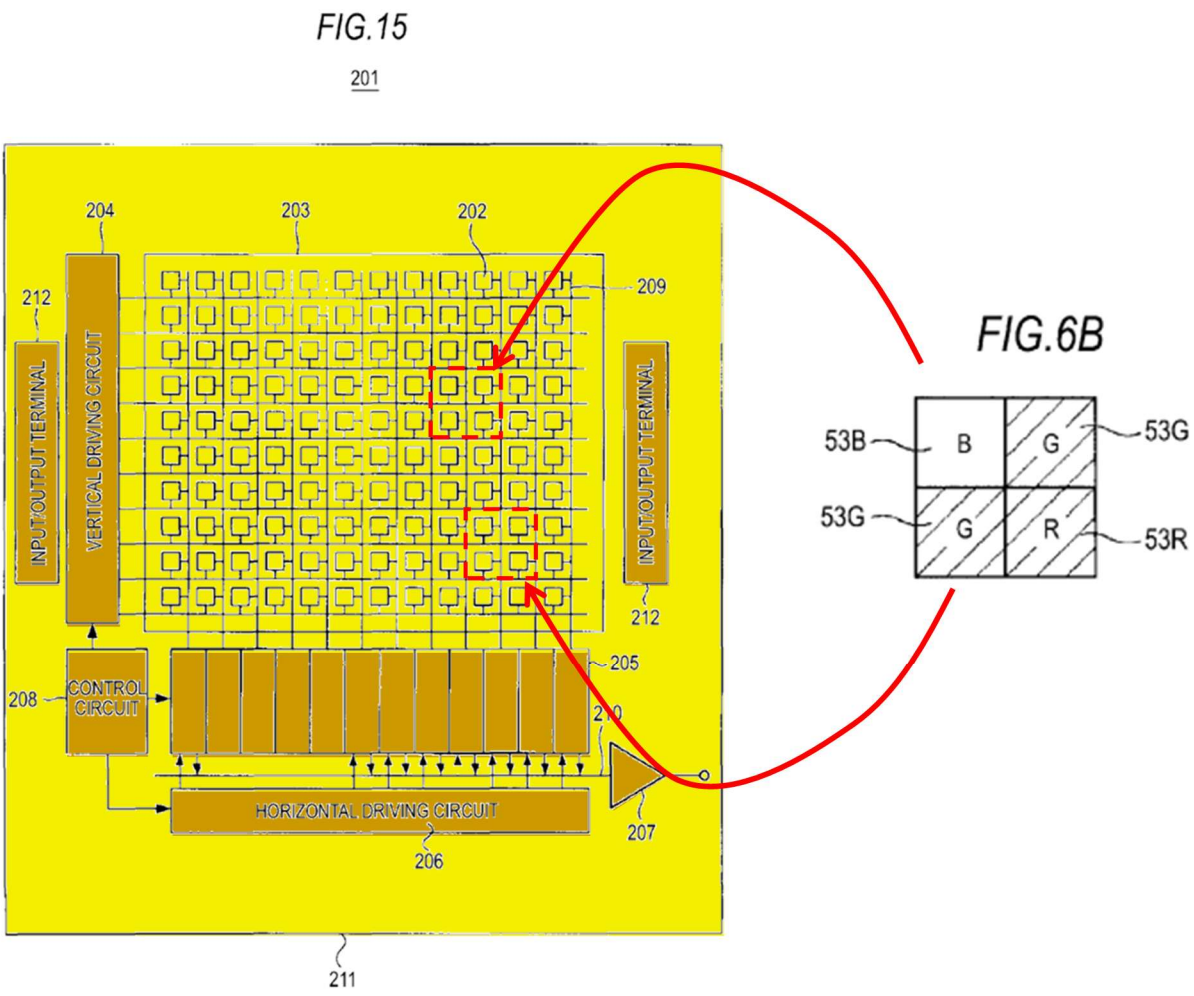
229. *Kuboi* discloses that p^+-type region 18 ("P-doped region") is formed on the side of semiconductor layer 12 where light enters and n^+-type region 17 ("N-doped region") is formed on the side of semiconductor layer 12 where light does not enter. *Kuboi*, ¶[56]. *Kuboi*'s Figure 6A, reproduced above, shows light (hν) entering semiconductor layer 12 of the blue pixel 53B through p^+-type region 18. *Kuboi*, Fig. 6A.

230. Accordingly, in my opinion, one skilled in the art would have recognized that the photoelectric conversion portion (photodetector) of *Kuboi*'s blue pixel 53B is configured such that light passes first through at least a part of the p^+-type region 18 ("P-doped region")—which is "one of" the p^+-type region 18

and n^+-type region 17—of the photodetector before reaching any part of n-type region 16.

231. In my opinion, if the term "other doped region" is construed as the name of a distinct region of the photodetector, then *Kuboi*'s n-type region 16 corresponds to the claimed "other doped region." Alternatively, if "other" in the phrase "other doped region" is construed in a relational sense—that is, to refer to the second of two previously mentioned regions (either the P-doped region or N-doped region)—then, *Kuboi*'s n^+-type region 17 is the claimed "other doped region." One skilled in the art would have recognized that, under either construction, *Kuboi* discloses the limitations of this claim.

232. In my opinion, one skilled in the art would have understood that the phrase "at least some of" encompasses a single occurrence, but even if it is interpreted to require multiple occurrences, one skilled in the art would have recognized that *Kuboi*'s imaging device includes multiple blue pixels 53B. *Kuboi* discloses that Figure 15's imaging device 201 is applicable to all disclosed pixel configurations. *Kuboi*, ¶¶[34], [48]; *supra* VIII.A. Accordingly, in my opinion, one skilled in the art would have understood that the two-dimensional array of pixels 53B, 53G, and 53R (*see Kuboi*, ¶¶[90]-[94]) will be implemented within imaging device 201 as illustrated below.



Kuboi, Figs. 15, 6B.

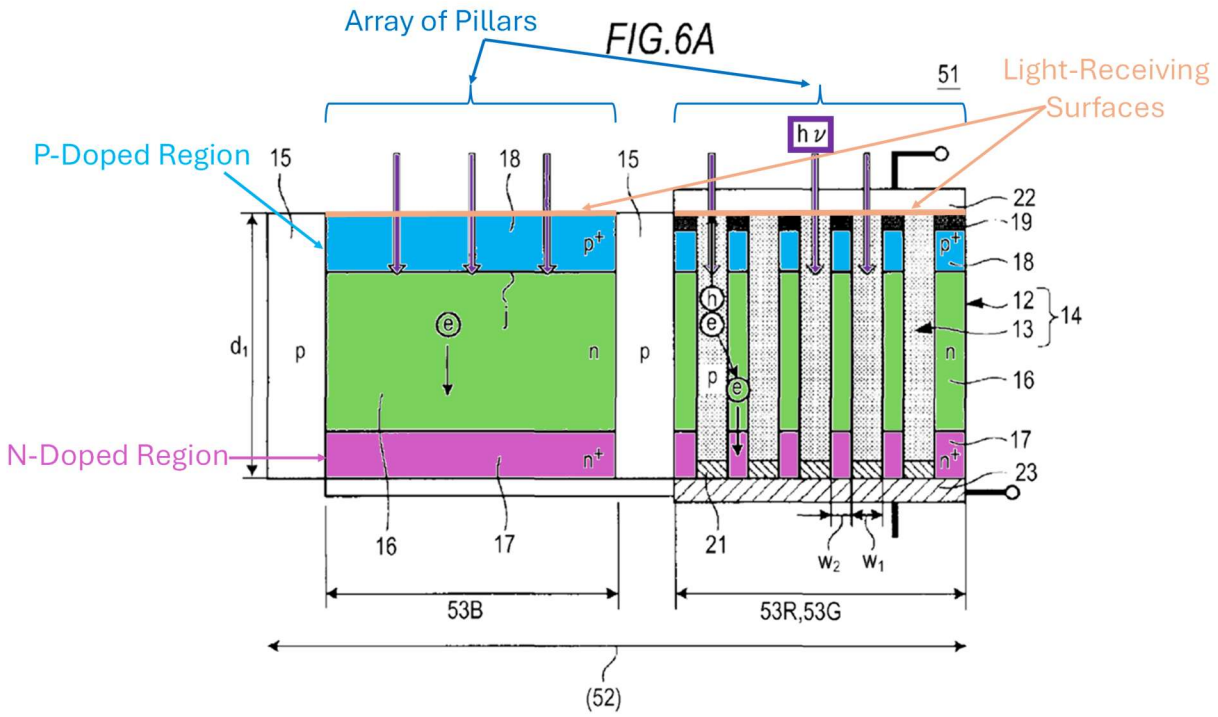
233. Thus, one skilled in the art would have understood *Kuboi*'s imaging device to include multiple blue pixels 53B.

9. Claim 12

a. "The integrated structure of claim 1, in which the doped regions of each of at least some of the photodetectors are configured such that the light passes through at least a part of the P-doped region before reaching any part of the N-doped region."

234. In my opinion, *Kuboi* discloses this additional limitation.

235. As I explained for claims [1b] and 11, in *Kuboi*'s semiconductor layer 12, p^+-type region 18 is the "P-doped" region and n^+-type region 17 is the "N-doped" region, with p^+-type region 18 formed on the side where light enters and n^+-type region 17 formed where light does not enter. *Supra* XI.A.1.d, XI.A.8.a; *Kuboi*, ¶[56].



Kuboi, Fig. 6A.

236. In *Kuboi*, p^+-type region 18 and n^+-type region 17 are positioned on opposing sides of n-type region 16. *See Kuboi*, ¶¶[56], [71]. One skilled in the art would have understood that the photoelectric conversion portion (photodetector) of blue pixel 53B includes a doped region configured such that incident light (hν) first

traverses p^+-type region 18 (P-doped region) before reaching any portion of n^+-type region 17 (N-doped region).

237. And as I explained above, one skilled in the art would have recognized that *Kuboi*'s imaging device includes multiple blue pixels 53B. *Supra* XI.A.8.a (claim 11). Thus, one skilled in the art would have recognized that, in *Kuboi*, the doped regions of each of at least some of the photodetectors are configured such that the light passes through at least a part of the P-doped region before reaching any part of the N-doped region as claimed.

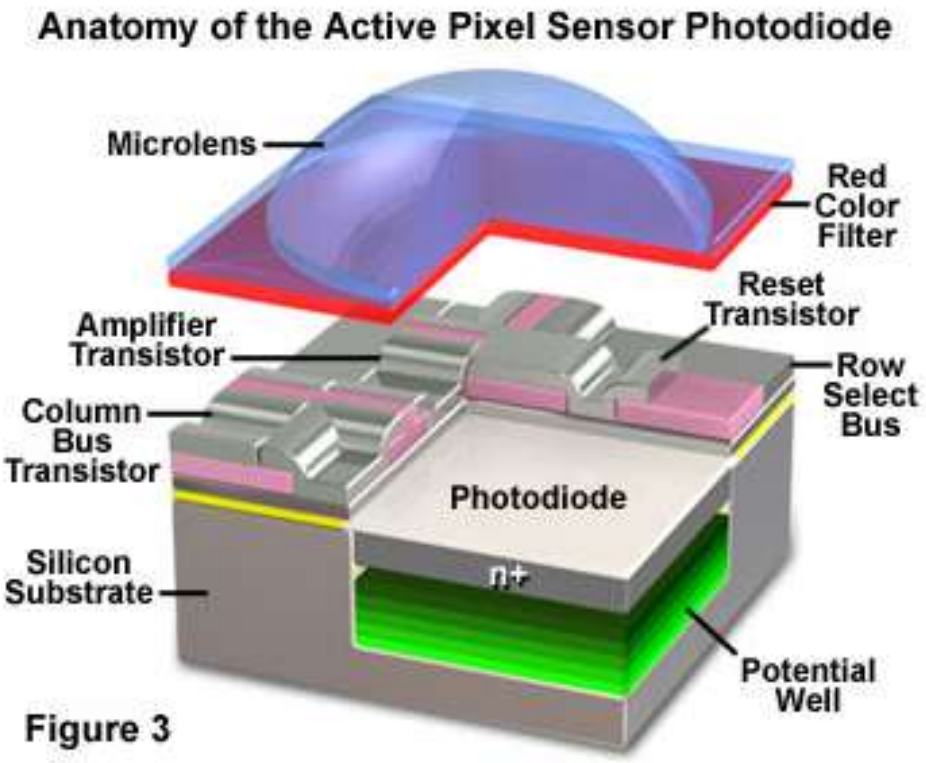
B. Ground 2: Claims 4-6 and 13-16 Are Obvious over *Kuboi* in View of *Vasylyev*

1. *Kuboi* and *Vasylyev* Are Analogous Art to the '948 Patent

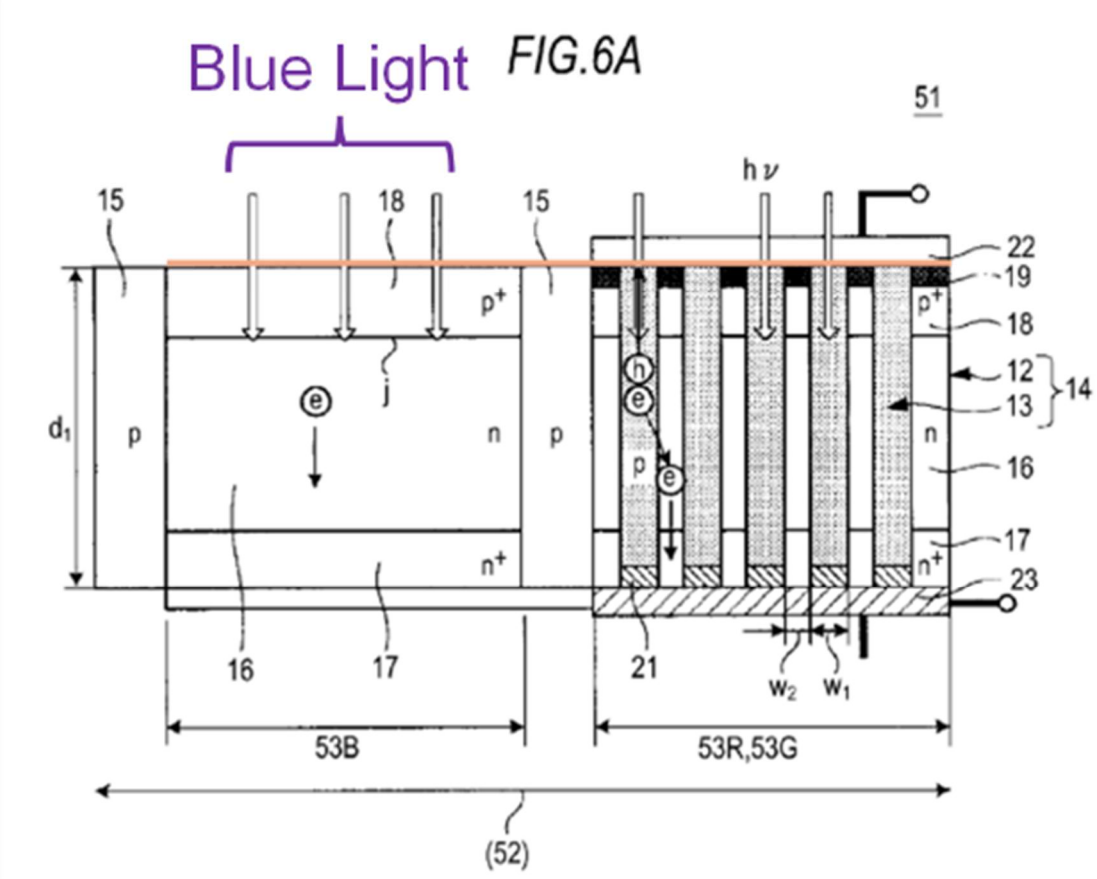
238. One skilled in the art would have understood that *Kuboi* and *Vasylyev* are analogous art to the '948 patent because, like the '948 patent, *Kuboi* and *Vasylyev* seek to improve light absorption efficiency of their respective photoelectric devices. The '948 patent is directed to techniques for enhancing photon absorption. '948 patent, Abstract. Similarly, *Kuboi* is directed to a solid-state imaging device in which light absorption efficiency is increased to improve sensitivity. *Kuboi*, ¶¶[9]-[19]. Likewise, *Vasylyev* discloses techniques to light absorption and energy conversion efficiency in a photoelectric device. *Vasylyev*, ¶[14].

2. Motivation to Apply *Vasylyev*'s Teaching of a Single Light Input Port in Pairwise Optical Relationship with a Microlens to *Kuboi*'s Blue Pixel 53B

239. In *Kuboi*'s Bayer configuration image sensor, blue pixel 53B is positioned beneath an on-chip microlens and corresponding color filter, enabling it to receive light primarily within the blue wavelength range (or blue light). *Kuboi*, ¶¶[90], [107], [120]. This is consistent with other prior art that would have been known to one skilled in the art. For example, to focus the incident light on the photodiode, Ex. 1048 discloses that the photodiode is positioned beneath a microlens and a color filter to capture color information from the incident light. Ex. 1048, 3-4, Fig. 3.



Ex. 1048, 3 (Fig. 3).



Kuboi, Fig. 6A.

240. One skilled in the art would have understood that, in a Bayer configuration image sensor as depicted above, the blue color filter transmits blue light within a wavelength range of approximately 400-500 nm. Ex. 1024, 6 (Fig. 4).

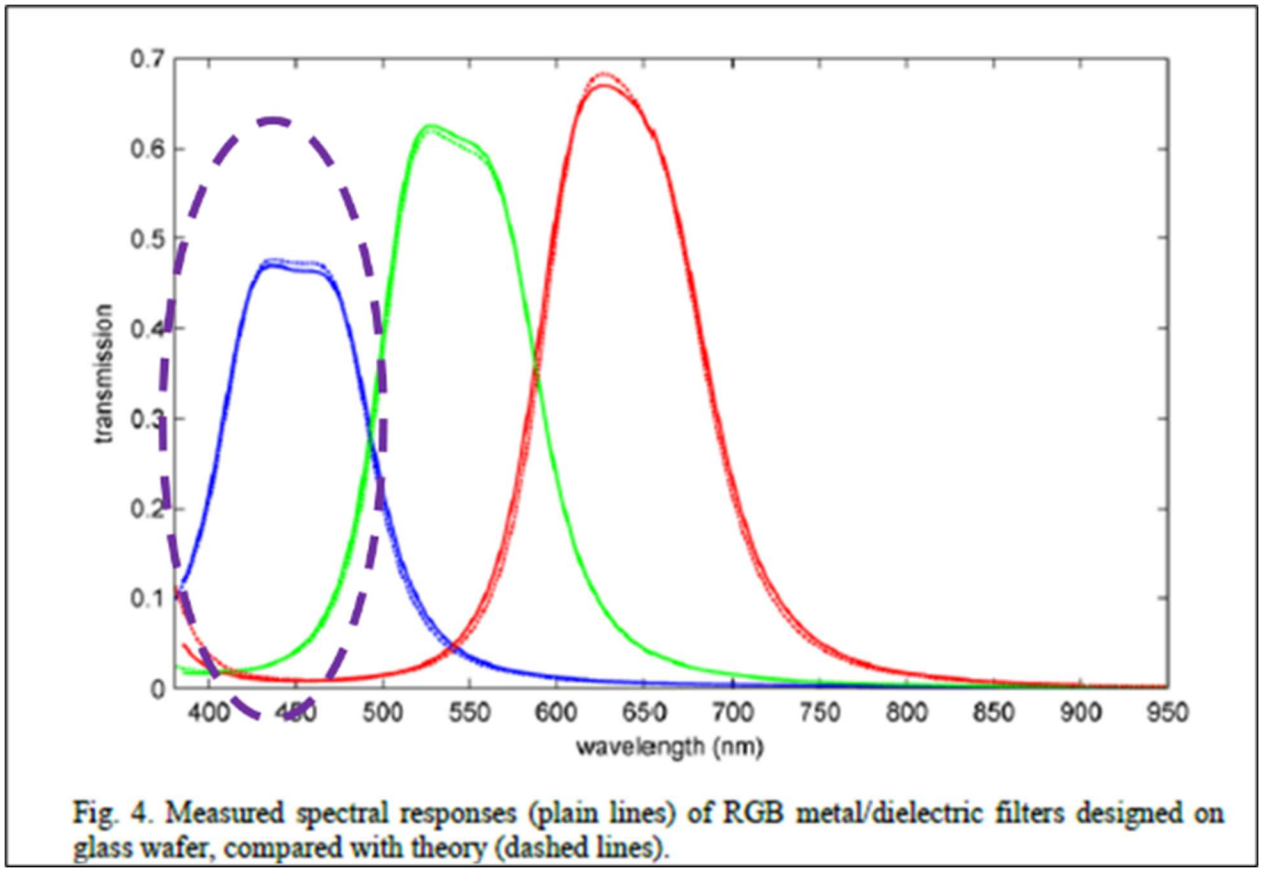


Fig. 4. Measured spectral responses (plain lines) of RGB metal/dielectric filters designed on glass wafer, compared with theory (dashed lines).

Ex. 1024, 6 (Fig. 4).

241. The graph above also shows that light transmission through the blue filter is lower than through the green and red filters, indicating that a greater portion of light is reflected by the blue filter.

242. *Vasylyev* discloses that "bulk crystalline Si, for example, has the refractive index of 3.57 at 1,000 (nanometers) and 5.59 at 400nm which results in the Fresnel reflection of 32% to 49% of the incident light at 1,000nm and 400nm." *Vasylyev*, ¶[12]. Based on *Vasylyev*'s disclosure, one skilled in the art would have understood that at a 400 nm wavelength—falling within the transmission range of a blue color filter—approximately 49% of incident light is reflected off the silicon

light-receiving surface of *Kuboi*'s blue pixel 53B due to Fresnel reflection. *Vasylyev*, ¶[12]; *Kuboi*, ¶¶[90]-[91].

243. *Vasylyev* teaches that incorporating a single port 14 on light-receiving surface 32 of its silicon photovoltaic layer 4, aligned with the optical axis of corresponding lens 10, improves light coupling efficiency by minimizing Fresnel reflection and further enhances light absorption and energy conversion efficiency by confining the incident light between the parallel surfaces of layer 4. *Supra* VIII.B; *Vasylyev*, ¶¶[14]-[16], [93]-[95]. *Vasylyev*'s arrangement is shown below.

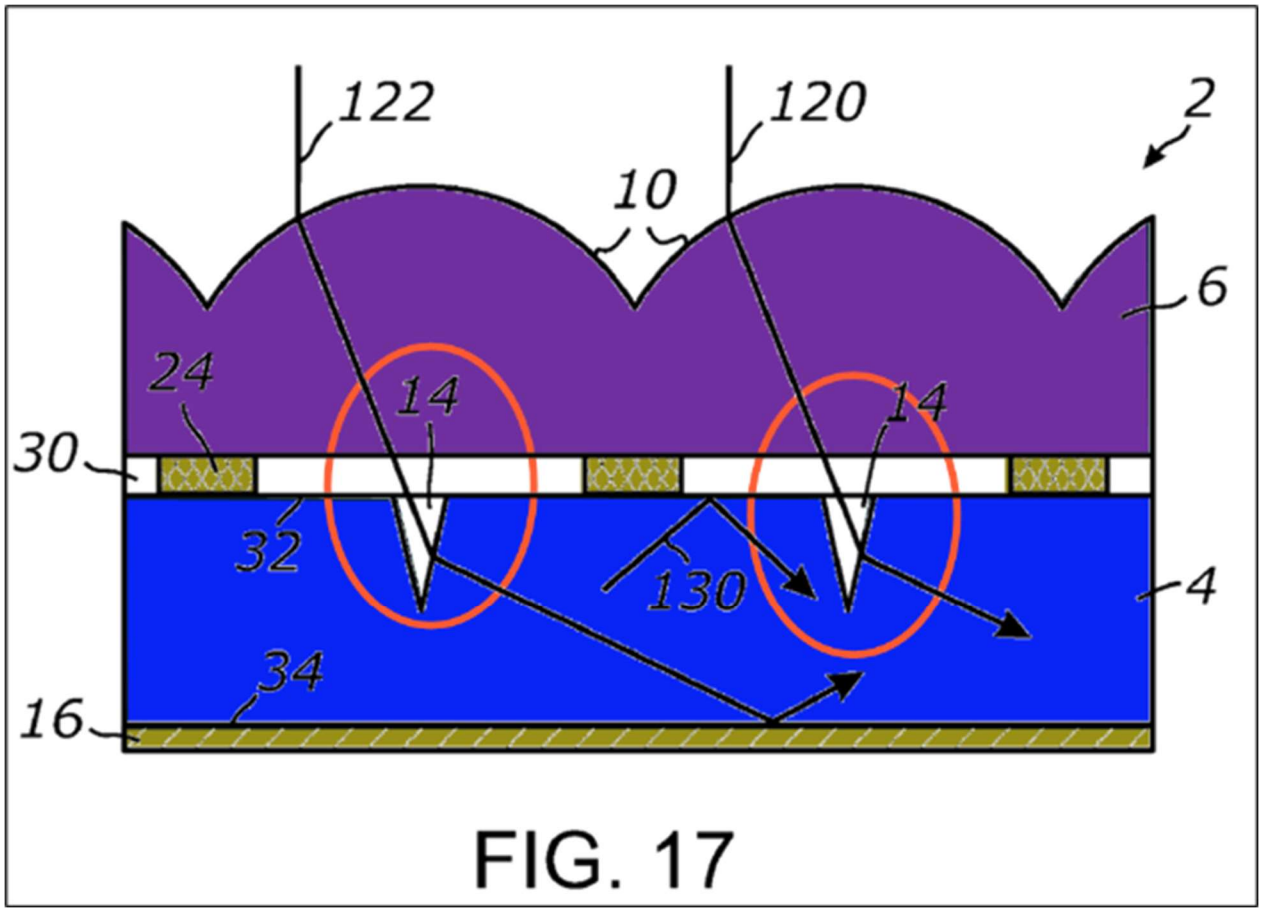
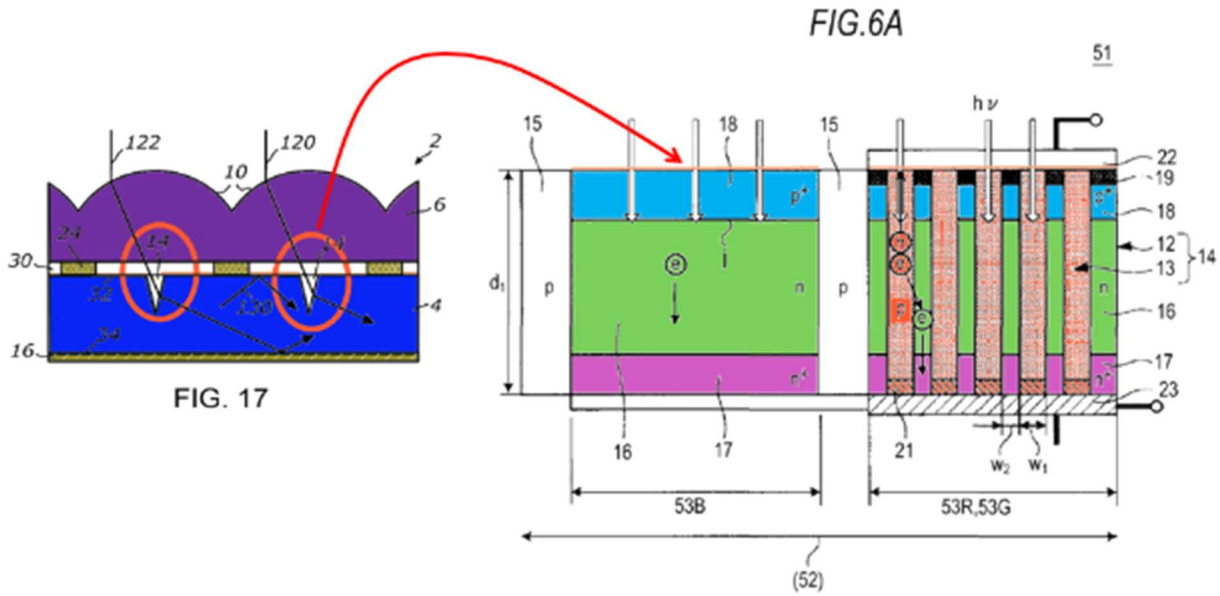


FIG. 17

Vasylyev, Fig. 17.

244. Based on *Vasylyev*'s teachings, in my opinion, it would have been obvious for one skilled in the art to implement single port 14 on the light-receiving surface of semiconductor layer 12 in blue pixel 53B, as depicted below, to enhance light coupling by reducing Fresnel reflection of blue light and to further improve light absorption and energy conversion efficiency of blue pixel 53B by confining the incident light within layer 12.



Vasylyev, Fig. 17 (left); *Kuboi*, Fig. 6A (right).

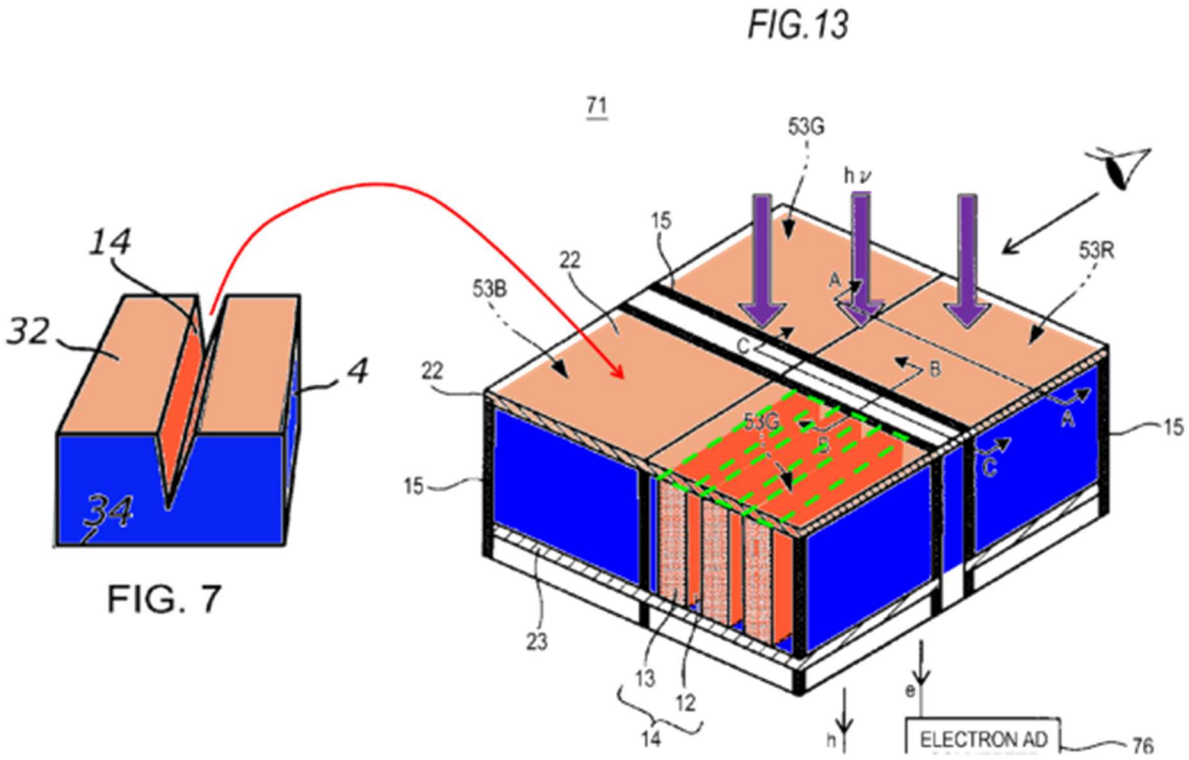
245. Like *Vasylyev*'s photovoltaic layer 4, *Kuboi*'s semiconductor layer 12 forming each blue pixel 53B is a photo-absorptive layer composed of crystalline silicon with a PiN configuration positioned beneath a single lens. *Vasylyev*, ¶¶[65]-[66], [76]-[77]; *Kuboi*, ¶¶[90]-[91], [93]. Moreover, *Vasylyev*'s port 14 is fabricated by dry etching the light-receiving surface, in a manner similar to the

formation of holes 38 in *Kuboi*'s red and green pixels (53R, 53G) adjacent to blue pixel (53B). *Vasylyev*, ¶¶[83], [108]; *Kuboi*, ¶[72].

246. In my opinion, one skilled in the art would have had a reasonable expectation of success in incorporating *Vasylyev*'s port 14 in *Kuboi*'s blue pixel 53B as it constitutes a predictable application of known elements according to their established functions. Both references address optical coupling into a silicon semiconductor layer. *Kuboi*'s blue pixel 53B is designed to receive light in the blue wavelength band. *Vasylyev* teaches that positioning single light input port 14 along the optical axis of a lens enhances light coupling and absorption by reducing Fresnel reflection of blue light and by confining incident light within the active layer. Given that *Kuboi*'s semiconductor layer 12 and *Vasylyev*'s photovoltaic layer 4 perform analogous photoelectric functions, and that *Kuboi* already employs etched holes—similar in function, structure, and fabrication to *Vasylyev*'s light input port 14—in adjacent pixels using a common process, one skilled in the art would have reasonably expected that applying *Vasylyev*'s teachings to *Kuboi*'s blue pixel 53B would predictably result in a single hole on its light-receiving surface with similar performance benefits—without requiring inventive skill or undue experimentation.

247. *Vasylyev* further teaches that each port 14 should have a small transverse dimension to limit surface coverage on light-receiving surface 32, while

remaining large enough to intercept a substantial portion of the incident light; and that such a port may be fabricated as an elongated groove extending along surface 32 to satisfy these criteria. *Vasylyev*, ¶¶[86]-[89], [94].



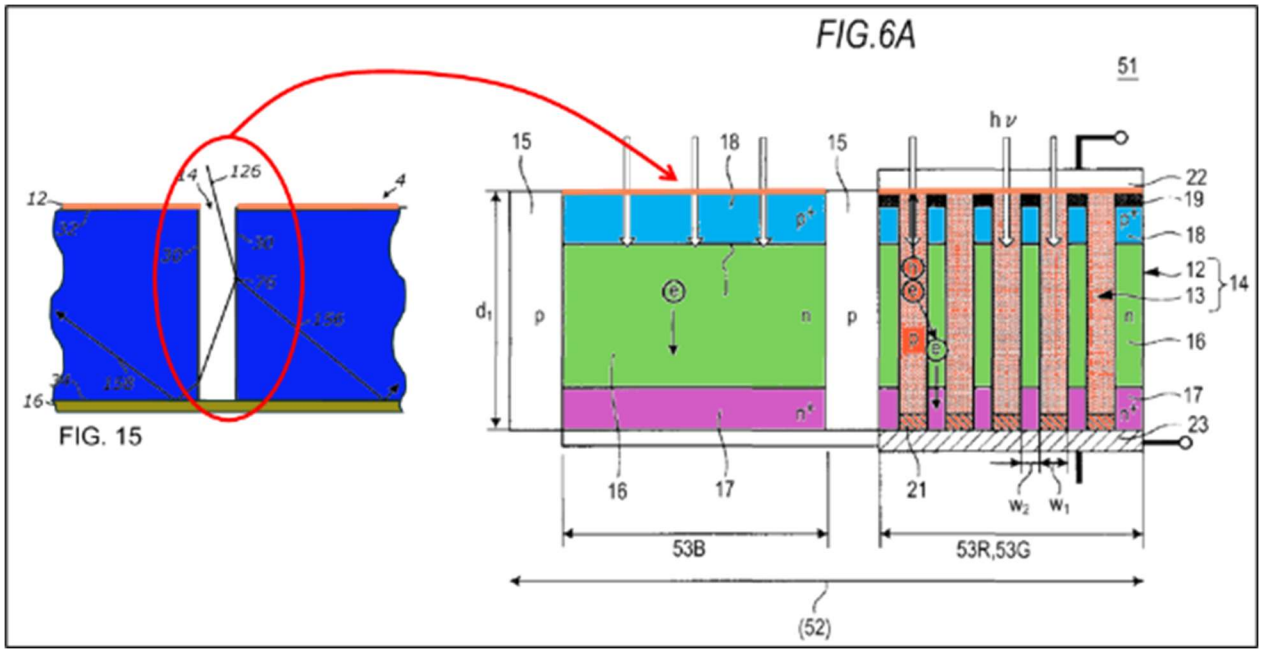
Vasylyev, Fig. 7 (left); *Kuboi*, Fig. 13 (right) (cropped).

248. For example, *Vasylyev* teaches that an elongated configuration of port 14 on surface 32 enhances light absorption efficiency by enabling interception of a substantial portion of incident light while reducing the chance that a light ray propagating within photovoltaic layer 4 will encounter another port and decouple from layer 4.

249. Based on *Vasylyev*'s teaching of port shape, one skilled in the art would have found it obvious to configure *Vasylyev*'s port 14—when incorporated

into *Kuboi*'s blue pixel 53B—with an elongated shape on the light-receiving surface of the pixel's semiconductor layer 12 to similarly enhance light absorption efficiency. Given that *Kuboi* already employs elongated holes 38 in adjacent pixels (53R, 53G) for a similar purpose, and that both *Kuboi*'s holes 38 and *Vasylyev*'s ports 14 are formed using a dry etching process, one skilled in the art would have had a reasonable expectation that implementing *Vasylyev*'s teachings on port 14 in *Kuboi* would predictably result in a single hole with an elongated shape on the light-receiving surface of *Kuboi*'s blue pixel 53B. *Kuboi*, ¶[72].

250. *Vasylyev* further teaches that, as illustrated in Figure 15 below, ports 14 may be fabricated as "deep linear trenches or grooves with vertical or near vertical walls," extending through the full thickness of layer 4 such that—based on optical principles—a light ray entering photovoltaic layer 4 via a vertical trench wall has a greater angle relative to the surface normal than its angle of incidence upon entering port 14, thereby increasing the optical path length within layer 4 and enhancing light absorption. *Vasylyev*, ¶¶[107]-[108], Fig. 15.



Vasylyev, Fig. 15 (left); *Kuboi*, Fig. 6A (right).

251. Based on *Vasylyev*'s port configuration teaching, one skilled in the art would have found it obvious to configure *Vasylyev*'s port 14—when incorporated into *Kuboi*'s blue pixel 53B—as a vertical trench that extends the full depth of the pixel's semiconductor layer 12 to similarly enhance light absorption. One skilled in the art would also have been motivated to configure port 14 in this manner for an additional reason: because *Kuboi*'s elongated holes 38 in adjacent pixels (53R, 53G) extend through the full depth of the respective semiconductor layers and, like *Vasylyev*'s ports 14, are fabricated using dry etching, one skilled in the art would have recognized that etching both cavities to the same depth would enable simultaneous processing in a common fabrication step, thereby simplifying and reducing the cost of manufacturing. *Kuboi*, ¶[72], Figs. 1B, 4B. Given that both

Kuboi's holes 38 and *Vasylyev*'s ports 14 serve a similar function and are formed by the same process, one skilled in the art would have reasonably expected that configuring the single hole formed in *Kuboi*'s blue pixel 53B similar to the holes in the adjacent green and red pixels (53G, 53R) would predictably result in a single hole that extends the full depth of the semiconductor layer 12 of blue pixel 53B.

252. *Vasylyev* additionally teaches encapsulating photovoltaic layer 4 using a transparent buffer layer 30, such as ethylene vinyl acetate (EVA) or optically clear silicone, to protect it from ambient air and moisture while also increasing light trapping in layer 4 via total internal reflection. *Vasylyev*, ¶¶[111], [116]. *Vasylyev* discloses that increasing light trapping increases the light path through layer 4 and thus improves light absorption and energy conversion efficiency. *Vasylyev*, ¶[14]. One skilled in the art would have recognized that, as illustrated below, encapsulating layer 4 in this manner would also result in filling ports 14 on layer 4 with buffer layer 30. *Vasylyev* teaches that buffer layer 30 may comprise ethylene vinyl acetate (EVA) or optically clear silicone. *Vasylyev*, ¶[111]. One skilled in the art would have understood that both materials are widely used as dielectric coatings for encapsulating conductive wiring in optical systems. *See* Ex. 1040, 2-5; Ex. 1041, 2; Ex. 1042, 2 ("EVA … provides good dielectric properties."); Ex. 1045, 7:14-26.

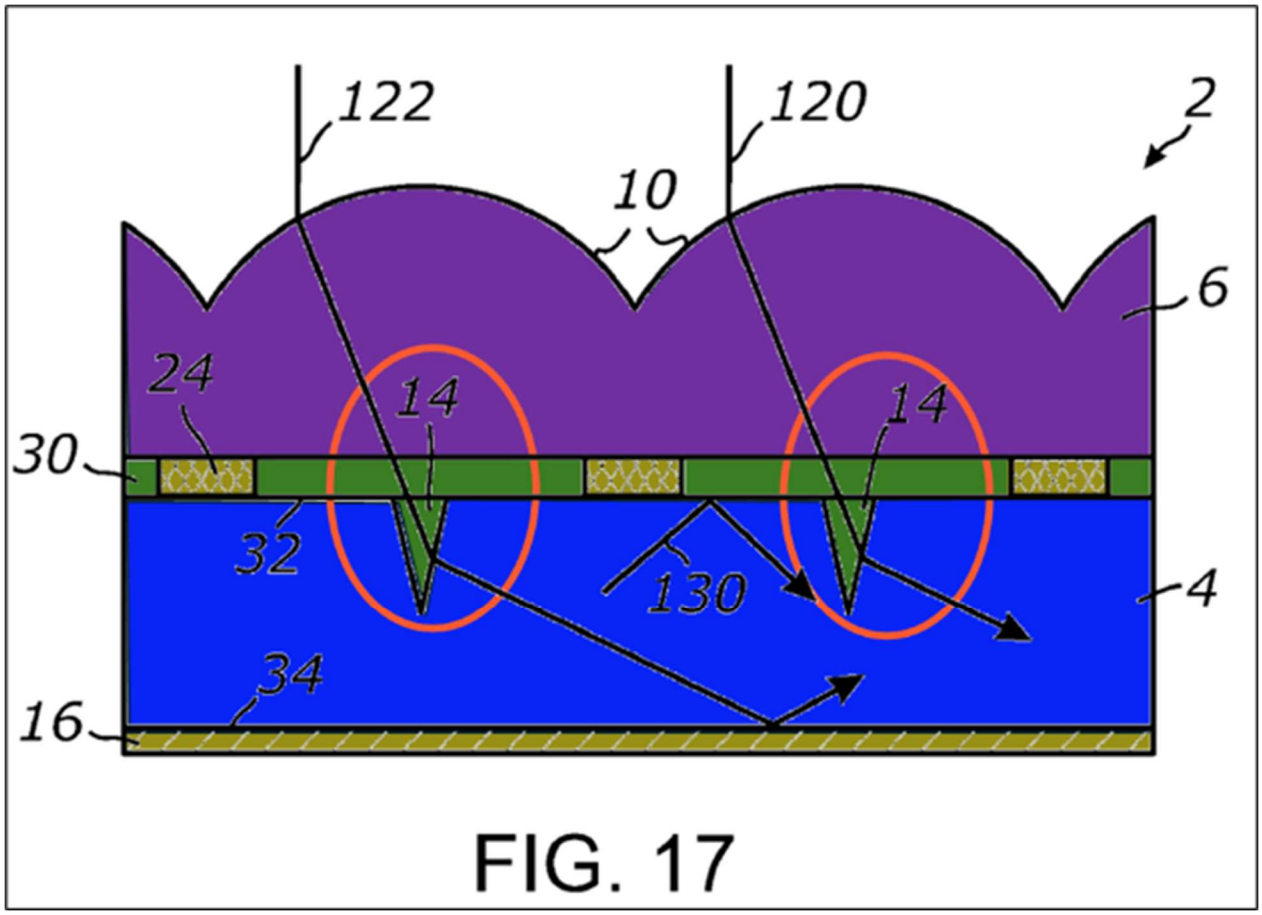


FIG. 17

Vasylyev, Fig. 17.

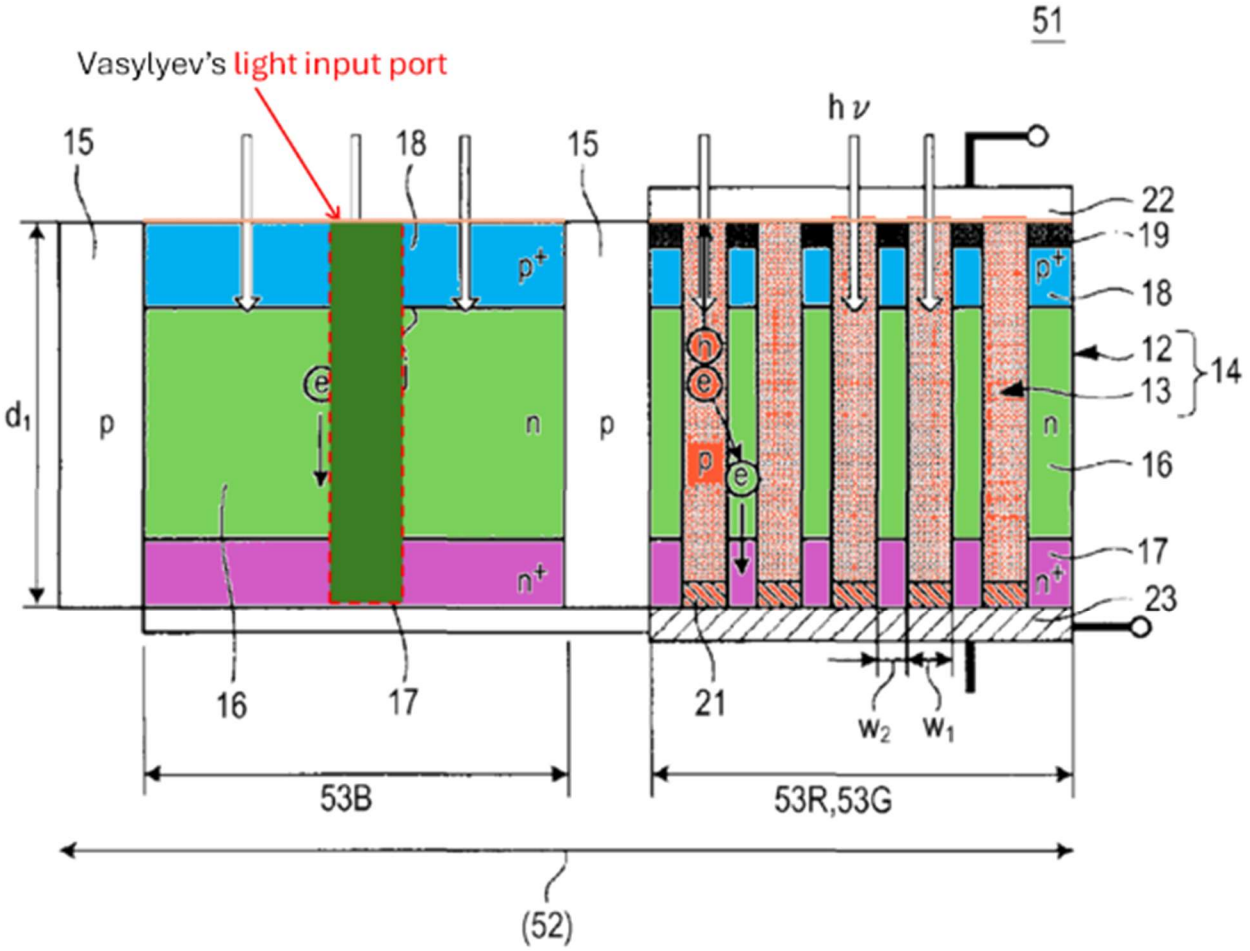
253. In light of *Vasylyev*'s teaching, one skilled in the art would have found it obvious to encapsulate port 14—when implemented in *Kuboi*'s blue pixel 53B—with *Vasylyev*'s transparent buffer layer 30 to similarly shield semiconductor layer 12 of *Kuboi*'s blue pixel 53B from ambient air and moisture while enhancing light trapping and thereby improving absorption and energy conversion efficiency. Moreover, in my opinion, one skilled in the art would have understood that it was well known that dielectric coatings are used "for capping doped films to prevent the loss of dopants, and for passivation to protect devices

from impurities, moisture, and scratches." Ex. 1012, 12. Based on this established understanding, one skilled in the art would have reasonably expected that applying a dielectric coating like *Vasylyev*'s buffer layer 30 over the exposed doped surfaces and port on pixel 53B would preserve dopant integrity and protect the device from environmental degradation. This is nothing more than a predictable use of a known technique to address a known problem—modifying a similar device for a similar purpose to achieve known benefits.

254. Accordingly, as shown below, one skilled in the art would have found it obvious, in view of *Vasylyev*'s teachings, to implement single port 14—structured as an elongated, narrow trench extending through the full thickness of semiconductor layer 12 and encapsulated with *Vasylyev*'s transparent dielectric buffer layer—in *Kuboi*'s blue pixel 53B[2] to enhance the coupling and trapping of blue light and thereby improve absorption and energy conversion efficiency.

[2] This declaration refers to *Kuboi*'s imaging device with a single light input port having this configuration incorporated in blue pixel 53B, based on *Vasylyev*'s teachings, as the *Kuboi-Vasylyev-1* imaging device.

FIG.6A

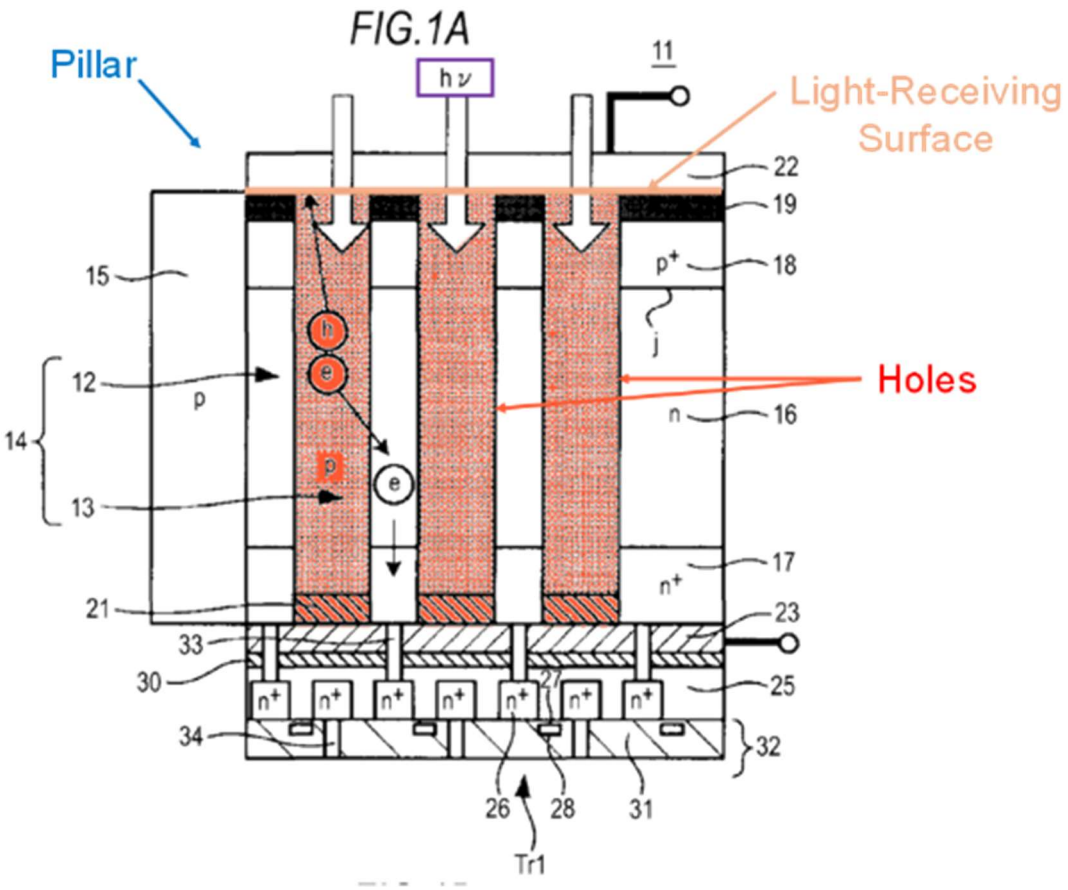


Kuboi, Fig. 6A.

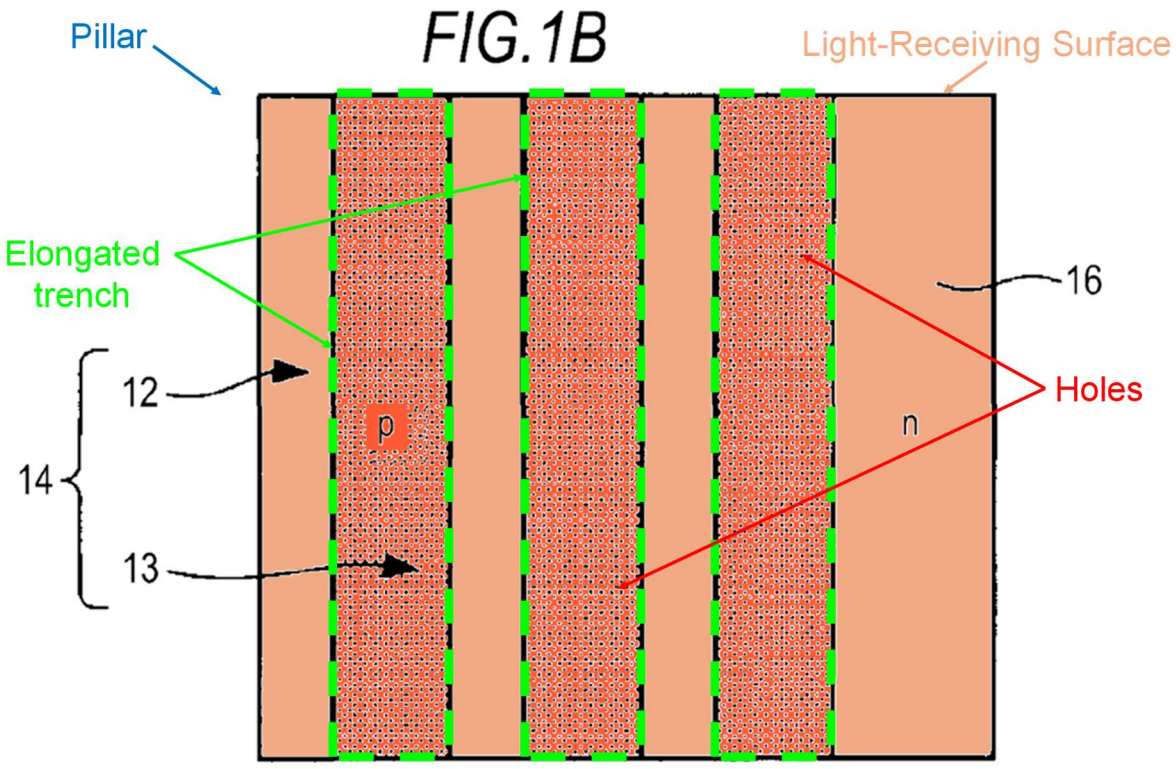
255. One skilled in the art would have reasonably expected success in this *Kuboi-Vasylyev* combination, as it involves the straightforward integration of known elements and fabrication techniques already disclosed by *Vasylyev*.

3. Motivation to Apply *Vasylyev*'s Teaching of a Light Input Port Extending Along a "Substantial Portion" of the Light-Receiving Surface to *Kuboi*'s Green and Red Pixels (53G, 53R)

256. In *Kuboi*'s image sensor, illustrated below, photoelectric conversion portion 14 of green and red pixels (53G, 53R) includes multiple vertical holes 38—such as elongated trenches—formed within semiconductor layer 12, incorporating organic photoelectric conversion film 13 and extending "in a stripe shape" across the entire light-receiving surface of photoelectric conversion portion 14. *Supra* XI.A.1.e (claim [1c], Ground 1); *Kuboi*, ¶¶[72], [90]. *Kuboi* suggests that the shape of the photoelectric conversion film 13 may be modified from a stripe configuration to a shorter form, such as a "dot shape," to improve performance characteristics. *See Kuboi*, ¶[57].


FIG.1A
Pillar
hν
11
Light-Receiving Surface
22
19
18
15
12
p
14
13
h
e
p
e
j
Holes
n
16
17
21
23
33
30
25
27
34
32
26
28
31
Tr1

Kuboi, Fig. 1A.

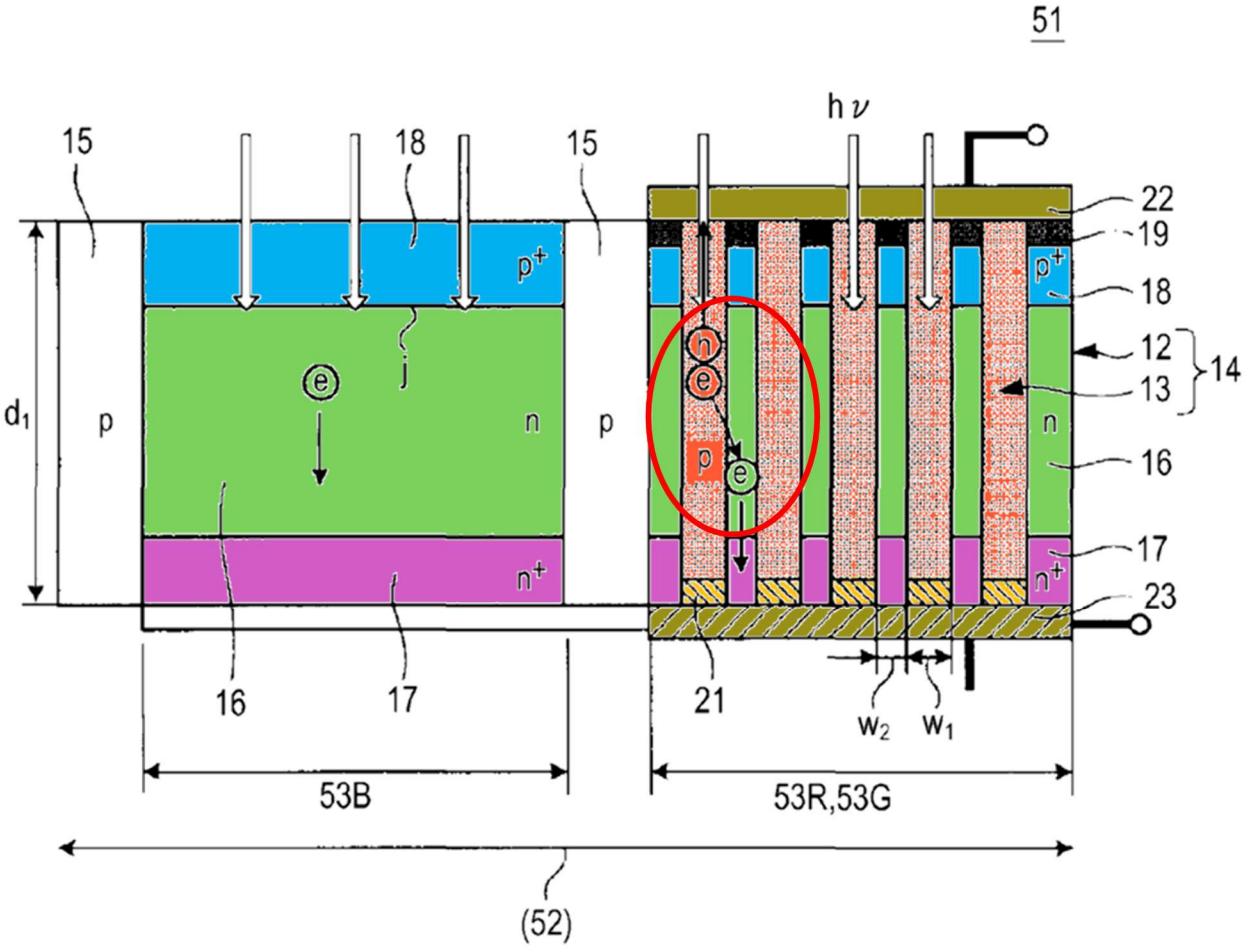


Kuboi, Fig. 1B.

257. In *Kuboi*, light (hν) passes through the on-chip microlens and enters film 13 located in holes 38, where photoelectric conversion occurs, generating electrons (e) that subsequently migrate into semiconductor layer 12 through the film/silicon interface for collection. *Kuboi*, ¶¶[11], [64].

258. According to *Kuboi*, although organic films 13 in green and red pixels (53G, 53R) exhibit greater light absorption than silicon, their electron mobility is comparatively lower, which reduces operational speed. *See Kuboi*, ¶¶[3], [8], [12], [80], [82], [92].

FIG.6A



Kuboi, Fig. 6A.

259. To address this reduction in operational speed, holes 38 are designed to facilitate rapid transfer of the photogenerated electrons from films 13 into semiconductor layer 12. *Kuboi*, ¶¶[8], [12], [65]. *Kuboi* discloses that embedding multiple films 13 within a single pixel serves two purposes: (a) it shortens the average distance electrons must travel to reach the interface with semiconductor layer 12, and (b) it increases the interface area, promoting more efficient electron transfer and improving the device's operating speed. *See Kuboi*, ¶¶[8], [12], [65].

260. *Kuboi* further discloses that increasing the silicon-film interface area beyond the initial configuration amplifies electron transport efficiency, resulting in an even greater improvement in device operating speed. *Kuboi*, ¶¶[8], [68], [72]. To further increase the interface area, a Bosch process may be used to form the holes' vertical walls in a concavo-convex shape. *Kuboi*, ¶¶[67]-[68], Fig. 9.

261. Like *Kuboi*, light enters *Vasylyev*'s photovoltaic layer 4 through its light input ports 14. *Supra* VIII.B; *Vasylyev*, ¶[97]. And like *Kuboi*'s holes 38, *Vasylyev*'s ports 14 (illustrated below) may be formed as "deep linear trenches" on the light-receiving surface 32. *Vasylyev*, ¶¶[107]-[108].

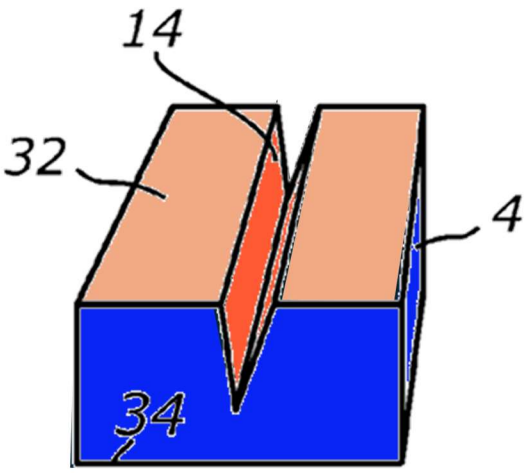


FIG. 7

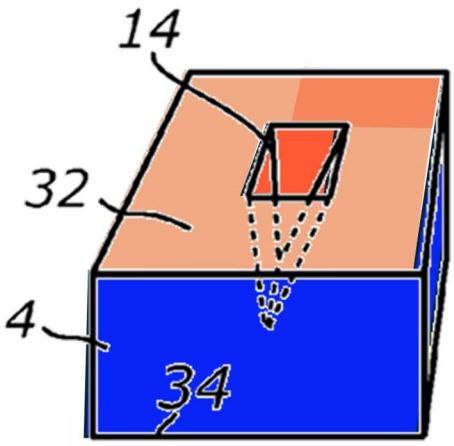
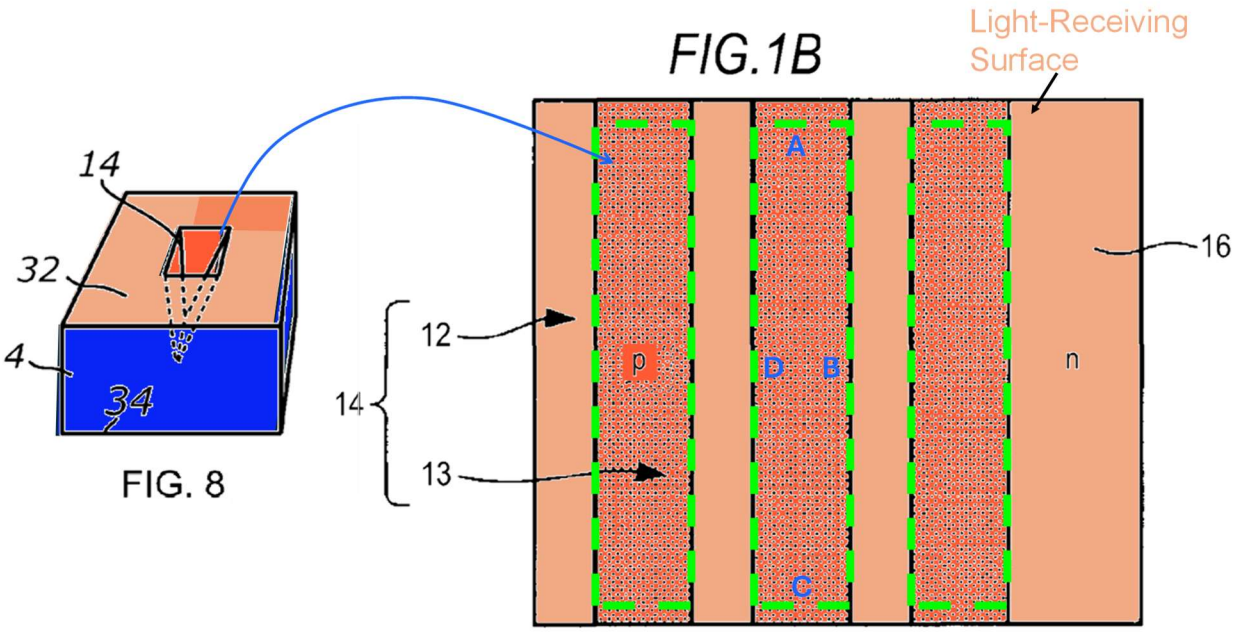


FIG. 8

Vasylyev, Figs. 7-8.

262. *Vasylyev*'s port 14 can extend "all the way along [its light-receiving] surface 32 or its substantial portion." *Vasylyev*, ¶[89].

263. In my opinion, based on *Vasylyev*'s teachings, it would have been obvious to one skilled in the art that extending holes 38 in photoelectric conversion portions 14 of *Kuboi*'s green and red pixels (53G, 53R) along a substantial portion—rather than the full extent—of the light-receiving surface would further reduce the average distance to the silicon-film interface, increase the interface area, and thereby improve device operating speed. *See Kuboi*, ¶¶[8], [68], [72]. Additionally, *Kuboi* explicitly proposes modifying the shape of the films 13 within the holes—such as shortening it from a stripe configuration—to enhance device performance. *Kuboi*, ¶[57].



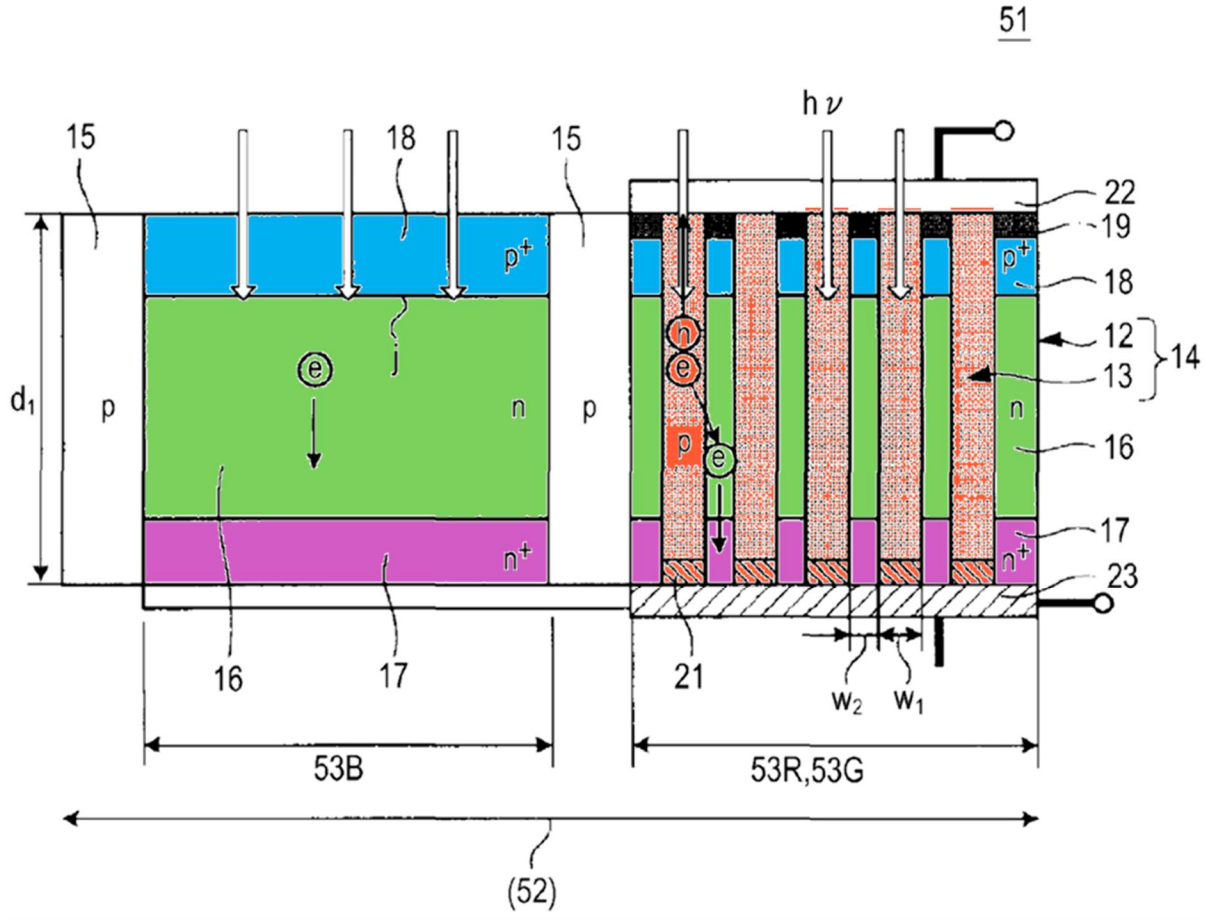
Vasylyev, Fig. 8 (left); *Kuboi*, Fig. 1B (right).

264. In my opinion, one skilled in the art would have recognized that modifying holes 38 in *Kuboi*'s green and red pixels (53G, 53R) in this manner

reduces the distance to the silicon-film interface by enabling electrons generated in film 13 to enter semiconductor layer 12 via the interfaces along edges A and C, in addition to those along edges B and D. Additionally, such a modification to the hole configuration would increase the silicon-film interface area.

265. Photoelectric conversion portion 14 of *Kuboi*'s green and red pixels (53G, 53R) measures 1.4 μm x 1.4 μm, with a 1.4 μm semiconductor layer depth d_1. *Kuboi*, ¶[94].

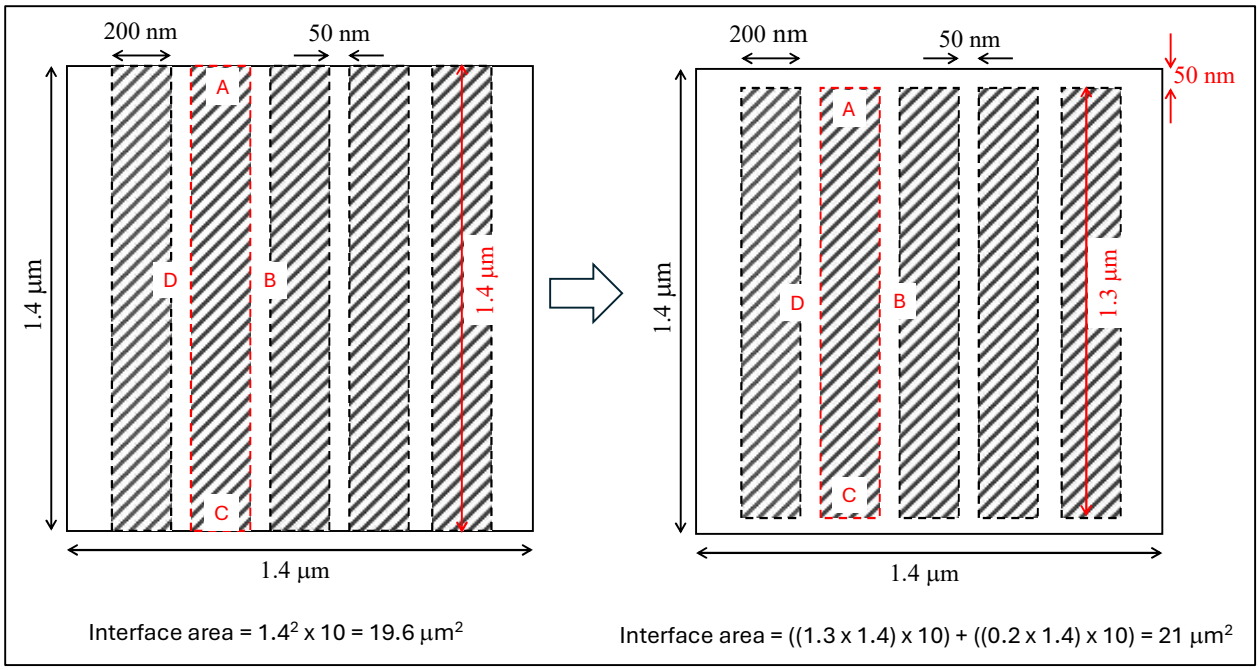
FIG.6A



Kuboi, Fig. 6A.

