IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

W&WSENS DEVICES INC., Plaintiff, v. SAMSUNG ELECTRONICS CO., LTD., SAMSUNG ELECTRONICS AMERICA, INC., SAMSUNG SEMICONDUCTOR, INC., and SAMSUNG AUSTIN SEMICONDUCTOR LLC, Defendants.	Civil Action No. **JURY TRIAL DEMANDED**

COMPLAINT FOR PATENT INFRINGEMENT

Plaintiff W&Wsens Devices Inc. ("W&W") files this Complaint for Patent Infringement and Demand for Jury Trial against Samsung Electronics Co., Ltd. ("SEC"), Samsung Electronics America, Inc. ("SEA"), Samsung Semiconductor, Inc. ("SSI"), and Samsung Austin Semiconductor LLC ("SAS") (together, "Defendants" or "Samsung") and alleges as follows:

1. W&W is seeking to protect its valuable intellectual property from Samsung's ongoing willful infringement. W&W developed and patented novel technology that covers improving light sensors. W&W contacted Samsung to attempt to discuss potential partnerships and attempt to engage Samsung in licensing discussions. Samsung chose to willfully infringe W&W's patents rather than take a license, necessitating this action.

THE PARTIES

2. W&W is a Delaware corporation with its principal place of business at 4546 El Camino Real, Suite 215, Los Altos, California, 94022.

3. SEC is a corporation organized and existing under the laws of the Republic of Korea, with its principal place of business located at 129 Samsung-ro, Maetan-3dong, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Republic of Korea. SEC designs and makes products, including telecommunication, semiconductor, and mobile phone products that are sold throughout the United States, including in this District, and introduces products into the stream of commerce that incorporate infringing technology knowing that they would be sold in this District and elsewhere in the United States.

4. SEA is a corporation organized and existing under the laws of New York, with its principal place of business located at 85 Challenger Road, Ridgefield Park, New Jersey 07660. SEA has been registered to do business in Texas under File Number 0011028006 since at least June 10, 1996. SEA may be served with process through its registered agent, CT Corporation System, located at 1999 Bryan St., Ste. 900, Dallas, Texas 75201. SEA is a wholly-owned subsidiary of SEC. SEA conducts business operations at multiple locations within this District. For example, SEA maintains offices at 6625 Excellence Way, Plano, Texas 75023; a retail store at 2601 Preston Road, Frisco, Texas 75034; and a support center at 3580 Preston Road, Suite 100, Frisco, Texas 75034. SEA markets and sells products, including consumer electronics and mobile devices, throughout the United States, including in this District, and introduces products into the stream of commerce that incorporate infringing technology knowing that they would be sold in this District and elsewhere in the United States.

5. SSI is a corporation organized and existing under the laws of the State of California, with its principal place of business at 3665 North First Street, San Jose, California 95134. SSI may be served with process through its registered agent, CT Corporation, 1999 Bryan St., Suite 900, Dallas, Texas 75201. SSI sells and offers to sell products and services

throughout the United States, including in this District, and introduces products into the stream of commerce that incorporate infringing technology knowing that they would be sold in this District and elsewhere in the United States.

6. SAS is limited liability company organized and existing under the laws of Delaware, with its principal place of business at 12100 Samsung Boulevard, Austin, Texas 78754. SAS may be served with process through its registered agent, CT Corporation, 1999 Bryan St., Suite 900, Dallas, Texas 75201. SAS makes products that are sold throughout the United States, including in this District, and introduces products into the stream of commerce that incorporate infringing technology knowing that they would be sold in this District and elsewhere in the United States.

7. SAS is a wholly owned subsidiary of SSI, which is a wholly owned subsidiary of SEA, which is a wholly owned subsidiary of SEC.

8. SEC, SEA, SSI and SAS work collectively in making, using, offering for sale, selling, importing, or otherwise providing, within the United States and this District, directly or indirectly, the infringing products described below.

JURISDICTION AND VENUE

9. Jurisdiction and venue for this action are proper in this District.

10. This action for patent infringement arises under the patent laws of the United States, 35 U.S.C. § 1 *et seq.* This Court has original subject matter jurisdiction over this controversy pursuant to 28 U.S.C. §§ 1331 and 1338(a) because this is a civil action arising under the Patent Act.

11. Each Defendant is subject to this Court's personal jurisdiction consistent with the principles of due process and the Texas Long Arm Statute. Tex. Civ. Prac. & Rem. Code §§ 17.041, *et seq.*

12. This Court has personal jurisdiction over each Defendant at least because, through each Defendant's own acts and through the acts of the other Defendants acting as its agent, representative, or alter ego, they each (i) have a presence or a regular and established place of business in the State of Texas and this District; (ii) have purposefully availed themselves of the rights and benefits of the laws of the State of Texas and this District; (iii) have done and are doing substantial business in the State of Texas and this District, directly or through intermediaries, both generally and with respect to the allegations in this Complaint, including their one or more acts of infringement in the State of Texas and this District; (iv) maintain continuous and systematic contacts in the State of Texas and this District; and (v) place products alleged to be infringing in this Complaint in the stream of commerce, directly or through intermediaries, with awareness that those products are likely destined for use, offered for sale, sold, and imported into the State of Texas and this District.

13. For example, Defendants have authorized retailers and distributors in the State of Texas and this District for the products alleged to be infringing in this Complaint, and Defendants have derived substantial revenues from their infringing acts occurring within the State of Texas and this District.

14. Defendants have established sufficient minimum contacts with the State of Texas and this District such that they should reasonably and fairly anticipate being brought into court in the State of Texas and this District without offending traditional notions of fair play and substantial justice, and Defendants have purposefully directed activities at residents of the State of Texas and this District. Moreover, the patent infringement claims alleged herein arise out and are related to one or more of the foregoing activities. A substantial part of the events giving rise

to Plaintiffs' claims, including acts of patent infringement, have occurred in the State of Texas and this District.

15. Venue is also proper in this Court under 28 U.S.C. §§ 1391(b) and (c) and 1400(b) because each Defendant is subject to personal jurisdiction in this District and has committed acts of infringement in this District. Each Defendant, through its own acts and through the acts of each other Defendant acting as its agent, representative, or alter ego, makes, uses, sells, offers to sell, and imports infringing products within this District, has a continuing presence within this District, and has the requisite minimum contacts with this District such that venue is proper.

16. For example, SEA maintains a regular and established place of business in this District at 6625 Excellence Way, Plano, Texas 75023 and has committed acts of infringement in this District, as described herein. Further, SEC directs and controls the actions of SEA such that it too maintains a regular and established place of business in this District at 6625 Excellence Way, Plano, Texas 75023 and has committed acts of infringement in this District. Additionally, venue is proper as to SEC, a foreign corporation, because suits against foreign entities are proper in any judicial district under 28 U.S.C. § 1391(c)(3).

17. Defendants have submitted to venue and the exercise of personal jurisdiction in this District in patent infringement actions previously filed by other parties. *See, e.g.*, Answer, ¶¶ 11-20, *The Research Foundation for the S.U.N.Y., et. al. v. Samsung Elecs. Co., et. al.*, No. 2:23-cv-00141 (E.D. Tex. Aug. 10, 2023), ECF No. 25; Answer, ¶¶ 13, 18, *Cal. Inst. Tech v. Samsung Elecs. Co.*, No. 2:21-cv-00446 (E.D. Tex. Apr. 5, 2022), ECF No. 19; Answer to Amended Complaint, ¶¶ 6, 7, *Jawbone Innovations LLC v. Samsung Elecs. Co.*, No. 2:21-cv-00186 (E.D. Tex. Dec. 9, 2021), ECF No. 27.

W&W'S INNOVATIONS

18. The founders of W&W invented breakthrough photosensor technology that substantially increases light sensitivity in low-light, high-speed and near infrared applications of Complimentary Metal-Oxide Semiconductor ("CMOS") image sensors. These sensors are semiconductors that capture light and convert it into an electrical signal and are used in almost every smartphone and digital camera today. CMOS sensors have a wide range of other applications, such as scanners, webcams, security systems, autonomous vehicles, and optical interconnect for data centers.

