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,
Petitioners,

v.

W&WSENS DEVICES INC.,
Patent Owner.

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

PATENT OWNER'S PRELIMINARY RESPONSE

TABLE OF CONTENTS

Page

I. INTRODUCTION 1

II. OVERVIEW 3

A. There Was a Long-Felt Need to Increase the Sensitivity of Thin-Silicon Photodetectors 3

B. The '948 Patent Uses Microstructures to Increase the Sensitivity of Thin-Silicon Photodetectors 7

C. The Examiner Found That the Prior Art Lacks In-Pillar Holes in Side-Insulated Pillars 9

D. Kuboi Does Not Disclose a Microstructure-Enhanced Photodetector Device 13

E. Vasylyev Does Not Disclose Pillars or In-Pillar Holes 15

F. Shinohara Does Not Disclose Microstructures 16

III. SAMSUNG'S CHALLENGE AND ASSERTED REFERENCES 16

IV. LEVEL OF ORDINARY SKILL IN THE ART 17

V. THE CHALLENGED CLAIMS ARE PATENTABLE 17

A. Kuboi Does Not Disclose an Array of Pillars (Grounds 1-4) 17

B. Kuboi Does Not Disclose the Holes Fabricated As Recesses in Pillars (Grounds 1-4) 21

1. Kuboi Does Not Disclose Holes that Enhance Light Absorption of the Photodetectors (Grounds 1-4) 22

2. Kuboi Does Not Disclose Holes Fabricated as Recesses At or Under the Light-Receiving Surface of Each Pillar (Grounds 1-4) 24

3. Kuboi Does Not Disclose Holes That are Filled at Least Partly with Solid Dielectric Material (Grounds 1-4) 30

C. The Asserted References Do Not Disclose In-Pillar Holes That Increase Light Absorption "By a Factor of At Least 1.1" (Grounds 1-4) 38

D. The '948 Patent is Enabled by its Specification (Ground 5).....41

1. The Specification Teaches a POSITA How to Make and Use the Claimed Invention.....42

2. The Examiner in a Divisional Patent's Examination Dropped its § 112(a) Rejection in Response to Patent Owner's Arguments 44

VI. CONCLUSION.....45

TABLE OF AUTHORITIES

Page(s)

Cases

China Lithium Battery Tech. Co. v. Contemporary Amperex Tech. Co.,
No. PGR2022-00008, Paper 8 (P.T.A.B. Jun. 6, 2022).....42

Enzo Life Sciences, Inc. v. Roche Molecular Sys., Inc.,
928 F.3d 1340 (Fed. Cir. 2019) 42

Travelocity.com L.P. v. Cronos Techs., LLC,
No. CBM2014-00082, Paper 12 (P.T.A.B. Oct. 16, 2014) 17

United States v. Telectronics, Inc.,
857 F.2d 778 (Fed. Cir. 1988) 42

Western Digital Techs., Inc. v. Godo Kaisha IP Bridge 1,
No. IPR2025-00701, Paper 11 (P.T.A.B. Oct. 8, 2025).....26

Statutes

35 U.S.C. § 312(a)(3).....24

PATENT OWNER'S EXHIBIT LIST

Exhibit	Description
2001	Messages between W&Wsens and Samsung (April 25, 2019 through April 26, 2019)
2002	Messages between W&Wsens and Samsung (April 27-28, 2019, August 14, 2019, February 20, 2020)
2003	Messages between W&Wsens and Samsung (April 27, 2019, August 14-15, 2019, February 20, 2020)
2004	Messages between W&Wsens and Samsung (April 24-25, 2019, May 14, 2019, August 14, 2019, March 3, 2020)
2005	W&Wsens Devices Inc. presentation – Thin Silicon Photosensors for The Next Generation
2006	Excerpts from the file history of U.S. Patent No. 10,348,240
2007	Excerpts from the file history of U.S Patent No. 10,587,095
2008	Excerpts from Plaintiff W&Wsens Devices Inc.'s Supplemental Objections and Responses to Defendants' First Set of Interrogatories (Nos. 1, 3, 4, and 5), *W&Wsens Devices, Inc. v. Samsung Elecs. Co*., No. 24-cv-00854-JRG, E.D. Tex., served October 1, 2025
2009	Excerpts from Plaintiff W&Wsens Devices Inc.'s Objections and Responses to Defendants' First Set of Interrogatories (Nos. 1-11), *W&Wsens Devices, Inc. v. Samsung Elecs. Co*., No. 24-cv-00854-JRG, E.D. Tex., served March 20, 2025
2010	Photon-trapping microstructures enable high-speed high-efficiency silicon photodiodes, Nature Photonics 11, 301-308 (2017)
2011	Order Denying Motion to Stay, *W&Wsens Devices, Inc. v. Samsung Elecs. Co*., No. 24-cv-00854-JRG, Dkt. No. 90 (E.D. Tex. Nov. 3, 2025)

Exhibit	Description
2012	Second Amended Docket Control Order, *W&Wsens Devices, Inc. v. Samsung Elecs. Co*., No. 24-cv-00854-JRG, Dkt. No. 54 (E.D. Tex. April 22, 2025)
2013	Order, *Resonant Sys., Inc. v. Sony Grp. Corp.*, No. 2:22-cv-00424-JRG, Dkt. No. 84 (E.D. Tex. July 9, 2024)
2014	Order, *Gen. Access Sols., Ltd. v. Cellco P'ship*, No. 2:22-cv-00394-JRG, Dkt. No. 225 (E.D. Tex. May 22, 2024)
2015	Order, *Cal. Inst. of Tech. v. Samsung Elecs. Co.*, No. 21-cv-00446-JRG, Dkt. No. 108 (E.D. Tex. Jan. 20, 2023)
2016	U.S. District Court – National Judicial Caseload Profile Federal for the Eastern District of Texas (June 2025)
2017	Excerpts from Defendants' Supplemental Invalidity Contentions cover pleading, *W&Wsens Devices, Inc. v. Samsung Elecs. Co*., No. 24-cv-00854-JRG, E.D. Tex., served May 30, 2025
2018	U.S. Patent No. 10,622,498
2019	U.S. Patent No. 9,530,905
2020	Tech Times Webpage – Three types of photodiodes and their structure and operating principles, available at https://techtimes.dexerials.jp/en/photonics/three-types-of-photodiodes/
2021	U.S. Patent Application Publication No. 2020/0006416 ("*Baba*")
2022	Excerpts from file history of U.S. Patent Application No. 16/042,535
2023	PV Education Webpage – Optical Properties of Silicon, available at https://www.pveducation.org/pvcdrom/materials/optical-properties-of-silicon#
2024	TechInsight – The state of the art of CMOS Image Sensors, by Ziad Shukri, presented at IISW 2021

Exhibit	Description
2025	Excerpts from "Introduction to Solid State Physics," by Charles Kittel (7th ed. 1996)
2026	U.S. Patent Application Publication No. 2011/0309331 ("Yu-331")
2027	U.S. Patent Application Publication No. 2014/0016660 ("Lunev")
2028	Intentionally Omitted
2029	Excerpts from "Electrical Engineering Dictionary," by Phillip. A. Laplante, CRC Press LLC 2000
2030	PatDocs Machine Translation of JP3423279B2 to Hiramoto
2031	Wikipedia webpage, "Beer-Lambert law" available at https://en.wikipedia.org/wiki/Beer-Lambert_law, dated October 8, 2025
2032	"Understanding the Limits of the Bouguer-Beer-Lambert Law," by T. Mayerhöfer, et al., Spectroscopyonline, available at https://www.spectroscopyonline.com/view/understanding-the-limits-of-the-bouguer-beer-lambert-law, dated 2023-2024
2033	JP3423279B2 to Hiramoto
2034	Excerpts from file history of U.S. Patent Application No. 19/036,506 (the "'947 Divisional") from Sept. 16, 2025 to Nov. 21, 2025
2035	U.S. Provisional Application 61/826,446 filed May 22, 2013

I. INTRODUCTION

The Director should deny institution of this Petition because the asserted references do not disclose the requisite integrated device having an "array of pillars" with side isolation and "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." These claimed microstructures play a critical role, as "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 [the] holes," a property that is absent from the asserted art.

Silicon photodetectors have many advantages, including high carrier mobility, mature manufacturing processes, and high quantum efficiencies for photoelectric conversion over most of the visible light range. However, because silicon is relatively transparent to red and infrared light, traditional silicon-based photodetectors struggled to achieve acceptable photoconversion efficiency, especially in dim-light settings. Ex. 1001 ("the '948 Patent") at 2:4-7. One solution to this problem is to increase the thickness of the photodetector, but this solution comes at the cost of decreased bandwidth in telecommunications applications and confounding manufacturing challenges as pixel dimensions continue to shrink. *Id.* at 2:7-9, 2:16-21. To increase the quantum efficiency of silicon photodetectors, W&Wsens invented microstructured, side-isolated pillars and in-pillar holes in thin

silicon with photodetectors, which dramatically improved their sensitivity in low-light situations.

Kuboi, the primary reference cited against the Challenged Claims (1-16) in Grounds 1 to 4, does not disclose an "array of pillars" or "holes that are fabricated as recesses at or under the light-receiving surface of each . . . of the pillars" because it takes an altogether different approach to this problem. Rather than introducing microstructures to enhance the efficiency of a silicon-based photodetector, Kuboi proposes a hybrid photodetector that replaces silicon with semiconducting ***organic films*** that perform the photoconversion.

Although Petitioner Samsung likens these organic films to the microstructures disclosed and claimed in the '948 Patent, they are very different concepts. Kuboi's organic film features do not ***enhance*** a silicon-based photodetector like the microstructured pillars and holes of the '948 Patent do. Instead, Kuboi's organic films themselves perform the photodetection, taking the place of conventional silicon-based photodetectors.

Samsung's attempt to combine Kuboi, Vasylyev, and Shinohara in Grounds 2 and 4 also fails because none of the asserted references—individually or in combination—disclose "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" that enhance light absorption by at least a factor of 1.1. Vasylyev does not disclose in-pillar holes at

all and instead describes light input ports and a focusing array. The Office reached the same conclusion when it allowed the '948 Patent after W&Wsens disclosed Vasylyev during prosecution, and Samsung does not identify any error in the Examiner's analysis. Accordingly, Grounds 2 and 4 fail to show it is more likely than not any claim of the '948 Patent is unpatentable.

Samsung's attempt to challenge the '948 Patent's claims under § 112(a) is also without merit. The specification and intrinsic record of the '948 Patent fully enable, a person of ordinary skill in the art to practice the claimed limitation of "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."