266. Five photoelectric conversion films 13, each having a 200 nm width (W_1), are embedded in semiconductor layer 12 at a 50 nm spacing (W_2). *Kuboi*, ¶[94]. In this configuration, disregarding the thickness of light shielding film 19 and electron blocking film 21—each measuring only several tens of nanometers (*Kuboi*, ¶¶[73], [75])—the area of the silicon-film interface is approximately 1.4^2 x 5 x 2 = 19.6 μm^2.

267. One skilled in the art would have recognized that modifying *Kuboi*'s holes 38 to extend along a substantial portion of the light-receiving surface—such as 1.3 μm instead of 1.4 μm, as illustrated below—increases the silicon-film interface area by approximately 7%.



268. Accordingly, based on *Vasylyev*'s teachings, it would have been obvious for one skilled in the art to modify holes 38 in *Kuboi*'s green and red

pixels (53G, 53R) to extend along a substantial portion—rather than the entire length—of the light-receiving surface to reduce the average distance to the silicon-film interface, enlarge the interface area, and thereby increase *Kuboi*'s operational speed.[3] *See Kuboi*, ¶¶[8]-[9].

269. One skilled in the art would have recognized that, even though reducing the length of each hole 38 by 100 nm slightly decreases the light incidence area of organic film 13 within hole 38, this reduction would have minimal impact on the light absorption performance of photoelectric conversion portion 14, owing to the high absorption efficiency (α) of organic films 13.

270. One skilled in the art would have had a reasonable expectation of success in incorporating *Vasylyev*'s teaching regarding port 14 in *Kuboi*'s red pixel 53R because it constitutes a predictable application of known elements according to their established functions. Both references address optical coupling into a silicon semiconductor layer using microstructured cavities. Building on *Kuboi*'s teaching that increasing the silicon-film interface enhances electron transport and device speed, one skilled in the art would have understood that applying *Vasylyev*'s

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[3] This declaration refers to *Kuboi*'s imaging device with the holes of green and red pixels (53G, 53R) modified in this manner, based on *Vasylyev*'s teachings, as the *Kuboi-Vasylyev-2* imaging device.

teaching of port 14 to the holes in *Kuboi*'s green and red pixels (53G, 53R) would further improve the imaging device's operating speed. *Kuboi*, ¶¶[8], [68], [72]. Moreover, since *Kuboi*'s semiconductor layer 12 and *Vasylyev*'s photovoltaic layer 4 perform analogous photoelectric functions, and that *Kuboi* already employs etched holes—similar in function, structure, and fabrication to *Vasylyev*'s port 14—in adjacent pixels using a common process, one skilled in the art would have reasonably expected that implementing *Vasylyev*'s teachings in *Kuboi*'s green and red pixels (53G, 53R) would predictably result in holes that extend along less than the full extent of the light-receiving surface of these pixels.

4. Motivation to Additionally Incorporate a Single Light Input Port in the Blue Pixel 53B of the *Kuboi-Vasylyev-2* Imaging Device Based on *Vasylyev*'s Teaching

271. As previously discussed, one skilled in the art would have found it obvious to modify the holes 38 in *Kuboi*'s green and red pixels (53G, 53R) so that they extend across a substantial portion—rather than the full length—of the light-receiving surface, thereby forming the *Kuboi-Vasylyev-2* imaging device with increased operational speed. *Supra* XI.B.3.

272. Based on *Vasylyev*'s teachings, one skilled in the art would have found it obvious to incorporate an additional single light input port 14 into the blue pixel 53B—configured as an elongated hole that extends along a substantial portion—rather than the full length—of the light-receiving surface, penetrates the

full thickness of the semiconductor layer 12, and is encapsulated by *Vasylyev*'s transparent buffer layer 30—to enhance blue light coupling and trapping, thereby improving light absorption and energy conversion efficiency in the *Kuboi-Vasylyev-2* imaging device. *Supra* XI.B.2.

273. One skilled in the art would have understood that Fresnel reflection is greatest for blue light, and the prior art combination reduces the amount of this unwanted Fresnel reflection. Ex. 1039, 2. *Vasylyev* further teaches that up to 49% of incident blue light at 400 nm may be lost due to Fresnel reflection at the surface of the blue pixel 53B. *Vasylyev*, ¶[12]. Accordingly, one skilled in the art would have been motivated to additionally incorporate *Vasylyev*'s single light input port 14 on the light-reflective surface of the blue pixel 53B in the *Kuboi-Vasylyev-2* imaging device to mitigate reflection losses and enhance light coupling and optical efficiency.[4] *Supra* XI.B.2; *infra* XI.B.5.a (claim 4).

274. The holes in green and red pixels (53G, 53R) of the *Kuboi-Vasylyev-2* imaging device extend along a substantial portion—but not the full extent—of the light-receiving surface. *Supra* XI.B.3. One skilled in the art would have found it

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[4] This declaration refers to the *Kuboi-Vasylyev-2* imaging device additionally modified to incorporate a single light input port in the blue pixel (53B) based on *Vasylyev*'s teachings, as the *Kuboi-Vasylyev-3* imaging device.

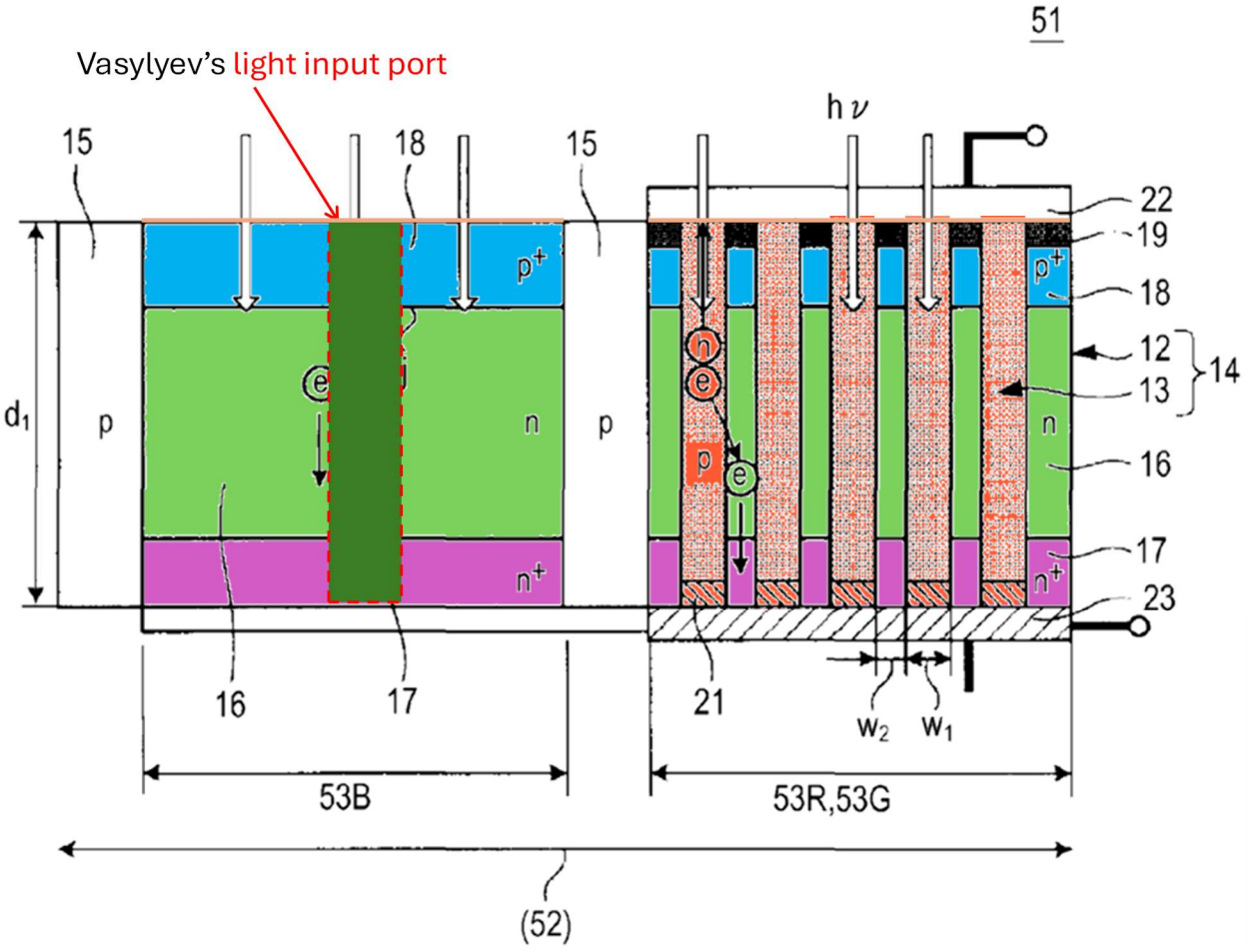
obvious to configure *Vasylyev*'s light input port 14, incorporated in blue pixel 53B of the *Kuboi-Vasylyev-2* imaging device, to match the shape of the holes in adjacent green and red pixels (53G, 53R) to simplify and reduce fabrication costs. One skilled in the art would have recognized that by limiting the lateral extent of *Vasylyev*'s port 14 incorporated in the light-receiving surface of *Kuboi*'s blue pixel, light can enter its photoelectric conversion portion from all four sides of the port rather than just two opposing sides. *Supra* XI.B.3. One skilled in the art would have known that this multidirectional light entry increases the effective optical path length in the photoelectric conversion portion, thereby increasing light trapping and absorption. In contrast, a hole that spans the full width of the light-receiving surface restricts light entry to two sides, reducing the light interaction volume and diminishing absorption efficiency.

275. Moreover, because both *Vasylyev*'s ports and *Kuboi*'s holes are fabricated using dry etching, one skilled in the art would have recognized that shaping and etching the cavities across all pixels in a common masking and etching step would enable simultaneous processing, streamlining fabrication and lowering cost. Given that these cavities serve a similar function of increasing light absorption and are produced using the same technique, one skilled in the art would have reasonably expected that configuring port 14 in the blue pixel 53B to

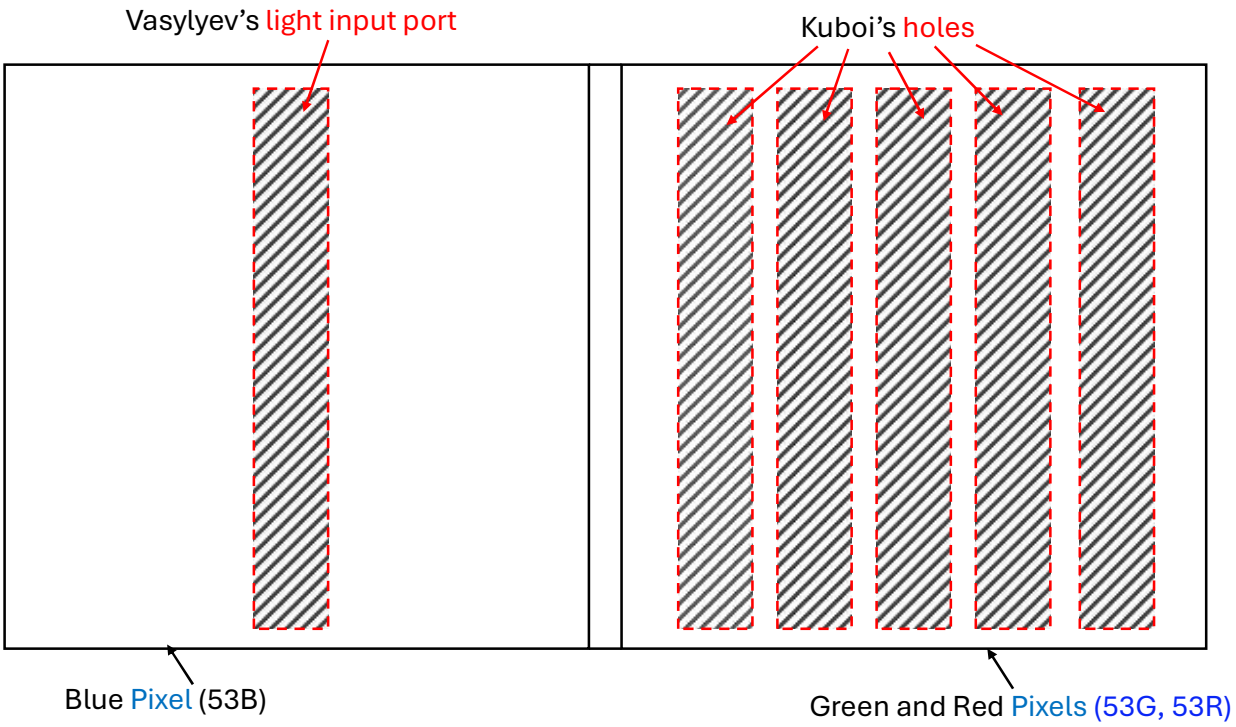
resemble the holes in green and red pixels (53G, 53R) would yield predictable results.

276. When the *Kuboi-Vasylyev-2* imaging device is further modified in this manner based on the teachings of *Vasylyev*, blue pixel 53B would have only a single elongated hole aligned with the optical axis of the corresponding microlens, extending along a substantial portion—rather than the full length—of the light-receiving surface, penetrating the full thickness of semiconductor layer 12, and encapsulated by *Vasylyev*'s dielectric buffer layer 30. This is further illustrated below.

FIG.6A



Kuboi, Fig. 6A (modified).



277. Since the thickness of blue pixel 53B (d_1) is 1400 nm, one skilled in the art would recognize that port 14 will extend into blue pixel 53B to a depth ranging from 100-10,000 nanometers. *Kuboi*, ¶[94]; *supra* XI.A.1.e (claim [1c], Ground 1).

5. Claim 4

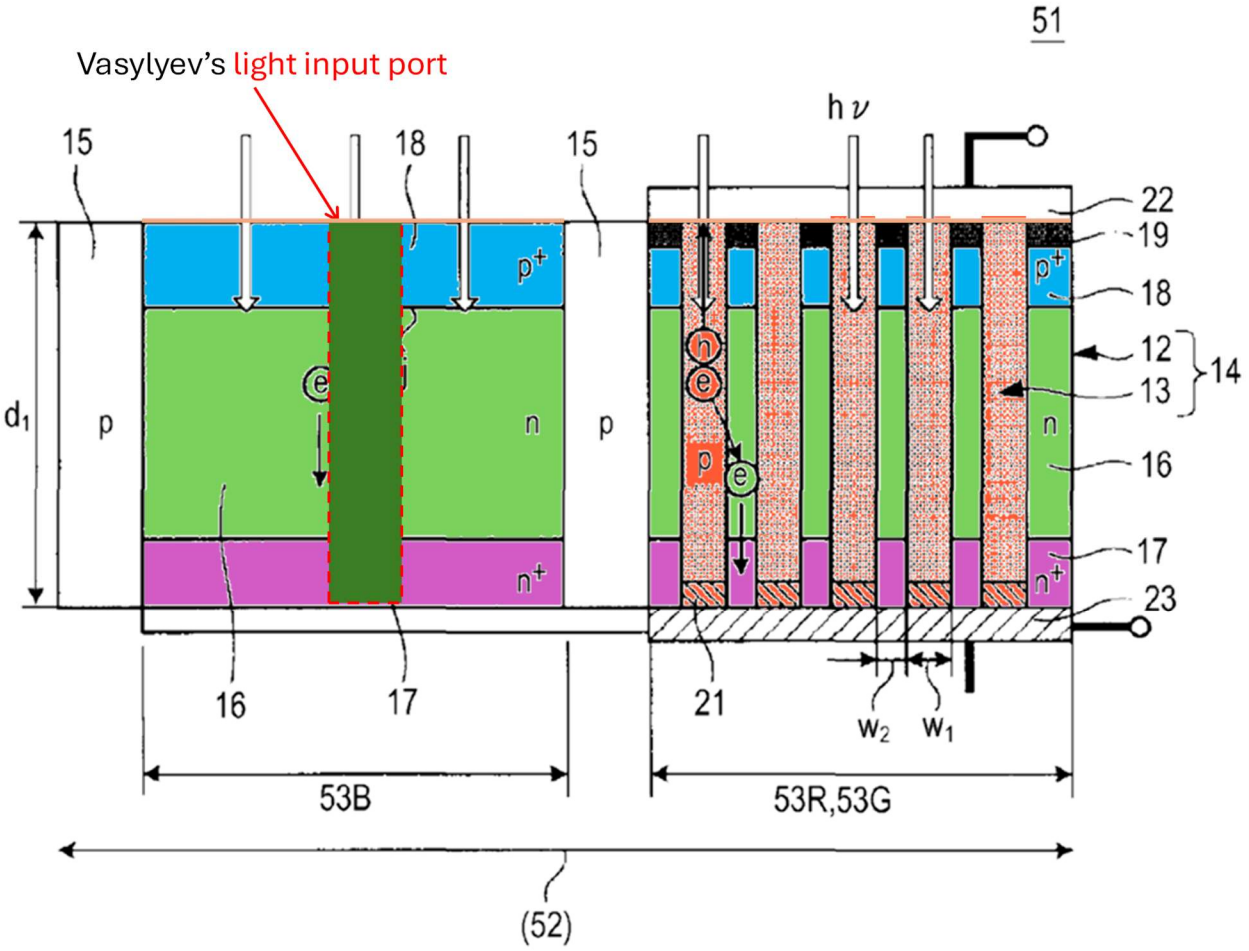
a. "The integrated structure of claim 1, wherein each of at least some of the pillars has only one of the elongated holes."

278. As I explained for claim 1 under Ground 1, *Kuboi* discloses and/or renders obvious the limitations of independent claim 1. *Supra* XI.A.1. In my opinion, *Kuboi* in view of *Vasylyev* renders obvious this additional limitation.

279. As explained above, based on *Kuboi*'s and *Vasylyev*'s teachings and as illustrated below, one skilled in the art would have found it obvious to incorporate *Vasylyev*'s single port 14 into *Kuboi*'s blue pixel 53B. *Supra* XI.B.2. In the resulting *Kuboi-Vasylyev-1* imaging device, port 14—designed as an elongated trench extending along the light-receiving surface and penetrating the full thickness of pixel 53B's semiconductor layer 12, and encapsulated by *Vasylyev*'s transparent buffer layer 30—enhances blue light coupling and trapping within the semiconductor layer, thereby improving the photodiode's light absorption and

energy conversion efficiency. *Supra* XI.B.2.

FIG.6A



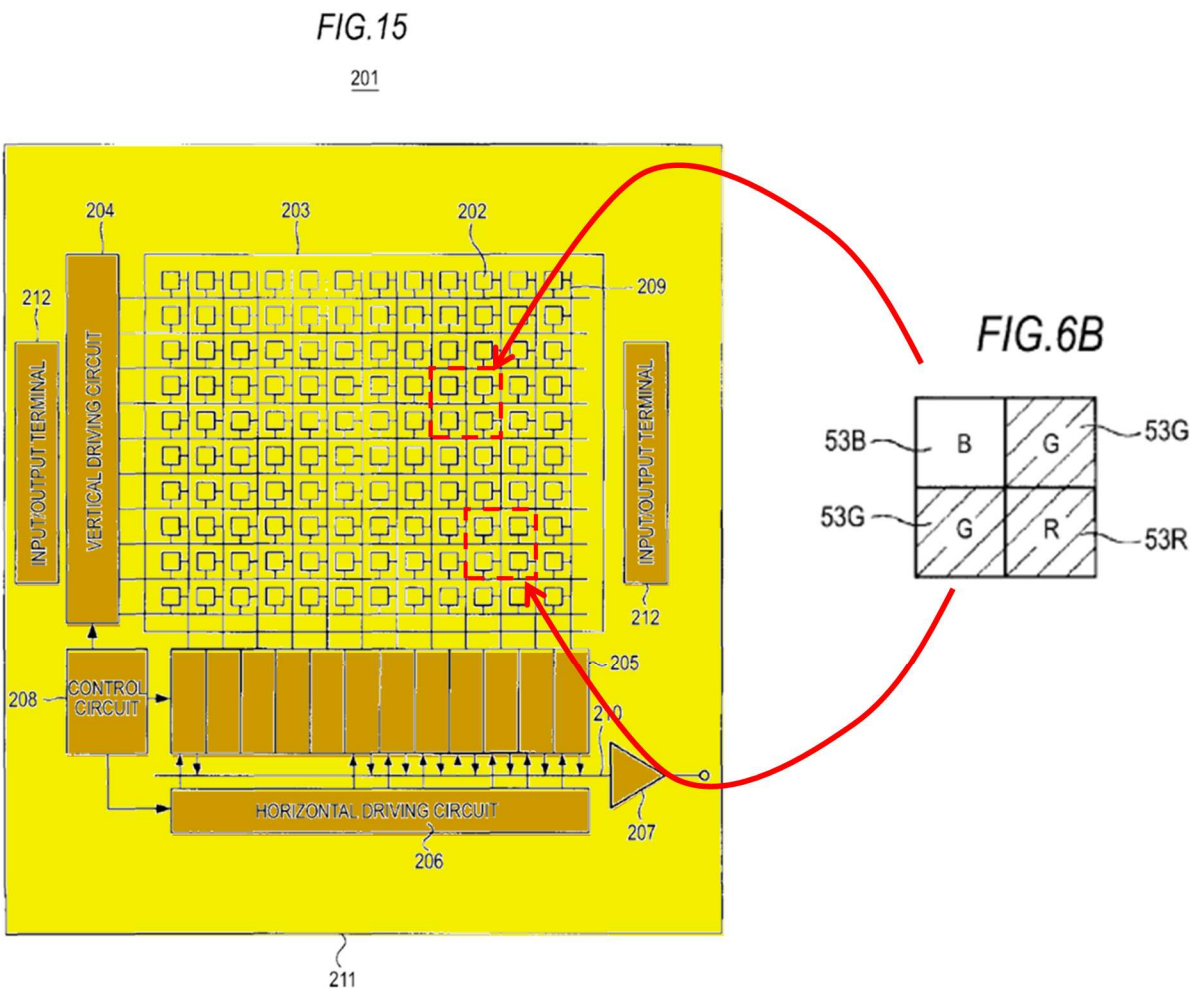
Kuboi, Fig. 6A (modified).

280. One skilled in the art would have understood that, in the *Kuboi-Vasylyev-1* imaging device, single port 14—configured as an elongated hole aligned with the light-receiving surface—would be formed on blue pixel 53B, extending through the full thickness d_1 of semiconductor layer 12 and be at least partially filled with *Vasylyev*'s dielectric buffer layer. *Supra* XI.B.2. Given that d_1

= 1.4 μm = 1400 nm, the port extends into pixel 53B to a depth ranging from 100-10,000 nm. *Kuboi*, ¶[94].

281. Accordingly, one skilled in the art would have recognized that blue pixel 53B of the *Kuboi-Vasylyev-1* imaging device includes only one elongated hole. Because this hole is elongated along the light-receiving surface, extends into blue pixel 53B to a 1400 nm depth, and is at least partially filled with a solid dielectric material, it satisfies all the requirements of "the elongated hole" recited in claims [1c] and [1d] under Ground 1. *Supra* XI.A.1.e-XI.A.1.f.

282. In my opinion, even if it is determined that the term "at least some of the pillars" requires multiple pillars, one skilled in the art would have understood that pixels 53B, 53G, and 53R would be implemented in *Kuboi*'s imaging device 201 as shown below. *Supra* VIII.A, XI.A.8.a (claim 11, Ground 1).



Kuboi, Figs. 15, 6B.

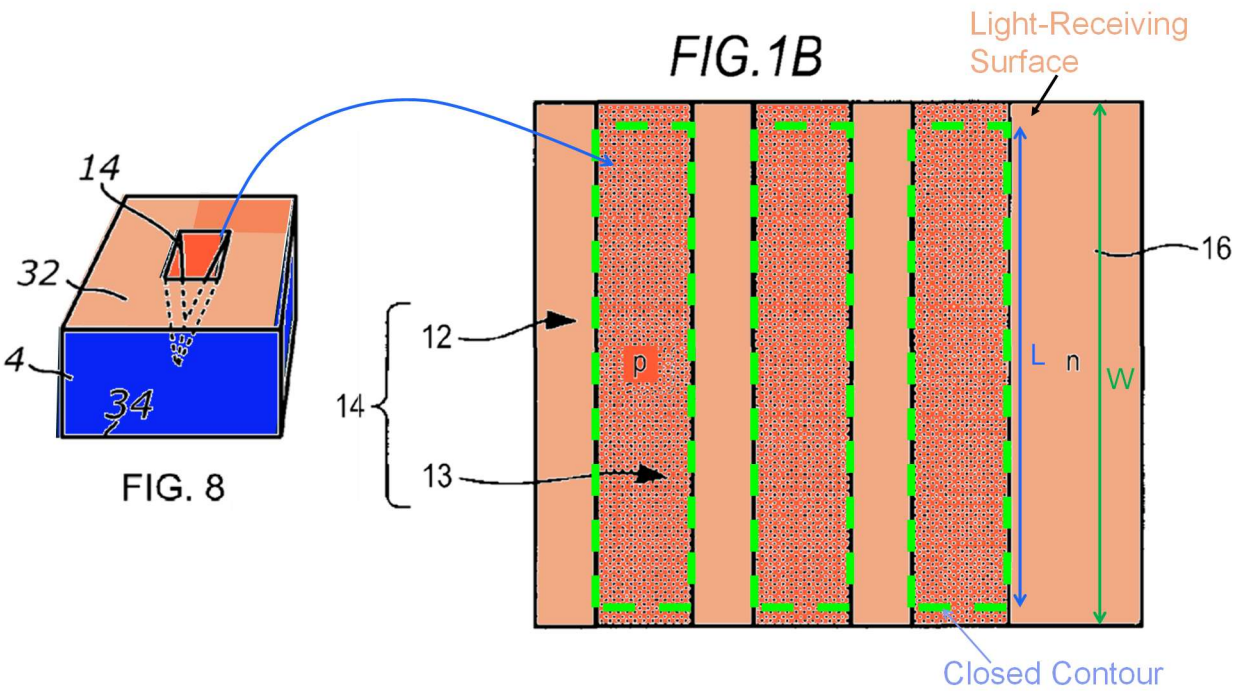
283. Accordingly, one skilled in the art would have understood that the *Kuboi-Vasylyev-1* imaging device incorporates multiple blue pixels 53B with a single elongated hole.

6. Claim 5

a. "The integrated structure of claim 1, in which the light-receiving surfaces have respective widths, and the elongated holes extend along less than the widths of the light-receiving surfaces of at least some of the pillars in which the holes are fabricated."

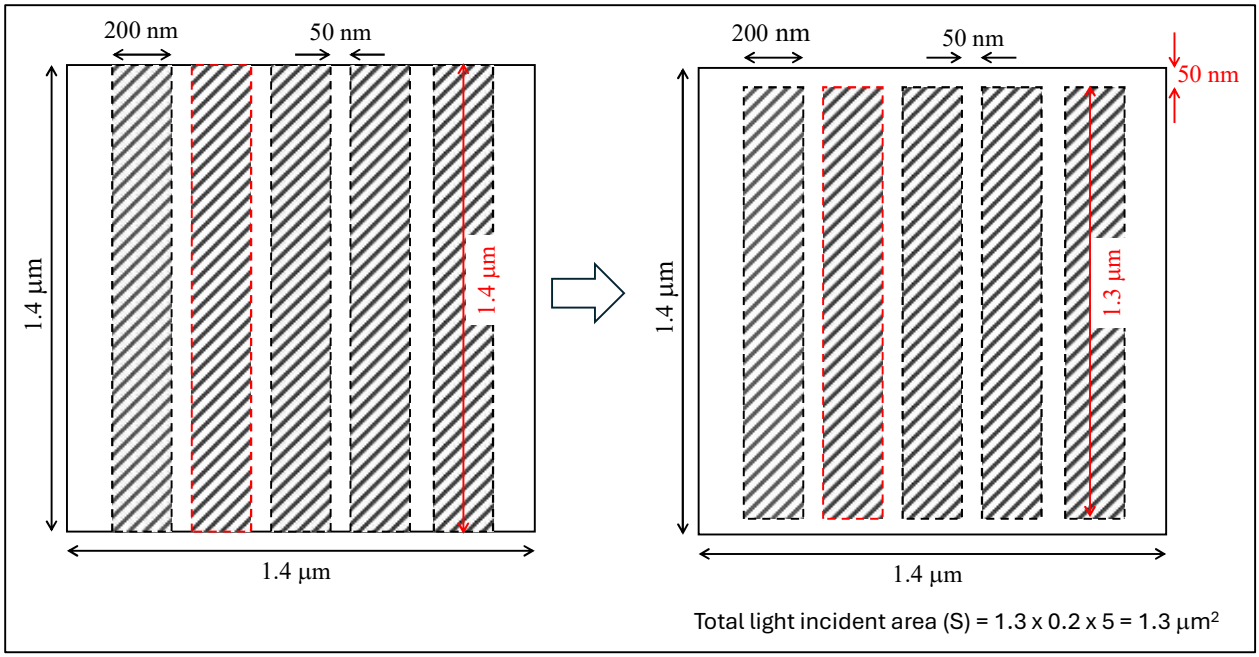
284. As I explained for claim 1 under Ground 1, *Kuboi* discloses and/or renders obvious the limitations of independent claim 1. *Supra* XI.A.1. In my opinion, *Kuboi* in view of *Vasylyev* renders obvious this additional limitation.

285. As explained above, based on *Kuboi*'s and *Vasylyev*'s teachings, it would have been obvious to one skilled in the art to extend holes 38 in *Kuboi*'s green and red pixels (53G, 53R) along a substantial portion—rather than the full extent—of the light-receiving surface of photoelectric conversion portion 14 to reduce the average distance to the silicon-film interface, increase the interface area, and thereby improve device operating speed. *Supra* XI.B.3; *Kuboi*, ¶¶[8], [68], [72]. This is illustrated below.



Vasylyev, Fig. 8 (left); *Kuboi*, Fig. 1B (right).

286. One skilled in the art would have recognized that, in the resulting *Kuboi-Vasylyev-2* imaging device, the elongated holes in green and red pixels (53G, 53R) extend along a length (L) along less than the widths (W) of the light-receiving surfaces of these pixels (pillars). This dimensional reduction is illustrated below.



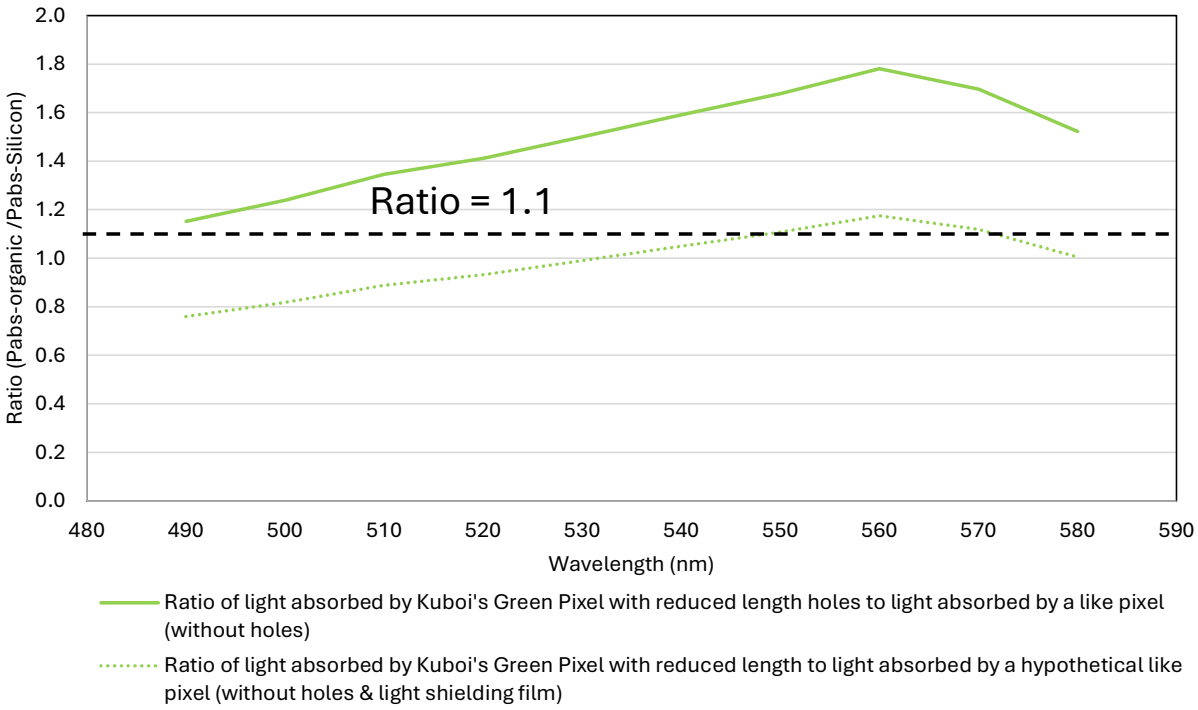
287. One skilled in the art would have understood that reducing the length (L) of the holes in green and red pixels (53G, 53R) will also reduce their light incidence area. For example, decreasing the extent length (L) from 1.4 µm to 1.3 µm (*supra* XI.B.3) will reduce the total light incident area (S) of the holes to 1.3 µm x 0.2 µm from 1.4 µm x 0.2 µm. Despite this reduction, the high absorption coefficients (α) of the organic material in the holes of green and red pixels (53G, 53R) still result in at least a 1.1x increase in light absorption—across selected visible and infrared wavelengths—relative to "like" photodetectors lacking such holes as required by claim [1h], Ground 1. *Supra* XI.A.1.j.

288. Because the area of light incidence (S) in both pixels (53G, 53R) and the "like" pixel are defined by the opening of light shielding film 19 (*supra* XI.A.1.j (claim [1h], Ground 1)), the reduction of the light incidence area in

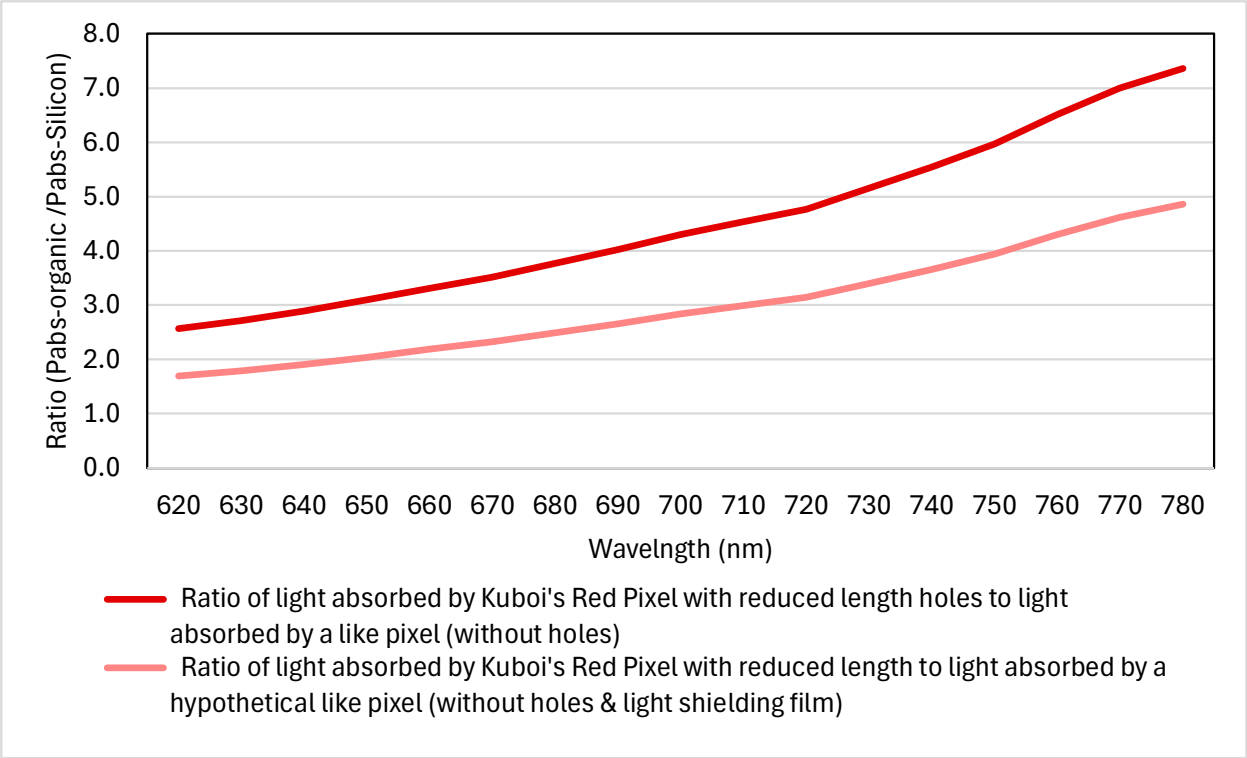
modified pixels (53G, 53R) will similarly reduce the light incidence area in the "like" pixel and keep the ratio of light absorptions ($P^{(53G, 53R)}/ P^{(\text{"like" pixel})}$) unchanged.

289. In my opinion, even if the "like" photodetectors are considered to lack both light shielding film 19 and holes 38 (*supra* XI.A.1.j (claim [1h], Ground 1)), one skilled in the art would have understood that the ratio of light absorption in modified pixels (53G, 53R) to such a hypothetical like pixel ($P^{(53G, 53R)}/ P^{(\text{hypothetical pixel})}$) would be at least 1.1. For example, when the hole length (L) is reduced from 1.4 μm to 1.3 μm, the light incidence area of modified pixels (53G, 53R) is about 66% (=1.3/1.96) of the light incidence area of the hypothetical pixel.

290. The graph below plots the ratio $P^{(53G)}/ P^{(\text{hypothetical pixel})}$ for the modified green pixel 53G in the 490-580 nm wavelength range. As shown above, even with the reduced hole length (L), the ratio of $P^{(53G)}/ P^{(\text{hypothetical pixel})}$ exceeds 1.1 between a wavelength range of about 550-570 nm of the green light spectrum.



291. The graph below plots $P^{(53R)}/ P^{(hypothetical\ pixel)}$ for the modified red pixel 53R for the 620-780 nm wavelength range. As shown below, even with the reduced hole length (L), the ratio of $P^{(53R)}/ P^{(hypothetical\ pixel)}$ exceeds 1.1 across the entire 620-780 nm range of red light and infrared light.



292. Since the hole period Λ remains unchanged despite the reduction in hole length (L) from 1.4 μm to 1.3 μm, one skilled in the art would recognize that the revised hole array continues to satisfy the HCG condition ($\lambda/n_1 < \Lambda < \lambda/n_2$), resulting in an absorption coefficient that is enhanced by a factor of 1.1 to 100 compared to the bulk absorption coefficient. *Supra* XI.A.1.j (claim [1h], Ground 1). Likewise, given that the hole depth remains 1.4 μm after the reduction in hole length (L), one skilled in the art would recognize that the modified hole array continues to enhance light absorption by a factor of 1.8 (0.22/0.12), consistent with the teachings of *Han*. *Supra* XI.A.1.j (claim [1h], Ground 1).

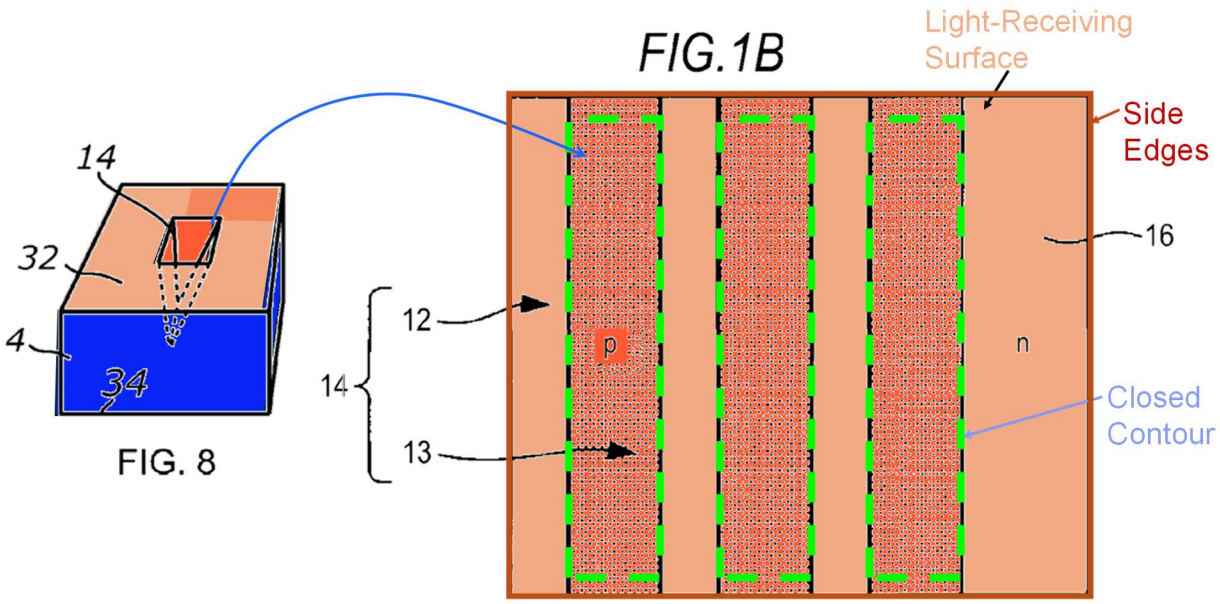
293. Thus, in my opinion, one skilled in the art would recognize that, even with the reduced hole length (L), the *Kuboi-Vasylyev-1* imaging device meets the limitations of claim [1h] as discussed under Ground 1. *Supra* XI.A.1.j.

7. Claim 6

a. "The integrated structure of claim 5 in which each of at least some of the elongated holes has at least one closed contour remote from respective side edges of the light-receiving surface in which the hole is fabricated.

294. In my opinion, *Kuboi* in view of *Vasylyev* renders obvious these additional limitations.

295. As explained above, one skilled in the art would have found it obvious to extend holes 38 in *Kuboi*'s green and red pixels (53G, 53R) along a substantial portion of the light-receiving surface, as shown in the figure below, to reduce the average distance to the silicon-film interface, expand the interface area, and increase device speed. *Supra* XI.B.3, XI.B.6.a (claim 5).



Vasylyev, Fig. 8 (left); *Kuboi*, Fig. 1B (right).

296. In my opinion, one skilled in the art would have understood that in the resulting *Kuboi-Vasylyev-2* imaging device, each hole in green and red pixels (53G, 53R) has a closed contour positioned remote from the side edges of the light-receiving surface.

8. Independent Claim 13

a. [13(pre)] "An integrated structure comprising:"

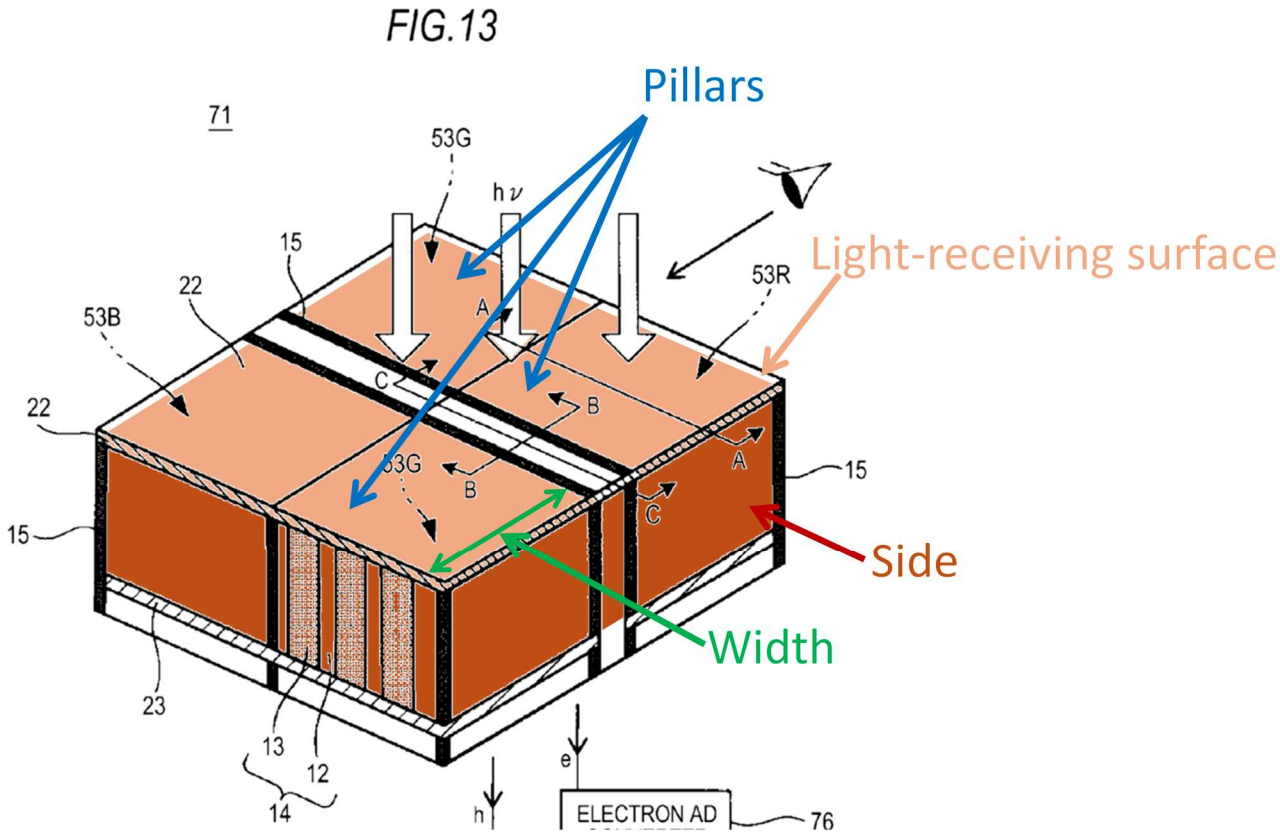
297. In my opinion, to the extent the preamble is limiting, *Kuboi* discloses this limitation as I explained above. *Supra* XI.A.1.a (claim [1(pre)], Ground 1).

b. [13a(1)] "an array of pillars comprising Si, Ge, and/or alloyed SiGe semiconductor material,"

298. As I explained for claim [1a(1)] under Ground 1, *Kuboi* discloses this portion of the limitation. *Supra* XI.A.1.b.

c. [13a(2)] "wherein at least some of the pillars have respective sides and respective light-receiving surfaces with selected widths and comprise at least one photodetector;"

299. In my opinion, one skilled in the art would have recognized that *Kuboi* discloses this portion of the limitation. As I explained for claim [1a(2)] under Ground 1, *Kuboi*'s pixels ("pillars") have respective sides and respective light-receiving surfaces, and comprise at least one photoelectric conversion portion ("photodetector"). *Supra* XI.A.1.c.



Kuboi, Fig. 13 (cropped).

300. In my opinion, one skilled in the art would have understood that each pixel's light-receiving surface has a selected width.

d. [13b] "wherein at least some of the pillars comprise P-doped and N-doped regions and are configured to respond to illumination with light in selected visible and infrared wavelengths by generating electrical charge carriers;"

301. In my opinion, one skilled in the art would have recognized that this limitation is identical to claim [1b]. As I explained for claim [1b] under Ground 1, *Kuboi* discloses and/or renders obvious this limitation. *Supra* XI.A.1.d.

e. [13c] "one or more holes that are fabricated as recesses at or under the light-receiving surface of each of at least some of the pillars,"

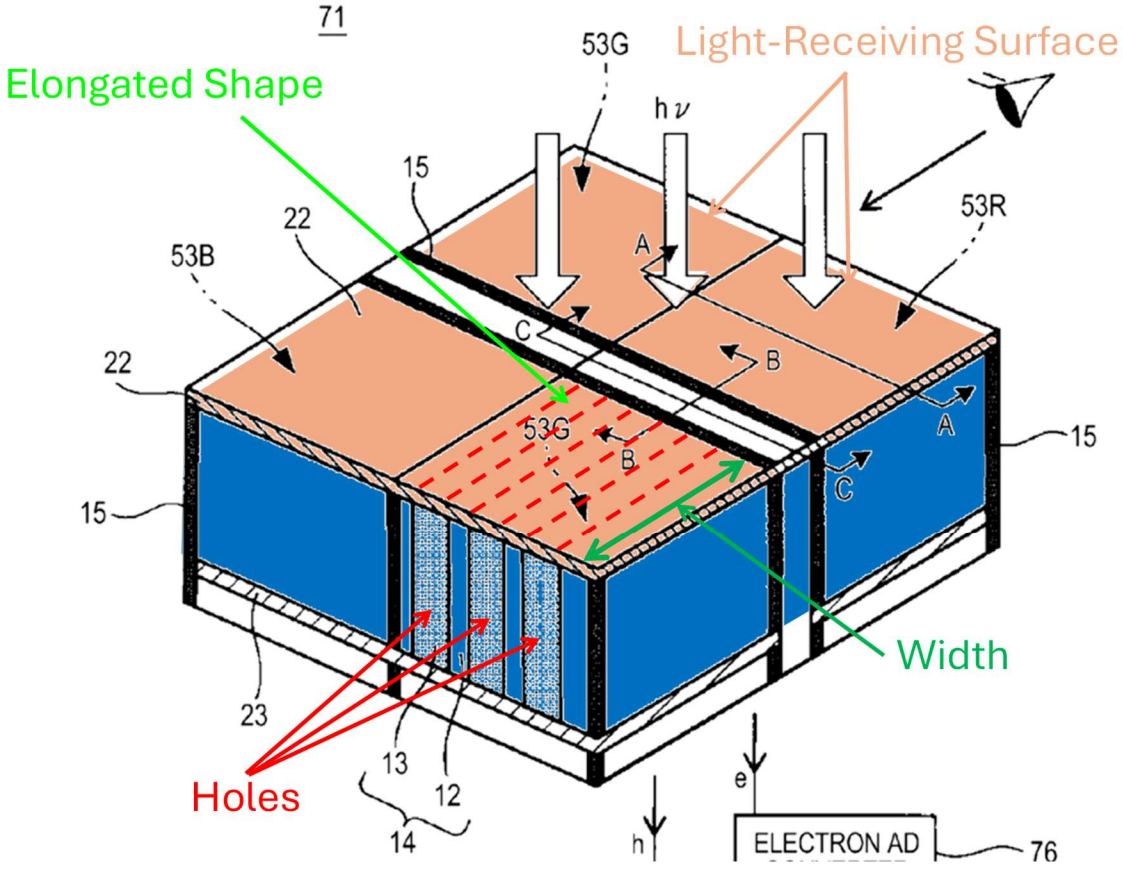
302. In my opinion, one skilled in the art would have recognized that claim [1c] includes these limitations. As I explained for claim [1c] under Ground 1, *Kuboi* discloses these limitations. *Supra* XI.A.1.e.

f. [13d(1)] wherein each of the holes (i) has an elongated shape extending in length over less than the width of the light-receiving surface in which the hole is fabricated, (ii) has at least one closed contour at the light-receiving surface in which the hole is fabricated,"

303. In my opinion, *Kuboi* in view of *Vasylyev* renders obvious this portion of the limitation.

304. As I explained for claims [1c] and [1d] under Ground 1, each hole 38 in *Kuboi*'s green and red pixels (53G, 53R) has an elongated shape on the light-receiving surface of the respective pixel (i.e., pillar). *Supra* XI.A.1.e, XI.A.1.f.

FIG.13

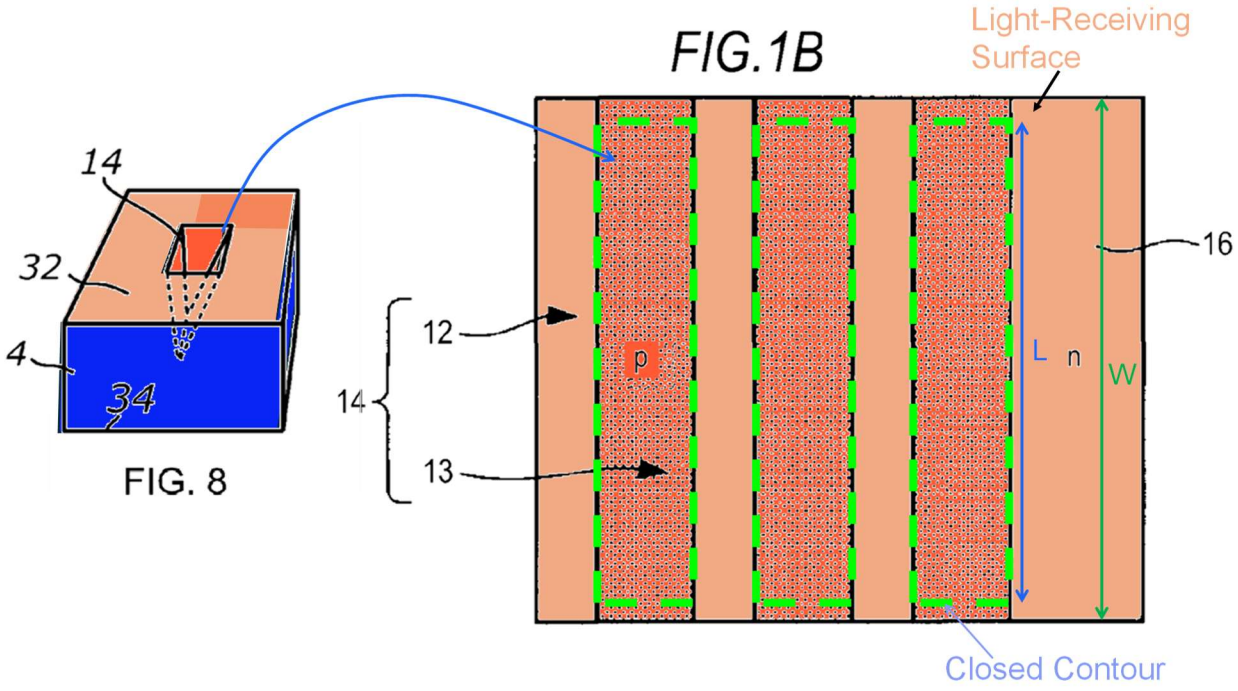


Kuboi, Fig. 13 (cropped).

305. *Kuboi* does not expressly disclose that the elongated shape of holes 38 extends in length over less than the width of the light-receiving surface in which the hole is fabricated.

306. However, as I explained for claim 5 and illustrated below, based on the teachings of *Kuboi* and *Vasylyev*, it would have been obvious to one skilled in the art to extend holes 38 in *Kuboi*'s green and red pixels (53G, 53R) along a substantial portion—rather than the full extent—of the pixels' light-receiving

surface to reduce the average distance to the silicon-film interface, increase the interface area, and thereby further improve device operating speed. *Supra*, XI.B.3, XI.B.6.a (claim 5).



Vasylyev, Fig. 8 (left); *Kuboi*, Fig. 1B (right).

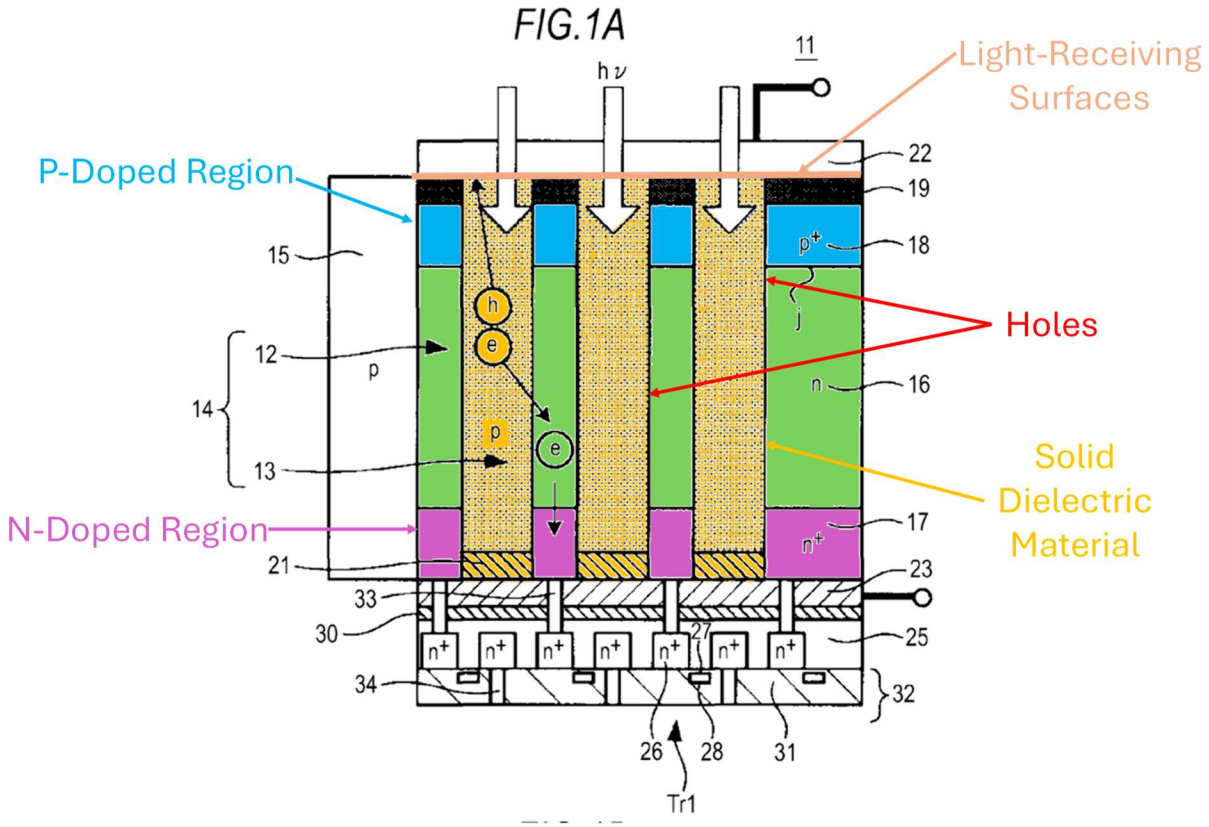
307. In my opinion, one skilled in the art would have recognized that, in the resulting *Kuboi-Vasylyev-2* imaging device, the elongated holes of green and red pixels (53G, 53R) extend over a length L less than the width W of the light-receiving surface of respective pixels 53G, 53R (pillars).

308. As I explained for claim 6, one skilled in the art would have understood that, in the *Kuboi-Vasylyev-2* imaging device, the elongated holes in

green and red pixels (53G, 53R) have a closed contour on the light-receiving surface in which the hole is fabricated. *Supra* XI.B.7.a.

g. [13d(2)] "([iii]) extends into the pillar in which the hole is fabricated to a depth of 100 to 10000 nm, and (iv) is filled at least partly with solid dielectric material;"

309. In my opinion, *Kuboi* discloses this portion of the limitation. As I explained for claim [1c] under Ground 1 and illustrated below, each hole 38 in *Kuboi*'s green and red pixels (53G, 53R) extends into the pixel by a depth d_1 of "about 1.4 μm" (i.e., 1400 nm). *Supra* XI.A.1.e; *Kuboi*, ¶[94].



Kuboi, Fig. 1A.

310. As I also explained for claim [1c], in *Kuboi*, holes 38 are filled with electron blocking film 21 and photoelectric conversion films 13, both of which are composed of solid dielectric materials. *Supra* XI.A.1.e; *Kuboi*, ¶¶[73], [91].

h. [13e] "side-isolation comprising solid material between at least portions of the sides of at least some of the pillars;"

311. In my opinion, one skilled in the art would have recognized that this limitation is identical to claim [1e]. As explained for claim [1e] under Ground 1, in my opinion, *Kuboi* discloses this limitation. *Supra* XI.A.1.g.

i. [13f] "a solid dielectric material forming a base dielectric region for the array;"

312. In my opinion, one skilled in the art would have recognized that this limitation is identical to claim [1f]. As explained for claim [1f] under Ground 1, in my opinion, *Kuboi* discloses and/or renders obvious this limitation. *Supra* XI.A.1.h.

j. [13g] "electrical contacts configured to provide electrical pathways coupled electrically to at least some of the photodetectors, including for selected reverse-biasing thereof;"

313. In my opinion, one skilled in the art would have recognized that this limitation is identical to claim [1g]. As explained for claim [1g] under Ground 1, in my opinion, *Kuboi* discloses this limitation. *Supra* XI.A.1.i.

k. [13h] "wherein the presence of the one or more holes increases, by a factor of at least 1.1, absorption of the light by at least some of the photodetectors relative to like photodetectors lacking the holes; and"

314. In my opinion, one skilled in the art would have recognized that this limitation is substantively the same as claim [1h]. As I explained for claim [1h], in my opinion, *Kuboi* discloses and/or renders obvious this limitation. *Supra* XI.A.1.j.

l. [13i] "wherein the array is monolithically integrated with Si electronic devices for signal processing and transmission."

315. In my opinion, one skilled in the art would have recognized that this limitation is identical to the additional limitation of claim 9 as discussed under Ground 1, and one skilled in the art would have recognized that *Kuboi* discloses it for the same reasons. *Supra* XI.A.6.a.

9. Claim 14

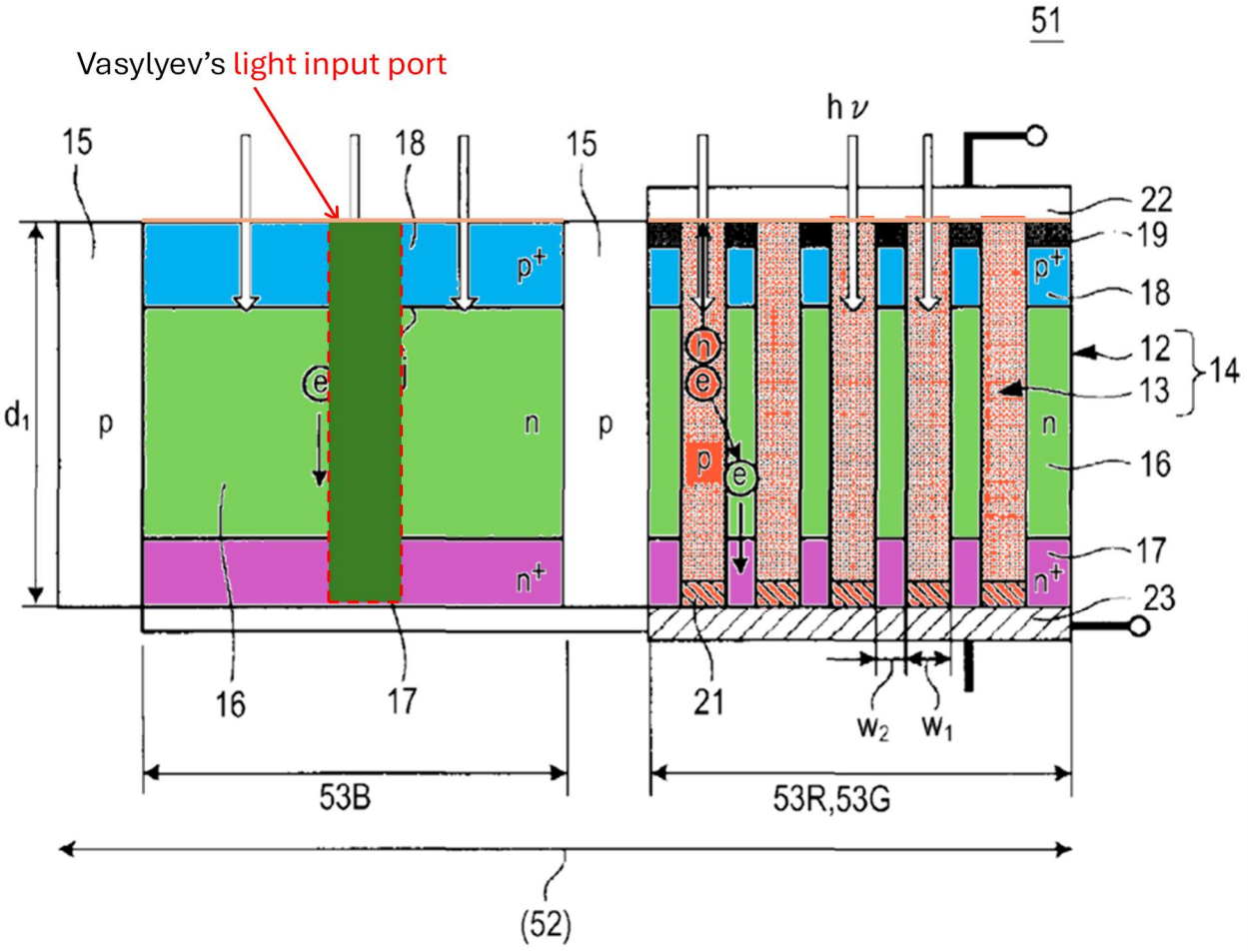
a. "The integrated structure of claim 13, in which each of at least some of the pillars has only one of the elongated holes fabricated therein."

316. In my opinion, *Kuboi* in view of *Vasylyev* renders obvious these additional limitations.

317. As I previously explained, in addition to modifying holes 38 in *Kuboi*'s green and red pixels (53G, 53R) such that they extend across a substantial portion—rather than the entire length—of the light-receiving surface, one skilled in the art would have found it obvious to incorporate a single light input port 14 in the

blue pixel 53B to reduce blue light reflection and enhance light absorption and energy conversion efficiency, resulting in the *Kuboi-Vasylyev-3* imaging device. *Supra* XI.B.4, XI.B.8.f-XI.B.8.g (claims [13d(1)]-[13d(2)]). Based on *Vasylyev*'s teachings, the single light input port 14 in the *Kuboi-Vasylyev-3* imaging device is an elongated trench that extends along a substantial portion—but not the entirety—of the light-receiving surface, penetrates the full 1400 nm thickness (d_1) of the semiconductor layer 12 of pixel 53B, and is encapsulated by *Vasylyev*'s transparent buffer layer 30. *Supra* XI.B.4. This is further illustrated below.

FIG.6A



Kuboi, Fig. 6A (modified).

318. Since the single port 14 in blue pixel 53B of the *Kuboi-Vasylyev-3* imaging device has an elongated shape that spans less than the full width of its light-receiving surface, forms a closed contour on that surface, extends into the pixel to a depth of 1400 nm, and is at least partially filled with solid dielectric material, one skilled in the art would have recognized that it also satisfies the requirements of claims [13d(1)] and [13d(2)]. *Supra* XI.B.4, XI.B.8.f-XI.B.8.g.

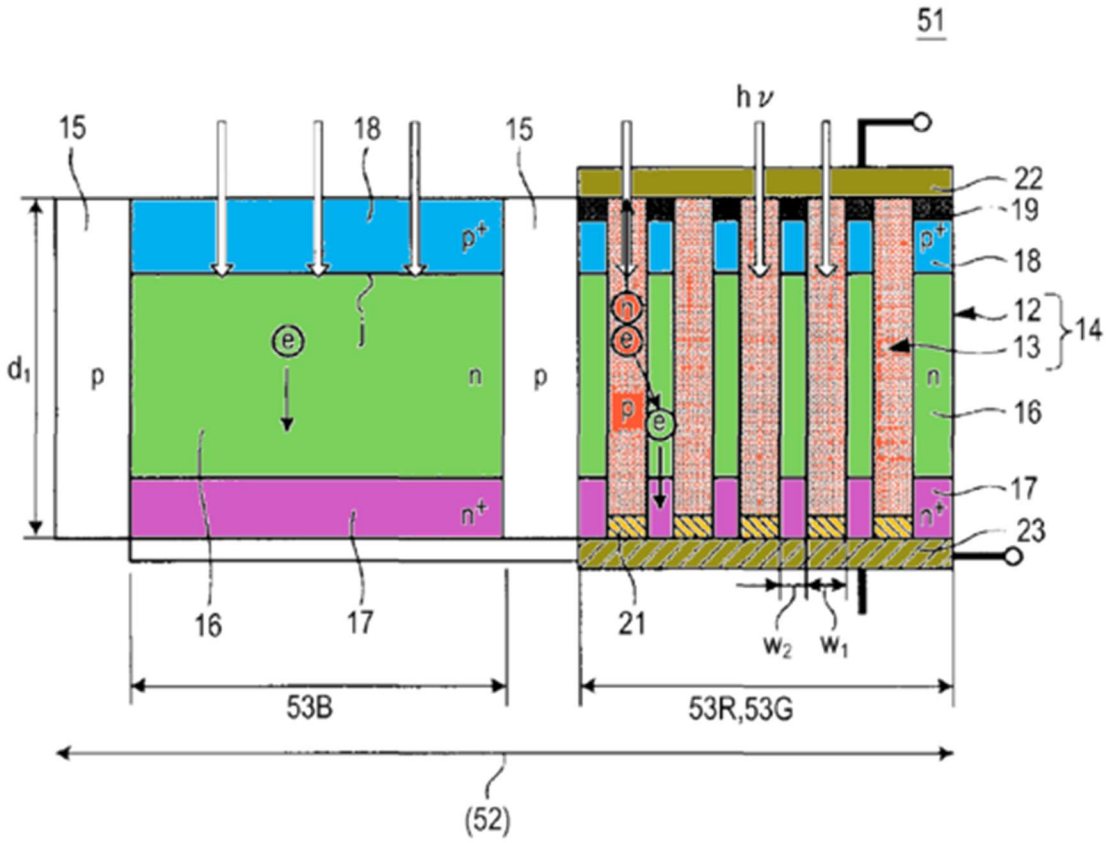
10. Claim 15

a. "The integrated structure of claim 13, in which each of at least some of the pillars has at least two of the elongated holes."

319. In my opinion, *Kuboi* in view of *Vasylyev* renders obvious these additional limitations.

320. *Kuboi* discloses that a "plurality of vertical holes 38 are formed at necessary intervals," and "organic photoelectric conversion film 13 is deposited so as to be embedded in the vertical holes 38." *Kuboi*, ¶¶[72]-[73]. As explained for claims [1d] under Ground 1 and [13d(1)], these holes have an elongated shape. *Supra* XI.A.1.f, XI.B.8.f. In green and red pixels (53G, 53R), as illustrated below, "[f]ive organic photoelectric conversion films 13 are disposed in the semiconductor layer 12." *Kuboi*, ¶[94].

FIG.6A



Kuboi, Fig. 6A.

321. Accordingly, in the *Kuboi-Vasylyev-2* imaging device, green and red pixels (53G, 53R) (pillars) have at least two of the elongated holes.

11. Claim 16

a. "The integrated structure of claim 13, in which each of at least some of the photodetectors includes at least one of the holes."

322. In my opinion, *Kuboi* in view of *Vasylyev* renders obvious these additional limitations. As I explained for claim 15, in the *Kuboi-Vasylyev-2* imaging device, green and red pixels (53G, 53R) (pillars) have at least two of the

elongated holes. *Supra* XI.B.10.a. In *Kuboi*, green pixel 53G and red pixel 53R are each formed by photoelectric conversion portion 14 (photodetector). *Kuboi*, ¶[90]. Photoelectric conversion portion 14 includes a plurality of organic material layers 13 embedded in holes. *Kuboi*, ¶¶[55], [71]-[73]. Accordingly, in the *Kuboi-Vasylyev-2* imaging device, photoelectric conversion portions 14 (photodetectors) of green pixel 53G and red pixel 53R include at least one of the holes. Additionally, as explained for claim 14, the photoelectric conversion portion of the blue pixel 53B of the *Kuboi-Vasylyev-3* imaging device also includes one of the holes. *Supra* XI.B.9.a.