19. W&W's founders have a remarkable track record of academic and industry success. CEO and Co-Founder Shih-Ping (Bob) Wang, is a graduate of Rensselaer and MIT, and was the founder of various companies that developed innovative technology, which were acquired for a collective total of around $400 million. CTO and Co-Founder Shih-Yuan (SY) Wang, obtained a Ph.D. from U.C. Berkeley. While at HP Labs, he received over 200 patents, leading to multiple important advances in the field of high-speed photodetectors. For example, SY Wang is a co-inventor of the groundbreaking multimode VCSELS patent (U.S. Patent No. 5,359,447) that paved the way for optical datacenter interconnect and the laser light source for the face ID technology used in Apple's iPhones.

20. Bob Wang and SY Wang formed W&W in 2014 in an effort to design better low-light CMOS photosensors. CMOS sensors are a type of active-pixel sensor (APS), which is an image sensor where each pixel sensor unit cell has a photodetector (typically a pinned photodiode) and one or more active transistors. These sensors have an array of photodiodes (PDs) or avalanche photodiodes (APDs), which 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. After the CMOS sensor gathers the data, it

transfers it to an analog-to-digital converter (ADC), which converts individual pixels made up of cells with different electron charges into colors of various shades. The cells of the CMOS sensors are generally made from semiconducting silicon.

21. The W&W inventions cover the use of tiny nano-microstructure holes in the surface of silicon photodiodes that trap photons, which improves the sensitivity of CMOS devices.

22. W&W's inventions addressed a significant problem in the prior art related to the use of silicon in optical applications. This problem arose from the trend in CMOS sensors of increasing resolution (number of pixels) and reducing pixel size, as depicted below, with the blue dots showing the increasing trend of active silicon thickness with decreasing pixel pitch.

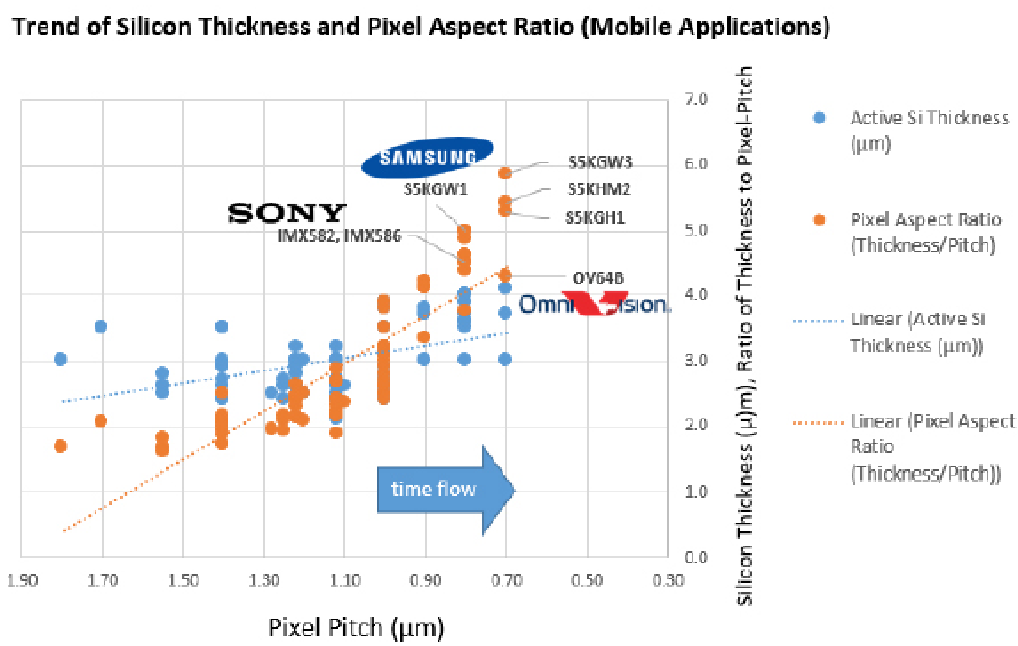
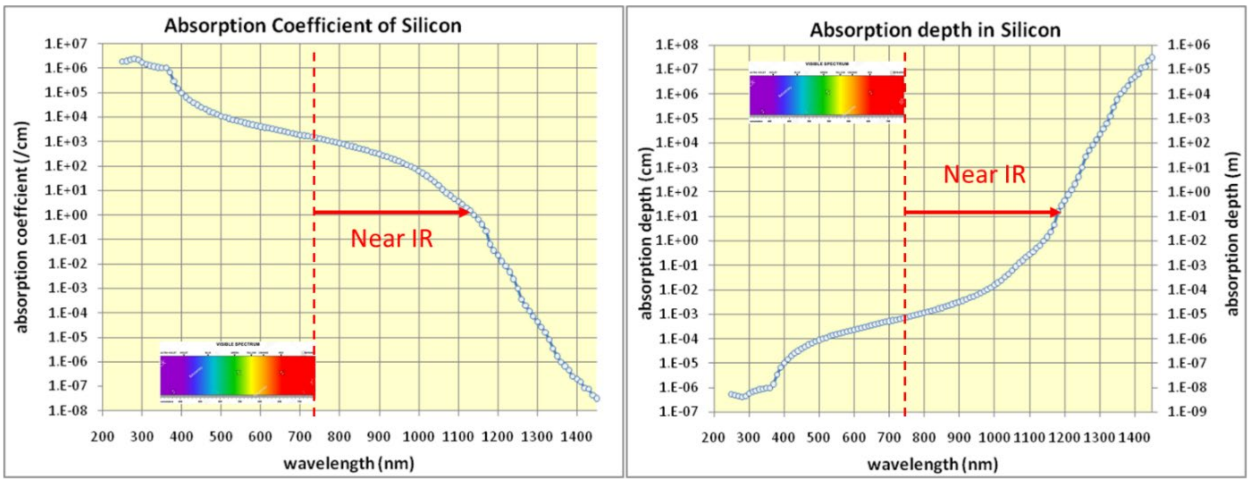


Figure 3 Trend of silicon thickness to pixel pitch ratio.

Ex. 6 at Figure 3 (2021 International Image Sensor Workshop (IISW) by TechInsights).

23. Prior to W&W's inventions, this trend had created significant challenges in ensuring sufficient light sensitivity and absorption, particularly when pixel dimensions shrunk to

1µm or below (as shown by blue dots in the graph above). Specifically, long wavelength light (red to infrared) corresponds to silicon's indirect bandgap, as shown in the graphs below, and would require thicker silicon to have acceptable sensitivity and absorption. For wavelengths longer than 730nm, a thickness of at 10µm of silicon would be necessary to have more than 64% of absorption of the incident light.



Ex. 7 (https://www.pveducation.org/pvcdrom/materials/optical-properties-of-silicon#) (annotations added).

24. However, there was a problem in the prior art of fabricating silicon devices with such thickness while maintaining the smaller lateral dimensions of the pixels used in higher resolution CMOS sensors (e.g., close to 1µm). This problem resulted in lower yield and increased costs for the CMOS sensors. Further reduction in pixel size would require a thinner absorption region, reducing detection efficiency, especially for red to infrared light. Thus, there was a long-felt need to increase the absorption coefficient of thinner silicon, permitting smaller pixels and increased sensitivity for infrared applications, such as low-light photography, depth detection, facial recognition.

25. W&W's patented technology addresses this problem with its use of microstructures in the silicon absorption layer of CMOS sensors, which improved light

sensitivity without the need for a thicker silicon absorption layer. These highly valuable inventions thereby avoided the conventional limitations of silicon in CMOS sensors.

26. The W&W inventors directed a technical group at University of California at Davis (UCD) to fabricate initial demonstrative silicon photosensors. In testing those demonstrative photosensors, they confirmed that the microstructures allowed them to trap photons and dramatically improved the low-light performance of the photosensors. These demonstrative silicon photosensors were never sold or offered for sale.