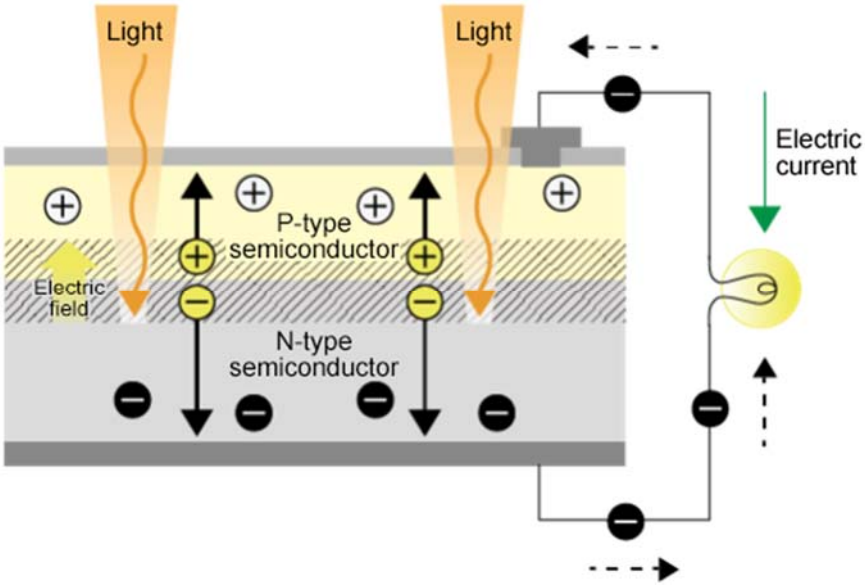
Thus, institution should be denied.

II. OVERVIEW

A. There Was a Long-Felt Need to Increase the Sensitivity of Thin-Silicon Photodetectors

There was a long-felt need to increase the effective absorption coefficient of thinner silicon in order to shrink pixels. *See* '948 Patent at 8:17-35. Each pixel in an active-pixel sensor (APS), like a CMOS (Complementary Metal-Oxide-Semiconductor) or CCD (Charge-Coupled Device) sensor, has an array of photodetectors and one or more active transistors. The photodetectors convert light into electricity that can be stored as a signal and read by a computer. These signals

measure the amount of light in a scene and, in combination, can be used to create an image. The cells of CMOS sensors are generally made from semiconducting silicon.



Ex. 2020 at 4 (showing schematic of photodiode structure).

To improve device performance, CMOS sensor designers have been increasing pixel count and shrinking individual pixel size so more pixels fit on the sensor and resolution rises. As the distance between adjacent pixel centers—the pixel pitch—decreases, chip designers have been increasing the active silicon thickness of the photodiode region to preserve light absorption and maintain image quality.

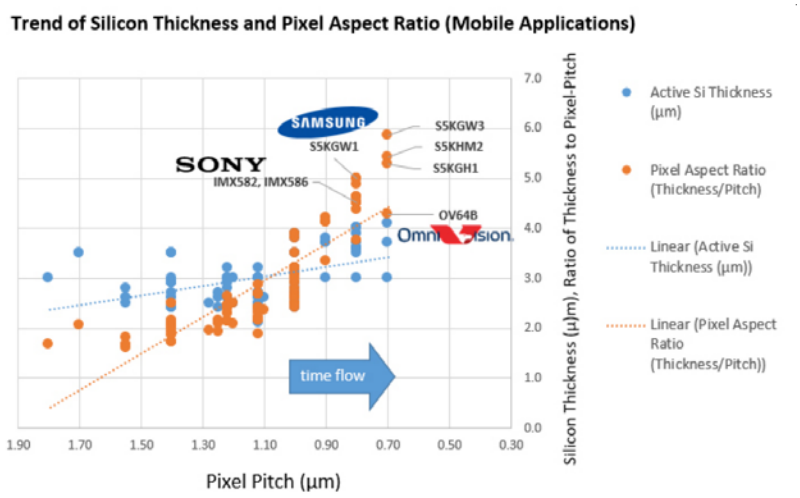
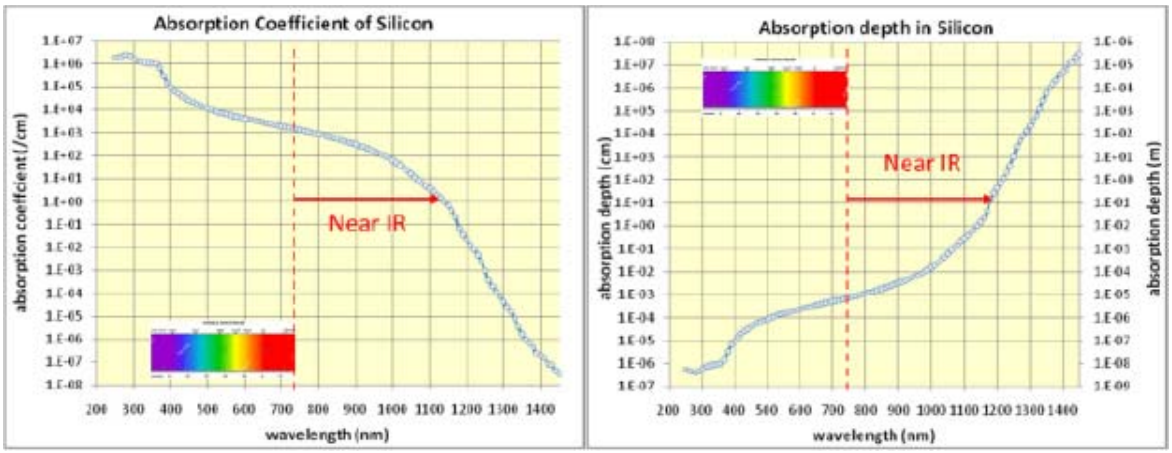


Figure 3 Trend of silicon thickness to pixel pitch ratio.

Ex. 2024 at 8, Fig. 3 (showing the trend of decreasing pixel pitch and increasing active silicon thickness over time).

Prior to W&Wsens' inventions, these trends had created significant challenges in ensuring sufficient light sensitivity and absorption, particularly once pixel dimensions shrunk to 1µm and below. Specifically, long-wavelength light (red to infrared) corresponds to silicon's indirect bandgap, which necessitates a relatively thick silicon layer to achieve acceptable sensitivity and absorption. '948 Patent at 2:7-18. For example, for wavelengths longer than 730nm, a thickness of at least 10µm of silicon would be necessary to absorb more than 64% of the incident light:



Ex. 2023 at 2-3 (annotations added) (illustrating silicon's decreasing ability to absorb longer wavelength light).

Fabricating silicon devices with such thickness while maintaining the smaller lateral dimensions of the pixels used in higher resolution CMOS sensors in the 1µm scale led to difficulties, including lower yield and increased costs for the CMOS sensors. Further reduction in pixel size requires a thinner absorption region, but thinning this region reduces detection efficiency, especially for light with wavelengths in the red to infrared part of the spectrum. Materials other than silicon, such as indium gallium arsenide (InGaAs), are relatively expensive and have high multiplication noise as compared to silicon. '948 Patent at 2:29-31; Ex. 1028 at 7 ("Silicon photode[]tectors and receiver OEICs, therefore, are the only choice when high volumes are needed and the price has to be low as, for instance, in consumer electronics.").

Thus, there was a long-felt need to increase the effective absorption coefficient of thinner silicon to shrink pixels while increasing photosensitivity. '948 Patent at 1:61-2:31, 8:17-35.

B. The '948 Patent Uses Microstructures to Increase the Sensitivity of Thin-Silicon Photodetectors

To overcome the limitations of conventional silicon CMOS sensors, W&Wsens' inventions use microstructures in the surface of pillars with light-sensitive silicon photodetectors. These microstructures, such as side-isolated pillars and holes, improve the silicon's sensitivity without the need for a thicker silicon absorption layer, which results in telecommunications bandwidths over 10 Gb/s for 850 nm wavelength light and photodetector quantum efficiencies exceeding 90%.[1] '948 Patent, Abstract and 10:13-23, 10:60-67, 11:45-51, 15:26-35.

This result is counterintuitive because the presence of holes reduces the amount of the pillars' photosensitive silicon material available to absorb incident light, which would have been expected to reduce light absorption. Yet the '948 Patent's photodetector device ultimately enhances the effective absorption length of the thin silicon because light interacts with the absorbing silicon layers for a longer

[1] "[Q]uantum efficiency η is defined as the number of photogenerated electron–hole pairs, which contribute to the photocurrent, divided by the number of the incident photons." Ex. 1028 at 25.

length of time, which the industry previously achieved by using a thick silicon layer. *Id.* at 8:17-35, 9:4-14. To capitalize on this invention, the '948 Patent claims "an integrated structure," such as the "high-speed high efficiency microstructured photodiode 520" of Fig. 5B, which has "an array of pillars" that are side-isolated and "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," an example of which is depicted in Fig. 49 reproduced below:

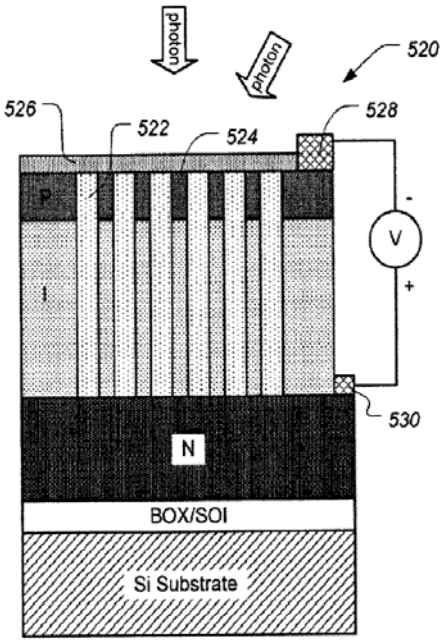


FIG. 5B

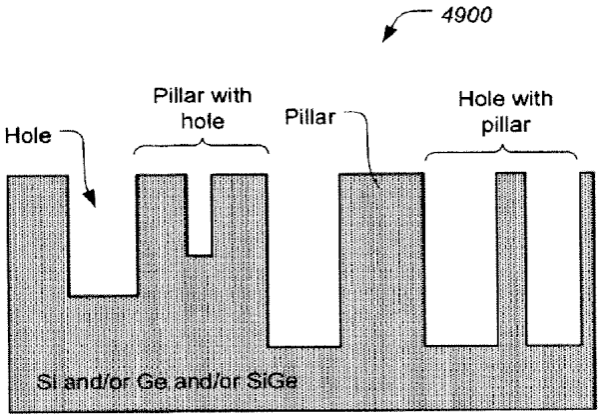


FIG. 49

'948 Patent, Fig. 5B; *see id.* at 55:38-43 (Claim 1), 16:9-59 (explaining embodiment in Fig. 5B), 55:48-53 (Claim 1), Fig. 49 (depicting an example "Pillar with hole"); *see also id.* at 49:52-50:33 (describing microstructured surface of Fig. 49).

This novel structure and arrangement of in-pillar holes results in a marked increase in light absorption compared to other photodetectors lacking these in-pillar holes. *Id.* at 55:64-67 (claims reciting "presence of said [] holes increase[] by a factor of at least 1.1 the absorption of the light by [] the photodetectors relative to like photodetectors lacking said holes").