C. Ground 3: Claims 1-3 and 7-12 Are Obvious over *Kuboi* in View of *Shinohara*

1. *Kuboi* and *Shinohara* Are Analogous to the '948 Patent

323. In my opinion, one skilled in the art would have recognized that *Kuboi* and *Shinohara* are analogous art to the '948 patent because, like the '948 patent, *Kuboi* and *Shinohara* also aim to improve the light absorption efficiency of their respective imaging devices. The '948 patent is directed to techniques for enhancing photon absorption. '948 patent, Abstract. Similarly, *Kuboi* is directed to a solid-state imaging device in which light absorption efficiency is increased to improve sensitivity. *Kuboi*, ¶¶[9]-[19]. Likewise, *Shinohara* discloses a solid-state imaging device that improves sensitivity by improving a pixel's light absorption, thereby reducing leakage of charge into an adjacent pixel. *Shinohara*, ¶¶[12]-[13].

2. Motivation to Apply *Shinohara*'s Monolithic Integration Teachings in *Kuboi*

324. In my opinion, one skilled in the art would have been motivated to implement *Shinohara*'s teaching of monolithic integration of the array of pixels with pixel transistors and electronic circuits for signal processing and transmission in *Kuboi*'s imaging device. Indeed, the integration of photodetectors, pixel transistors, and signal processing circuitry on a single substrate to form a single-chip device was known long before the purported invention date.

325. *Kuboi* discloses forming a pixel region and a peripheral circuit portion, including logic circuits, input and output circuits, and a control circuit on a substrate. *Kuboi*, ¶¶[48]-[49], [69], [78]. This substrate "may be created in advance and be bonded to the semiconductor substrate on which the semiconductor region 25 having the pixel transistors, the multilayer wiring layer 32, the lower electrode 23, and the like are formed." *Kuboi*, ¶[78]. *Shinohara* discloses forming a pixel region, a peripheral circuit portion, pixel transistors, and a wiring layer ***on the same substrate***. *Shinohara*, ¶¶[68]-[82].

326. One skilled in the art would have understood that including the pixel region, peripheral circuit portion, pixel transistors, and wiring layer on the same substrate (i.e., monolithically integrating) provides several engineering and performance advantages. By integrating these components within a single silicon substrate, the fabrication process becomes more streamlined and cost-effective,

allowing manufacturers to leverage established CMOS technology. *See Hasegawa*, ¶[9]; Ex. 1021, Abstract; Ex. 1022, 2; *NXP*, ¶¶[16], [32], [37]. This configuration also enables a more compact design, which is particularly beneficial for applications where space constraints matter, such as mobile devices and embedded systems. One skilled in the art would have known that, electrically, the close proximity between photodiodes and their corresponding transistors minimizes parasitic capacitance and signal delay, resulting in faster charge transfer and improved readout speed. *Hasegawa*, ¶[9]. Furthermore, this single-substrate approach ensures efficient electrical coupling, enhancing overall signal integrity. *Hasegawa*, ¶[9].

327. In my opinion, it would have been obvious to one skilled in the art to apply *Shinohara*'s monolithic integration teachings to *Kuboi* by forming the pixel transistors, multilayer wiring layer 32, array of pixels 201, and logic circuits 204-208 of the peripheral circuit portion on a single substrate to create a monolithically integrated structure,[5] motivated by the opportunity to streamline fabrication, lower costs, and enhance electrical performance. One skilled in the art would have recognized that applying *Shinohara*'s monolithic integration teachings to *Kuboi*

[5] This declaration refers to *Kuboi*'s integrated structure as modified by *Shinohara*'s teachings as the *Kuboi-Shinohara* integrated structure.

involves nothing more than the use of a known technique—forming the pixel region and all associated electronic circuitry on the same substrate—to improve a similar device—*Kuboi*'s imaging device—in the same way, namely, by improving manufacturing reliability, reducing manufacturing cost and package size, reducing signal attenuation, reducing noise, and improving high-bandwidth performance of *Kuboi*'s device.

328. In my opinion, one skilled in the art would have had a reasonable expectation of success in using *Shinohara*'s teachings to manufacture *Kuboi*'s imaging device. Given that both *Kuboi* and *Shinohara* disclose similar CMOS imaging devices that include a pixel region, pixel transistors, and a peripheral circuit portion, manufacturing *Kuboi*'s pixel region and associated electronic circuitry, including *Kuboi*'s pixel transistors, using *Shinohara*'s techniques would have been well within the skill of one skilled in the art. One skilled in the art would have had a reasonable expectation of success in this modification because it merely requires combining well-known prior elements and manufacturing methods already taught by *Shinohara*.

3. Independent Claim 1

329. In my opinion, *Kuboi* in view of *Shinohara* renders obvious these claims.

a. [1(pre)]-[1e], [1g]-[1h]

330. As I explained before for claim 1 under Ground 1, *Kuboi* discloses or renders obvious these limitations. *Supra* XI.A.1.a-XI.A.1.g (claims [1(pre)]-[1e]), XI.A.1.i-XI.A.1.j (claims [1g]-[1h]).

b. [1f] "a solid dielectric material forming a base dielectric region for the array;"

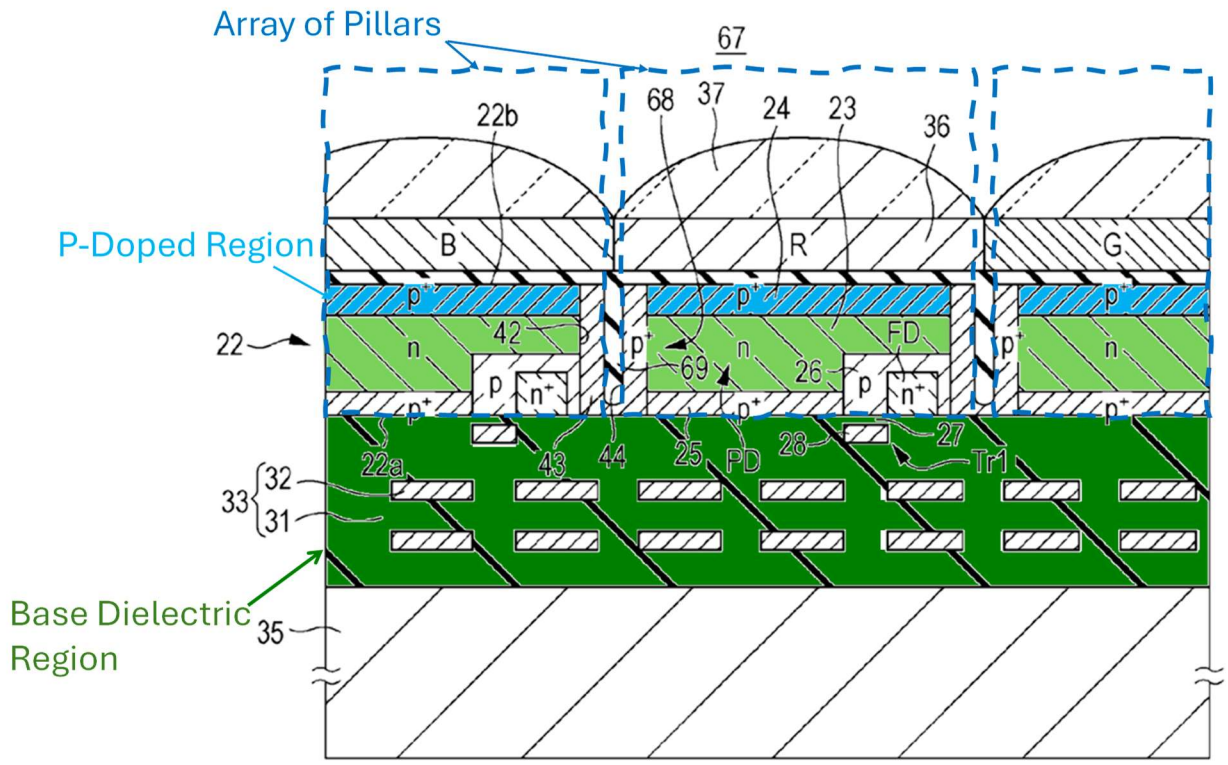
331. In my opinion, *Kuboi* in view of *Shinohara* renders obvious claim [1f].

332. *Kuboi* discloses a semiconductor substrate that includes semiconductor region 25 with a multilayer wiring layer 32 that includes a plurality of layers of wirings with interlayer insulating film 31 disposed between the wirings. *Kuboi*, ¶¶[61]-[62], [69]; *supra* XI.A.1.h (claim [1f], Ground 1). Further, *Kuboi* discloses bonding the silicon semiconductor substrate with pixels to the semiconductor substrate 25 that includes multilayer wiring layer 32 with interlayer insulating film 31, with insulating film 30 disposed between the substrate with the pixels and semiconductor substrate 25. *Kuboi*, ¶¶[70], [61]-[62], [69]. Thus, *Kuboi* discloses bonding a first substrate, including insulating film 31 with a second substrate including *Kuboi*'s image sensor and peripheral circuits to form its imaging device.

333. *Shinohara* discloses forming multilayer wiring layer 33, including wires 32 and interlayer insulating film 31, on the same substrate 22 on which

pixels B, R, and G are formed. *Shinohara*, ¶¶[82], [68]-[89]; *supra* VIII.C. *Shinohara*'s interlayer insulating film 31 is a base dielectric region because it is disposed at the base of *Shinohara*'s pixels B, R, and G. *Shinohara*'s base dielectric region is illustrated below.

FIG. 9A



Shinohara, Fig. 9A.

334. One skilled in the art would have understood that insulating films for separating wires from each other or from an electrical contact, like *Kuboi*'s insulating films 30 or 31 or *Shinohara*'s insulating film 31, constitute silicon oxide or silicon nitride, which are dielectric materials, or at least would have been motivated to use silicon oxide or silicon nitride because these materials can be

fabricated using standard silicon fabrication processes and because these materials provide good barriers to impurity and moisture diffusion. Ex. 1012, 4-5, 20-21, 23, 34; Ex. 1013, 34-35; Ex. 1027, ¶¶[13]-[14]. In my opinion, one skilled in the art would have found it obvious to form *Shinohara*'s insulating film 31 (i.e., base dielectric material) of a solid dielectric material like silicon oxide or silicon nitride. One skilled in the art would also have a reasonable expectation of success in making *Shinohara*'s insulating film 31 with a solid dielectric material because methods of formation with such materials in semiconductor fabrication were well known in the art before the '948 patent. Ex. 1012, 20-21, 23; Ex. 1013, 34-35.

335. As explained above, one skilled in the art would have found it obvious to modify *Kuboi* in view of *Shinohara* to form the *Kuboi-Shinohara* integrated structure in which *Kuboi*'s array of pillars (i.e., photodetectors) and Si electronic devices are formed on the same substrate. *Supra* XI.C.2. One skilled in the art would have also understood that applying *Shinohara*'s monolithic integration to form the *Kuboi-Shinohara* integrated structure would result in forming *Kuboi*'s insulating film 30 and interlayer insulating film 31 to be formed on the same substrate as *Kuboi*'s array of pillars (i.e., photodetectors). One skilled in the art would have further understood that in the *Kuboi-Shinohara* integrated structure, *Kuboi*'s insulating films 30 and 31 would be disposed below *Kuboi*'s array of pillars as illustrated in *Kuboi*'s Figure 1A. Moreover, because *Kuboi*'s insulating

films 30 and 31 are made of solid dielectric material, one skilled in the art would understand that *Kuboi*'s insulating film 30 and/or 31 would form the claimed base dielectric region below *Kuboi*'s array of pillars in the *Kuboi-Shinohara* integrated structure.

4. Claim 2

a. "The integrated structure of claim 1, wherein the array is monolithically integrated with Si electronic devices."

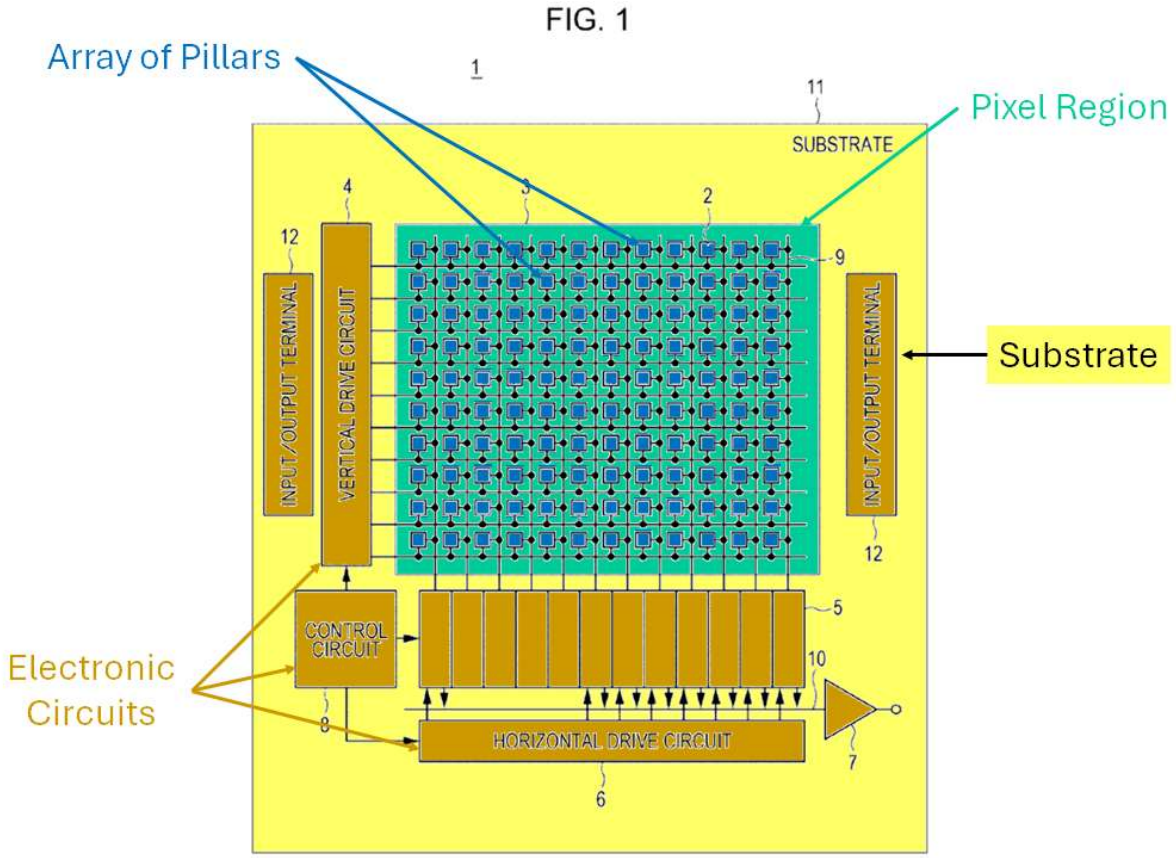
336. To the extent Patent Owner argues that *Kuboi* does not disclose monolithic integration, in my opinion, the *Kuboi-Shinohara* integrated structure renders claim 2 obvious.

337. Referring to its Figure 1, *Shinohara* discloses "a MOS solid-state imaging device" that "includes a pixel region (so-called imaging region) 3 in which a plurality of pixels 2 each having a photoelectric conversion portion is regularly arranged in a semiconductor substrate 11, such as a silicon substrate, in a two-dimensional matrix and a peripheral circuit portion." *Shinohara*, ¶[51]. *Shinohara* also discloses that its "peripheral circuit portion includes so-called logic circuits, such as a vertical drive circuit 4, a column signal processing circuit 5, a horizontal drive circuit 6, an output circuit 7, and a control circuit 8." *Shinohara*, ¶[52].

338. *Shinohara* discloses a method for manufacturing the imaging device on a "p-type silicon semiconductor substrate 22." *Shinohara*, ¶[68]. *Shinohara* teaches forming the photodiodes and the separation regions between the photodiodes on the imaging device on a "p-type silicon semiconductor." *Shinohara*, ¶¶[68]-[82]. According to *Shinohara*, "the floating diffusion portion," "transfer gate electrode," "transfer transistor," "reset transistor," "amplification transistor," and "selection transistor" are each "formed in the other part of the p-type semiconductor well region" of the substrate. *Shinohara*, ¶[81]. As a result, "the pixel region in which the pixels are arranged in a two-dimensional matrix is formed." *Shinohara*, ¶[81]. *Shinohara* discloses that "the peripheral circuit portion (not shown) by CMOS transistors is formed in the periphery of the pixel region." *Shinohara*, ¶[81]. *Shinohara* also discloses that "the multilayer wiring layer 33 in which a plurality of layers of the wires 32 is disposed with at least one interlayer insulating film 31 provided therebetween is formed on the surface of the semiconductor substrate 22." *Shinohara*, ¶[82].

339. Thus, *Shinohara* discloses forming the pixel region (i.e., including array of pillars), the peripheral circuit portion, the floating diffusion portion, the transfer gate electrode, transistors (i.e., transfer transistor, reset transistor, amplification transistor, and selection transistor), and multilayer wiring layer 33 (i.e., electronic circuits) on the same substrate 22. In my opinion, one skilled in the

art would have understood that *Shinohara* discloses monolithically integrating its pixel region and the peripheral circuit portion, including various electronic circuits and transistors, on the same substrate. *Shinohara*'s integrated structure with these features is illustrated below.



Shinohara, Fig. 1.

340. In my opinion, one skilled in the art would have found it obvious to combine *Shinohara*'s teachings with *Kuboi*, resulting in an integrated structure in which *Kuboi*'s array of pillars (i.e., pixel region) is monolithically integrated with electronic circuits (including devices) that include active elements for signal processing and transmission. Ex. 1011, 3.

5. Claims 3 and 7-8

341. In my opinion, *Kuboi* in view of *Shinohara* renders obvious these claims.

342. As I explained above, one skilled in the art would have found it obvious to apply *Shinohara*'s teachings on monolithic integration to *Kuboi* by forming the pixel transistors, multilayer wiring layer 32, pixel array 201, and logic circuits 204-208 on a common substrate to form the *Kuboi-Shinohara* integrated structure. *Supra* XI.C.2. As I explained for claims 3 and 7-8 under Ground 1, the *Kuboi-Shinohara* integrated structure satisfies the limitations of these claims. *Supra* XI.A.3-XI.A.5.

6. Claim 9

a. "The integrated structure of claim 1, wherein the array is monolithically integrated with Si electronic devices for signal processing and transmission."

343. In my opinion, *Kuboi* in view of *Shinohara* renders obvious the additional limitations of this claim.

344. As I explained for claim 2 above, in the *Kuboi-Shinohara* integrated structure, the pixel array is monolithically integrated with logic circuits 204-208 comprising Si electronic devices. *Supra* XI.C.4.a. *Kuboi*'s column signal processing circuits 205 perform signal processing on signals from pixels 202 and forward them to output circuit 207, which conducts further processing and outputs

the final signals. *Kuboi*, ¶¶[49], [52]-[54]; *supra* XI.A.6.a (claim 9, Ground 1). One skilled in the art would therefore have recognized that the pixel array is monolithically integrated with Si electronic devices for signal processing and transmission of electrical signals in the *Kuboi-Shinohara* integrated structure.

7. Claim 10

a. "The integrated structure of claim 1, wherein the array is monolithically integrated with Si electronic devices for transmitting electrical signals related to accumulations of the charge carriers in at least some of the photodetectors."

345. In my opinion, *Kuboi* in view of *Shinohara* renders obvious the additional limitations of claim 10.

346. As explained for claim 9 above, one skilled in the art would have recognized that, in the *Kuboi-Shinohara* integrated structure, the pixel array is monolithically integrated with Si electronic devices for transmission of electrical signals. *Supra* XI.C.6.a. As I explained for claim 10 under Ground 1, these transmitted electrical signals are related to accumulations of the charge carriers in the photoelectric conversion portions of at least some of the pixels. *Supra* XI.A.7.a.

8. Claim 11

a. "The integrated structure of claim 1, in which each of at least some of the photodetectors is configured such that the light passes through at least a part of the one of the P-doped region and N-doped region of the photodetector before reaching any part of the other doped region of the photodetector."

9. Claim 12

a. "The integrated structure of claim 1, in which the doped regions of each of at least some of the photodetectors are configured such that the light passes through at least a part of the P-doped region before reaching any part of the N-doped region."

347. In my opinion, *Kuboi* in view of *Shinohara* renders obvious these claims.

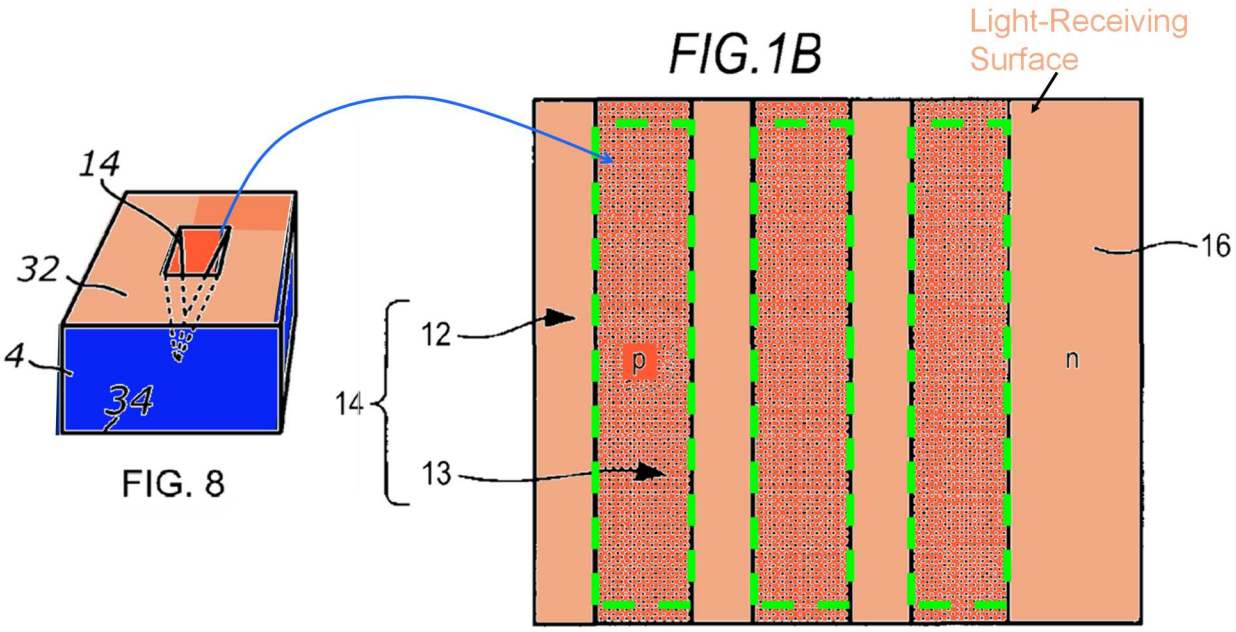
348. As I explained above, one skilled in the art would have found it obvious to apply *Shinohara*'s teachings on monolithic integration to *Kuboi* to form the *Kuboi-Shinohara* integrated structure. *Supra* XI.C.2. As I explained for claims 11-12 under Ground 1, the *Kuboi-Shinohara* integrated structure satisfies the limitations of these claims. *Supra* XI.A.8.a-XI.A.9.a.

D. Ground 4: Claims 4-6 and 13-16 Are Obvious over *Kuboi* in View of *Vasylyev* and *Shinohara*

1. Motivation to Modify *Kuboi* in View of *Vasylyev* and *Shinohara*

349. As I previously explained, one skilled in the art would have understood that *Kuboi*, *Vasylyev*, and *Shinohara* are analogous art to the '948

patent. *Supra* VIII.A, XI.B.1, XI.C.1. As I explained above for Section XI.B.3, in light of *Vasylyev*'s teachings, one skilled in the art would have found it obvious to modify *Kuboi*'s green and red pixels (53G, 53R) by extending holes 38 in photoelectric conversion portions 14 along a substantial portion—rather than the entire extent—of their light-receiving surfaces to form the *Kuboi-Vasylyev-2* imaging device.

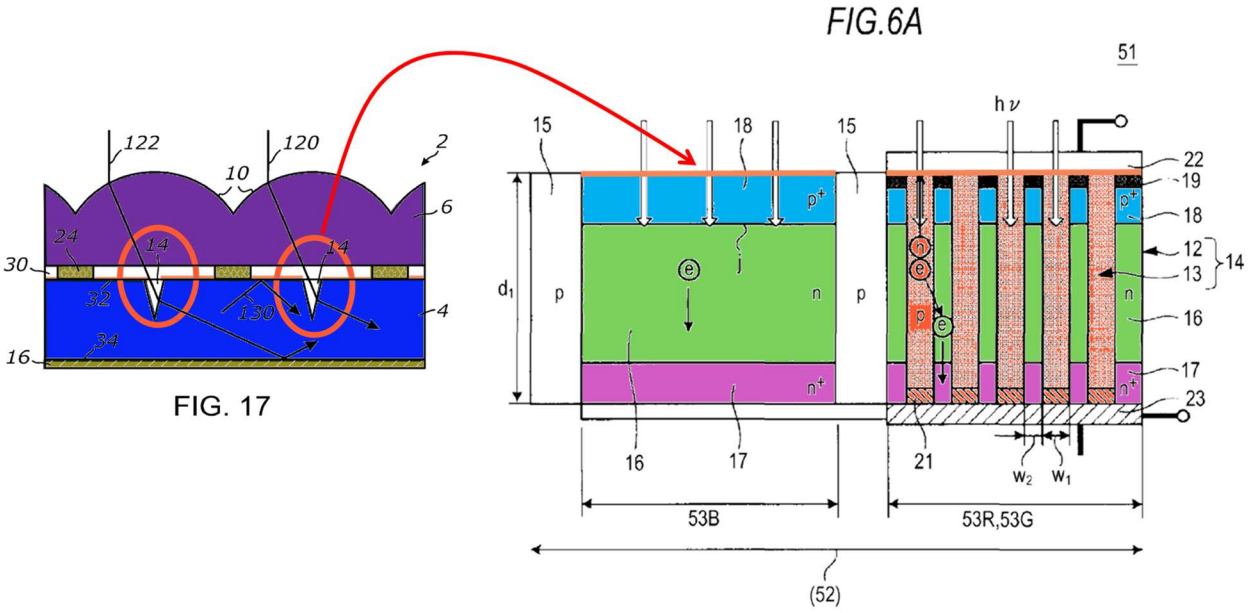


Vasylyev, Fig. 8 (left); *Kuboi*, Fig. 1B (right).

350. Based on *Kuboi*'s disclosure, one skilled in the art would have known that this modification to green and red pixels (53G, 53R) would reduce the average distance that photogenerated electrons in organic film 13 must travel to reach the

silicon-film interface, increase the interface area, and thereby enhance the imaging device's operating speed. *Supra* XI.B.3; *Kuboi*, ¶¶[8], [67]-[68].

351. As I explained for Section XI.B.4, to reduce reflection of blue light and increase optical efficiency, one skilled in the art would also have found it obvious to additionally incorporate a single light input port 14—configured as an elongated, narrow trench extending through the full thickness of semiconductor layer 12 and at least partially filled with a dielectric material—into blue pixel 53B of the *Kuboi-Vasylyev-2* imaging device and form the *Kuboi-Vasylyev-3* imaging device. *Supra* XI.B.9.a (claim 14, Ground 2). This is illustrated below.



Vasylyev, Fig. 17 (left); *Kuboi*, Fig. 6A (right).

352. In addition to applying *Vasylyev*'s teachings to the blue, green, and red pixels (53B, 53G, 53R) in *Kuboi*'s imaging device, one skilled in the art would

have found it obvious to further incorporate *Shinohara*'s teachings in the *Kuboi-Vasylyev-3* imaging device to form a *Kuboi-Vasylyev-Shinohara* imaging device to streamline fabrication, reduce fabrication cost, and improve electrical performance. *Supra* XI.C.2. One skilled in the art would have recognized that the *Kuboi-Vasylyev-Shinohara* imaging device would be a monolithically integrated device with the pixel array 201 and associated electronic circuits—such as pixel transistors, multilayer wiring layer 32, and peripheral logic circuits 204-208—on a single substrate with *Shinohara*'s interlayer insulating film 31 as a base dielectric region. *Supra* XI.C.2, XI.C.3.b (claim [1f], Ground 3).

353. In my opinion, one skilled in the art would have had a reasonable expectation of success in combining the known teachings of *Kuboi*, *Vasylyev*, and *Shinohara* as each addresses similar technical challenges and proposes solutions that operate according to well-understood principles and are aimed at improving the same device functionality. *Supra* XI.B.2-XI.B.4, XI.C.2.

2. Claims 4-6

354. In my opinion, *Kuboi* discloses and/or renders obvious the limitations of independent claim 1 as discussed under Ground 1. *Supra* XI.A.1. Claims 4-6 further depend from claim 1, and for the same reasons as I explained for claims 4-6 under Ground 2, the *Kuboi-Vasylyev-Shinohara* device satisfies the limitations of these claims. *Supra* XI.B.5-XI.B.7.

3. Claim 13

a. [13(pre)]-[13e], [13g]-[13h]

355. In my opinion, *Kuboi* in view of *Vasylyev* and *Shinohara* renders obvious these limitations. *Supra* XI.B.8.a-XI.B.8.h (claims [13(pre)]-[13e], Ground 2), XI.B.8.j-XI.B.8.k (claims [13g]-[13h], Ground 2).

b. [13f]

356. In my opinion, *Kuboi* in view of *Vasylyev* and *Shinohara* renders obvious this limitation. One skilled in the art would have recognized that this limitation is identical to claim [1f], and as discussed for claim [1f] under Ground 3 and claim 5 under Ground 2, *Kuboi* in view of *Shinohara* renders obvious claim [1f]. *Supra* XI.C.3.b, XI.B.6. One skilled in the art would have recognized that *Kuboi* in view of *Vasylyev* and *Shinohara* likewise renders obvious this limitation.

c. [13i]

357. In my opinion, one skilled in the art would have recognized that this limitation is identical to claim 9. As I explained for claim 9 under Ground 3, *Kuboi* in view of *Shinohara* renders obvious claim 9. *Supra* XI.C.6. One skilled in the art would have recognized that *Kuboi* in view of *Vasylyev* and *Shinohara* likewise renders obvious this limitation.

4. Claims 14-16

358. Claims 14-16 depend from claim 13. As I explained for Ground 2, the *Kuboi-Vasylyev-3* imaging device renders obvious claim 14 (*supra* XI.B.9) and *Kuboi* satisfies claims 15 and 16. *Supra* XI.B.10-XI.B.11. In my opinion, one skilled in the art would have recognized that *Kuboi* in view of *Vasylyev* and *Shinohara* also renders obvious these limitations for the same reasons discussed above.

E. Ground 5: Claims 1-16 Lack Enablement Under 35 U.S.C. § 112

359. Independent claim 1 recites "wherein the presence of said one or more holes increases by a factor of at least 1.1 the absorption of the light by at least some of the photodetectors relative to like photodetectors lacking said holes." Independent claim 13 recites a similar limitation. As I explained above with respect to Section XI.A.1.j (claim [1h], Ground 1), based on Patent Owner's representations in the '948 patent, one skilled in the art would have understood that the absorption of light, at selected visible and infrared wavelength ranges, by at least some of *Kuboi*'s photodetectors with holes would be at least 1.1 times that of like photodetectors lacking said holes.

1. The Claims Are Not Enabled If *Kuboi*'s Disclosure Is Deemed Insufficient

360. In my opinion, if Patent Owner contends that the '948 patent's representations as understood by one skilled in the art are insufficient to establish

that the prior art disclosure applied in this declaration meets any of the 1.1 requirements of any of the claims, the '948 patent specification necessarily fails to enable such claims. Relying on Chang-Hasnain (Ex. 1033), Patent Owner represents in the '948 patent that a microstructured pillar hole array having microstructure period Λ and satisfying the relationship $\lambda/n_1<\Lambda<\lambda/n_2$ forms a high contrast grating (HCG). *Supra* XI.A.1.j (claim [1h], Ground 1). According to Patent Owner, if the microstructure pillar hole array forms an HCG, then the physical phenomena of near-wavelength and deep-wavelength result in an enhanced absorption coefficient of 1.1 to 100 times the bulk absorption coefficient. *Supra* XI.A.1.j (claim [1h], Ground 1). But if this disclosure is insufficient to know whether a given photodetector with holes would be at least 1.1 times that of like photodetectors lacking said holes, then the '948 patent specification does not enable the full scope of claims 1-16.

2. Because the Claims Cover Single-Hole Structures, the Full Scope of Claims 1, 4, 13, and 14 Is Not Enabled

361. Independent claims 1 and 13's recitation of "one or more holes … are fabricated … under the light-receiving surface of each of at least some of the pillars" covers embodiments in which each pillar includes a single hole. The phrase "one or more" includes the singular "one," and the claims' structure permits configurations where only one hole is present per pillar. Furthermore, claims 4 and 14 require that "each of at least some of the pillars has only one of the elongated

holes." But the '948 patent fails to enable such embodiments with respect to the claimed 1.1 requirement. *Supra* XI.A.1.j (claim [1h], Ground 1).

362. In my opinion, the specification lacks sufficient guidance to allow one skilled in the art to make and use an embodiment with a single hole per pillar that achieves the claimed enhancement. It does not disclose how such a configuration would function to produce the required increase in absorption. Instead, the described mechanism for determining increased absorption—such as the high contrast grating (HCG) effect that occurs when the microstructure period Λ satisfies the relationship $\lambda/n_1 < \Lambda < \lambda/n_2$—requires multiple holes arranged with a periodicity Λ, which is absent in a single-hole embodiment. For instance, one skilled in the art would have expected a substantial change in the HCG effect at lower values of the period Λ. *See* Ex. 1051, 1-6. Accordingly, in my opinion, the '948 patent does not enable one skilled in the art to practice the full scope of claims 1-16.

3. Because the Claims Cover Millimeter-Sized Pillars, the Full Scope of Claims 1 and 13 Is Not Enabled

363. Application No. 19/036,506 ("the '948 Divisional") is a pending application with claims substantively similar to those in the '948 patent. Ex. 1050, 290-294. Ex. 1049 (U.S. Patent Application Publication No. 2025/0194293 A1) is a publication of the '948 Divisional. Like claim 1 of the '948 patent, independent claim 18 of the '948 Divisional recites an integrated structure comprising "an array

of pillars … includ[ing] photodetectors," where at least some pillars include "P-doped and N-doped regions," "one or more holes" extending to depths of less than 10,000 nm, "wherein the presence of the one or more holes increases by a factor of at least 1.1 the absorption of the light by at least some of the photodetectors relative to like photodetectors lacking said holes." Ex. 1050, 290. Independent claim 32 contains similar limitations. Ex. 1050, 293-294.

364. The Examiner rejected independent claims 18 and 32 for lack of enablement, explaining that the specification does not support the full scope of the claims. Ex. 1050, 8. According to the Examiner, the claims encompass "pillars [that] could be sized to be on the order of magnitude of either millimeter or nanometer sized pillars," which are not disclosed in the application. Ex. 1050, 8. Instead, the specification "specifically centers the pillar dimensions at around 100 micrometers and micrometers in general." Ex. 1050, 8. (citation omitted).

365. The Examiner's reasoning for claims 18 and 32 of the '948 Divisional applies equally to claims 1 and 13 of the '948 patent because the claims are substantively similar and are supported by the same disclosure. In my opinion, the '948 patent does not provide sufficient detail for one skilled in the art to make and use the full scope of claims 1 and 13, which, as noted by the Examiner, encompass millimeter-sized pillars. In my opinion, the '948 patent fails to describe how to make and use an integrated structure with millimeter-sized pillars where

"the presence of the one or more holes increases by a factor of at least 1.1 the absorption of the light by at least some of the photodetectors relative to like photodetectors lacking said holes." '948 patent, 11:52-12:55, 20:43-64 ("The pillar diameter range [is] from 50-1200 nm (smallest dimension can be 50 and largest dimension 1200 nm)."). Therefore, in my opinion, claims 1-16 are not enabled.

XII. CONCLUSION

366. For the reasons set forth above, it is my opinion that one skilled in the art would have found claims 1-16 of the '948 patent obvious over the prior art. My opinion would remain the same even if the level of skill in the art was slightly lower (e.g., requiring only a bachelor's degree instead of a master's degree).

XIII. DECLARATION

367. In signing this declaration, I understand that the declaration will be filed as evidence in a contested case 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.

368. I declare that all statements made herein of my 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 knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. § 1001.

Wednesday, August 27, 2025

Date: By:_____

Michael Lebby

APPENDIX A

Michael Lebby



EDUCATION:

2004, Doctor of Engineering (D. Eng.)
University of Bradford, United Kingdom
Electrical and Electronic Engineering with citation, "*Technical Contributions to Optoelectronics"*
(NB: This is a higher doctorate awarded on technical contribution to the field)

1987, Ph.D.
University of Bradford, United Kingdom
Electrical and Electronic Engineering with thesis, "*Characterization and Fabrication of the HFET and BICFET"*

1985, MBA
University of Bradford, United Kingdom
Thesis, "*Small Business Planning for a Start-up"*

1984, Bachelors (B. Eng. – Honours)
University of Bradford, United Kingdom
Electrical and Electronic Engineering with thesis, "*Computer Aided Testing of Semiconductor Devices"*

SUMMARY OF TECHNICAL EXPERTISE:

Industry roles (majority of career): Dr. Lebby is currently Chair of the Corporate Engagement Council, and Board of Directors for Optica (2024-2026). Dr. Lebby was honored in October 2024 as 'Photonics 100' for 2025 by Electro Optics Publication. The award is based on exceptional contributions and achievements in the field of photonics. Dr. Lebby is also currently CEO of GenusTechnik Inc., a company that provides expert witness consulting services in patent/Intellectual Property litigations as well as consulting to technology companies. GenusTechnik Inc. has served many top-tier technology clients that include both $B and $T market capitalization companies as well as well-established international level law firms.

Dr. Lebby has founded and led several companies in various positions including CEO and CTO (Ignis Optics, Oculi, One Chip Photonics, OIDA, Translucent Photonics, and Lightwave Logic). Dr. Lebby recently (Dec 2024) retired as Chairman & CEO of a public company (Lightwave Logic Inc. NASDAQ:LWLG). As CEO, Dr. Lebby led LWLG from an OTCQB company to OTCQX, and then to up-list on NASDAQ, organically, without raising financing (which is extremely rare), on 1st September 2021. Subsequently, Dr. Lebby was invited to 'ring the bell' and close the NASDAQ stock market for ethe week on 10th September 2021. The event was carried live on Fox, CNBC, Bloomberg, and BNN networks. On 1st September 2022, Lebby was elected Chairman of Lightwave Logic Inc.

Academia role (minor part of career): Dr. Lebby has been a full professor (part-time) in optoelectronics at Glyndŵr University, Wales, UK (2013-15). Dr. Lebby has over 60 publications and has a google scholar h-index = 47 (which includes issued patents and published patent applications), i10-index = 173, with over 9200 citations.

Key professional bodies: Dr. Lebby is a Fellow of the National Academy of Inventors (NAI), the IEEE (Institute of Electrical and Electronic Engineers), and Optica (previously: Optical Society of America). Dr. Lebby is a

Professor (Dr. Dr.) Michael S. Lebby, B. Eng. (Hons), MBA, Ph.D., D. Eng, Fellow NAI, IEEE, Optica (OSA); C. Eng.
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Chartered Engineer of the British Institute of Electrical Engineers (roughly equivalent to the professional engineer status in USA).

Dr. Lebby started work in telecommunications industry and has generated over 40 years of experience in a broad range of technical disciplines and technologies. Dr. Lebby is well versed in photonics, PICs (photonic integrated circuits), electronics, semiconductor physics, optoelectronics, optics, materials, temperature, and mechanical engineering in general. Dr. Lebby is also experienced in matters of semiconductor packaging, pluggable transceiver module design, electrical interconnect and connectors, ICs (digital, analog, RF, power, compound semiconductor), lighting, LIDAR, applications of artificial intelligence, sensing, displays, and polymers in general. Dr. Lebby has experience in commercial and industrial research of technologies such as silicon, silicon photonics, silicon photonic PICs, compound semiconductors, GaAs PICs, InP PICs, electronics, connectors, manufacturing, fabrication, design, simulation, testing, evaluation, reliability, qualification of new ideas, concepts and products.

Dr. Lebby is co-inventor of the world's first 'oxide VCSEL' in 1991 (this is a type of semiconductor laser) that is now being utilized for consumer applications for structured sensing. One example is structured sensing in modern day smart phones, another example is the application of laser mice for PCs). US Patent #5359618 "High Efficiency VCSEL and Method of Fabrication" issued 25th October 1994. Estimated aggregated commercial volumes of this semiconductor device exceed many billions of units today.

Dr. Lebby has over 230 issued utility patents with the USPTO in subjects such as electronics, optoelectronics, photonics, packaging, transceiver modules, LiDAR components/PICs, electrical and optical connectors, sensing components, optical sub-assemblies, materials, epitaxial growth, device design, assembly, and various active and passive components (both electronic and optoelectronic). Dr. Lebby has over 400 media events in which he has been a speaker (keynote, invited, contributed, webcasts, panels, interviews etc.), and regularly receives invites to speak at technical conferences as well as banking and financial conferences on subjects that range from optical networking, internet, generative-artificial intelligence, semiconductor eco-systems, foundries, outsourced manufacturing, technology roadmaps, corporate leadership, bring a new technology platform to market, and finance issues for small and entrepreneurial companies. Dr. Lebby has appeared in panels and interviews many times and regularly is communicating with the public on various platforms both technically, as well as financially. Dr. Lebby is currently chairman of the International PIC conference based in Europe (since it's conception in 2015). Dr. Lebby has a combined total of over 335 USPTO issued utility patents and published patent applications. This number grows to over 500 if international derivatives are included.

Dr. Lebby has participated in over 180 patent litigation cases as a technical expert witness, including over 20 trials and over 60 depositions. Dr. Lebby has authored numerous expert reports and is familiar with State (District), Federal (ITC) and PTAB-IPR court processes for expert witness testimony. Dr. Lebby has been cited in patent litigation case history (ITC investigation in the matter of: Certain Active Optical Cables and Products Containing the Same (ITC Inv #337-TA-1233)). See details below in Expert Witness Experience.

The types of products that Dr. Lebby understands and includes but are not limited to; Light Emitting Diodes (LEDs), Laser Diodes (LDs), silicon photonics, PICs, InP PICs, GaAs PICs, photodetectors (PDs), optical waveguides, fiber optics, displays (LCD, LED, OLED), lighting luminaires, plastic photonics, optical polymers, connectors, sensors, LIDAR, solar cells, lighting, data communication, CMOS, and even new opportunities such as medical and life science applications for photonics. Dr. Lebby is internationally known for his work with integrated photonics, PICs (Photonic Integrated Circuits), silicon photonics, and semiconductor technologies such as InP, GaAs, III-N, GaN, silicon, as well as SiGe and silicon ICs (MOSFETs, FinFETs, bipolar), power FETs, RF FETs, various display technologies such as LCD, OLED, LED, cameras, as well as micro-fluidics and nanostructures/wires etc. Dr. Lebby has worked with DC current as well as AC current, high frequency design, microwave design, twisted wire pairs, and multi-wavelength, visible wavelengths, in addition to 850nm/1310nm/1500nm/NIR fiber optic communications. Dr. Lebby has worked extensively in fiber optics which includes Fiber based systems, chassis', trays, modules, adapters, splice devices, connectors (electrical and optical), transceivers, packaging as well as architecture and optical communication standards/protocols that include synchronous and asynchronous architectures. Fiber-optic based communications are indirectly impacted by generative-artificial intelligence (G-AI), as these systems carry the increase computational data load generated by G-AI electronics technology.

Dr. Lebby recently retired as Chairman and CEO of a public company (Lightwave Logic Inc. NASDAQ:LWLG). As CEO, Dr. Lebby took LWLG from an OTCQX company to up-list on NASDAQ, organically, without raising financing (which is extremely rare). LWLG was listed on NASDAQ 1st September 2021, and Dr. Lebby was invited to close the NASDAQ stock market on 10th September 2021 and "ring the bell". The event was carried on Fox, CNBC, Bloomberg, and BNN networks.

Dr. Lebby was voted in 2023 to become chair of Optica's Corporate Engagement Council (2024-2026) and become a member of the Optica Board of Directors. Dr. Lebby is currently a member of Optica's Corporate

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Engagement Council which represents the global photonics industry and is a member of Optica's Board of Directors (Jan 2024-Dec 2025).

BIOGRAPHY (style 1 technical focus):

Dr. Lebby (born 1961, London, UK) is an Anglo-American entrepreneur and intrapreneur in the fields of optoelectronics/photonics, electronics (lasers, LEDs, detectors, PICs, IC, RF, power, microwave etc.), and semiconductors in general. Dr. Lebby's career started with the British Government in 1977 in telecommunications and he did research at their research labs (RSRE Malvern) in the early 1980s. Dr. Lebby worked at AT&T's research labs: Bell Labs (1985-1989) in photonics, especially PICs, and subsequently drove the development (and co-authored the first patent) of the oxide VCSEL diode laser at Motorola in the 1990s (which is now used in laser mice, 3D structured light sensing in mobile phones, optical interconnects; where volumes of the laser are over 1B units today). From 2005-2010 he led the USA trade association in optoelectronics (OIDA) and represented the optoelectronics and photonics industry on Capitol Hill. In this role he produced broad market analysis in fiber optic communications, lighting, displays, automotive LIDAR, sensing, solar, photonics manufacturing, as well as associated technology roadmaps for the market verticals and technologies.

Dr. Lebby was a member of Lightwave Logic's Board of Directors from 2015 to 2024. In May 2017, Dr. Lebby assumed the role of CEO, and in September 2022, Chairman and CEO of Lightwave Logic Inc (NASDAQ:LWLG) until 10th December 2024. Lightwave Logic is a technological company commercializing Electro-Optical polymers and successfully up listed the company to NASDAQ on 1st September, 2021. Dr. Lebby was invited to close the NASDAQ stock market on 10th September 2021. The event was carried on Fox, CNBC, Bloomberg, BNN networks.

Dr. Lebby has led and run technical start-ups and commercialized optoelectronic and photonics technology into volume manufacturing. He has also had roles as a Venture Capitalist specializing in Optical Communications. He is currently a technical expert to the European Commission. He is a Fellow member of NAI (National Academy of Inventors), IEEE, and OSA, and has been voted PIC (Photonic Integrated Circuit) business leader of the year by the PIC International Conference in 2018.

Dr. Lebby holds over 500 issued international patents (as per search engine) in photonics and electronics, that have been derived from over 230 issued USPTO utility patents, mostly in the field of optoelectronics, photonics, and semiconductors. He has been cited by the USPTO to be in the most prolific 75 inventors in USA from 1988-1997.

Dr. Lebby is passionate about photonics and has focused his efforts over the last 30years to drive new photonics manufacturing programs in USA and Europe as well as industry-based photonics technology roadmaps.

Dr. Lebby is also a keen hobbyist in optics and philately, and has been elected to both the London Guild of Spectacle Makers as well as the Royal Philatelic Society London.

BIOGRAPHY (style 2 corporate focus):

Dr. Michael S. Lebby has deep experience running and leading technology companies, especially those developing, manufacturing and productizing new platform technologies. Dr. Lebby's experience includes research, development, volume scale, marketing, sales, finance, and corporate activities both with management as well as at a board director level. Dr. Lebby is globally recognized as an expert witness in technology. With over 60 Federal court depositions that relate to optics, photonics, electronics and semiconductors, Dr.Lebby has represented many major technology companies in patent litigation. Dr. Lebby's technical acumen stems from his entrepreneurial and intrapreneurial skills working throughout his career in both large corporate organizations as well as venture backed start-ups and public companies. Dr. Lebby was a member of LWLG's Board of Directors from 2015 to 2024 and chair from 2022,. Dr Lebby led the corporation as CEO in 2017 and successfully navigated LWLG from OTCQ to the NASDAQ through an organic uplisting with the rare situation of no reverse splits or associated public offering in 2021. The new technology electro-optic polymer platform for optical modulators that Dr. Lebby was driving at LWLG has the potential to change the way the internet operates and performs both from a performance as well as power efficiency perspective and he gave many keynote talks and interviews to put the technology platform on international technology roadmaps. Dr. Lebby has built world class teams not only to productize new and novel technology platforms from research concepts through development to production, but also in sales, marketing, human relations, legal, and finance. Dr. Lebby's career started with the British Government in 1977 in telecommunications and he did

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research at their prestigious research labs (RSRE Malvern) in the early 1980s and worked at AT&T Bell Labs (1985-1989) in photonics. At Motorola in the 1990s he drove the development, including the first patent co-authorship of the oxide VCSEL diode laser which is now used in laser mice, 3D sensing/structured light in mobile phones and short distance datacenter optical interconnects with estimated volumes of over 1B units today. From 2005-2010 he led the USA trade association in optoelectronics (OIDA) and represented and petitioned on behalf of the optoelectronics industry on Capitol Hill for major multi-national corporations. Dr. Lebby has run and led several technological start-ups such as Ignis Optics, One Chip Photonics, Translucent Photonics, Lightwave Logic, as well as groups in Motorola, Tyco Electronics, AT&T, Intel and others. Dr. Lebby has nurtured innovative technology through building a range of customers from small business enterprises to multi-national corporations. Dr. Lebby was honored in October 2024 as 'Photonics 100' for 2025 by Electro Optics Publication. The award is based on exceptional contributions and achievements in the field of photonics. Dr. Lebby was voted PIC (Photonic Integrated Circuit) business leader of the year by the industry-based PIC International Conference in 2018. He is a technical expert to the European Commission, and a Fellow of NAI, IEEE and Optica. He also is Chair (2024-2026) of Optica's Corporate Engagement Counsel, a board of industry representatives to further business activity in the sector as well as a Board member of Optica. Dr. Lebby is CEO of GenusTechnik Inc., which assists companies on patent/IP, expert witness, and new leading-edge technologies.

BIOGRAPHY (style 3 key points focus):

Michael Lebby recently retired (Dec 2024) as chairman and chief executive officer of Lightwave Logic after nearly a decade. He joined the Board in 2015, became CEO in 2017, and assumed the additional position of chairman in 2022. Michael is an expert in semiconductors, electronics, optoelectronics/photonics, and optical systems. He has extensive experience with technology companies developing manufacturing and productizing new platform technologies.

During his career, Michael's roles include serving as a director and executive of large corporate organizations as well as venture backed start-ups. He has deep experience in corporate activities in R&D, volume scale, sales and marketing, and finance at start-ups he ran and led including Ignis Optics, One Chip Photonics, and Translucent Photonics as well as for groups in Motorola, Tyco Electronics, AT&T, and Intel. For five years until 2010, he led the Optoelectronics Industry Development Association. He is a technical expert to the European Commission.
Michael began his career in telecommunications at the prestigious RSRE Malvern research labs where he focused on electrical and electronic engineering, and later in photonics at AT&T Bell Labs. At Motorola in the 1990s, he drove development, including the first patent co-authorship of the oxide VCSEL diode laser that is widely used in laser mice, 3D/structured sensing in mobile phones and electrical/optical interconnects.

Michael was honored in October 2024 as 'Photonics 100' for 2025 by Electro Optics Publication. The award is based on exceptional contributions and achievements in the field of photonics. He was also honored in 2018 as a photonic integrated circuit (PIC) business leader of the year by the PIC International Conference. He is a Fellow of NAI, IEEE and Optica, and is Chair of the Corporate Engagement Counsel at Optica, a board of industry representatives that works to promote business activity in the optics and photonics sector. He holds a master's in business administration and two doctorates in engineering, compound semiconductors / optoelectronics from the University of Bradford in England.

WORK HISTORY:

2023 – Present **GenusTechnik Inc.,** *CEO and CTO (part-time consulting)*

GenusTechnik Inc., provides consulting in expert witness, trial, deposition, expert reports, infringement, invalidity, and various patent and IP litigation in the general areas of photonics, optoelectronics, semiconductors, and fiber optics. GenusTechnik has engaged with patent agencies such as: IMS Expert Services, Thomson Reuters Expert Witness Services (now Round Table Group), LitXpert Expert Witness Group, Teklicon Expert Witness Agency, Beche Expert Services Group, Forensis Group: Expert Witness

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Services, and Expertconnect. GenusTechnik Inc. also provides consulting to Ambature Inc. in superconductivity.

2003 – 2022 **Oculi LLC,** *CEO and CTO (part-time consulting)*

Oculi LLC), provided consulting in expert witness, trial, deposition, expert reports, infringement, invalidity, for patent and IP litigation. Subjects included: photonics, optoelectronics, semiconductors, electronic transistors, electronic circuits, integrated circuits (ICs), displays, cameras, optics, lenses, packaging, and fiber optics for telecommunication technology in general. Oculi LLC provided consulting to Ambature Inc. in superconductivity.

2015 – 2024 **Lightwave Logic (NASDAQ:LWLG)**, *Chairman, CEO, & Director, Board of Directors*

In 2015 Dr. Lebby became a director of Lightwave Logic to assist in the company for competitive optical modulator products and associated packaging, manufacturing, and technology roadmaps/marketing. In May 2017, Dr. Lebby became CEO of Lightwave Logic. On 1st September 2021, Dr. Lebby successfully guided Lightwave Logic to up-list to NASDAQ, and was invited to ring the closing bell on 10th September 2021. The NASDAQ up-list was organic i.e. no reverse split, no raised funds. The organic up-list is considered very rare in the financial industry. In September 2022, Lebby became Chairman and CEO of Lightwave Logic Inc. Dr. Lebby retired from Lightwave Logic in December 2024.

2014 – 2016 **University Southern California,** *Director CFR (Corp & Foundation Relations)*

Dr. Lebby assisted USC Viterbi Engineering to foster tighter faculty-industry relationships in high technology, IT, social media, graphic arts, electronics, photonics (solar, display, medical) and fiber communications segments.

2013 – Present **European Commission**, *Technical Expert*

In 2013 Dr. Lebby became a technical expert for the Photonics Unit of the European Commission. Dr. Lebby has participated in organizing workshops, lectures, evaluating photonics proposals, and advising the Commission on funded projects. Dr. Lebby currently is an advisor on 7 photonics and PIC based pilot lines (MIRPHAB, PI-SCALE, PIX4LIFE, PIXAPP, InPULSE, Phabulous, PhotonHub) and photonics based cardiovascular disease programs (CARDIS and InSide) as well as LIDAR/RADAR programs (Coralidar and Retina). More recently, Dr. Lebby has been consulting on larger framework (multi-country) projects that include electronics (power/RF) as well as photonic PIC based technologies and associated fabrication techniques (photolithography, etching, dielectrics, metallization etc.). Work includes displays, LEDs, lighting/LED luminaires, OLEDs, LIDAR, automotive, G-AI applications, micro-optics, optics, optical lenses, electrical and electronic ICs, packages and connectors, InP/Silicon PIC based photonics, near infra-red technologies (including PICs), fiber optics that includes transceivers, optical networking, as well as synchronous and asynchronous architectures, sensing, medical photonics, and medical imaging, technology roadmapping, electronics, electrical interconnects/connectors, IC design, RF electronics, Power electronics, microwave, acoustic and optical filters etc.

2013 – 2015 **OneChip Photonics Corporation**, *President and CEO*

In 2008 Dr. Lebby was elected independent board member for One Chip Photonics Inc. He was elected CEO in 2013. One Chip Photonics focused on technical and business operational strategy for communications based InP Photonic Integrated Circuit (PIC) and optoelectronic Integrated Circuit (OEIC) platforms.

2013 – 2015 **Glyndŵr University**, *Professor, Chair of Optoelectronics*

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In 2013 Dr. Lebby became full Professor of Optoelectronics (part-time) to assist Glyndwr University to position itself as a leader in semiconductors, optoelectronics and photonics. Areas of focus include design, simulation, and testing of photonic integrated circuits (PICs) and optoelectronics integrated circuits (OEICs), laser diodes, displays, optics, and solar cells.

2010 – 2013 **Translucent, Inc.,** *GM and CTO*

Dr. Lebby positioned Translucent on the product development and manufacture of epitaxial semiconductor wafers for the solar, power and lighting industries. Dr. Lebby led the R&D and development of MBE based rare earth oxide single crystal epitaxial layers deposited onto large silicon wafers. On top of these wafers both MBE and MOCVD Gallium Nitride (GaN, III-Nitride) epitaxial device layers were grown for devices and PIC solutions using novel fabrication techniques and electrode and contact formation. The use of GaN-on-Si is expected to be a strong catalyst for change in the power electronics and LED lighting industries. In a parallel program at Translucent, Dr. Lebby led the development efforts to develop and productize Germanium-Tin (GeSn) template wafers onto large format silicon wafers (Ge-on-Si) to enable cost effective, and ultra-high efficiency multi-junction solar cells for the CPV industry. Areas of advanced interconnect using new and novel material compounds were explored that focused on lighting, sensing, biomedical, RF electronics, Power electronics, solar, fiber optic communications, RF filters, ICs etc.

2005 – 2010 **OIDA** (Optoelectronic Industry Development Association)**,** *Executive Director, President, and CEO (Board Member)*

Dr. Lebby represented the optoelectronics industry and organized technical conferences/workshops/forecasts with industry roadmaps. Initiated green photonics metrics. Dr. Lebby positioned OIDA as a national resource in the field of optoelectronics and has represented industry in many capacities ranging from talks, papers, expert witness, testimony, market and technical reports. Dr. Lebby created ***new industry-based initiatives*** in fiber optics broadband as well as the green photonics movement (solar technologies, displays, LED lighting technologies, automotive) that is now occurring globally. Parts of the roadmap included various applications for PIC based photonic technologies.

2003 – 2005 **OCLARO (after acquisition by Bookham in 2003),** *VP Technology and Business Development*

Telecommunication optoelectronic components, San Jose, Ca. Focus on technology strategy for components and sub-systems that included InP based PICs.

2001–- 2003 **Ignis Optics,** *President and CEO (Founder/Board Member)*

Venture-backed start-up, San Jose, California manufacturing 10Gbps and OC192/OC48 fiber optic transceivers with micro-controllers using the XFP form-factor.

1999 – 2001 **Intel Capital,** *Director Business Development/Investor (w/Board observer positions on Investment)*

Intel Capital, Santa Clara, California. In 1999, Dr. Lebby joined Intel as a corporate investor and was responsible for sourcing, negotiating, and closing private placement equity deals in the optical networking, component, display, projection technologies, LED lighting, LED luminaires, and silicon, silicon photonics/PIC semiconductor arenas.

1998 – 1999 **TE Connectivity (renamed from AMP, then Tyco Electronics),** *Director Technology & Business Development (Fiber Optics)*

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Global Optoelectronics Division: Technology strategy for optical communications products that included electrical and optical interconnects, electrical and optical connectors (RJ, MT, LC etc.), for backplane, cabinet, switching, network management systems.

1989 – 1998 **Motorola,** *R&D Manager*

Corporate R&D Labs, Tempe, Arizona. Focus on semiconductors, semiconductor fabrication techniques (metallization, etching, photolithography, dielectrics). Optoelectronics: VCSEL based product solutions (OPTOBUS); materials, devices, packaging, systems. Other technologies included displays, field emission, LED, LCD, OLED, virtual/micro and projection. At the time, Dr. Lebby was also the lead inventor in Motorola's history with over 150 issued utility patents. Dr. Lebby worked in the silicon and compound semiconductor fabrication plants (fabs) to become proficient in deposition/etching/alignment tooling as well as design and simulation. Many of the component technologies that were researched at Motorola can now be found in AR, VR, displays, automotive LIDAR, solar, sensing, consumer products such as mobile phones, as well as traditional electronics industries that include both InP, GaAs, GaN, and silicon photonics based PICs. Work included optical networking with both electronics as well as optoelectronics synchronous and asynchronous architectures as well as electronic and optical interconnects with both electrical and optical connectors. Both wireline (twisted wire pair, fiber optics) as well as wireless (RF, microwave, optical) interconnects were utilized for a number of applications.

1985 – 1989 **AT&T,** *Researcher*

AT&T Bell Labs - Photonics Research Dept (Dept 11366), Holmdel, NJ. Dr. Lebby designed and fabricated new GaAs and InP optoelectronic and electronic devices that were grown both by MOCVD and MBE for projects that included optical computing and fiber optic communications that were focused on PIC based solutions. Work involved the fabrication of electrodes, contacts, etching, dielectrics, photolithography etc.

1977 – 1984 **UK Ministry of Defense,** *Apprenticeship/Journeyman + Electronics Engineer (REME – Royal Electrical and Mechanical Engineers, and RSRE – Royal Signals and Radar Establishment)*

Dr. Lebby started his career at the Royal Electrical and Mechanical Engineer (REME) division of the Ministry of Defence in the UK. Lebby was a telecommunications apprentice and repaired all types of radio/RF/UHF communications equipment that included electrical connections, connectors, and circuits. Equipment included both wireless communications as well as telecommunications electronics switching systems for traditional wireline calls. Lebby qualified as a fully qualified Apprentice (or Journeyman) specializing in electronic telecommunications in 1980. Dr. Lebby moved to the Royal Signal and Radar Establishment (RSRE) to study material, fabrication and characterization issues of GaAs and InP semiconductor devices and high frequency/ultra-high frequency wireline and wireless communications.

SELECTED PROFESSIONAL ACTIVITIES & AWARDS:

- Nominated for the Photonics 100 for 2025 by Electro Optics Publication October 2024. The award is based on exceptional contributions and achievements in the field of photonics as well a level of dedication and innovation that continues to inspire and advance the photonics industry.
- Elected Chairman of Lightwave Logic Inc., NASDAQ:LWLG 1st September 2022 until retiring in December 2024.
- Elected to the Corporate Engagement Council (newly formed OIDA to represent the global optical industry) for Optica in June 2022 and voted to become Chairman for 2024-2026 that is represented on Optica's Board of Directors.
- Invited to ring the closing bell of NASDAQ (with associated TV interviews) on 10th September, 2021
- Elected Fellow of the **National Academy of Inventors** (NAI) in 2020.
- Voted winner at the PIC Conference (Photonic Integrated Circuits) as PIC **Entrepreneur and Business Leader of the Year** (March 2018).

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- Dr. Lebby is **co-inventor of the oxide VCSEL** (semiconductor laser) that is now being utilized for consumer applications (*structured sensing in smart mobile phones*). US Patent #5359618 "High Efficiency VCSEL and Method of Fabrication" issued 25th October 1994.
- Dr. Lebby was recognized professionally as a **Fellow of IEEE (2005) and OSA (2007)** with his technical contributions to the field of optoelectronics.
- Dr. Lebby is a member of the Fellows review committee of IEEE.
- As an inventor Dr. Lebby has achieved **over 230 issued utility patents with the USPTO.**
- As an inventor Dr. Lebby has ~80 published utility patent applications with the USPTO
- As an inventor Dr. Lebby has **over 500 issued patents** world-wide if international derivatives are counted.
- Dr. Lebby's novel laser-based device, packaging, modules designs led Motorola to sell their patent portfolio independently where a number of the patents have "very high licensing coefficients." Dr. Lebby was given a special award from the Chairman of Motorola for exemplary patent invention accomplishments in 1998 and **# 1 prolific inventor in Motorola's history**.
- **Over 60 publications** (www.linkedin.com/in/lebby)
- **Over 400 public media activities** (that include: Books, Chapters, Reports, Abstracts, Videos, Lectures, Speeches, Reviews, Courses, Talks, Invited Talks, Keynote Talks, Plenary Talks, Webinars, Interviews, Articles, etc.). See at www.linkedin.com/in/lebby
- Author of OIDA's **annual market optoelectronics report** and forecast (2009 version is over 600 pages), which receives international exposure and recognition. Regularly interacts with government agencies in Washington DC on photonics-based projects (DARPA, ARPA-E, NIH, NSF, DOE, NIST, DoD etc.). Typical chapters included: LEDs, laser diodes, fiber optic communications, sensors, displays, solar, green photonics, military photonics, automotive LIDAR, medical, biomedical, lighting (LED, OLED), displays (LCD, OLED) and applications of photonics and electronics that include RF/power/compound semiconductor, ICs, and associated components.
- Is the recipient of a **2nd doctorate** (higher) from Bradford University, UK, and only the second in the universities history to receive a D.Eng from industry (rest being academia).
- **Intrepreneur** at: (i) Motorola: Co-founded Optobus division – VCSEL laser based parallel optical interconnect solution, and (ii) Intel: Co-founded the Intel optics division for silicon photonics where over $300M was initially invested for the division.
- **Entrepreneur**: Founded (and CEO) Ignis Optics Inc., a venture backed company (>$30M) that designed and manufactured 10Gbps fiber optic transceivers. Sold the company to Bookham (NASDAQ: BKHM) in 2003. Restructured OneChip Photonics (as CEO) through bankruptcy, and new VC-based funding. Assisted in the raising of >$50M VC funding as a member of BoD. Founded Oculi LLC and Obsidian Motors LLC.
- IEEE CPMT **Board of Governors** ('98- '02); IEEE Phoenix Waves and Devices Junior Engineer of the Year (1993); CPMT Distinguished lecturer (2000), CPMT technical committee (TC-10 & ECTC) 1991 to 2011
- Advised at **Board of Director** level for a number of technical start-ups
- **Chartered Engineer** (C.Eng) from IEE (UK). The chartered engineering status is equivalent to the US PE (professional engineer)

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EXPERT WITNESS EXPERIENCE

Summary:
Depositions (total-to-date) >60
Trial/Hearing/court/PTAB appearances >20 (with IPR/PTAB 'paper trial', this total increases to >40)

Cited patent litigation case history: In essence, the following case history means that the expert doesn't have to disclose every minute detail in his expert report. He is allowed to disclose theories in the report and expand on them in his witness statement.

See also In The Matter Of Certain Light-Emitting Diode Products, Systems, And Components Thereof, Inv. No. 337-TA-1168, Order No. 34, 2020 WL 1026335 (Feb. 14, 2020) (denying motion *in limine* to preclude testimony where: "[t]he invalidity theories at issue were previously disclosed at least in Dr. Lebby's expert report, and LSG had the opportunity to test these theories at Dr. Lebby's deposition.")

See case # 81 below

Patent litigation cases engaged:

1. Active case work: 1Q2009 (March 24th 2009); *Testimony: US-China Economic and security review commission on the optoelectronics industry. US Congress, Capitol Hill;* Written statement on the status of the USA optoelectronics industry with aural cross-examination by the commission. Trial experience.
    a. Deposition: 0 (Cumulative total: 0)
    b. Trial/Hearing/court/PTAB appearance: 1 (Cumulative total: 1)
        i. ITC trial appearance: 0 (Cumulative total: 0)
        ii. District Court trial appearance: 0 (Cumulative total: 0)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 0)
    c. Technology: Optoelectronics (optical storage, fiber optic communications, sensors, high power lasers, LED lighting, LED luminaires etc.).
2. Active case work: 3Q2010-1Q2011; *Finisar Corp. v. Optical Communication Products Inc.*, No. 10-CV-05617 and No. 11-cv-00104 (retained by plaintiff - Morgan, Lewis & Bockius LLP).
    a. Deposition: 0 (Cumulative total: 0)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 1)
        i. ITC trial appearance: 0 (Cumulative total: 0)
        ii. District Court trial appearance: 0 (Cumulative total: 0)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 0)
    c. Technology: semiconductor lasers/VCSELs, fiber optic transceiver modules
3. Active case work: 1Q2011; *Ziptronix, Inc. v. OmniVision Technologies, Inc., Taiwan Semiconductor Manufacturing Company Ltd., and TSMC North America Corp.,* No. 11-CV-5235 (retained by plaintiff – Alston Bird LLP).
    a. Deposition: 0 (Cumulative total: 0)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 1)
        i. ITC trial appearance: 0 (Cumulative total: 0)
        ii. District Court trial appearance: 0 (Cumulative total: 0)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 0)
    c. Technology: CMOS image sensors; design and fabrication
4. Active case work: 3Q2011 to 3Q2012; *Certain Light-Emitting Diodes and Products Containing Same*, Inv. No. 337-TA-798 (USITC filed July 15, 2011) (retained by respondent Samsung – Covington & Burling LLP). Deposition (x2) and trial experience.
    a. Deposition: 3 (Cumulative total: 3)
    b. Trial/Hearing/court/PTAB appearance: 1 (Cumulative total: 2)
        i. ITC trial appearance: 1 (Cumulative total: 1)
        ii. District Court trial appearance: 0 (Cumulative total: 0)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 0)
    c. Technology: LEDs, device design, color gamut, packaging, optical lensing, lead frames, surface mount packaging.
5. Active case work: 3Q2011 to 2Q2015; *Cheetah Omni, LLC v. Alcatel-Lucent USA Inc.*, No. 11-CV-390 (E.D. Tex. filed July 29, 2011) (retained by plaintiff – Brooks Kushman). Deposition experience (x2).
    a. Deposition: 1 (Cumulative total: 4)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 2)

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i. ITC trial appearance: 0 (Cumulative total: 1)
ii. District Court trial appearance: 0 (Cumulative total: 0)
iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 0)

c. Technology: Fiber optic networks, optical switches, ROADMs and optical filters (dielectric based).

6. Active case work: 4Q2012 to 3Q2014**;** *Finisar Corp. v. Cheetah Omni, LLC*, No. 11-CV-15625 (E.D. Mich. filed Dec. 23, 2011) (retained by defendant – Brooks Kushman). Deposition experience (x1).
   a. Deposition: 1 (Cumulative total: 5)
   b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 2)
      i. ITC trial appearance: 0 (Cumulative total: 1)
      ii. District Court trial appearance: 0 (Cumulative total: 0)
      iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 0)
   c. Technology: Wavelength optical switches, optical filters, and optical components, liquid crystal technology.
7. Active case work: 4Q2012 to 3Q2013**;** *Certain Optoelectronic Devices for Fiber Optic Communications, Components Thereof, and Prods. Containing the Same*, Inv. No. 337-TA-860 (USITC filed Sept. 24, 2012) (retained by respondent – Mellanox, IPtronics and FCI Inc and counsel Alston & Bird LLP). Deposition (x2) and trial experience.
   a. Deposition: 2 (Cumulative total: 7)
   b. Trial/Hearing/court/PTAB appearance: 1 (Cumulative total: 3)
      i. ITC trial appearance: 1 (Cumulative total: 2)
      ii. District Court trial appearance: 0 (Cumulative total: 0)
      iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 0)
   c. Technology: IC design, layout, and operation; especially laser driver chips for VCSELs. High speed laboratory testing.
8. Active case work: 3Q2014 to 2Q2015**;** *Microscan Sys., Inc. v. Cognex Corp.*, No. 14-CV-6952 (S.D.N.Y. filed Aug. 27, 2014) (retained by plaintiff – Morrison & Foerster LLP). Deposition (x1) and trail experience.
   a. Deposition: 1 (Cumulative total: 8)
   b. Trial/Hearing/court/PTAB appearance: 1 (Cumulative total: 4)
      i. ITC trial appearance: 0 (Cumulative total: 2)
      ii. District Court trial appearance: 1 (Cumulative total: 1)
      iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 0)
   c. Technology: Bar code scanners and associated optics such as imagers, lasers, LEDs, molded optics. Laboratory testing.
9. Active case work: 2Q2014 to 1Q2016**;** *Avago Techs. Fiber IP (Singapore) PTE Ltd. v. IPtronics Inc.*, No. 10-CV-2863 (N.D. Cal. filed June 29, 2010) (retained by respondent – Alston & Bird LLP).
   a. Deposition: 0 (Cumulative total: 8)
   b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 4)
      i. ITC trial appearance: 0 (Cumulative total: 2)
      ii. District Court trial appearance: 0 (Cumulative total: 1)
      iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 0)
   c. Technology: IC design, layout, and operation; especially laser driver chips for VCSELs. High speed laboratory testing.
10. Active case work: 1Q2015 to 3Q2015; *Regarding certain optical disc drives*, Inv. No. 337-TA-897 (USITC filed Oct. 21, 2013) (retained by respondent – O'Melveny & Myers LLP).
    a. Deposition: 0 (Cumulative total: 8)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 4)
       i. ITC trial appearance: 0 (Cumulative total: 2)
       ii. District Court trial appearance: 0 (Cumulative total: 1)
       iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 0)
    c. Technology: CD, CVD, BluRay optical disk drives, optical components, laser diodes, and optical beam patterns. Laboratory testing of visible optics.
11. Active case work: 1Q2015 to 2Q2015; *BMW of N. Am., LLC v. Innovative Display Techs., LLC*, No. IPR2015-00933, IPR2015-00934 (P.T.A.B. filed Mar. 24, 2015) (retained by plaintiff – Crowell Moring LLP).
    a. Deposition: 0 (Cumulative total: 8)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 4)
       i. ITC trial appearance: 0 (Cumulative total: 2)
       ii. District Court trial appearance: 0 (Cumulative total: 1)
       iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 0)
    c. Technology: LED backlights for vehicles; LED package and optical module/LED luminaire design.
12. Active case work: 1Q2015 to 2Q2015; *BMW of N. Am., LLC v. Innovative Display Techs., LLC*, No. IPR2015-00934 (P.T.A.B. filed Mar. 24, 2015) (retained by plaintiff – Crowell Moring LLP).
    a. Deposition: 0 (Cumulative total: 8)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 4)
       i. ITC trial appearance: 0 (Cumulative total: 2)

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ii. District Court trial appearance: 0 (Cumulative total: 1)
iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 0)

c. Technology: LED backlights for vehicles; LED package and optical module/luminaire design.