27. W&W disclosed its microstructure technology in 2017 in a ground-breaking article in Nature Photonics that is now widely cited (W&W's "2017 Microstructure Article"), attached as Exhibit 8 (available at https://faculty.engineering.ucdavis.edu/islam/wp-content/uploads/sites/116/2019/01/Ultrafast-Silicon-PD-Nature-Photonics-May-2017.pdf).

W&W'S ASSERTED PATENTS

28. In recognition of its innovations, the United States Patent and Trademark Office ("USPTO") has awarded W&W numerous patents covering its novel technologies for semiconductor photodetectors. These patents stem from a series of provisional applications filed starting in 2013.

29. On September 10, 2024, the USPTO issued U.S. Patent No. 12,087,871 (the "'871 Patent"), entitled "Microstructure Enhanced Absorption Photosensitive Devices." The '871 Patent lists Shih-Yuan Wang and Shih-Ping Wang as its inventors and is assigned to W&W. Attached hereto as Exhibit 1 is a true and correct copy of the '871 Patent.

30. On April 4, 2023, the USPTO issued U.S. Patent No. 11,621,360 (the "'360 Patent"), entitled "Microstructure Enhanced Absorption Photosensitive Devices." The '360

Patent lists Shih-Yuan Wang and Shih-Ping Wang as its inventors and is assigned to W&W. Attached hereto as Exhibit 2 is a true and correct copy of the ’360 Patent.

31. On November 5, 2019, the USPTO issued U.S. Patent No. 10,468,543 (the “’543 Patent”), entitled “Microstructure Enhanced Absorption Photosensitive Devices.” The ’543 Patent lists Shih-Yuan Wang, Shih-Ping Wang, and M. Saif Islam as its inventors and is assigned to W&W. Attached hereto as Exhibit 3 is a true and correct copy of the ’543 Patent.

32. On October 15, 2019, the USPTO issued U.S. Patent No. 10,446,700 (the “’700 Patent”), entitled “Microstructure Enhanced Absorption Photosensitive Devices.” The ’700 Patent lists Shih-Yuan Wang, Shih-Ping Wang, and M. Saif Islam as its inventors and is assigned to W&W. Attached hereto as Exhibit 4 is a true and correct copy of the ’700 Patent.

33. On December 20, 2016, the USPTO issued U.S. Patent No. 9,525,084 (the “’084 Patent”), entitled “Microstructure Enhanced Absorption Photosensitive Devices.” The ’084 Patent lists Shih-Yuan Wang and Shih-Ping Wang as its inventors and is assigned to W&W. Attached hereto as Exhibit 5 is a true and correct copy of the ’084 Patent.

34. The ’871, ’360, ’543, ’700, and ’084 Patents (together, the “Asserted Patents”) cover inventions for enhancement of light detection sensitivity with micro- or nano- structures near the semiconductor surface of photosensitive devices.

35. W&W owns all rights, title, and interest in and to the Asserted Patents.

36. W&W has not offered for sale or sold any product that embodies any claim of any of the Asserted Patents, nor has it licensed the Asserted Patents to any third party. Thus, W&W’s recovery of pre-suit damages for Samsung’s infringement of the Asserted Patents is not limited by 35 U.S.C. §287(a). In addition, Samsung has had actual notice and knowledge of the Asserted Patents, as set forth below.

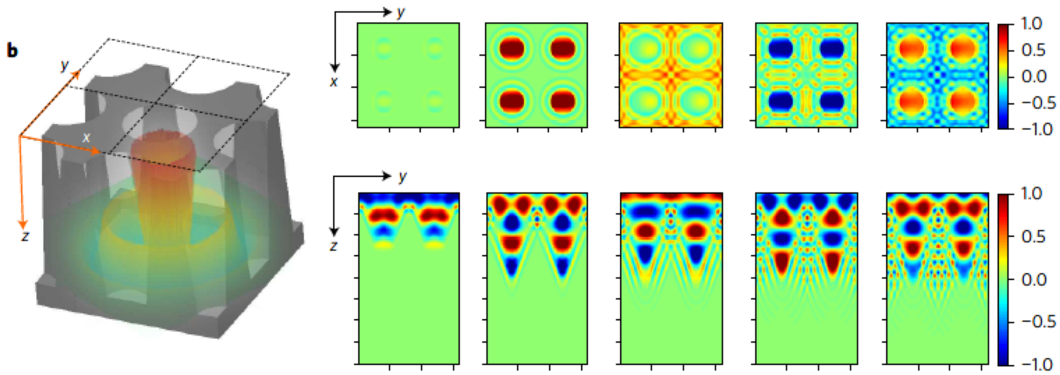
37. All of the Asserted Patents are patent eligible, valid and enforceable. The Asserted Patents disclose and specifically claim non-abstract, inventive CMOS devices that incorporate W&W's pioneering use of microstructures. These devices represent significant improvements over conventional CMOS devices by using novel physical structures to improve the devices' performance.

38. W&W's inventions solved the problems posed in the prior art when pixel dimensions continued to shrink to achieve higher resolutions and lower cost, which required reduction in the thickness of the photosensitive regions of the sensors. The reduced thickness of the photosensitive regions decreased detection efficiency, particularly for wavelengths in the red and near infrared spectrum. Thus, there was a long felt need to increase the absorption coefficient of silicon for a thickness that permits smaller pixels while increasing sensitivity, particularly for infrared applications, such as low-light photography, depth detection and facial recognition.

39. W&W's inventions address this need by incorporating microstructures in the surface of silicon photodiodes to trap photons, dramatically improving the sensitivity of CMOS devices. These microstructures provide a significant improvement to the modern CMOS sensors. These structures were not routine, conventional or previously known or understood in the art. For each claim of the Asserted Patents, the claim elements, individually and in combination, result in enhanced absorption and sensitivity.

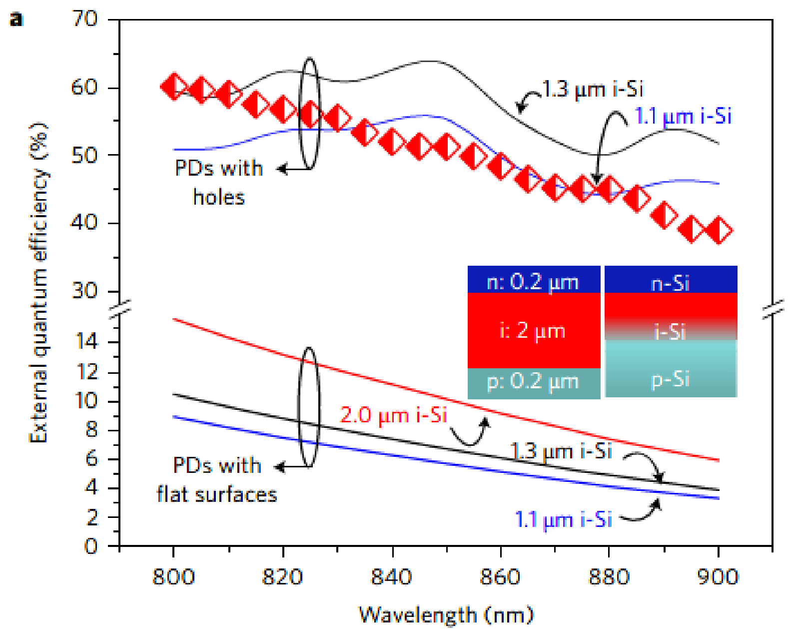
40. The use of these microstructures as disclosed in the Asserted Patents provides a novel and non-obvious solution to the problems with prior CMOS sensors. For instance, they address the shortcomings of silicon in optical applications and the difficulty of altering silicon's optical properties, which are based on the interaction of light with the electrons in the silicon.

Silicon's electronic state can be altered slightly by electric field (via electrooptical effect) or by carrier injection (via free carrier absorption), both requiring an external driving force. W&W's patented microstructures instead passively alter the optical properties of the silicon by altering the propagation of light inside the materials and, as verified by optical simulation, trapping light inside the material. As shown below, such simulation shows formation of lateral modes around holes in the first 21 femto (10^{-15}) seconds:



Ex. 8 (2017 Microstructure Article) at Fig. 2.