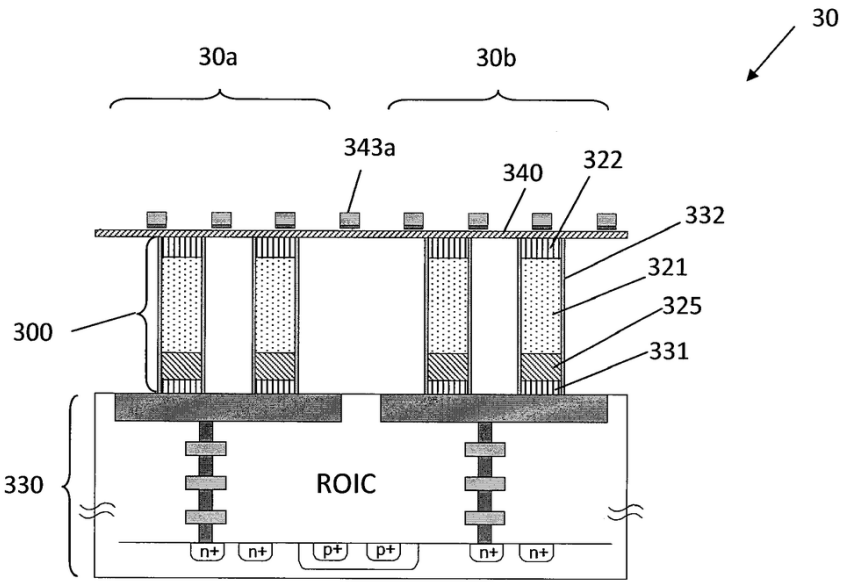
C. The Examiner Found That the Prior Art Lacks In-Pillar Holes in Side-Insulated Pillars

The Examiner explained in the '948 Patent's Reasons for Allowance that the prior art lacked the required in-pillar holes that improved absorption by a factor of at least 1.1:

> Regarding claim 1, the prior art of Yu et al. (US 2011/0309331) discloses in Fig. 5 and Lunev et al. (US 2014/0016660) discloses in Fig. 4B, pillar shaped photodetector devices, but ***fails to disclose the specific characteristic recited in the claims of the instant invention*** e.g. the combination of claimed features of ***an array of pillars*** with particular material composition and NP junction sensitive to visible and infrared wavelengths, ***one or more holes*** that are fabricated as recesses at or under the light receiving surface of at least some of the pillars, ***wherein at least some of the holes are elongated along the respective light receiving surfaces***, ***side isolation***, solid dielectric forming base dielectric,

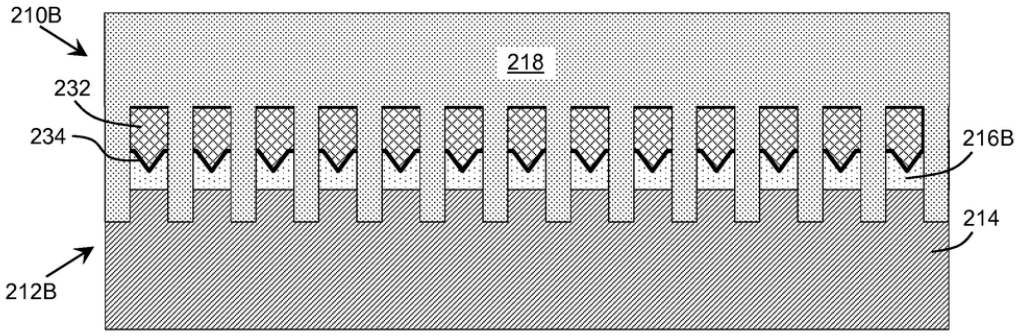
> electrical contacts and ***the presence of the holes increase absorption by a specific amount***.

Ex. 1003 at 22-23 (emphasis added); *id*. (finding now-issued Challenged Claim 13 allowable for similar reasons); *id*. at 22 ("[P]illar shaped photodetector device as recited in the claims of the instant invention fail to be taught by the prior art cited of interest."). The Examiner cited Fig. 5 of Yu-331 (Ex. 2026) (reproduced below) as disclosing "pillar shaped photodetector devices," but found that Yu-331 fails to disclose, among other elements, the presence of the claimed in-pillar holes that increase absorption by at least 1.1x:



Ex. 1003 at 22; Ex. 2026 (Yu-331), Fig. 5. The Examiner also cited Fig. 4B of Lunev (Ex. 2027) (reproduced below) as disclosing "pillar shaped photodetector devices," but found that Lunev similarly does not disclose in-pillar holes that increase absorption.

FIG. 4B



Ex. 1003 at 22; Ex. 2027 (Lunev), Fig. 4B.

During prosecution, the Examiner identified certain prior art as having "similar structures depicting the state of the art at the time of the invention" but that these references did not have sufficient disclosure to invalidate the Challenged Claims. Ex. 1003 at 296-298. For example, the Examiner cited a vertical pillar structured photovoltaic device disclosed in U.S. Patent No. 9,515,218 to Yu as having similar but distinguishable structures as the then-pending '948 claims.

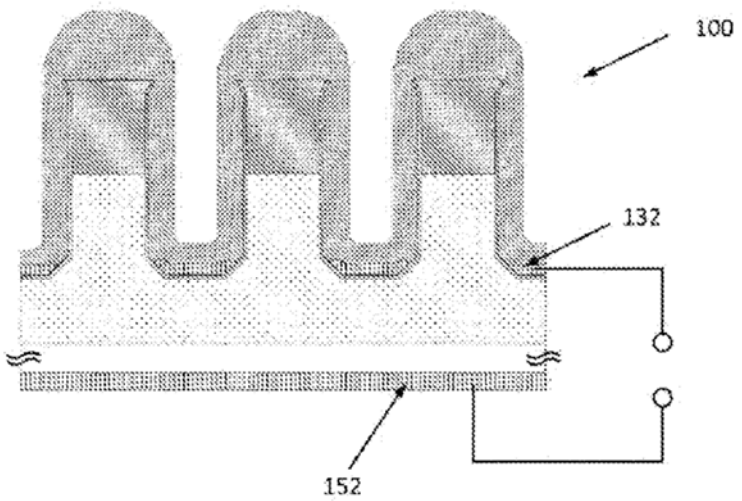
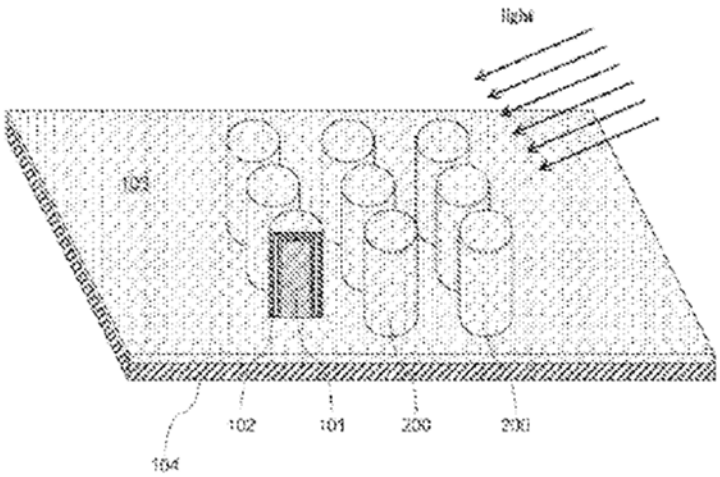
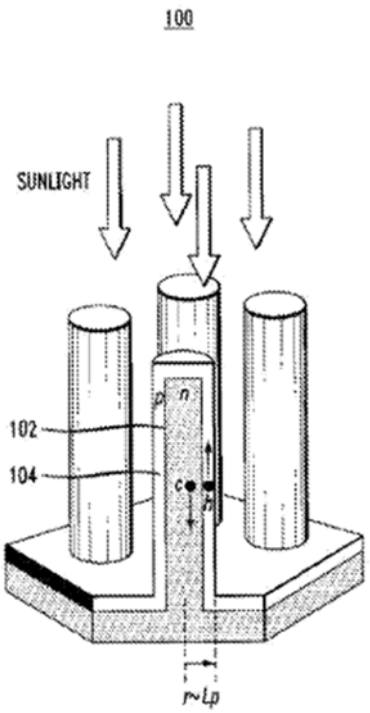


Fig. 8A

Id. at 296 (citing U.S. Pat. No. 9,515,218 to Yu, Fig. 8A). In another example, the Examiner cited to a nanopillar tunneling photovoltaic cell disclosed in U.S. Patent Publication No. 2013/0125965 to Hazeghi et al., reproduced below, as having structures distinguishable from the then-pending '948 Patent claims.



Ex. 1003 at 296 (citing U.S. Patent Pub. No. 2013/0125965 to Hazeghi et al., Fig. 1). Lastly, the Examiner cited to techniques for fabricating nanowire and microwire-based solar cells, disclosed in U.S. Patent Publication No. 2012/0196401 to Graham, reproduced below, but found that, like the other references, it did not disclose the claimed structures.



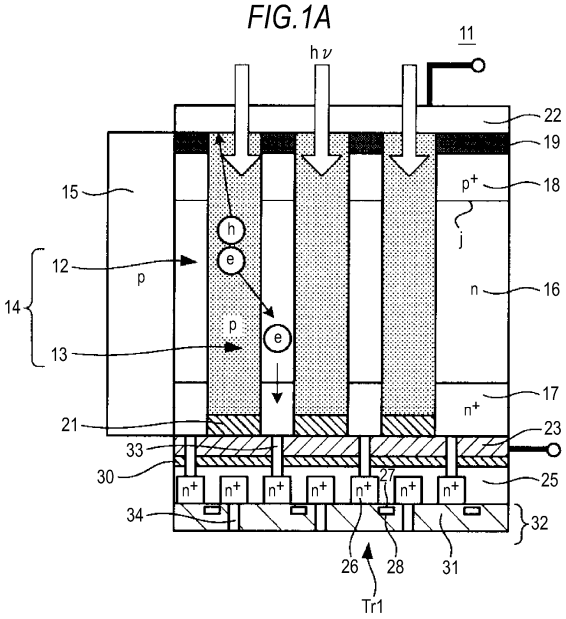
Ex. 1003 at 297 (citing U.S. Patent Pub. No. 2012/0196401 to Graham, Fig. 1).

Thus, the Examiner repeatedly distinguished the '948 Patent over the prior art for the Claims' specific recitations of an "array of pillars" with side isolation, "one or more holes that are fabricated as receives at or under the light-receiving surfaces of . . . some of the pillars," or the holes enhancing light absorption by a specific amount. As set forth below, Samsung's asserted references in this IPR also lack these key features.

D. Kuboi Does Not Disclose a Microstructure-Enhanced Photodetector Device

Kuboi (Ex. 1004) does not disclose an integrated structure enhanced by microstructures, such as pillars and holes, as is required by the Challenged Claims. It discloses a "solid-state imaging device" that includes photodetectors with a

"hybrid photoelectric conversion portion 14" having "organic material layers 13" embedded in a silicon "semiconductor layer 12." Kuboi at [0001], [0055].