13. Active case work: 1Q2015 to 3Q2016; *OneChip Photonics Inc.*, Pre-litigation IP Case No. TBD; (retained by plaintiff – Patent Monetization Inc. (PMI)).
    a. Deposition: 0 (Cumulative total: 8)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 4)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 1)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 0)
    c. Technology: Photonic Integrated Circuits using InP (Indium Phosphide); lasers, detectors, waveguides, mux/demux, spot size converters.
14. Active case work: 2Q2016; *IDT v. Hyundai Motor Co.*, No. 14-CV-201 (E.D. Tex. filed May 4, 2015) (retained by defendant – DLA Piper LLP).
    a. Deposition: 0 (Cumulative total: 8)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 4)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 1)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 0)
    c. Technology: LED devices, packages and modules/luminaires for vehicles.
15. Active case work: 1Q2015 to 3Q2015; *Cree Inc., v. Honeywell Int'l Inc.,* No. 3:14-CV-737 (W.D. Wisc. filed Oct. 28, 2014) (retained by defendant - Arnold & Porter LLP). Deposition experience (x1).
    a. Deposition: 1 (Cumulative total: 9)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 4)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 1)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 0)
    c. Technology: LEDs for mobile phones; LED epitaxial layers, device designs, optical lensing, packaging. Laboratory reverse engineering using TEM/SEM/EDAX etc.
16. Active case work: 2Q2015 to 4Q2015; *Trs. of Boston Univ. v. Everlight Elecs. Co.*, Nos. 12-CV-11935, 12-CV-12326, 12-CV-12330 (D. Mass. filed Oct. 17, 2012) (retained by plaintiff - Shore Chan DePumpo LLP). Deposition (x1) and trial experience.
    a. Deposition: 1 (Cumulative total: 10)
    b. Trial/Hearing/court/PTAB appearance: 1 (Cumulative total: 5)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 1 (Cumulative total: 2)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 0)
    c. Technology: GaN buffer layers for LEDs, and associated technical marketing, sales and import process into USA.
17. Active case work: 3Q2015 to 3Q2016; *LG Elecs. Inc. v. Toshiba Samsung Storage Tech. Corp.*, No. 12-CV-1063 (D. Del. filed Aug. 22, 2012) and IPR2015-01659 (PTAB filed Jul. 31st 2015 (retained by plaintiff – DLA Piper & Nixon Law). IPR deposition (i.e. trial) experience (x1).
    a. Deposition: 1 (Cumulative total: 11)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 6)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 1 (Cumulative total: 2)
        iii. PTAB Court trial/deposition appearance: 1 (Cumulative total: 1)
    c. Technology: Optical storage using laser diodes, photodetectors and optical materials
18. Active case work: 3Q2015 to 3Q2016; *LG Elecs. Inc. v. Toshiba Samsung Storage Tech. Corp.*, No. 12-CV-1063 (D. Del. filed Aug. 22, 2012) and IPR2015-01642 (PTAB filed Jul. 30th 2015) (retained by plaintiff – DLA Piper & Nixon Law).
    a. Deposition: 0 (Cumulative total: 11)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 6)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 2)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 1)
    c. IPR/PTAB trial/deposition: 0 (Cumulative total: 1)
    d. Technology: Optical storage using laser diodes, photodetectors and optical materials
19. Active case work: 3Q2015 to 3Q2016; *LG Elecs. Inc. v. Toshiba Samsung Storage Tech Corp.*, IPR2016-01677 (PTAB filed Aug. 24th 2016 (retained by plaintiff – DLA Piper & Nixon Law).
    a. Deposition: 0 (Cumulative total: 11)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 6)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 2)

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iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 1)
c. Technology: Optical storage using laser diodes, photodetectors and optical materials

20. Active case work: 3Q2015 to 3Q2016; *LG Elecs. Inc. v. Toshiba Samsung Storage Tech. Corp.*, IPR2015-01678 (PTAB filed Aug. 24th 2016) (retained by plaintiff – DLA Piper & Nixon Law).
    a. Deposition: 0 (Cumulative total: 11)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 6)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 2)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 1)
    c. Technology: Optical storage using laser diodes, photodetectors and optical materials
21. Active case work: 3Q2015 to 3Q2016; *LG Elecs. Inc. v. Toshiba Samsung Storage Tech. Corp.*, IPR2015-01644 (PTAB filed Jul. 30th 2015) (retained by plaintiff – DLA Piper & Nixon Law).
    a. Deposition: 0 (Cumulative total: 11)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 6)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 2)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 1)
    c. Technology: Optical storage using laser diodes, photodetectors and optical materials
22. Active case work: 3Q2015 to 3Q2016; *LG Elecs. Inc. v. Toshiba Samsung Storage Tech. Corp.*, IPR2015-01653 (PTAB filed Jul. 31st 2015) (retained by plaintiff – DLA Piper & Nixon Law).
    a. Deposition: 0 (Cumulative total: 11)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 6)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 2)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 1)
    c. Technology: Optical storage using laser diodes, photodetectors and optical materials
23. Active case work: 3Q2015; *Heptagon* Pre-litigation IPR petition; (retained by plaintiff – Proskaurer Rose LLP).
    a. Deposition: 0 (Cumulative total: 11)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 6)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 2)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 1)
    c. Technology: Proximity sensors using LEDs, photodetectors and innovative semiconductor packaging.
24. Active case work: 1Q2016 to 2Q2017; *Dentsply v. Am. Orthodontics Inc.*, No. 15-CV-1706 (D. Pa. filed Sept. 1, 2015) and IPR2016-01652 (PTAB filed Aug. 19th 2016) (retained by defendant – Godfrey Kahn LLP). IPR deposition (x1) experience.
    a. Deposition: 1 (Cumulative total: 12)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 7)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 2)
        iii. PTAB Court trial/deposition appearance: 1 (Cumulative total: 2)
    c. Technology: High power lasers (YAG, CO2) to engrave and scribe dental orthodontic brackets.
25. Active case work: 2Q2016 to 2Q2017; *Koninklijke Philips N.V. v. Elect-tech Int'l (H.K.),* No. 14-CV-2737 (N.D. Cal. filed Aug. 12, 2015) (retained by plaintiff – Reed Smith LLP).
    a. Deposition: 0 (Cumulative total: 12)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 7)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 2)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 2)
    c. Technology: Trade secret and misappropriation of trade secrets for: MOCVD epitaxial growth techniques for high power GaN/InGaN LED technology, luminaires, modules and packaging.
26. Active case work: 2Q2016 to 4Q2016; *Bluestone Innovations llc. v. E. Mishan & Co. Inc.*, Pre-litigation IP Case No. TBD; (retained by defendant - Notaro, Michalos, & Zaccaria P.C.).
    a. Deposition: 0 (Cumulative total: 12)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 7)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 2)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 2)
    c. Technology: GaN/InGaN LEDs on structured substrates with reverse engineering laboratory analysis.
27. Active case work: 3Q2016-1Q2017; *511 Innovations Inc. v. HTC Am., Inc.*, No. 15-CV-1524 (E.D. Tex. Filed June 30, 2016) (retained by plaintiff – The Davis Firm). Deposition (x2)
    a. Deposition: 2 (Cumulative total: 14)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 7)
        i. ITC trial appearance: 0 (Cumulative total: 2)

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ii. District Court trial appearance: 0 (Cumulative total: 2)
iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 2)

c. Technology: Proximity sensors for mobile phones.

28. Active case work: 3Q2016-4Q2016; *Mellanox Techs. Ltd. v. Methode Elecs. Inc.,* No. 15-CV-3730 (N.D. Cal. filed Aug. 16, 2015) (retained by plaintiff – Alston & Bird).
    a. Deposition: 0 (Cumulative total: 14)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 7)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 2)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 2)
    c. Technology: Fiber optic transceiver modules.
29. Active case work: 4Q2016-1Q2017; *Novanta Inc., v Iradion Inc*., No. 15-CV-01033 (D. Del. filed Nov. 9, 2015) (retained by defendant – Barnes and Thornburg LLP).
    a. Deposition: 0 (Cumulative total: 14)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 7)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 2)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 2)
    c. Technology: High power gas laser design and operation.
30. Active case work: 1Q2017-1Q2017; *Optolum Inc., v Cree Inc*., No. 16-CV-03828; (D. Az. filed Nov. 3, 2016) (retained by defendant – Jones Day).
    a. Deposition: 0 (Cumulative total: 14)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 7)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 2)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 2)
    c. Technology: LED packaging for illumination. LED luminaires.
31. Active case work: 1Q2017-4Q2017; *Polygroup Macau Ltd (BVI)., v Willlis Electric Co., Ltd.,* 15-CV-00552 (W.D. NC. Filed: Apr 21st 2016), (retained by plaintiff - Troutman Sanders LLP). Deposition experience (x2)
    a. Deposition: 2 (Cumulative total: 16)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 8)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 2)
        iii. PTAB Court trial/deposition appearance: 1 (Cumulative total: 3)
    c. Technology: Electrical connector, IC, and LED light product design including luminaires.
32. Active case work: 1Q2017-4Q2017; *Polygroup Macau Ltd (BVI)., v Willlis Electric Co., Ltd.,* IPR2017-00309 (PTAB filed Nov. 21st 2017), (retained by plaintiff - Troutman Sanders LLP).
    a. Deposition: 0 (Cumulative total: 16)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 8)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 2)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: Electrical connector, IC, and LED light product design including luminaires.
33. Active case work: 1Q2017-4Q2017; *Polygroup Macau Ltd (BVI)., v Willlis Electric Co., Ltd.,* IPR2017-00330 (PTAB filed Nov. 24th 2017), (retained by plaintiff - Troutman Sanders LLP).
    a. Deposition: 0 (Cumulative total: 16)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 8)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 2)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: Electrical connector, IC, and LED light product design including luminaires.
34. Active case work: 1Q2017-4Q2017; *Polygroup Macau Ltd (BVI)., v Willlis Electric Co., Ltd.,* IPR2017-00331 (PTAB filed Nov. 24th 2017), (retained by plaintiff - Troutman Sanders LLP).
    a. Deposition: 0 (Cumulative total: 16)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 8)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 2)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: Electrical connector, IC, and LED light product design including luminaires.
35. Active case work: 1Q2017-4Q2017; *Polygroup Macau Ltd (BVI)., v Willlis Electric Co., Ltd.,* IPR2017-00332 (PTAB filed Nov. 25th 2017), (retained by plaintiff - Troutman Sanders LLP).
    a. Deposition: 0 (Cumulative total: 16)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 8)
        i. ITC trial appearance: 0 (Cumulative total: 2)

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ii. District Court trial appearance: 0 (Cumulative total: 2)
iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)

c. Technology: Electrical connector, IC, and LED light product design including luminaires.

36. Active case work: 1Q2017-4Q2017; *Polygroup Macau Ltd (BVI)., v Willlis Electric Co., Ltd.,* IPR2017-00334 (PTAB filed Nov. 25th 2017), (retained by plaintiff - Troutman Sanders LLP).
    a. Deposition: 0 (Cumulative total: 16)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 8)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 2)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: Electrical connector, IC, and LED light product design including luminaires.
37. Active case work: 1Q2017-4Q2017; *Polygroup Macau Ltd (BVI)., v Willlis Electric Co., Ltd.,* IPR2017-00335 (PTAB filed Nov. 25th 2017), (retained by plaintiff - Troutman Sanders LLP).
    a. Deposition: 0 (Cumulative total: 16)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 8)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 2)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: Electrical connector, IC, and LED light product design including luminaires.
38. Active case work: 1Q2017-4Q2017; *Macom Technology Solutions Holdings Inc., and Nitronex, LLC., v. Infineon Technologies AG and Infineon Technologies North American Corp.,* 16-CV-02859 (C.D. Ca. filed Apr 26, 2016) (retained by plaintiff – Baker Botts LLP).
    a. Deposition: 0 (Cumulative total: 16)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 8)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 2)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: High performance GaN based RF FET device design and operation.
39. Active case work: 1Q2017-1Q2017; *Quanergy Systems, Inc. v. Velodyne LiDAR, Inc.* (16-cv-05251; N.D. Ca. filed: Sep 13th 2016 (retained by plaintiff Velodyne) - Latham & Watkins LLP
    a. Deposition: 0 (Cumulative total: 16)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 8)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 2)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: Laser/photodetector-based LIDAR design and operation for self-driving vehicles.
40. Active case work: 1Q2017-2Q2017; *The Chamberlain Group Inc., v. Techtronic Industries Co., Ltd, Techtronic Industries North America et al.,* Challenge to U.S Patent No. 7,862,209 (retained by plaintiff – The Chamberlain Group) – Morgan, Lewis & Brockius, LLP.
    a. Deposition: 0 (Cumulative total: 16)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 8)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 2)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: LED based luminaire design for lighting.
41. Active case work: 1Q2017-1Q2018; *Uber Technologies Inc., Ottomottto LLC., Otto Trucking LLC., v. Waymo LLC (Google),* 17-CV-00939 (N.D. Ca filed: Mar 10th, 2017), (retained by defendant Uber Technologies Inc.) – Morrison and Foerster LLP. Deposition experience (x3) and trial experience (case settled at trial).
    a. Deposition: 3 (Cumulative total: 19)
    b. Trial/Hearing/court/PTAB appearance: 1 (Cumulative total: 9)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 1 (Cumulative total: 3)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: Optical and electrical device, optics, and package designs for LIDAR based self-driving vehicles.
42. Active case work: 2Q2017-2Q2017; *Heptagon v. ST Mircoelectronics* IPR petition; (retained by plaintiff Heptagon) – Proskaurer Rose LLP).
    a. Deposition: 0 (Cumulative total: 19)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 9)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 3)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: Optoelectronic based proximity sensors using LEDs and photodetectors.

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43. Active case work: 2Q2017-2Q2018; *AT&T Inc., v. Sycamore Holdings LLC.*, 16-CV-00588 (E. D. Tx filed: Jun 6th 2016); (retained by defendant AT&T Inc.) - Kirkland and Ellis LLP. Deposition experience (x1)
    a. Deposition: 1 (Cumulative total: 20)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 9)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 3)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: Coding designs of optical digital signals for high performance optical networks.
44. Active case work: 2Q2017 – 4Q2017; *Clearfield Inc., v. CommScope, ADC, Tyco, and TE Connectivity,* 17-CV-00307 (D.C. Minn. filed Jan 31st 2017); (retained by defendant Clearfield, Inc.) – Pepper Hamilton LLP
    a. Deposition: 0 (Cumulative total: 20)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 9)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 3)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: Fiber optic connectors, panels, and distribution switches using optoelectronic components.
45. Active case work: 2Q2017 – 4Q2017; *Clearfield Inc., v. CommScope, ADC, Tyco, and TE Connectivity,* IPR2017-02122 (PTAB filed Sep. 15th 2017); (retained by defendant Clearfield, Inc.) – Pepper Hamilton LLP
    a. Deposition: 0 (Cumulative total: 20)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 9)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 3)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: Fiber optic connectors, panels, and distribution switches using optoelectronic components.
46. Active case work: 2Q2017 – 4Q2017; *Clearfield Inc., v. CommScope, ADC, Tyco, and TE Connectivity,* IPR2018-00003 (PTAB filed Oct. 6th 2017); (retained by defendant Clearfield, Inc.) – Pepper Hamilton LLP
    a. Deposition: 0 (Cumulative total: 20)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 9)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 3)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: Fiber optic connectors, panels, and distribution switches using optoelectronic components.
47. Active case work: 2Q2017 – 4Q2017; *Clearfield Inc., v. CommScope, ADC, Tyco, and TE Connectivity,* IPR2018-00154 (PTAB filed Nov. 7th 2017); (retained by defendant Clearfield, Inc.) – Pepper Hamilton LLP
    a. Deposition: 0 (Cumulative total: 20)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 9)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 3)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: Fiber optic connectors, panels, and distribution switches using optoelectronic components.
48. Active case work: 4Q2016-2Q2017; *Antunes Inc.*, Pre-litigation IP patent review; Case No. TBD; (retained by plaintiff – Antunes Inc. and Chapman Spingola LLP).
    a. Deposition: 0 (Cumulative total: 20)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 9)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 3)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: High power grating surface emitter laser diodes, and associated packaging and device design for laser-based cooking ovens.
49. Active case work: 1Q2017-2Q2017; *Core Optical Technologies LLC. v. Fujitsu Network Communications, Inc.*, 16-CV-00437 (C. D. Ca filed: Mar 7th 2016); (retained by defendant Fujitsu Network Communications) – Morrison & Foerster LLP.
    a. Deposition: 0 (Cumulative total: 20)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 9)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 3)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: Fiber optic based optical communications for coherent technologies
50. Active case work: 3Q2017-4Q2018; *Oyster Optics LLC v. Coriant America, et al*, 16-CV-01302 (E. D. Tx filed: Nov 24th 2016); (retained by plaintiff Oyster Optics LLC) – Russ August & Kabat LLP.

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a. Deposition: 1 (Cumulative total: 21)
b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 9)
    i. ITC trial appearance: 0 (Cumulative total: 2)
    ii. District Court trial appearance: 0 (Cumulative total: 3)
    iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
c. Technology: Fiber optic based optoelectronic semiconductor component design and operation.

51. Active case work: 3Q2017-4Q2018; *Oyster Optics LLC v. Infinera, Alcatel-Lucent, Fujitsu, Cisco Systems, Huawei,* 16-CV-01295, 16-CV-01297, 16-CV-01299, 16-CV-01301, 16-CV-01303 (E. D. Tx filed: Nov 24th 2016); (retained by plaintiff Oyster Optics LLC) – Russ August & Kabat LLP. Deposition experience (x1).
    a. Deposition: 1 (Cumulative total: 22)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 9)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 3)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: Fiber optic based optoelectronic semiconductor component design and operation. Including both direct detect and coherent communications, and encoding techniques such as PSK, QPSK, AM, FM etc.
52. Active case work: 3Q2017-4Q2017; *Olympus,* Pre-litigation IP and Due Diligence; Case No. TBD; (retained by plaintiff – Olympus and Fish & Richardson P.C.)
    a. Deposition: 0 (Cumulative total: 22)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 9)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 3)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: High volume, low cost optical lens and optics technology.
53. Active case work: 3Q2017-1Q2018; *Honeywell International, Inc et al v. Code Corporation et al.,* ITC No 337-TA-1061 (filed Jun 28th 2017), "Certain barcode readers, scan engines, products containing the same, and components thereof," (retained by respondent – Honeywell and Alston and Bird LLP
    a. Deposition: 1 (Cumulative total: 23)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 9)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 3)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: Bar-code scanners and associated optical/optoelectronic component performance and operation.
54. Active case work: 4Q2017-1Q2019; *Godo Kaisha IP Bridge 1 v. Intel Corp.*, 17-CV-00676 (filed Sep 29th 2017), (retained by plaintiff – Godo Kaisha IP Bridge 1) - Ropes and Gray, LLP.
    a. Deposition: 0 (Cumulative total: 23)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 9)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 3)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: Fabrication, design, and reverse engineering of silicon-based FET ICs.
55. Active case work: 4Q2017-3Q2018; *Maxim Integrated Products, Inc. and Volterra Semiconductor LLC., v. Silicon Mitus Inc., and Silicon Mitus Technology Inc.*, 17-CV-03507 (N. D. Ca: filed Jun 16th 2017), (retained by defendant Silicon Mitus) – Pillsbury Winthrop Shaw Pittman, LLP. (Deposition x1 and trial experience x1)
    a. Deposition: 1 (Cumulative total: 24)
    b. Trial/Hearing/court/PTAB appearance: 1 (Cumulative total: 10)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 1 (Cumulative total: 4)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: Fabrication, design, characterization, and packaging of silicon-based FET ICs for power applications
56. Active case work: 2Q2018-3Q2018; *Cree, Inc., v. Document Security Systems Inc.,* 17-CV-4263 (C.D. Ca filed: Apr 17th 2017), (retained by defendant Cree Inc.) - Jones Day, LLP
    a. Deposition: 0 (Cumulative total: 24)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 10)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 4)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: Design and packaging of high brightness GaN based LEDs for luminaires.
57. Active case work: 2Q2018-2Q2018; Weisen v., Ram Telecom International (RTI)., CGC-16-554331 (Sup Ca: filed 3rd May 2017) (retained by plaintiff Weisen, J) - Yetter Coleman, LLP. Deposition experience (x1) and trial experience (x1).

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a. Deposition: 1 (Cumulative total: 25)
b. Trial/Hearing/court/PTAB appearance: 1 (Cumulative total: 11)
    i. ITC trial appearance: 0 (Cumulative total: 2)
    ii. District Court trial appearance: 1 (Cumulative total: 5)
    iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
c. Technology: Submarine and subsea fiber optic cables: technology, markets, economic impact, and history.

58. Active case work: 2Q2018-3Q2018; *Seoul Semiconductor., v. Document Security Systems Inc.,* 17-CV-00981 (C.D. Ca filed: Apr 17th 2017), (retained by defendant Seoul Semiconductor) - Latham and Watkins LLP
    a. Deposition: 1 (Cumulative total: 26)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 11)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 5)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: Design and packaging of high brightness GaN based LEDs for luminaires.
59. Active case work: 3Q2018-4Q2018; *NEC Display Solutions Inc., and NEC Display Solutions of America, Inc., v. Ultravision.,* ITC Case# 337-TA-1114 (filed 24th May 2018), "Certain Modular LED Display Panels and Components Thereof," (retained by respondent Jones Day, LLP)
    a. Deposition: 0 (Cumulative total: 26)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 11)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 5)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: Large LED Panels, LED displays, LED modular panel design, LED thermal engineering and color displays for outdoor environments.
60. Active case work: 3Q2018-3Q2018; IFT (Innovative Foundry Technologies) (pre-lit), retained by plaintiff Mintz Levin, Cohen, Ferris, Glovsky, and Popeo PC.)
    a. Deposition: 0 (Cumulative total: 26)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 11)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 5)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: CMOS device (inc FinFETs) and IC fabrication techniques at 40, 28, 20, 16nm nodes.
61. Active case work: 4Q2018-2Q2019; *Eidolon Optical LLC., v. Haag-Streit AG.,* IPR2018-01311, (retained by patent owner Eidolon Optical LLC) - McInnes & McLane LLP
    a. Deposition: 0 (Cumulative total: 26)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 11)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 5)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: High brightness InGaAlP, GaP, AlGaAs, and GaN/InGaN based LEDs for use in medical instruments
62. Active case work: 3Q2018-3Q2018; *Voxtel Inc., v. Joseph Lachapelle & Luminar Technologies Inc.,* 18-CV-27356 (D. Or. filed: Dec 18th 2017), (retained by plaintiff Voxtel Inc.) - Ater Wynne LLP
    a. Deposition: 0 (Cumulative total: 26)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 11)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 5)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: LIDAR optical and electronic component and system technology
63. Active case work: 3Q2018-1Q2019; *Alta Devices, v. LG Electronics Inc.,* 18-CV-00404 (N.D. Ca. filed: May 7th 2018), (retained by defendant LG Electronics Inc.) - Hogan Lovells LLP
    a. Deposition: 0 (Cumulative total: 26)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 11)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 5)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: Trade Secrets and misappropriation of trade secrets for: GaAs based solar cell design, fabrication, manufacturing, and device performance
64. Active case work: 3Q2018-3Q18; *Opterna AM Inc., v. Commscope Technologies Inc.,* Pre-litigation preparation, (retained by defendant Opterna AM Inc.) - Sterne Kessler LLP
    a. Deposition: 0 (Cumulative total: 26)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 11)
        i. ITC trial appearance: 0 (Cumulative total: 2)

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ii. District Court trial appearance: 0 (Cumulative total: 5)
iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)

c. Technology: Fiber optic connectors, panels, and distribution switches using optoelectronic components.

65. Active case work: 4Q2018 – 1Q2019; *U.D. Electronic Corp., v. Pulse Electronics, Inc.,* Preparation for IPR filing: IPR2019-00508 (PTAB filed Dec 26th 2018); and support for 18-CV-00373 (S.D. Ca. filed: Feb 16th 2018) (retained by petitioner U. D. Electronic Corp.) – Procopio, Cory, Hargreaves and Savitch LLP
    a. Deposition: 0 (Cumulative total: 26)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 11)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 5)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: Electrical and fiber optic connectors, panels, and distribution switches using both electronic and optoelectronic components.
66. Active case work: 4Q2018 – 1Q2019; *U.D. Electronic Corp., v. Pulse Electronics, Inc.,* Preparation for IPR filing: IPR2019-00515 (PTAB filed Dec 31st 2018); and support for 18-CV-00373 (S.D. Ca. filed: Feb 16th 2018) (retained by petitioner U. D. Electronic Corp.) – Procopio, Cory, Hargreaves and Savitch LLP
    a. Deposition: 0 (Cumulative total: 26)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 11)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 5)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: Electrical and fiber optic connectors, panels, and distribution switches using both electronic and optoelectronic components.
67. Active case work: 4Q2018 – 1Q2019; *U.D. Electronic Corp., v. Pulse Electronics, Inc.,* Preparation for IPR filing: IPR2019-00262 (PTAB filed Nov 9th 2018); and support for 18-CV-00373 (S.D. Ca. filed: Feb 16th 2018) (retained by petitioner U. D. Electronic Corp.) – Procopio, Cory, Hargreaves and Savitch LLP
    a. Deposition: 0 (Cumulative total: 26)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 11)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 5)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: Electrical and fiber optic connectors, panels, and distribution switches using both electronic and optoelectronic components.
68. Active case work: 4Q2018 – 1Q2019; *U.D. Electronic Corp., v. Pulse Electronics, Inc.,* Preparation for IPR filing: IPR2019-00511 (PTAB filed Dec 28th 2018); and support for 18-CV-00373 (S.D. Ca. filed: Feb 16th 2018) (retained by petitioner U. D. Electronic Corp.) – Procopio, Cory, Hargreaves and Savitch LLP
    a. Deposition: 0 (Cumulative total: 26)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 11)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 5)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: Electrical and fiber optic connectors, panels, and distribution switches using both electronic and optoelectronic components.
69. Active case work: 4Q2018 – 1Q2019; *Semiconductor Energy Laboratory Co. Ltd., v. Bluehouse Global Ltd.,* Preparation for IPR filing: IPR2018-01405 (PTAB filed Jul 18th 2018); (retained by patent owner SEL Co Ltd.) – Robinson Intellectual Law Office, P.C. (Counsel represented by Fish and Richardson LLP).
    a. Deposition: 0 (Cumulative total: 26)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 11)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 5)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: Semiconductor displays using active matrix LCD and thin film transistor technology. Design, fabrication, and circuit layout.
70. Active case work: 4Q2018 – 1Q2019; *Semiconductor Energy Laboratory Co. Ltd., v. Bluehouse Global Ltd.,* Preparation for IPR filing: IPR2018-01393 (PTAB filed Jul 13th 2018); (retained by patent owner SEL Co Ltd.) – Robinson Intellectual Law Office, P.C. (Counsel represented by Fish and Richardson LLP)
    a. Deposition: 0 (Cumulative total: 26)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 11)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 5)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: Semiconductor displays using active matrix LCD and thin film transistor technology. Design and fabrication technology.

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71. Active case work: 4Q2018 - 1Q2019; *The Sloan Company dba SloanLED, v. Principle Lighting Group, LLC.*, 18-CV-06449 (C.D. Ca. filed: Jul 26th 2018), (retained by defendant Sloan LED.) - Ferguson Case Orr Paterson LLP
    a. Deposition: 0 (Cumulative total: 26)
    b. Trial/Hearing/court/PTAB appearance: 1 (Cumulative total: 12)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 1 (Cumulative total: 6)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: LED lighting, LED luminaires, LED performance, electrical and mechanical design and construction.
72. Active case work: 1Q2019 - 1Q2019; *HTC Corporation, v. Lemire Illumination Technologies.*, 18-CV-00021 (E.D. Tx. filed: Jan 21st 2018), (retained by defendant HTC Corporation) - Perkins Coie LLP
    a. Deposition: 0 (Cumulative total: 26)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 12)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 6)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: LEDs for mobile phones
73. Active case work: 1Q2019 - 2Q2019; *Frys Electronics, v. Seoul Semiconductor Co, and Seoul Viosys Co.*,, 2:18-CV-00386-JRG (E. D. Tx. filed: Nov 20th 2018), (retained by defendant Frys Electronics) - Lamkin IP Defense
    a. Deposition: 0 (Cumulative total: 26),
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 12)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 6)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: LED chips, LED packaging, LED lenses, LED luminaires, backlights, displays, and televisions/monitors
74. Active case work: 2Q2019 – 4Q2019; *Hanwha Q CELLS & Advance Materials Corporation, v. JinkoSolar, LONGi Solar, REC Solar*, ITC 337-TA-1151 (filed: Apr 4th 2019), ("Certain Photovoltaic Cells and Products Containing Same,"), retained by patent owner and plaintiff Hanwha Q CELLS) - Covington and Burling LLP
    a. Deposition: 2 (Cumulative total: 28)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 12)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 6)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
75. Active case work: 2Q2019-3Q2019; *Hanwha Q CELLS & Advance Materials Corporation, v. JinkoSolar and affiliates*, 19-CV-00450 (D. Del. filed: Jan 21st 2018), (retained by patent owner and plaintiff Hanwha Q CELLS) - Covington and Burling LLP
    a. Deposition: 0 (Cumulative total: 28)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 12)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 6)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: Silicon solar cells and materials analysis of passivation layers
76. Active case work: 2Q2019-2Q2019; *Oyster Optics LLC v. Infinera Inc*, 2:18-CV-00206 (E. D. Tx filed: May 15th 2018); (retained by plaintiff Oyster Optics LLC) – Russ August & Kabat LLP.
    a. Deposition: 0 (Cumulative total: 28)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 12)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 6)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: Fiber optic based optoelectronic semiconductor component and transceiver design/ operation.
77. Active case work: 2Q2019 – 2Q2019; *Nichia Corporation & Osram Opto Semiconductors Inc., v. Lighting Science Group Corp.*, IPR filing: IPR2019-01259 (PTAB filed Jun 28th 2019); (retained by petitioner Nichia and Osram Opto.) – Shearman and Sterling, LLP
    a. Deposition: 0 (Cumulative total: 28)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 12)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 6)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: LED chips, LED packaging and ceramic thermal heat sinking technology.
78. Active case work: 2Q2019 – 3Q2019; *Nichia Corporation v. Lighting Science Group Corp.*, 2:17-CV-08849 (C. D. Ca filed Jul 12th 2017); (retained by defendant Nichia) – Shearman and Sterling, LLP

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a. Deposition: 0 (Cumulative total: 28)
b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 12)
    i. ITC trial appearance: 0 (Cumulative total: 2)
    ii. District Court trial appearance: 0 (Cumulative total: 6)
    iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
c. Technology: LED chips, LED packaging and ceramic thermal heat sinking technology

79. Active case work: 3Q2019-3Q2019; *Applied Optoelectronics Inc v. Class Action Lawsuit,* 4:17-CV-02399 (S. D. Tx filed: Mar 6th 2018); (retained by plaintiff Class Action Lawsuit) – Levi and Korsinsky, LLP
    a. Deposition: 0 (Cumulative total: 28)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 12)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 6)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: Fiber optic based optoelectronic semiconductor components, transceivers, and sub-systems.
80. Active case work: 3Q2019-3Q2019; *DNA Motor v. Kuen Hwa Traffic Industrial Co.,* 18-CV-05664 (C. D. Ca filed: Jan 15th 2019); (defendant DNA Motor) – Elizabeth Yang, Law and Mediation Office
    a. Deposition: 0 (Cumulative total: 28)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 12)
        i. ITC trial appearance: 0 (Cumulative total: 2)
        ii. District Court trial appearance: 0 (Cumulative total: 6)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: LED design patent, and the design of an aftermarket LED based headlight assembly for an automobile.
81. Active case work: 3Q2019 – 1Q2020; *Nichia Corporation, Osram Opto Semiconductors Inc., Philips Lumileds, GE Consumer Lighting, Cree, and Signify v. Lighting Science Group Corp.,* ITC 337-TA-1168 (filed: Apr 30th 2019), ("Certain Light-Emitting-Diode products, systems, and components thereof (III)") (retained by respondents Nichia, Osram Optoelectronics, Philips Lumileds, GE Consumer Lighting, Cree Hong Kong., Signify Corp.) – Shearman and Sterling, LLP
    a. Deposition: 1 (Cumulative total: 29)
    b. Trial/Hearing/court/PTAB appearance: 1 (Cumulative total: 13)
        i. ITC trial appearance: 1 (Cumulative total: 3)
        ii. District Court trial appearance: 0 (Cumulative total: 6)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: LED chips, LED packaging and ceramic thermal heat sinking technology (LTCC).
82. Active case work: 4Q2019 – 1Q2020; *Amazon.com Inc, Bed, Bath and Beyond, IKEA, Target, and Walmart Inc., v. Regents of the University of California,* ITC 337-TA-1172 (filed: July 30th 2019), ("Certain Filament Light-Emitting-Diodes and products containing same") (retained by respondents Amazon.com Inc, Bed, Bath and Beyond, IKEA, Target, and Walmart Inc.) – Morrison and Foerster, LLP
    a. Deposition: 2 (Cumulative total: 31)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 13)
        i. ITC trial appearance: 0 (Cumulative total: 3)
        ii. District Court trial appearance: 0 (Cumulative total: 6)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: LED chips, LED packaging and light bulb filaments with transparent sub-mounts.
83. Active case work: 4Q2019 – 4Q2019; *U.D. Electronic Corp., v. Pulse Electronics, Inc.,* IPR2019-00511 (PTAB filed Dec 28th 2018), (retained by petitioner U. D. Electronic Corp.) – Procopio, Cory, Hargreaves and Savitch LLP
    a. Deposition: 0 (Cumulative total: 31)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 13)
        i. ITC trial appearance: 0 (Cumulative total: 3)
        ii. District Court trial appearance: 0 (Cumulative total: 6)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: Electrical and fiber optic connectors, panels, and distribution switches using both electronic and optoelectronic components.
84. Active case work: 1Q2020 – 2Q2020; *IKEA, v. Regents of the University of California,* ITC 337-TA-1172 (filed: July 30th 2019), ("Certain Filament Light-Emitting-Diodes and products containing same") (retained by respondents IKEA) – Flaster and Greenberg, LLP
    a. Deposition: 2 (Cumulative total: 31)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 13)
        i. ITC trial appearance: 0 (Cumulative total: 3)
        ii. District Court trial appearance: 0 (Cumulative total: 6)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: LED chips, LED packaging and light bulb filaments with transparent sub-mounts.

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85. Active case work: 1Q2020-1Q2020; *Hanwha Solutions Corporation, v. Longi Green Energy, Longi Solar Technology, Longi Trading et al.*, IPR2019-01072 (PTAB filed 13th May 2019), (retained by patent owner Hanwha Solutions Corporation) - Covington and Burling LLP
    a. Deposition: 0 (Cumulative total: 31)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 13)
        i. ITC trial appearance: 0 (Cumulative total: 3)
        ii. District Court trial appearance: 0 (Cumulative total: 6)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: Silicon solar cells and materials analysis of passivation layers
86. Active case work: 1Q2020-1Q2020; *Hanwha Solutions Corporation, v. REC Solar Pte. Ltd. and JinkSolar (U.S.) Inc.* IPR2019-01145 (PTAB filed 6th March 2019), (retained by patent owner Hanwha Solutions Corporation) - Covington and Burling LLP
    a. Deposition: 0 (Cumulative total: 31)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 13)
        i. ITC trial appearance: 0 (Cumulative total: 3)
        ii. District Court trial appearance: 0 (Cumulative total: 6)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: Silicon solar cells and materials analysis of passivation layers
87. Active case work: 4Q2019 – 2Q2020; *Viavi Solutions Inc., v Optrontec Inc.*, ITC 337-TA-1187 (filed: 18th November 2019), ("Certain Electronic devices with Optical Filters and Optical Sensor Systems and Components Thereof") (retained by complainant Viavi Solutions Inc.,) – Venable, LLP
    a. Deposition: 0 (Cumulative total: 31)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 13)
        i. ITC trial appearance: 0 (Cumulative total: 3)
        ii. District Court trial appearance: 0 (Cumulative total: 6)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: Optical filters and optical sensor systems, design and fabrication of dielectric materials for passband filters in applications such as optical communications, imaging, sensing, medical, automotive.
88. Active case work: 2Q2020 – 4Q2020; *Leviton Manufacturing Co., v. Corning Optical Communications LLC.*, ITC 337-TA-1194 (filed: 19th March 2020), ("Certain High-Density Fiber Optic Equipment and Components Thereof") (retained by respondent Leviton Manufacturing Co.,) – Morrison & Foerster, LLP
    a. Deposition: 1 (Cumulative total: 32)
    b. Trial/Hearing/court/PTAB appearance: 1 (Cumulative total: 14)
        i. ITC trial appearance: 1 (Cumulative total: 4)
        ii. District Court trial appearance: 0 (Cumulative total: 6)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: Fiber optic adapters, fiber optic connectors (simplex, duplex, quad, multi-fiber), fiber trays, racks, and fiber cabinet equipment.
    d. Technology: LED chips, LED packaging and light bulb filaments with transparent sub-mounts.
89. Active case work: 2Q2020 – 2Q2020; subject to PO/NDA and engagement letter *xxx v. yyy*, Post Grant Review petition for proceedings (US Patent # zzz), retained by Morrison and Foerster, LLP
    a. Deposition: 0 (Cumulative total: 31)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 14)
        i. ITC trial appearance: 0 (Cumulative total: 4)
        ii. District Court trial appearance: 0 (Cumulative total: 6)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Optoelectronics, LEDs, lead frame packaging, optics, optical lenses, GaN (Gallium Nitride), optical transparency
90. Active case work: 1Q2020-3Q2020; *Cellect LLC, v. Samsung Electronics Co., LTD and Samsung Electronics America, Inc.*, IPR2020-00560 (PTAB filed 16th Feb 2020), (retained by patent owner Cellect LLC) – retained by Kramer Levin Naftalis & Frankel LLP
    a. Deposition: 0 (Cumulative total: 32)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 14)
        i. ITC trial appearance: 0 (Cumulative total: 4)
        ii. District Court trial appearance: 0 (Cumulative total: 6)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)
    c. Technology: Silicon CMOS image sensors, drive electronics, smart pixels and CCD technology
91. Active case work: 2Q2020-2Q2020; *Panasonic, v. 3M Innovative Properties Company.*, Preparation for IPR filing, (retained by defendant Panasonic) – retained by Westerman Hattori Daniels & Adrian LLP
    a. Deposition: 0 (Cumulative total: 32)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 14)
        i. ITC trial appearance: 0 (Cumulative total: 4)
        ii. District Court trial appearance: 0 (Cumulative total: 6)

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iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 3)

c. Technology: Touch sensor (resistive, optical, and capacitive) technology for mobile displays. Analysis of display, electronic, and optical technologies.

92. Active case work: 2Q2020-3Q2020; *Longi Green Energy Technology Co, Longi Solar Technology Co, Long Solar Technology (H.K., Kuching, Taizhou, Zhejiang, Hefei, US) v. Hanwha Solutions Corporation*., IPR 2019-01072, (retained by patent owner Hanwha Solutions Corporation) – Quinn Emanuel Urquhart & Sullivan, LLP
    a. Deposition: 1 (Cumulative total: 33)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 16)
        i. ITC trial appearance: 0 (Cumulative total: 4)
        ii. District Court trial appearance: 0 (Cumulative total: 6)
        iii. PTAB Court trial/deposition appearance: 1 (Cumulative total: 5)
    c. Optoelectronics; solar cell design, fabrication, device performance, packaging, and interface issues relating to passivation (both chemical and electric field enhanced).
93. Active case work: 3Q2020-3Q2020; *Oyster Optics LLC v. Ciena Corp*, 4:17-CV-05920 (N. D. CA filed: April 22nd 2020); (retained by plaintiff Oyster Optics LLC) – Russ August & Kabat LLP.
    a. Deposition: 0 (Cumulative total: 33)
    b. Trial/Hearing/court/PTAB appearance: 1 (Cumulative total: 16)
        i. ITC trial appearance: 0 (Cumulative total: 4)
        ii. District Court trial appearance: 0 (Cumulative total: 6)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 5)
    c. Technology: Fiber optic based optoelectronic semiconductor component design and operation, especially phase shift keying (PSK, QPSK) and phase based coherent communications.
94. Active case work: 3Q2020-2Q2021; *Capella Photonics Inc., v. Infinera Corporation, Tellabs, Tellabs Operations Inc., Coriant American Inc., and Coriant USA Inc., 2*:20-CV-00077 (E. D. TX filed: March 16th 2020); (retained by defendant Infinera Inc.) – Baker Botts LLP.
    a. Deposition: 1 (Cumulative total: 34)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 16)
        i. ITC trial appearance: 0 (Cumulative total: 4)
        ii. District Court trial appearance: 0 (Cumulative total: 6)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 5)
    c. Technology: Fiber optic wavelength selective switches (WSS), reconfigurable add-drop multiplexors (ROADMs), and their design. Technical issues include polarization, wavelength selection, coupling, mux/demux and operation in optical networks.
95. Active case work: 3Q2020-3Q2020; *Longi Green Energy Technology Co, Longi Solar Technology Co, Long Solar Technology (H.K., Kuching, Taizhou, Zhejiang, Hefei, US) v. Hanwha Solutions Corporation*., IPR 2020-00353, (retained by patent owner Hanwha Solutions Corporation) – Quinn Emanuel Urquhart & Sullivan, LLP
    a. Deposition: 0 (Cumulative total: 34)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 16)
        i. ITC trial appearance: 0 (Cumulative total: 4)
        ii. District Court trial appearance: 0 (Cumulative total: 6)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 5)
    c. Optoelectronics: solar cell design, fabrication, device performance, packaging, and interface issues relating to passivation (both chemical and electric field enhanced).
96. Active case work: 3Q2020-2Q2021; *Appotronics Corporation Ltd. v. Delta Electronics Inc*., *2*:19-CV-00466 (E. D. Va filed: July 22nd 2020); (retained by defendant Delta Corporation Inc) – Pillsbury Winthorp Shaw Pitman LLP.
    a. Deposition: 1 (Cumulative total: 35)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 16)
        i. ITC trial appearance: 0 (Cumulative total: 4)
        ii. District Court trial appearance: 0 (Cumulative total: 6)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 5)
    c. Technology: Light projectors for display and the color wheel, phosphor technology, high power visible lasers for projection, and the associated packaging of the modules/projectors for efficient cost design..
97. Active case work: 3Q2020 – 2Q2021; *Ideal Industries Lighting LLC (dba Cree Lighting) v. RAB Lighting Inc*., ITC 337-TA-1213 (filed: 15th July 2020), ("Certain Light-emitting Diode Products, Fixtures, and Components thereof"), (retained by plaintiff Ideal Industries Lighting LLC (dba Cree Lighting) – Quinn Emanuel Urquhart an Sullivan, LLP
    a. Deposition: 1(Cumulative total: 36)
    b. Trial/Hearing/court/PTAB appearance: 2(x2 oral testimony); (Cumulative total: 18)
        i. ITC trial appearance: 2 (Cumulative total: 6)
        ii. District Court trial appearance: 0 (Cumulative total: 6)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 5)
    c. Technology: Visible GaN based LEDs and various packaging optical lens designs for directing and re-directing LED light output with applications in street lighting.

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98. Active case work: 3Q2020-3Q2020; *Cellect LLC, v. Samsung Electronics Co., LTD and Samsung Electronics America, Inc., ex parte* declaration entitled, 'Hand-held computers incorporating reduced area imaging devices', for U.S. Patent 6,982,742 (control number 90/014,453), (retained by patent owner Cellect LLC) – retained by Kramer Levin Naftalis & Frankel LLP
    a. Deposition: 0 (Cumulative total: 36)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 18)
        i. ITC trial appearance: 0 (Cumulative total: 6)
        ii. District Court trial appearance: 0 (Cumulative total: 6)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 5)
    c. Technology: Hand-held silicon CMOS image sensors, drive electronics, smart pixels and CCD technology. Technical history of CCD v. CMOS image sensors in the 1990s and associated performance criteria.
99. Active case work: 3Q2020-3Q2020; *Cellect LLC, v. Samsung Electronics Co., LTD and Samsung Electronics America, Inc., ex parte* declaration entitled, 'Communication devices incorporating reduced area imaging devices', for U.S. Patent 6,452,626 (control number 90/014,455), (retained by patent owner Cellect LLC) – retained by Kramer Levin Naftalis & Frankel LLP
    a. Deposition: 0 (Cumulative total: 36)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 18)
        i. ITC trial appearance: 0 (Cumulative total: 6)
        ii. District Court trial appearance: 0 (Cumulative total: 6)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 5)
    c. Technology: Hand-held silicon CMOS image sensors, drive electronics, smart pixels and CCD technology. Technical history of CCD v. CMOS image sensors in the 1990s and associated performance criteria.
100. Active case work: 4Q2020-4Q2020; *Cellect LLC, v. Samsung Electronics Co., LTD and Samsung Electronics America, Inc.,* IPR declaration for U.S. Patent 9,198,565 (IPR2020-00476), (retained by patent owner Cellect LLC) – retained by Kramer Levin Naftalis & Frankel LLP
    a. Deposition: 0 (Cumulative total: 36)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 18)
        i. ITC trial appearance: 0 (Cumulative total: 6)
        ii. District Court trial appearance: 0 (Cumulative total: 6)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 5)
    c. Technology: Hand-held silicon CMOS image sensors, drive electronics, smart pixels and CCD technology. Technical history of CCD v. CMOS image sensors in the 1990s and associated performance criteria.
101. Active case work: 4Q2020-4Q2020; *Cellect LLC, v. Samsung Electronics Co., LTD and Samsung Electronics America, Inc.,* IPR declaration for U.S. Patent 9,667,896 (IPR2020-00477), (retained by patent owner Cellect LLC) – retained by Kramer Levin Naftalis & Frankel LLP
    a. Deposition: 0 (Cumulative total: 36)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 18)
        i. ITC trial appearance: 0 (Cumulative total: 6)
        ii. District Court trial appearance: 0 (Cumulative total: 6)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 5)
    c. Technology: Hand-held silicon CMOS image sensors, drive electronics, smart pixels and CCD technology. Technical history of CCD v. CMOS image sensors in the 1990s and associated performance criteria.
102. Active case work: 4Q2020 – 1Q2021; *U.D. Electronic Corp., v. Pulse Electronics, Inc.,* 3:18-CV-00373 (Filed Fed 16th 2018), (retained by petitioner U. D. Electronic Corp.) – retained by defendant Perkins Coie LLP.
    a. Deposition: 1 (Cumulative total: 37)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 18)
        i. ITC trial appearance: 0 (Cumulative total: 6)
        ii. District Court trial appearance: 0 (Cumulative total: 6)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 5)
    c. Technology: Electrical and fiber optic connectors, panels, and distribution switches using both electronic and optoelectronic components. Noise suppression using EMI between electrical components and connectors.
103. Active case work: 4Q2020-4Q2020; *Cellect LLC, v. Samsung Electronics Co., LTD and Samsung Electronics America, Inc.,* IPR declaration for U.S. Patent 9,186,052 (IPR2020-00512), (retained by patent owner Cellect LLC) – retained by Kramer Levin Naftalis & Frankel LLP
    a. Deposition: 1 (Cumulative total: 38)
    b. Trial/Hearing/court/PTAB appearance: 1 (Cumulative total: 19)
        i. ITC trial appearance: 0 (Cumulative total: 6)
        ii. District Court trial appearance: 0 (Cumulative total: 6)
        iii. PTAB Court trial/deposition appearance: 1 (Cumulative total: 6)

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c. Technology: Hand-held silicon CMOS image sensors, drive electronics, smart pixels and CCD technology. Technical history of CCD v. CMOS image sensors in the 1990s and associated performance criteria.

104. Active case work: 4Q2020-4Q2020; *Cellect LLC, v. Samsung Electronics Co., LTD and Samsung Electronics America, Inc.*, IPR declaration for U.S. Patent 9,186,052 (IPR2020-00475), (retained by patent owner Cellect LLC) – retained by Kramer Levin Naftalis & Frankel LLP
    a. Deposition: 1 (Cumulative total: 39)
    b. Trial/Hearing/court/PTAB appearance: 1 (Cumulative total: 20)
        i. ITC trial appearance: 0 (Cumulative total: 6)
        ii. District Court trial appearance: 0 (Cumulative total: 6)
        iii. PTAB Court trial/deposition appearance: 1 (Cumulative total: 7)
    c. Technology: Hand-held silicon CMOS image sensors, drive electronics, smart pixels and CCD technology. Technical history of CCD v. CMOS image sensors in the 1990s and associated performance criteria.
105. Active case work: 3Q2020 – 1Q2021; *Huawei Technologies Co. Ltd. v. Verizon Communications, Inc., et al.*, 20-CV-030-JRG (TX E. D. Filed 2[1st] April 2020), (retained by plaintiff Huawei Technologies Co. Ltd.) – retained by plaintiff Caldwell Cassady Curry P.C.
    a. Deposition: 0 (Cumulative total: 39)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 20)
        i. ITC trial appearance: 0 (Cumulative total: 6)
        ii. District Court trial appearance: 0 (Cumulative total: 6)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 7)
    c. Technology: Analysis of coding for fiber optic communications, specifically in relation to the standardization process for the Telecommunication Standardization Sector of the International Telecommunications Union ("ITU-T"), including the ITU-T's G.709: Interfaces for the optical transport network standard ("G.709" or "the G.709 Standard"). In particular, the technical issues that relate to OTN hierarchy; functionality of the overhead in support of multi-wavelength optical networks; frame structures, bit rates, and formats for mapping client signals.
106. Active case work: 1Q2021 – 3Q2021; *IKEA et al., v. Regents of the University of California*, ITC 337-TA-1220 (filed: 29[th] September 2020), ("Certain filament light-emitting diodes and products containing same (II)"), (retained by respondent JDG: IKEA, Global Value Lighting, Signify, Home Depot, GE, Satco) – retained by Flaster Greenberg PC, Kirkland and Ellis, GT Law (Greenberg Traurig), Alston and Bird, Jones Day and Goodwin Law as JDG counsel.
    a. Deposition: 2 (Cumulative total: 41)
    b. Trial/Hearing/court/PTAB appearance: 1 (Cumulative total: 21)
        i. ITC trial appearance: 1 (Cumulative total: 7)
        ii. District Court trial appearance: 0 (Cumulative total: 6)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 7)
    c. Technology: LED chips, LED packaging and light bulb filaments with transparent sub-mounts.
107. Active case work 4Q2020 – 1Q2021; *Uber Technologies Inc., v. Anthony Scott Levandowski*; Case No. 20-30242 (HLB) and 20-03050 (filed 16[th] September 2020), retained by defendant Uber Technologies Inc., retained by Jenner and Block LLP.
    a. Deposition: 0 (Cumulative total: 41)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 21)
        i. ITC trial appearance: 0 (Cumulative total: 7)
        ii. District Court trial appearance: 0 (Cumulative total: 6)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 7)
    c. Technology: LIDAR technology for motor vehicles that includes fiber amplifiers, LIDAR hardware, laser diodes, photodetectors, fiber links, and free space communications.
108. Active case work: 1Q2021 – 3Q2021; *CoSemi Technologies, v. Everpro Technologies, Fibbr Technologies, Logitech, and Facebook Technologies*, ITC 337-TA-1233 (filed: 29[th] October 2020), "Certain active optical cables and products containing same", (retained by claimant Cosemi Technologies) – retained by Rutan & Tucker LLP.
    a. Deposition: 1 (Cumulative total: 42)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 21)
        i. ITC trial appearance: 0 (Cumulative total: 7)
        ii. District Court trial appearance: 0 (Cumulative total: 6)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 7)
    c. Technology: Active optical cables with embedded silicon modulator ICs, copper cable, fiber optic cable, VCSEL laser diodes, photodetectors and cable sheathing for consumer applications such as gaming, HDMI, USB, etc.
109. Active case work: 2Q2021 – 3Q2021; *Acuity Brands Lighting ,Inc. v. Heavy Duty Lighting (HDL), LLC.*, 20-CV-03648-SCJ (GA N. D. Filed 2[nd] September 2020), (retained by defendant Acuity Brands Lighting) – retained by defendant Duane Morris LLP.

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a. Deposition: 1 (Cumulative total: 43)
b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 21)
    i. ITC trial appearance: 0 (Cumulative total: 7)
    ii. District Court trial appearance: 0 (Cumulative total: 6)
    iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 7)
c. Technology: LED lighting, LED chips, LED packages and LED packaging technologies such as molding, glob-top, substrates, die mounting, optical reflectors, and electrical interconnect layouts.

110. Active case work: 2Q2021 – 4Q2021; *Jiaxing Super Lighting Electric Appliance Co., LTD and Obert Inc. v. CH Lighting Technology co., LTD., Elliott Electric Supply Inc., and Shaoxing Ruising Lighting co., Ltd*., 20-CV-00018-ADA (TX W D. Filed 16th March 2020), (retained by defendant CH Lighting et al) – retained by defendant Holland and Knight LLP.
    a. Deposition: 1 (Cumulative total: 44)
    b. Trial/Hearing/court/PTAB appearance: 1 (Cumulative total: 22)
        i. ITC trial appearance: 0 (Cumulative total: 7)
        ii. District Court trial appearance: 1 (Cumulative total: 7)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 7)
    c. Technology: LED lighting and LED packaging technologies for T8 and T12 form factor tube lighting. Technologies such as LED luminaire/tube packaging, mechanical structure, thermal heat dissipation, electronic circuitry, printed circuit boards, and LED chips.
111. Active case work: 3Q2021 – 1Q2022; ASUSTEK Computer Inc, *v. KT Imaging USA LLC*, 20-CV-00300-ADA (TX W D. Filed 20th April 2020, (retained by defendant ASUSTEK Computer Inc) – retained by defendant Turner Boyd LLP.
    a. Deposition: 0 (Cumulative total: 44)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 22)
        i. ITC trial appearance: 0 (Cumulative total: 7)
        ii. District Court trial appearance: 0 (Cumulative total: 7)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 7)
    c. Technology: Image sensor modules, cameras in PCs/laptops, consumer products, tear downs, optical lenses, optical packaging, optical alignment.
112. Active case work: 3Q2021 – 3Q2021; *Jiaxing Super Lighting Electric Appliance Co., LTD and Obert Inc. v. Maxlite Inc*., 19-CV-04047 (CA C.D. Filed 8th May 2019), (retained by defendant Maxlite Inc) – retained by defendant Holland and Knight LLP.
    a. Deposition: 0 (Cumulative total: 44)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 22)
        i. ITC trial appearance: 0 (Cumulative total: 7)
        ii. District Court trial appearance: 0 (Cumulative total: 7)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 7)
    c. Technology: LED lighting and LED packaging technologies for T8 and T12 form factor tube lighting. Technologies such as LED luminaire/tube packaging, mechanical structure, thermal heat dissipation, electronic circuitry, printed circuit boards, and LED chips.
113. Active case work: 3Q2021 – 1Q2023; *Feit Electric Company Inc., v. Nichia Corporation*, 20-CV-00359-GW, (CA C. D. Filed 13th January 2020), (retained by defendant Feit Electric Company) – retained by Benesch Friedlander Coplan &Aronoff LLP
    a. Deposition: 2 (Cumulative total: 46)
    b. Trial/Hearing/court/PTAB appearance: 2 (Cumulative total: 24)
        i. ITC trial appearance: 0 (Cumulative total: 7)
        ii. District Court trial appearance: 2 (Cumulative total: 9)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 7)
    c. Technology: LED lighting, LED chips, LED packages and LED packaging technologies such as lead-frames, molding, glob-top, substrates, die mounting, optical reflectors, and electrical interconnect layouts.
114. Active case work: 2Q2021 – 2Q2022; *Samsung Corporation vs TBD*, Pre-patent litigation, (retained by plaintiff Samsung Corporation), - retained by Quinn Emanuel Urquhart & Sullivan, LLP).
    a. Deposition: 0 (Cumulative total: 46)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 24)
        i. ITC trial appearance: 0 (Cumulative total: 7)
        ii. District Court trial appearance: 0 (Cumulative total: 9)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 7)
    c. Technology: TV displays, OLEDs, LCDs, color gamut, and quality of RGB/white color as per CIE charts and colorimetry (NTSC, sRGB, AdobeRGB etc,.). Analysis of CHL (constant hue locus), quantum dots, nano-crystals, nano-devices, nano-structures to improve light quality output.
115. Active case work 2Q2021 – 2Q2021, *Holochip Corporation v, Edmund Optics, Optotune AG and others TBD*, Pre-patent litigation for ITC, (retained by plaintiff Holochip Corporation), - retained by King and Spalding LLP).
    a. Deposition: 0 (Cumulative total: 46)

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   b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 24)
      i. ITC trial appearance: 0 (Cumulative total: 7)
      ii. District Court trial appearance: 0 (Cumulative total: 9)
      iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 7)
   c. Technology: Fluid lenses, and optical lenses with controlled focus facilities. Packaging of fluid lenses using piezoelectric actuators, and hermetic chambers. Deformable surfaces using micro-fluidics.

116. Active case work: 2Q2021-3Q2021; *Home Depot USA Inc., v. Lynk Labs, Inc.,* IPR declaration for U.S. Patent 10,757,783 (IPR2021-01368), (retained by petitioner Home Depot USA, Inc) – retained by DLA Piper LLP
   a. Deposition: 1 (Cumulative total: 47)
   b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 25)
      i. ITC trial appearance: 0 (Cumulative total: 7)
      ii. District Court trial appearance: 0 (Cumulative total: 9)
      iii. PTAB Court trial/deposition appearance: 1 (Cumulative total: 8)
   c. Technology: LED products, LED circuits, including both DC and AC circuit design. LED color emission, white light, color mixing, CIE charts, and black body radiators for color temperature.
117. Active case work: 2Q2021-3Q2021; *Home Depot USA Inc., v. Lynk Labs, Inc.,* IPR declaration for U.S. Patent 10,492,251 (IPR2021-01369), (retained by petitioner Home Depot USA, Inc) – retained by DLA Piper LLP
   a. Deposition: 1 (Cumulative total: 48)
   b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 26)
      i. ITC trial appearance: 0 (Cumulative total: 7)
      ii. District Court trial appearance: 0 (Cumulative total: 9)
      iii. PTAB Court trial/deposition appearance: 1 (Cumulative total: 9)
   c. Technology: LED products, LED circuits, including both DC and AC circuit design. LED color emission, white light, color mixing, CIE charts, and black body radiators for color temperature.
118. Active case work: 3Q2021-3Q2021; *Home Depot USA Inc., v. Lynk Labs, Inc.,* IPR declaration for U.S. Patent 10,091,842 (IPR2021-01540), (retained by petitioner Home Depot USA, Inc) – retained by DLA Piper LLP
   a. Deposition: 1 (Cumulative total: 49)
   b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 27)
      i. ITC trial appearance: 0 (Cumulative total: 7)
      ii. District Court trial appearance: 0 (Cumulative total: 9)
      iii. PTAB Court trial/deposition appearance: 1 (Cumulative total: 10)
   c. Technology: LED products, LED circuits, including both DC and AC circuit design. LED color emission, white light, color mixing, CIE charts, and black body radiators for color temperature.
119. Active case work: 4Q2021-4Q2021; *Home Depot USA Inc., v. Lynk Labs, Inc.,* IPR declaration for U.S. Patent 10,517,149 (IPR2022-000023), (retained by petitioner Home Depot USA, Inc) – retained by DLA Piper LLP
   a. Deposition: 1 (Cumulative total: 50)
   b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 28)
      i. ITC trial appearance: 0 (Cumulative total: 7)
      ii. District Court trial appearance: 0 (Cumulative total: 9)
      iii. PTAB Court trial/deposition appearance: 1 (Cumulative total: 10)
   c. Technology: LED products, LED circuits, including both DC and AC circuit design. LED color emission, white light, color mixing, CIE charts, and black body radiators for color temperature.
120. Active case work: 4Q2021-4Q2022; *Everlight Elecs. Co. Ltd. v. Amazon.com, Inc. et al.,* 6:21-CV-00906 (W. D. TX filed: August 31st 2021); (retained by defendant Amazon.com) – Morrison and Foerster LLP.
   a. Deposition: 0 (Cumulative total: 50)
   b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 28)
      i. ITC trial appearance: 0 (Cumulative total: 7)
      ii. District Court trial appearance: 0 (Cumulative total: 9)
      iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 10)
   c. Technology: LED chips, LED packaging with metallic electrodes, flip-chip solder bumping, and doping of semiconductors for electrical conduction.
121. Active case work: 4Q2021-2Q2021; *Hanwha Solutions Corporation and affiliated companies including Q-Cells, Boviet Renewable Power, Boviet Solar, Canadian Solar International v. Advanced Silicon Group Technologies,* ITC 337-TA-1271 (filed: 14th October 2020) "Certain silicon photovoltaic cells and modules with nanostructures, and products containing the same." (retained by joint defense group consisting of Quinn Emanual Urquhart & Sullivan, LLP., Morgan Lewis and Bockius, LLP., and Sidley Austin LLP.).
   a. Deposition: 2 (Cumulative total: 52)
   b. Trial/Hearing/court/PTAB appearance: 1 (Cumulative total: 29)
      i. ITC trial appearance: 1 (Cumulative total: 8)
      ii. District Court trial appearance: 0 (Cumulative total: 10)
      iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 10)
   c. Technology: Silicon based solar/photovoltaic cells and modules that include fabrication techniques such as deposition, diffusion, wet/dry etching of nanostructures, nanowires, and nano-structures, nano-features, black silicon, monocrystalline wafers, and polysilicon fabrication.

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122. Active case work: 4Q2021-2Q2022; *Dell Computer Inc, v. KT Imaging USA LLC,* Declaration for IPR with patent number 6,876,544 as petitioner, (to be filed), (retained by defendant Dell Computer Inc) – retained by petitioner Farella, Braun, and Martel.
    a. Deposition: 0 (Cumulative total: 52)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 29)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 10)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 10)
    c. Technology: Image sensor modules, cameras in PCs/laptops, consumer products, tear downs, optical lenses, optical packaging, optical alignment.
123. Active case work: 1Q2022-2Q2022; *Cree Lighting, Wolfspeed, Ideal Industries Lighting, v. CAO Lighting,* Declaration for IPR with patent number 6,465,961 as petitioner, (filed 8th April 2022), (retained by defendant Cree Lighting) – retained by Kilpatrick Townsend & Stockton LLP.
    a. Deposition: 2 (Cumulative total: 54)
    b. Trial/Hearing/court/PTAB appearance: 2 (Cumulative total: 31)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 10)
        iii. PTAB Court trial/deposition appearance: 2 (Cumulative total: 12)
    c. Technology: LED based light bulbs, LED chips, LED arrays, LED packaging, chip-on-board, heat sinks, GaN, InGaN, AlGaN (Gallium Nitride, Indium Gallium Nitride, Aluminum Gallium Nitride) epitaxial layers, active regions, cladding layers, optical mirrors, DBRs
124. Active case work: 1Q2022-2Q2022; *Cree Lighting, Wolfspeed, Ideal Industries Lighting, v. CAO Lighting,* Declaration for IPR with patent numbers 6,634,770 as petitioner, (filed 8th April 2022), (retained by defendant Cree Lighting) – retained by Kilpatrick Townsend & Stockton LLP.
    a. Deposition: 1 (Cumulative total: 55)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 32)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 10)
        iii. PTAB Court trial/deposition appearance: 1 (Cumulative total: 13)
    c. Technology: LED based light bulbs, LED chips, LED arrays, LED packaging, chip-on-board, heat sinks, GaN, InGaN, AlGaN (Gallium Nitride, Indium Gallium Nitride, Aluminum Gallium Nitride) epitaxial layers, active regions, cladding layers, optical mirrors, DBRs
125. Active case work: 1Q2022-2Q2022; *Cree Lighting dba Ideal Industries Lighting, v. CAO Lighting,* 1:21-cv-00634 (MD NC filed 12th Aug 2021,), (retained by defendant Cree Lighting) – retained by Kilpatrick Townsend & Stockton LLP.
    a. Deposition: 0 (Cumulative total: 55)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 32)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 10)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 13)
    c. Technology: LED based light bulbs, LED chips, LED arrays, LED packaging, chip-on-board, heat sinks, GaN, InGaN, AlGaN (Gallium Nitride, Indium Gallium Nitride, Aluminum Gallium Nitride) epitaxial layers, active regions, cladding layers, optical mirrors, DBRs
126. Active case work: 1Q2022-2Q2022; *Lite-On Technology Corporation and Genesis Photonics Inc., v. Sensor Electronic Technology Inc., (SETi),* 6:21-cv-00322 (WD Tex filed 12th Aug 2021,), (retained by plaintiff LiteOn and Genesis) – retained by Pillsbury Winthrop Shaw Pittman LLP.
    a. Deposition: 0 (Cumulative total: 55)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 32)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 10)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 13)
    c. Technology: LED based light bulbs, LED chips, LED arrays, LED packaging, flip-chip packaging, chip-on-board, heat sinks, GaN, InGaN, AlGaN (Gallium Nitride, Indium Gallium Nitride, Aluminum Gallium Nitride) epitaxial layers, GaN fabrication, LED quantum well active regions, LEDcladding layers, optical mirrors, DBRs
127. Active case work: 1Q2022-2Q2022; *Lite-On Technology Corporation and Genesis Photonics Inc., v. Sensor Electronic Technology Inc., (SETi),* Declaration for IPR (IPR2022-00395) as patent owner, (retained by plaintiff LiteOn and Genesis) – retained by Pillsbury Winthrop Shaw Pittman LLP.
    a. Deposition: 2 (Cumulative total: 57)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 34)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 10)
        iii. PTAB Court trial/deposition appearance: 2 (Cumulative total: 15)

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c. Technology: LED based light bulbs, LED chips, LED arrays, LED packaging, flip-chip packaging, chip-on-board, heat sinks, GaN, InGaN, AlGaN (Gallium Nitride, Indium Gallium Nitride, Aluminum Gallium Nitride) epitaxial layers, GaN fabrication, LED quantum well active regions, LED cladding layers, optical mirrors, DBRs

128. Active case work: 1Q2022-2Q2022; *Lite-On Technology Corporation and Genesis Photonics Inc., v. Sensor Electronic Technology Inc., (SETi),* Declaration for IPR (IPR2022-00396) as patent owner, (retained by plaintiff LiteOn and Genesis) – retained by Pillsbury Winthrop Shaw Pittman LLP.
    a. Deposition: 0 (Cumulative total: 57)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 34)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 10)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 15)
    c. Technology: LED based light bulbs, LED chips, LED arrays, LED packaging, flip-chip packaging, chip-on-board, heat sinks, GaN, InGaN, AlGaN (Gallium Nitride, Indium Gallium Nitride, Aluminum Gallium Nitride) epitaxial layers, GaN fabrication, LED quantum well active regions, LED cladding layers, optical mirrors, DBRs
129. Active case work: 1Q2022-2Q2022; *Lite-On Technology Corporation and Genesis Photonics Inc., v. Sensor Electronic Technology Inc., (SETi),* Declaration for IPR (IPR2022-00397) as patent owner, (retained by plaintiff LiteOn and Genesis) – retained by Pillsbury Winthrop Shaw Pittman LLP.
    a. Deposition: 0 (Cumulative total: 57)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 34)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 10)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 15)
    c. Technology: LED based light bulbs, LED chips, LED arrays, LED packaging, flip-chip packaging, chip-on-board, heat sinks, GaN, InGaN, AlGaN (Gallium Nitride, Indium Gallium Nitride, Aluminum Gallium Nitride) epitaxial layers, GaN fabrication, LED quantum well active regions, LED cladding layers, optical mirrors, DBRs
130. Active case work: 1Q2022-2Q2022; *Lite-On Technology Corporation and Genesis Photonics Inc., v. Sensor Electronic Technology Inc., (SETi),* Declaration for IPR (IPR2022-00406) as patent owner, (retained by plaintiff LiteOn and Genesis) – retained by Pillsbury Winthrop Shaw Pittman LLP.
    a. Deposition: 0 (Cumulative total: 57)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 34)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 10)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 15)
    c. Technology: LED based light bulbs, LED chips, LED arrays, LED packaging, flip-chip packaging, chip-on-board, heat sinks, GaN, InGaN, AlGaN (Gallium Nitride, Indium Gallium Nitride, Aluminum Gallium Nitride) epitaxial layers, GaN fabrication, LED quantum well active regions, LED cladding layers, optical mirrors, DBRs
131. Active case work: 1Q2022-2Q2022; *Lite-On Technology Corporation and Genesis Photonics Inc., v. Sensor Electronic Technology Inc., (SETi),* Declaration for IPR (IPR2022-00419) as patent owner, (retained by plaintiff LiteOn and Genesis) – retained by Pillsbury Winthrop Shaw Pittman LLP.
    a. Deposition: 1 (Cumulative total: 58)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 35)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 10)
        iii. PTAB Court trial/deposition appearance: 1 (Cumulative total: 16)
    c. Technology: LED based light bulbs, LED chips, LED arrays, LED packaging, flip-chip packaging, chip-on-board, heat sinks, GaN, InGaN, AlGaN (Gallium Nitride, Indium Gallium Nitride, Aluminum Gallium Nitride) epitaxial layers, GaN fabrication, LED quantum well active regions, LED cladding layers, optical mirrors, DBRs
132. Active case work: 1Q2022-3Q2022; *Panasonic Corporation, v. Magna International Inc.,* 21-cv-00319 (WD Tex filed 31st Mar 2021,), (retained by plaintiff Magna International) – retained by Sidley Austin LLP.
    a. Deposition: 0 (Cumulative total: 58)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 35)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 10)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 16)
    c. Technology: Automotive sensors, cameras, electronic circuitry, controls, packaging, surround view camera systems.
133. Active case work: 2Q2022 – 4Q2022; *Jiaxing Super Lighting Electric Appliance Co., LTD and Obert Inc. v. Maxlite Inc.,* 19-CV-04047 (CA C.D. Filed 8th May 2019), (retained by defendant Maxlite Inc) – retained by defendant Procopio, Cory, Hargreaves and Savitch LLP.

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a. Deposition: 0 (Cumulative total: 58)
b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 35)
    i. ITC trial appearance: 0 (Cumulative total: 8)
    ii. District Court trial appearance: 0 (Cumulative total: 10)
    iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 16)
c. Technology: LED lighting and LED packaging technologies for T8 and T12 form factor tube lighting. Technologies such as LED luminaire/tube packaging, mechanical structure, thermal heat dissipation, electronic circuitry, printed circuit boards, and LED chips.