41. This result is counterintuitive because the presence of holes reduces the amount of silicon material to absorb the light, which would have been expected to reduce light absorption. However, the data from testing confirms that the absorption is increased with the presence of the microstructures. Specifically, as shown below, the data compared the measured external quantum efficiency (QE) (i.e., the measure of the effectiveness of the sensor to convert incident photons into electrons, which indicates the level of light absorption) of photodiodes with holes (depicted below by red diamond symbols), with the simulations of photodiodes without holes (depicted below by blue and black lines): As shown, photodiodes with holes have much higher external quantum efficiency for the wavelength range between 800nm to 900nm:



Ex. 8 (2017 Microstructure Article) at Fig. 4.

42. The benefits of W&W's inventions to CMOS devices were further discussed in a paper co-authored by S. Y. Wang in May 2021 entitled "Single Microhole per Pixel in CMOS Image Sensors with Enhanced Optical Sensitivity in Near-Infrared," published in IEEE Sensors Journal (W&W's "2021 Microhole Article"), attached as Exhibit 9. The 2021 Microhole Article disclosed various hole structures, as shown below:

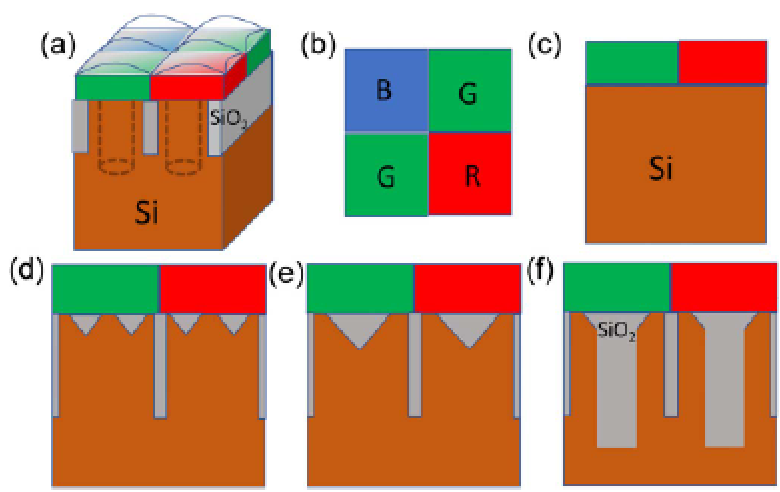


Fig. 1. Schematic diagram of CMOS image pixels: a) view of the pixel with micro lenses, color filters, and trenches; b) Bayer filter array c) planar pixel with color filters d) pixels with inverted pyramids array; e) pixel with a single inverted pyramid, and d) pixel with single funnel holes.

Ex. 9 (2021 Microhole Article) at Fig. 1 (showing various light-absorption enhancing structures).

43. The study concludes that even "a single hole with a size of about 900 nm increases the optical efficiency of the image sensors for all the colors and in near-infrared wavelengths." Ex. 9 (2021 Microhole Article) at 10560.

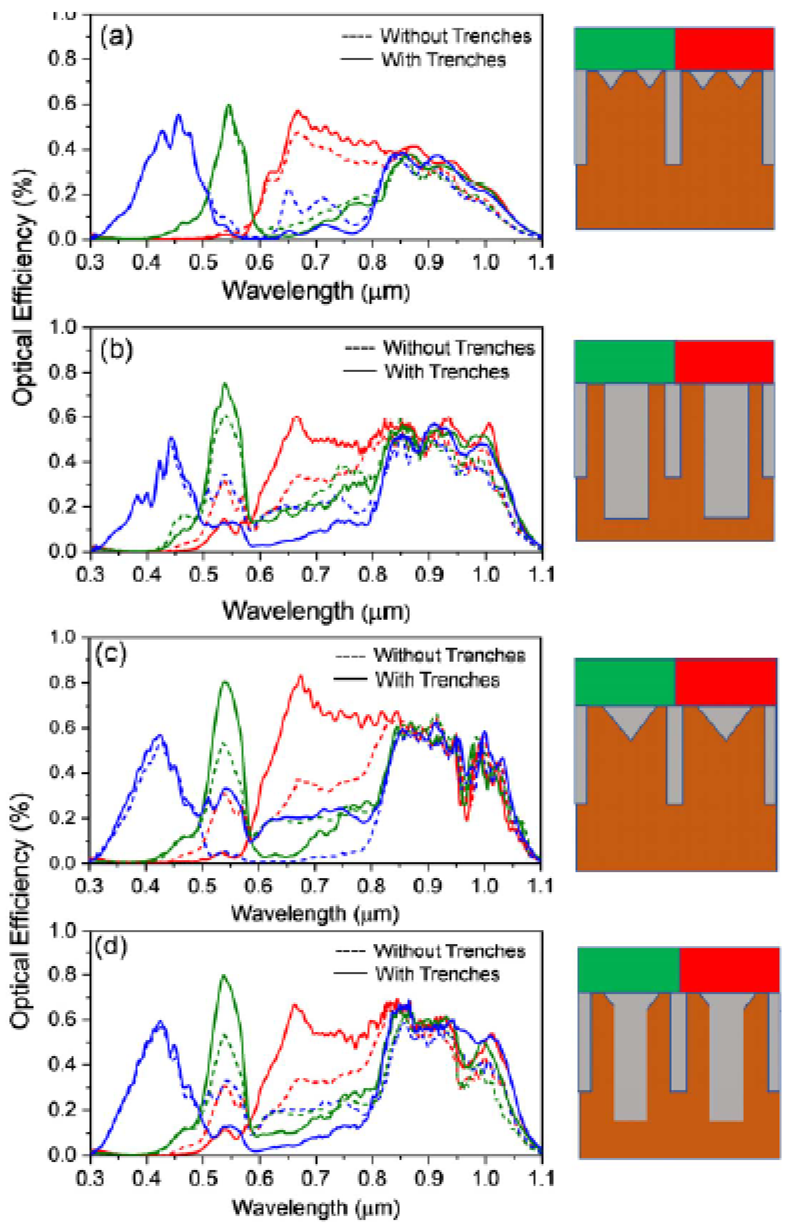


Fig. 3. Calculated optical efficiency (OE) with (solid) and without (dashed) trenches for (a) inverted pyramids array, (b) single cylindrical holes, (c) single inverted pyramid, and (d) single funnel shaped hole.

Ex. 9 (2021 Microhole Article) at Fig. 3 (showing enhancement of light absorption between 0.5µm to 1µm wavelength range).

44. Accordingly, the innovative microstructures of the Asserted Patents permit a new kind of CMOS sensor to be fabricated with higher yield and higher performance. Use of such microstructures for increasing CMOS sensors' light sensitivity was not known prior to W&W's 2017 Microstructure Article, let alone years earlier when the inventors conceived the claimed inventions.

45. As set forth below, after publication of the 2017 Microstructure Article, CMOS sensor manufacturers such as Samsung began adopting this patented technology into their CMOS sensors, without license from W&W.

SAMSUNG'S INFRINGING PRODUCTS

A. Samsung's Accused Products Incorporate Infringing CMOS Image Sensors

46. Samsung makes, uses, sells, offers for sale, and imports into the United States and this District products and services that infringe the Asserted Patents (the "Accused Products"). The Accused Products include Samsung's CMOS image sensors (CIS) (the "CIS Accused Products") and its "Time-of-Flight" (ToF) CMOS image sensors (the "ToF Accused Products), both of which are part of its flagship ISOCELL product line. The Accused Products also include Samsung's products that include the CIS Accused Products (the "CIS Accused End Products"), such as its Galaxy product line, which depend on Samsung's infringing Accused Products to provide low-light photography.

47. Samsung intentionally and deliberately fabricates the infringing microstructures. As discussed below, Samsung has reported the benefits to the Accused Products of including these microstructures and makes the microstructures through specific fabrication and processing steps.