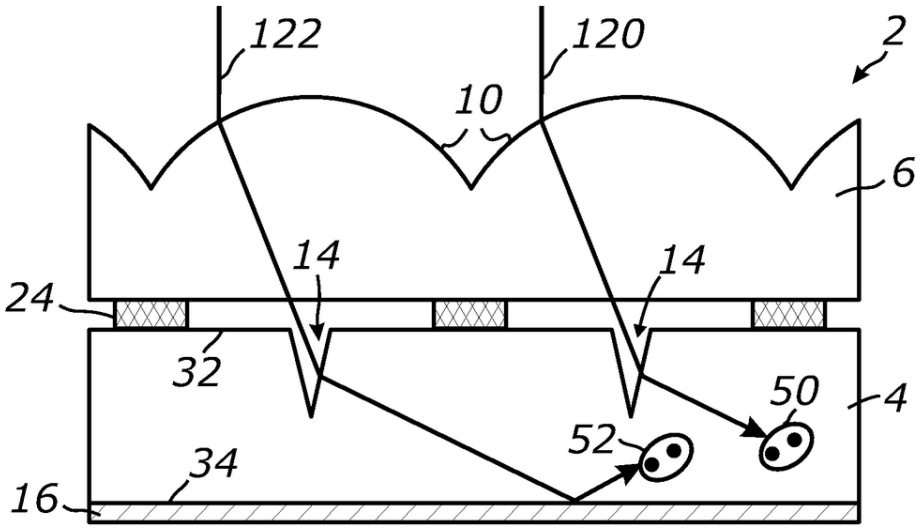


Id., Fig. 1A (showing Kuboi's hybrid structure).

Unlike the photon-absorbing, silicon/germanium-based image sensors claimed in the '948 Patent, Kuboi's imaging device is configured so that "[t]he organic material layer 13 is [the] region where photoelectric conversion is performed," rather than its silicon semiconductor layer 12. *Id.* at [0057]. Accordingly, for reasons described in greater detail below, Kuboi does not disclose a microstructure enhanced photodetector device that absorbs light in pillars of Si, Ge, or a SiGe alloy, because it does not utilize any types of microstructures, such as an "array of pillars" or "one or more holes that are fabricated as recesses at or under the light-receiving surface . . . of the pillars]," to enhance its imaging device.

E. Vasylyev Does Not Disclose Pillars or In-Pillar Holes

Vasylyev (Ex. 1005) does not disclose side-isolated pillars with in-pillar holes (i.e., "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"). Vasylyev is limited to a "light harvesting system" in which "[l]ight is injected into a photoresponsive layer through light input ports using a focusing array." Vasylyev at [0015], [0016].



Id., Fig. 11 (showing light input ports 14). W&Wsens disclosed Vasylyev to the Office during examination of the '948 Patent, and the Office expressly allowed the claims of '948 Patent over Vasylyev. Ex. 1003 at 487 (IDS filed 9/3/2024), 319 (IDS considered). In Grounds 2 and 4, Samsung only relies on Vasylyev as allegedly disclosing limitations 13d(1) and 13d(2) 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" (Claim 13). Pet. at 114-117; *see also id*. at 112-119 (arguing, by reference to Ground 1, that *Kuboi* allegedly discloses limitations 13(pre), 13a(1)-(2), 13b, 13c, 13d(2), 13e, 13f, 13g, 13h, 13i).

F. Shinohara Does Not Disclose Microstructures

Samsung does not contend that Shinohara (Ex. 1006) teaches any of the microstructure claim limitations of the Challenged Claims that are missing from Kuboi and Vasylyev. Shinohara describes an imaging device having a "backside illuminated structure" including "an element isolation region isolating the pixels." Shinohara at Abstract. Samsung cites Shinohara as allegedly disclosing, among other things, "a base dielectric region." Pet. at 128-132 (limitation [1f]).

III. SAMSUNG'S CHALLENGE AND ASSERTED REFERENCES

The Petition presents the following grounds:

Ground	Claims	35 U.S.C.	References/Details
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

Id. at 8.

Although there are multiple reasons the '948 Patent is valid over Kuboi, Vasylyev, and Shinohara and is valid under 35 U.S.C. § 112, this Preliminary Response focuses on only limited reasons why post grant review should not be instituted. *See Travelocity.com L.P. v. Cronos Techs., LLC*, No. CBM2014-00082, Paper 12 at 10 (P.T.A.B. Oct. 16, 2014) ("[N]othing may be gleaned from the Patent Owner's challenge or failure to challenge the grounds of unpatentability for any particular reason.").

IV. LEVEL OF ORDINARY SKILL IN THE ART

For purposes of this Preliminary Response only, W&Wsens adopts Samsung's definition of a person of ordinary skill in the art: "A person of ordinary skill in the art ('POSITA') 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." Pet. at 8.

V. THE CHALLENGED CLAIMS ARE PATENTABLE

A. Kuboi Does Not Disclose an Array of Pillars (Grounds 1-4)

Kuboi does not disclose a silicon/germanium "array of pillars . . . configured to include photodetectors [that] 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***." '948 Patent at 55:39-47 (emphasis added). The claimed array of pillars must be formed from at least silicon

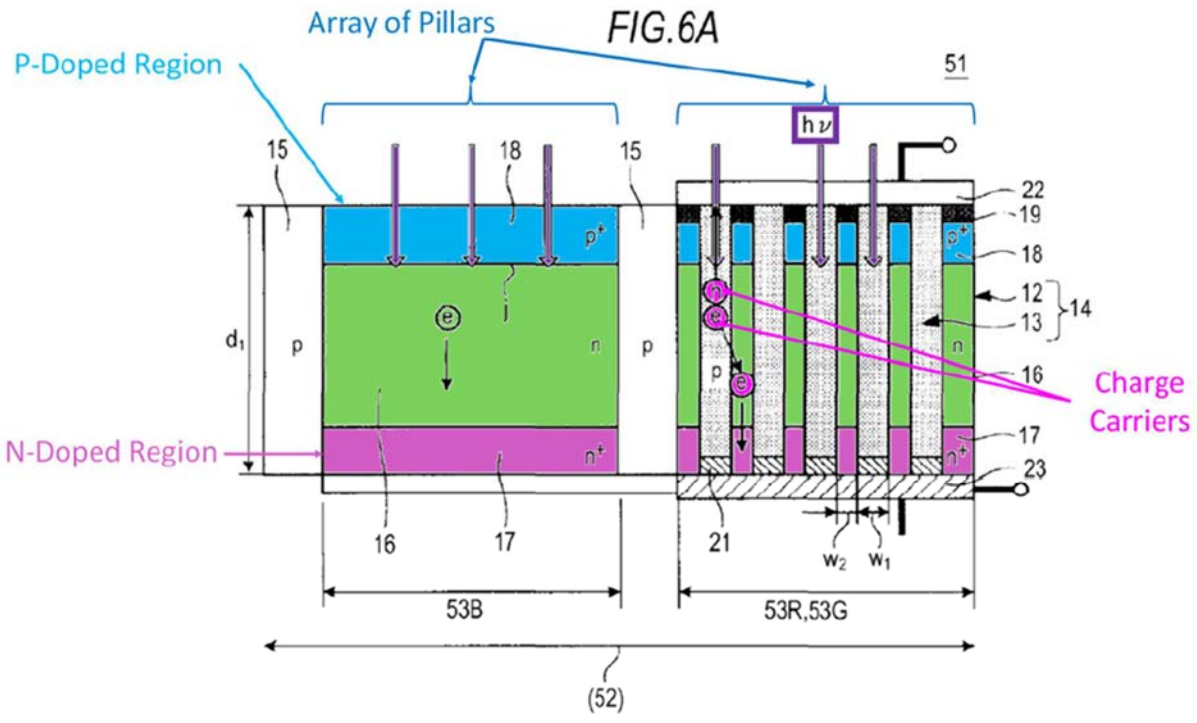
or germanium. *Id.* at 55:39-40 ("an array of pillars comprising Si, Ge, and/or SiGe alloy semiconductor material"). Accordingly, the Challenged Claims require silicon/germanium-based photodetectors that have photosensitive semiconductor materials ("P-doped and N-doped regions") designed to absorb light and generate electrical output ("electrical charge carriers"). There is no such structure in Kuboi.

The Challenged Claims' limitations are fully consistent with the specification, which describes silicon and germanium light absorption regions that generate electrical charge carriers. *Id.* at 3:6-35 (describing "absorbing region and the microstructures are formed of silicon"); *id.* at 3:36-61 (describing "the absorbing semiconductor region and the microstructures are formed of silicon and germanium"); *id.* at Fig. 5B, 16:9-29 (describing Fig. 5B and the photodetector "photosensitive area (defined by the P-I-N . . . junction area)").

Kuboi itself distinguishes solid-state imaging devices "having a silicon-based photodiode," such as those claimed by the '948 Patent, and those "in which an organic material layer is used as the photoelectric conversion portion." Kuboi at [0002]-[0004]. The '948 Patent claims improvements in the former, while Kuboi is limited to the latter. Specifically, rather than use microstructures to enhance photon absorption in the silicon-based semiconductor layers of the photodetector, Kuboi proposes a "hybrid" photodetector, where electron-hole pairs are generated in organic material layers ***instead of*** in the silicon-based semiconductor layers:

> The hybrid photoelectric conversion portion is configured so that charges generated in the organic material layers through photoelectric conversion move inside the semiconductor layer so as to be guided to a charge accumulation region.

Kuboi at [0011]. Thus, Kuboi distinguishes its organic material layers, which generate charges, from the semiconductor layer, which guides the already generated charges to the accumulation region. This arrangement is illustrated in Samsung's annotated Kuboi Fig. 6A, where light is incident only on "organic material layers 13":



Pet. at 25 (citing Kuboi, Fig. 6A (annotated)).

Kuboi uses a "light shielding film 19" on the surface "so that light hν ***does not enter*** the semiconductor layer 12," Kuboi at [0059] (emphasis added), [0064] ("The light hν does not enter the semiconductor layer 12 due to the light shielding film 19."); '948 Patent at 55:44-47 (Claim 1). This further confirms that Kuboi's semiconductor layer 12 does not act as an absorption layer that "respond[s] to illumination with light in selected visible and infrared wavelengths by generating electrical charge carriers," as claimed.

Kuboi's imaging device does not, therefore, include silicon/germanium photodetectors comprised of "P-doped and N-doped regions" that are "configured to respond to illumination with light in selected visible and infrared wavelengths by generating electrical charge carriers." Pet. at 22-26. Instead, Kuboi's "photoelectric conversion films 13" (which Samsung alleges are microstructure holes) are the elements that themselves perform photoelectric conversion. Kuboi at [0057] (organic material layers 13 are "where photoelectric conversion is performed"); *id.* at [0012] ("hybrid photoelectric conversion portion in which photoelectric conversion is performed in the organic material layer"); *id.* at [0014] ("Photoelectric conversion is performed in the organic material layer of the hybrid photoelectric conversion portion, . . ."); *see also id.* at [0076], [0080], [0082], [0107].

Accordingly, organic material layers 13 are the active part of Kuboi's photodetector, not the alleged array of pillars of inorganic semiconductor material,

and the alleged pillars are not "configured" to create "electrical charger carriers" from illumination on light-receiving surfaces of an array of pillars.

B. Kuboi Does Not Disclose the Holes Fabricated As Recesses in Pillars (Grounds 1-4)

Kuboi fails to disclose the claimed "one or more holes" fabricated as recesses in pillars, which have the following claimed requirements:

(1) the holes must enhance light absorption properties of the photodetectors.[2]

(2) the holes are fabricated as recesses at or under ***the light-receiving surface of each pillar***;[3] and

(3) the holes "are filled at least partly with solid dielectric material."[4]

'948 Patent at Claims 1 and 13.