134. Active case work: 1Q2022 – 4Q2022; *Advanced Engineering Services LLC., v. Lumasense Technologies Inc., and DOES* 1-50, 21-CV-03279-WHO combined with 20-CV-07905-WHO (CA N.D. Filed 23rd Feb 2022), (retained by plaintiff Advanced Engineering Services LLC) – retained by plaintiff SAC Attorneys LLP
    a. Deposition: 1 (Cumulative total: 59)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 35)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 10)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 16)
    c. Technology: Thermal, gas, and flow sensing for use in designing and manufacturing equipment used in semiconductor chip manufacturing. In particular, review of data relating to the simulation of finite element analysis ("FEA") and computational fluid dynamics ("CFD") data for gases, temperature, and stress with actual sensor data that could be intelligently integrated, customized, installed, tested, verified, and validated.
135. Active case work: 2Q2022-3Q2022; *Frontier Communications v. Charter Communications*, Pre-litigation IP and Due Diligence; Case No. TBD; Retained by Frontier Communications, (retained by Mayer Brown LLP)
    a. Deposition: 0 (Cumulative total: 59)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 35)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 10)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 16)
    c. Technology: Optical PON for high-speed data FTTH evaluation, testing, and analysis.
136. Active case work: 2Q2022-3Q2022; *Russ, August & Kabat*, Pre-litigation IP and Due Diligence; Case No. TBD; (retained by plaintiff – Russ, August & Kabat LLP)
    a. Deposition: 0 (Cumulative total: 59)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 35)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 10)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 16)
    c. Technology: High volume fiber optic transceivers for EPON/GPON with: CDR circuits, 'Intelligence-in-the-Module' and 'M-ary' families.
137. Active case work: 2Q2022-3Q2022; *Signify Holding B.V. v. GE Lighting Solutions LLC.*, Declaration for IPR (IPR2022-XXX – in draft form for US patent #7,497,973) as petitioner, (retained by petitioner Signify Holding B.V.) – retained by Alston and Bird LLP
    a. Deposition: 0 (Cumulative total: 59)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 35)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 10)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 16)
    c. Technology: LED based light bulbs, LED chips that emit in the UV and visible, LED arrays, LED packaging including phosphors and encapsulants, and the type of phosphors utilized for different emission. In particular, phosphors that are activated by dopants such as Europium (Eu), Manganese (Mn) and the associated ions for these materials e.g. Mn2+, Mn3+, Mn4+, Mn6+, etc. Included analysis of InGaN and AlGaN based epitaxial material systems, and the use of phosphors in high pressure mercury vapor lamps.
138. Active case work: 3Q2022 – 2Q2023; *Canon, Inc., and Canon USA Inc v. WSOU Investments, LLC d/b/a Brazos Licensing and Development.*, Declaration for IPR ((IPR2022-01532) for US patent #7,493,030 as petitioner, (retained by Canon Inc) – retained by Orrick LLP
    a. Deposition: 0 (Cumulative total: 59)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 35)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 16)
    c. Technology: Digital camera operation including optical focus, image sensing, optical train, depth of field, exposure time, different focus and focal areas of a portion of the image, general photography and optical principles.

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139. Active case work: 3Q2022 – 2Q2023; *Canon, Inc., and Canon USA Inc v. WSOU Investments, LLC d/b/a Brazos Licensing and Development.*, 21-CV- 00166-ADA-DTG (W.D. TX.) Filed 29th Sept 2022. (retained by defendant Canon Inc) – retained by Orrick LLP
    a. Deposition: 1 (Cumulative total: 60)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 35)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 10)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 16)
    c. Technology: Digital camera operation including optical focus, image sensing, optical train, depth of field, exposure time, different focus and focal areas of a portion of the image, general photography and optical principles.
140. Active case work: 3Q2022 – 4Q2023; *Fujifilm Sonosite., v. Butterfly Network, Inc.,* 1-22-CV-00309 (D. De) Filed 29th Mar 2022), (retained by defendant Butterfly Network, Inc.,) – retained by defendant Akin Gump LLP
    a. Deposition: 0 (Cumulative total: 60)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 35)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 10)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 16)
    c. Technology: Ultra-sonic equipment that includes displays, especially OLED displays. The electronic circuits and how displays are electronically controlled.
141. Active case work: 3Q2022 – 3Q2023; *LedComm LLC., v. IKEA US Retail LLC et al,* 6-22-CV-00302-ADA (W.D. Tx.) Filed 21st Mar 2022), (retained by defendant IKEA US Retail LLC et al.) – retained by defendant Flaster Greenberg LLP
    a. Deposition: 0 (Cumulative total: 60)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 35)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 10)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 16)
    c. Technology: LED surface mount packaging, LED GaN/InGaN chips, and associated LED lighting performance specifications.
142. Active case work: 2Q2022 – 3Q2022; *NXP Semiconductors N.V. and NXP USA Inc., v. MediaTek Inc, Amazon.com Inc., Belkin International Inc, Linksys USA Inc., et al,* ITC Investigation 337-TA-1287 entitled "Certain integrated circuits, and electronic devices and products containing the same" (Filed 1st Dec 2021), (retained by respondents Amazon.com Inc.,) – retained by respondent Morrison Foerster LLP
    a. Deposition: 0 (Cumulative total: 60)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 35)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 10)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 16)
    c. Technology: LED surface mount packaging, LED GaN/InGaN chips, and associated LED lighting performance specifications. LED Luminaires.
143. Active case work: 3Q2022 – 4Q2022; *Amazon.com Inc., v. Epistar Corp.,* 6-22-CV-00526-ADA (W.D. Tx.) Filed 24th May 2022), (retained by defendant Amazon.com Inc..) – retained by defendant Morrison Foerster LLP
    a. Deposition: 0 (Cumulative total: 60)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 35)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 10)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 16)
    c. Technology: LED surface mount packaging, LED GaN/InGaN chips, GaN/InGaN epitaxial growth, fabrication, device design and packaging. LED luminaires.
144. Active case work: 4Q2022 – 2Q2023; *Amazon.com Inc., v. Epistar Corp.,* 6-22-CV-00526-ADA (W.D. Tx.) Filed 24th May 2022), (retained by defendant Amazon.com Inc..) – retained by defendant Perkins Coie LLP
    a. Deposition: 0 (Cumulative total: 60)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 35)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 10)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 16)
    c. Technology: LED surface mount packaging, LED GaN/InGaN chips, GaN/InGaN epitaxial growth, fabrication, device design and packaging. LED Luminaires.
145. Active case work: 4Q2022 – 2Q2024; *Qorvo., v. Akoustis Technologies Inc.,* 1-21-CV-1417-JPM (C.A.) Filed 4th Oct 2021), (retained by defendant Akoustis.) – retained by defendant Pillsbury LLP
    a. Deposition: 1 (Cumulative total: 61)
    b. Trial/Hearing/court/PTAB appearance: 1 (Cumulative total: 36)
        i. ITC trial appearance: 0 (Cumulative total: 8)

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ii. District Court trial appearance: 1 (Cumulative total: 11)
iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 16)

c. Technology: acoustic wave filters, BAW filters (bulk-acoustic-wave) filters for RF applications, devices, fabrication, and characterization. Trade secrets and the misappropriation of trade secrets, confidential information, security policies, and overall development of new technology platforms.

146. Active case work: 4Q2022 – 3Q2023; *LG Electronics Inc., v. TCL Electronics Holdings Ltd. (f/k/a TCL § Multimedia Technology Holdings, Ltd.); § TCL Industries Holdings Co., Ltd.; TCL § Industries Holdings (H.K.) Limited; TTE § Technology, Inc. (d/b/a TCL North § America); TTE Corporation; TCL Moka § International Limited; TCL Moka § Manufacturing S.A. de C.V.; TCL King § Electrical Appliances (Huizhou) Co. Ltd.; § Manufacturas Avanzadas S.A. de C.V.; § TCL Smart Device (Vietnam) Co., Ltd.; § Shenzhen TCL New Technology Co., Ltd.; § TCL Optoelectronics Technology (Huizhou) § Co., Ltd.; TCL Overseas Marketing Ltd.; § and TCL Technology Group Corporation § (f/k/a TCL Corp.), TCL Electronics Holdings Ltd et al.,* 2-22-CV-0122-JRG (W.D. Tx.) Filed 14th Oct 2022), (retained by plaintiff LGE) – retained by plaintiff counsel Baker Botts LLP
    a. Deposition: 0 (Cumulative total: 61)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 36)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 16)
    c. Technology: BLU and backlighting of displays, especially LCD displays. Optical waveguide, reflecting, and transmission technology, optical sheet materials, optical shapes all utilizing LEDs in various optical package designs.
147. Active case work: 1Q2023 – Present; *NextGen Innovations, LLC v. Nokia of America Corporation et al.*, 2-22-CV-00309-JRG-RSP (E.D. Tex.), (filed: 9th Aug 2022), retained by plaintiff NextGen Innovations LLC., - retained by plaintiff counsel Russ August and Kabat LLP.
    a. Deposition: 0 (Cumulative total: 61)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 36)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 16)
    c. Technology: Optical network systems, transceiver modules, passive optical networks, transceiver electronic and optoelectronic components and ICs.
148. Active case work: 1Q2023 – 1Q2023; *NextGen Innovations, LLC v. Infinera et al.*, 2-22-CV-00306-JRG-RSP (E.D. Tex.), (filed: 9th Aug 2022), retained by plaintiff NextGen Innovations LLC., - retained by plaintiff counsel Russ August and Kabat LLP.
    a. Deposition: 1 (Cumulative total: 62)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 36)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 16)
    c. Technology: Optical network systems, transceiver modules, passive optical networks, transceiver electronic and optoelectronic components and ICs.
149. Active case work: 3Q2023 – 4Q2023; *Ikea North America Services LLC., Ikea US Retail LLC., v. Everlight Electronics et al,* 2-23-CV-00126-ADA (E.D. Tx.) Filed 27th Mar 2023), (retained by defendant Ikea US Retail LLC et al.) – retained by defendant counsel Flaster Greenberg LLP
    a. Deposition: 0 (Cumulative total: 62)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 36)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 16)
    c. Technology: LED surface mount packaging, LED GaN/InGaN chips, and associated LED lighting performance specifications.
150. Active case work: 1Q2023 – 3Q2023; *Jiaxing Super Lighting Electric Appliance Co., LTD and Obert Inc. v. Current Lighting Solutions, LLC d/b/a GE Current.,* 6-22-CV-00534-ADA (W.D. Tx). Filed 16th Sep 2022), (retained by defendant GE Current) – retained by defendant counsel Norton Rose Fulbright US LLP.
    a. Deposition: 0 (Cumulative total: 62)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 36)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 16)
    c. Technology: LED lighting and LED packaging technologies for T8 and T12 form factor tube lighting. Technologies such as LED luminaire/tube packaging, mechanical structure, thermal heat dissipation, electronic circuitry, printed circuit boards, and LED chips.

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151. Active case work: 1Q2023 – 2Q2023; *Jiaxing Super Lighting Electric Appliance Co., LTD and Obert Inc. v. Current Lighting Solutions, LLC d/b/a GE Current.,* Declaration for IPR petition (IPR2023-00272) for US patent #10,830,397 as petitioner, (retained by Current Lighting) – retained by counsel Norton Rose Fulbright US LLP.
    a. Deposition: 0 (Cumulative total: 62)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 36)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 16)
    c. Technology: LED lighting and LED packaging technologies for T8 and T12 form factor tube lighting. Technologies such as LED luminaire/tube packaging, mechanical structure, thermal heat dissipation, electronic circuitry, printed circuit boards, and LED chips.
152. Active case work: 1Q2023 – 2Q2023; *Jiaxing Super Lighting Electric Appliance Co., LTD and Obert Inc. v. Current Lighting Solutions, LLC d/b/a GE Current.,* Declaration for IPR petition (IPR2023-00984) for US patent #9,841,174 as petitioner, (retained by Current Lighting) – retained by counsel Norton Rose Fulbright US LLP.
    a. Deposition: 0 (Cumulative total: 62)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 36)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 16)
    d. Technology: LED lighting and LED packaging technologies for T8 and T12 form factor tube lighting. Technologies such as LED luminaire/tube packaging, mechanical structure, thermal heat dissipation, electronic circuitry, printed circuit boards, and LED chips.
153. Active case work: 1Q2023 – 2Q2023; *Jiaxing Super Lighting Electric Appliance Co., LTD and Obert Inc. v. Current Lighting Solutions, LLC d/b/a GE Current.,* Declaration for IPR petition (IPR2023-00983) for US patent #10,487,991 as petitioner, (retained by Current Lighting) – retained by counsel Norton Rose Fulbright US LLP.
    a. Deposition: 0 (Cumulative total: 62)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 36)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 16)
    c. Technology: LED lighting and LED packaging technologies for T8 and T12 form factor tube lighting. Technologies such as LED luminaire/tube packaging, mechanical structure, thermal heat dissipation, electronic circuitry, printed circuit boards, and LED chips.
154. Active case work: 1Q2023 – 2Q2023; *Jiaxing Super Lighting Electric Appliance Co., LTD and Obert Inc. v. Current Lighting Solutions, LLC d/b/a GE Current.,* Declaration for IPR petition (IPR2023-00676) for US patent #9,939,140 as petitioner, (retained by Current Lighting) – retained by counsel Norton Rose Fulbright US LLP.
    a. Deposition: 0 (Cumulative total: 62)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 36)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 16)
    c. Technology: LED lighting and LED packaging technologies for T8 and T12 form factor tube lighting. Technologies such as LED luminaire/tube packaging, mechanical structure, thermal heat dissipation, electronic circuitry, printed circuit boards, and LED chips.
155. Active case work: 1Q2023 – 2Q2023; *US Conec. Ltd. v. Senko Advanced Components Inc.,* 1-23-CV-00083-UNA (D. De). Filed 24th Jan 2023), (retained by defendant US Conec Ltd.) – retained by defendant counsel Troutman Pepper Hamilton Sanders LLP.
    a. Deposition: 0 (Cumulative total: 62)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 36)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 16)
    c. Technology: Fiber optic adapters, fiber optic connectors (simplex, duplex, quad, multi-fiber), fiber trays, racks, and fiber cabinet equipment. Single mode and multimode connector design, and fiber optic connector standards.
156. Active case work: 1Q2023 – 2Q2023; *US Conec. Ltd. v. Senko Advanced Components Inc.,* Declaration for IPR petition (IPR2023-00XXX) for US patent #11,307,369 as petitioner (retained by defendant US Conec Ltd.) – retained by defendant counsel Alston and Bird LLP (pending).
    a. Deposition: 0 (Cumulative total: 62)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 36)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 16)

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c. Technology: Fiber optic adapters, fiber optic connectors (simplex, duplex, quad, multi-fiber), fiber trays, racks, and fiber cabinet equipment. Single mode and multimode connector design, and fiber optic connector standards.

157. Active case work: 1Q2023 – 2Q2023; *Inneos LLC., v. Opticis Co., Ltd.,* 8-23-CV-00185-JWH-ADS (C.D. Ca). Filed 30th Jan 2023), (retained by plaintiff GE Current) – retained by plaintiff counsel Womble Bond Dickinson (US) LLP.
    a. Deposition: 1 (Cumulative total: 63)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 37)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 1 (Cumulative total: 17)
    c. Technology: VCSEL transceiver WDM (wavelength division multiplexing) modules, package design, optics, freeform, diffractive, refractive, and optical filters. Multimode fiber optics designs.
158. Active case work: 1Q2023 – 1Q2023; *Viavi Solutions Inc., v Zhejiang Crystal-Optech Co. Ltd.,* 2-21-CV-0378-JRG (E.D. Tx) (filed: 3rd Aug 2022), retained by complainant Viavi Solutions Inc., – retained by counsel Venable, LLP.
    a. Deposition: 0 (Cumulative total: 63)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 37)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 17)
    c. Technology: Optical filters and optical sensor systems, design and fabrication of dielectric materials for passband filters in applications such as optical communications, imaging, sensing, medical, automotive.
159. Active case work: 1Q2023 – 2Q2023; *Signify North America Corporation and Signify Holding BV., v Satco Products Inc.,* 2-19-CV-06125-JMA-SIL (E.D. NY) (filed: 30th Oct 2022), retained by defendant Satco Products Inc., – retained by defendant counsel Pillsbury Winthrop Shaw Pittman, LLP
    a. Deposition: 0 (Cumulative total: 63)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 37)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 17)
    c. Technology: LED backlights, optical techniques for light distribution. Display panels, and LED packaging.
160. Active case work: 1Q2023 – 1Q2023; *Becton Dickinson and Company v. Beckman Coulter Inc.*, 1-21-CV-00833-CLC-JFH (D. De), (filed: 3rd Jan 2023), retained by plaintiff Becton Dickinson and Company, - retained by plaintiff counsel Quinn Emanuel Urquhart & Sullivan, LLP.
    a. Deposition: 0 (Cumulative total: 63)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 37)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 17)
    c. Technology: Optical filters, sensors, micro-fluidics, lasers, optical test and measurement. Optical instrumentation for fluorescence analysis, characterization of fluorescent material.
161. Active case work: 2Q2023 – 2Q2023; *138 East LCD Advancements Limited v. Chongqing HKC Optoelectronics Technology Ltd*., Declaration for IPR patent owner response (IPR2023-00476) for US patent #7,335,913 as patent owner, (retained by 138 East LCD Advancements Ltd.) – retained by counsel Robins Kaplan LLP
    a. Deposition: 0 (Cumulative total: 63)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 37)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 17)
    c. Technology: LCD display layouts, designs for optical and electronic fabrication, design, IC (drivers, electrical wiring, electrodes), and packaging.
162. Active case work: 2Q2023 – 2Q2023; *138 East LCD Advancements Limited v. Chongqing HKC Optoelectronics Technology Ltd*., Declaration for IPR patent owner response (IPR2023-00475) for US patent #7,116,390 as patent owner, (retained by 138 East LCD Advancements Ltd.) – retained by counsel Robins Kaplan LLP
    a. Deposition: 0 (Cumulative total: 63)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 37)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 17)
    c. Technology: LCD display layouts, designs for optical and electronic fabrication, design, IC (drivers, electrical wiring, electrodes), and packaging.

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163. Active case work: 2Q2023 – 3Q2023; *Samsung Display Company Limited v. Mianyang BOE Optoelectronics Technology Co., Ltd.*, ITC 337-TA-1351 (filed: 27th Jan 2023), "Certain Active Matrix Organic Light-Emitting Diode Display Panels And Modules For Mobile Devices, And Components Thereof", (retained by plaintiff Samsung Display Company Ltd.) – retained by counsel Covington and Burling LLP.
    a. Deposition: 0 (Cumulative total: 63)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 37)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. IPR/PTAB trial/deposition: 0 (Cumulative total: 17)
    c. Technology: Active-matrix OLED display panels and modules for mobile products and devices.
164. Active case work: 2Q2023 – 3Q23; *Hesai Group, Hesai Technology Co., Ltd. and Hesai Inc. v. Ouster*, ITC 337-TA-1363 (filed: 11th May 2023), "Certain LiDAR (Light Detection And Ranging) Systems And Components Thereof", (retained by respondent Hesai et al.) – retained by counsel Quinn Emanuel Urquhart & Sullivan, LLP.
    c. Deposition: 1 (Cumulative total: 64)
    d. Trial/Hearing/court/PTAB appearance: 1 (Cumulative total: 38)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 18)
    e. Technology: Optical and electrical device, optics, and package designs for LIDAR based self-driving vehicles. Rotating LIDAR unit, magnetic rotor/stator design, electronic pcbs, bulk, micro-optics, and optical and electronic system design.
165. Active case work: 4Q2023 – Present; *Samsung Electronics v. Pictiva Display International*, 2-23-CV-00495-1 (E.D. Tx), (filed: 12th Dec 2022), "Certain LiDAR (Light Detection And Ranging) Systems And Components Thereof", (retained by defendant Samsung Electronics) – retained by counsel Covington and Burling LLP.
    a. Deposition: 0 (Cumulative total: 64)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 38)
        i. ITC trial appearance: 0 (Cumulative total: 8)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 18)
    c. Technology: Based on OLED displays, color emission, conversion, packaging, optical performance, phosphor characteristics, display panel designs. Patents asserted include: U.S. Patent Nos. 6,949,389 and 8,314,547
166. Active case work: 3Q2023 – Present; *Innoscience Zhuhai Technology Company, Ltd v. Efficient Power Conversion Corporation (EPC)*, ITC 337-TA-1366 (filed: 3rd July 2023), "Semiconductor Devices and Products Containing the Same", (retained by respondent Innoscience) – retained by counsel Finnegan, Henderson, Farabow, Garrett & Dunner, LLP.
    a. Deposition: 1 (Cumulative total: 65)
    b. Trial/Hearing/court/PTAB appearance: 1 (Cumulative total: 39)
        i. ITC trial appearance: 1 (Cumulative total: 9)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 18)
    c. Technology: Gallium Nitride (GaN) based power field effect transistors (FETs), their design, fabrication, characterization, and performance. Particular emphasis on enhancement mode GaN FETs and their operation, application, and product development.
167. Active case work: 3Q2023 – Present; *Innoscience Zhuhai Technology Company, Ltd v. Efficient Power Conversion Corporation (EPC)*, 2-23-CV-04026 (C.D Ca), (filed: 3rd July 2023), (retained by defendant Innoscience) – retained by counsel Finnegan, Henderson, Farabow, Garrett & Dunner, LLP.
    a. Deposition: 0 (Cumulative total: 65)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 39)
        i. ITC trial appearance: 0 (Cumulative total: 9)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 18)
    c. Technology: Gallium Nitride (GaN) based power field effect transistors (FETs), their design, fabrication, characterization, and performance. Particular emphasis on enhancement mode GaN FETs and their operation, application, and product development.
168. Active case work: 2Q2023 – 4Q2023; *Littlefuse, Inc., v. Mersen USA EP Corp*, USDC D. Mass. Case No. 1:17-CV-12375-IT, (filed: 9th Dec 2022), (retained by defendant Littlefuse) – retained by counsel Bejin Bieneman PLC ("B2IP").
    a. Deposition: 0 (Cumulative total: 65)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 39)
        i. ITC trial appearance: 0 (Cumulative total: 9)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 18)

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c. Technology: Electrical fuse technology, with extruded metal and alloys, design of mechanical structure. Application with solar cell industrial equipment.

169. Active case work: 2Q2023 – 1Q2024; *Immervision., v. Apple Inc.*, 1:21-CV-01484, (D. De.), (filed: 28th April 2022), (retained by plaintiff) – retained by counsel Panitch Schwarze Belisario & Nadel LLP.
    a. Deposition: 0 (Cumulative total: 65)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 39)
        i. ITC trial appearance: 0 (Cumulative total: 9)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 18)
    c. Technology: Optical lenses for ultra-wide angle imaging including wide angle panomorphic lenses, imaging techniques, and design of the optics. Application market verticals include mobile phones, portable display accessories and other portable consumer equipment.
170. Active case work: 2Q2023 – 3Q2023; *Samsung v. Apt-ability dba d/b/a Mobile Sentrix et al*, ITC 337-TA-1351 (filed: 3rd July 2023), "Certain Active Matrix Organic Light-Emitting Diode Display Panels And Modules For Mobile Devices, And Components Thereof", (retained by respondent Samsung) – retained by counsel Covington and Burling, LLP.
    a. Deposition: 0 (Cumulative total: 65)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 39)
        i. ITC trial appearance: 0 (Cumulative total: 9)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 18)
    c. Technology: OLED display panels for mobile devices including display electronics, backlights, panel design, and OLED pixel fabrication. Emphasis on pixel shape, layout and display pixel structure.
171. Active case work: 1Q2024 – 1Q2024; *Immervision., v. Apple Inc.*, Declaration for IPR patent owner response (IPR2023-00472) for US patent #10,795,120 as patent owner, (retained by plaintiff) – retained by counsel Panitch Schwarze Belisario & Nadel LLP.
    a. Deposition: 0 (Cumulative total: 65)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 39)
        i. ITC trial appearance: 0 (Cumulative total: 9)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 18)
    c. Technology: Optical lenses for ultra-wide angle imaging including wide angle panomorphic lenses, imaging techniques, and design of the optics. Application market verticals include mobile phones, portable display accessories and other portable consumer equipment.
172. Active case work: 1Q2024 – Present; *Innoscience Zhuhai Technology Company, Ltd v. Infineon*, Declaration for IPR petitioner response (IPR2024-00975) for US patent #9,899,481 as petitioner, (retained by defendant Innoscience) – retained by counsel Finnegan, Henderson, Farabow, Garrett & Dunner, LLP.
    a. Deposition: 0 (Cumulative total: 65)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 39)
        i. ITC trial appearance: 0 (Cumulative total: 9)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 18)
    c. Technology: Gallium Nitride (GaN) based power field effect transistors (FETs), their design, fabrication, characterization, and performance. Particular emphasis on enhancement mode GaN FETs and their operation, application, and product development.
173. Active case work: 1Q2023 – present; *Polaris Powerled Technologies llc (plaintiff), v. Samsung Electronics America Inc, Samsung Display Company Ltd, Samsung Electronics Company, Ltd. (defendants)*, 2:22-CV-00469-JRG, (E.D. Tx.), (filed: 28th June 2023), (retained by defendant) – retained by counsel Baker Botts LLP.
    a. Deposition: 1 (Cumulative total: 66)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 39)
        i. ITC trial appearance: 0 (Cumulative total: 9)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 18)
    d. Technology: OLED displays, OLED driver circuits, OLED red, green, blue pixels and associated display design and packaging technologies. Tear down of OLED displays for consumer cameras.
174. Active case work: 2Q2024 – present; *Ikea North America Services LLC., Ikea US Retail LLC., v. Everlight Electronics et al.;* Declaration for IPR patent owner response (IPR2024-00XXXX) for US patent #9,640,733 as petitioner, (retained by defendant Ikea US Retail LLC et al.) – retained by defendant counsel Flaster Greenberg LLP
    a. Deposition: 0 (Cumulative total: 66)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 39)
        i. ITC trial appearance: 0 (Cumulative total: 9)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 18)

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c. Technology: LED surface mount packaging, LED GaN/InGaN chips, and associated LED lighting performance specifications.

175. Active case work: 2Q2024 – present; *Ikea North America Services LLC., Ikea US Retail LLC., v. Everlight Electronics et al.;* Declaration for IPR patent owner response (IPR2024-00XXXX) for US patent #7,554,126 as petitioner, (retained by defendant Ikea US Retail LLC et al.) – retained by defendant counsel Flaster Greenberg LLP
    a. Deposition: 0 (Cumulative total: 66)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 39)
        i. ITC trial appearance: 0 (Cumulative total: 9)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 18)
    c. Technology: LED surface mount packaging, LED GaN/InGaN chips, and associated LED lighting performance specifications.
176. Active case work: 3Q2024 – present; *Semisilicon Technology Group v. Xu Peicheng (Hong Kong) Optoelectronic Technology Co. Limited;* Declaration for IPR patent owner response (IPR2024-00156) for US patent #8,884,546, (retained by defendant SemiSilicon Technology Group) – retained by defendant counsel Finnegan LLP
    a. Deposition: 0 (Cumulative total: 66)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 39)
        i. ITC trial appearance: 0 (Cumulative total: 9)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 18)
    c. Technology: LED surface mount and through-pin packaging (3/5mm as well as surface mount packages), COB (chip-on-board), flexible boards, LED GaN/InGaN chips, and associated LED control chips/slave chips, synchronous logic operation for LED strings and string architectures.
177. Active case work: 3Q2024 – present; *Semisilicon Technology Group v. Xu Peicheng (Hong Kong) Optoelectronic Technology Co. Limited;* Declaration for reexam (RE) patent owner (Reexamination control #90/015,328 for US patent #8,124,988), (retained by defendant SemiSilicon Technology Group) – retained by defendant counsel Finnegan LLP
    a. Deposition: 0 (Cumulative total: 66)
    b. Trial/Hearing/court/PTAB appearance (reexam interview): 1 (Cumulative total: 40)
        i. ITC trial appearance: 0 (Cumulative total: 9)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 1 (Cumulative total: 19)
    c. Technology: LED surface mount and through-pin packaging (3/5mm as well as surface mount packages), COB (chip-on-board), flexible boards, LED GaN/InGaN chips, and associated LED lighting performance specifications including waterproofing.
178. Active case work: 1Q2023 – 4Q2023; *Samsung v. BOE Technology Group Ltd, BMOT f/k/a Kunming BOE Display Technology, BOE Technology America Inc., Chengdu BOE Optoeletronics Technology Co., Ltd., Chongqing BOE Optoeletronics Technology Co., Ltd., Mianyang BOE Optoelectronics Technology Co., Ltd., Ordos Yuansheng Optoelectronics Co., Ltd., Wuhan BOE Optoeletronics Technology Co., Ltd.*, ITC 337-TA-1378 (filed: 31st October 2023), "Certain Organic Light-Emitting Diode Display Modules and Components Thereof", (retained by Complainant Samsung) – retained by counsel Quinn Emanual, LLP.
    a. Deposition: 2 (Cumulative total: 68)
    b. Trial/Hearing/court/PTAB appearance: 1 (Cumulative total: 41)
        i. ITC trial appearance: 1 (Cumulative total: 10)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 18)
    c. Technology: Manufacturing of OLED display panels (both half 6G carrier glass FMM (fine metal mask) mobile OLEDs and silicon based micro-OLEDs) for mobile devices including fabrication process, tool design, factory layout, technical yield performance, evaporation, encapsulation, pixel formation, cell cutting using CO2 lasers, etc. Emphasis on trade secrets and the misappropriation of trade secrets.
179. Active case work: 4Q2024 – Present; *Innoscience (Suzhou) Technology Company, Ltd.; Innoscience Zhuhai Technology Company, Ltd., and Innoscience America Inc., v. Infineon Technologies Austria AG., (defendants)* 3-24-CV-01553 (N.D. Cal.), (retained by defendant Innoscience) – retained by counsel Finnegan, Henderson, Farabow, Garrett & Dunner, LLP.
    a. Deposition: 0 (Cumulative total: 68)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 41)
        i. ITC trial appearance: 0 (Cumulative total: 10)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 18)
    c. Technology: Gallium Nitride (GaN) based power field effect transistors (FETs), their design, fabrication, characterization, and performance. Particular emphasis on enhancement mode GaN FETs and their operation, application, and product development.

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180. Active case work: 4Q2024 – Present; *Innoscience (Suzhou) Technology Company, Ltd.; Innoscience Zhuhai Technology Company, Ltd., and Innoscience America Inc., v. Infineon Technologies Austria AG.*, ITC 337-TA-3763 (filed: 26th July 2024), "*Certain Semiconductor Devices and Products Containing the Same"*, International Trade Commission), (retained by respondent Innoscience) – retained by counsel Finnegan, Henderson, Farabow, Garrett & Dunner, LLP.
    a. Deposition: 0 (Cumulative total: 68)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 41)
        i. ITC trial appearance: 0 (Cumulative total: 10)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 18)
    a. Technology: Gallium Nitride (GaN) based power field effect transistors (FETs), their design, fabrication, characterization, and performance. Particular emphasis on enhancement mode GaN FETs and their operation, application, and product development.
181. Active case work: 3Q2024 – Present; *Samsung Electronics Co., Ltd.; Samsung Electronics America, Inc.; and Samsung Semiconductor, Inc. v. SiOnyx, LLC.*, ITC 337-TA-1403 (filed: 30th April 2024), "*Certain Sensors with Pixels and Products Containing Same"*, International Trade Commission), (retained by respondent Samsung) – retained by counsel Covington and Burling, LLP.
    a. Deposition: 0 (Cumulative total: 68)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 41)
        i. ITC trial appearance: 0 (Cumulative total: 10)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 18)
    a. Technology: Silicon sensors and pixels for CMOS sensors with silicon fabrication that includes impact, wafer bonding, dielectric doping, wet and dry etching, passivation, optics, optical reflection, optical refraction, as well as general device characteristics for arrays.
182. Active case work: 3Q2024 – Present; *Samsung Electronics Co., Ltd.; Samsung Electronics America, Inc.; and Samsung Semiconductor, Inc. v. SiOnyx, LLC.*, Declaration for IPR patent owner response (IPR2024-01431) for US patent #11,069,737, (retained by defendant Samsung) – retained by defendant counsel Covington and Burling, LLP.
    a. Deposition: 0 (Cumulative total: 68)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 41)
        i. ITC trial appearance: 0 (Cumulative total: 10)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 18)
    a. Technology: Silicon sensors and pixels for CMOS sensors with silicon fabrication that includes impact, wafer bonding, dielectric doping, wet and dry etching, passivation, optics, optical reflection, optical refraction, as well as general device characteristics for arrays.
183. Active case work: 3Q2024 – Present; *Samsung Electronics Co., Ltd.; Samsung Electronics America, Inc.; and Samsung Semiconductor, Inc. v. SiOnyx, LLC.*, Declaration for IPR patent owner response (IPR2024-XXXXX) for US patent #10,347,682, (retained by defendant Samsung) – retained by defendant counsel Covington and Burling, LLP.
    c. Deposition: 0 (Cumulative total: 68)
    d. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 41)
        i. ITC trial appearance: 0 (Cumulative total: 10)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 18)
    a. Technology: Silicon sensors and pixels for CMOS sensors with silicon fabrication that includes impact, wafer bonding, dielectric doping, wet and dry etching, passivation, optics, optical reflection, optical refraction, as well as general device characteristics for arrays.
184. Active case work: 3Q2024 – Present; *Samsung Electronics Co., Ltd.; Samsung Electronics America, Inc.; and Samsung Semiconductor, Inc. v. SiOnyx, LLC.*, Declaration for IPR patent owner response (IPR2024-XXXXX) for US patent #11,721,714, (retained by defendant Samsung) – retained by defendant counsel Covington and Burling, LLP.
    e. Deposition: 0 (Cumulative total: 68)
    f. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 41)
        i. ITC trial appearance: 0 (Cumulative total: 10)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 18)
    a. Technology: Silicon sensors and pixels for CMOS sensors with silicon fabrication that includes impact, wafer bonding, dielectric doping, wet and dry etching, passivation, optics, optical reflection, optical refraction, as well as general device characteristics for arrays.
185. Active case work: 4Q2024 – Present; *Commscope Inc., Commscope Inc. of North Carolina, and Commscope Technologies LLC v. Belden Canada ULC., (plaintiff)* 1-22-CV-00782 (D. Del.), (retained by defendant Commscope) – retained by counsel Carlson Caspers, LLP.

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a. Deposition: 0 (Cumulative total: 68)
b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 41)
    i. ITC trial appearance: 0 (Cumulative total: 10)
    ii. District Court trial appearance: 0 (Cumulative total: 11)
    iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 18)
c. Technology: Electronic and electrical connectors, specifically RJ-45 and associated structure, operation, pins, springs, polymer molding and operational characteristics.

186. Active case work: 3Q2023 – 3Q23; *Hesai Group, Hesai Technology Co., Ltd. and Hesai Inc. v. Ouster*, Declaration for IPR patent owner response (IPR2023-01422) for US patent #11,287,515, (retained by petitioner Hesai) – retained by petitioner counsel Quinn Emanuel, LLP.
    a. Deposition: 0 (Cumulative total: 68)
    b. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 41)
        i. ITC trial appearance: 0 (Cumulative total: 10)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 18)
    c. Technology: Optical and electrical device, optics, and package designs for LIDAR based self-driving vehicles. Rotating LIDAR unit, magnetic rotor/stator design, electronic pcbs, bulk, micro-optics, and optical and electronic system design.
187. Active case work: 3Q2024 – 3Q2024; *Acuity Brands Lighting, Inc., v. Seoul Semiconductor Co. Ltd., and Seoul Viosys Co. Ltd.*, Exploration for IPR (IPR2024-XXXXX) for US patent #x,xxx,xxx (retained by Acuity Brands Lighting, Inc.) – retained by counsel Duane Morris, LLP.
    g. Deposition: 0 (Cumulative total: 68)
    h. Trial/Hearing/court/PTAB appearance: 0 (Cumulative total: 41)
        i. ITC trial appearance: 0 (Cumulative total: 10)
        ii. District Court trial appearance: 0 (Cumulative total: 11)
        iii. PTAB Court trial/deposition appearance: 0 (Cumulative total: 18)
    a. Technology: LED lighting, LED devices, light characteristics, luminaires, GaN blue LED chips and associated SMT packaging.
    c.

ISSUED utility PATENTS and PUBLISHED PATENT APPLICATIONS ISSUED:

Current combined total = 341

Dr. Lebby holds over 500 issued international patents (as per search engine) in photonics and electronics, that have been derived from over 230 issued USPTO utility patents, mostly in the field of optoelectronics, photonics, and semiconductors. He has been cited by the USPTO to be in the most prolific 75 inventors in USA from 1988-1997.

Recent activity

1	US-11974508-B2	Preview PDF	Josephson Junction using molecular beam epitaxy
2	US-11927868-B2	Preview PDF	Electro-optic polymer devices having high performance claddings, and methods of preparing the same
3	US-11757008-B2	Preview PDF	Electronic device with 2-dimensional electron gas between polar-oriented rare-earth oxide layer grown over a semicor
4	US-20230280605-A1	Preview PDF	SLOT MODULATORS WITH IMPROVED RF AND BANDWIDTH PERFORMANCE
5	US-20230251543-A1	Preview PDF	Electro-Optic Polymer Devices Having High Performance Claddings, and Methods of Preparing the Same
6	US-20230172075-A1	Preview PDF	Axis Josephson Junctions with Improved Smoothness

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Listed patents and patent applications

1	US-11614670-B2	Preview	PDF	Electro-optic polymer devices having high performance claddings, and methods of preparing the same	Yi; Youngwoo et al.	2023-03-28	21
2	US-11520175-B2	Preview	PDF	Active region-less modulator and method	Lebby; Michael et al.	2022-12-06	62
3	US-11506918-B2	Preview	PDF	Hybrid EO polymer modulator with ALD sealant layer	Lebby; Michael et al.	2022-11-22	18
4	US-11495670-B2	Preview	PDF	Integrated epitaxial metal electrodes	Pelzel; Rodney et al.	2022-11-08	25
5	US-11435603-B2	Preview	PDF	TFP optical transition device and method	Leonberger; Frederick J. et al.	2022-09-06	32
6	US-11435604-B2	Preview	PDF	Hybrid EO polymer modulator with silicon photonics	Lebby; Michael et al.	2022-09-06	21
7	US-20220246822-A1	Preview	PDF	Josephson Junction using Molecular Beam Epitaxy	Lebby; Michael S. et al.	2022-08-04	10
8	US-20220187638-A1	Preview	PDF	HYBRID EO POLYMER MODULATOR WITH ALD SEALANT LAYER	Lebby; Michael et al.	2022-06-16	18
9	US-20220187637-A1	Preview	PDF	HYBRID EO POLYMER MODULATOR WITH SILICON PHOTONICS	Lebby; Michael et al.	2022-06-16	22
10	US-20220113566-A1	Preview	PDF	TFP OPTICAL TRANSITION DEVICE AND METHOD	Leonberger; Frederick J. et al.	2022-04-14	32
11	US-11262605-B2	Preview	PDF	Active region-less polymer modulator integrated on a common PIC platform and method	Lebby; Michael et al.	2022-03-01	32
12	US-20220052249-A1	Preview	PDF	A-axis Josephson Junctions with Improved Smoothness	Lebby; Michael S. et al.	2022-02-17	40

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13	US-11201278-B2	Preview	PDF	Josephson Junction using molecular beam epitaxy	Lebby; Michael S. et al.	2021-12-14	10
14	US-11201451-B2	Preview	PDF	Porous distributed Bragg reflectors for laser applications	Hammond; Rich et al.	2021-12-14	20
15	US-11067748-B2	Preview	PDF	Guide transition device and method	Lebby; Michael et al.	2021-07-20	24
16	US-11063114-B2	Preview	PDF	III-N to rare earth transition in a semiconductor structure	Dargis; Rytis et al.	2021-07-13	23
17	US-11042051-B2	Preview	PDF	Direct drive region-less polymer modulator methods of fabricating and materials therefor	Lebby; Michael et al.	2021-06-22	25
18	US-20210141251-A1	Preview	PDF	ACTIVE REGION-LESS MODULATOR AND METHOD	Lebby; Michael et al.	2021-05-13	63
19	US-20210141250-A1	Preview	PDF	ACTIVE REGION-LESS MODULATOR AND METHOD	Lebby; Michael et al.	2021-05-13	29
20	US-10989871-B2	Preview	PDF	Protection layers for polymer modulators/waveguides	Becker; Richard et al.	2021-04-27	12
21	US-20210005720-A1	Preview	PDF	ELECTRONIC DEVICE WITH 2-DIMENSIONAL ELECTRON GAS BETWEEN POLAR-ORIENTED RARE-EARTH OXIDE LAYER GROWN OVER A SEMICONDUCTOR	Dargis; Rytis et al.	2021-01-07	23
22	US-10886694-B2	Preview	PDF	Hermetic capsule and method	Lebby; Michael	2021-01-05	17
23	US-10825912-B2	Preview	PDF	Integrated epitaxial metal electrodes	Pelzel; Rodney et al.	2020-11-03	20
24	US-20200285085-A1	Preview	PDF	DIRECT DRIVE REGION-LESS POLYMER MODULATOR METHODS OF FABRICATING AND MATERIALS THEREFOR	Lebby; Michael et al.	2020-09-10	25
25	US-10754093-B2	Preview	PDF	Fabrication process of polymer based photonic apparatus and the apparatus	Liu; Zhiming et al.	2020-08-25	12
26	US-20200183201-A1	Preview	PDF	ACTIVE REGION-LESS POLYMER MODULATOR INTEGRATED ON A COMMON PIC PLATFORM AND METHOD	Lebby; Michael et al.	2020-06-11	31

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27	US-20200183245-A1	Preview	PDF	ELECTRO-OPTIC POLYMER DEVICES HAVING HIGH PERFORMANCE CLADDINGS, AND METHODS OF PREPARING THE SAME	Yi; Youngwoo et al.	2020-06-11	21
28	US-20200161417-A1	Preview	PDF	III-N TO RARE EARTH TRANSITION IN A SEMICONDUCTOR STRUCTURE	Dargis; Rytis et al.	2020-05-21	20
29	US-20200150363-A1	Preview	PDF	CONDUCTIVE MULTI-FIBER/PORT HERMETIC CAPSULE AND METHOD	Lebby; Michael	2020-05-14	27
30	US-20200119516-A1	Preview	PDF	HERMETIC CAPSULE AND METHOD	Lebby; Michael	2020-04-16	16
31	US-10615141-B2	Preview	PDF	Pnictide buffer structures and devices for GaN base applications	Clark; Andrew et al.	2020-04-07	16
32	US-10605987-B2	Preview	PDF	Re-based integrated photonic and electronic layered structures	Clark; Andrew et al.	2020-03-31	42
33	US-20200091398-A1	Preview	PDF	JOSEPHSON JUNCTION USING MOLECULAR BEAM EPITAXY	Lebby; Michael S. et al.	2020-03-19	10
34	US-20200088939-A1	Preview	PDF	GUIDE TRANSITION DEVICE AND METHOD	Lebby; Michael et al.	2020-03-19	23
35	US-20200088941-A1	Preview	PDF	PROTECTION LAYERS FOR POLYMER MODULATORS/WAVEGUIDES	Becker; Richard et al.	2020-03-19	12
36	US-10591755-B2	Preview	PDF	Direct-drive polymer modulator methods of fabricating and materials therefor	Becker; Richard et al.	2020-03-17	20
37	US-20200083668-A1	Preview	PDF	GUIDE TRANSITION DEVICE WITH DIGITAL GRATING DEFLECTORS AND METHOD	Lebby; Michael et al.	2020-03-12	15
38	US-10573686-B2	Preview	PDF	Epitaxial AlN/cREO structure for RF filter applications	Wang; Wang Nang et al.	2020-02-25	19
39	US-10574025-B2	Preview	PDF	Hermetic capsule and method for a monolithic photonic integrated circuit	Lebby; Michael	2020-02-25	17
40	US-10566944-B2	Preview	PDF	Layer structures for RF filters fabricated using rare earth oxides and epitaxial aluminum nitride	Pelzel; Rodney et al.	2020-02-18	28

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41	US-10527786-B2	Preview	PDF	Polymer modulator and laser integrated on a common platform and method	Leonberger; Frederick J et al.	2020-01-07	27
42	US-10520673-B2	Preview	PDF	Protection layers for polymer modulators/waveguides	Becker; Richard et al.	2019-12-31	12
43	US-10509164-B2	Preview	PDF	Guide transition device and method	Lebby; Michael et al.	2019-12-17	23
44	US-10511146-B2	Preview	PDF	Guide transition device with digital grating deflectors and method	Lebby; Michael et al.	2019-12-17	16
45	US-20190353843-A1	Preview	PDF	FABRICATION PROCESS OF POLYMER BASED PHOTONIC APPARATUS AND THE APPARTUS	Liu; Zhiming et al.	2019-11-21	12
46	US-20190305039-A1	Preview	PDF	EPITAXIAL AlN/cREO STRUCTURE FOR RF FILTER APPLICATIONS	Wang; Wang Nang et al.	2019-10-03	18
47	US-10431729-B2	Preview	PDF	Josephson junction using molecular beam epitaxy	Lebby; Michael S. et al.	2019-10-01	10
48	US-20190278036-A1	Preview	PDF	EMBEDDED HERMETIC CAPSULE AND METHOD	Lebby; Michael	2019-09-12	22
49	US-20190237930-A1	Preview	PDF	HERMETIC CAPSULE AND METHOD	Lebby; Michael	2019-08-01	17
50	US-20190227233-A1	Preview	PDF	RE-based Integrated Photonic and Electronic Layered Structures	Clark; Andrew et al.	2019-07-25	41
51	US-20190221993-A1	Preview	PDF	POROUS DISTRIBUTED BRAGG REFLECTORS FOR LASER APPLICATIONS	Hammond; Rich et al.	2019-07-18	19
52	US-20190204506-A1	Preview	PDF	PROTECTION LAYERS FOR POLYMER MODULATORS/WAVEGUIDES	Becker; Richard et al.	2019-07-04	12
53	US-10332857-B2	Preview	PDF	Rare earth pnictides for strain management	Clark; Andrew et al.	2019-06-25	30
54	US-20190172923-A1	Preview	PDF	Integrated Epitaxial Metal Electrodes	Pelzel; Rodney et al.	2019-06-06	24
55	US-20190148913-A1	Preview	PDF	GUIDE TRANSITION DEVICE WITH DIGITAL GRATING DEFLECTORS AND METHOD	Lebby; Michael et al.	2019-05-16	16

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56	US-20190139761-A1	Preview	PDF	Pnictide Buffer Structures and Devices for GaN Base Applications	Clark; Andrew et al.	2019-05-09	15
57	US-20190122885-A1	Preview	PDF	GROUP III SEMICONDUCTOR EPITAXY FORMED ON SILICON VIA SINGLE CRYSTAL REN AND REO BUFFER LAYERS	Dargis; Rytis et al.	2019-04-25	13
58	US-20190079243-A1	Preview	PDF	GUIDE TRANSITION DEVICE AND METHOD	Lebby; Michael et al.	2019-03-14	24
59	US-20190074365-A1	Preview	PDF	Integrated Epitaxial Metal Electrodes	Pelzel; Rodney et al.	2019-03-07	20
60	US-20190064436-A1	Preview	PDF	POLYMER MODULATOR AND LASER INTEGRATED ON A COMMON PLATFORM AND METHOD	Leonberger; Frederick J et al.	2019-02-28	26
61	US-20190028081-A1	Preview	PDF	LAYER STRUCTURES FOR RF FILTERS FABRICATED USING RARE EARTH OXIDES AND EPITAXIAL ALUMINUM NITRIDE	Pelzel; Rodney et al.	2019-01-24	28
62	US-10162111-B1	Preview	PDF	Multi-fiber/port hermetic capsule sealed by metallization and method	Lebby; Michael	2018-12-25	34
63	US-10128350-B2	Preview	PDF	Integrated epitaxial metal electrodes	Pelzel; Rodney et al.	2018-11-13	20
64	US-20180259798-A1	Preview	PDF	DIRECT-DRIVE POLYMER MODULATOR METHODS OF FABRICATING AND MATERIALS THEREFOR	Becker; Richard et al.	2018-09-13	20
65	US-10075143-B2	Preview	PDF	Layer structures for RF filters fabricated using rare earth oxides and epitaxial aluminum nitride	Pelzel; Rodney et al.	2018-09-11	29
66	US-20180138284-A1	Preview	PDF	Integrated Epitaxial Metal Electrodes	Pelzel; Rodney et al.	2018-05-17	19
67	US-20180012858-A1	Preview	PDF	RARE EARTH INTERLAYS FOR MECHANICALLY LAYERING DISSIMILAR SEMICONDUCTOR WAFERS	Clark; Andrew et al.	2018-01-11	15
68	US-20180013053-A1	Preview	PDF	Josephson Junction using Molecular Beam Epitaxy	Lebby; Michael S. et al.	2018-01-11	10
69	US-20170353002-A1	Preview	PDF	Rare Earth Pnictides for Strain Management	Clark; Andrew et al.	2017-12-07	29
70	US-20170141750-A1	Preview	PDF	LAYER STRUCTURES FOR RF FILTERS FABRICATED USING RARE EARTH OXIDES AND EPITAXIAL ALUMINUM NITRIDE	Pelzel; Rodney et al.	2017-05-18	29
71	US-9496132-B2	Preview	PDF	Nucleation of III-N on REO templates	Arkun; Erdem et al.	2016-11-15	9
72	US-9443939-B2	Preview	PDF	Strain compensated REO buffer for III-N on silicon	Dargis; Rytis et al.	2016-09-13	7
73	US-20160133708-A1	Preview	PDF	STRAIN COMPENSATED REO BUFFER FOR III-N ON SILICON	Dargis; Rytis et al.	2016-05-12	7
74	US-9236249-B2	Preview	PDF	III-N material grown on REN epitaxial buffer on Si substrate	Dargis; Rytis et al.	2016-01-12	9

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75	US-9105471-B2	Preview	PDF	Rare earth oxy-nitride buffered III-N on silicon	Clark; Andrew et al.	2015-08-11	7
76	US-20150014676-A1	Preview	PDF	III-N MATERIAL GROWN ON REN EPITAXIAL BUFFER ON Si SUBSTRATE	Dargis; Rytis et al.	2015-01-15	10
77	US-20140357014-A1	Preview	PDF	HIGH EFFICIENCY SOLAR CELL USING IIIB MATERIAL TRANSITION LAYERS	LEBBY; MICHAEL et al.	2014-12-04	10
78	US-8889978-B2	Preview	PDF	III-V semiconductor interface with graded GeSn on silicon	Roucka; Radek et al.	2014-11-18	12
79	US-8878188-B2	Preview	PDF	REO gate dielectric for III-N device on Si substrate	Dargis; Rytis et al.	2014-11-04	8
80	US-8872308-B2	Preview	PDF	AlN cap grown on GaN/REO/silicon substrate structure	Arkun; Erdem et al.	2014-10-28	5
81	US-8835955-B2	Preview	PDF	IIIO.sub.xN.sub.y on single crystal SOI substrate and III n growth platform	Arkun; Erdem et al.	2014-09-16	10
82	US-8823055-B2	Preview	PDF	REO/ALO/A1N template for III-N material growth on silicon	Arkun; Erdem et al.	2014-09-02	7
83	US-8823025-B1	Preview	PDF	III-N material grown on AlO/AlN buffer on Si substrate	Arkun; Erdem et al.	2014-09-02	5
84	US-20140239307-A1	Preview	PDF	REO GATE DIELECTRIC FOR III-N DEVICE ON Si SUBSTRATE	DARGIS; RYTIS et al.	2014-08-28	8
85	US-20140231817-A1	Preview	PDF	III-N MATERIAL GROWN ON ALO/ALN BUFFER ON SI SUBSTRATE	Arkun; Erdem et al.	2014-08-21	5
86	US-20140231818-A1	Preview	PDF	AlN CAP GROWN ON GaN/REO/SILICON SUBSTRATE STRUCTURE	Arkun; Erdem et al.	2014-08-21	5
87	US-20140225123-A1	Preview	PDF	REO/ALO/AlN TEMPLATE FOR III-N MATERIAL GROWTH ON SILICON	Arkun; Erdem et al.	2014-08-14	10
88	US-8794010-B2	Preview	PDF	Laser cooling of modified SOI wafer	Williams; David L. et al.	2014-08-05	12
89	US-20140167057-A1	Preview	PDF	REO/ALO/AlN TEMPLATE FOR III-N MATERIAL GROWTH ON SILICON	Arkun; Erdem et al.	2014-06-19	7
90	US-8748900-B1	Preview	PDF	Re-silicide gate electrode for III-N device on Si substrate	Dargis; Rytis et al.	2014-06-10	10
91	US-8680507-B1	Preview	PDF	A1N inter-layers in III-N material grown on DBR/silicon substrate	Arkun; Erdem et al.	2014-03-25	6
92	US-20140076390-A1	Preview	PDF	III-V SEMICONDUCTOR INTERFACE WITH GRADED GeSn ON SILICON	Roucka; Radek et al.	2014-03-20	13
93	US-20140077240-A1	Preview	PDF	IV MATERIAL PHOTONIC DEVICE ON DBR	Roucka; Radek et al.	2014-03-20	5

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94	US-20140077338-A1	Preview	PDF	Si-Ge-Sn ON REO TEMPLATE	Roucka; Radek et al.	2014-03-20	5
95	US-20140077339-A1	Preview	PDF	DELTA DOPING AT Si-Ge INTERFACE	Roucka; Radek et al.	2014-03-20	5
96	US-20140053894-A1	Preview	PDF	GRADED GeSn ON SILICON	Roucka; Radek et al.	2014-02-27	13
97	US-8637763-B2	Preview	PDF	Solar cells with engineered spectral conversion	Lebby; Michael et al.	2014-01-28	18
98	US-8636844-B1	Preview	PDF	Oxygen engineered single-crystal REO template	Dargis; Rytis et al.	2014-01-28	10
99	US-8633569-B1	Preview	PDF	AlN inter-layers in III-N material grown on REO/silicon substrate	Arkun; Erdem et al.	2014-01-21	5
100	US-20140008644-A1	Preview	PDF	OXYGEN ENGINEERED SINGLE-CRYSTAL REO TEMPLATE	Dargis; Rytis et al.	2014-01-09	10
101	US-8623747-B1	Preview	PDF	Silicon, aluminum oxide, aluminum nitride template for optoelectronic and power devices	Arkun; Erdem et al.	2014-01-07	6
102	US-20130334536-A1	Preview	PDF	SINGLE-CRYSTAL REO BUFFER ON AMORPHOUS SiOx	Dargis; Rytis et al.	2013-12-19	7
103	US-8559097-B2	Preview	PDF	Integrated pump laser and rare earth waveguide amplifier	Williams; David L. et al.	2013-10-15	10
104	US-8553741-B2	Preview	PDF	Integrated rare earth devices	Lebby; Michael	2013-10-08	9
105	US-20130248853-A1	Preview	PDF	NUCLEATION OF III-N ON REO TEMPLATES	Arkun; Erdem et al.	2013-09-26	8
106	US-8542437-B1	Preview	PDF	Earth abundant photonic structures	Lebby; Michael S. et al.	2013-09-24	21
107	US-20130214282-A1	Preview	PDF	III-N ON SILICON USING NANO STRUCTURED INTERFACE LAYER	Arkun; Erdem et al.	2013-08-22	7
108	US-8501635-B1	Preview	PDF	Modification of REO by subsequent III-N EPI process	Clark; Andrew et al.	2013-08-06	10
109	US-20130153918-A1	Preview	PDF	REO-Si TEMPLATE WITH INTEGRATED REO LAYERS FOR LIGHT EMISSION	Clark; Andrew et al.	2013-06-20	9
110	US-8455756-B2	Preview	PDF	High efficiency solar cell using IIIB material transition layers	Lebby; Michael et al.	2013-06-04	10
111	US-20130099357-A1	Preview	PDF	STRAIN COMPENSATED REO BUFFER FOR III-N ON SILICON	Dargis; Rytis et al.	2013-04-25	7
112	US-20130071960-A1	Preview	PDF	INTEGRATED RARE EARTH DEVICES	LEBBY; MICHAEL	2013-03-21	10

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113	US-20130062609-A1	Preview	PDF	III-N FET ON SILICON USING FIELD SUPPRESSING REO	Smith; Robin et al.	2013-03-14	10
114	US-20130062610-A1	Preview	PDF	LATTICE MATCHED CRYSTALLINE REFLECTOR	Clark; Andrew et al.	2013-03-14	11
115	US-8394194-B1	Preview	PDF	Single crystal reo buffer on amorphous SiO.sub.x	Dargis; Rytis et al.	2013-03-12	7
116	US-20130032858-A1	Preview	PDF	RARE EARTH OXY-NITRIDE BUFFERED III-N ON SILICON	Clark; Andrew et al.	2013-02-07	8
117	US-8331410-B2	Preview	PDF	Spontaneous/stimulated light emitting .mu.-cavity device	Lebby; Michael et al.	2012-12-11	8
118	US-8331413-B2	Preview	PDF	Integrated rare earth devices	Lebby; Michael	2012-12-11	9
119	US-20120280276-A1	Preview	PDF	Single Crystal Ge On Si	Dargis; Rytis et al.	2012-11-08	6
120	US-20120256232-A1	Preview	PDF	Multilayer Rare Earth Device	Clark; Andrew et al.	2012-10-11	24
121	US-20120183767-A1	Preview	PDF	HEXAGONAL REO TEMPLATE BUFFER FOR III-N LAYERS ON SILICON	Dargis; Rytis et al.	2012-07-19	10
122	US-20120145243-A1	Preview	PDF	SOLAR CELLS WITH MAGNETICALLY ENHANCED UP-CONVERSION	Williams; David L. et al.	2012-06-14	13
123	US-20120147906-A1	Preview	PDF	LASER COOLING OF MODIFIED SOI WAFER	Williams; David L. et al.	2012-06-14	12
124	US-20120104443-A1	Preview	PDF	IIIOxNy ON SINGLE CRYSTAL SOI SUBSTRATE AND III n GROWTH PLATFORM	Clark; Andrew et al.	2012-05-03	9
125	US-20120104567-A1	Preview	PDF	IIIOxNy ON REO/Si	Clark; Andrew et al.	2012-05-03	6
126	US-20120090672-A1	Preview	PDF	REO-Ge Multi-Junction Solar Cell	LEBBY; MICHAEL S. et al.	2012-04-19	16
127	US-20120085399-A1	Preview	PDF	REO-Ge Multi-Junction Solar Cell	Lebby; Michael S. et al.	2012-04-12	17
128	US-20120073648-A1	Preview	PDF	Photovoltaic conversion using rare earths plus Group IV Sensitizers	Clark; Andrew et al.	2012-03-29	18
129	US-20120019902-A1	Preview	PDF	INTERGRATED PUMP LASER AND RARE EARTH WAVEGUIDE AMPLIFIER	Williams; David L. et al.	2012-01-26	10
130	US-20110290313-A1	Preview	PDF	SOLAR CELLS WITH ENGINEERED SPECTRAL CONVERSION	LEBBY; MICHAEL et al.	2011-12-01	19
131	US-8049100-B2	Preview	PDF	Multijunction rare earth solar cell	Clark; Andrew et al.	2011-11-01	24

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132	US-8039738-B2	Preview	PDF	Active rare earth tandem solar cell	Clark; Andrew et al.	2011-10-18	25
133	US-8039737-B2	Preview	PDF	Passive rare earth tandem solar cell	Clark; Andrew et al.	2011-10-18	17
134	US-20110220173-A1	Preview	PDF	ACTIVE SOLAR CONCENTRATOR WITH MULTI-JUNCTION DEVICES	LEBBY; MICHAEL	2011-09-15	15
135	US-20110203666-A1	Preview	PDF	HIGH EFFICIENCY SOLAR CELL USING IIIB MATERIAL TRANSITION LAYERS	Lebby; Michael et al.	2011-08-25	10
136	US-20110188533-A1	Preview	PDF	INTEGRATED RARE EARTH DEVICES	LEBBY; MICHAEL	2011-08-04	10
137	US-7968384-B2	Preview	PDF	Stacked transistors and process	Atanakovic; Petar B. et al.	2011-06-28	7
138	US-7967653-B2	Preview	PDF	Full color display	Lebby; Michael et al.	2011-06-28	11
139	US-20110108908-A1	Preview	PDF	MULTILAYERED BOX IN FDSOI MOSFETS	Lebby; Michael et al.	2011-05-12	34
140	US-7821066-B2	Preview	PDF	Multilayered BOX in FDSOI MOSFETS	Lebby; Michael et al.	2010-10-26	33
141	US-20100122720-A1	Preview	PDF	Passive Rare Earth Tandem Solar Cell	Clark; Andrew et al.	2010-05-20	17
142	US-20100116315-A1	Preview	PDF	Active rare earth tandem solar cell	Clark; Andrew et al.	2010-05-13	25
143	US-20100112736-A1	Preview	PDF	FULL COLOR DISPLAY	Lebby; Michael et al.	2010-05-06	12
144	US-20100109047-A1	Preview	PDF	Multijunction rare earth solar cell	Clark; Andrew et al.	2010-05-06	23
145	US-20100084680-A1	Preview	PDF	SPONTANEOUS/STIMULATED LIGHT EMITTING .mu.-CAVITY DEVICE	Lebby; Michael et al.	2010-04-08	8
146	US-7643526-B1	Preview	PDF	Spontaneous/stimulated light emitting .mu.-cavity device	Lebby; Michael et al.	2010-01-05	8
147	US-20090291535-A1	Preview	PDF	STACKED TRANSISTORS AND PROCESS	Atanackovic; Petar B. et al.	2009-11-26	7
148	US-7605531-B1	Preview	PDF	Full color display including LEDs with rare earth active areas and different radiative transistions	Lebby; Michael et al.	2009-10-20	11
149	US-7579623-B2	Preview	PDF	Stacked transistors and process	Atanackovic; Petar B. et al.	2009-08-25	7
150	US-7538016-B2	Preview	PDF	Signal and/or ground planes with double buried insulator layers and fabrication process	Atanakovic; Petar B. et al.	2009-05-26	8

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151	US-7388230-B1	Preview	PDF	Selective colored light emitting diode	Lebby; Michael et al.	2008-06-17	9
152	US-20080135924-A1	Preview	PDF	Multilayered box in FDSOI MOSFETS	Lebby; Michael et al.	2008-06-12	34
153	US-7365357-B2	Preview	PDF	Strain inducing multi-layer cap	Atanackovic; Petar B. et al.	2008-04-29	6
154	US-20080093670-A1	Preview	PDF	SIGNAL AND/OR GROUND PLANES WITH DOUBLE BURIED INSULATOR LAYERS AND FABRICATION PROCESS	Atanakovic; Petar B. et al.	2008-04-24	8
155	US-7355269-B1	Preview	PDF	IC on non-semiconductor substrate	Lebby; Michael et al.	2008-04-08	4
156	US-7323396-B2	Preview	PDF	Signal and/or ground planes with double buried insulator layers and fabrication process	Atanackovic; Petar B. et al.	2008-01-29	7
157	US-20070018166-A1	Preview	PDF	Stacked transistors and process	Atanackovic; Petar B. et al.	2007-01-25	8
158	US-20070018203-A1	Preview	PDF	Strain inducing multi-layer cap	Atanackovic; Petar B. et al.	2007-01-25	6
159	US-20060246691-A1	Preview	PDF	Signal and/or ground planes with double buried insulator layers and fabrication process	Atanackovic; Petar B. et al.	2006-11-02	8
160	US-6999644-B1	Preview	PDF	Discrete optoelectric package	Lebby; Michael S. et al.	2006-02-14	17
161	US-6966703-B1	Preview	PDF	Self eject latch mechanism for an optical transceiver module	Lebby; Michael S. et al.	2005-11-22	9
162	US-6795461-B1	Preview	PDF	Optoelectric module	Blair; Thomas H. et al.	2004-09-21	19
163	US-6663296-B1	Preview	PDF	Optoelectric module	Blair; Thomas H. et al.	2003-12-16	14
164	US-6412989-B1	Preview	PDF	Directable laser transmission module	Hartman; Davis Howard et al.	2002-07-02	8

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165	US-6243056-B1	Preview	PDF	Transceiver with miniature virtual image display	Jachimowicz; Karen E. et al.	2001-06-05	12
166	US-6228440-B1	Preview	PDF	Perishable media information storage mechanism and method of fabrication	Dailey; Conan B. et al.	2001-05-08	7
167	US-6158884-A	Preview	PDF	Integrated communicative watch	Lebby; Michael S. et al.	2000-12-12	9
168	US-6161106-A	Preview	PDF	Perishable media system and method of operation	Dailey; Conan B. et al.	2000-12-12	7
169	US-6156582-A	Preview	PDF	Method of fabricating top emitting ridge VCSEL with self-aligned contact and sidewall reflector	Shieh; Chan-Long et al.	2000-12-05	6
170	US-6131017-A	Preview	PDF	Dual system portable electronic communicator	Lebby; Michael S. et al.	2000-10-10	8
171	US-6122023-A	Preview	PDF	Non-speckle liquid crystal projection display	Chen; Diana et al.	2000-09-19	8
172	US-6121068-A	Preview	PDF	Long wavelength light emitting vertical cavity surface emitting laser and method of fabrication	Ramdani; Jamal et al.	2000-09-19	7
173	US-6115618-A	Preview	PDF	Portable electronic device with removable display	Lebby; Michael S. et al.	2000-09-05	6
174	US-6111839-A	Preview	PDF	Optical pickup head including a coherent first order mode laser light source	Milster; Tom D. et al.	2000-08-29	7
175	US-6096666-A	Preview	PDF	Holographic textile fiber	Jachimowicz; Karen E. et al.	2000-08-01	6
176	US-6097748-A	Preview	PDF	Vertical cavity surface emitting laser semiconductor chip with integrated drivers and photodetectors and method of fabrication	Huang; Rong-Ting et al.	2000-08-01	11
177	US-6097528-A	Preview	PDF	Microscanner for portable laser diode displays	Lebby; Michael S. et al.	2000-08-01	8
178	US-6091754-A	Preview	PDF	VCSEL having integrated photodetector for automatic power control	Jiang; Wenbin et al.	2000-07-18	5

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179	US-6084697-A	Preview	PDF	Integrated electro-optical package	Lebby; Michael S. et al.	2000-07-04	9
180	US-6080690-A	Preview	PDF	Textile fabric with integrated sensing device and clothing fabricated thereof	Lebby; Michael S. et al.	2000-06-27	8
181	US-6069593-A	Preview	PDF	Display carrier and electronic display control for multiple displays in a portable electronic device	Lebby; Michael S. et al.	2000-05-30	6
182	US-6064780-A	Preview	PDF	Interconnect substrate with a single contact accessible in an upper and an end surface	Blair; Thomas H. et al.	2000-05-16	6
183	US-6061380-A	Preview	PDF	Vertical cavity surface emitting laser with doped active region and method of fabrication	Jiang; Wenbin et al.	2000-05-09	8
184	US-6061485-A	Preview	PDF	Method for wavelength division multiplexing utilizing donut mode vertical cavity surface emitting lasers	Jiang; Wenbin et al.	2000-05-09	7
185	US-6029073-A	Preview	PDF	Display carrier with binocular viewing for a portable electronic device	Lebby; Michael S. et al.	2000-02-22	7
186	US-6026111-A	Preview	PDF	Vertical cavity surface emitting laser device having an extended cavity	Jiang; Wenbin et al.	2000-02-15	6
187	US-6022760-A	Preview	PDF	Integrated electro-optical package and method of fabrication	Lebby; Michael S. et al.	2000-02-08	12
188	US-6021146-A	Preview	PDF	Vertical cavity surface emitting laser for high power single mode operation and method of fabrication	Jiang; Wenbin et al.	2000-02-01	7
189	US-6021147-A	Preview	PDF	Vertical cavity surface emitting laser for high power single mode operation and method of fabrication	Jiang; Wenbin et al.	2000-02-01	7
190	US-6008067-A	Preview	PDF	Fabrication of visible wavelength vertical cavity surface emitting laser	Ramdani; Jamal et al.	1999-12-28	5
191	US-5978398-A	Preview	PDF	Long wavelength vertical cavity surface emitting laser	Ramdani; Jamal et al.	1999-11-02	5
192	US-5974071-A	Preview	PDF	VCSEL with integrated photodetectors for automatic power control and signal detection in data storage	Jiang; Wenbin et al.	1999-10-26	8

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193	US-5966399-A	Preview	PDF	Vertical cavity surface emitting laser with integrated diffractive lens and method of fabrication	Jiang; Wenbin et al.	1999-10-12	7
194	US-5959315-A	Preview	PDF	Semiconductor to optical link	Lebby; Michael S. et al.	1999-09-28	6
195	US-5956363-A	Preview	PDF	Long wavelength vertical cavity surface emitting laser with oxidation layers and method of fabrication	Lebby; Michael S. et al.	1999-09-21	7
196	US-5956364-A	Preview	PDF	Vertical cavity surface emitting laser with shaped cavity mirror and method of fabrication	Jiang; Wenbin et al.	1999-09-21	6
197	US-5953355-A	Preview	PDF	Semiconductor laser package with power monitoring system	Kiely; Philip et al.	1999-09-14	6
198	US-5946121-A	Preview	PDF	IrDA data link with VCSEL light source	Jiang; Wenbin et al.	1999-08-31	4
199	US-5943359-A	Preview	PDF	Long wavelength VCSEL	Ramdani; Jamal et al.	1999-08-24	5
200	US-5943357-A	Preview	PDF	Long wavelength vertical cavity surface emitting laser with photodetector for automatic power control and method of fabrication	Lebby; Michael S. et al.	1999-08-24	7
201	US-5939773-A	Preview	PDF	Semiconductor laser package including a lead frame and plastic resin housing	Jiang; Wenbin et al.	1999-08-17	8
202	US-5936929-A	Preview	PDF	Optical submodule and method for making	Jiang; Wenbin et al.	1999-08-10	7
203	US-5923696-A	Preview	PDF	Visible light emitting vertical cavity surface emitting laser with gallium phosphide contact layer and method of fabrication	Ramdani; Jamal et al.	1999-07-13	7
204	US-5914973-A	Preview	PDF	Vertical cavity surface emitting laser for high power operation and method of fabrication	Jiang; Wenbin et al.	1999-06-22	7
205	US-5906004-A	Preview	PDF	Textile fabric with integrated electrically conductive fibers and clothing fabricated thereof	Lebby; Michael S. et al.	1999-05-25	7
206	US-5905750-A	Preview	PDF	Semiconductor laser package and method of fabrication	Lebby; Michael S. et al.	1999-05-18	10
207	US-5903586-A	Preview	PDF	Long wavelength vertical cavity surface emitting laser	Ramdani; Jamal et al.	1999-05-11	5
208	US-5898722-A	Preview	PDF	Dual wavelength monolithically integrated vertical cavity surface emitting lasers and method of fabrication	Ramdani; Jamal et al.	1999-04-27	8

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209	US-5886972-A	Preview	PDF	Recording information in a phase change optical medium with a vertical cavity surface emitting laser	Jiang; Wenbin et al.	1999-03-23	5
210	US-5883912-A	Preview	PDF	Long wavelength VCSEL	Ramdani; Jamal et al.	1999-03-16	5
211	US-5881084-A	Preview	PDF	Semiconductor laser for package with power monitoring system	Huang; Rong-Ting et al.	1999-03-09	8
212	US-5848086-A	Preview	PDF	Electrically confined VCSEL	Lebby; Michael S. et al.	1998-12-08	7
213	US-5838703-A	Preview	PDF	Semiconductor laser package with power monitoring system and optical element	Lebby; Michael S. et al.	1998-11-17	9
214	US-5838707-A	Preview	PDF	Ultraviolet/visible light emitting vertical cavity surface emitting laser and method of fabrication	Ramdani; Jamal et al.	1998-11-17	8
215	US-5835521-A	Preview	PDF	Long wavelength light emitting vertical cavity surface emitting laser and method of fabrication	Ramdani; Jamal et al.	1998-11-10	7
216	US-5831960-A	Preview	PDF	Integrated vertical cavity surface emitting laser pair for high density data storage and method of fabrication	Jiang; Wenbin et al.	1998-11-03	7
217	US-5821571-A	Preview	PDF	Dual sided integrated electro-optical package	Lebby; Michael S. et al.	1998-10-13	13
218	US-5818404-A	Preview	PDF	Integrated electro-optical package	Lebby; Michael S. et al.	1998-10-06	18
219	US-5815524-A	Preview	PDF	VCSEL including GaTlP active region	Ramdani; Jamal et al.	1998-09-29	5
220	US-5796769-A	Preview	PDF	Red light vertical cavity surface emitting laser	Ramdani; Jamal et al.	1998-08-18	6
221	US-5789733-A	Preview	PDF	Smart card with contactless optical interface	Jachimowicz; Karen E. et al.	1998-08-04	7
222	US-5774486-A	Preview	PDF	Waveguide power monitoring system for vertical cavity surface emitting lasers	Jiang; Wenbin et al.	1998-06-30	6
223	US-5764671-A	Preview	PDF	VCSEL with selective oxide transition regions	Lebby; Michael S. et al.	1998-06-09	10
224	US-5757741-A	Preview	PDF	CD ROM head with VCSEL or VCSEL array	Jiang; Wenbin et al.	1998-05-26	11
225	US-5757829-A	Preview	PDF	Flip chip power monitoring system for vertical cavity surface emitting lasers	Jiang; Wenbin et al.	1998-05-26	6
226	US-5757836-A	Preview	PDF	Vertical cavity surface emitting laser with laterally integrated photodetector	Jiang; Wenbin et al.	1998-05-26	8
227	US-5751757-A	Preview	PDF	VCSEL with integrated MSM photodetector	Jiang; Wenbin et al.	1998-05-12	5