1. Samsung's CIS and ToF Accused Products

48. Samsung's CIS Accused Products infringe the '871, '360, '543, and '700 Patents.

49. The CIS Accused Products include Samsung's ISOCELL products with dual-PD or similar PDAF features or RGB Bayer technology, including at least the following ISOCELL models: GNK (S5KGNK), HP2 (S5KHP2), HPX (S5KHPX), HP3 (S5KHP3), HP1 (S5KHP1), HM6 (S5KHM6), HM3 (S5KHM3), HM2 (S5KHM2), HMX (S5KHMX), HM1 (S5KHM1), GWB (S5KGWB), GW3 (S5KGW3), GW2 (S5KGW2), GW1 (S5KGW1), GN9 (S5KGN9), GN5 (S5KGN5), GN3 (S5KGN3), GN2 (S5KGN2), GN1 (S5KGN1), JN1 (S5KJN1), GM5 (S5KGM5), GM2 (S5KGM2), GM1 (S5KGM1), GH1 (S5KGH1), JD1 (S5KJD1), GD2 (S5KGD2), GD1 (S5KGD1), 2L3 (SAK2L3, S5K2L3), 2L1 (S5K2L1), 2L2 (S5K2L2), 2L4 (SAK2L4, S5K2L4), 2L7 (S5K2L7), 2L8 (S5K2L8), 3P8 (S5K3P8), 3P9 (S5K3P9), 3T1 (S5K3T1SP), 3T2 (S5K3T2, S5K3T2SP), 3LU (S5K3LU), GN8 (S5KGN8), 2X5 (S5K2X5), HP9 (S5KHP9), GNJ (S5KGNJ), JN5 (S5KJN5), GNK (S5KGNK). Exs. 41-42 (representative sample of public documents for exemplary CIS Accused Products showing that they include dual-PD or similar PDAF features or RGB Bayer technology); *see also* Ex. 24 (https://en.wikipedia.org/wiki/ISOCELL).

50. The ToF Accused Products include Samsung's ISOCELL ToF sensors, including at least the following models: Vizion 33D, Vizion 63D, and Vizion 931. The ToF Accused Products infringe the '084 Patent.

2. Samsung's CIS Accused End Products

51. Samsung's CIS Accused End Products infringe the '871, '360, '543, and '700 Patents.

52. Samsung's CIS End Accused Products are widely used in a variety of products, including smartphones, tablets, computers, digital cameras and more, which Samsung and third parties make, use, offer for sale, sell, and import into the United States and this District. These third parties using CIS Accused Products include Google and Motorola.

53. For instance, Samsung makes, uses, sells, offers for sale, and imports into the United States and this District its Galaxy product line that include CIS Accused Products (the "CIS Accused End Products"), including at least the following models: Samsung Galaxy S24 Ultra, S23 Ultra, S22 Ultra, S21 Ultra, S21 Ultra 5G, S20 Ultra, Note 20 Ultra, A35, A32, A41, A6s, M52 5G, S20, S20+, S21, S21+, Note 20, A52s 5G, A70s, A71, A71 5G, F41, M31, A53 5G, A54, S22, S22+, S23, S23+, S23 FE, S24, S24+, Z Fold 4, Z Fold 5, Z Flip 6, Z Fold 6, A13, A13 5G, A14 5G, A23, A23 5G, A24 5G, A25, A04s, M13, M13 5G, M23, M23 5G, A12, F12, M12, A21s, A22, A22 5G, A32 5G, A42 5G, M42 5G, M32 5G, S10 Lite, A90 5G, M30s, S20 Ultra 5G, A70, A60, S9, S9+, Note 9, S7, S7 Edge, S7 Active, Note 7, Note FE, S8, S8+, Note 8, S10, S10+, S10e, Note 10, Note 10+, Fold, Z Flip 4G, Z Flip 5G, S20 FE, S21 FE, Z Fold 3, Z Flip 4, Z Flip 5, Z Flip 6, Z Fold 6, S10 5G, Z Note, A5, A7, C5 Pro, C7 Pro, C9 Pro, Z Flip 4G/5G and M53. Exs. 42, 45 (highlighting added) (representative sample of public documents for exemplary CIS Accused End Products showing that they include a CIS Accused Product); *see also* Ex. 24 (https://en.wikipedia.org/wiki/ISOCELL).

B. Samsung's Accused Products Incorporate Infringing Microstructures

54. Samsung's CIS Accused Products infringe the '871, '360, '543, and '700 Patents based on their use of trenches with dual-pixel autofocusing or RGB Bayer technology, which are described further below. With these techniques, multiple photodiodes are used as a single pixel

(or photodetector), such that the trenches constitute holes within a pixel as claimed in the ’871, ’360, ’543, and ’700 Patents. In addition, the ToF Accused Products infringe the ’084 Patent in view of their use of trenches as part of deep trench isolation and backside scattering technology, as described below.

55. Samsung’s CIS Accused Products have microstructures in the photosensitive region in the manner claimed in the Asserted Patents. These products use shallow trenches and, more recently, deep trenches (such as in the ISOCELL GN5) as holes within the pillars in pixels, as shown below and as described in Samsung’s publication entitled, “An All Pixel PDAF CMOS Image Sensor with 0.64μm×1.28μm Photodiode Separated by Self-aligned In-pixel Deep Trench Isolation for High AF Performance,” 2017 Symposium on VLSI Technology Digest of Technical Papers (Samsung’s “DTI Article”), attached as Exhibit 10.

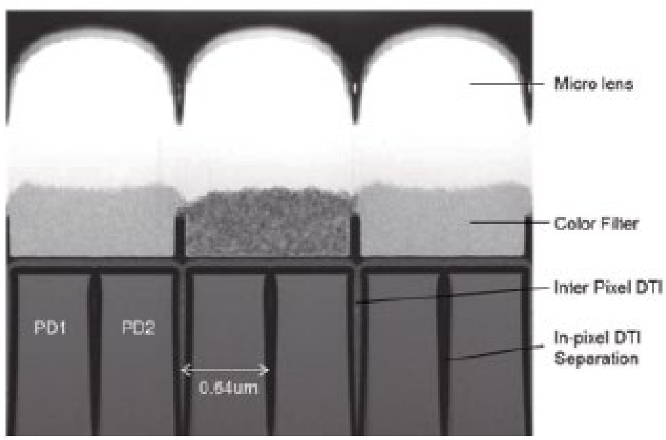
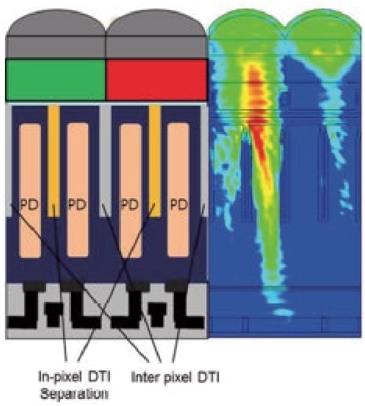


Figure 3. VSEM image of the sensor with in-pixel DTI separation.

Ex. 10 (Samsung’s DTI Article) at Fig. 3 (showing inter-pixel deep trench isolation and in-pixel deep trench isolation).

56. Samsung reports that this deep trench isolation improves light sensitivity of its sensors. Specifically, in Figure 2 of the DTI Article, the device structure with in-pixel deep trench isolation is shown along with an optical simulation. Figure 7 compares the quantum

efficiency between the pixel structures with and without deep trench isolation separation. The comparison shows improved quantum efficiency with deep trench isolation separation for wavelengths longer than 500 nm, confirming the benefit of W&W's patented technology. Ex. 10 (DTI Article) at T104 ("sensitivity of Red and Green light is gained as one can see from Fig. 7").