Kuboi fails to meet these claimed requirements for the reasons set forth below.

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[2] '948 Patent at 55:64-67 ("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").

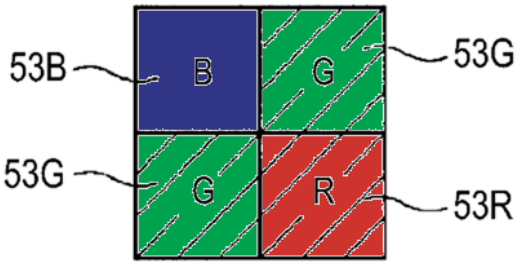
[3] '948 Patent at 55:48-50 (claiming "one or more holes that are fabricated as recesses at or under the light-receiving surface of each of at least some of the pillars").

[4] '948 Patent at 55:52-53.

1. Kuboi Does Not Disclose Holes that Enhance Light Absorption of the Photodetectors (Grounds 1-4)

Kuboi fails to disclose "one or more holes . . ." that "increase[] . . . the absorption of the light" of the photodetectors. Kuboi discloses an imaging device with "a pixel region 52 in which a group of pixels made up of a blue (B) pixel 53B, a red (R) pixel 53R, a green (G) pixel 53G." Kuboi at [0090], Figs. 6A, 6B.

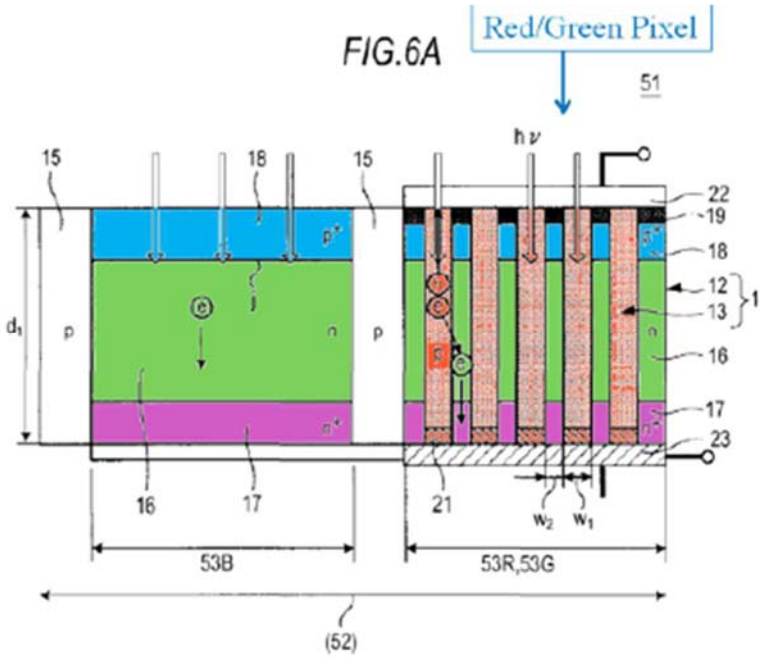
FIG.6B



Kuboi, Fig. 6B (annotated); *see* Pet. at 16 (acknowledging Kuboi's pixels are "arranged in a Bayer configuration").

Kuboi's pixels do not contain any "holes" fabricated as recesses in pillars that improve performance of the photodetector, as recited in the Challenged Claims. The blue pixel 53B in this array performs conventional silicon-based photoelectric conversion, and the red and green pixels 53R and 53G have the "hybrid photoelectric conversion portion[s]" with organic layers. Kuboi at [0090] ("[B]lue 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."). These two-pixel types are shown side by side in Fig. 6A.



Pet. at 41 (citing Kuboi, Fig. 6A (annotated)); *id*. at 26-32 (alleging the "holes 38" of Kuboi constitute holes fabricated in pillars).

Kuboi's blue pixel 53B does not include holes or any structures that increase light absorption. Indeed, the Petition does not allege that Kuboi discloses the blue pixel 53B has "holes" fabricated as recesses in the pillars. *Id*. at 29-32 (alleging holes fabricated pixels 53R, 53G with organic hybrid photoconversion, but not pixel 53B).

Kuboi's red and green pixels operate according to an entirely different principle than Kuboi's blue pixel 53B and the invention claimed in the '948 Patent,

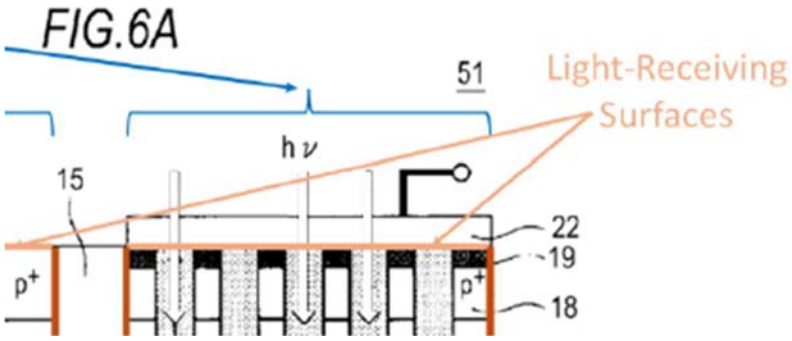
as discussed above. *See supra* § V.A. Rather than Kuboi's alleged holes "increas[ing] . . . the absorption of the light by . . . the photodetectors," as recited in the Challenged Claims, Kuboi relies on an entirely different material system with a device that performs photoelectric conversion using organic layers while blocking light from entering the inorganic, silicon-based semiconductor layers with a light shielding film 19. Kuboi at [0091].

For these reasons, Kuboi does not disclose any holes fabricated in pillars that increase the absorption of light on the photodetectors, as required by the Challenged Claims.

2. Kuboi Does Not Disclose Holes Fabricated as Recesses At or Under the Light-Receiving Surface of Each Pillar (Grounds 1-4)

Samsung does not identify "with particularity" which elements in Kuboi allegedly disclose "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." 35 U.S.C. § 312(a)(3). Instead, Samsung shifts between identifying three different structures as the purported "light-receiving surface," but none of those locations satisfy the claims. *See* Pet. at 18-27. This inconsistent mapping of different structures to the same element across different limitations of the challenged claim is an independent basis to deny the Petition.

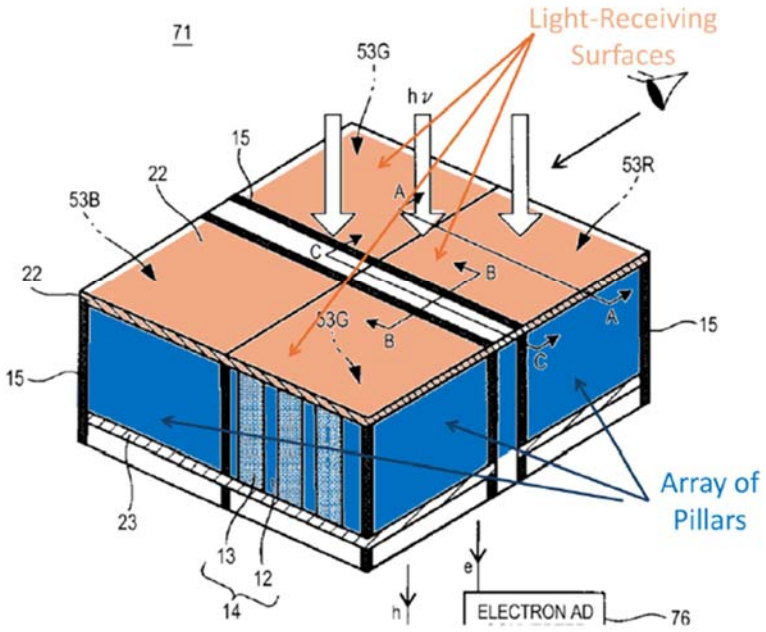
First, in discussing limitation [1a(2)], which provides the antecedent basis for the "light-receiving surfaces" in limitation [1c], Samsung points to "the light incident side . . . of Kuboi's pixels" that is "***located on upper electrode 22's lower surface***." Pet. at 18 (arguing "electrode 22 is formed ***on*** the light incident side") (emphases added). Samsung also identifies the lower surface of the upper electrode 22 in its annotated Fig. 6A as the light-receiving surface.



Id. at 21 (citing Kuboi, Fig. 6A, annotated to identify the lower-surface of the upper electrode 22 as the light-receiving surface) (excerpted); *see also id*. at 28 (citing Kuboi, Fig. 1A) (similar); *id.* at 31 (same).

Second, Samsung takes the inconsistent position that ***the top surface*** of the upper electrode 22 is the claimed "light-receiving surface" when discussing how the "light hν is incident on and enters via each pixel's light-receiving surface." *Id*. at 18. This is shown in Samsung's annotation of Fig. 13, reproduced below:

FIG.13



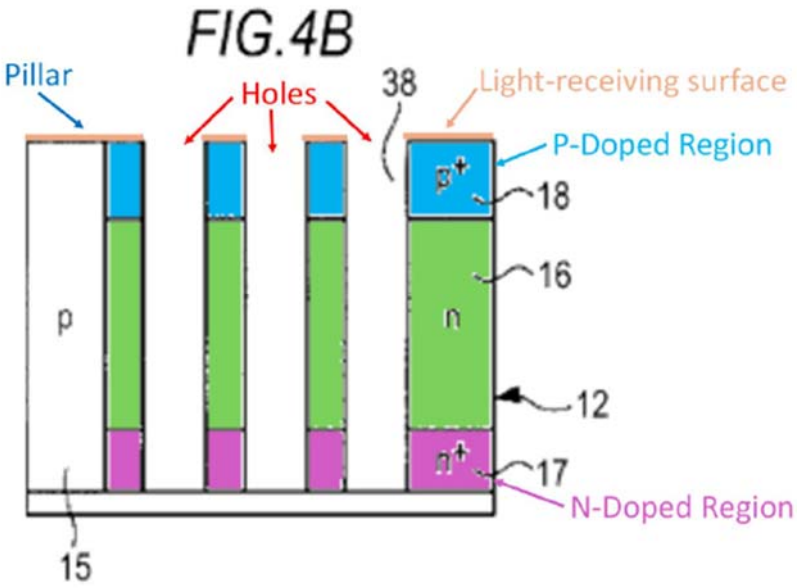
Id. at 19 (citing Kuboi, Fig. 13, annotated to identify the upper surface of electrode 22 as the light-receiving surface); *see id*. at 20, 32 (same).

Third, Samsung takes yet another inconsistent position in arguing that the light-receiving surface is the ***top surface of the semiconductor region 18***. *Id*. at 26-27 (citing Kuboi, Fig. 4B (annotated)).

Samsung's inconsistent mapping of the "light-receiving surface" to three different structures for different limitations confirms that there is no structure in Kuboi that satisfies the requirements that a pillar is configured to include a photodetector ***and*** has a light-receiving surface with one or more holes fabricated as recesses therein. This failure to provide a coherent and consistent mapping to the claim limitations is a further basis to deny institution. *See Western Digital Techs.,*

Inc. v. Godo Kaisha IP Bridge 1, No. IPR2025-00701, Paper 11 at 17, 20 (P.T.A.B. Oct. 8, 2025) (denying institution where petitioners inconsistently map different structures to the same element across different limitations of the challenged claim).