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228	US-5751471-A	Preview	PDF	Switchable lens and method of making	Chen; Diana et al.	1998-05-12	8
229	US-5748665-A	Preview	PDF	Visible VCSEL with hybrid mirrors	Jiang; Wenbin et al.	1998-05-05	7
230	US-5748161-A	Preview	PDF	Integrated electro-optical package with independent menu bar	Lebby; Michael S. et al.	1998-05-05	22
231	US-5742630-A	Preview	PDF	VCSEL with integrated pin diode	Jiang; Wenbin et al.	1998-04-21	6
232	US-5741724-A	Preview	PDF	Method of growing gallium nitride on a spinel substrate	Ramdani; Jamal et al.	1998-04-21	5
233	US-5739800-A	Preview	PDF	Integrated electro-optical package with LED display chip and substrate with drivers and central opening	Lebby; Michael S. et al.	1998-04-14	19
234	US-5732103-A	Preview	PDF	Long wavelength VCSEL	Ramdani; Jamal et al.	1998-03-24	5
235	US-5719892-A	Preview	PDF	Hybrid mirror structure for a visible emitting VCSEL	Jiang; Wenbin et al.	1998-02-17	8
236	US-5719893-A	Preview	PDF	Passivated vertical cavity surface emitting laser	Jiang; Wenbin et al.	1998-02-17	7
237	US-5710441-A	Preview	PDF	Microcavity LED with photon recycling	Ackley; Donald E. et al.	1998-01-20	5
238	US-5708280-A	Preview	PDF	Integrated electro-optical package and method of fabrication	Lebby; Michael S. et al.	1998-01-13	12
239	US-5706306-A	Preview	PDF	VCSEL with distributed Bragg reflectors for visible light	Jiang; Wenbin et al.	1998-01-06	6
240	US-5703664-A	Preview	PDF	Integrated electro-optic package for reflective spatial light modulators	Jachimowicz; Karen E. et al.	1997-12-30	13
241	US-5699073-A	Preview	PDF	Integrated electro-optical package with carrier ring and method of fabrication	Lebby; Michael S. et al.	1997-12-16	19
242	US-5661075-A	Preview	PDF	Method of making a VCSEL with passivation	Grodzinski; Piotr et al.	1997-08-26	9
243	US-5654228-A	Preview	PDF	VCSEL having a self-aligned heat sink and method of making	Shieh; Chan-Long et al.	1997-08-05	7
244	US-5644369-A	Preview	PDF	Switchable lens/diffuser	Jachimowicz; Karen E. et al.	1997-07-01	8
245	US-5638392-A	Preview	PDF	Short wavelength VCSEL	Ramdani; Jamal et al.	1997-06-10	6
246	US-5636298-A	Preview	PDF	Coalescing optical module and method for making	Jiang; Wenbin et al.	1997-06-03	8

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247	US-5633886-A	Preview	PDF	Short wavelength VCSEL with Al-free active region	Ramdani; Jamal et al.	1997-05-27	6
248	US-5625734-A	Preview	PDF	Optoelectronic interconnect device and method of making	Thomas; Ronald E. et al.	1997-04-29	7
249	US-5574744-A	Preview	PDF	Optical coupler	Gaw; Craig A. et al.	1996-11-12	7
250	US-5563900-A	Preview	PDF	Broad spectrum surface-emitting led	Ackley; Donald E. et al.	1996-10-08	7
251	US-5557626-A	Preview	PDF	Patterned mirror VCSEL with adjustable selective etch region	Grodzinski; Piotr et al.	1996-09-17	8
252	US-5555341-A	Preview	PDF	Waveguide with an electrically conductive channel	Sharma; Ravinder K. et al.	1996-09-10	7
253	US-5550941-A	Preview	PDF	Optoelectronic interface module	Lebby; Michael S. et al.	1996-08-27	8
254	US-5545359-A	Preview	PDF	Method of making a plastic molded optoelectronic interface	Ackley; Donald E. et al.	1996-08-13	9
255	US-5546413-A	Preview	PDF	Integrated light emitting device	Lebby; Michael S. et al.	1996-08-13	10
256	US-5543958-A	Preview	PDF	Integrated electro-optic package for reflective spatial light modulators	Lebby; Michael S. et al.	1996-08-06	14
257	US-5540799-A	Preview	PDF	Method of fabricating optical waveguide from a laminate	Lebby; Michael S. et al.	1996-07-30	6
258	US-5538919-A	Preview	PDF	Method of fabricating a semiconductor device with high heat conductivity	Lebby; Michael S. et al.	1996-07-23	8
259	US-5539200-A	Preview	PDF	Integrated optoelectronic substrate	Lebby; Michael S. et al.	1996-07-23	6
260	US-5539554-A	Preview	PDF	Integrated electro-optic package for reflective spatial light	Lebby; Michael S. et al.	1996-07-23	14
261	US-5534888-A	Preview	PDF	Electronic book	Lebby; Michael S. et al.	1996-07-09	8
262	US-5530715-A	Preview	PDF	Vertical cavity surface emitting laser having continuous grading	Shieh; Chan-Long et al.	1996-06-25	7
263	US-5521992-A	Preview	PDF	Molded optical interconnect	Chun; Christopher K. Y. et al.	1996-05-28	10
264	US-5517348-A	Preview	PDF	Voltage controlled transparent layer for a bi-directinal device	Lebby; Michael S.	1996-05-14	5
265	US-5511138-A	Preview	PDF	Interlocking waveguide and method of making	Lebby; Michael S. et al.	1996-04-23	8

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266	US-5498883-A	Preview	PDF	Superluminescent edge emitting device with apparent vertical light emission and method of making	Lebby; Michael S. et al.	1996-03-12	7
267	US-5493437-A	Preview	PDF	External communication link for a credit card pager	Lebby; Michael S. et al.	1996-02-20	10
268	US-5491491-A	Preview	PDF	Portable electronic equipment with binocular virtual display	Lebby; Michael S. et al.	1996-02-13	11
269	US-5486946-A	Preview	PDF	Integrated electro-optic package for reflective spatial light modulators	Jachimowicz; Karen E. et al.	1996-01-23	14
270	US-5485318-A	Preview	PDF	Dual image manifestation apparatus with integrated electro-optical package	Lebby; Michael S. et al.	1996-01-16	17
271	US-5482658-A	Preview	PDF	Method of making an optoelectronic interface module	Lebby; Michael S. et al.	1996-01-09	8
272	US-5482891-A	Preview	PDF	VCSEL with an intergrated heat sink and method of making	Shieh; Chan-Long et al.	1996-01-09	6
273	US-5478774-A	Preview	PDF	Method of fabricating patterned-mirror VCSELs using selective growth	Ackley; Donald E. et al.	1995-12-26	7
274	US-5473716-A	Preview	PDF	Fiber bundle interconnect and method of making same	Lebby; Michael S. et al.	1995-12-05	8
275	US-5468656-A	Preview	PDF	Method of making a VCSEL	Shieh; Chan-Long et al.	1995-11-21	9
276	US-5469185-A	Preview	PDF	Remote sensory unit and driver	Lebby; Michael S. et al.	1995-11-21	7
277	US-5468582-A	Preview	PDF	Fused optical layer and method of making	Blair; Thomas H. et al.	1995-11-21	7
278	US-5466633-A	Preview	PDF	Optical reading head and method for making same	Ackley; Donald E. et al.	1995-11-14	11
279	US-5467215-A	Preview	PDF	Integrated electro-optic package for reflective spatial light modulators	Lebby; Michael S. et al.	1995-11-14	13
280	US-5452387-A	Preview	PDF	Coaxial optoelectronic mount and method of making same	Chun; Christopher K. Y. et al.	1995-09-19	5
281	US-5446752-A	Preview	PDF	VCSEL with current blocking layer offset	Ackley; Donald E. et al.	1995-08-29	10
282	US-5437092-A	Preview	PDF	Method of making contact areas on an optical waveguide	Hartman; Davis H. et al.	1995-08-01	7
283	US-5432809-A	Preview	PDF	VCSEL with Al-free cavity region	Grodzinski; Piotr et al.	1995-07-11	7
284	US-5432630-A	Preview	PDF	Optical bus with optical transceiver modules and method of manufacture	Lebby; Michael S. et al.	1995-07-11	16

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285	US-5428704-A	Preview	PDF	Optoelectronic interface and method of making	Lebby; Michael S. et al.	1995-06-27	16
286	US-5422901-A	Preview	PDF	Semiconductor device with high heat conductivity	Lebby; Michael S. et al.	1995-06-06	7
287	US-5416870-A	Preview	PDF	Optoelectronic interface device and method with reflective surface	Chun; Christopher K. Y. et al.	1995-05-16	8
288	US-5408547-A	Preview	PDF	Optical read/write head	Lebby; Michael S. et al.	1995-04-18	10
289	US-5400423-A	Preview	PDF	Molded star coupler and method of making same	Chun; Christopher K. Y. et al.	1995-03-21	5
290	US-5400352-A	Preview	PDF	Semiconductor laser and method therefor	Lebby; Michael S. et al.	1995-03-21	5
291	US-5389312-A	Preview	PDF	Method of fabricating molded optical waveguides	Lebby; Michael S. et al.	1995-02-14	8
292	US-5390275-A	Preview	PDF	Molded waveguide and method for making same	Lebby; Michael S. et al.	1995-02-14	9
293	US-5388120-A	Preview	PDF	VCSEL with unstable resonator	Ackley; Donald E. et al.	1995-02-07	5
294	US-5369529-A	Preview	PDF	Reflective optoelectronic interface device and method of making	Kuo; Shun-Meen et al.	1994-11-29	7
295	US-5369415-A	Preview	PDF	Direct retinal scan display with planar imager	Richard; Fred V. et al.	1994-11-29	6
296	US-5367593-A	Preview	PDF	Optical/electrical connector and method of fabrication	Lebby; Michael S. et al.	1994-11-22	10
297	US-5361317-A	Preview	PDF	Assembly with fixture aligning and affixing an optical fiber to an optical device	Hartman; Davis H. et al.	1994-11-01	7
298	US-5359686-A	Preview	PDF	Interface for coupling optical fibers to electronic circuitry	Galloway; David et al.	1994-10-25	17
299	US-5358880-A	Preview	PDF	Method of manufacturing closed cavity LED	Lebby; Michael S. et al.	1994-10-25	6
300	US-5359618-A	Preview	PDF	High efficiency VCSEL and method of fabrication	Lebby; Michael S. et al.	1994-10-25	6
301	US-5359669-A	Preview	PDF	Remote retinal scan identifier	Shanley; Charles W. et al.	1994-10-25	7
302	US-5351257-A	Preview	PDF	VCSEL with vertical offset operating region providing a lateral waveguide and current limiting and method of fabrication	Lebby; Michael S. et al.	1994-09-27	10
303	US-5351331-A	Preview	PDF	Method and apparatus for splicing optical fibers with signal I/O	Chun; Christopher K. Y. et al.	1994-09-27	11

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304	US-5349210-A	Preview	PDF	Optical reading head with angled array	Ackley; Donald E. et al.	1994-09-20	10
305	US-5348616-A	Preview	PDF	Method for patterning a mold	Hartman; Davis H. et al.	1994-09-20	12
306	US-5345524-A	Preview	PDF	Optoelectronic transceiver sub-module and method for making	Lebby; Michael S. et al.	1994-09-06	9
307	US-5345527-A	Preview	PDF	Intelligent opto-bus with display	Lebby; Michael S. et al.	1994-09-06	11
308	US-5345530-A	Preview	PDF	Molded waveguide and method for making same	Lebby; Michael S. et al.	1994-09-06	8
309	US-5337391-A	Preview	PDF	Optoelectronic sub-module and method of making same	Lebby; Michael S.	1994-08-09	10
310	US-5337397-A	Preview	PDF	Optical coupling device and method for making	Lebby; Michael S. et al.	1994-08-09	7
311	US-5335300-A	Preview	PDF	Method of manufacturing I/O node in an optical channel waveguide and apparatus for utilizing	Hartman; Davis H. et al.	1994-08-02	10
312	US-5325451-A	Preview	PDF	Modular optical waveguide and method for making	Hartman; Davis et al.	1994-06-28	5
313	US-5324964-A	Preview	PDF	Superluminescent surface light emitting device	Ackley; Donald E. et al.	1994-06-28	5
314	US-5323477-A	Preview	PDF	Contact array imager with integral waveguide and electronics	Lebby; Michael S. et al.	1994-06-21	10
315	US-5313545-A	Preview	PDF	Molded waveguide with a unitary cladding region and method of making	Kuo; Shun-Meen et al.	1994-05-17	11
316	US-5309537-A	Preview	PDF	Optoelectronic coupling device and method of making	Chun; Christopher K. Y. et al.	1994-05-03	11
317	US-5286982-A	Preview	PDF	High contrast ratio optical modulator	Ackley; Donald E. et al.	1994-02-15	7
318	US-5282071-A	Preview	PDF	Contact areas on an optical waveguide and method of making	Hartman; Davis H. et al.	1994-01-25	8
319	US-5276762-A	Preview	PDF	Magnetic holding methods for optical fiber I/O assembly	Hartman; Davis H. et al.	1994-01-04	4
320	US-5276754-A	Preview	PDF	Optoelectronic mount and method for making	Blair; Thomas H. et al.	1994-01-04	7
321	US-5271083-A	Preview	PDF	Molded optical waveguide with contacts utilizing leadframes and method of making same	Lebby; Michael S. et al.	1993-12-14	10
322	US-5265184-A	Preview	PDF	Molded waveguide and method for making same	Lebby; Michael S. et al.	1993-11-23	8
323	US-5249245-A	Preview	PDF	Optoelectroinc mount including flexible substrate and method for making same	Lebby; Michael S. et al.	1993-09-28	10
324	US-5230030-A	Preview	PDF	Interface coupling electronic circuitry	Hartman; Davis H. et al.	1993-07-20	6

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325	US-5228101-A	Preview	PDF	Electrical to optical links using metalization	Lebby; Michael S. et al.	1993-07-13	6
326	US-5225816-A	Preview	PDF	Electrical connector with display	Lebby; Michael S. et al.	1993-07-06	4
327	US-5218465-A	Preview	PDF	Intelligent interconnects for broadband optical networking	Lebby; Michael S. et al.	1993-06-08	6
328	US-5172384-A	Preview	PDF	Low threshold current laser	Goronkin; Herbert et al.	1992-12-15	14
329	US-5170448-A	Preview	PDF	Optical waveguide apparatus and method for partially collecting light	Ackley; Donald E. et al.	1992-12-08	7
330	US-5125054-A	Preview	PDF	Laminated polymer optical waveguide interface and method of making same	Ackley; Donald E. et al.	1992-06-23	6
331	US-5116461-A	Preview	PDF	Method for fabricating an angled diffraction grating	Lebby; Michael S. et al.	1992-05-26	5
332	US-5067829-A	Preview	PDF	Dynamic optical beam steering	Jaskie; James E. et al.	1991-11-26	7
333	US-5068007-A	Preview	PDF	Etching of materials in a noncorrosive environment	Rogers; Stephen P. et al.	1991-11-26	6
334	US-5045908-A	Preview	PDF	Vertically and laterally illuminated p-i-n photodiode	Lebby; Michael S.	1991-09-03	5
335	US-5034092-A	Preview	PDF	Plasma etching of semiconductor substrates	Lebby; Michael S. et al.	1991-07-23	5

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PUBLICATIONS (Papers)

1. As of 19th February 2024; Journal of Lightwave Technology, JLT-33420-2023.R1, "Ring-Assisted Mach-Zehnder Modulator on the InP Membrane on Silicon Platform," has been accepted for publication in the next available issue of the IEEE/OPTICA PUBLISHING GROUP Journal of Lightwave Technology. Kashi, A.A., Tol van der, J.J.G.M., Lebby, M.S., Zhang, X., Williams, K., Jiao, Y., "Ring-Assisted Mach-Zehnder Modulator on the InP Membrane on Silicon Platform," Journal of Lightwave Technology.
2. C. Eschenbaum, A. Mertens, C. Fullner, A. Kuzmin, A. Schwarzenberger, A. Kotz, G. Ramann, M. Chen, J. Drisko, B. Johnson, J. Zyskind, J. Marcelli, M. Lebby, W. Freude, S. Randel, C. Koos, "Thermally Stable Silicon-Organic Hybrid (SOH) Mach-Zehnder Modulator for 140 GBd PAM4 transmission with Sub-1V Drive Signals" ECOC Post Deadline session 1; 13:42 to 13:54pm, 22nd September 2022; "Thermally Stable Silicon-Organic Hybrid (SOH) Mach-Zehnder Modulator for 140 GBd PAM4 Transmission With Sub-1 v Drive Signals (Th3B.2) given by Carsten Eschenbaum, *Karlsruhe Inst Tech (KIT)* and SilOriX Gmbh.
3. Amir Abbas Kashi; Jos J. G. M. Van der Tol; Kevin A. Williams; Weiming Yao; Michael S. Lebby; Cory Pecinovsky; and Yuqing Jiao' "**Electro-Optic Slot Waveguide Phase Modulator on the InP Membrane on Silicon Platform**" IEEE Journal of Quantum Electronics, Year: 2021 | Volume: 57, Issue: 1, pages 1-10.
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5. Dargis, R.; Williams, D.; Smith, R.; Arkun, E.; Semans, S; Vosters, G.; **Lebby, M**.; and Clark, A., "Study of the Structural and Thermal Properties of Single Crystalline Epitaxial Rare-Earth-Metal Oxide Layers Grown on Si," (2011); ECS Transactions **doi: 10.1149/1.3633032,** ECS Trans. **2011** volume 41, issue 3, **161-167** http://www.ecsdl.org/getabs/servlet/GetabsServlet?prog=normal&id=ECSTF8000041000003000161000001&idtype=cvips&gifs=yes&ref=no.
6. Dargis, Rytis; Arkun, E. ; Clark, Andrew ; Roucka, R. ; Smith, Robin ; Williams, David ; **Lebby, Michael** ; Demkov, Alexander A. "Rare-earth-metal oxide buffer for epitaxial growth of single crystal GeSi and Ge on Si(111)," Journal of Vacuum Science & Technology Volume:30 Issue:2
7. Dargis. R, Clark. A, Arkun. F.E, Smith. R, **Lebby. M**, "Engineering of the Interface between Silicon and Rare-Earth Oxide Buffer for GaN Growth," ECS Meeting, 27 October, 2013, San Francisco, USA. Doi: 10.1063/1.4753828.
8. Roucka. R, Clark. A, Semans. S, Tolle. J, **Lebby. M,** "Scalable virtual Ge templates for III-V integration on Si wafers," 8th International conference on concentrating photovoltaic systems: CPV8, 16-18th April 2012, Toledo, Spain.
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11. F. Erdem Arkuna, **Michael Lebby**b, Rytis Dargisb, Radek Rouckab, Robin S. Smithb and Andrew Clarkb "Scalable GaN-on-Silicon Using Rare Earth Oxide Buffer Layers," doi: 10.1149/05009.1065ecst *ECS Trans.* 2013 volume 50, issue 9, 1065-1071 [Electrochemical Society].
12. R. Dargisz, A. Clark, E. Arkun, R. Roucka, D. Williams, R. Smith and **M. Lebby** "Epitaxial Si and Gd_2O_3 Heterostructures: Distributed Bragg Reflectors with Stress Management Function for GaN on Si Light Emitting Devices,"; doi: 10.1149/2.004206jss *ECS J. Solid State Sci. Technol.* 2012 volume 1, issue 5, P246-P249.
13. R. Dargisz, D. Williams, R. Smith, E. Arkun, R. Roucka, A. Clark and **M. Lebby** "Structural and Thermal Properties of Single Crystalline Epitaxial Gd_2O_3 and Er_2O_3 Grown on Si(111),"; 10.1149/2.005202jss *ECS J. Solid State Sci. Technol.* 2012 volume 1, issue 2, N24-N28
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15. Rytis Dargisa, Andrew Clarka, Erdem Arkuna, Radek Rouckaa, David Williamsa, Robin S. Smitha and **Michael Lebby**a ,"Epitaxial Si and Gd_2O_3 Heterostructures - Distributed Bragg Reflectors with Stress Management Function for GaN on Si Light Emitting Devices,"; doi: 10.1149/05004.0047ecst *ECS Trans.* 2013 volume 50, issue 4, 47-52.
16. Rytis Dargisa, David Williamsa, Robin Smitha, Erdem Arkuna, Scott Semansa, Gary Vostersa**, Michael Lebby**a and Andrew Clarka, "Study of the Structural and Thermal Properties of Single Crystalline Epitaxial Rare-Earth-Metal Oxide Layers Grown on Si(111),"; doi: 10.1149/1.3633032 *ECS Trans.* 2011 volume 41, issue 3, 161-167.
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19. **Lebby, M.S**., "Green photonics technology and markets," Electronics Letters, vol. 45 , no. 20, pp.1007, Sept. 2009. DOI: 10.1049/el.2009.2563, Print ISSN 0013-5194, Online ISSN 1350-911X.
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24. **Lebby, M.S**. and Clayton, R, Optoelectronics Roadmap OIDA-iNEMI, IEEE Packaging and Assembly, May 2007.
25. **Lebby, Michael**, "A new model for the optoelectronic indium-based semiconductor industry," Optics and Photonics News, May 2006.
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27. **Lebby, M**., "OEICs: commercialization at last," Compound Semiconductor, vol. 7, no. 6, pp. 81-2, 85, July 2001.
28. **M. S. Lebby** & W. B. Jiang. "Packaging of Optical Components and Systems," Wiley Encyclopedia of Electrical and Electronics Engineering, Vol 15 pp 499-516. John G. Webster (Ed.), John Wiley & Sons, New Jersey, 1999.
29. W. B. Jiang, & **M. S. Lebby**, "Optical Sources: Light-emitting diodes and laser technology," Handbook of fiber optic data communication, C. DeCusatis, et al, (Ed.), Academic Press, 1998.
30. W. B. Jiang, & **M. S. Lebby**, "Semiconductor laser and light emitting diode fabrication," Handbook of fiber optic data communication, C. DeCusatis, et al, (Ed.), Academic Press, 1998.
31. Berry, G.; Summers, H.D.; Blood, P.; Claisse, P.; **Lebby, M**., "Optical bistability in vertical cavity surface emitting lasers with a simple intra-cavity epitaxial absorber layer," Conference Digest. ISLC 1998 NARA. 1998 IEEE 16th International Semiconductor Laser Conference, 1998.
32. Jiang, W.; Norton, L.; Kiely, P.; Schwartz, D.; Gable, B.; **Lebby, M**.; Raskin, G., "Vertical cavity surface emitting laser-based parallel optical data link," Optical Engineering, vol. 37, no. 12, pp. 3113-18, Dec. 1998.
33. Robertsson, M.E.; Hagel, O.J.; Gustafsson, G.; Dabek, A.; Popall, M.; Cergel, L.; Wennekers, P.; Kiely, P.; **Lebby, M.**; Lindahl, T., "O/e-MCM packaging with new, patternable dielectric and optical materials," 1998 Proceedings. 48th Electronic Components and Technology Conference, pp. 1413-21, May 1998.
34. Popall, M.; Dabek, A.; Robertsson, M.E.; Gustafsson, G.; Hagel, O.-J.; Olsowski, B.; Buestrich, R.; Cergel, L.; **Lebby, M**.; Kiely, P.; Joly, J.; Lambert, D.; Schaub, M.; Reichl, H., "ORMOCERsTM-new photo-patternable dielectric and optical materials for MCM-packaging," 1998 Proceedings. 48th Electronic Components and Technology Conference, May 1998.
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Professor (Dr. Dr.) Michael S. Lebby, B. Eng. (Hons), MBA, Ph.D., D. Eng, Fellow NAI, IEEE, Optica (OSA); C. Eng.
1 Hawthorne St., unit 25a, San Francisco, CA 94105, USA; mobile +1 717 839 7078; drmlebby@gmail.com

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37. **Lebby, M.S**.; Claisse, P.; Jiang, W.; Kiley, P.; Roll, M.; Boughter, L.; Sanchez, P.; Lawrence, B., "VCSEL devices and packaging," Proceedings of the SPIE - The International Society for Optical Engineering, vol. 3289, pp.2-12, Jan. 1998.
38. Popall, M.; Dabek, A.; Robertsson, M.E.; Gustafsson, G.; Hagel, O.-J.; Olsowski, B.; Buestrich, R.; Cergel, L.; **Lebby, M**.; Kiely, P.; Joly, J.; Lambert, D.; Schaub, M.; Reichl, H., "ORMOCERs - new photo-patternable dielectric and optical materials for MCM-packaging," Proceedings of the 1998 48th Electronic Components & Technology Conference, Jan. 1998.
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40. Jiang, W.; Claisse, P.; Gaw, C.; Kiely, P.; Lawrence, B.; **Lebby, M**.; Roll, M., "Vertical cavity surface emitting laser packaging with auto power control," 1997 Proceedings. 47th Electronic Components and Technology Conference, pp. 368-70, May 1997.
41. Gaw, C.A.; Jiang, W.; **Lebby, M**.; Kiely, P.A.; Claisse, P.R., "Characteristics of VCSELs and VCSEL arrays for optical data links," Proceedings of the SPIE - The International Society for Optical Engineering, vol. 3004, pp. 122-33, Feb. 1997.
42. Raskin, G.; **Lebby, M.S**.; Carney, F.; Kazakia, M.; Schwartz, D.B.; Gaw, C.A., "Parallel interconnect for a novel system approach to short distance high information transfer data links," Proceedings of the SPIE - The International Society for Optical Engineering, vol. 3038, pp. 165-74, Feb. 1997.
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45. Schwartz, D.B.; Chun, C.K.Y.; Foley, B.M.; Hartman, D.H.; **Lebby, M**.; Lee, H.C.; Chan Long Shieh; Kuo, S.M.; Shook, S.G.; Webb, B., "A low-cost high-performance optical interconnect," (1996), http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?arnumber=533892.
46. **Lebby, M**.; Gaw, C.A.; Jiang, W.; Kiely, P.A.; Claisse, P.R.; Grula, J., "Key challenges and results of VCSELs in data links," Conference Proceedings. LEOS '96 9th Annual Meeting. IEEE Lasers and Electro-Optics Society 1996 Annual Meeting, pp. 167-8, vol. 2, Nov. 1996.
47. Schwartz, D.B.; Carney, F.; Chun, C.K.Y.; Claisse, P.; Foley, B.M.; Gaw, C.; Hartman, D.H.; Kiely, P.; Knapp, J.; Wenbin Jiang; Shun Meen Kuo; **Lebby, M**.; Planer, S.; Norton, L.J.; Raskin, G.; Sauvageau, J.; Chan Long Shieh; Shook, S.G.; Tapp, S., "Low-cost high-performance optical interconnect," CLEO '96. Summaries of Papers Presented

Professor (Dr. Dr.) Michael S. Lebby, B. Eng. (Hons), MBA, Ph.D., D. Eng, Fellow NAI, IEEE, Optica (OSA); C. Eng.
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48. **Lebby, M**.; Gaw, C.A.; Jiang, W.; Kiely, P.A.; Chan Long Shieh; Claisse, P.R.; Ramdani, J.; Hartman, D.H.; Schwartz, D.B.; Grula, J., "Characteristics of VCSEL arrays for parallel optical interconnects," 1996 Proceedings. 46th Electronic Components and Technology Conference, pp. 279-91, May 1996.
49. **Lebby, M**., "Characteristics of VCSEL Parallel Optical Interconnecters,", IEEE, May 1996.
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51. **Lebby, M**.; Gaw, C.A.; Jiang, W.; Kiely, P.A.; Shieh, C.L.; Claisse, P.R.; Ramdani, J.; Hartman, D.H.; Schwartz, D.B.; Chun, C.K.Y.; Foley, B.M., "Parallel optical interconnects using VCSELs," Proceedings. IEEE/Cornell Conference on Advanced Concepts in High Speed Semiconductor Devices and Circuits, pp. 348-56, Aug. 1995.
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56. Taylor, G.W.; Kiely, P.A.; Izabelle, A.; Crawford, D.L.; **Lebby, M.S**.; Chang, T.-Y.; Tell, B.; Goebeler, K.B.; Simmons, J.G., "An n-channel BICFET in the GaAs/AlGaAs material system," IEEE Electron Device Letters, vol. 10, no. 2, pp. 88-90, Feb. 1989.
57. G. W. Taylor, **M. S. Lebby**, T. Y. Chang, R. P. Gnall, N. Sauer, B. Tell, and J. G. Simmons, " Very High Transconductance HFET", *IEEE International Electron Devices Conference and Proceedings*, LA, Dec 1988.
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BICFETs versus HBTs," Proceedings of the 1988 Bipolar Circuits and Technology Meeting, pp. 41-5, Sept. 1988.

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61. **Lebby, M.S**.; Taylor, G.W.; Izabelle, A.; Tell, B.; Brown-Goebeler, K.; Chang, T.-Y.; Simmons, J.G., "A p-channel BICFET in the InGaAs/InAlAs material system," IEEE Electron Device Letters, vol. 9 , no. 6 , pp. 278-80, June 1988.
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63. Taylor, Geoffrey; **Lebby, M S**; Izabelle, A; Tell, B; Brown-Goebeler, K., "Demonstration of a p-channel GaAs/AlGaAs BICFET (Bipolar Inversion- Channel)," IEEE Electron Device Letters, vol. 9, pp. 84-86, Feb. 1988.
64. **Lebby, Michael Stephen**, "Fabrication And Characterisation Of The Heterojunction Field Effect Transistor (Hfet) And The Bipolar Inversion Channel Field Effect Transistor (Bicfet): Characterisation Of Hfets And Bicfets, Fabricated From Gallium-Arsenide/Aluminum-Gallium - Arsenide With Magnetron Ion Etching, Sputtered Tungsten Gates, Ion Implanted Source/Drain Contacts And Rapid Thermal Anneals," University Of Bradford, UK, 1987.
65. Taylor, G.W.; **Lebby, M.S**.; Chang, T.Y.; Gnall, R.N.; Sauer, N.; Tell, B.; Simmons, J.G., "GaAs/AlGaAs inversion channel devices for an integrated opto-electronic technology," Electronics Letters, vol. 23, no. 2, pp. 77-9, Jan. 1987.
66. Taylor, G.W.; **Lebby, M.S**.; Chang, T.Y.; Gnall, R.N.; Sauer, N.; Tell, B.; Tennant, D.M.; Simmons, J.G., "A new heterostructure FET," International Electron Devices Meeting 1986. Technical Digest, pp. 817-21, Dec. 1986.

PUBLIC MEDIA (Books, Chapters, Reports, Abstracts, Videos, Lectures, Speeches, Reviews, Courses, Talks, Invited Talks, Keynote Talks, Plenary Talks, Webinars, Interviews, Articles, etc.)

1986

1) Paper: A new heterostructure FET
    a. Dec 1986
    b. "Electron Devices Meeting, 1986 International Volume: 32 Digital Object Identifier: 10.1109/IEDM.1986.191323 Publication Year: 1986, Page(s): 817-821"

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1987

2) Thesis: Fabrication and characterization of the heterojunction field effect transistor and the bipolar inversion channel field effect transistor
    a. 1987
    b. Characterization of HFETs and BICFETs fabricated from GaAs/AlGaAs with magnetron ion etching, sputtered tungsten gates, ion implanted source/drain contacts and rapid thermal anneals.
    c. University of Bradford, UK 1987
    d. http://www.edt.brad.ac.uk/home/
3) http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=1486581Paper: Very high-transconductance heterojunction field-effect transistor (HFET)
    a. Jan 1987
    b. "A new form of FET has been demonstrated in the GaAs/AlGaAs material system. Designated the HFET, it has shown a transconductance of 500mS/mm at 300 K for a nominal Lg = 2/un and a drain current of 430mA/mm. The conduction occurs in an inversion channel at the heterointerface"
    c. "Electronics Letters Volume: 23, Issue: 2 Digital Object Identifier: 10.1049/el:19870056 Publication Year: 1987 , Page(s): 77 - 79"
    d. http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=4257306
4) Talk and abstract: Magnetron Ion Etching of self aligned HFETs
    a. May 1987
    b. Electrochemical Society (ECS) Conference proceedings SOTAPOCS VI, Compound Semiconductors, Philadelphia
    c. http://www.electrochem.org/meetings/biannual/past_meetings_list.htm

1988

5) Paper: Demonstration of a p-channel GaAs/AlGaAs BICFET
    a. Feb 1988
    b. "Electron Device Letters, IEEE Volume: 9, Issue: 2 Digital Object Identifier: 10.1109/55.2048 Publication Year: 1988 , Page(s): 84 - 86"
    c. http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=2048
6) Paper: GaAs/AlGaAs inversion channel devices for an integrated opto-electronic technology
    a. Jun 1988

Professor (Dr. Dr.) Michael S. Lebby, B. Eng. (Hons), MBA, Ph.D., D. Eng, Fellow NAI, IEEE, Optica (OSA); C. Eng.
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   b. "Electron Devices, IEEE Transactions on Volume: 35, Issue: 12 Digital Object Identifier: 10.1109/16.8871 Publication Year: 1988"
   c. http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8871
7) Paper: A p-channel BICFET in the InGaAs/InAlAs material system
   a. Jun 1988
   b. "Electron Device Letters, IEEE Volume: 9, Issue: 6 Digital Object Identifier: 10.1109/55.716 Publication Year: 1988 , Page(s): 278 - 280"
   c. http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=716&tag=1
8) Paper: An inversion channel technology for opto-electronic integration
   a. Sep 1988
   b. "Optical Communication, 1988. (ECOC 88). Fourteenth European Conference on (Conf. Publ. No.292), Publication Year: 1988, Page(s): 211 - 214 vol.1"
9) http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=93560 Paper: Performance and advantages of BICFETs versus HBTs
   a. Sep 1988
   b. "Bipolar Circuits and Technology Meeting, 1988., Proceedings of the 1988 Digital Object Identifier: 10.1109/BIPOL.1988.51041 Publication Year: 1988 , Page(s): 41- 45"
   c. http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=51041
10) Talk and abstract: RIE and MIE comparison for optoelectronic integrated circuit processing
   a. Nov 1988
   b. IEEE LEOS Conference, Santa Clara, California
11) Paper: Reactive ion etching (RIE) and magnetron ion etching (MIE) combinations for opto-electronic integrated circuit (OEIC) processing
   a. Nov 1988
   b. Proc. SPIE Vol. 1037, p. 88, Monitoring and Control of Plasma-Enhanced Processing of Semiconductors, James E. Griffiths; Ed.
   c. http://spie.org/x648.html?product_id=951018

1989

1) Paper: An n-channel BICFET in the InGaAs/InAlGaAs/InAlAs material system
   a. 1989
   b. "Electron Device Letters, IEEE Volume: 10 , Issue: 7 Digital Object Identifier: 10.1109/55.29660 Publication Year: 1989 , Page(s): 304 - 306"
   c. http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=29660&tag=1
2) Paper: An n-channel BICFET in the GaAs/AlGaAs material system
   a. Feb 1989

Professor (Dr. Dr.) Michael S. Lebby, B. Eng. (Hons), MBA, Ph.D., D. Eng, Fellow NAI, IEEE, Optica (OSA); C. Eng.
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   b. "Electron Device Letters, IEEE Volume: 10, Issue: 2 Digital Object Identifier: 10.1109/55.32438 Publication Year: 1989 , Page(s): 88 - 90"
   c. http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=32438&tag=1
3) Paper: An Inversion Channel Technology For Opto-Electronic Integration
   a. 8th Feb 1989
   b. A new approach to optoelectronic integration is reported which combines electronic and optical devices fabricated with a common sequence and a single MBE wafer growth. The devices have in common, an inversion layer structure produced by charge sheet doping.
   c. Proceedings Vol. 0994 Optoelectronic Materials, Devices, Packaging, and Interconnects II, Glen M. McWright; Henry J. Wojtunik, Editors, pp.251-510 Date: 9 February 1989 ISBN: 9780819400291
   d. http://spie.org/x648.html?product_id=960136

1991

4) Invited talk and abstract: Use of VCSELs for the MONSOON parallel digital computer
   a. Jan 1991
   b. International workshop on architectures for free-space digital computing, Colorado.
5) Invited Paper and Presentation: Approaching the problem of high-density interconnects in the 'Monsoon' data-flow parallel processor with optics"
   a. 28th Jan1991
   b. AFOSR, ONR, DARPA: A compendium of position papers from the workshop on architectures for free space digital optical computing
   c. http://www.researchgate.net/publication/235184814_A_Compendium_of_Position_Papers_from_the_Workshop_on_Architectures_for_Free_Space_Digital_Optical_Computing_Held_in_Vail_Colorado_on_28-30_January_1991

1993

6) Invited talk and abstract: Optoelectronic Devices and Applications
   a. 1993
   b. IEEE workshop on optical interconnects
7) Invited talk and abstract: VCSEL Technology and Progress

Professor (Dr. Dr.) Michael S. Lebby, B. Eng. (Hons), MBA, Ph.D., D. Eng, Fellow NAI, IEEE, Optica (OSA); C. Eng.
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a. 1993
b. IEEE Waves and Devices, Phoenix Section, Tempe, Arizona, Arizona State University

1994

8) Invited talk and abstract: Ridge waveguide VCSELs: improvement over planar VCSELs
    a. May 1994
    b. USA Laser workshop, CLEO, Baltimore, MD
9) Invited talk and abstract: Packaging VCSELs with GUIDECAST(tm) an overmolded waveguide packaging platform
    a. Aug 1994
    b. IEEE Tropical workshop on optoelectronic packaging, Breckenridge, Colorado.

1995

10) Paper: Parallel optical interconnects using VCSELs
    a. 1995
    b. "High Speed Semiconductor Devices and Circuits, 1995. Proceedings., IEEE/Cornell Conference on Advanced Concepts in Digital Object Identifier: 10.1109/CORNEL.1995.482526 Publication Year: 1995 , Page(s): 348 - 356"
    c. http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=482526
11) Book: Research in VCSEL devices - Annual technical review1995
    a. 1995
    b. Annual collection of optoelectronic device and reliability department papers at the photonics technology center, Motorola, Tempe, USA.
    c. Key focus was the commercialization of VCSEL technology, especially at 850nm for the Optobus™ parallel array product and other associated VCSEL prototypes.
    d. Motorola
12) Invited talk and abstract: Ridge waveguide VCSEL device performance
    a. May 1995
    b. USA Laser workshop, CLEO, Anaheim, California
13) Invited talk and abstract: VCSEL Arrays and GUIDECAST(tm) packaging technology as used in OPTOBUS(tm)
    a. Sep 1995

Professor (Dr. Dr.) Michael S. Lebby, B. Eng. (Hons), MBA, Ph.D., D. Eng, Fellow NAI, IEEE, Optica (OSA); C. Eng.
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b. European Laser Workshop, Eindhoven, Netherlands

1996

14) Book: Research in optoelectronic devices volume II
    a. 1996
    b. Annual collection of optoelectronic device and reliability department papers at the photonics technology center, Motorola, Tempe, USA. Key focus was the commercialization of VCSEL technology, especially at 850nm for the optobus parallel array product and other associated VCSEL prototypes. Demonstration of 660nm VCSELs discussed.
    c. Motorola
15) Paper: Low-cost high-performance optical interconnect
    a. 1996
    b. Proceedings, Conference on Lasers and Electro-Optics, (CLEO), vol 9, 1996
    c. http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=864750
16) Paper: Key challenges and results of VCSELs in data links
    a. 1996
    b. "Lasers and Electro-Optics Society Annual Meeting, 1996. LEOS 96., IEEE Volume: 2 Digital Object Identifier: 10.1109/LEOS.1996.571604 Publication Year: 1996 , Page(s): 167 - 168 vol.2"
    c. http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=571604
17) Paper: A low-cost high-performance optical interconnect
    a. 1996
    b. "Components, Packaging, and Manufacturing Technology, Part B: Advanced Packaging, IEEE Transactions on Volume: 19 , Issue: 3 Digital Object Identifier: 10.1109/96.533892 Publication Year: 1996 , Page(s): 532- 539"
    c. http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=533892
18) Paper: Characteristics of VCSEL arrays for parallel optical interconnects
    a. 1996
    b. "Electronic Components and Technology Conference, 1996. Proceedings., 46th Digital Object Identifier: 10.1109/ECTC.1996.517404 Publication Year: 1996 , Page(s): 279 - 291"
    c. http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=517404
19) Paper: Use of VCSEL arrays for parallel optical interconnects
    a. 10th Apr 1996
    b. Proc. SPIE 2683, Fabrication, Testing, and Reliability of Semiconductor Lasers, 81 (April 10, 1996); doi:10.1117/12.237679
    c. http://proceedings.spiedigitallibrary.org/proceeding.aspx?articleid=1015866

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1 Hawthorne St., unit 25a, San Francisco, CA 94105, USA; mobile +1 717 839 7078; drmlebby@gmail.com

20) Paper: A low-cost high-performance optical interconnect
    a. Aug 1996
    b. The Optobus™ link is a ten channel parallel bidirectional data link based on multimode fiber ribbons. The guiding principal of the Optobus™ design was to produce an optical interconnect capable of competing with copper on price, not just performance. Recognizing that packaging dominates the cost of optical interconnects, the design focused on minimizing the complexity of the optical subassembly. A key component of this strategy is the use of AlGaAs/GaAs vertical cavity surface emitting lasers (VCSELs). Another is designing the silicon receiver and transmitter arrays around the module level packaging parasitics. The resulting parallel transceiver modules achieve a minimum throughput of 1.5 Gb/s in each direction with a power dissipation of 1.6 W
    c. Components, Packaging, and Manufacturing Technology, Part B: Advanced Packaging, IEEE Transactions on Volume: 19 , Issue: 3 Page(s): 532- 539
    d. http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=533892
21) Invited talk and abstract: Ridge Waveguide and Planar VCSEL Device Reliability
    a. Sep 1996
    b. European Laser Workshop, Olso, Norway
22) Invited talk and abstract: Vertical cavity surface emitting lasers for communication applications
    a. Oct 1996
    b. Optical Society of America (OSA) Annual meetings, proceedings, paper WR1, Rochester, NY
23) Paper: Characteristics of VCSELs and VCSEL arrays for Optical Data Links
    a. 10th Dec 1996
    b. Motorola: Technical Enrichment Matrix Conference, Motorola SPS- SABA, Hilton Pavilion, Mesa, Az

1997

24) Paper: Effect of proton implantation on the degradation of GaAs/AlGaAs vertical cavity surface emitting lasers
    a. 1997
    b. Electronics Letters, ISSN 0013-5194, 1997, Volume 33, Issue 2, p. 137
    c. http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=579434
25) Paper (invited): Laser safety issues with VCSEL arrays in OPTOBUS(tm)
    a. 1997
    b. Optical Society of America (OSA); Annual Meeting, Micro-optics session

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26) Paper: Relative intensity noise of 780nm vertical cavity surface emitting lasers Jan 1997
    a. Proceedings of the 1997 Pacific Rim Conference on Lasers and Electro-Optics, CLEO/Pacific Rim, No 46984, Jan 1997
    b. http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=610586
27) Paper: Characteristics of VCSELs and VCSEL arrays for optical data links
    a. Feb 1997
    b. Proc. SPIE 3004, Fabrication, Testing, and Reliability of Semiconductor Lasers II, 122 (May 1, 1997); doi:10.1117/12.273825
    c. http://proceedings.spiedigitallibrary.org/proceeding.aspx?articleid=918720
28) Paper: Parallel interconnect for a novel system approach to short distance high information transfer data links
    a. April 1997
    b. Proceedings of SPIE, ISSN 0277-786X, 04/1997, Volume 3038, Issue 1
    c. http://www.deepdyve.com/lp/spie/parallel-interconnect-for-a-novel-system-approach-to-short-distance-RFreDaEJjb
29) Paper: Vertical cavity surface emitting laser packaging with auto power control
    a. May 1997
    b. Proceedings, 47th Electronic Components and Technology Conference, pp. 368-370, May 1007
    c. http://www.researchgate.net/publication/3700010_Vertical_cavity_surface_emitting_laser_packaging_with_auto_powercontrol
30) Course (peer reviewed): "Optoelectronic devices and packaging"
    a. May 1997
    b. IEEE ECTC
    c. http://www.ectc.net
31) Paper: Vertical cavity surface emitting laser packaging with auto power control
    a. 18th May 1997
    b. Electronic Components and Technology Conference, 1997. Proceedings., 47th
    c. http://ieeexplore.ieee.org/xpl/articleDetails.jsp?tp=&arnumber=606195&contentType=Conference+Publications&sortType%3Dasc_p_Sequence%26filter%3DAND(p_IS_Number%3A13278)
32) Invited Talk and Abstract: VCSEL/detector technology for parallel optical interconnects
    a. 17th Jun 1997
    b. International Workshop for new technologies, interconnects, and communications in distributed and parallel systems by IRIT, ONERA, CERT, CNRS, and LAAS (France)
33) Invited talk and abstract: Vertical cavity surface emitting lasers and applications
    a. Sep 1997
    b. European Laser Workshop, Glasgow, Scotland

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1998

34) Course and Tutorial: Optoelectronic Devices and Packaging: VCSEL Technology
    a. Jan 1998
    b. "Optoelectronic devices and packaging have found increasing use in many new products over the last 20 Yrs. This tutorial primarily will focus on semiconductor laser based technology with particular emphasis on emerging new technologies such as the Vertical Cavity Surface Emitting Laser (VCSEL) and how to take advantage of itâ€™s uniqueness in packaging. The tutorial will look at the driving factors required for low cost high volume VCSEL based packages and what impact they will have in tomorrows products. As there are many packaging solutions for VCSEL based technology proposed, the course will show the relative merits of popular new technologies with respect to high volume and low cost manufacturing.
    c. 4th IEEE Workshop on AST Phoenix Research Center
    d. http://www.ewh.ieee.org/soc/cpmt/ast98/lebby-01.ppt
35) Paper: ORMOCERs - new photo-patternable dielectric and optical materials for MCM-packaging
    a. Jan 1998
    b. Hybrid inorganic-organic polymers (ORMOCERs*) have been developed and tested in an ongoing EU-program (BE 7250 DONDOMCM) for evaluation in MCM applications. The photopattemable materials with negative resist behavior are composed o f inorganic oxidic structures cross-linked or substituted by organic groups. They are prepared from organosilane precursors by sol-gel-processing in combination with organic crosslinking of polymerizable organic functions. As a result of these functionalities the properties of the ORMOCERs can be adjusted to particular applications. Systematic variation of composition combined with adaptation to micro system technology allows great flexibility in processing. Some features of these materials are: Postbaking at moderate temperatures (120 "C - 180 "C) enables processing on substrates such as FR-4 and BT. Combined use as dielectric and passivation layers in electrical systems and devices as well as core and cladding for optical applications enables e/o applications with high integration levels. Easily adaptable to thin film technology: spin-on with planarization >90% and via diameters down to 20 pm have been achieved
    c. Proceedings of the 1998 48th Electronic Components and Technology Conference
    d. http://ieeexplore.ieee.org/xpl/articleDetails.jsp?reload=true&arnumber=678838&contentType=Conference+Publications
36) Paper and Invited talk: VCSEL Devices and Packaging for Fiber Optic Transceivers
    a. 30th Mar 1998
    b. OSA Technical Digest: Integrated Photonics Research (IPR) 1998 paper: IWD1

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c. http://www.opticsinfobase.org/abstract.cfm?URI=IPR-1998-IWD1

37) Paper: Automatic power control of a VCSEL using an angled lid TO56 package
   a. May1998
   b. 1998 Proceedings. 48th Electronic Components and Technology Conference
   c. http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=678694&url=http%3A%2F%2Fieeexplore.ieee.org%2Fiel4%2F5582%2F14953%2F00678694.pdf%3Farnumber%3D678694
38) Paper: O/e-MCM packaging with new, patternable dielectric and optical materials
   a. May 1998
   b. Electronic Components & Technology Conference, 1998. 48th IEEE
   c. http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=678929&url=http%3A%2F%2Fieeexplore.ieee.org%2Fiel4%2F5582%2F14953%2F00678929.pdf%3Farnumber%3D678929
39) Paper: ORMOCERs(TM)-new photo-patternable dielectric and optical materials for MCM-packaging
   a. May 1998
   b. Hybrid inorganic-organic polymers (ORMOCERs*) have been developed and tested in an ongoing EU-program (BE 7250 DONDOMCM) for evaluation in MCM applications. The photo-pattemable materials with negative resist behavior are composed of inorganic oxidic structures cross-linked or substituted by organic groups. They are prepared from organosilane precursors by sol-gel-processing in combination with organic crosslinking of polymerizable organic functions. As a result of these functionalities the properties of the ORMOCERs can be adjusted to particular applications. Systematic variation of composition combined with adaptation to micro system technology allows great flexibility in processing. Some features of these materials are: Post baking at moderate temperatures (120 "C - 180 "C) enables processing on substrates such as FR-4 and BT. Combined use as dielectric and passivation layers in electrical systems and devices as well as core and cladding for optical applications enables e/o applications with high integration levels. Easily adaptable to thin film technology: spin-on with planarization >90% and via diameters down to 20 pm have been achieved
   c. 1998 Proceeedings. 48th Electronic Components and Technology Conference
   d. http://ieeexplore.ieee.org/xpl/articleDetails.jsp?reload=true&arnumber=678838&contentType=Conference+Publications
40) Course (peer reviewed): "Optoelectronic devices and packaging: VCSEL technology"
   a. May 1998
   b. IEEE ECTC
   c. http://www.ectc.net
41) Co-Chairman Optoelectronics session, 48th ECTC Conference
   a. 25th May 1998
   b. Co-chairman Optoelectronics session, 48th ECTC Conference Seattle, Washington

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c. ECTC, IEEE-CPMT, EIA/ECA
d. http://www.ectc.net

42) Invited Presentation and Abstract: VCSEL Technology - VCSEL technology is discussed with the work between AMP and MODE (division of EMCORE) fiber optics.
   a. Sep 1998
   b. ECOC European Laser Workshop (in association with ECOC 1998, Madrid, Spain
   c. https://openlibrary.org/books/OL22322573M/ECOC_'98_24th_European_Conference_on_Optical_Communication
   d.
43) Paper: Optical bistability in vertical cavity surface emitting lasers with a simple intra-cavity epitaxial absorber layer
   a. 4th Oct 1998
   b. Conference Digest: Semiconductor Laser Conference, 1998. ISLC 1998 NARA. 1998 IEEE 16th International
44) Talk: Optical bistability in vertical cavity surface emitting lasers with a simple intra-cavity epitaxial absorber layer
   a. 4th Oct 1998
   b. Conference Digest: Semiconductor Laser Conference, 1998. ISLC 1998 NARA. 1998 IEEE 16th International
   c.
45) Paper: Vertical cavity surface emitting laser-based parallel optical data link
   a. Dec 1998
   b. Optical Engineering, vol 37, no. 12, pp.3113-18, Dec. 1998.
   c. http://spie.org/x648.html?product_id=318648
46) Paper: VCSEL devices and packaging
   a. Dec 1998
   b. Proceedings of SPIE, ISSN 0277-786X, 05/2003, Volume 3289, Issue 1
   c. http://proceedings.spiedigitallibrary.org/proceeding.aspx?articleid=935769

1999

47) Paper and Interviewed Article: Commercial VCSEL Manufacturing
   a. Apr 1999
   b. Compound Semiconductor
48) Course (peer reviewed): "Optoelectronic devices and packaging: VCSEL and edge emitter technology"
   a. May 1999
   b. IEEE Electronics and components technology conference; San Diego, California

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c. http://www.ectc.net

2000

49) Invited Panel Session: Opto Electronic Integrated Circuits - More IC than OE?
    a. 5th Mar 2000
    b. "The panel session focused on optical integration for communications. Other panel members included Brendan Hyland CEO of Kymata amongst others.
    c. OSA Executive Forum: Photonics and Telecommunications: the tidal wave of the new millennium
    d. http://www.laserfocusworld.com/articles/2000/02/osa-executive-forum-at-ofc-2000.html
50) Course: Optoelectronics Components and Modules for Datacom and Telecom
    a. May 2000
    b. Optoelectronics components and modules for the Telecommunication industry and Datacom Networks are rapidly advancing in terms of speed, lower cost and design. The main objectives of this course are to review the current and future trends for active devices and packaging technology for discrete components and data network modules. The course will cover in detail the fundamental active III-V devices and components used today and review current trends in both III-V device technology and packaging for telecom and datacom applications.
    c. Proceedings 50th Electronics Components and Technology Conference May 2000
    d. http://www.thierry-lequeu.fr/data/Ectc/ECTC2000/ECTC2000.pdf
51) Invited Presentation and Abstract: An investor's perspective on optical interconnects
    a. 24th May 2000
    b. The talk discusses the investor's perspective on optical interconnects from Intel Capital.
    c. IEEE: Workshop on interconnections within high=speed digital systesm
    d. http://www.oi-ieee.org/
52) Invited Presentation: Optoelectronic Integration for Metro DWDM: Intel's perspective...
    a. 3rd Sep 2000
    b. As part of the ECOC conference in Munich Germany, this workshop invited 9 speakers to discuss the future of optical networking in metropolitan environments.
    c. Electronicast Europe
    d. http://www.electronicastconsultants.com
53) Keynote Presentation: Optoelectronics Integration for Metro DWDM, Intel's Perspective
    a. 9th Oct 2000
    b. Electronicast Corporations: Optical communications start-up and emerging companies conference

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c. http://www.electronicastconsultants.com

54) Panel Session: Semiconductors to Optics
   a. 6th Nov 2000
   b. Representing Intel at the conference, the panel explored the reasons why Intel was investing into photonics, optics, and fiber optic communications. Panel moderator was Drew Lanza, VC Morgenthaler.
   c. JP Morgan communications components conference: the convergence of optical components and communications ICs
   d. http://www.thefreelibrary.com/Endwave+Founder+and+EVP+To+Speak+at+JP+Morgan+Communications...-a067529552

2001

55) Paper: Optical components and their role in optical networks
   a. 2001
   b. Electronic Components and Technology Conference, 2001. Proceedings., 51st
   c. http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=927765&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D927765
56) Invited Presentation: "Starting a company and hitting the ground running"
   a. 7th Feb 2001
   b. Storm Ventures limited partner meeting
   c. http://www.stormventures.com
57) Keynote Talk: Industry 'Optomism'
   a. 30th Apr 2001
   b. Electronicast; Fiber Optics for the next decade conference; 13th Annual Monterey conference http://www.electronicastconsultants.com
58) Keynote Talk: Next decade in fiber optic communications
   a. 1st May 2001
   b. Electronicast: 13th Annual Fiber Optics for the Next Decade Conference
   c. http://www.photonics.com/Article.aspx?AID=8916
59) Panel session: Next decade in fiber optic communications
   a. 2nd May 2001
   b. Electroicast: 13th Annual Fiber Optics for the Next Decade Conference
   c. http://www.photonics.com/Article.aspx?AID=8916
60) Paper: OEICs: commercialization at last
   a. Jul 2001
   b. Compound Semiconductor, vol. 7. no. 6, pp. 81-2, 85, July 2001
   c. http://www.compoundsemiconductor.net/csc/features-details.php?cat=features&id=11719

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2002

61) Book chapter: "Optical sources: Light-emitting diodes and laser technology"
    a. Published 2002
    b. "The Handbook includes chapters on all the major industry standards, quick reference tables, helpful appendices, plus a new glossary and list of acronyms. This practical handbook can stand alone or as a companion volume to DeCusatis: Fiber Optic Data Communication: Technological Advances and Trends (February 2002, ISBN: 0-12-207892-6), which was developed in tandem with this book.
    c. Academic Press (1998, 2002); ISBN: 0-12-207892-6; Handbook of Fiber Optic Data Communication By Casimer DeCusatis
    d. http://books.google.com/books?id=Rlb61Kknl8IC&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false
62) Book chapter: "Semiconductor laser and light emitting diode fabrication"
    a. Published 2002
    b. "The Handbook includes chapters on all the major industry standards, quick reference tables, helpful appendices, plus a new glossary and list of acronyms. This practical handbook can stand alone or as a companion volume to DeCusatis: Fiber Optic Data Communication: Technological Advances and Trends (February 2002, ISBN: 0-12-207892-6), which was developed in tandem with this book.
    c. Academic Press: Editor DeCusatis: Fiber Optic Data Communication: Technological Advances and Trends (February 2002, ISBN: 0-12-207892-6)
    d. http://books.google.com/books?id=Rlb61Kknl8IC&lpg=PP1&pg=PP1#v=onepage&q&f=false
63) Keynote speech: "Business and Technical Perspectives for Optical Networking
    a. 14th Jul 2002
    b. PhoPack 2002 Stanford University
    c. http://www.accessmylibrary.com/coms2/summary_0286-25792277_ITMhttp://books.google.com/books/about/LEOS_88.html?id=LUS0cQAACAAJ
64) Interview Optcon (Japan), "Ignis Optics: Small is beautiful"
    a. 15th Aug 2002
    b. Overview of Ignis Optics strategy for fiber optic transceivers with innovative optoelectronic devices and packaging (in Japanese).
    c. Optcon volume 8, no 161, pp50-51
    d. http://magissuelist.nichigai.co.jp/detail?id=000000098732
65) Panel Session: An adventure into venture capital - lessons from silicon valley
    a. 12th Sep 2002

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b. Evening forum discussion chaired by Professor Richard Harrison, Chair, with panel members Pitch Johnson (VC), Brendan Hyland (Nutrior Ventures), Jane Karwoski (All-hotels Ltd), and Colin Rutherford (Intelli Partners). Sponsored by Scottish Development International, University of Edinburgh, British Council

66) Invited Paper: Elegant cost-effective optical subsystems for next generation optical networks
   a. 13th Nov 2002
   b. Electronicast: 4th Annual OADM and advanced photonics communication networks conference - market and technology trends, San Mateo, California
   c. http://www.electronicastconsultants.com/

2004

67) Invited Paper (extended abstract) and Presentation: Automated commercial fabrication of wideband tunable lasers using ultra-high resolution e-beam lithography
   a. 27th Oct 2004
   b. IoP/CS-MAX extended abstract at the Compound Semiconductor Manufacturing Expo, Monterey, California, pp92-94 in the technical digest.
   c. http://www.compoundsemiconductor.net

2005

68) Book: Optoelectronic Markets 2005
   a. Jun 2005
   b. Comprehensive market report and forecast of current optoelectronics markets, needs, technologies, and applications. This report forecasts the current state and direction of the optoelectronics industry.
   c. OIDA
   d. http://www.oida.org/home/publications/oida-publication-report-library/
69) Cover story/Interview: Does a foundry model add up for InP optoelectronics
   a. Jul 2005
   b. Interview with Michael Hatcher from Compound Semiconductor magazine. Volume 11, Number 7, August 2005 pp 17-19
   c. Compound Semiconductor: Three-fives and silicon heterostructures
   d. http://www.compoundsemiconductor.net

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70) Short Article: President's Letter to OIDA Membership
    a. Nov 2005
    b. OIDA Newsletter, quarterly from 2005-2009
    c. http://www.wsr-ods.com/files/oidanews_0408.pdf
71) Invited talk: Worldwide Optoelectronic Trends and Economic Opportunities.
    a. 18th Nov 2005
    b. UNCC 4th Annual symposium: UNC Charlotte Center for Optoelectronics and Optical Communications
    c. http://opticscenter.uncc.edu/node/275

2006

72) Workshop: 100 Gb Ethernet: The Next Challenge for Communications Systems
    a. 1st Oct 2006
    b. Workshop chairman and editor of the report: Abstract: The communications market is continuously evolving to provide better and cheaper services. These changes have led to the movement away from the traditional voice-switched networks to more data-centric packet networks. This report seeks to examine the next generation of Ethernet devices as we strain the technology limits at 100 Gb/s? How will datacom and telecom networks differ in their approaches? OIDA http://www.oida.org/home/publications/oida_publication_report_library/100_gb_ethernet_the_next_challenge_for_communi_(1)/
    c.
73) Workshop: The Challenge for Indium Phosphide Photonic Development and the Optical Foundry
    a. 2006
    b. "Workshop chairman and editor of the report.
    c. Abstract: Indium Phosphide, InP, is a semiconductor material with properties that make it particularly suitable for optoelectronic devices. Optical communications requirements drove its initial development. Recently, the applications for InP semiconductor devices have broadened to include high-speed electronics and optical sensors. This report examines the current state of the InP device market and its future direction. Addresses challenges for a pure foundry play and the role for InP devices. Seeks to find the best ways to address the needs for InP device development in the U.S."
    d. OIDA
    e. http://www.oida.org/home/publications/oida_publication_report_library/the_challenge_for_indium_phosphide_photonic_develo/

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74) Workshop: Nitride LED and Laser Technology and Its Impact on the Display, Medical, and Storage Industries
    a. 2006
    b. Workshop chairman and editor of the report:
    c. Abstract: Since the development of p-type material in 1989, research in nitride emitter technology has developed rapidly over the last 15 years. This material system provided a new range of color applications that could be better utilized and with far better reliability than the II-VI material system. This report examines material systems and developments for short wavelength (green-ultraviolet) lasers and LEDs with techniques such as color-mixing and phosphor conversion.
    d. OIDA
    e. http://www.oida.org/home/publications/oida_publication_report_library/nitride_led_and_laser_technology_and_its_impact_on/
    f.
75) Invited Article: A New Model for the Optoelectronic Indium-based Semiconductor Industry
    a. May 2006
    b. OSA: Optics and Photonics News
    c. http://www.osa-opn.org/Content/ViewFile.aspx?id=10456
76) Book: Worldwide Optoelectronics Markets and Trends 2006
    a. Jun 2006
    b. Comprehensive market report and forecast of current optoelectronics markets, needs, technologies, and applications. This report forecasts the current state and direction of the optoelectronics industry.
    c. OIDA, 431 pages
    d. http://www.oida.org/home/publications/oida_publication_report_library/2006_global_optoelectronics_industry_market_report/
77) Workshop: High Power Diode Laser Sources and Their Impact on Industrial, Medical, and Military Laser Industries
    a. 1st Jul 2006
    b. Workshop chairman and editor of the report:
    c. Abstract: High power semiconductor laser diodes are used in several different market segments today. The technology continues to advance and improvements in efficiency and power are reported each year. Semiconductor laser diodes are used either directly or indirectly to enable new applications or as a replacement for older technology approaches. This report examines practical implementations and limitations for lasers in the 100 W to 100 kW range and roadmaps and developments anticipated over the next five years.
    d. OIDA
    e. http://www.oida.org/home/publications/oida_publication_report_library/high_power_diode_laser_sources_and_their_impact_on/
78) Workshop: Biophotonic Sensors and Smart Fiber Optic Sensor Networks
    a. 1st Aug 2006

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b. Workshop chairman and editor of the report:
c. Abstract: This roadmap report examines biophotonic sensor opportunities from many perspectives including; government, industrial, university and venture capital. The markets, technologies, commercialization, and roadmap trends are presented in addition to promising areas for R & D.
d. OIDA
e. http://www.oida.org/home/publications/oida_publication_report_library/biophotonic_sensors_and_smart_fiber_optic_sensor_n/

79) Workshop: Wide Area Surveillance
a. 1st Oct 2006
b. Workshop chairman and editor of the report:
c. Abstract: This report examines wide area surveillance of pipelines and other strategic infrastructure as it is rapidly becoming an important issue on a worldwide basis. The increasing need for surveillance for both homeland security as well as defense applications should make this commercially attractive to both the defense as well as to commercial industry. (Report is 62 pages followed by hard copies of presentations from the forum.)
d. OIDA
e. http://www.oida.org/home/publications/oida_publication_report_library/wide_area_surveillance/

80) Invited Talk: OIDA optoelectronics markets, technology and opportunities for optofluidics
a. 20th Oct 2006
b. Organized by the DARPA center for optofluidics: translational research and commercialization workshop.
c. DARPA Optofluidics industry forum, UCSD San Diego, CA
d. http://www.biophot.caltech.edu/optofluidics/

81) Invited talk: Global optoelectronics technology roadmaps and trends
a. 27th Oct 2006
b. UNCC 5th Annual Symposium: UNC Charlotte Center for Optoelectronics and Optical Communications
c. http://opticscenter.uncc.edu/node/268

82) Workshop: Artificial vision systems
a. 1st Dec 2006
b. Workshop chairman and editor of the report:
c. Abstract: The ability to identify objects of interest and emerging threats around a vehicle in real time or by a warfighter looking for threats in a large field of view is currently severely hampered by the limitations of current algorithms and processing platforms. There have been recent advances in several technology areas, which if combined intelligently could solve this hard problem in enhancing situational awareness cost effectively. This report looks at the issues surrounding automated surveillance systems specifically looking at enhanced binoculars and convoy vehicle automated protection systems.

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d. OIDA
e. http://www.oida.org/home/publications/oida_publication_report_library/artificial_vision_systems/

83) Keynote address: Global perspectives in optoelectronics and photonics
a. 6th Dec 2006
b. Photonics 21: European Union's 7th Framework Program Key Photonics Platform
c. http://www.photonics21.org/downloads/download_presentations.php

2007

84) Workshop: Micropackaging for the Next Generation of Optical and Electrical Components
a. 2007
b. Workshop chairman and editor of the report:
c. Abstract: Optical components are ubiquitous. Applications that use them include DVD players, audio devices, cell phones, re-writable drives, projection displays, and communication devices. This report concentrates on the role of micropackaging for the for next generation fiber optic components with an eye towards lower cost and higher volume.
d. OIDA
e. http://www.oida.org/home/publications/oida_publication_report_library/micropackaging_for_the_next_generation_of_optical/

85) Workshop: Silicon Photonics: Challenges and Future, 2007
a. 2007
b. Workshop chairman and editor of the report:
c. Abstract: Copper interconnects are currently used extensively within the data center environment. Fiber optic technology is used as a connectivity solution when higher performance is required and the cost differential compared to a copper solution is affordable. Fiber optic technology offers several key advantages over copper solutions for data transmission. This report looks at silicon photonics as a potential optical interconnect solution and addresses the issues and technology paths being pursued.
d. OIDA
e. http://www.oida.org/home/publications/oida_publication_report_library/silicon_photonics_challenges_and_future,_2007/

86) Workshop: Photonic Sensors Roadmapping Report, 2007
a. 2007
b. Workshop chairman and editor of the report:

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c. Abstract: This OIDA workshop report examines application specific sensor needs for both the government and the private sector with an emphasis on the oil and gas market, sensing function integration, cost reduction opportunities, and barriers and competing technologies.
d. OIDA
e. http://www.oida.org/home/publications/oida_publication_report_library/photonic_sensors_roadmapping_report,_2007/

87) Paper: Fiber optic sensing technology: emerging markets and trends
a. 2007
b. Third European Workshop on Optical Fibre Sensors.
c. Edited by Cutolo, Antonello; Culshaw, Brian; Lopez-Higuera, Joshua Miguel.
d. Proceedings of the SPIE, Volume 6619, pp. 661902 (2007). (SPIE Homepage)
e. http://adsabs.harvard.edu/abs/2007SPIE.6619E...2H

88) Article: "Optoelectronics Technology: New and Exciting Markets in Consumer and Entertainment"
a. 10th Jan 2007
b. "The total optoelectronics components and enabled products grew 20% in 2005 to $364 billion, from $304 billion in 2004. Components grew 17% in 2005 to $104 billion, from $89 billion in 2004. When flat panel displays are excluded as components, components grew 10% in 2005 to $30 billion, from $27 billion in the previous year. Enabled products grew 21% to $260 billion in 2005, from $215 billion in 2004.
c. IEEE CPMT Santa Clara
d. http://www.cpmt.org/scv/meetings/cpmt0701.html

89) Abstract and conference invited talk: The case for a photonics foundry in USA
a. 27th April 2007
b. European Conference on Integrated Optics (2007): Towards foundries for photonic ICs
c. http://www.epixnet.org/index.php?id=393

90) Paper: Optoelectronics Roadmap OIDA-iNEMI
a. May 2007
b. IEEE Packaging and Assembly

91) Workshop: 100 Gbit Interconnects and Above: The Need for Speed
a. 1st May 2007
b. Workshop chairman and editor of the report:
c. Abstract: The electronic society we live in today is seeing increased demand for data transfer, internet downloads, online applications, video sharing and storage. The electronic world of banks, companies, universities and governments require large secure datacenters connected to secure networks. This continuously drives for the development of more powerful servers and computer systems. This report examines needs and motivations for optical interconnect implementation. Looks at the applications, history, market drivers, and future issues that affect this crossover.