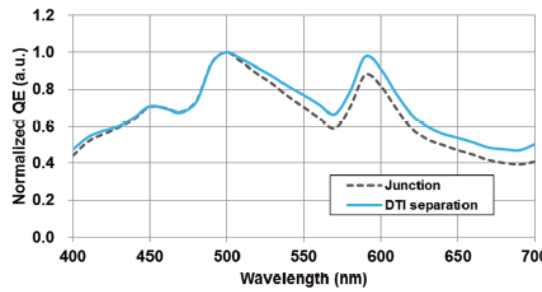
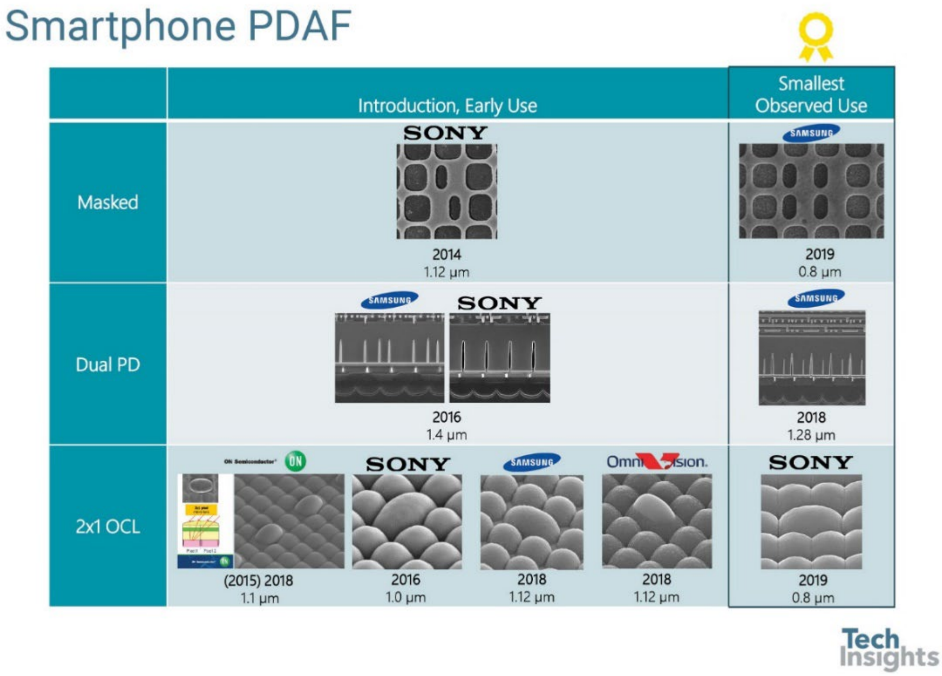


Figure 7. Comparison of QE summation. DTI separation increases the sensitivity.

Ex. 10 (DTI Article) at Figs. 2 and 7 (showing enhancement of light sensitivity using in-pixel deep trench isolation separation for the wavelength longer than 500nm).

1. Dual-Photodiode Autofocusing

57. Various of Samsung's CIS Accused Products use a dual-photodiode architecture for Phase Detection Auto Focus (PDAF), as shown below. These products infringe the '871, '360, '543, and '700 Patents.

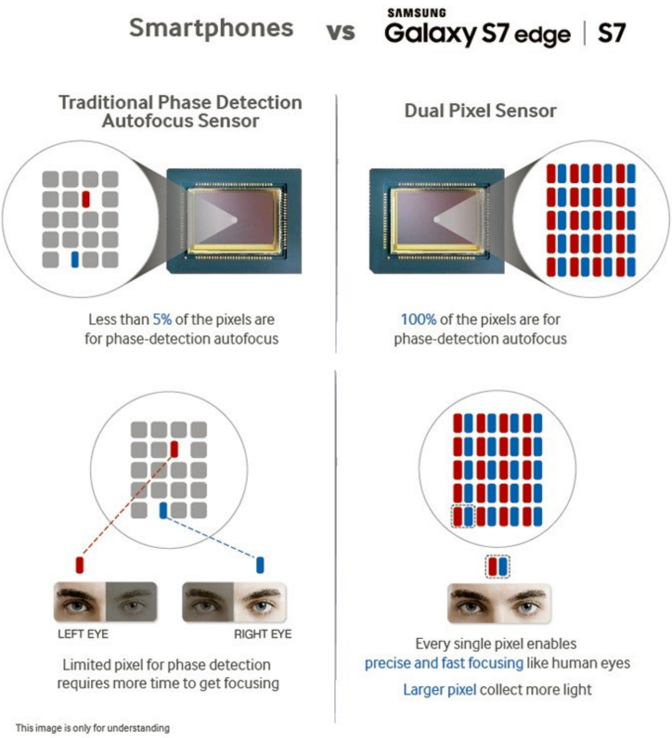


Ex. 11 at Fig. 4 (https://www.techinsights.com/blog/part-4-non-bayer-cfa-phase-detection-autofocus-pdaf).

58. PDAF was first introduced for the purpose of auto focusing. Historically, PDAF uses two separate pixels and compares the intensity detected by these two pixels during focusing. Under this dual-photodiode architecture, two photodiodes are used for phase detection, but when an image is acquired, both photodiodes are used together as one pixel. In the early implementation, only a low percentage of pixels were used for PDAF. Later, Samsung introduced dual-photodiode architecture for every pixel in certain of its CIS models, which it refers to as "Dual Pixel technology."

59. Samsung explained its Dual Pixel technology in March 2016: "With 12 million pixels working as a phase detection auto-focus (PDAF) agent, the new image sensor brings professional auto-focusing performance to a mobile device." Ex. 12 at 1 (https://news.samsung.com/global/samsung-elevates-mobile-phone-picture-quality-with-dual-pixel-technology-in-its-newest-image-sensor). A consumer website explains that "each and

every pixel of the Dual Pixel image sensor is capable of detecting phase differences of perceived light for significantly faster auto-focus," as shown below:



Ex. 13 at 2-3 (https://www.fonearena.com/blog/177643/samsung-12mp-dual-pixel-sensor-in-galaxy-s7-and-s7-edge-detailed.html) (describing Samsung 12MP Dual Pixel sensor in Galaxy S7 and S7 edge).

60. Samsung further detailed its Dual-Pixel technology in a 2020 paper entitled "A Low-power 65/14nm Stacked CMOS Image Sensor," published in IEEE International Symposium on Circuits and Systems (ISCAS) (Samsung's "2020 2PD Article"). Ex. 14. Figure 2 of the 2020 2PD Article shows two photodiodes under each color filter, specifically depicting "a block diagram of the implemented CIS with bonding between a top chip in 65nm and a bottom chip in 14nm. The top chip consists of 4,032 x 3,040 pixels which are divided into a left and a right [photodiodes (PD)]. Each pixel has partial-depth deep trench isolation (DTI) structures to reduce crosstalk between PDs." Ex. 14 at 1.

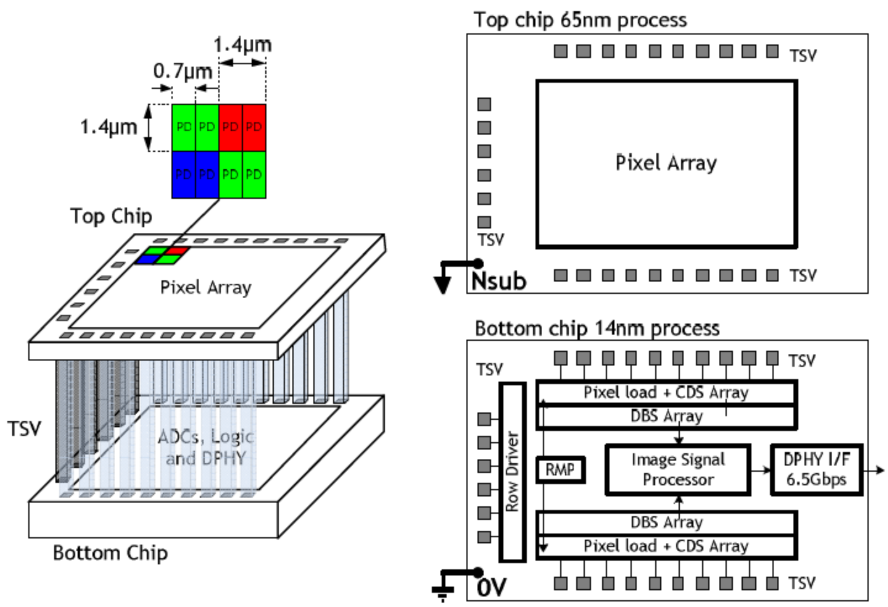


Fig. 2. 65/14nm stacked sensor architecture.