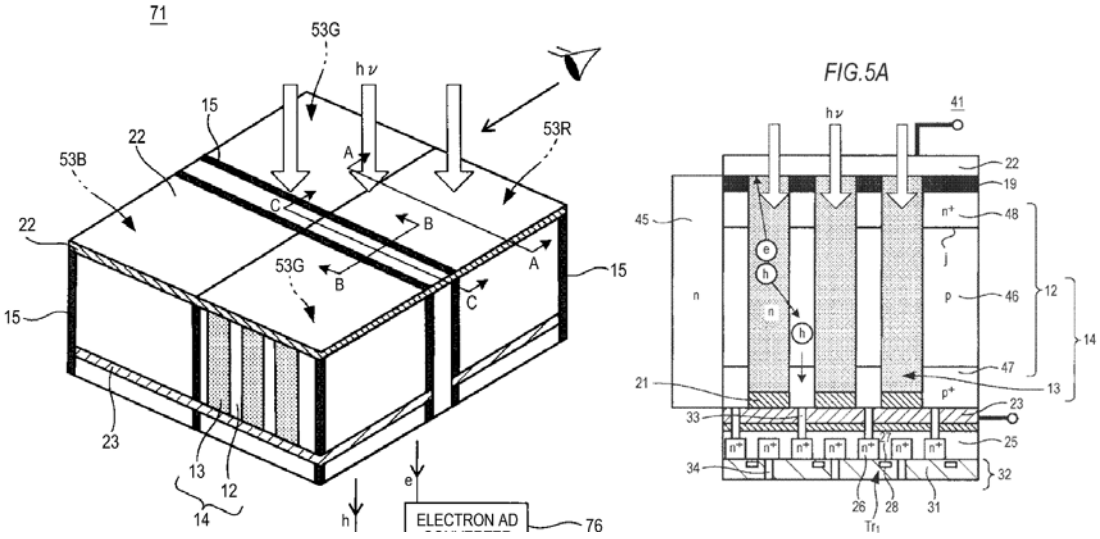
Samsung's inconsistent approaches also fail because Kuboi's alleged holes are actually fabricated into the top of the p-type region, which is not a light-receiving surface. Samsung admits this in its argument that Kuboi discloses fabricating holes as recesses at or under the light-receiving surface, as illustrated in their annotated Fig. 4B, reproduced below:



Pet. at 27 (citing Kuboi, Fig. 4B (annotated)); *see* Kuboi at [0072] (disclosing openings dry-etched into region 18). Because the upper surface of the p-type region 18 is covered by light-shielding film 19, which prevents the top surface of the p-type region 18 of the semiconductor layer 12 from receiving any light at all, the top of p-

type region 18 is not a light-receiving surface. *Id.* at [0087] ("The light hν does not enter the semiconductor layer 12 due to the light shielding film 19."); *see supra* § V.A. Thus, Kuboi does not show the fabrication of holes in the light-receiving surface of the inorganic material.

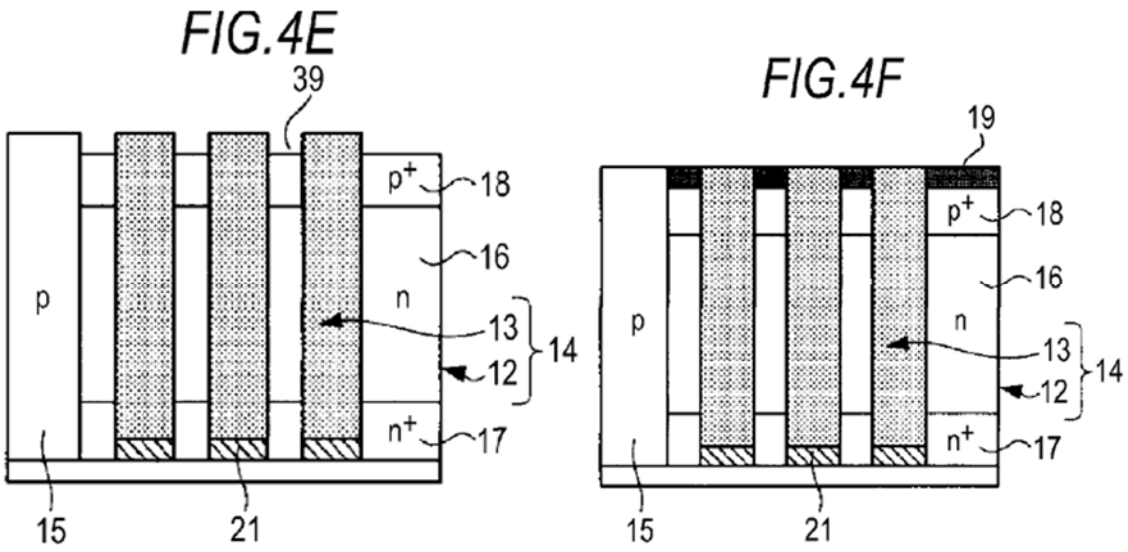
Consistent with this aspect of Kuboi's fabrication process, holes are not fabricated in the upper electrode 22, in its top surface or its lower surface, as Samsung sometimes argues. *See* Pet. at 18-20. As illustrated below, there are no holes fabricated as recesses in any portion of the upper electrode 22:



Kuboi, Figs. 13 (excerpted) and 5A (showing a solid electrode with no holes fabricated as recesses in the top surface, middle, or bottom surface of upper electrode 22).

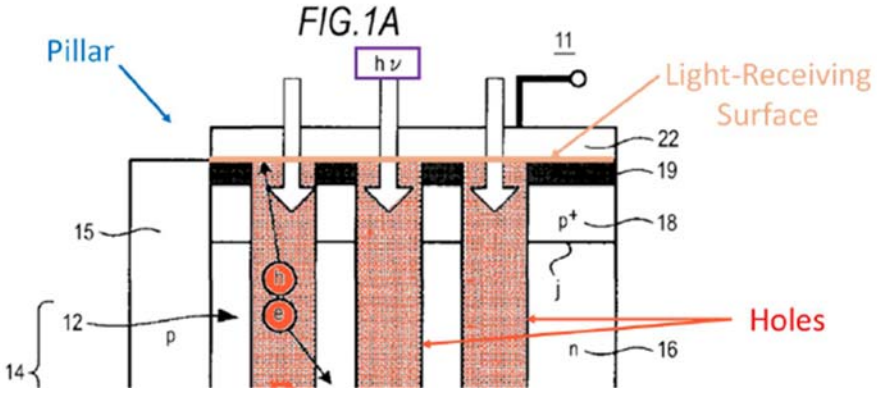
In Kuboi, there are also no holes fabricated as recesses in any location between the top of the upper electrode and the top of p-type region 18. As Kuboi discloses

with respect to Figures 4E and 4F, organic material 13 protrudes above the surface of p-type region 18, and light shielding film 19 fills in the concave portions between the films. Kuboi at [0075]-[0076].



Kuboi, Figs. 4E, 4F. Thus, no "holes" are fabricated as recesses in any region between p-type region 18 and the top of upper electrode 22.

The upper surface of p-type region 18 is also plainly not the "upper electrode 22's lower surface," which Samsung sometimes contends is the claimed "light-receiving surface." Pet. at 18.

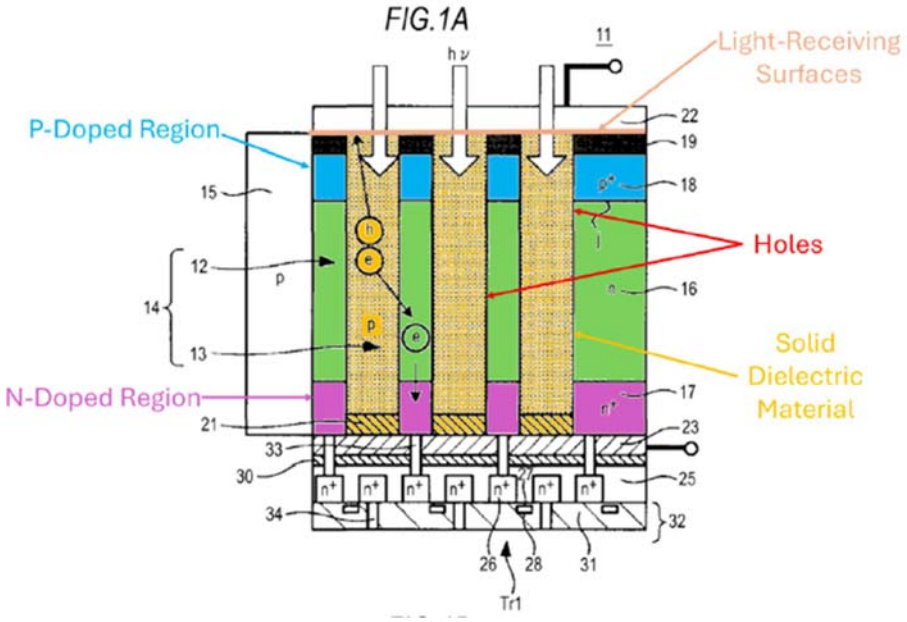


Id. at 28 (annotating Kuboi's Fig. 1A); *see also* Kuboi at [0077] (describing the formation of the upper electrode after alleged holes are etched).

As a result, Kuboi's holes 38 are not holes "that are fabricated as recesses at or under ***the light-receiving surface*** of each of at least some of the pillars," as required by the Challenged Claims, and Kuboi teaches away from the claimed design.

3. Kuboi Does Not Disclose Holes That are Filled at Least Partly with Solid Dielectric Material (Grounds 1-4)

Kuboi fails to disclose "one or more holes . . . [that] are filled at least partly with solid dielectric material" because Kuboi's holes 38 are not filled with solid dielectric material. There are multiple reasons that Samsung is incorrect to contend that "electron blocking film 21 and photoelectric conversion film 13 together entirely fill Kuboi's holes and are solid dielectric materials." Pet. at 31.



Id. (citing Kuboi, Fig. 1A (annotated)).