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d. OIDA
e. http://www.oida.org/home/publications/oida_publication_report_library/100_gb_ethernet_the_next_challenge_for_communicati/

92) Book: 2007 Global Optoelectronics Industry Market Report and Forecast
   a. Jun 2007
   b. Comprehensive market report and forecast of current optoelectronics markets, needs, technologies, and applications. This report forecasts the current state and direction of the optoelectronics industry.
   c. OIDA, 517 pages
   d. http://www.oida.org/home/publications/oida_publication_report_library/2007_global_optoelectronics_industry_market_report/

93) Paper: Growing at light speed
   a. The article discusses the significance of optoelectronics in high technology manufacturing industries. Optoelectronics components are being used in the manufacturing cameras of mobile phones, plasma display panel TVs and LCD TVs, among others. Since its application allows product differentiation and innovation, it has spurred growth in segments such as the consumer/entertainment, computer and communications industries. The article also discusses the differences in the material and processing equipment such as silicon photonics.
   b. Sep 2007
   c. IEEE Circuits Assembly; Sep 2007, Vol. 18 Issue 9, p44
   d. http://www.thefreelibrary.com/Growing+at+light+speed%3a+after+a+false+start%2c+OE+is+fast+becoming+a...-a0168812805

94) Keynote/special invited talk: "10 Grand Challenges in Photonics"
   a. 31st Oct 2007
   b. Sixth annual symposium UNCC Optoelectronics Center
   c. http://opticscenter.uncc.edu/node/265

2008

95) Workshop: Perspectives on the Optoelectronics Industry: Manufacturing in the 21st Century, 2008
   a. 2008
   b. Workshop chairman and editor of the report:
   c. Abstract: This report provides insight and perspectives by senior-level representatives from industry on global trade and manufacturing practices in the field of optoelectronics. Three areas examined are: 1) Can automation or optical integration relieve the momentum to outsource and off-shore manufacturing from

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North America? 2) The supply chain and the economics of manufacturing in the U.S., Europe, and Asia, and 30 The implications of offshore manufacturing on both the U.S. defense and commercial market sectors within the different fields of optoelectronics.

d. OIDA
e. http://www.oida.org/home/publications/oida_publication_report_library/perspectives_on_the_optoelectronics_industry_manuf/

96) Workshop: Perspectives on the Optoelectronics Industry: Innovation, 2008
   a. 2008
   b. Workshop chairman and editor of the report: Abstract: This report documents some of the issues raised at the Optoelectronics Industry Development Association (OIDA) forum and provides a review on the critical issue of innovation in the U.S. and the impact it has on future American competitiveness and technology leadership. This report looks at innovation and R&D from many perspectives: global, business. university, government funding agencies.
   c. OIDA
   d. http://www.oida.org/home/publications/oida_publication_report_library/perspectives_on_the_optoelectronics_industry_innov/
97) Workshop: Perspectives on the Optoelectronics Industry, 2008
   a. 2008
   b. Workshop chairman and editor of the report:
   c. Abstract: The United States is falling behind in the manufacturing, packaging, and assembling of optoelectronics products. Innovating technology may also be imperiled. This report is the result of the first of three optoelectronic forums sponsored by the Defense Advanced Research Projects Agency (DARPA), This report details the trends, findings, and directions for optoelectronics in each of these market applications. Included in the first chapter of this report is the global optoelectronics summary that was compiled by OIDA in 2007.
   d. OIDA
   e. http://www.oida.org/home/publications/oida_publication_report_library/perspectives_on_the_optoelectronics_industry,_2008/
98) Workshop: Future Optical Communication Systems, 2008
   a. 2008
   b. Workshop chairman and editor of the report:
   c. Abstract: This report examines future optical communication needs and technologies. Topics include: Networks, Core, Metro, and Access Technology, photonic integration, and markets.
   d. OIDA
   e. http://www.oida.org/home/publications/oida_publication_report_library/future_optical_communication_systems,_2008/
99) Book chapter: Being an Intrapreneur and Entrepreneur in the Optoelectronics Industry
   a. 2008

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b. This book provides actual entrepreneurial stories giving insight into the pitfalls and successes one might find in starting or even continuing with a small high-tech business. Insights into innovative, speculative, and (largely) successful new ventures, as experienced by those who went through the process, are complemented by comments and observations from others in the field including researchers, economists, investors, regional development agencies, technology transfer organizations, and universities. The book is recommended to entrepreneurs in all high technology disciplines and in particular for students and early career professionals. It can be also useful for undergraduate and postgraduate courses in entrepreneurship, which many institutions are currently introducing, and to those who are interested in how a high-tech business might develop.
c. SPIE: Engineering a High-Tech Business: Entrepreneurial Experiences and Insights By JosÃ© Miguel LÃ³pez-Higuera, B. Culshaw (Editors) ISBN 978-0-8194-7180-2
d. http://books.google.com/books?hl=en&lr=&id=wXV9tffoGeYC&oi=fnd&pg=PR9&dq=michael+lebby&ots=cYEwXIHMDC&sig=KlCtj2ZDgbOYEhnqKdHiMo6SdzA#v=onepage&q=michael%20lebby&f=false

2009

100) Workshop: Green Photonics: The Role of Optoelectronics in a Sustainable Future, 2009
   a. 2009
   b. Workshop chairman and editor of the report:
   c. Abstract: This report explores the optoelectronics expectations for green photonics technology, and forecasts the associated markets through 2020. The cultural impact for a green, clean, and energy efficient lifestyle is just beginning. Over the next decade, many innovative new products will emerge in a variety of industries that will better define and demonstrate green photonics technology. It is clear to many that a broad range of products and services that the economy will utilize over the next decade will contain optoelectronics (interchangeable with the term photonics), either as key components or as components that enable better and more efficient systems.
   d. OIDA
   e. http://www.oida.org/home/publications/oida_publication_report_library/green_photonics_the_role_of_optoelectronics_in_a_s/
101) Conference: Optomism: "Powering the green revolution through photonics"
   a. 4th Jan 2009

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b. "Co-chairman of Optomism conference with Pennwell.
c. OIDA and Pennwell (Laser Focus World)
d. http://www.laserfocusworld.com/articles/print/volume-45/issue-4/world-news/conference-preview-optomism-to-emphasize-lsquogreenrsquo-growth.html

102) Invited talk, short abstract, and session chairman: Energy Efficient Photonics
a. 19th Mar 2009
b. Summary: Green photonics initiatives: The role of optoelectronics in a sustainable future...
c. European Commission: High Level Event on ICT for Energy Efficiency
d. http://ec.europa.eu/information_society/events/cf/ee09/item-display.cfm?id=2174

103) Trial & Cross: Testimony before the US-China economic and security review commission on the optoelectronics industry
a. 24th Mar 2009
b. "Expert witness and testimony on Capitol Hill
c. Final oral comments: In preparing this testimony, many people I contacted stressed the importance of decisive action by the U.S. government and industry now. Optoelectronics sits at the intersection of multiple technical disciplines. U.S. universities and industry are particularly adept at bringing diverse people together to work on complex problems. We have, by the nature of our inherent diversity, an advantage. What for many presents a challenge, for us comes naturally. Thank you for this opportunity to present our industry's perspective. "
d. United States China Commission
e. http://www.uscc.gov/hearings/2009hearings/written_testimonies/09_03_24_wrts/09_03_24_lebby_statement.pdf

104) Report: Photonics industry-university collaborations (PICs)
a. 1st Jun 2009
b. OIDA Final Technical Report
c. http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADA502737

105) Paper: Green photonics technology and markets
a. Sep 2009
b. Green photonics technology will open up opportunities over the next decade for new and creative products to be designed as the interest in a green, clean and energy efficient lifestyle continues to grow. This overview forecasts the optoelectronics expectations for green photonics technology and associated markets over the next decade and explores just a few of the exciting opportunities from green photonics technology.
c. Electronics Letters, Vol 45, issue 20
d. http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=5270369&url=http%3A%2F%2Fieeexplore.ieee.org%2Fiel5%2F2220%2F5270368%2F05270369.pdf%3Farnumber%3D5270369

106) Paper: Photonic Intgeration: what is the Holy Grail?
a. 14th Oct 2009

Professor (Dr. Dr.) Michael S. Lebby, B. Eng. (Hons), MBA, Ph.D., D. Eng, Fellow NAI, IEEE, Optica (OSA); C. Eng.
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b. Compound Semiconductor
c. http://compoundsemiconductor.net/csc/features-details.php?id=40435

107) Keynote talk: Global optoelectronics and green photonics trends
a. 28th Oct 2009
b. UNCC 8th Annual Symposium: Optoelectronics Center
c. http://opticscenter.uncc.edu/node/255

108) Keynote talk and abstract: Is this the rise of green photonics?
a. Dec 2009
b. ICFO (Institut de Ciancies Fotoniques) Barcelona, Spain
c. http://www.icfo.es/images/news/ICFO%20CLP%20DAY%20Program.pdf

109) Book: 2009 Global Optoelectronics Industry Market Report and Forecast
a. Dec 2009
b. Comprehensive market report and forecast of current optoelectronics markets, needs, technologies, and applications. This report forecasts the current state and direction of the optoelectronics industry.
c. OIDA, 545 pages
d. http://www.oida.org/home/publications/oida_publication_report_library/2009_global_optoelectronics_industry_market_report/

110) Video presentation: Living at the speed of light
a. 10th Dec 2009
b. Living at the speed of light, hosted by renown physicist Michael Lebby, takes us on a fast paced fly through of the many facets of photonics and how the use of light touches the many aspects of our lives
c. National Research Council: Canadian Photonics Fabrication Centre
d. http://www.youtube.com/watch?v=t8EB-1-1irY

111) Book chapter: Packaging of Optical Components and Systems
a. 27th Dec 2009
b. "In this article, several types of semiconductor optical components are introduced, and packaging of optical components and systems will be discussed. Specifically, three common types of optical sources will be addressed: light emitting diodes (LED), edge-emitting semiconductor lasers, and vertical cavity surface emitting lasers (VCSEL).
c. Wiley Encyclopedia of Electrical and Electronics Engineering; DOI: 10.1002/047134608X.W2106; originally published in 1999, Vol 15, pp 499-516; John G Webster (Editor)
d. http://onlinelibrary.wiley.com/doi/10.1002/047134608X.W2106/abstract

2010

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112) Workshop: Fabrication Challenges and Opportunities in Photonics, 2010
   a. 2010
   b. Workshop chairman and editor of the report: Abstract: This report examines different operational models employed by industry (fabless, fab-lite, pure play foundry and vertically integrated companies), and the role of governments in stimulating the growth of the photonics industry.
   c. OIDA
   d. http://www.oida.org/home/publications/oida_publication_report_library/fabrication_challenges_and_opportunities_in_photon/

113) Video and presentation: Green Photonics: Will it Change our Lives over the Next Decade?
   a. April 2010
   b. Photonics is growing to enable new green technologies and products. Photonics already has a large presence in various modules and components with opportunities to expand to home displays, solar cells, lighting, and various consumer applications. The global optoelectronics industry has a strong outlook for growth in the near future, with even faster growth in green photonics. Green photonics can help reduce greenhouse gas emissions, generate or conserve energy, reduce pollution, and improve human health.
   c. University of California, Santa Barbara: Institute of Energy Efficiency
   d. http://iee.ucsb.edu/node/1024

114) Conference and workshop: 3rd Annual Green Photonics Forum (OIDA Green 2010)
   a. 10th Jun 2010
   b. Conference chairman: OIDA's innovative green photonics forums have become a focal point for photonics and optics in the area of sustainable energy. The annual forum on green photonics, brings together key players involved in developing the technical and business roles of photonics in building a more sustainable and renewable future. Efficiency, monitoring, and energy generation are areas where photonics technology will play a key role and the photonics industry will deliver solutions.
   c. OIDA
   d. http://www.clocate.com/conference/3rd-Annual-Green-Photonics-Forum-OIDA-Green-2010/4045/

115) Paper: Silicon light emitting device based on rare earth oxide superlattice
   a. Sep 2010
   b. 7th IEEE International conference on Group IV photonics, Beijing China
   c. http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=5643407&url=http%3A%2F%2Fieeexplore.ieee.org%2Fiel5%2F5623516%2F5643317%2F05643407.pdf%3Farnumber%3D5643407

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2011

116) Paper: Study of the Structural and Thermal Properties of Single Crystalline Epitaxial Rare-Earth-Metal Oxide Layers Grown on Si(111)
   a. 2011
   b. ECS Transactions 16, 161 (2011)
   c. http://ecst.ecsdl.org/content/41/3/161
117) Webinar and presentation
   a. 29th Mar 2011
   b. "The future of photonics webinar and presentation: The Future of Photonics: Three Perspectives brings together three expert viewpoints on the future of the photonics industry (Michael Lebby will be the expert on market trends and photonic integrated circuits (PICs)). You will learn: global optoelectronics market outlook through 2021 trends in photonic integrated circuits over the next two decades."
   c. Photonics Media
   d. http://www.photonics.com/Webinar.aspx?WebinarID=7
118) Keynote invited speech: Green Photonics and GaN-on-Si for LEDs and Ge-on-Si for high Efficiency Multi-junction for PVs
   a. Dec 2011
   b. Conference proceedings: High Capacity Optical Networks and Enabling Technologies (HONET), 2011
   c. http://honet.uncc.edu/archive/honet11/speakers.htm

2012

119) Paper: Structural and Thermal Properties of Single Crystalline Epitaxial Gd2O3 and Er2O3 Grown on Si(111)
   a. 2012
   b. ECS Journal of Solid State Science and Technology 1, N24 (2012)
   c. http://jss.ecsdl.org/content/1/2/N24.full.pdf+html
120) Paper: Epitaxial Si, SiGe and Ge on binary and ternary rare earth oxide buffers
   a. 2012
   b. Phys. Status Solidi C 9, 2031 (2012)
   c. http://onlinelibrary.wiley.com/doi/10.1002/pssc.201200255/abstract
121) Paper: Integrated high reflectivity silicon substrates for GaN LEDs
   a. 13th Jan 2012

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b. Volume 9, Issue 3-4, pages 814-817, March 2012, physica status solidi (c)
c. http://onlinelibrary.wiley.com/doi/10.1002/pssc.201100393/abstract

122) Paper: Integrated high reflectivity silicon substrates for GaN LEDs
a. 13th Jan 2012
b. "Conference Publication: ICNS-9 "Contributed Article Integrated high reflectivity silicon substrates for GaN LEDs
c. F. Erdem Arkun*,Rytis Dargis, Robin Smith, David Williams, Andrew Clark, Michael Lebby
d. Article first published online: 13 JAN 2012" ICNS-9 "Contributed Article Integrated high reflectivity silicon substrates for GaN LEDs
e. http://onlinelibrary.wiley.com/doi/10.1002/pssc.201100393/abstract

123) Paper: Rare-earth-metal oxide buffer for epitaxial growth of single crystal GeSi and Ge on Si(111)
a. 1st Mar 2012
b. Conference and journal publication."Rare-earth-metal oxide buffer for epitaxial growth of single crystal GeSi and Ge on Si(111)"
c. With publication details: 28th North American Molecular Beam Epitaxy Conference, Published by AVS through the American Institute of Physics, 2012 ISBN 978-0-9836933-0-7 ISSN: 2166-27646 J.Vac.Sci.Technol B 30(2), Mar/Apr 2012 pp02B110-1 to pp-3B110-6
d. http://ieeexplore.ieee.org/xpl/articleDetails.jsp?reload=true&arnumber=6118290&contentType=Journals+%26+Magazines

124) Paper: Scalable virtual Ge templates for III-V integration on Si wafers
a. 18th April 2012
b. AIP Conference Proceedings / Volume 1477 / CONCENTRATOR SOLAR CELLS, CELL ASSEMBLIES AND RELATED MATERIALS
c. http://proceedings.aip.org/resource/2/apcpcs/1477/1/36_1?bypassSSO=1

125) Paper and talk: Engineering of the Interface Between Silicon and Rare-Earth Oxide Buffer for GaN growth
a. Sept 2012
b. ECS Meeting Oct 2013, San Francisco, USA
c. http://scholar.googleusercontent.com/scholar?q=cache:l3-oHWxNDzwJ:scholar.google.com/+%22michael+lebby%22&hl=en&as_sdt=1,5&as_ylo=2013&as_vis=1

126) Paper: Scalable GaN-on-Silicon using rare earth oxide buffer layers
a. 9th Oct 2012
b. ECS Trans 2013 volume 50, issue 9, 1065-1071
c. http://ma.ecsdl.org/content/MA2012-02/30/2538.short

2013

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127) Paper: Expitaxial Si and Gd2O3 Heterostructures - Distributed Bragg Reflectors with Stress Management Function for GaN on Si Light Emitting Devices
   a. 2013
   b. ECS Trans 2013 volume 50, issue 4, 47-52
   c. http://ecst.ecsdl.org/content/50/4/47.short
128) Article: OPTICAL MATERIALS: 'On-silicon' engineered substrates speed photonic device development
   a. 1st Apr 2013
   b. Laser Focus World
   c. http://www.laserfocusworld.com/articles/print/volume-49/issue-04/features/optical-materials---on-silicon--engineered-substrates-speed-phot.html
129) Paper & Poster: 100Gb/s Multi-guide vertical integration transmitter PIC in InP for fiber-optics interconnects
   a. 24th Sep 2013
   b. Sasa Ristic and Michael Lebby, Valery Tolstikhin, and Kirill Pimenov,
   c. ECOC 2013
   d. http://www.ecoc2013.org/sc2.html
130) Paper: Epitaxial Si and Gd2O3 Heterostructures - Distributed Bragg Reflectors with Stress Management Function for GaN on Si Light Emitting Devices
   a. 1st Oct 2012
   b. ECS J. Solid State Sci. Technol. 1, 246 (2012)
   c. http://jss.ecsdl.org/content/1/5/P246.full
131) Growth of GaN by MOCVD on rare earth oxide on Si(111)
   a. 31st Oct 2013
   b. ECS Transactions, 58, 455 (2013)
   c. http://ecst.ecsdl.org/content/58/4/455.short
132) Invited talk/plenary: Next generation ICs using photonics integration
   a. 10th Dec 2013
   b. Talk that reviews OneChip Photonics technology and in general PICs, OEICs, Silicon photonics, and how these technologies play into datacenters (data centers) for client side high speed 100G fiber (fibre) optic transceiver interconnects and cabling.
   c. IQE Capital markets day, Sky Pavillion, Rothschild Building, London, UK
   d. http://www.euroinvestor.com/news/2013/12/10/iqe-plc-capital-markets-day/12617916
133) Poster paper: A versatile InP OEIC (PIC) platform enabling 100G+ coherent receiver and client-side transceiver engines
   a. 12th Nov 2013
   b. Poster paper describing OneChip's latest results in coherent receivers, LR4 optical engines, and PSM4 optical engines.
   c. Silicon Photonics Workshop, Southampton University, UK

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d. http://www.orc.soton.ac.uk/UKSP_presents.html

134) Talk and panel session: Approaches for combining 3-5 and silicon, add functionality to Si photonics, heterogeneous versus hybrid integration, introduction of photonic platforms
   a. 5th Dec 2013
   b. Short presentation on PICs, OEICs, Si photonics, and combinations of these technologies from a revenue, investment, application and technology standpoint.
   c. EPIC workshop: Meet or eat? collaboration and/or competition in photonic integrated circuits (PICs)
   d. http://epic-assoc.com/contact-us/?at=94

135) Invited talk: Feedback USA/International related events
   a. 5th Dec 2013
   b. Feedback on the subject of InP PICs, OEICs, and silicon photonics from workshops and related international events from around the globe.
   c. EPIC workshop: Meet or eat? Collaboration and/or competition in Photonic Integrated Circuits (PICs)?
   d. http://epic-assoc.com/contact-us/?at=94

2014

136) Invited talk/plenary: High-Performance Datacenter Platform: Using InP for Silicon Photonics
   a. 8th Jan 2014
   b. IEEE-CPMT/Photonics Society local chapter meeting, Santa Clara, California
   c. http://www.cpmt.org/scv/meetings/cpmt1401.html

137) Invited talk/Panel session “Optical interconnect in datacenters”
   a. 18th Mar 2014
   b. "The 1st Optical Interconnect in Data Centers Symposium takes place on the 18th and 19th of March 2014 in Berlin/ Germany.
   c. It is focused on high-performance, low-energy and low-cost and small-size optical interconnects across the different hierarchy levels in data center and high-performance computing systems: on-board, board-to-board and rack-to-rack.
   d. EPIC: Symposium on optical interconnect in datacenters
   e. http://www.phoxtrot.eu/1st-optical-interconnect-in-data-centers-symposium/

138) Keynote talk: Photonic integration in InP: A regrowth-free platform for fabless manufacturing model
   a. 19th March 2014
   b. CS International Conference Frankfurt, March 17th-20th 2014
   c. http://cs-international.net/agenda.php

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139) Invited talk/Panel session: InP based photonics integration platform for datacenter and coherent communications
   a. 2nd April 2014
   b. Invited talk/panel session on the future of integrated photonics. Discussion was on both InP and silicon photonics technologies over the next decade.
   c. Workshop on the future of Integrated Photonics organized by the Netherlands Office for Science & Technology is pleased to invite you to a workshop, occurring in conjunction with the upcoming Photonics West conference
   d. http://www.hollandinthevalley.com/panel-discussion-on-the-future-of-integrated-photonics/
140) Invited talk and abstract: Coherent Receiver Chip for 100G DP-QPSK
   a. 30th April 2014
   b. SIOE (Semiconductor and integrated optoelectronics) Conference, Cardiff, Wales, UK 29th April-1st May 2014, Institute of Physics
   c. http://www.astro.cardiff.ac.uk/research/cmp/events/resources/Sioeprogramme14final.pdf
141) Invited talk/keynote lecture: Compound semiconductors driving photonics technologies to become the future for high-speed communications through integration, performance, and sustainability
   a. 12th Jun 2014
   b. Glyndwr University, Wales, UK
   c. http://www.glyndwr.ac.uk/en/AboutGlyndwrUniversity/Newsandmediacentre/Newsarchive/PressReleases2014/UniWeek/
142) Invited Talk/Panel session: EPIC technology workshop on Photonic Integrated Circuits (PIC) packaging standardization
   a. 18th Jun 2014
   b. EPIC
   c. http://epic-assoc.com/contact-us/?at=94
143) Invited talk: Compound Semiconductors (CS) driving photonics
   a. 11th June 2014
   b. Invited presentation for Welsh Gvt and commercial industry in epitaxial growth. The talk covered photonics: global markets, green photonics, photonics technology sectors (lighting, solar, displays, sensors, communications), integrated photonics and silicon photonics. Commercial industry invite by International Quantum Epitaxy (IQE)
   c. Growth and application of epitaxial heterostructures with polymorphous rare earth oxides
   d. Journal of Crystal Growth
   e. http://www.sciencedirect.com/science/article/pii/S0022024812009487
144) Invited presentation for Day of Photonics at Glyndwr University: Photonics - markets, applications, integrated, next generation IC
   a. 21st Oct 2014
   b. Invited presentation/lecture on photonics at the Glyndwr University.

Professor (Dr. Dr.) Michael S. Lebby, B. Eng. (Hons), MBA, Ph.D., D. Eng, Fellow NAI, IEEE, Optica (OSA); C. Eng.
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c. Welsh Optoelectronic Forum (WOF)
d. http://www.wof.org.uk/home.php?page_id=4&event_id=317

145) Invited talk and moderator: Integrated photonics pilot lines
a. 14th Nov 2014
b. "Photonics Pilot Line Workshop 14 November 2014 - Brussels, Belgium
c. European Commission and Photonics21
d. http://www.photonics21.org/download/Events/DraftagendaPhotonicsPilotLineworkshop-Website.pdf

2015

146) Invited talk: Integrated photonics roadmap synthesis
a. 7th May 2015
b. Integrated Photonics Institute for Manufacturing Innovation (IP-IMI) site visit technical review:
c. The University of Southern Californiaâ€™s (USC) Information Sciences Institute (ISI) is leading an effort with partner universities at the University of California-Los Angeles (UCLA), the University of California-Berkeley (UCB), the University of California-San Diego (UCSD), Arizona State University, the University of New Mexico, and the Ohio State University, as well as numerous industry partners, to develop the only California-based and led proposal to compete for the IP-IMI award. If successful, the proposal will receive a federal award of up to $110 million over five years. A successful proposal requires 100 percent or more in matching funds (cash or in-kind) from state and local governments and from industry partners.
d. IPI-CDMS (Integrated Photonics Institute and Center for Design and Manufacturing Services)
e. http://www.isi.edu/news/story/531784

147) Invited talk and Chair panel session: EPIC workshop on photonic integrated circuits; "Global integrated photonics update and roadmaps"
a. 9th Jun 2015
b. "Invited talk: Global integrated photonics update and roadmaps
c. Panel Session: Integrated photonics foundry status
d. EPIC trade association, Europe
e. http://www.epic-assoc.com/epic-workshop-on-photonic-integrated-circuits/

148) Keynote talk and invited abstract: "Integrated photonics as a vehicle for the next generation IC"
a. 9th Sep 2015

Professor (Dr. Dr.) Michael S. Lebby, B. Eng. (Hons), MBA, Ph.D., D. Eng, Fellow NAI, IEEE, Optica (OSA); C. Eng.
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b. Internet Technology Applications (ITA) ITA-15 conference Wrexham, Wales, UK 8-11th Sept 2015
c. http://www.ita15.net/keynote-speaker/

149) Press interview: "Building Big Business with the Next Generation Integrated Circuits!"
a. 15th Sep 2015
b. "Insights from Michael Lebby, CEO OneChip Photonics Corporation, the keynote speaker at the Photonics Integration Conference
c. Photonics Integration Conference, organized by Jakajima, Netherlands
d. http://www.phiconference.com/photonics/building-big-business-with-the-next-generation-integrated-circuits/

150) Project advisor: European Commission ICT-28-2015 Cross-Cutting ICT KETs: Innovation Action (b) Pilot line for OLEDs on flexible substrates
a. 20th Sept 2015
b. European Commission
c. http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/916-ict-28-2015.html

151) Project advisor: European Commission ICT-28-2015 Cross-Cutting ICT KETs: Innovation Action (b) Pilot line for analytical mid-infrared (MIR) micro-sensors
a. 22nd Sep 2015
b. European Commission
c. http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/916-ict-28-2015.html

152) Keynote talk and abstract: "PIC the next generation IC..."
a. 23rd Sep 2015
b. Photonic Integration Conference, organized by Jakajima, Netherlands
c. http://www.phiconference.com/program/

153) Project advisor: European Commission ICT-28-2015 Cross-Cutting ICT KETs: Innovation Action (b) Pilot line for PIC fabrication on III-V and/or dielectric based platforms for PICs (Photonic Integrated Circuits)
a. 24th Sep 2015
b. European Commission
c. http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/916-ict-28-2015.html

154) Session organizer/Committee member: Market Focus at ECOC exhibit 2015
a. 28th Sep 2015
b. Session organizer/Committee member: Market Focus at ECOC exhibit 2015 with sessions in broadband access, datacentres, service provider optical transmission, network agility/SDN, photonics integration and packet optical transport. Nexus Business Media Ltd
c. http://webcache.googleusercontent.com/search?q=cache:Qb68vjzhV5IJ:www.ecocexhibition.com/visitorhome/marketfocus2015/cfs+&cd=1&hl=en&ct=clnk&gl=us&client=safari

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2016

155) Reviewer: European Commission ICT-29-2016: Photonics KET 2016 (section a(i) Biophotonics: advanced imaging for in-depth disease diagnosis)
   a. 10th May 2016
   b. European Commission
   c. http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/5094-ict-29-2016.html

156) Reviewer: European Commission ICT-29-2016: Photonics KET 2016 (a(iii) Pervasive high-specificity and high-sensitivity sensing for a safer environment)
   a. 12th May 2016
   b. European Commission

157) Reviewer: European Commission ICT-29-2016 Photonics KET (b) Innovation Actions (i) Application driven core photonic devices integrated in systems.
   a. 14th May 2016
   b. European Commission
   c. http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/5094-ict-29-2016.html

158) European Commission Reviewer: European Commission ICT-29-2016 Photonics KET (b) Innovation Actions (ii) Pilot line for assembly and packaging
   a. 15th May 2016
   b. European Commission
   c. http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/5094-ict-29-2016.html
   d. http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/5094-ict-29-2016.html

159) Invited Talk: Annual Shareholder Meeting 2016 - Market Perspective LWLG Polymer Photonics vs Legacy Devices
   a. 20th May 2016
   b. Presentation to investor group at Lightwave Logic's Annual Shareholder Meeting Lightwave Logic
   c. http://lightwavelogic.com/company-updates/

160) Technical presentation for Lightwave Logic Inc., at the Annual Shareholder Meeting (ASM).
   a. 20th May 2016
   b. Lightwave logic Inc., Boulder, Colorado.
   c. Annual shareholder meeting for Lightwave Logic Inc., with live presentation with live Q&A from investors

Professor (Dr. Dr.) Michael S. Lebby, B. Eng. (Hons), MBA, Ph.D., D. Eng, Fellow NAI, IEEE, Optica (OSA); C. Eng.
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161) Invited Presentation and abstract: "High-Performance Polymer Photonics for Next-Generation Photonic Integrated Circuits"
   a. 3rd Oct 2016
   b. ECOC Market Focus by ECOC Exhibition
   c. http://www.ecocexhibition.com/marketfocus

162) Video Interview: ECOC Market Focus on Datacenters and emerging new PIC technologies that include silicon and polymer photonics
   a. 3rd Oct 2016
   b. Video taped interview by ECOC Exhibition Market Focus on Datacenters and emerging new PIC technologies that include polymer photonics.
   c. ECOC Exhibition
   d. http://www.ecocexhibition.com/interviews2016

163) Panel session: European Commission ICT-29-2016: Photonics KET 2016 (section a(ii) Breakthrough in miniaturization of SSL light engines and systems); comment on industry and academic technology.
   a. 5th Nov 2016
   b. http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/5094-ict-29-2016.html

164) Reviewer: European Commission ICT-29-2016: Photonics KET 2016 (section a(ii) Breakthrough in miniaturization of SSL light engines and systems)
   a. 5th Nov 2016
   b. European Commission: Reviewing submitted technical photonics proposals for Horizon 2020, and rate proposals to EU guidelines.
   c. http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/5094-ict-29-2016.html

2017

165) Invited Talk and Panelist: Emerging Technologies Summit; Integrated Photonics session, Stanford University, as part of the Kingdom of the Netherlands trade mission to Silicon Valley
   a. 10th Jan 2017
   b. "Discussion with HRH Prince Constantijn and DG Bertolt Leeftink about photonics ecosystem and startups. Photonics highlights (Michael Lebby)
   c. Consulate General San Francisco, The Kingdom of Netherlands
   d. https://ez.atavist.com/emerging-technologies-summit

166) Video: The importance of photonics roadmapping
   a. 30th Jan 2017

Professor (Dr. Dr.) Michael S. Lebby, B. Eng. (Hons), MBA, Ph.D., D. Eng, Fellow NAI, IEEE, Optica (OSA); C. Eng.
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b. Video on the importance of roadmapping photonics technologies at Photonics West San Francisco, 30th Jan 2017. Interview by Photon Delta.
c. http://www.photondelta.eu

167) Technical Advisor/Expert: 2nd review of MIRPHAB pilot line consortium funded by H2020 at European Commission
a. 20th Feb 2017
b. 2nd review for MIRPHAB consortium at the European Commission, Brussels
c. European Commission, Brussels
d. https://www.iaf.fraunhofer.de/en/research/research-areas/semiconductor-lasers/mirphab.html

168) Technical Advisor/Expert: 2nd review of PI-SCALE project pilot line funded by H2020, European Commission
a. 21st Feb 2017
b. 2nd review of PI-SCALE consortium pilot line at European Commission, Brussels
c. European Commission, Brussels, Belgium
d. http://pi-scale.eu

169) Technical Advisor/Expert: 1st review of PIXAPP pilot line consortium funded by H2020 at European Commission
a. 21st Feb 2017
b. 1st Review of Pixapp project at EU Commission as part of the pilot line project.
c. European Commission, Brussels
d. http://www.fabiodisconzi.com/open-h2020/projects/206352/index.html

170) Invited Talk: Belgium LWLG Investor Group at the Royal Antwerp Golf Club
a. 6th Mar 2017
b. Invited talk entitled "High performance polymer photonics for next generation PICs"
c. Belgium LWLG Investor Group
d. http://www.lightwavelogic.com

171) Chairman: PIC (Photonic Integrated Circuits) International Conference, Brussels, Belgium
a. 7th Mar 2017
b. "Photonic Integrated Circuits International
c. CS International
d. http://www.picinternational.net

172) Invited Talk: Photonics Integration Circuits - Global Market Analysis 2017
a. 13th Mar 2017
b. Invite by The Netherlands Department of Economics to review PIC technology and markets for potential investment.
c. The Dutch Government - Dept of Economics, The Hague together with Photon Delta, The Netherlands
d. http://www.photondelta.eu

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173) Technical Advisor/Expert: 2nd review of PIX4LIFE pilot line consortium funded by H2020 at European Commission
   a. 14th Mar 2017
   b. 2nd review of PIX4LIFE pilot line consortium at the European Commission, Brussels.
   c. European Commission, Brussels, Belgium
   d. http://www.pix4life.eu

174) Keynote talk: Entitled "The rise of PIC based technologies over the next decade and how datacenters and telecom may enable other exciting applications"
   a. 1st May 2017
   b. Xilinx as part of their; "Xilinx silicon technology series seminars"
   c. http://www.xilinx.com

175) Invited Talk: Lightwave Logic Inc Annual Shareholder Meeting "High Performance Polymer Photonics for Next Generation PICs"
   a. 18th May 2017
   b. Presentation of corporate technology and strategy for Lightwave Logic Inc and polymer PIC platforms.
   c. Lightwave Logic Inc (OTCQB:LWLG)
   d. http://www.lightwavelogic.com/presentations

176) Management/CEO presentation for Lightwave Logic Inc., at the Annual Shareholder Meeting (ASM).
   a. 18th May 2017
   b. Lightwave logic Inc., Boulder, Colorado.
   c. Annual shareholder meeting for Lightwave Logic Inc., with live presentation with live Q&A from investors.

177) Plenary Talk: Global Market Research at the World Technology Mapping Forum, s'Hertogenbosch, Netherlands
   a. 14th Jun 2017
   b. "PhotonDelta and the AIM Photonics Academy are organising the first meeting of the World Technology Mapping Forum. The goal of the forum is to produce the first International Photonic Systems Roadmap, looking ahead to global technology needs in 2030 and beyond.
   c. PhotonDelta, Netherlands as part of the International Photonics System Roadmap (IPSR) conference
   d. https://worldtechnologymappingforum.org/the-programme

178) Video interview: World Photonic Mapping Forum; s'Hertogenbosch, Netherlands
   a. 15th Jun 2017
   b. Interview on photonics roadmaps.
   c. PhotonDelta (via Videographer Jonathan Marks)
   d. https://worldtechnologymappingforum.org/the-programme

179) Invited video 'Lightwave Logic roadmaps for polymer photonics at the 3rd International Roadmap conference, Eindhoven, Netherlands
   a. 16th June 2017

Professor (Dr. Dr.) Michael S. Lebby, B. Eng. (Hons), MBA, Ph.D., D. Eng, Fellow NAI, IEEE, Optica (OSA); C. Eng.
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b. PhotonDelta video PR team
c. https://vimeo.com/317216466

180) Invited talk and abstract: Polymer based PICs
a. 14th Sep 2017
b. ECOC, Datacenter technologies. Sweden

181) Video: Polymer based PICs
a. 15th Sep 2017 ECOC, Sweden as part of Market Focus at the ECOC Exhibit. (youtube: Michael Lebby ECOC 2017)

182) Keynote invited talk and abstract: PIC based technologies
a. 22nd Sep 2017
b. PIC Conference, The Netherlands

183) Invited talk and abstract: Polymer PIC technology as part of the Photonics Integrated Circuits (PIC) conference in Eindhoven, Netherlands.
a. 5th Oct 2017
b. PIC technologies and polymer photonics

184) Invited talk: PIC Training conference/workshop in Sunnyvale, Silicon Valley
a. PIC training session/workshop

185) Invited talk: Photonics Pilot Lines
a. 8th Dec 2017
b. European Commission, Photonics Proposers Meeting, Brussels

2018

186) International Roadmap meeting at Berenshot, Utrecht, Netherlands
a. 20th Jan 2018
b. Invited talk: International Roadmap meeting: Datacom/Telecom ICT markets, AOC, and Polymer PIC technology platforms

187) Co-Chairman: PIC (Photonic Integrated Circuits), International Conference, Brussels, Belgium
a. 10th Apr 2018
b. Photonic Integrated Circuits International
c. CS International
d. http://www.picinternational.net

188) Session chair and moderator: High volume, high performance PICs (Photonic Integrated Circuits) at the International Conference, Brussels, Belgium
a. 10th Apr 2018
b. Photonic Integrated Circuits International
c. CS International
d. http://www.picinternational.net

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189) Session chair and moderator: Silicon Photonics (SiP) PICs (Photonic Integrated Circuits) at the International Conference, Brussels, Belgium
   a. 11th Apr 2018
   b. Photonic Integrated Circuits International
   c. CS International
   d. http://www.picinternational.net
190) Invited Talk: Scalable PIC platforms: "The impact of using polymer PICs for 100 and 400Gbps datacom applications," PICs (Photonic Integrated Circuits) at the International Conference, Brussels, Belgium
   a. 10th Apr 2018
   b. Photonic Integrated Circuits International
   c. CS International
   d. http://www.picinternational.net
191) Management/CEO presentation for Lightwave Logic Inc., at the Annual Shareholder Meeting (ASM).
   a. 17th May 2018
   b. Lightwave logic Inc., Denver, Colorado.
   c. Annual shareholder meeting for Lightwave Logic Inc., with live presentation with live Q&A from investors.
192) Invited video 'Welcome to WTMF 18' at the 2nd International Roadmap conference, Eindhoven, Netherlands
   a. 12th June 2018
   b. PhotonDelta video PR team
   c. https://vimeo.com/275376937
193) Reviewer: European Commission ICT-03-2018: Photonics Pilot lines (InP and silicon photonics PICs)
   a. 11th Jun 2018
   b. European Commission: Reviewing submitted technical photonics proposals for Horizon 2020, and rate proposals to EU guidelines.
   c. http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020
194) Reviewer: European Commission ICT-04-2018: Tbps optical fiber optic transceivers
   a. 11th Jun 2018
   b. European Commission: Reviewing submitted technical photonics proposals for Horizon 2020, and rate proposals to EU guidelines.
   c. http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020
195) Reviewer: European Commission ICT-04-2018: Connected lighting
   a. 11th Jun 2018
   b. European Commission: Reviewing submitted technical photonics proposals for Horizon 2020, and rate proposals to EU guidelines.
   c. http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020
196) Workgroup chair and moderator: Telecom long haul roadmap committee at the International world mapping conference, Enschede, Netherlands

Professor (Dr. Dr.) Michael S. Lebby, B. Eng. (Hons), MBA, Ph.D., D. Eng, Fellow NAI, IEEE, Optica (OSA); C. Eng.
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a. 20th Jun 2018
b. Photondelta Conference: chairing technical workgroup meetings to address photonics roadmap trends and challenges.
c. Photondelta in coordination with iNEMI, and AIM photonics.
d. https://www.photondelta.eu

197) Invited talk: Telecom, Datacom, and ICT roadmap committee at the International world mapping conference, Enschede, Netherlands
a. 20th Jun 2018
b. Photondelta Conference: chairing technical workgroup meetings to address photonics roadmap trends and challenges.
c. Photondelta in coordination with iNEMI, and AIM photonics.
d. https://www.photondelta.eu

198) Invited talk and abstract: Pushing the performance of 50Gbps NRZ polymer modulators towards 100Gbps NRZ in a PIC platform to access 400 and 800Gbps data-rates
a. 25th Sep 2018
b. ECOC, Datacenter technologies. Sweden

199) Reviewer (European Commission) for pilot line PISCALE
a. 18th Sept 2018
b. European Commission, Brussels
c. PISCALE is a pilot line that is focused on bringing to commercial market flexible organic display technologies in both panel and reel to reel formats.

200) Reviewer (European Commission) for pilot line MIPHAB
a. 19th Sept 2018
b. European Commission, Brussels
c. MIPHAB is a pilot line that is focused on bringing to commercial market near infra-red devices and packaging for industrial, defense, military and high volume applications.

201) Video: Pushing the performance of 50Gbps NRZ polymer modulators towards 100Gbps NRZ in a PIC platform to access 400 and 800 Gbps datarates.
a. 25th Sept 2018
b. ECOC, Market Focus at the ECOC Exhibit, (Youtube: Michael Lebby ECOC 2018)

202) Invited talk and abstract: ECOC International Symposium on Hybrid PICs entitled “Polymer PICs: technology and prospects"
a. 26th Sept 2018
b. International Symposium on Hybrid PICs co-located at the ECOC conference, Rome, Italy.

203) Reviewer (European Commission) for pilot line PIXAPP
a. 2nd Oct 2018
b. European Commission, Brussels

Professor (Dr. Dr.) Michael S. Lebby, B. Eng. (Hons), MBA, Ph.D., D. Eng, Fellow NAI, IEEE, Optica (OSA); C. Eng.
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c. PIXAPP is a pilot line that is focused on bringing to commercial market PIC (photonic integrated circuit) packaging solutions for InP and silicon photonics based technologies.

204) Reviewer (European Commission) for pilot line PIX4LIFE
   a. 3rd Oct 2018
   b. European Commission, Brussels
   c. PIX4LIFE is a pilot line that is focused on bringing to commercial market PIC dielectric solutions for applications in the visible wavelength range in the medical applications market.

2019

205) Invited talk: Polymer modulators and polymer PIC technologies: PIC Training conference/workshop in Sunnyvale, Silicon Valley
   a. 28th Jan 2019
   b. PIC training session/workshop at Keysight facility

206) Reviewer (European Commission) for pilot line MIPHAB
   a. 16th Feb 2019
   b. European Commission, Brussels
   c. MIPHAB is a pilot line that is focused on bringing to commercial market near infra-red devices and packaging for industrial, defense, military and high volume applications.

207) Reviewer (European Commission) for pilot line PIX4LIFE
   a. 25th Mar 2019
   b. European Commission, Brussels
   c. PIX4LIFE is a pilot line that is focused on bringing to commercial market PIC dielectric solutions for applications in the visible wavelength range in the medical applications market.

208) Co-Chairman: PIC (Photonic Integrated Circuits), International Conference, Brussels, Belgium
   a. 26-27th Mar 2019
   b. Photonic Integrated Circuits International
   c. CS International
   d. http://www.picinternational.net

209) Session chair and moderator: High volume, high performance PICs (Photonic Integrated Circuits) for Foundries at the International Conference, Brussels, Belgium
   a. 26th Mar 2019
   b. Photonic Integrated Circuits International
   c. CS International

Professor (Dr. Dr.) Michael S. Lebby, B. Eng. (Hons), MBA, Ph.D., D. Eng, Fellow NAI, IEEE, Optica (OSA); C. Eng.
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d. http://www.picinternational.net

210) Session chair and moderator: High volume PICs (Photonic Integrated Circuits) at the International Conference, Brussels, Belgium
   a. 27th Mar 2019
   b. Photonic Integrated Circuits International
   c. CS International
   d. http://www.picinternational.net

211) Invited Talk: Polymer PICs for 400Gbps+ datacom applications," PICs (Photonic Integrated Circuits) at the International Conference, Brussels, Belgium
   a. 27th Mar 2019
   b. Photonic Integrated Circuits International
   c. CS International
   d. http://www.picinternational.net

212) Reviewer (European Commission) for project CARDIS
   a. 18th Apr 2019
   b. European Commission, Brussels
   c. CARDIS is an EU project for PIC based technology to monitor blood flow and artery stiffness in the human body using long wavelength lasers and silicon photonics.

213) Management/CEO presentation for Lightwave Logic Inc., at the Annual Shareholder Meeting (ASM).
   a. 16th May 2019
   b. Lightwave logic Inc., Denver, Colorado.
   c. Annual shareholder meeting for Lightwave Logic Inc., with live presentation with live Q&A from investors with presentation: https://drive.google.com/file/d/1wh8irF8rmi9bU6VeGKAHFqVURyUcytdX/view?usp=sharing

214) Reviewer: European Commission ICT-03-2019: Fiber optic communications and bio-photonics for medical applications
   a. 6th June 2019
   b. European Commission: Reviewing submitted technical photonics proposals for Horizon 2020, and rate proposals to EU guidelines.
   c. http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020

215) Workgroup chair and moderator: Datacom roadmap committee at the International world mapping conference, Berlin, Germany
   a. 12th June 2019
   b. Photondelta Conference: chairing technical workgroup meetings to address photonics roadmap trends and challenges.
   c. Photondelta in coordination with iNEMI, and AIM photonics.
   d. https://www.photondelta.eu

216) Keynote speaker: 'Global markets for PIC technologies' at the 3rd International world mapping conference, at the Fraunhofer HHI, Berlin, Germany
   a. 15th June 2019

Professor (Dr. Dr.) Michael S. Lebby, B. Eng. (Hons), MBA, Ph.D., D. Eng, Fellow NAI, IEEE, Optica (OSA); C. Eng.
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b. Photondelta Conference: chairing technical workgroup meetings to address photonics roadmap trends and challenges.
c. Photondelta in coordination with iNEMI, and AIM photonics.
d. https://www.photondelta.eu

217) Reviewer: European Commission ICT-05-2019: Pilot lines (free form optics and integrated photonics for bio-medical applications
a. 16th June 2019
b. European Commission: Reviewing submitted technical photonics proposals for Horizon 2020, and rate proposals to EU guidelines.
c. http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020

218) Invited speaker: 'Lightwave Logic polymer modulator platform' at the Spring Investor Conference, NYC, NY
a. 2nd April 2019
b. Spring Investor Summit (Microcap Conference) (www.springinvestorsummit.com

219) Invited video 'Lightwave Logic polymer modulator platform' at the Spring Investor Conference, NYC, NY
a. 2nd April 2019
b. Spring Investor Summit (Microcap Conference)
c. https://www.youtube.com/watch?v=Mn4oICQpVTQ

220) Invited video 'Lightwave Logic advancing its silicon photonic prototypes" by Proactive, (https://www.proactiveinvestors.com)NY
a. 2nd April 2019
b. Proactive video (Wall St) series: https://www.youtube.com/watch?v=3B0oGXvyogA
c. Lightwave Logic, Inc. (OTCQX: LWLG) CEO Michael Lebby tells Proactive the Englewood, Colorado-based technology platform company is in discussions with large and small players within the telecommunications and data-communications space, including companies who are involved in the manufacturing routers.

221) Reviewer: (European Commission) for project InSiDe
a. 29th Apr 2019
b. European Commission, Brussels
c. InSiDe is an EU project for PIC based technology in the medical field to monitor blood flow and artery stiffness in the human body using long wavelength lasers and silicon photonics. Hospital clinical trials will be conducted. It is a follow-on with more clinical trials from the initial CARDIS EU project.
d. http://www.inside-h2020.eu

222) Invited video Interview by EPIC CTO Jose Pozo in EPIC's Photonics Industry Luminary video series.
a. 28th Jan 2019 (at Photonics West conference in San Francisco)
b. EPIC Trade Association, Europe
c. https://www.youtube.com/watch?v=e_V4TeTSwaM

223) Invited video 'Global Markets and Trends' at the 3rd International Roadmap conference, Faunhofer HHI, Berlin Germany

Professor (Dr. Dr.) Michael S. Lebby, B. Eng. (Hons), MBA, Ph.D., D. Eng, Fellow NAI, IEEE, Optica (OSA); C. Eng.
1 Hawthorne St., unit 25a, San Francisco, CA 94105, USA; mobile +1 717 839 7078; drmlebby@gmail.com

a. 16th June 2019
b. PhotonDelta video PR team
c. https://vimeo.com/341952732

224) Reviewer (European Commission) for pilot line PISCALE
a. 11th Sept 2019
b. European Commission, Brussels
c. PISCALE is a pilot line that is focused on bringing to commercial market flexible organic display technologies in both panel and reel to reel formats.

225) Invited talk and abstract: ECOC International Symposium on Hybrid PICs entitled "Polymer modulators enable the next generation of speeds and low power in optical networks"
a. 22nd Sept 2019
b. International Symposium and workshop (WO5) on Hybrid PICs,
c. ECOC conference 2019, Dublin, Ireland
d. https://www.ecoc2019.org/workshop.html

226) Invited talk and abstract: "Polymer modulators with >50GHz performance for power consumption reduction at 400, 800, and 1600 Gbaud aggregated data-rates"
a. 24th Sept 2019
b. Market Focus Session, Photonics Integration and Digital Silicon Photonics,
c. ECOC 2019, Dublin, Ireland
d. https://www.ecocexhibition.com/visit/market-focus/market-focus-2019-timetable/

227) Video: Polymer modulators with >50GHz performance for power consumption reduction at 400, 800, and 1600 Gbaud aggregated datarates"
a. 24th Sept 2019
b. ECOC, Market Focus at the ECOC Exhibit, (Youtube: Michael Lebby ECOC 2019)
c. ECOC 2019, Dublin, Ireland

228) Chairman and moderator, Market Focus ECOC 2019 session: Service and Content Provider Optical Transmission
a. 24th Sept 2019
b. Market Focus Session #5, ECOC 2019, Dublin, Ireland
c. https://www.ecocexhibition.com/visit/market-focus/market-focus-2019-timetable/

229) Chairman and moderator, Market Focus ECOC 2019 session: Optical Network Agility/Software Defined Networks
a. 24th Sept 2019
b. Market Focus Session #7, ECOC 2019, Dublin, Ireland
c. https://www.ecocexhibition.com/visit/market-focus/market-focus-2019-timetable/

230) Reviewer (European Commission) for pilot line MIPHAB
a. 10th Dec 2019
b. European Commission, Brussels

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c. MIPHAB is a pilot line that is focused on bringing to commercial market near infra-red devices and packaging for industrial, defense, military and high-volume applications.

2020

231) Webinar: Wall Street resource
   a. 9th Jan 2020
   b. Lightwave Logic HQ facilities in Denver, Colorado
   c. A 30min recorded webinar answering questions on Lightwave Logic and its business plans, technology and plans for the future.

232) Invited video Interview by EPIC in EPIC's Photonics Industry video series on European funded pilot lines.
   a. 5th Feb 2020 (at Photonics West conference in San Francisco)
   b. EPIC Trade Association, Europe

233) Reviewer (European Commission) for pilot line InPULSE
   a. 19th Mar 2020
   b. European Commission, Brussels
   c. InPULSE is a pilot line that is focused on bringing to commercial market InP based photonic integrated circuits (PICs) for fiber communications, both datacom as well as telecom high-volume applications.

234) Keynote and Plenary speaker SPIE Photonics Europe International Conference
   a. Originally 31st March (then moved to 7th April 2020)
   b. Strasbourg, France (the plenary talk was completed using audio embedded powerpoint video remotely).
   c. The conference was held virtually in 2020 and the talk was attended by over 1000 attendees/visits.
   d. https://spie.org/profile/michael.lebby-4009?SSO=1

235) Chairman (elected) of ECOC Market Focus technical committee as part of the ECOC Exhibition.
   a. 10th May 2020
   b. Committee hosted and organized by ECOC Exhibition
   c. Market Focus Committee at: : https://www.ecocexhibition.com/visit/market-focus/

236) Invited speaker and presentation at Lightwave Logic Annual Shareholder meetings 2020 with Business Management Update, and presentation entitled, "Lightwave logic business review"
   a. 14th May 2020

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b. Presentation can be found at: https://drive.google.com/file/d/1xfisLKe6QIykCAIMjOZ0XdiR-Ht_O7zZ/view?usp=sharing
c. Hosted by Lightwave Logic Inc. and MZ Group (Investor Relations)

237) Co-Chair (and summit host) of online summit for PIC International virtual session with live Q&A.
a. 19th May 2020
b. Hosted by Angel Tech (https://onlinesummit.angel-tech.net/breakout/pic-international)
c. Virtual conference with combination of pre-recorded presentations, live presentations, and live Q&A. Over 150 attendees.

238) Invited video clip on PIC technologies for online summit of PIC International conference.
a. 19th May 2020
b. Video clip (2:04) can be found at https://onlinesummit.angel-tech.net/breakout/pic-international
c. Summit host's introduction to the online summit PIC conference.

239) Invited speaker, EPIC 24hr Photonics World Tour virtual conference with talked entitled; "EO Polymers enable high speed and low power modulators at 1550nm and 1310nm."
a. 24th Jun 2020
b. EPIC 24hr Photonics World Tour final talk #72 and concluding remarks.
c. https://www.epic-assoc.com/24hours/ and video on Youtube at: https://www.youtube.com/watch?v=aiUSlfxP1z0 starting at 46:00

240) Invited paper/article entitled, "Electro-Optic Polymers Improve Speed and Power Efficiency" with co-authors Karen Liu and Cory Pecinovsky, Lightwave Logic Inc.
a. 5th Aug 2020
b. Published by Photonics Spectra magazine,
c. Hosted by photonics.com https://www.photonics.com/Articles/Electro-Optic_Polymers_Improve_Speed_and_Power/p5/vo180/i1193/a65902

241) Invited video interview, "2020 Market Focus and technology trends for ECOC 2020, Brussels, Belgium" as Chairman of ECOC 2020 Market Focus Technical Committee
a. 5th Aug 2020
b. Market Focus Exhibition for ECOC 2020,
c. Hosted by ECOC exhibition: https://www.ecocexhibition.com/visit/market-focus/

242) Chair and invited speaker, PIC International virtual conference on PICs: PIC Virtual II with presentation entitled; "Optical devices and industry roadmaps."
a. 2nd Nov 2020
b. PIC International Conference, (https://picmagazine.net/article/112351/AngelTech_Virtual_2_-_The_Sequel_Proves_A_Hit_Success) and (https://onlinesummit.angel-tech.net)

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243) Invited speaker, EPIC Virtual Conference on Datacenters (in collaboration with EA and COBO) with presentation entitled; "Using polymer modulators to upgrade your PIC + Industry Roadmaps."
   a. 4th Nov 2020
   b. EPIC Trade Association and subsequent YouTube video (https://www.youtube.com/watch?v=tHh-z724D2g) and also at EPIC: https://www.epic-assoc.com/epic-online-technology-meeting-on-datacenter-interconnects-in-cooperation-with-cobo-and-ea/
   c. Hosted by EPIC
   d. Hosted by CS International and PIC International (Angel Business, London)

244) Reviewer (European Commission) for pilot line PIX4LIFE
   a. 2nd Dec 2020
   b. European Commission, Brussels (virtual review)
   c. PIX4LIFE is a pilot line that is focused on bringing to commercial market PIC dielectric solutions for applications in the visible wavelength range in the medical applications market.

2021

245) Invited speaker, EPIC Photonics Plus conference (virtual) with a talk entitled "Polymer Plus™: Upgrading your PIC with Ultrafast and Low Power Modulators."
   a. 16th Feb 2021
   b. EPIC Trade Association https://photonicsplus.com and also at EPIC: https://photonicsplus.com/exhibitors/
   c. Hosted by EPIC

246) Invited speaker (updated virtual presentation), EPIC Photonics Plus conference (virtual) with a talk entitled "Commercializing Polymer Modulators."
   a. 10th Mar 2021
   b. EPIC Trade Association https://photonicsplus.com and also at https://www.lightwavelogic.com/presentation/video-presentation-commercializing-polymer-modulators/
   c. Hosted by EPIC

247) Invited Webinar and panelist: Roth Capital Partners (https://www.roth.com/Page/Corporate-Access-Past-Conferences)
   a. 17th Mar 2021
   b. 33rd Annual Roth Conference
   c. Financial investment conference for public company review. Panelist for answering questions by bankers, investment specialists, and fund managers on Lightwave Logic and its business plans, technology and plans for the future.

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248) Invited white paper/article entitled, "Polymers for Fiber Optic Communications: What does the Integrated Photonics Roadmap Say" co-authors Michael Lebby and Karen Liu, Lightwave Logic Inc.
   a. 24th Mar 2021
   b. Published by Lightwave Logic Inc., (https://www.lightwavelogic.com/wp-content/uploads/sites/319/2021/03/WP_IPSR-Roadmap-Decoded.pdf)
   c. Executive summary: The IPSR (Integrated Photonic Systems Roadmap), a recent broad collaboration that unified the efforts of multiple established photonics roadmap efforts, describes the key technology bottlenecks for a broad array of applications and most promising solutions to overcome them. This whitepaper highlights the portion of the roadmap specific to fiber optic communications and within that the implications for the role of electro-optic polymers. Key findings identify critical advances that will be needed over the next decade to support the growth of very high data rate applications. By the end of the decade, integration of electronics with photonics will be part of broad integrated platforms. Innovative materials technologies such as polymers can be useful to enhance integrated photonics platforms with the use of high- speed modulators and passive optical interconnects.

249) Reviewer (European Commission) for pilot line Phabulous
   a. 31st Mar 2021
   b. Via European Commission (virtual review)
   c. Phabulous is a pilot line that is focused on bringing to commercial market micro-optics and free-form optics technology. Focus is on SMEs, prototyping and small volume manufacturing.

250) Chair and invited speaker, PIC International virtual conference on PICs: PIC Virtual III with presentation entitled; "Integrated photonic roadmaps."
   a. 12th Apr 2021
   b. PIC International Conference, (https://picmagazine.net/article/112351/AngelTech_Virtual_2_-_The_Sequel_Proves_A_Hit_Success) and (https://onlinesummit.angel-tech.net)
   c. Hosted by CS International and PIC International (Angel Business, London)

251) Reviewer (European Commission) for pilot line InPULSE (also known as Jeppix)
   a. 23rd Apr 2021
   b. Via European Commission (virtual review)
   c. InPULSE is a pilot line that is focused on bringing to commercial market InP based photonic integrated circuits (PICs) for fiber communications, both datacom as well as telecom high-volume applications.

252) Invited speaker, EPIC Virtual Conference on PIC Packaging with presentation entitled; "Integrated photonics roadmaps: enabling high performance packaging."
   a. 26th Apr 2021
   b. EPIC Trade Association and subsequent YouTube video (https://www.youtube.com/watch?v=tHh-z724D2g) and also at EPIC: https://www.epic-assoc.com/epic-online-technology-meeting-on-pic-packaging/

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c. Hosted by EPIC

253) Invited conference and panelist: Oppenheimer 6th Annual Virtual Emerging Growth Conference (https://www.oppenheimer.com/events/2021/6th-annual-emerging-growth-conference.aspx)
   a. 11th May 2021
   b. Oppenheimer 6th Annual Virtual Emerging Growth Conference.
   c. Financial investment conference for public company review. Panelist for answering questions with a variety of bankers, investment specialists, and fund managers on Lightwave Logic and its business plans, technology and plans for the future.

254) Invited speaker and presentation at Lightwave Logic Annual Shareholder meetings 2021 with Business Management Update, and presentation entitled, "Lightwave logic business review"
   a. 27th May 2021
   b. Presentation can be found at: https://www.lightwavelogic.com/presentation/2021-asm-business-update-por-lightwave-logic-ceo-dr-michael-lebby/
   c. Hosted by Lightwave Logic Inc. and MZ Group (Investor Relations)

255) Keynote speaker for PITC opening ceremony with presentation entitled, "Photonic Integrated Circuits (PICs): Enabling our future…"
   a. 2nd June 2021
   b. Agenda at: https://brainporteindhoven.com/en/events/launch-photonics-integration-techology-center and presentation at: https://www.lightwavelogic.com/presentation/photonic-integration-technology-center-keynote/
   c. Hosted by PITC (Photonics Integrated Technology Center); Photon Delta, TNO, Eindhoven University, Twente University.

256) Invited speaker: LD Micro Invitational XI conference (virtual) with presentation entitled, "Lightwave Logic Investor Presentation"
   a. 10th June 2021
   b. Presentation at: https://api.mziq.com/mzfilemanager/v2/d/307dbc8b-e212-48ba-9968-8cef3f6b5188/8c054319-48a6-bd6b-2a0c-66e56f5f489f?origin=2
   c. Hosted by LD Micro NASDAQ: SRAX

257) Invited video interview: "2021 Market Focus and technology trends for ECOC 2021, Bordeaux, France" as Chairman of ECOC 2021 Market Focus Technical Committee
   a. 15th June 2021
   b. Market Focus Exhibition for ECOC 2021,
   c. Hosted by ECOC exhibition: https://www.ecocexhibition.com/visit/market-focus/

258) Invited speaker at HC Wainwright non-deal roadshow (virtual)
   a. 3rd and 4th August 2021
   b. Presentation of "Lightwave Logic investor presentation"
   c. Hosted by HC Wainwright Investment Bank

259) Invited speaker at Q3 Investor Summit (virtual)

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a. 17th and 18th August 2021
b. Presentation of "Lightwave Logic investor presentation" and link: https://drive.google.com/file/d/1mH0bCzOd8UxtvN6FeR50KIP7moFsFhjJ/view?usp=sharing
c. Hosted by Investor Summit (https://investorsummitgroup.com)

260) Invited speaker and video recording at HC Wainwright conference (virtual)
a. 13-15th September 2021
b. Presentation of "Lightwave Logic investor presentation"
c. Hosted by HC Wainwright Investment Bank

261) Invited speaker and video interview at NASDAQ for 10th September 2021 marketing closing. Live interview at NASDAQ HQ in Times Square, NYC.
a. 10th September 2021
b. Live interview for TV networks of Lightwave Logic's aspirations.
c. Hosted by NASDAQ at their TV studios: https://www.nasdaq.com/videos/lightwave-logic-inc.-rings-the-nasdaq-stock-market-opening-bell

262) Invited interview to close the week of trading at NASDAQ on 10th September, 2021 with live speech, and televised session. The closing was carried by CNBC, FOX, Bloomberg, BNN networks during the close session.
a. 10th September, 2021
b. Live interview for Lightwave Logic, and live market closing for NASDAQ
c. Hosted by NASDAQ at their TV studios: https://youtu.be/8dmHC8MeF6E
a. https://youtu.be/8dmHC8MeF6E

263) TV and video interview by TD Ameritrade in conjunction with the ringing of the closing bell at NASDAQ on 10th September, 2021
a. 10th September 2021
b. Live TV interview on TD Ameritrade at NASDAQ studios, Time Square, NYC
c. Hosted by TD Ameritrade financial network; https://tdameritradenetwork.com/video/rB4A-HvPH-2Be9Hw1tYC0w

264) Session chairman: ECOC Market Focus technical committee as part of the ECOC Exhibition: sessions included PIC and Silicon Photonics, Optics in Cloud computing, optical transmission (SDN, network agility), Fiber Access, 5G, Cable, PON, FTTX, FTTC, Fiber to the room, New technologies and optical systems, New markets, and new packaging platforms.
a. 13th September 2021
b. Committee hosted and organized by ECOC Exhibition
c. Market Focus Committee at: : https://www.ecocexhibition.com/visit/market-focus/

265) Invited video interview: "2021 Market Focus impact for ECOC 2021, Bordeaux, France" as Chairman of ECOC 2021 Market Focus Technical Committee at the conference by ECOC TV https://www.youtube.com/watch?v=VrFeSwqnWAk
a. 13th September 2021
b. Market Focus Exhibition for ECOC 2021,

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c. Hosted by ECOC exhibition: https://www.ecocexhibition.com/visit/market-focus/ with video at

266) Invited talk and abstract: "Advancing integrated photonics with elector-optic polymer modulators".
   a. 13th September 2021
   b. Market Focus Session, PIC and SiPH/Datacenters/Optics in cloud computing, https://www.ecocexhibition.com/visit/market-focus/market-focus-2021-session-details/
   c. ECOC 2021, Bordeaux, France

267) Winner: Acceptance of glass trophy for ECOC Industry awards on behalf of Lightwave Logic in the optical integration category: https://www.ecocexhibition.com/visit/ecoc-exhibition-industry-awards/
   a. 14th September 2021
   b. Product Focus session, ECOC Exhibition Industry Award Winner Announcement
   c. ECOC 2021, Bordeaux, France

268) Interview: ECOC Industry awards on behalf of Lightwave Logic in the optical integration category by ECOC TV
   a. 14th September 2021
   b. Product Focus session, ECOC Exhibition Industry Award Winner Announcement
   c. ECOC 2021, Bordeaux, France

269) Video interview: PIC International Conference November 9-11, Brussels, Belgium
   a. 24th September 2021
   b. Overview of conference, technical sessions, and integrated photonics
   c. PIC International, Brussels, Belgium as part of the online web portal presence.

270) Reviewer (European Commission) for pilot line InPULSE (also known as Jeppix)
   a. 21st Sep 2021
   b. Via European Commission (virtual review)
   c. MedPhab is a pilot line that is focused on bringing to commercial market silicon photonics based technologies for medical applications. Demonstrator use-cases as prototype products have been selected for the validation of the pilot line technologies covering both *in-vivo* and *in-vitro* domains. The cases include: manufacturing a disposable plasmonic-fluidic sensors and a wearable PCI temperature sensor.
   d. https://medphab.eu

271) Reviewer: (European Commission) for pilot line MIRPHAB
   a. 28th Sep 2021
   b. Via European Commission (virtual review)
   c. MIRPHAB is a pilot line that is focused on bringing to commercial market infra-red wavelength modules and technologies based on quantum cascade lasers, MIR detectors, Antimonide based compound semiconductors and their associated packaging.

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d. https://www.iaf.fraunhofer.de/en/research/research-areas/semiconductor-lasers/mirphab.html

272) Reviewer: (European Commission) for pilot line InPULSE (also known as Jeppix)
   a. 1st Oct 2021
   b. Via European Commission (virtual review)
   c. InPULSE is a pilot line that is focused on bringing to commercial market InP based photonic integrated circuits (PICs) for fiber communications, both datacom as well as telecom high-volume applications.
   d. https://www.inpulse.jeppix.eu

273) Invited Video presentation: LD Micro Main Investor conference entitled "Investor Presentation for LD Micro"
   a. 12th October 2021
   b. For virtual attendees at the LD Micro conference in Los Angeles (Luxe Hotel), California
   c. Invited video presentation for virtual audience at LD Micro main event in LA California: https://www.meetmax.com/sched/event_76871/conference_home.html
   d. https://www.youtube.com/watch?v=JEvSV8qYGMA

274) Invited audio interview: LD Micro for BIZPOD (the Drill Down by Cory Johnson).
   a. 12th October 2021
   b. Located at LD Micro main in LA, California
   c. BIZPOD audio interview as part of their start-up entrepreneur series: https://www.bizpod.net

275) Invited oral presentation: Includes Q&A for LD Micro Main Investor conference entitled "Investor Presentation for LD Micro"
   a. 12th October 2021
   b. For live in-person attendees at the LD Micro conference in Los Angeles (Luxe Hotel), California
   c. Invited live presentation on Lightwave Logic technology and business plans for virtual audience at LD Micro main event in LA California: https://www.meetmax.com/sched/event_76871/conference_home.html
   d. https://www.youtube.com/watch?v=JEvSV8qYGMA and https://me21.mysequire.com/recording?session_id=d354f581-6ab6-47d9-99de-d642c1c25d87

276) Invited Video presentation: Ladenburg Thalmann Virtual Technology Expo conference entitled "Investor Presentation for Ladenburg Thalmann virtual Technology Expo Investor Presentation"
   a. Video-taped on 27th October 2021 for release on 18th November 2021
   b. For virtual attendees at the Thalmann Virtual Technology Expo conference.
   c. Invited video presentation for virtual audience at 2021 Ladenburg Thalmann Virtual Technology Expo: https://ladenburg21.mysequire.com
   d. Presentation can be found at: https://ladenburg21.mysequire.com

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277) Invited video: Chairmans introduction to the 5th PIC International Conference, www.picinternational.net,
   a. 7th-10th November 2021
   b. Conference hosted by Angel events.
   c. Sheraton Airport Hotel, Brussels, Belgium.
278) Session Chairman: 2nd PIC Pilot Line Conference, , www.picinternational.net,
   a. 7th November 2021
   b. Conference hosted by Angel events.
   c. Sheraton Airport Hotel, Brussels, Belgium.
279) Keynote speaker: Includes presentation entitled, "PIC Pilot Lines: Competitive Positioning" as part of the of 2nd PIC Pilot Line Conference, , www.picinternational.net,
   a. 7th November 2021
   b. As of the conference hosted by Angel events.
   c. Sheraton Airport Hotel, Brussels, Belgium.
280) Session chairman: 5th PIC International conference, www.picinternational.net
   a. 8-10th November 2021
   b. Conference hosted by Angel events together with CS International, SSI International, and PIC Pilot Line Conference.
   c. Sheraton Airport Hotel, Brussels, Belgium.
281) Invited Panelist: For the panel entitled, "PICs for LIDAR" of 6th PIC International conference, www.picinternational.net
   a. 8-10th November 2021
   b. Conference hosted by Angel events together with CS International, SSI International, and PIC Pilot Line Conference.
   c. Sheraton Airport Hotel, Brussels, Belgium.
282) Invited speaker: With presentation entitled, "Increasing power efficiency with electro-optic (EO) polymers" at the 5th PIC International conference, www.picinternational.net in the day 2 session, "PICs vision- evolution and revolution"
   a. 8-10th November 2021
   b. Conference hosted by Angel events together with CS International, SSI International, and PIC Pilot Line Conference.
   c. Sheraton Airport Hotel, Brussels, Belgium.
283) Keynote speaker: For Macrotrends (http://arnaerteconomics.com/dagvandetips2020/) investor conference (https://vimeo.com/653240070) and talk entitled "Investor Presentation'
   a. 12th November 2021
   b. Conference hosted by Marcotrends with 200 in person attendees, and 3-500 online attendees.
   c. Ghent, Belgium
284) Invited Live TV interview: Benzinga (Spencer Israel show).
   a. TV interview on 7th Dec 2021 with youtube recording: https://www.youtube.com/watch?v=kS-7FVTNE2Y
   b. Presentation can be found at: https://www.youtube.com/watch?v=kS-7FVTNE2Y

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and the Spencer Israel show/background at https://www.linkedin.com/in/spencer-israel-44b02b31/ and https://www.benzinga.com/author/spencer-israel

2022

285) Invited Live TV interview: Benzinga (Spencer Israel show).
   a. TV interview on 11th Feb 2022 with youtube recording: https://www.youtube.com/watch?v=jFiB9P3voUk
   b. Presentation can be found at: https://www.youtube.com/watch?v=jFiB9P3voUk and the Spencer Israel show/background at https://www.linkedin.com/in/spencer-israel-44b02b31/ and https://www.benzinga.com/author/spencer-israel

286) Invited Webinar and panelist: Roth Capital Partners at the 34th Annual Roth Dana Point Conference, (https://www.roth.com/Page/Corporate-Access-Past-Conferences) with Lightwave Logic investor presentation and meetings.
   a. 13-15th March 2022
   b. 34th Annual Roth Deer Valley Conference (invite only)
   c. Financial investment conference for public company review. Panelist for answering questions by bankers, investment specialists, and fund managers on Lightwave Logic and its business plans, technology and plans for the future.

287) Invited Article and Interview entitled: "Q&A: Electro-optic polymers herald a new age of ultra-fast communication." With Digital Journal (https://www.digitaljournal.com), and interviewer; Dr. Tim Sandle.
   a. Digital Journal interview and publication on 1st April 2022 in the Digital Journal.
   b. Article and interview can be found at: https://www.digitaljournal.com/tech-science/qa-electro-optic-polymers-herald-a-new-age-of-ultra-fast-communication/article

288) Invited Article entitled: "Electro-optic polymers allow faster, more efficient data transmission." With Broadband Communities (https://www.bbcmag.com)
   a. Published in Broadband Communities 13th April 2022.
   b. Article can be found at: https://www.bbcmag.com/pub/doc/BBC_Mar22_webFINAL.pdf

289) Invited video: Chairmans introduction to the 6th PIC International Conference, www.picinternational.net, recorded on 10th May 2022.
   a. 8th May 2022 to be published in May 2022 for the conference being held on 27-29th June 2022
   b. Conference hosted by Angel events.
   c. Sheraton Airport Hotel, Brussels, Belgium.

290) Invited speaker at Oppenheimer 7th Annual Emerging Growth Conference (virtual)
   a. 10th May 2022

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b. Presentation of "Lightwave Logic investor presentation"
c. Hosted by Oppenheimer Investment Bank: https://www.meetmax.com/sched/event_80933/conference_invlogin.html?event_id=80933&username=LWLG&confirmation_number=MVRJ8BYW865 and https://www.oppenheimer.com/events/2022/7th-annual-emerging-growth-conference.aspx

291) Invited interview: Authority Magazine: "The future of communication technology"
a. 11th May 2022, and published 18th May 2022.
b. Interview on the future of communications, hosted by https://medium.com/authority-magazine
c. Interview with David Liu, Authority Magazine

292) Reviewer (European Commission) for pilot line InPULSE (also known as Jeppix)
a. 17th May 2022
b. Via European Commission (virtual review)
c. InPULSE is a pilot line that is focused on bringing to commercial market InP based photonic integrated circuits (PICs) for fiber communications, both datacom as well as telecom high-volume applications.

293) Invited speaker and presentation at Lightwave Logic Annual Shareholder meetings 2022 with Business Management Update, and presentation entitled, "Lightwave logic CEO management review"
a. 26th May 2022
b. Presentation can be found at: https://www.lightwavelogic.com/presentation/2021-asm-business-update-por-lightwave-logic-ceo-dr-michael-lebby/ and stream-video at: https://viavid.webcasts.com/starthere.jsp?ei=1544482&tp_key=3c8d96d340
c. Hosted by Lightwave Logic Inc. and MZ Group (Investor Relations)

294) Invited oral presentation: LD Micro 12th Annual LD Micro Invitational conference with presentation entitled, "Lightwave Logic"
a. 7th June 2022
b. Presentation Webcast can be found at: https://me21.mysequire.com/
c. Hosted by LD Micro NASDAQ: SRAX and located at Four Seasons in Westlake Village, California on 7-8th June 2022.

295) Invited video presentation: LD Micro XII Annual Invitational conference, recorded on 25th May 2022 (https://ldinv12.sequireevents.com)
a. 7th June 2022
b. Presentation at: : https://me21.mysequire.com/
c. Hosted by LD Micro NASDAQ: SRAX at the Four Seasons in Westlake Village, California on 7-8th June 2022.

296) Invited speaker and presentation at MIT IPSRI roadmap event with presentation entitled "Transceiver roadmap 2022".
a. 10th June 2022

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b. Presentation can be found at: https://photonicsmanufacturing.org/how-get-involved
c. and https://www.eventbrite.com/e/2022-spring-ipsr-i-roadmap-meeting-tickets-323380047427
d. Hosted by IPRSI, MIT, and PhotonDelta world photonics roadmap

297) Board member Optica's Corporate Engagement Council, with activities focusing on industrial membership, marketing, conferences, workshops, meetings etc., for the photonics community globally.
a. 10th June 2022, election to the CEC (https://www.optica.org/en-us/about/leadership_and_volunteers/councils/councils/
b. CEC listing: https://www.optica.org/en-us/about/leadership_and_volunteers/councils/councils/#Industry
c. Optica (Optical Society of America – previous name)

298) Reviewer: European Commission HORIZON-CL4-2022-DIGITAL-EMERGING-01-38 (CSA): International cooperation in semiconductors
a. 8th June 2022
b. European Commission: Reviewing submitted technical and coordinated support actions for electronics and photonics proposals for Horizon 2022 evaluation calls and rate proposals to EU guidelines.
c. CSA:http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020

299) Reviewer: European Commission HORIZON-CL4-2022-DIGITAL-EMERGING-01-03: Advanced multi-sensing systems.
a. 10th June 2022
b. European Commission: Reviewing submitted technical photonics proposals for Horizon 2022 evaluation calls and rate proposals to EU guidelines.
c. RIA:http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020

300) Invited live interview with Dan Loney, Wharton Business Daily Radio Station
a. 15th June 2022
b. Wharton Business Daily live radio interview. Subject: Lightwave Logic business and technology plans for growth: https://twitter.com/whartonbizdaily?lang=en
c. Location: virtual recording at Lightwave Logic, Englewood, CO.