Ex. 14 at Fig. 2.

61. With the dual-photodiode architecture, for each pixel there are two photodiodes under a micro-lens (μ-lens). These photodiodes share the same circuitry. When these two photodiodes are used in autofocusing mode, the difference in the signal strengths detected by the photodiodes is sent to output memory. These two photodiodes individually do not engage in image acquisition. When these two photodiodes are used in the image acquisition mode, they are used together with transmission gates TG_L and TG_R, both turned on simultaneously so that the charges stored in the photodiodes are transferred out. In the image acquisition mode, these two photodiodes operate as one pixel under one μ-lens.

62. The operation of the circuitry is further explained in the diagram below:

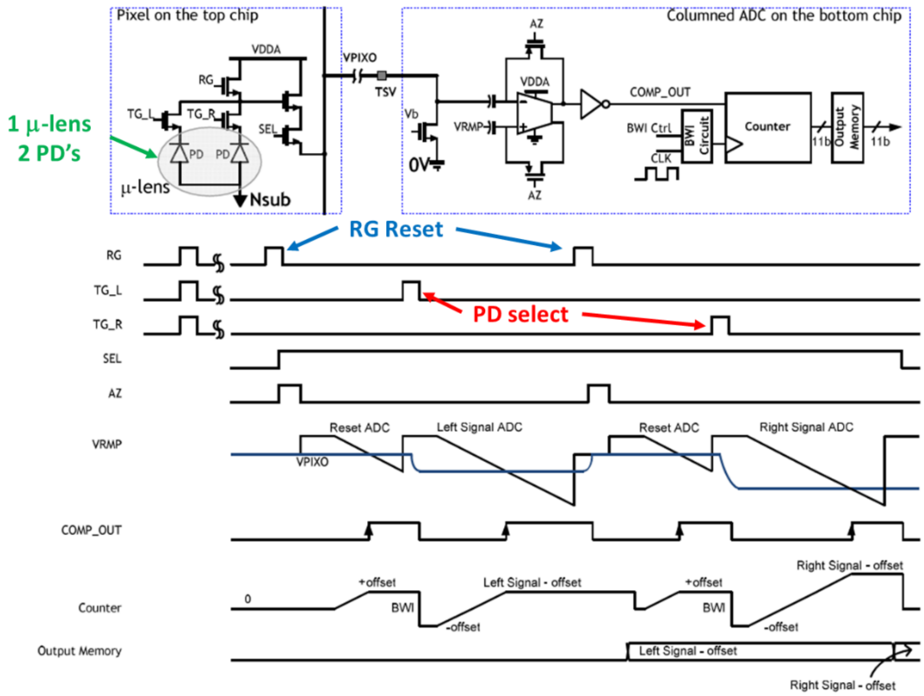


Fig. 3. Column ADC with timing diagram.

Ex. 14 (2020 2PD Article) at Fig. 3 (annotated to show the timing of the RG transistor and TG_L and TG_R that the circuit resets before reading photodiodes).

63. For each autofocusing reading, the objective is to detect the difference between the charges stored in the two photodiodes under each μ-lens. *See* Ex. 13 (https://www.fonearena.com/blog/177643/samsung-12mp-dual-pixel-sensor-in-galaxy-s7-and-s7-edge-detailed.html) ("[E]ach and every pixel of the Dual Pixel image sensor is capable of detecting phase differences of perceived light for significantly faster auto-focus."). If the image is precisely focused on the CMOS image sensor, the left and the right photodiodes should detect the same amount of the signal. This is how the camera system performs the autofocusing. "[T]he disparity between left and right PD signals is used for the phase detection auto-focus (AF) data and the sum signal of them is used as the output image data." Ex. 14 (2020 2PD Article) at

2. Thus, when the CIS operates as an image sensor, it uses the sum of the signal of the two photodiodes within a single pixel (or photodetector).

64. Each μ-lens operates as one pixel, or one photodetector, when the camera acquires a focused image. This pixel (i.e., photodetector) includes deep trench isolation, as explained above and shown in the image below:

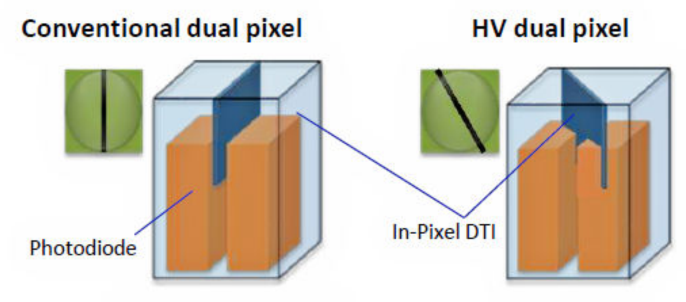


Fig 4: Earlier dual-pixel phase detection directed light to the left and right phase-detecting pixel photodiodes using vertical Deep Trench Isolation (DTI). The Samsung GN2 sensor uses a diagonal DTI structure to allow the two photodiodes in a green pixel to detect and focus on both horizontal and vertical lines. (Image Credit: Samsung)

Ex. 15 (Samsung's GN2 CIS) at Fig. 4 (showing holes are fabricated to provide in-pixel deep trench isolation inside a pixel).

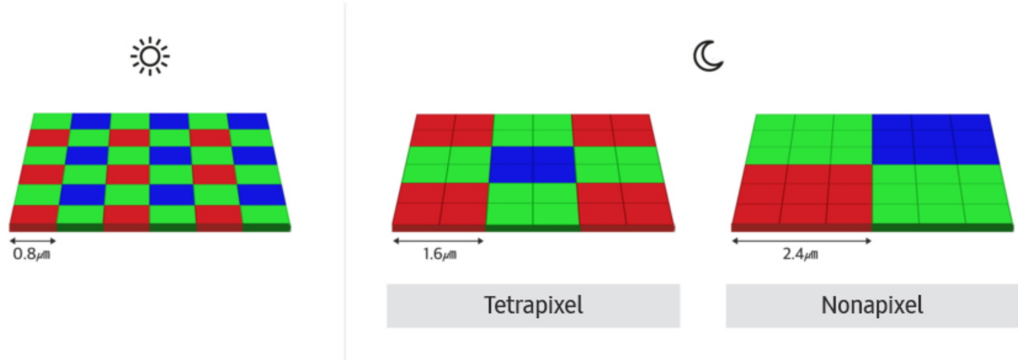
2. RGB Bayer

65. Certain CIS Accused Products have used one of the following arrangements of sub-pixels as part of the Bayer filter, which is a color filter array for arranging Red-Green-Blue (RGB) color filters on a square grid of photosensors:

- Tetracell uses a Quad Bayer or 4-cell design. For darker scenes, signal processing can combine data from 2x2 pixel groups to act like a larger pixel with a repeating 4×4 subpixel pattern with 4 red, 8 green and 4 blue subpixels. For brighter scenes, signal processing can convert the Tetracell into a Red-Green-Blue (RGB) filter to achieve 4x higher resolution.
- Nonacell is similar to Tetracell, but with 3x3 pixel groups and a 6×6 pattern with 9 red, 18 green and 9 blue subpixels.

- ChameleonCell is similar to Tetracell and Nonacell, but with 4x4 pixel groups and an 8x8 pattern with 16 red, 32 green and 16 blue subpixels.

The CIS Accused Products using Tetracell, Nonacell or Chameleoncell RGB Bayer technology, in both binning mode and remosaic mode (which are described below), infringe the ’871, ’360, ’543, and ’700 Patents. Below is a depiction of the Nonapixel and the Tetrapixel designs:



At a 1/1.33” scale with 108-million 0.8μm pixels, the ISOCELL Bright HM1 features the industry’s first state-of-the-art Nonapixel technology, which delivers brighter images in low-light settings. In 2017, Samsung introduced Tetrapixel,** a pixel-binning technology with a special two-by-two array that merges four neighboring pixels to work as a single large pixel. Nonapixel is an enhanced version of Tetrapixel with a three-by-three pixel structure. In the HM1, Nonapixel merges nine neighboring 0.8μm pixels to mimic a large 2.4μm pixel, more than doubling Tetrapixel’s light absorption.