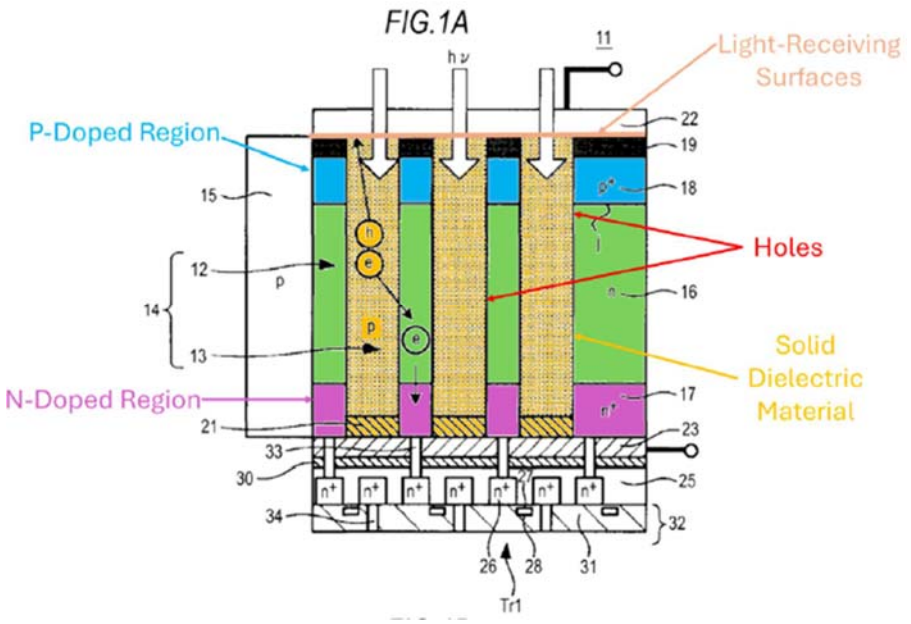
First, the requirement that the holes be "filled at least partly with solid dielectric material" ('948 Patent at Claim 1) establishes a fundamental difference from Kuboi, which teaches a thin SiO_2 liner followed by an organic semiconductor bulk fill. On the other hand, the '948 Patent discloses filling or partly filling holes with a solid dielectric material, "such as silicon nitride, or silicon oxide." '948 Patent at 19:30-42 (disclosing a filler 916 that fills or partially fills the space between the Si pillars 914, rather than only a thin liner on the bottom of the space). A partial fill of the hole may result in the rest of the hole being filled with air, which has significant benefits to device performance:

> In FIG. 9D a filler 916 is used to ***fill or partially fill the space*** between the Si pillars 914 to support subsequent contact layers to be deposited. The filler 916 can be spin on glass, polyimide, dielectric such as silicon nitride, or silicon oxide, that can be deposited for example using plasma enhanced chemical vapor deposition. Once the contacts are made the fillers can be left in place or removed by dissolving the filler with an etchant or solvent. ***Removing the filler has an advantage of further reducing the capacitance of the device since air has a dielectric constant of 1***. The reduction of the capacitance allows the device to operate at higher bandwidth due to reduction of the RC time.

'948 Patent at 19:30-42 (emphasis added); *see also id*. at 21:18-38 (disclosing that similar fabrication processes are used to create "microstructured hole arrays" as the "light traps," and that "[i]n the case of the hole arrays, it is possible that the filler need not extend the entire length of the hole").

The '948 Patent explains that it is beneficial to fill microstructure holes with a low-capacitance, low-refractive index material to enhance device bandwidth (by reducing capacitance) and increasing light absorption (via high contrast grating effects). *See, e.g.*, '948 Patent at 9:4-14, 9:56-10:5. Accordingly, partly filling the holes with a solid dielectric material, and leaving the rest filled only with air or vacuum, improves device performance because air/vacuum has even more desirable properties than solid dielectrics. *Id.* at 19:38-40. Accordingly, while some amount of dielectric filler material is necessary during fabrication, the '948 Patent teaches that at least some of that filler material may be stripped away, leaving air in its place, which has the desirable benefit of reducing capacitance and increasing absorption. *Id.* at 19:30-42.

Kuboi's holes 38 are not "at least partly" filled with electron blocking film 21. An electron blocking film coats only the bottom of the holes, which are ***fully*** filled with a semiconducting organic material:



Pet. at 31 (citing Kuboi at Fig. 1A (annotated)); *see* Kuboi at [0073] (disclosing that electron blocking film 21 is a thin film that is only "several tens of nm [nanometers]" in thickness). Accordingly, holes 38 are not "filled at least partly with solid dielectric material," they are fully filled with semiconducting material. Kuboi at [0073]. Kuboi's organic semiconductor is designed to be optically and electrically active to absorb photons and transport charge carriers, not to function as a passive, low-k, solid dielectric or to create a beneficial air void. *Id.* at [0057].

Second, because Kuboi's electron blocking film 21 does not at least partly fill holes 38, Samsung takes the untenable position that Kuboi's photoactive organic materials ("perylene-based compounds, phthalocyanine compounds, quinacridone compounds, porphyrin compounds, merocyanine compounds") are solid dielectric materials. Pet. at 30-31 (quoting Kuboi at [0058]). They are not.

The term "dielectric material" is well-understood in the art to mean an ***insulator*** that can be polarized in an electric field and is different from a semiconductor:

> **dielectric** (1) a medium that exhibits negligible or no electrical conductivity and thus acts as a good electrical insulator. (2) a medium characterized by zero conductivity, unity relative permeability, and a relative permittivity greater than one. Also known as an insulator.

Ex. 2029 at 3 (Electrical Engineering Dictionary); *see also id*. at 4 ("**dielectric medium** - medium that is polarizable but relatively nonconducting"). Samsung's own extrinsic evidence confirms that semiconductors are different from dielectric layers. *See* Ex. 1012 at 20 ("Dielectric layers such as silicon dioxide and silicon nitride are used for insulation between conducting layers . . . ."). Dielectric materials, like all insulators, are not suitable for photoconversion because they lack the necessary band structure to create signal charges when illuminated. Ex. 1028 at 22-25 (discussing optical absorption and photogeneration in ***semiconductor materials***).

Kuboi also cites to references that establish that organic photoconversion films are ***semiconductors***, not dielectric materials. *See, e.g.*, Kuboi at [0005] (citing Ex. 2030 (JP Patent 3423279), "Hiramoto"). According to Kuboi, Hiramoto discloses a "method of effectively extracting electrons generated by photoelectric

conversion using an organic film made of two kinds of organic materials." Kuboi at [0005]. Accordingly, Kuboi states that its organic layers may include "***perylene***-based compounds, ***phthalocyanine*** compounds," (*id.* at [0058] (emphasis added)), and Hiramoto discloses that those layers are semiconducting. Ex. 2030 (Hiramoto) at 6 ("A preferable example of the ***organic semiconductor layer*** is a co-evaporated thin film of a ***phthalocyanine*** pigment and a ***perylene*** pigment."); *see also id.* at 5 ("[A]n organic ***semiconductor*** thin-film solar cell having a structure in which co-deposited thin films of two kinds of organic semiconductors are sandwiched between electrodes.") (emphases added); Ex. 2033. Therefore, Kuboi's organic films are semiconductors, not dielectrics.

In view of the foregoing, the Board should reject Dr. Lebby's claim that a "POSITA would have understood that phthalocyanine, perylene-based, and porphyrin compounds are solid dielectric materials" because it is plainly erroneous and contradicted by the cited reference itself. Pet. at 30-31 (citing Lebby Decl., ¶¶ 150-152). Dr. Lebby's opinion is based on the incorrect notion that any material with a "dielectric constant" or "dielectric properties" is a dielectric material. Ex. 1002 ("Lebby Decl."), ¶ 151. The term "dielectric constant" merely refers to "an electric property of an insulator or semi-conducting material, which describes how differently electric fields will behave inside of the material as compared to air." Ex. 2029 at 3-4 (Electrical Engineering Dictionary) (definition of "dielectric constant").

Indeed, Dr. Lebby opines elsewhere that "silicon nitride (Si3N4) and silicon oxide (SiO2) are solid dielectric materials" ***because*** they are insulators. Lebby Decl., ¶ 146.

Accordingly, although semiconductors can have non-zero dielectric constants and measurable "dielectric properties," they are not dielectric materials because they are not insulators:

> The crystal behaves as an insulator if the allowed energy bands are either filled or empty, for then no electrons can move in an electric field. The crystal behaves as a metal if one or more bands are partly filled, say between 10 and 90 percent filled. The crystal is a semiconductor or semimetal if one or two bands are slightly filled or slightly empty.

Ex. 2025 (Kittel) at 7. Energy bands for different types of materials are illustrated below:

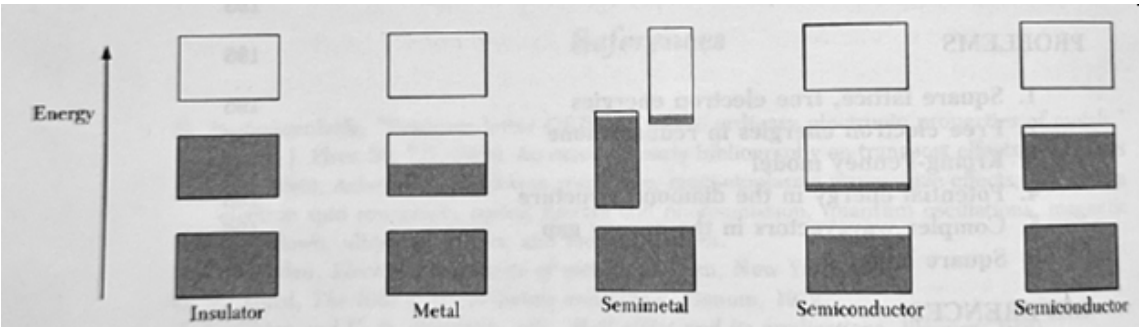


Figure 1 Schematic electron occupancy of allowed energy bands for an insulator, metal, semimetal, and semiconductor. The vertical extent of the boxes indicates the allowed energy regions; the shaded areas indicate the regions filled with electrons. In a **semimetal** (such as bismuth) one band is almost filled and another band is nearly empty at absolute zero, but a pure **semiconductor** (such as silicon) becomes an insulator at absolute zero. The left of the two semiconductors shown is at a finite temperature, with carriers excited thermally. The other semiconductor is electron-deficient because of impurities.

Id. at 6.

Kuboi's organic films are semiconducting because they are characterized as p-type or n-type materials that carry signal charges. *See, e.g.*, Kuboi at [0055], [0056], [0085]. By definition, organic semiconductors that are doped to be p-type or n-type and that carry signal charges are not dielectric materials because they are not insulators. Ex. 2029 at 3 (Electrical Engineering Dictionary) (definition of "dielectric").

FIG.2A

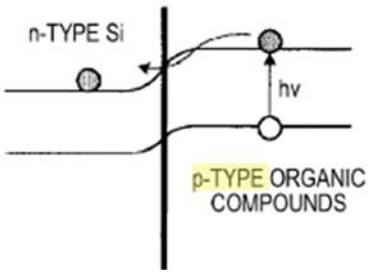
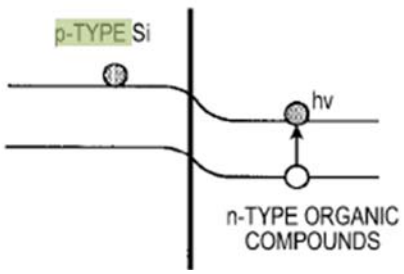


FIG.2B



Kuboi, Figs. 2A and 2B (illustrating electron excitation in the band diagram of semiconducting organic compounds, which could not occur in an insulator due to its band structure); *see also, e.g.*, *id.* at [0057] ("In this example, since signal charges are electrons, the organic photoelectric conversion film 13 is formed of a p-type organic material."); [0058] ("As the p-type organic material, organic compounds which have a desired absorption band and satisfy an energy band structure shown in FIG. 2A described later are used."); [0085] ("The organic photoelectric conversion film 13 is formed by an n-type organic material. As the n-type organic material, organic materials such as, for example, naphthalene-based compounds, perylene-based compounds, and C60 can be used.").