301) Invited speaker at Diamond Equity Research Emerging Growth Invitational Conference (virtual)
a. 17th June 2022
b. Presentation of "Lightwave Logic investor presentation"
c. Hosted by Diamond Equity Research Bank: https://www.diamondequityresearch.com/conferences/ at Lightwave Logic, Englewood, Colorado.

302) Invited video interview: "2022 Market Focus impact for ECOC 2022, Basel, Switzerland" as Chairman of ECOC 2022 Market Focus Technical Committee at the conference by ECOC TV (link to be published)

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a. 17th June 2022
b. Market Focus Exhibition, technical sessions and awards for ECOC 2022,
c. Hosted by ECOC exhibition: https://www.ecocexhibition.com/ecoc-exhibition-2022/ and recorded virtually in San Francisco, CA.

303) Invited interview: MicrocapDaily: "Microcapdaily Interviews Dr. Michael Lebby CEO of Lightwave Logic, Inc. (NASDAQ: LWLG) On Radical Innovation Needed to Keep the Internet Growing"
a. 23rd June 2022
b. Interview on the radical innovation needed for the internet and optical networking, hosted by https://microcapdaily.com/microcapdaily-interviews-dr-michael-lebby-ceo-of-lightwave-logic-inc-nasdaq-lwlg-on-radical-innovation-needed-to-keep-the-internet-growing-2/
c. Interview with Boe Rimes, Microcap Daily

304) Session chairman: 7th PIC International conference, www.picinternational.net
a. 28-29th June 2022
b. Conference hosted by Angel events together with CS International and SSI International.
c. Sheraton Airport Hotel, Brussels, Belgium.

305) Invited Panelist: For the panel entitled, "Optica Industry Panel: Hybrid Integration" of 6th PIC International conference, www.picinternational.net
a. 28-29th June 2022
b. Conference hosted by Angel events together with CS International, and SSI International.
c. Sheraton Airport Hotel, Brussels, Belgium.

306) Invited speaker: With presentation entitled, "Enabling low power consumption optical networking using high speed, low power polymer modulators" at the 6th PIC International conference, www.picinternational.net in the day 2 session, "Optimizing the PIC architecture"
a. 28-29th June 2022
b. Conference hosted by Angel events together with CS International, and SSI International.
c. Sheraton Airport Hotel, Brussels, Belgium.

307) Invited speaker: "Status of Lightwave Logic and electro-optic polymers" at the Cleydael Golf Club, Antwerp, Belgium (www.cleydael.be)
a. 30th June 2022
b. Meeting organized by Belgium and Dutch retail investors of Lightwave Logic Inc. (NASDAQ:LWLG)
c. Location: Belgium

308) Invited Article for 7th PIC conference entitled, "PIC International proved to be a fantastic success" (https://angel-tech.net/marketing/2022/mailers/post-show/pic/)
a. 7th July 2022
b. Conference hosted by Angel events together with CS International, and SSI International.

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c. Sheraton Airport Hotel, Brussels, Belgium.

309) Invited Live TV interview: Benzinga All Access Fireside Chat (Zunaid Suleman show).
   a. TV interview on 22nd July 2022 with youtube recording: https://www.youtube.com/watch?v=TyKY9R8WT_U
   b. Video interview can be found at: https://www.benzinga.com/markets/emerging-markets/22/07/28231018/lightwave-logic-the-company-with-a-proprietary-solution-to-make-transmitting-data-faster and the Zunaid Suleman show/background at https://www.benzinga.com/events/speakers/zunaid-suleman/
   c. Location: Virtually recorded in Washington DC

310) Invited Live TV interview with SNN network show Planet MicroCap Podcast and host Robert Kraft: https://www.youtube.com/watch?v=zCD-hTKtkLg
   a. 22nd July 2022
   b. Hosted by SNN and Robert Kraft, and video interview can be found at: https://podcasts.apple.com/us/podcast/lightwave-logic-nasdaq-lwlg-designing-modulators-that/id1024217659?i=1000574742796
   c. Location: Virtually recorded in Washington DC

311) Invited Live Radio interview with Bloomberg markets radio show and hosts Paul Sweeney and Matt Miller. Topic, "Lightwave Logic background, radical innovation, business plans, impact on the internet, and where will the industry go in 5years?" Link to radio interview: "Efficient Data Transmission (Audio)."
   a. 9th August 2022
   b. Hosted by Paul Sweeney and Matt Miller at Bloomberg Market Radio show https://www.bloombergradio.com/shows/bloomberg-markets-am/
   c. Location: recorded at Lightwave Logic, Englewood, Colorado.

312) Invited video interview with Smart Photonics' "50 Leaders of change" to address where the internet is going from a technology, photonics, and optical networking system perspective. Filmed by London based TBD Media and can be found at: https://vimeo.com/tbdmediagroup/review/742996199/8dc9821c7a. with interview at 3:00-50.
   a. 10th August 2022
   b. Hosted and videoed by TBD Media hub on Bloomberg.com
   c. Location: Filmed at Lightwave Logic HQ in Englewood, Colorado and released on 9th November 2022.

313) Invited talk: Jefferies Semiconductors, IT Hardware & Communications Infrastructure Summit
   a. 29-31st August 2022
   b. Hosted by Jefferies Investment Banking
   c. Sofitel Hotel, Chicago, Illinois

314) Invited lecture – TU/e (University of Eindhoven, Netherlands); Electrical Engineering (Photonics); "Polymer Modulators"
   a. 2nd September 2022
   b. Hosted by Photonics Integrated Circuits team, Electrical Engineering, TU/e

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c. TU/e (Eindhoven University), Eindhoven, Netherlands

315) Invited review PhD thesis and defense that included review of thesis, public questions for the candidate and ceremonial procession. Amir Abbas Kashi's thesis is entitled, "Electro-optic slot waveguide phase modulators on the InP membrane on silicon platform"
   a. 2nd September 2022
   b. Hosted by TU/e Electrical Engineering, integrated photonics department with co-reviewers including: Prof. J. Leuthold, Prof. K. Williams, and Prof Van der tol.
   c. TU/e (Eindhoven University), Eindhoven, Netherlands

316) Invited keynote talk as part of the 'New Materials in PICs' at "EPIC meeting on CMOS compatible integrated photonics at IMEC." With link to website: https://epic-assoc.com/events/epic-meeting-on-cmos-compatible-integrated-photonics-at-imec/
   a. 7-8th September 2022 with the talk on the 8th September 2022
   b. Hosted by IMEC and EPIC photonics association. With EPIC photonics at: https://epic-assoc.com
   c. Location at Leuven, Belgium at IMEC 1 foundry.

317) Invited speaker: "Status of Lightwave Logic and electro-optic polymers for foundry applications" at the Cleydael Golf Club, Antwerp, Belgium (www.cleydael.be)
   a. 8th September 2022
   b. Meeting organized by Belgium and Dutch retail investors of Lightwave Logic Inc. (NASDAQ:LWLG)
   c. Location: Belgium

318) Invited talk at HW Wainwright conference called: 'H.C. Wainwright 24th Annual Global Investment Conference', with a talk entitled, "Lightwave Logic Investor Presentation" and link to website: https://journey.ct.events/hub/660eb381-b261-4d25-afae-35b654ed04c1 and https://hcwco.com
   a. 12 and 13th September 2022 (talk on 13th September 2022)
   b. Meeting organized by HC Wainwright Investment Banking (https://hcwco.com)
   c. Location: Lotte Palace Hotel, New York City, NY

319) Invited interview: Interviewed by Greg Bryan at Telegeography (https://www2.telegeography.com) Podcast which can be found at: https://telegeography.podbean.com/ as well as https://blog.telegeography.com/simply-illuminating-considering-the-future-of-optical-transport
   a. 16th September 2022
   b. Published by Telegeography Podcast and Greg Bryan on 27th September 2022
   c. Virtual interview

320) Invited review article: Subject was for EPIC on their CMOS-foundry workshop : https://epic-assoc.com/events/epic-meeting-on-cmos-compatible-integrated-photonics-at-imec/
   a. 13th September 2022
   b. Published by EPIC photonics association and associated media outlets
   c. Review written in NYC, 13th September 2022

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321) Invited article: Ping! Zine technology insights and can be found at: https://www.pingzine.com/featured-article/the-radical-innovation-of-a-new-polymer-internet/
   a. 29th September 2022
   b. Published by Ping! Zine technology insights on 29th September 2022
   c. Ping! Zine publishes in-depth content through authoritative contribution and thorough interviews with technology subject matter experts across multiple disciplines including cloud, data center, AI, big data, cybersecurity and more.

322) Session chairman: ECOC Market Focus technical committee as part of the ECOC Exhibition: sessions included PIC and Silicon Photonics, Optics in Cloud computing, optical transmission (SDN, network agility), Fiber Access, 5G, Cable, PON, FTTX, FTTC, Fiber to the room, new technologies and optical systems, new markets, and new packaging platforms.
   a. 19-21st September 2022
   b. Committee hosted and organized by ECOC Exhibition
   c. Market Focus Committee at: : https://www.ecocexhibition.com/visit/market-focus/

323) Invited video interview: "2022 Market Focus impact for ECOC 2022, Basel, Switzerland," as Chairman of ECOC 2022 Market Focus Technical Committee at the conference by ECOC TV https://youtu.be/X8iQoB4vqaA
   a. 20th September 2022
   b. Market Focus Exhibition for ECOC 2022,
   c. Hosted by ECOC exhibition: https://www.ecocexhibition.com/visit/market-focus/

324) Invited talk and abstract: "Utilizing foundries to scale hybrid electro-optic polymer modulators" with Dr. John Zyskind, VP Engineering, Lightwave Logic Inc: https://www.ecocexhibition.com/visit/market-focus/components-ics-pics-fiber/
   a. 19th September 2022
   b. Market Focus Session, PIC components https://www.ecocexhibition.com/visit/market-focus/market-focus-timetable-2022/
   c. ECOC 2022, Basel, Switzerland

325) Interview, industry award chairman, and award presentation to Market Focus Industry Award winners: ECOC exhibition industry awards (in conjunction with optical connections magazine) https://www.ecocexhibition.com/visit/ecoc-exhibition-industry-awards/ :
   a. 20th September 2022
   b. Product Focus session, ECOC Exhibition Industry Award Winner Announcement
   c. ECOC 2022, Basel, Switzerland

326) Market Focus Interview: ECOC TV on behalf of Lightwave Logic in the optical integration category by ECOC TV and can be found at: https://youtu.be/nRd3dYCozUM
   a. 21st September 2022

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b. Market Focus Session, PIC components https://www.ecocexhibition.com/visit/market-focus/market-focus-timetable-2022/
c. ECOC 2022, Basel, Switzerland

327) Invited talk and panelist for ECOC Rump session, with talk entitled, "Hybrid Integration Roadmap: From pilot production to production in a semiconductor fab" at ECOC technical conference, chaired by Dr Jose Pozo, CTO Optica.
a. 21st September 2022
b. ECOC Rump session
c. ECOC 2022, Basel, Switzerland

328) Paper (co-author): Post-deadline submission to ECOC 2022 entitled, "Thermally Stable Silicon-Organic Hybrid (SOH) Mach-Zehnder Modulator for 140 GBd PAM4 Transmission With Sub-1 v Drive Signals (Th3B.2) given by Carsten Eschenbaum, *Karlsruhe Inst Tech (KIT)* and SilOriX Gmbh.
a. 22nd September 2022
b. ECOC Post Deadline session 1; 13:42 to 13:54pm https://www.optica.org/events/topical_meetings/ecoc/schedule/?day=Thursday#Th3B.2
c. ECOC 2022, Basel, Switzerland

329) Cited Acknowledgement for Post Deadline Paper: Post-deadline submission to ECOC 2022 entitled, ">500 GHz Bandwidth Graphene Photodetector Enabling Highest-Capacity Plasmonic-to-Plasmonic Links (Th3B.5) given by Stefan Koepfli, *Eidgenossische Technische Hochschule (ETH) Zurich*.
a. 22nd September 2022
b. ECOC Post Deadline session 1; 14:18 to 14:30pm https://www.optica.org/events/topical_meetings/ecoc/schedule/?day=Thursday#Th3B.5
c. ECOC 2022, Basel, Switzerland

330) Invited presentation: Diamond Equity Research's annual Spotlight Emerging Growth Invitational Virtual Investor Conference, with a presentation entitled, "Lightwave Logic Investor Presentation" and can be found at https://us02web.zoom.us/webinar/register/WN_2aoRT-XPSZiCFd1cLkVrXA and https://finance.yahoo.com/news/diamond-equity-research-host-spotlight-113000297.html
a. 4th October 2022 (10:20-10:50am East coast time)
b. Diamond Equity Research's Spotlight Emerging Growth Invitational Virtual Investor Conference, conferences@diamondequityresearch.com
c. Recorded 30th September 2022 virtually at LWLG.

331) Project advisor and panelist: European Commission PhotonHub EU project number/grant agreement 101016665 for 1st review meeting (virtual). Project call DT-ICT-04-2020 - Photonics Innovation Hubs
a. 6th October 2022
b. European Commission: https://www.photonhub.eu and https://cordis.europa.eu/project/id/101016665

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c. PhotonHub: PhotonHub Europe is a unique European full-service one-stop-shop Photonics Innovation Hub to advance EU competitiveness.

332) Invited interview: Interviewed by Cory Johnson at The Drill Down podcast (https://twitter.com/drilldownpod?lang=en) Podcast which can be found at: https://www.iheart.com/podcast/269-the-drill-down-81530167/as well as https://twitter.com/DrillDownPod/status/1449964020522360836
   a. 7th October 2022
   b. Published by The Drill Down Podcast and Cory Johnson on 17th October 2022
   c. Virtual interview

333) Invited oral presentation: LD Micro Main Event XV conference with presentation entitled, "Lightwave Logic Update"
   a. 25th October 2022
   b. Oral presentation details can be found at: https://www.meetmax.com/sched/event_86249/conference_home.html as well as https://www.meetmax.com/sched/event_86249/conference_presentations.html?bank_access=0&event_id=86249
   c. Hosted by LD Micro NASDAQ: SRAX

334) Invited video presentation: LD Micro Main Event XV conference, recorded on 25th October 2022
   a. 25th October 2022
   b. Presentation at: https://www.meetmax.com/sched/event_86249/conference_presentations.html?bank_access=0&event_id=86249
   c. Hosted by LD Micro NASDAQ: SRAX at the Luxe Sunset Boulevard Hotel LA 24-26th October 2022

335) Invited closing comments: Optica Co-packaged and pluggable optics industry summit. Comments were on pluggables vs co-packaged integrated photonics solutions, roadmapping, and transceiver trends on data rate and low power consumption.
   a. 25th and 26th October 2022
   b. Details on the event can be found at: https://www.optica.org/en-us/events/industry_events/2022_optica_industry_summit/
   c. Hosted by Optica (formally OSA) https://www.optica.org/en-us/home/ at Du Pont's innovation laboratories Sunnyvale, CA.

336) Invited speaker: Photonics Spectra Annual Conference with presentation entitled, "How electro-optic polymers boost PIC speed and power efficiency".
   a. Recorded on 28th October 2022, for 9-11th January 2023
   b. Details on the event can be found at: https://www.photonics.com/Advertise/MarketingBlog.aspx?AID=68312
   c. Hosted by Photonics Spectra (www.photonics.com)

337) Invited talk at the Board meeting of Optica's Corporate Engagement Council. Presentation on focusing to increase industrial membership, improve marketing, optimize conferences and workshops for the industrial photonics community globally.((https://www.optica.org/en-us/about/leadership_and_volunteers/councils/councils/

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a. 1st November 2022,
b. CEC listing: https://www.optica.org/en-us/about/leadership_and_volunteers/councils/councils/#Industry
c. Optica (Optical Society of America – previous name)

338) Invited interview with Laser Focus editor Peter Fretty, Editor in Chief of LASER FOCUS WORLD, on the subject of Lightwave Logic, and the radical innovation needed by the optical network and internet.
a. 3rd November 2022,
b. Laser Focus world can be found at: https://www.laserfocusworld.com and the magazine at: https://www.laserfocusworld.com/magazine
c. Laser Focus World

339) Invited panel moderator at PIC Summit Conference, Eindhoven, Netherlands in conjunction with IPSR-I workshops. Panel entitled, "Heterogeneous Intergration: Electronics and Photonics united" with companies that included: IMEC, LionX, VTT, Ligentec, Corning, Smart Photonics, Fraunhofer HHI
a. 7th November 2022
b. PIC Summit Europe conference. https://www.picsummiteurope.com/program/
c. Located at the High Tech Center, Eindhoven, Netherlands

340) Invited speaker at PIC Summit Conference, Eindhoven, Netherlands in conjunction with IPSR conference to summarize panel findings and discussion with audience.
a. 7th November 2022
b. PIC Summit Europe conference. https://www.picsummiteurope.com/program/
c. Located at the High Tech Center, Eindhoven, Netherlands

341) Invited Speaker and chair of datacom group at the PIC Summit Europe Conference and IPSR-I workshops with sessions entitled, 'Paving the way to killer applications in 2035.'located at TU/e Eindhoven University, Netherlands. Workshop 1c: Datacom roadmap for 2023.
a. 8th November 2022
b. PIC Summit Europe conference and IPSR-I roadmap workshops. https://www.picsummiteurope.com/program/
c. Located at the TU/e Eindhoven University, Netherlands.

342) Invited talk: IEEE IPC (Integrated Photonics Conference) https://ieee-ipc.org/industry-day/ as part of the conference https://ieee-ipc.org in the session Industry Day-Hot topics in industry. Talk entitled: "Enabling More Efficient Optical Networking using Ultra-high Speed, Ultra-low Power, Ultra-small Foundry based Polymer Modulators"
a. 14th November 2022
b. IEEE IPC IEEE IPC (Integrated Photonics Conference) https://ieee-ipc.org
c. Located at the Hyatt Regency, Vancouver, BC, Canada.

343) Invited talk and panelist: IEEE IPC (Integrated Photonics Conference) https://ieee-ipc.org/industry-day/ as part of the conference https://ieee-ipc.org in the session Roundtable on Topics in Entrepreneurship. Talk entitled: "Entrepreneur or

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Intrapreneur" with company CEOs that included: OEwaves, Polariton, Freedom Photonics/Luminar, Aeponyx, Octane Wireless.

a. 14th November 2022
b. IEEE IPC IEEE IPC (Integrated Photonics Conference) https://ieee-ipc.org
c. Located at the Hyatt Regency, Vancouver, BC, Canada.

344) Invited Video presentation: Ladenburg Thalmann Virtual Technology Expo conference 2022 entitled "Investor Presentation for Ladenburg Thalmann virtual Technology Expo Investor Presentation"

a. Video-taped on 29th November 2022 for release on 7th December 2022
b. For virtual attendees at the Thalmann Virtual Technology Expo conference 2022.
c. Invited video presentation for virtual audience at 2022 Ladenburg Thalmann Virtual Technology Expo: https://ladenburgtech22.sequireevents.com/
d. Presentation can be found at: https://ladenburgtech22.sequireevents.com/

345) Invited panelist: Photonics Spectra panel (virtual and recorded) titled, "Scaling PIC-based applications to volume production." Panelists included representatives from Sicoya, Polariton, and Ligentec, and hosted by Dr. Jose Pozo, CTO Optica.

a. Recorded on 6th December 2022, for release 9-11th January 2023 (https://events.photonics.com/Event.aspx?EID=9&OC=EM)
b. Details on the event can be found at: https://www.photonics.com/Advertise/MarketingBlog.aspx?AID=68312
c. Hosted by Photonics Spectra (www.photonics.com)

346) Invited speaker at PhotonDelta's Delta Dialogues virtual interview entitled, "Heterogeneous Integration for PICs" on the summary and findings of PIC Summit Europe conference on Heterogeneous Integration that took place in November 2022. The session was chaired by Jorn Smeets, PhotonDelta.

a. 7th December, 2022
b. Details of the event can be found at www.photondelta.com and https://www.photondelta.com/events/ and https://www.photondelta.com/events/delta-dialogues-december-2022/
c. Hosted by PhotonDelta www.photondelta.com

347) Invited Panelist: Ladenburg Thalmann Virtual Technology Expo conference and presentation can be found at: https://ladenburgtech22.sequireevents.com/

a. 7th December 2022
b. For virtual attendees at the Thalmann Virtual Technology Expo conference 2022.
c. Invited investor presentation at 2022 Ladenburg Thalmann Virtual Technology Expo: https://ladenburgtech22.sequireevents.com/

348) Invited Webinar and panelist: Roth Capital Partners at the 11th Annual Roth Deer Valley Conference, (https://www.roth.com/Page/Corporate-Access-Past-Conferences) with Lightwave Logic investor presentation and meetings.

a. 14-16th December 2022
b. 11th Annual Roth Deer Valley Conference

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c. Financial investment conference for public company review. Panelist for answering questions by bankers, investment specialists, and fund managers on Lightwave Logic and its business plans, technology and plans for the future.

349) Invited reviewer for European Commission program as part of the IPCEI (Important Project of Common European Interest) program on electronics and photonics.
   a. Duration of review process Jun 2022 to Dec 2022
   b. IPCEI (Important Project of Common European Interest) based on public funding.
   c. IPCEIs are projects by the EU commission that have the potential to make important contributions to sustainable economic growth, jobs, competitiveness and resilience for industry and the economy in the Union as well as strengthen its open strategic autonomy, by enabling breakthrough innovation and infrastructure projects through cross-border cooperation and with positive spill-over effects on the internal market and the society as a whole. In particular, semiconductor power FETs, laser diodes, amplifiers, FET technologies using both compound semiconductors (GaAs, GaN, InP) as well as silicon semiconductors (Silicon, SiGe) were reviewed.

2023

350) Reviewer: (European Commission) for project InSiDe
   a. 24th Jan 2023
   b. Located at IMEC Ghent University facility, Ghent, Belgium
   c. InSiDe is an EU project for PIC based technology in the medical field to monitor blood flow and artery stiffness in the human body using long wavelength lasers and silicon photonics. Hospital clinical trials will be conducted. It is a follow-on with more clinical trials from an initial CARDIS EU project.
   d. http://www.inside-h2020.eu

351) Invited speaker and panelist for Laser Focus World Executive Forum (https://www.laserfocusworld.com/executive-forum) in San Francisco with talk entitled. "Hybrid integration with electro-optic polymers" and panel session entitled, "Enabling silicon photonics success"
   a. 30th January 2023
   b. Details of the event can be found at https://www.laserfocusworld.com/executive-forum and agenda at https://www.lfwexecutiveforum.com
   c. Panelists included: Jose Pozo, CTO Optica, David Piehler, Dell Technologies, Peter Winzer, Nubis Communications, Robert Blum, Intel

352) Interview with Benjamin Glick of Mergermarket magazine entitled, "Lightwave could acquire more assets ahead of commercialization—CEO"
   a. 3rd February 2023
   b. Details of the interview can be found at: https://community.ionanalytics.com/lightwave-could-acquire-more-assets-ahead-of-commercialization-ceo

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c. Video interview remotely from Lightwave Logic HQ in Englewood, Colorado.

353) Interview and podcast with Don Witt of Telecom Reseller's Channel Daily News for a podcast on Lightwave Logic: Background, radical innovation, technology, acquisitions, world record results, goals, and the future of optical networking in a decade. Podcast can be found at https://telecomreseller.com/2023/02/14/lightwave-logic-technology-enables-the-existing-fiber-internet-infrastructure-to-perform-3-times-faster-than-current-speeds-podcast/
   a. 8th February 2023 (interview) and published 14th February 2023
   b. Details can be found at: https://telecomreseller.com/category/channel-daily-news/
   c. Podcast is with Telecom Reseller which provides information on voice mail, audio/video conferencing and peripherals, association and industry news, services, applications, and related topics of daily importance to telecommunications professionals.

354) Invited Article entitled: "The Internet Is the Brick Wall Nostradamus Didn't See Coming" with sub-heading, "The road maps Lightwave Logic is creating for the future of photonics will guide people toward the focus areas and the technology challenges they can expect as performance demands increase." For the industry trends section of BBC magazine (Broadband Communities) at (https://www.bbcmag.com)
   a. Published in Broadband Communities 14th February 2023.
   b. Article can be found at: https://www.bbcmag.com/pub/doc/BBC_Jan23_BrickWall.pdf

355) Interview with AlphaStreet entitled, "Lightwave Logic will license technology to make its polymers ubiquitous: CEO Dr. Michael Lebby" Interview can be found at https://news.alphastreet.com/lightwave-logic-will-license-technology-to-make-its-polymers-ubiquitous-ceo-dr-michael-lebby/
   a. 6th March 2023 (interview) and published 10th March 2023
   b. Details can be found at: https://news.alphastreet.com/lightwave-logic-will-license-technology-to-make-its-polymers-ubiquitous-ceo-dr-michael-lebby/
   c. Interview is with AlphaStreet which provides financial information on companies and utilize NLP and AI techniques in the research industry.

356) Invited speaker: Roth Capital Partners 35th Annual Roth Conference (https://www.roth.com/Page/Corporate-Access-Past-Conferences)
   a. 13th Mar 2023
   b. 35th Annual Roth Conference (www.roth.com/oc2023)
   c. Financial investment conference for public company review. Panelist for answering questions by bankers, investment specialists, and fund managers on Lightwave Logic and its business plans, technology and plans for the future.

357) Interview with Laser Focus by Jose Pozo as part of his Industry Executive interviews for the photonics industry. Key topics included intrapreneur and entrepreneur experience, Lightwave Logic, photonics experience, OIDA, roadmapping, and key drivers for a career in photonics integration Interview can be found at:

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https://www.laserfocusworld.com/fiber-optics/article/14293915/how-thinking-ahead-shaped-the-fiberoptics-industry

a. 16th March 2023 (interview) and published 17th May 2023
b. Details can be found at: https://www.laserfocusworld.com
c. Interview is with Laser Focus World which was originally published in 1965, as *Laser Focus World*—a monthly magazine for engineers, researchers, scientists, and technical professionals—provides comprehensive global coverage of optoelectronic technologies, applications, and markets. Nearly 70,000 qualified optoelectronics professionals from around the world currently subscribe.

358) Interview with IDC by Brandon Hoff on Lightwave Logic, background, radical innovation, proprietary electro-optic polymer technology, goals and why the company is planning on making polymers ubiquitous for the hyper-scaler, datacenter markets.

a. 16th March 2023 (interview)
b. Details can be found at: https://www.idc.com
c. Interview is with IDC which provides market and financial information on the information technology and optical networking industry.

359) Invited article for ISE entitled " Proactive Powering Problem-Solving with Polymers" https://www.isemag.com/fttx-optical-networks/article/14290981/proactive-powering-problemsolving-with-polymers

a. 16th March 2023
b. Details can be found at: https://www.isemag.com
c. ISE has articles on IT solutions and education.

360) Invited article and interview (from panel discussion) at Laser Focus World Executive Forum (https://www.laserfocusworld.com/executive-forum) in San Francisco with article entitled, "Silicon photonics: Is it witchcraft? https://www.laserfocusworld.com/executive-forum/article/14290913/silicon-photonics-is-it-witchcraft

a. 17th March 2023
b. Details of the event can be found at https://www.laserfocusworld.com/executive-forum and agenda at https://www.lfwexecutiveforum.com, and article at: https://www.laserfocusworld.com/executive-forum/article/14290913/silicon-photonics-is-it-witchcraft, written by Sally Cole Johnson for Laser Focus.
c. Panelists included: Jose Pozo, CTO Optica, David Piehler, Dell Technologies, Peter Winzer, Nubis Communications, Robert Blum, Intel

361) Invited article for IMS expert insights entitled, "An Expert Witness Perspective on Inter Partes Review of Patents" by Dr. Michael Lebby, IMS Elite Expert, https://www.expertservices.com/insight/expert-witness-ipr-patents/

a. 12th April 2023
b. Details can be found at https://www.expertservices.com
c. Patent litigation cases can be won or lost through the actions and competency of an expert witness—making their role not only important but crucial. The article takes a closer look at the part an expert witness plays during the *inter partes* review and considers how the IPR process could be improved.

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362) Invited interview with Semiconductor Engineering by Karen Heyman, in an article called https://semiengineering.com/transitioning-to-photonics/ entitled, "Transitioning to Photonics"
   a. Interview taken on 4th April 2023 and published online 14th April 2023
   b. Details can be found at: https://semiengineering.com/about-us/
   c. The article is based on the premise that high speed and low heat make photonics technology essential, especially compared to electronics, but it's extremely complex, and talent is hard to find and train.

363) Session Co-chairman: 8th PIC International conference, www.picinternational.net
   a. 17-18th April 2023 for 2 days of PIC sessions.
   b. Conference hosted by Angel events together with CS International and Power Electronics International conferences.
   c. Sheraton Airport Hotel, Brussels, Belgium.

364) Chair Panel session: For the panel entitled, "Foundry models for PICs" of 8th PIC International conference, www.picinternational.net and moderated by Jose Pozo, CTO Optica. Panel members included Global Foundries, Tower, VTT
   a. 17th April 2022
   b. Conference hosted by Angel events together with CS International, and Power Electronics International conferences.
   c. Sheraton Airport Hotel, Brussels, Belgium.

365) Invited speaker and oral presentation: With presentation entitled, "Positioning electro-optic polymer modulators as an optical engine to extend data rate and low power performance for optical networking" at the 8th PIC International conference, www.picinternational.net in the day 2 session, "Scaling PICs in volume using foundries"
   a. 18th April 2023
   b. Conference hosted by Angel events together with CS International, and Power Electronics International conferences.
   c. Sheraton Airport Hotel, Brussels, Belgium.

366) Invited speaker: "Status of Lightwave Logic and electro-optic polymers" at the Cleydael Golf Club, Antwerp, Belgium (www.cleydael.be)
   a. 18th April 2023
   b. Meeting organized by Belgium and Dutch retail investors of Lightwave Logic Inc. (NASDAQ:LWLG)
   c. Location: Belgium

367) Invited interview with Semiconductor Engineering by Karen Heyman, in an article called https://semiengineering.com/new-standards-push-co-packaged-optics/entitled, "New standard push co-packaged optics"
   a. Interview taken on 4th April 2023 and published online 26th April 2023
   b. Details can be found at: https://semiengineering.com/about-us/
   c. The article is based on the premise that co-packaged optics (CPOs) promises five times the bandwidth of pluggable connections, however, the new architecture requires multiple changes to accommodate different applications, and if the

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design is efficient the optical engines will be able to impact both on-board optics as well as pluggable transceivers.

368) Invited speaker and oral presentation for the Sequire Investor Summit, San Juan, Puerto Rico. The presentation was entitled, "LWLG April 2023 investor presentation" with link https://puertorico.srax.com with agenda: https://schedule.puertorico.srax.com
   a. Conference on 25th and 26th April 2023 with presentation on 25th April 2023
   b. Link to website for Sequire event: https://puertorico.srax.com
   c. Investor conference at the La Concha hotel San Juan, Puerto Rico.

369) Invited speaker and oral presentation: Ladenburg Thalmann Technology Expo and conference 2023. The presentation was entitled, "LWLG April 2023 investor presentation" and can be found at: https://www.meetmax.com/sched/event_94169/__co-list_cp.html
   a. 27th April 2023
   b. The conference and expo 2023, was held at Convene Hotel, Park and 41st, New York, New York and can be found at: https://www.meetmax.com/sched/event_94169/__co-list_cp.html and also at https://www.ladenburg.com/investment-banking/ladenburg-thalmann-co-inc-
   c. The 2023 Expo featured presentations from the managements of approximately 50-60 public and private technology companies covering Media and Content-Tech, Software and Service-Tech, and Hardware and Defend-Tech.

370) Invited article: 8th PIC International conference overview entitled, "An overview of Angeltech 2023 (PIC international conference)", which can be found at www.picinternational.net with newsletters@angelmail.co.uk
   a. 2nd May 2023
   b. Overview is based on the results of the PIC International Conference hosted by Angel events (17-18th April 2023) together with CS International and Power Electronics International conferences.
   c. Sheraton Airport Hotel, Brussels, Belgium.

371) Invited speaker to chair Lightwave Logic Inc's Annual Shareholder Meeting (ASM) at the Inverness Hilton, Englewood, Colorado.
   a. 25th May 2023
   b. Lightwave logic Inc., Denver, Colorado.
   c. Read script, chair voting procedures for Lightwave Logic Annual shareholder meeting for Lightwave Logic Inc.

372) Invited speaker for management/CEO presentation for Lightwave Logic Inc., at the Annual Shareholder Meeting (ASM) at the Inverness Hilton, Englewood, Colorado
   a. 25th May 2023
   b. Lightwave logic Inc., Denver, Colorado.
   c. Annual shareholder meeting for Lightwave Logic Inc., with live presentation with live Q&A from investors.

373) Reviewer: European Commission HORIZON-CL4-2022-DIGITAL-EMERGING-Human-01-57 (Digital and emerging technologies for competitiveness and

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fit for the Green Deal), Horizon IA: Towards next generation of cost-effective multi and hyper spectral remote sensing systems, and applications to health, automotive, and waster sorting.

a. 10-26th May 2023
b. European Commission: Reviewing submitted technical photonics proposals for Horizon 2023 evaluation calls and rate proposals to EU guidelines.
c. IA:http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020

374) Invited keynote speaker at Safecapital investor conference in Ghent with talk entitled, "Commercializing electro-optic polymers" hosted by Brecht Arnaert, Chief Editor www.safecapital.eu with Safecapital Lente meeting, Vander Valk Hotel, Ghent.

a. 27th May 2023
b. Vander Valk Hotel, Ghent, Belgium
c. Safecapital organized a retail investor event with an invite for Lightwave Logic to present and network with investors: https://tixoom.app/brechtarnaert/ur0v1eff

375) Invited interview with Stephen Hardy of Lightwave Online (www.lightwaveonline.com) with discussion entitled, "Lightwave Logic reaches electro-optic polymer materials commercialization with supply license agreement" and can be found at:https://www.lightwaveonline.com/optical-tech/components/article/14294661/lightwave-logic-reaches-electrooptic-polymer-materials-commercialization-with-supply-license-agreement?utm_source=LW+Friday+5&utm_medium=email&utm_campaign=CPS230602105&o_eid=9764C7112945F2S&rdx.ident%5Bpull%5D=omeda%7C9764C7112945F2S&oly_enc_id=9764C7112945F2S

a. Interview conducted on 30th May 2023, and published at www.lightwaveonline.com on 1st June in Stephen Hardy's Friday 5.
b. Article published at https://www.lightwaveonline.com
c. Lightwave online reports on activity in the fiber optics lightwave communications industry at https://www.lightwaveonline.com

376) Invited Live TV interview: Benzinga (Spencer Israel show).

a. TV interview on 9th June 2023 with youtube recording: https://www.youtube.com/watch?v=jFiB9P3voUk
b. Presentation can be found at: https://www.youtube.com/watch?v=jFiB9P3voUk and the Spencer Israel show/background at https://www.linkedin.com/in/spencer-israel-44b02b31/ and https://www.benzinga.com/author/spencer-israel/

377) Project advisor and panelist: European Commission HORIZON-CL4-2021-DIGITAL-EMERGING-01-07 LOLIPOP EU project number 101070441

a. 21st June 2023
b. European Commission
c. https://horizon-de-lolipop.eu
d. LOLIPOP: Lithium NiObate empowered siLIcon nitride Platform for fragmentation free OPeration in the visible and the NIR. Material technology includes LNOI (lithium niobate on insulator) and TFLN (thin film lithium niobate).

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378) Contributing author: Heterogeneous Integration Roadmap (2023 edition), Chapter 17 Test Technology which can be found at: https://eps.ieee.org/images/files/HIR_2023/ch17_test.pdf
   a. 9th August 2023
   b. https://eps.ieee.org/technology/heterogeneous-integration-roadmap.html
   c. Overview of the roadmap: The ITRS Assembly and Packaging Working Group has had many years of history of collaboration with the IEEE Societies in holding workshops and work sessions at IEEE Societies sponsored conferences and events around the world. The basis of this collaboration is the common shared interest in a Technology Roadmap for the IEEE Societies' membership, conference attendees and participants in the ITRS Technical Working Group work sessions. IEEE Societies Conferences are high profile forums on the latest research and development in Packaging, Interconnect, Test and the materials, processes and equipment supporting this R&D. The Roadmap workshops of the ITRS had provided an opportunity for the participants to review the directions of these technologies and build a technology Roadmap looking 15 years into the future.

379) Invited interview with the publication TWST (The Wall Street Transcript) and Erik Sherman, a reporter at (www.twst.com). The interview entitled "Interview with the Chairperson and CEO: Lightwave Logic Inc. (NASDAQ:LWLG)"
   a. Interview taken on 42nd August 2023 and published online 17th August 2023
   b. Details can be found at: (www.twst.com) and https://www.twst.com/interview/interview-with-the-chairperson-and-ceo-lightwave-logic-inc-nasdaqlwlg
   c. The Wall Street Transcript is a subscriber-based online and print publication for retail and institutional investors. For more than 50 years, it has published thousands of in-depth interviews with CEOs, industry analysts and professional money managers. The article is about Lightwave Logic and their market positioning for electro-optic polymer modulators in fiber optic communications.

380) Invited Live TV interview with Planet MicroCap Podcast and host Robert Kraft https://planetmicrocapshowcase.com as Chairman and CEO of Lightwave Logic Inc.
   a. Recorded 23rd August 2023 and went live at the conference 6th September 2023.
   b. Hosted by Robert Kraft with video interview can be found at the website https://planetmicrocapshowcase.com
   c. Location: Virtually recorded in Washington DC

381) Invited presentation entitled, "commercializing electro-optic polymers" with Q&A by host Robert Kraft for Vancouver conference by Planet MicroCap https://planetmicrocapshowcase.com
   a. 23rd August 2023 with presentation conveyed on 6th and 7th September 2023
   b. Hosted by Robert Kraft with video Q&A that can be found at the website https://planetmicrocapshowcase.com and https://planetmicrocapshowcase.com/page-1551

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c. Location: Virtually recorded in Washington DC for virtual viewing in Vancouver Canada.

382) Invited interview for the Denver Business Journal, reported by Cassidy Ritter. With title of article, "Englewood tech company making the internet faster expands lab to scale commercial arm: The CEO said high speed and low power are the internet's Achilles heels, but that his company's technology can address those concerns."
   a. 8th September 2023
   b. Web link: https://www.bizjournals.com/denver/news/2023/09/08/lightwave-logic-expands-lab-commerical-arm.html
   c. The Denver Business Journal reports on business activities in the Denver tech center region. https://www.bizjournals.com/denver/ Interview location at Lightwave Logic Headquarters in Englewood, Colorado.

383) Invited talk at HC Wainwright conference called: 'H.C. Wainwright 25th Annual Global Investment Conference', with a talk entitled, "Making the internet faster and more efficient" and link to website: https://journey.ct.events/hub/37dab2e5-2e54-48d4-9288-d6a3d11a986c and https://hcwco.com
   a. 11 and 12th September 2023 (talk on 11th September 2023)
   b. Meeting organized by HC Wainwright Investment Banking (https://hcwco.com and https://journey.ct.events/vpages/37dab2e5-2e54-48d4-9288-d6a3d11a986c/ae480130-ce5f-4513-9cd1-81afdb08853a). Location: Lotte Palace Hotel, New York City, NY

384) Invited article for Techradar: The Business Technology Experts (www.techradar.com) entitled: "Artificial intelligence is a very real data center problem"
   a. Published 18th September 2023
   b. Web link: https://www.techradar.com/pro/artificial-intelligence-is-a-very-real-data-center-problem
   c. The techradar pro (https://www.techradar.com/pro)

385) Chair of technical committee for ECOC exhibit's Market Focus sessions at ECOC 2023, at the SECC conference center, Glasgow, Scotland.
   a. 2nd – 4th October 2023
   b. Six Market Focus sessions and two panels were organized for ECOC Market Focus 2023 with sessions in broadband access, datacentres, service provider optical transmission, network agility/SDN, photonics integration, new component technologies and packet optical transport. ECOC exhibit organized by Nexus Business Media Ltd.
   c. https://www.ecocexhibition.com/ecoc-exhibition-2022/ and highlights including photographs at: https://www.ecocexhibition.com/home/2023-highlights/

386) Session Chair for two sessions at ECOC's Market Focus session 1 and session 2 on modules/sub-systems.
   a. 2nd October 2023
   b. These two sessions (am and pm) attracted up to 400 attendees in various talks, and focused on optical pluggable modules and transceivers, and their associated line cards, switches, routers and sub-system optical networking equipment.

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c. The sessions can be found at: https://www.ecocexhibition.com/visit/market-focus/market-focus-2023-timetable/ The Market Focus sessions were held at the SECC conference center, Glasgow, Scotland.

387) Awards committee chairman, Market Focus, ECOC exhibit, 2023. With role to present 9 awards to winners of industrial product-based technologies in optical communications.
   a. 3rd October 2023
   b. The Market Focus awards https://www.ecocexhibition.com/home/2023-highlights/ is a competition that is run by the technical committee with submissions from various industrial companies globally.
   c. The awards were presented to winners at the Product Focus auditorium to 9 winners on 3rd October 2023 (https://www.ecocexhibition.com/industry-awards/) at ECOC's exhibit, SECC conference center, Glasgow, Scotland.

388) Selected talk and speaker at ECOC's Market Focus session on modules/sub-systems. Talk was entitled, "Commercializing reliable hybrid electro-optic polymer modulators" and can be found at: https://www.ecocexhibition.com/visit/market-focus/
   a. 2nd October 2023
   b. Every year the Market Focus is the key place to get up-to-date knowledge from across the industry in key technical areas and discover the latest commercial trends in optical communications. Now in it's 17th year the Market Focus theatre is one of the highlights of the ECOC Exhibition attracting the world's best speakers from the industry globally.
   c. Talk can be found from the Market Focus session talks at: https://www.ecocexhibition.com/visit/market-focus/market-focus-2023-timetable/

389) Invited video interview by ECOC TV: "2023 Market Focus review in Glasgow, Scotland" as Chairman of ECOC 2023 Market Focus Technical Committee at the conference.
   a. Recorded 3rd October 2023
   b. Market Focus Exhibition for ECOC 2023,
   c. Hosted by ECOC exhibition: https://www.ecocexhibition.com/visit/market-focus/ and https://www.ecocexhibition.com/home/2023-highlights/

390) Invited video interview by ECOC TV for industrial award competition opening for 2024's ECOC at Frankfurt, Germany as Chairman of ECOC Market Focus Technical Committee.
   a. Recorded 3rd October 2023
   b. Market Focus Industrial Awards competition for ECOC 2024.
   c. Hosted by ECOC exhibition: https://www.ecocexhibition.com/visit/market-focus/ and https://www.ecocexhibition.com/home/2023-highlights/

391) Invited video interview by ECOC TV for invited abstracts for 2024's Market Focus technical sessions at ECOC at Frankfurt, Germany as Chairman of ECOC Market Focus Technical Committee.
   a. Recorded 3rd October 2023
   b. Market Focus invite for abstracts for ECOC 2024.

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c. Hosted by ECOC exhibition: https://www.ecocexhibition.com/visit/market-focus/ and https://www.ecocexhibition.com/home/2023-highlights/

392) Winner: Acceptance of glass trophy for ECOC Industry awards on behalf of Lightwave Logic Inc. in the most innovative hybrid/PIC (photonic integration circuit) integration platform: https://www.ecocexhibition.com/visit/ecoc-exhibition-industry-awards/

a. 3rd October 2023
b. Held at the Product Focus session, ECOC Exhibition Industry Award Winner Announcement (https://www.ecocexhibition.com/home/2023-highlights/)
c. ECOC 2023, Glasgow, Scotland. The award is for the most innovative product platform in hybrid PICs across the industry—what new product is driving change in its respective market segment. What's timely and helping to increase the use of optics. Metrics would include design features that are photonics, electronics, thermal, mechanical, chemical, environmental and carbon footprint based (https://www.ecocexhibition.com/industry-awards/).

393) Invited video 'Lightwave Logic advancing its silicon photonic prototypes" by Proactive, (https://www.proactiveinvestors.com), and is interviewed by Tom Warner with video https://www.proactiveinvestors.co.uk/companies/news/1028712/lightwave-logic-picks-up-industry-award-for-its-work-in-speeding-up-the-internet-1028712.html

a. 4th October 2023
b. Proactive video (Wall St) series (https://youtu.be/amz8jxV9YS4)
c. Lightwave Logic, Inc. (NASDAQ: LWLG) CEO Michael Lebby is interviewed live at ECOC 2023 show floor with a glass trophy in hand from winning the hybrid/PIC integration platform award at Market Focus Awards (https://www.ecocexhibition.com/industry-awards/)

394) Invited video interview by ECOC TV: "2023 Industry Award Winners ECOC Exhibition, Glasgow, Scotland" as Chairman of ECOC 2023 Market Focus Technical Committee at the conference: https://youtu.be/k_CYdV7CDd0

a. Recorded 3rd October 2023 and published 13th October 2023
b. Industry awards interview can be found at: https://youtu.be/k_CYdV7CDd0
c. Hosted by ECOC exhibition: https://www.ecocexhibition.com/visit/market-focus/ and https://www.ecocexhibition.com/home/2023-highlights/

395) Invited video interview by ECOC TV: "Winner of Most innovative Product – Hybrid PIC/Optical Integration Platform for Lightwave Logic Inc., https://youtu.be/KYYQjVHfDq8

a. Recorded 3rd October 2023 and published 13th October 2023
b. Industry winning award interview can be found at: https://youtu.be/KYYQjVHfDq8
c. Hosted by ECOC exhibition: https://www.ecocexhibition.com/visit/market-focus/ and https://www.ecocexhibition.com/home/2023-highlights
d.

396) Invited speaker at the Photonics Enabled Cloud Computing (PECC) Summit organized by Optica

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(https://www.optica.org/events/industry_events/2023/optica_photonic-enabled_cloud_computing_industry_summit_at_juniper_networks/program/) Talk entitled: "Commercializing Electro-Optic Polymers" and was given in the 5th session on Materials and Components to Advance Optical Technologies.

a. 24-25th October 2023; talk took place on 25th October 2023
b. Organized by Optica (https://www.optica.org/events/industry_events/2023/optica_photonic-enabled_cloud_computing_industry_summit_at_juniper_networks/)
c. Located at Juniper's conference facility, Sunnyvale, California.

397) Invited co-speaker at PIC Summit Conference, Eindhoven, Netherlands in conjunction with IPSR conference for Polymers

a. 8th November 2023
b. PIC Summit Europe conference. https://www.picsummiteurope.com
c. Located at the TU/e Eindhoven University, Netherlands.

398) Invited co-speaker at PIC Summit Conference, Eindhoven, Netherlands in conjunction with IPSR conference for datacom and telecom

a. 8th November 2023
b. PIC Summit Europe conference. . https://www.picsummiteurope.com
c. Located at the TU/e Eindhoven University, Netherlands.

399) Project advisor and panelist: European Commission HORIZON-CL4-2022-DIGITAL-EMERGING-01-03 CORALIDAR EU project number 101092834 for 1st review meeting (virtual).

a. 30th November 2023
b. European Commission: https://corali-dar.eu
c. CORA-LIDAR: Collaborative Radio - Light Detection And Ranging

400) Invited Live TV interview: Benzinga All Access Fireside Chat (15mins inclusive of Q&A) as part of the Zunaid Suleman show.

a. TV interview on 4th December 2023 with youtube recording: https://www.youtube.com/watch?v=CEZ51a_HTpY
b. Video interview can be found at: https://www.benzinga.com and https://www.youtube.com/watch?v=CEZ51a_HTpY and the Zunaid Suleman show/background at https://www.benzinga.com/events/speakers/zunaid-suleman/
c. Location: Virtually recorded in New York, NY

2024

401) Invited speaker and oral presentation for the Sequire Investor Summit, San Juan, Puerto Rico. The presentation was entitled, "LWLG January 2024 investor presentation" with link https://puertorico.srax.com with agenda: https://schedule.puertorico.srax.com

a. Conference on 24th and 26[5h] January 2024 with presentation on 24th January 2024
b. Link to website for Sequire event: https://puertorico.srax.com
c. Investor conference at the Conadado Vanderbuilt hotel San Juan, Puerto Rico.

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402) Introducing speaker and moderator for Optica's VIP executive meeting at MOMA (as part of Photonics West conference in San Francisco, CA). Moderating Alan Lowe through Q&A with an audience of >400.
   a. 29th Jan 2024
   b. Details can be found at www.optica.org
   c. Location: Museum of Modern Art, San Francisco,

403) Reviewer: (European Commission) for project InSiDe
   a. 30th Jan 2024
   b. Virtual meeting for the consortium.
   c. InSiDe is an EU project for PIC based technology in the medical field to monitor blood flow and artery stiffness in the human body using long wavelength lasers and silicon photonics. Hospital clinical trials will be conducted. It is a follow-on with more clinical trials from an initial CARDIS EU project.
   d. http://www.inside-h2020.eu

404) Chair and moderator/host for EPIC Photonics VIP executive reception, located at 1 Hawthorne Street, San Francisco, CA 94105.
   a. 30th Jan 2024
   b. Located at 1 Hawthorne St., San Francisco which attracted over 150 attendees.
   c. The EPIC VIP executive reception is the 4th in the series and was organized by EPIC Photonics.
   d.

405) Interviewer & Chair and moderator for Optica's VIP executive reception, located in parallel with SPIE's Photonics West 2024. The role included a speech to introduce Lumentum's President and CEO Alan Lowe, and to moderate questions and answers (on behalf of having the role of Chair, Corporate Engagement Council, Optica).
   a. 30th Jan 2024
   b. Located at the auditorium of the San Francisco Museum of Modern Art (SF-MOMA), which attracted a sellout of 500 guests.
   c. The Optica VIP executive reception is the 2nd in the series, with the first being held in 2023.

406) Project advisor and panelist: European Commission HORIZON-EIC-2022-TRANSITION OPEN-01 (ALUVIA) EU project number 101099699 for 1st review meeting (virtual).
   a. 16th February 2024
   b. European Commission: https://aluvia-project.eu
   c. ALUVIA: Aluminium oxide integrated photonic platform for applications in the ultraviolet (UV)

407) Invited and recorded TV interview: Benzinga All Access Fireside Chat (15mins inclusive of Q&A) as part of the Zunaid Suleman show.
   a. Recorded TV interview on 23rd February 2024 for release 1st March 2024 https://www.youtube.com/watch?v=CEZ51a_HTpY

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b. Video interview can be found at: https://www.benzinga.com and https://www.youtube.com/watch?v=CEZ51a_HTpY and the Zunaid Suleman show/background at https://www.benzinga.com/events/speakers/zunaid-suleman/
c. Location: Virtually recorded in Washington, DC.

408) Project advisor and panelist: European Commission Cordis InPULSE (jeppix) EU project number/grant agreement 824980 for 3rd review meeting (virtual).
a. 14th March 2024
b. European Commission: https://cordis.europa.eu/project/id/824980/reporting and https://www.jeppix.eu
c. InPULSE: Establishing a proven European PIC ecosystem by building an open access pilot line as well as InP pilot line for scaled up, self-sustained PIC eco-system.

409) Invited speaker and panelist for OFC workshop entitled "Will Heterogeneous Integration Meet the Needs of Future Applications?" (https://www.ofcconference.org/en-us/home/program-speakers/workshops/will-heterogeneous-integration-meet-the-needs/) in OFC 2024, San Diego, California. Presnetation was entitled, "Electro-optic polymers for heterogeneous integration."
a. 24th March 2024
b. Details of the event can be found at https://www.ofcconference.org/en-us/home/program-speakers/ and agenda at (https://www.ofcconference.org/en-us/home/program-speakers/workshops/will-heterogeneous-integration-meet-the-needs/) Panelists included: Wim Bogaerts, *Ghent University, Belgium*, Alex Chikhaoui, *X-Celeprint, Ireland*, Ivan Huang, *Avicena Tech, United States,* Sylvie Menezo, *Scintil, France,* Edward Preisler, *Tower Semiconductor, United States*, Mian Zhang, *Hyperlight, United States*
c. Location: Live at San Diego conference center, San Diego, California

410) Invited moderator for Optica's Executive forum CEO panel at OFC 2024 in San Diego, California, (https://www.optica.org/events/industry_events/2024/optica_executive_forum_at_ofc_2024/program/). The CEO panel consisted of: David Heard CEO, Infinera, Alan Lowe CEO, Lumentum, Chuck Mattera CEO, Coherent, Bill Brennan CEO, Credo
a. 25th March 2024
b. Details of the Executive Forum can be found at: https://www.optica.org/events/industry_events/2024/optica_executive_forum_at_ofc_2024/ located at the Hilton Bayfront, San Diego, California

411) Invited video "Lightwave Logic Demonstrates World-Class 200Gbps Heterogeneous Polymer/Silicon Photonic Modulator Results through Extending Silicon Photonics Performance using its Proprietary Perkinamine® Electro-Optic Materials Based on 200mm Commercial Wafers at the 2024 Optical Fiber Conference in San Diego" by Proactive, (https://www.proactiveinvestors.com), and is interviewed by Steve Darling with link: Lightwave Logic Leads the Way in Electro-Optic Polymer Technology for Enhanced Data Transmission
a. 4th April 2024 (published 11:21am)

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b. Proactive video (Wall St) series (https://www.proactiveinvestors.com/NASDAQ:LWLG/Lightwave-Logic-Inc)
c. Lightwave Logic, Inc. (NASDAQ: LWLG) Chairman and CEO Michael Lebby is interviewed after OFC2024.

412) Invited speaker: LD Micro Invitational XIV conference at Sofitel Hotel New York, NY with presentation entitled, "Lightwave Logic status and update" https://ldinv14.sequireevents.com/ and https://www.meetmax.com/sched/event_103991/investor_welcome.html
a. 8th and 9th April 2024 with oral presentation on 9th April 2024
b. Presentation at https://api.mziq.com/mzfilemanager/v2/d/307dbc8b-e212-48ba-9968-8cef3f6b5188/683426d1-5a08-bc3a-6df3-ce127bd5ef17?origin=2
c. Hosted by LD Micro NASDAQ: SRAX with URL: http://www.ldmicro.com

413) Project advisor and panelist: European Commission PhotonHub EU project number/grant agreement 101016665 for 2nd review meeting (virtual). Project call DT-ICT-04-2020 - Photonics Innovation Hubs
a. 11th and 12th April 2024
b. European Commission: https://www.photonhub.eu and https://cordis.europa.eu/project/id/101016665
c. PhotonHub: PhotonHub Europe is a unique European full-service one-stop-shop Photonics Innovation Hub to advance EU competitiveness.

414) Invited Chair and conference moderator for the 1st and inaugural ESS (Executive Strategy Summit) – a global perspective that includes electronics, semiconductors, photonics, sensing with focus a) economic trends and market drivers, b) funding opportunities , c) intellectual property, patents, mergers and acquisitions. https://angel-tech.net/executivestrategysummit/agenda
a. 15th April 2024
b. Brussels, Belgium
c. https://angel-tech.net/executivestrategysummit The conference will delve into key topics such as emerging economic trends, disruptive technologies, market forecasts, and funding strategies. By exploring these areas, attendees will gain a deeper understanding of the market landscape and the implications for their business strategies. Moreover, they will gain valuable insights into how to navigate the complex funding landscape and capitalize on growth opportunities in the CS, PIC and PE industries.

415) Invited panel speaker for PIC (PIC International Conference) panel entitled, "Advancing the frontier of photonic integration: challenges and innovations in PIC packaging" with panel members from PHIX, LWLG, Tyndall National Institute (PIXAPP), POET Technologies. https://picinternational.net/agenda
a. 16th April 2024
b. Brussels, Belgium
c. https://picinternational.net The 9th PIC International conference aims to connect, educate, and inspire the photonic integrated circuit (PIC) industry. With presentations covering seven sectors, attendees will gain insights into topics like

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Hybrid PICs: Pioneering New Frontiers in Photonic Integration; PIC Packaging: Securing Optimal Integration and Performance; Quantum Era: Unleashing PICs' Boundless Potential; Rapid Scaling: Foundries Fuelling PICs' Mass Production; Accelerating PIC Adoption in Established Markets; PIC Size and Simulation: Enhancing Design Efficiency, and Power Efficiency: Minimizing Consumption in PICs.

416) Invited conference co-chair (with David Cheskis) for 9th PIC (PIC International Conference) https://picinternational.net/agenda
   a. 16th and 17th April 2024
   b. Brussels, Belgium
   c. https://picinternational.net The 9th PIC International conference aims to connect, educate, and inspire the photonic integrated circuit (PIC) industry. With presentations covering seven sectors, attendees will gain insights into topics like Hybrid PICs: Pioneering New Frontiers in Photonic Integration; PIC Packaging: Securing Optimal Integration and Performance; Quantum Era: Unleashing PICs' Boundless Potential; Rapid Scaling: Foundries Fuelling PICs' Mass Production; Accelerating PIC Adoption in Established Markets; PIC Size and Simulation: Enhancing Design Efficiency, and Power Efficiency: Minimizing Consumption in PICs.

417) Invited speaker for 9th PIC International Conference with talk entitled, "High speed, low power, tiny modulators in a polymer PIC platform are poised to enable 800G/1.6Tbps data communications, driven in part by artificial intelligence." https://picinternational.net/agenda
   a. 16th April 2024
   b. Brussels, Belgium
   c. https://picinternational.net The 9th PIC International conference aims to connect, educate, and inspire the photonic integrated circuit (PIC) industry. With presentations covering seven sectors, attendees will gain insights into topics like Hybrid PICs: Pioneering New Frontiers in Photonic Integration; PIC Packaging: Securing Optimal Integration and Performance; Quantum Era: Unleashing PICs' Boundless Potential; Rapid Scaling: Foundries Fuelling PICs' Mass Production; Accelerating PIC Adoption in Established Markets; PIC Size and Simulation: Enhancing Design Efficiency, and Power Efficiency: Minimizing Consumption in PICs.

418) Invited talk for Lightwave Logic (LWLG) retail investor base, Antwerp, Belgium. Investor as part of a multi-company retail investor conference. Talk entitled, "Recent commercial and technical progress in Lightwave Logic polymer modulators."
   a. 19th April 2024
   b. Crown Plaza Hotel, Antwerp, Belgium
   c. Organized by Belgium and Dutch retail investors as part of a 150 person conference.

419) Invited keynote speaker at Safecapital investor conference in Ghent with talk entitled, "Recent progress in commercializing electro-optic polymers" hosted by Brecht

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Arnaert, Chief Editor www.safecapital.eu with Safecapital Lente meeting, Vander Valk Hotel, Ghent.

a. 20th April 2024
b. Vander Valk Hotel, Ghent, Belgium
c. Safecapital organized a retail investor event with an invite for Lightwave Logic to present and network with investors: https://tixoom.app/brechtarnaert/ur0v1eff

420) Project advisor and panelist: European Commission HORIZON-CL4-2021-DIGITAL-EMERGING-01-07 LOLIPOP EU project number 101070441 for 2nd review meeting (virtual).

a. 29th April 2024
b. European Commission: https://horizon-de-lolipop.eu
c. LOLIPOP: Lithium NiObate empowered siLIcon nitride Platform for fragmentation free OPeration in the visible and the NIR. Material technology includes LNOI (lithium niobate on insulator) and TFLN (thin film lithium niobate).

421) Invited speaker for HC Wainwright non-deal roadshow presenting Lightwave Logic investor presentations to selected funds, investment banks etc.

a. 30th April 2024
b. HW Wainwright banking https://hcwevents.com
c. HW Wainwright organized a NDR for LWLG Inc., https://hcwco.com/about-us/our-history/

422) Invited speaker and presentation at Lightwave Logic Annual Shareholder meetings 2024 with Business Management Update, and presentation entitled, "Lightwave logic CEO management review"

a. 22nd May 2024
b. Presentation can be found at: https://viavid.webcasts.com/viewer/event.jsp?ei=1661614&tp_key=0e4b468303

423) Invited speaker to chair Lightwave Logic Inc's Annual Shareholder Meeting (ASM) at the Inverness Hilton, Englewood, Colorado.

a. 22nd May 2024
b. Lightwave logic Inc., Denver, Colorado: https://viavid.webcasts.com/viewer/event.jsp?ei=1661614&tp_key=0e4b468303
c. Read script, chair voting procedures for Lightwave Logic Annual shareholder meeting for Lightwave Logic Inc.

424) Invited Webinar and virtual fireside chat with Maxim equity research analyst Matthew Galinko as part of their TMT Conference

a. 4th June 2024
b. Virtual interview/fireside chat and webinar.
c. Maxim equity research https://maximgrp.com/divisions/equity-research

425) Invited keynote speaker at ISLiST VII (VIIth International School of Light Sciences and Technologies (in collaboration with UIMP (Unversidad Internacional Menedez Pelayo), with keynote talk entitled, "Next Generation of Photonics Integrated Circuits as key for communications and sensing"

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a. 17th June 2024
b. Talk given at Palacio de la Magdalena (royal palace of Magdalena), Santander, Spain.
c. Conference organized by Professor Jose Miguel Lopez Higuera as part of light in communications, sensing and lighting.

426) Invited and recorded TV interview: Benzinga All Access Fireside Chat (15mins inclusive of Q&A) as part of the Zunaid Suleman show.
a. Recorded TV interview on 8th August 2024 for release 12th August 2024 https://www.youtube.com/watch?v=CEZ51a_HTpY
b. Video interview can be found at: https://www.benzinga.com and https://www.youtube.com/watch?v=CEZ51a_HTpY and the Zunaid Suleman show/background at https://www.benzinga.com/events/speakers/zunaid-suleman/
c. Location: Virtually recorded in San Francisco, CA.

427) Invited talk at HC Wainwright conference called: 'H.C. Wainwright 26th Annual Global Investment Conference', with a talk entitled, "Faster by design" and link to website: https://nqwfwxkab.cc.rs6.net/tn.jsp?f=001HNmOJkwLV6iDTd9M6szjF4dgaKY7RbqXCBMAl3-ZV_cJ5uO65rM2bMB8Cf3OFxUedu25J8jukebVGEuEcGEXoxga71OC9oBvxYr2CeTYhlMcyKD-l_RIhSgDvUQY_cOQUbN2rY5IGSX6ei8KBhK0r5woZnwTCRPx&c=oCrkIG6Is3Y1Q-3fBcnsY4AJ0IwiyDMzj3okgRwzDLURILnnZsoBnQ==&ch=3cs2_cAXlCQ8aLM2FB2Px9PgPlYrKVMe_hkBpE-iU-g1rHtTh5_huw==
a. 9th and 10th September 2024 (talk on 10th September 2024)
b. Meeting organized by HC Wainwright Investment Banking (https://my.ct.events/preview.aspx?type=attendee&meid=ca094a14-8507-4e5b-ab2c-f2a55c6e6913&jid=e762687f-678d-4ef7-8b88-b9b01f65aa4a&did=6bebbf91-e4f6-4177-b397-6858a60c6b8a&cid=8691ad74-8fa3-4b40-979c-e4e34a999c62). Location: Lotte Palace Hotel, New York City, NY

428) Invited interview with Jose Pozo, CTO Optica, at Lightwave Logic plant facilities, with the interview taking place in LWLG's chemistry and high speed testing laboratories.
a. 19th September 2024
b. Lightwave Logic Inc., facilities at Englewood, Colorado
c. https://www.linkedin.com/feed/update/urn:li:activity:7243920742885543936/

429) Invited talk Corporate Engagement Council, Optical Board of Directors, Strategic planning roadmap
a. 20th September 2024
b. Colorado Convention Center, Denver, Colorado
c. www.optica.com

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430) Invited talk ECOC Market Focus, entitled "World class performance for 200Gbps PAM4 and 400Gbps PAM4 lanes from electro-optic polymer modulators." Market Focus Exhibit session, opening talk, at ECOC 2024 conference (https://www.ecocexhibition.com/visit/market-focus/), and (https://www.ecocexhibition.com/visit/market-focus/market-focus-timetable-2024/)
   a. 23rd September 2024
   b. ECOC 2024, Messe convention center, Frankfurt, Germany
   c. Market Focus sessions as part of ECOC Exhibit, session on modules/sub-systems, opening talk

431) Invited fireside chat/interview with David Welch (Board member Infinera, and CEO of Atto-tude), as part of ECOC Market Focus session on modules/sub-systems, with Jose Pozo as host (https://www.ecocexhibition.com/visit/market-focus/market-focus-timetable-2024/)
   a. 23rd September 2024
   b. ECOC 2024, Messe convention center, Frankfurt, Germany
   c. Market Focus sessions as part of ECOC Exhibit, session on modules/sub-systems

432) Invited Chairman and moderator Market Focus, Sessions 1 & 2 Monday, and session 3 Tuesday (https://www.ecocexhibition.com/visit/market-focus/)
   a. 23rd and 24th September 2024
   b. ECOC 2024, Messe convention center, Frankfurt, Germany

433) Chairman and moderator Market Focus as part of ECOC Exhibit, Sessions called components/IC/PIC/Fiber as well as modules/sub-systems (https://www.ecocexhibition.com/visit/market-focus/market-focus-timetable-2024/)

434) Invited interview ECOC TV on Market Focus industry awards on day 2 of ECOC Exhibit with James Page, discussing day 1 market focus and the ECOC Market Focus industry awards ceremony.
   a. 24th September 2024
   b. ECOC 2024, Messe convention center, Frankfurt, Germany
   c. Interview by ECOC TV James Page, on market focus industry awards.

435) Invited interview ECOC TV on Lightwave Logic, and invited talk entitled "World class performance for 200Gbps PAM4 and 400Gbps PAM4 lanes from electro-optic polymer modulators." of market focus with James Page.
   a. 24th September 2024
   b. ECOC 2024, Messe convention center, Frankfurt, Germany
   c. Interview by ECOC TV James Page, on market focus industry awards.

436) Invited presenter for ECOC awards, as chair of industry awards committee https://www.ecocexhibition.com/industry-awards/ and https://youtu.be/wKRNdD6x-pg
   a. 24th September 2024
   b. ECOC 2024, Messe convention center, Frankfurt, Germany
   c. Product Focus session, ECOC Exhibition Industry Award Winner Announcement

437) Winner: Acceptance of glass trophy for ECOC Industry awards on behalf of Lightwave Logic in the optical hybrid integration category: https://youtu.be/KYYQjVHfDq8 and https://www.ecocexhibition.com/visit/ecoc-

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exhibition-industry-awards/ and https://opticalconnectionsnews.com/2024/10/ecoc-2024-exhibition-industry-awards/

a. 24th September 2024
b. Product Focus session, ECOC Exhibition Industry Award Winner Announcement
c. ECOC 2024, Messe convention center, Frankfurt, Germany

438) Invited panel moderator for CEO panel at the 1st Annual Meeting of Optica's Global Photonics Economic Forum (GPEF). Panel entited, "CEO Panel", with CEO's from Coherent (retired Chairman/CEO Chuck Vincent Mattera), Jabil (EVP Matt Crowley), Thorsten Mayer (CEO Vanguard representing Anders Linquist, CEO Mycronic), and John Lee, CEO MKS (https://www.optica.org/events/industry_events/2024/global_photonics_economic_forum_2024/schedule/)

a. 1st October 2024
b. Global Photonics Economic Forum (GPEF), FYMCA FYCMA, Palace of Congresses and Exhibitions
Málaga, Spain
c. Optica's GPEF can be found at: https://www.optica.org/events/industry_events/2024/global_photonics_economic_forum_2024/location/ and https://www.optica.org/events/industry_events/2024/global_photonics_economic_forum_2024/about/ . The Global Photonics Economic Forum aims to create a trusted platform for collaboration and innovation, addressing the industry's most pressing challenges and opportunities. With the rapid advancement of photonics technology and its increasing relevance across various sectors, the forum comes at a crucial time. The forum's discussions will explore the complexities introduced by geopolitical tensions, such as those surrounding the Chips Act, and the critical role of photonics in meeting the surging energy demands of artificial intelligence and data centers.

439) Invited interview optical connections by Peter Dykes, Editor, Optical connections. Subject: Lightwave Logic history, technology progress and future roadmap opportunities

a. 4th October 2024
b. Virtual video interview by Peter Dykes, Editor, Optical connections Magazine
c. Optical Connections has been providing the fibre optic community with the latest industry news and reports since 2011 via its website, monthly newsletter and now quarterly magazine. Optical connections media provides coverage of market influencing technology advancements, commercial prospects, product developments and editorial insight.

440) Interview with Benzina with Meg Flippin, entitled, "Lightwave Logic presents at European Conference on Optical Communications and takes home award" and can be found at: https://www.benzinga.com/partner/emerging-markets/24/10/41311612/lightwave-logic-presents-at-2024-european-conference-on-optical-communications-takes-hom

a. Published 14th October 2024

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b. Benzinga
c. Location: Virtually recorded at the Global Photonics Economic Forum, Malaga, Spain, October 2024

441) Industry award "Photonics 100 for 2025" by Europascience https://www.europascience.com/publications/ and Electro Optics Publication (photonics business applications and technology), https://www.electrooptics.com/ . The award is based on exceptional contributions and achievements in the field of photonics as well a level of dedication and innovation that continues to inspire and advance the photonics industry.
   a. 28th October 2024 (published and announced)
   b. Electro Optics Publication https://www.electrooptics.com/
   c. EO publication is a resource for entrepreneurs, engineers and researchers involved in photonics business, technology and applications. It gives access to news of the latest technological developments, trends and opinions in the photonics industry as well as independent, in-depth editorial content. It also provides informed commentary and analysis on topics of interest for those involved in the photonics industry.

442) Invited article from Gazettabyte (www.gazettabyte.com) and editor Roy Rubenstein on the review and reflections from 50th ECOC conference in Frankfurt, October 2024. Article can be located at; https://www.gazettabyte.com/home/2024/10/29/ecoc-2024-industry-reflections-final-part.html
   a. 29th October 2024 (published)
   b. Gazettabyte publication (https://www.gazettabyte.com)
   c. Gazettabyte is a resource for the optical community. It includes in-depth features on datacom and telecom topics as well as information targeted at individuals working in the optical industry.

443) Invited and recorded TV interview: Benzinga All Access Fireside Chat 20 mins inclusive of Q&A) as part of the Dan Leach show (https://www.youtube.com/watch?v=vhbdv8jXmvQ)
   a. Recorded TV interview on 12th November 2024 for release 14th November 2024
   b. Video interview can be found at: https://www.benzinga.com and https://www.youtube.com/watch?v=vhbdv8jXmvQ and the Dan Leach show/background
   c. Location: Virtually recorded in Englewood, Denver, CO.

444) Invited interview and article: Optical Connections News, Industry Focus, interview with Peter Dykes, Editor. Article titled, "Electro-optic polymers: A revolution in optical switching" www.opticalconnectionsnews.com
   a. 29th November 2024 (for release in Optical Connections News early 2025)
   b. Article can be found at www.opticalconnectionsnews.com
   c. Location: Virtually recorded in Englewood, Denver, CO.

445) Invited interview and/or podcast with "All things Photonics" from Photonics Spectra and Photonics Media.

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a. Published 10th December 2024 (recorded Nov 2024)
b. Article can be found at https://www.photonics.com/Podcast/Electro-Optic_Polymers_with_Michael_Lebby_and/p5/pc1/pce89
c. Location: Virtually recorded at Englewood, Denver, CO

2025

446) Invited interview with Laser Focus editor Justin Murphy, Editor, LASER FOCUS WORLD, on the subject of photonics, roadmaps, entrepreneurship and intrapreneurship, current trends in the industry and taking technologies from research to volume production. .
   a. 8th January 2025
   b. Laser Focus world can be found at: https://www.laserfocusworld.com and the magazine at: https://www.laserfocusworld.com/magazine
   c. Laser Focus World

447) Invited moderator for Optica's VIP Executive Reception at the Museum of Modern Art (MoMA) as part of Photonics West Conference, San Francisco, 2025 to introduce and chair the question and answer session for Teledyne Technology's CEO Edwin Roks, https://www.optica.org/events/industry_events/2025/vip_executive_reception/
   a. 27th January 2025
   b. Optica's reception talk can be viewed at: https://www.youtube.com/watch?v=-v9S6-2Lvz8
   c. Location: Museum of Modern Art, San Francisco, as part of SPIE's Photonics West conference.

448) Keynote speaker for EPICs EU Projects, Pilot Lines & Innovation Hubs Breakfast event with a talk entitled, "Innovative approaches to commercialize photonics" https://epic-photonics.com/events/eu-projects-innovation-hubs-breakfast-2025/
   a. 28th January 2025
   b. Location: W hotel San Francisco, as part of SPIE's Photonics West Conference, 2025

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