For these reasons, Kuboi fails to disclose the claimed "one or more holes . . . are filled at least partly with solid dielectric material."

C. The Asserted References Do Not Disclose In-Pillar Holes That Increase Light Absorption "By a Factor of At Least 1.1" (Grounds 1-4)

All of the Challenged Claims require that "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 [the] holes." '948 Patent at 55:64-67 (limitation [1h]), 57:5-8 (limitation [13h]) (similar). None of the asserted references disclose such structures or an improvement to the light absorption properties of photodetectors because of such structures.

Samsung does not argue that Kuboi discloses that the presence of alleged in-pillar holes increases light absorption by at least 1.1 times, as the Challenged Claims require. Pet. at 40-52, 118. Instead, Samsung tries to substitute for the absence of this disclosure in the reference by relying on 24 pages of expert testimony purporting to estimate an improvement in light absorption from the references' proposed designs. *Id*. at 40-52 (citing Lebby Decl., ¶¶ 175-201). Dr. Lebby's opinions are unreliable and at odds with the record evidence for at least two reasons.

First, Dr. Lebby, who does not claim to have pertinent experience with organic semiconductors, uses a facially-flawed methodology to attempt to calculate a hypothetical amount of light absorption for Kuboi's pixels based on the Lambert-Beer Law and a series of assumptions stemming from its pixel dimensions. Lebby Decl. ¶¶ 175-187; *see also id.* at ¶¶ 6-29 (describing Dr. Lebby's background). Samsung posits that "[a] POSITA would have understood that the amount of light absorbed by a material of thickness 'd' can be determined using the Lambert-Beer expression as I_0 (1- $e^{-\alpha d}$)A . . . ." Pet. at 40. The value "d" in the Lambert-Beer expression refers to the "path length" or the distance that the amount of light travels. Ex. 2031 at 1.

Dr. Lebby's analysis is flawed because he incorrectly assumes that the distance "d" is the depth of Kuboi's holes (1.4 μm). Lebby Decl., ¶¶ 183. A POSITA would understand the Lambert-Beer Law is only valid for homogeneous

structures, not the type of hybrid structure disclosed in Kuboi. *See* Ex. 2032 at 4 ("Understanding the Limits of Bouguer-Beer-Lambert Law") (discussing how, in contrast to a "microhomogenous" material, light "is reflected, leading to scattering" when traveling through a material with "microstructure[s]"); Ex. 2031 at 1 (The Lambert-Beer Law is only appropriate for analyzing light absorption of a "macroscopically homogeneous medium with which [the light] interacts."); *see also id.* at 5-6 ("There are at least six conditions that need to be fulfilled in order for the Beer-Lambert law ***to be valid***. These are: . . . ***The attenuating medium must be homogeneous in the interaction volume***.") (emphasis added).

A POSITA would, therefore, understand that simply plugging in the material thickness into the Lambert-Beer expression would not accurately determine the light absorption of Kuboi's hybrid photoelectric conversion portion. *See* Ex. 2032 at 4 (discussing an example microstructure polymer where "***simply determining the absorbance and dividing it by the thickness will not lead to the same result*** as [the Lambert-Beer expression] would imply" because of "scattering" and "reflected" when light "entering and leaving [a] pore") (emphasis added); *see also* '948 Patent at 8:37-65 (describing "resonance/scattering/near field effects of microstructures").

Samsung's use of the Lambert-Beer expression is, therefore, invalid because it fails to account for the light scattering and reflection effects of non-homogenous materials in the photodetectors that are the subject of the '948 Patent and the

structures in Kuboi. Other than Dr. Lebby's facially erroneous application of the Lambert-Beer expression, Samsung offers no support for its contention that Kuboi has structures that increase light absorption, as required.

Second, Samsung cites an external reference, Han (Ex. 1038), for its discussion of the alleged "impact of nanoholes on the ultimate efficiency associated with photon absorption." Pet. at 50-51 (citing Ex. 1038, Fig. 4). Han's Fig. 4 is "a graphical plot of the calculated ultimate efficiency as a function of the thickness of the nanohole array, the nanorod array, and the homogeneous c-Si film (a) with and (b) without a Si_3N_4 antireflection (AR) coating." Ex. 1038 at 5:31-33. But Han's graphs do not concern or disclose the efficiency of in-pillar holes because Han does not disclose or suggest the use of in-pillar holes. Samsung offers no explanation for how Han's discussion of the efficiency of its "nanoholes" applies to the efficiency of Kuboi's very different hybrid photoelectric conversion portion and organic photoelectric conversion film. Pet. at 50-51.

Therefore, Samsung fails to show that any of its asserted grounds disclose or achieve the claimed improvement in light absorption.

D. The '948 Patent is Enabled by its Specification (Ground 5)

The Challenged Claims are enabled because, as Samsung admits, the specification teaches a POSITA how to make and use the claimed invention. Pet. at 46-47 (Petition relying on explanations found in '948 Patent specification); *see also*

id. at 4-6. Samsung's inconsistent allegations that the Challenged Claims lack enablement finds no basis in the law and fundamentally misreads the claim language.

1. The Specification Teaches a POSITA How to Make and Use the Claimed Invention

To establish a lack of enablement, Samsung "must show 'that a person of ordinary skill in the art would not be able to practice the claimed invention without undue experimentation.'" *China Lithium Battery Tech. Co. v. Contemporary Amperex Tech. Co.*, No. PGR2022-00008, Paper 8 at 22 (P.T.A.B. Jun. 6, 2022) (quoting *Enzo Life Sciences, Inc. v. Roche Molecular Sys., Inc*., 928 F.3d 1340, 1345 (Fed. Cir. 2019)); *see also United States v. Telectronics, Inc.*, 857 F.2d 778, 785 (Fed. Cir. 1988) ("The test of enablement is whether one reasonably skilled in the art could make or use the invention from the disclosures in the patent coupled with information known in the art without undue experimentation."). Samsung does not allege any such deficiency in the '948 Patent's specification.

First, Samsung's conditional argument that the claims are not enabled if "the prior art's disclosure is deemed insufficient" is unfounded. Pet. at 139-140. As established above, Kuboi has an entirely different design for light detection than the '948 Patent. *See*, § V.A, *supra*. Kuboi does not purport to rely on the high contract grating (HCG) effect, so Samsung is wrong to assume that a deficiency in Kuboi "necessarily" establishes an enablement issue.

Second, the '948 Patent enables embodiments of "one or more" holes of claims 1 and 13 or "only one of the elongated holes" of claims 4 and 14 with respect to the claimed 1.1 factor requirement. Pet. at 140-141. Samsung does not dispute that the '948 Patent enables embodiments having a single in-pillar hole. *Id*. at 140. Samsung also does not dispute that the '948 Patent enables embodiments that increase the absorption of light by a factor of at least 1.1 compared to like photodetectors without such in-pillar holes. *Id*.

Samsung incorrectly assumes that the "high contrast grating (HCG)" effect is the sole physical mechanism underpinning the '948 Patent claims. Pet. at 140-141 (citing HCG as "the described mechanism for determining increased absorption"). Not so. The '948 Patent specification discloses that "in some embodiments", the properties of the claimed microstructures "can also be explained" (*i.e.,* indicating there are multiple explanations) by the "absorption mode of high contrast grating (HCG)." '948 Patent at 9:4-8. The '948 Patent specification then explains there are multiple physical mechanisms at work here. *Id.* at 8:37-65 (describing "resonance/scattering/near field effects of microstructures" on "path length"); 11:52-57 ("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."); *Id*. at 8:10-9:14 (generally).

Samsung's position that "a POSITA would have anticipated a substantial change in the HCG effect at lower values of the period Λ" is unsupported and conclusory. Pet. at 141. Samsung cites to its expert declaration, but Samsung's expert only parrots the same conclusory sentence and then cites the entirety of an academic paper titled "Size effect of high contrast gratings in VCSELs," with no additional commentary or explanation of this paper's relevance to its enablement argument. Lebby Decl. ¶ 362 (citing Ex. 1051, 1-6). Without more explanation, the academic paper's subject matter ("vertical cavity surface-emitting laser (VCSEL)") and discussion fail to fails. Ex. 1051, Abstract. Thus, Samsung fails to establish that a POSITA would require undue experimentation to practice these claims.

2. The Examiner in a Divisional Patent's Examination Dropped its § 112(a) Rejection in Response to Patent Owner's Arguments

There is no merit to Samsung's allegation of lack of enablement based on the Examiner's subsequently withdrawn rejection during examination of a divisional application No. 19/036,506 ("the '948 Divisional"), because the Examiner dropped its enablement rejection in response to W&Wsens' explanations and arguments during prosecution. Pet. at 141-142; Ex. 1050 ('948 Divisional File History from Jan. 24, 2025 to Jun. 13, 2025) at 7-8 (rejecting then-pending claims 1-12 for lack

of enablement under § 112(a)). W&Wsens previously demonstrated to the Office that the cited claim limitations are fully enabled by the intrinsic record of the '948 Patent. Ex. 2034 ('948 Divisional File History from Sept. 16, 2025 to Nov. 21, 2025) at 145-147 (September 26, 2025, Supplemental Response to Office Action). For example, the '948 Patent discloses that "the height of a pillar can be 100-10000 nm." *Id.* at 146 (citing Ex. 2035 (U.S. Provisional Application No. 61/826,446 filed May 22, 2013, page 12) ("[P]illars can be 100-10000 nm in length . . . ."). The '948 Patent also discloses that "[t]he presence of the in-pillar holes increases absorption by a factor of at least 1.1. compared to like photodetectors without holes or to bulk semiconductor without holes." Ex. 2034 at 147 (citing Ex. 2035 (U.S. Provisional Application 61/826,446, page 8, Table 8 and page 16) (enhancement of bulk absorption constant)); *see also* '948 Patent at 12:49-55. After considering W&Wsens' arguments, the Examiner withdrew the § 112(a) rejections in the '948 Divisional "in light of [these] remarks" and granted allowance to the '948 Divisional. Ex. 2034 at 158-159. Thus, the file history shows that the Office already considered these issues and found the Challenged Claims to be enabled, so Samsung fails to show that it is more likely than not that the '948 Patent claims are not enabled.

VI. CONCLUSION

For all of these reasons, W&Wsens requests that the Director deny institution of post-grant review of the Challenged Claims of the '948 Patent.

Respectfully submitted,

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CERTIFICATE OF COMPLIANCE WITH 37 C.F.R. § 42.24

The undersigned hereby certifies that the portions of the foregoing **PATENT OWNER'S PRELIMINARY RESPONSE** has 7,912 words in compliance with the 14,000 word limit set forth in 37 C.F.R. § 42.24. This word count was prepared using the Microsoft Word word-processing system used to prepare this paper.

Dated: December 5, 2025

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CERTIFICATE OF SERVICE

The undersigned certifies, in accordance with 37 C.F.R. § 42.6(e), and pursuant to agreement by the parties that filing with the Board through the Patent Trial and Appeal Case Tracking System (P-TACTS) constitutes electronic service, that service was made on Petitioners as detailed below.

Date of service	December 5, 2025
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