Ex. 16 at 2 (https://news.samsung.com/global/samsungs-108mp-isocell-bright-hm1-delivers-brighter-ultra-high-res-images-with-industry-first-nonapixel-technology#:~:text=In%202017%2C%20Samsung%20introduced%20Tetrapixel%2C%2A%2A%20a%20pixel-binning%20technology,version%20of%20Tetrapixel%20with%20a%20three-by-three%20pixel%20structure).

66. Each Bayer cell, under one color filter, comprises 2x2, 3x3 or 4x4 photodiodes. ISOCELL HM1 is an example of a CIS Accused Product that uses Nonacell RGB Bayer technology, which Samsung describes in its article entitled “A 0.8 μm Nonacell for 108 Megapixels CMOS Image Sensor with FD-Shared Dual Conversion Gain and 18,000e- Full-Well Capacitance” published in 2020 in the IEEE International Electron Devices Meeting (IEDM) (Samsung’s “2020 Nonacell Article”):

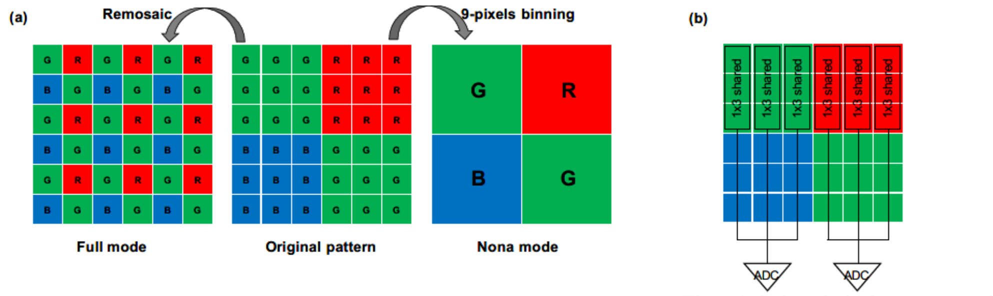


Fig. 1. (a) Nonacell diagrams transformed into the full and the nona-operating mode respectively. (b) Three 1x3 shared pixels are arranged horizontally to constitute 3x3, and each output from each shared pixel is combined in the ADC.

Ex. 17 (2020 Nonacell Article) at Fig. 1 (showing 3 1x3 shared pixels are arranged horizontally so that each output from each shared pixel is combined in the analog-to-digital converter).

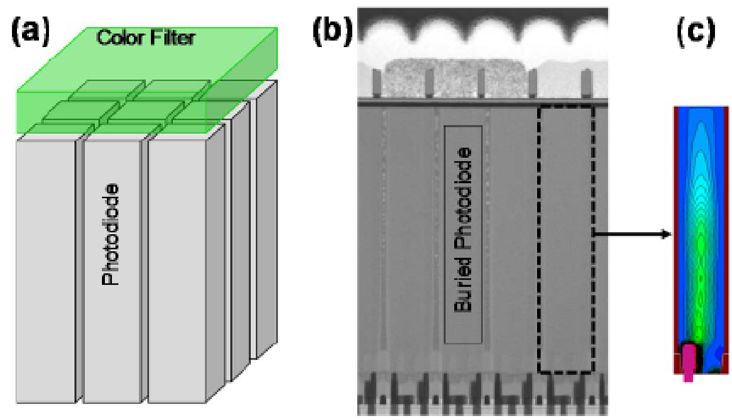


Fig. 3. (a) Schematic structure of the Nonacell. (b) Cross-sectional TEM image of the pixel and (c) vertical potential profile of the buried photodiode.

Ex. 17 (2020 Nonacell Article) at Fig. 3 (showing nine buried photodiodes under one color filter and holes fabricated inside each overall pixel structure).

67. While Samsung describes the HM1 as having 108 million (12000x9000) pixels (i.e., 108 megapixels (MPs)), its electronic circuitry, limited by available space, is organized as a 12 MP device (i.e., 108 MP / 9 buried photodiodes under one color filter), as explained in the 2020 Nonacell Article. Specifically, there are 3,000 analog-to-digital converters to output sequentially 4,000 data points during each readout frame. Thus, at any given frame, only 12 MP can be read out. When reading out the information of each pixel, either one of the nine buried photodiodes or all of the nine buried photodiodes are accessed, such that each Bayer cell is configured as one pixel, rather than nine pixels. After reading nine frames of data, each with a

selected buried photodiode of a Bayer cell, a post remosaic algorithm (described further below) up-converts these nine 12MP images into one combined image with an effective resolution of 108 MPs. Therefore, the HM1 is physically a 12 MP chip with a native resolution of 12 MPs.

68. For each 1x3 shared pixel shown in Fig. 1 of the 2020 Nonacell Article, the output is combined in the analog-to-digital converter. Thus, these buried photodiodes do not operate independently because they share the same Floating Diffusion (FD), which is a capacitor that stores charges temporarily. The FD has to be reset to an initial voltage before being used to store the charges transferred from the photodiode. Therefore, the buried photodiodes cannot be sampled separately from one another. Additional details regarding the circuitry are shown in Figure 4 of the 2020 Nonacell Article and discussed further below:

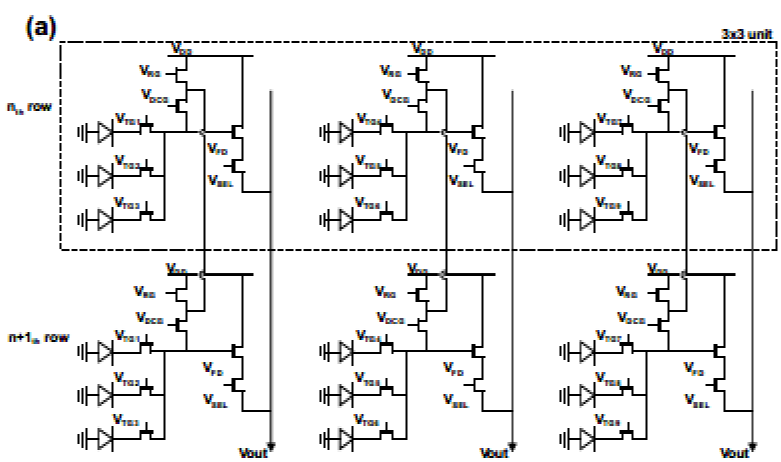


Fig. 4. (a) Schematic diagram of the Nonacell with inter-FD shared DCG structure.

Ex. 17 (Samsung's 2020 Nonacell Article) at Fig. 4a.

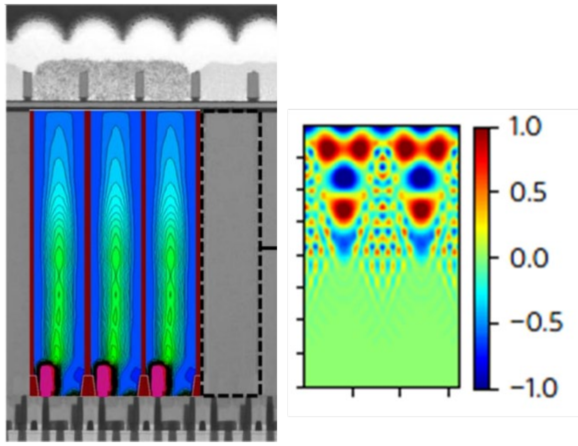
69. **Binning mode**: Samsung uses pixel-binning with its Tetracell, Nonacell and Chameleoncell technology, which is a technique that reduces the effective resolution of the camera sensor as it combines the data of multiple pixels (e.g., nine pixels with Nonacell) into one

larger pixel, reducing the amount of information to be processed. In binning mode, as described in the 2020 Nonacell Article, "[t]hree 1x3 shared pixel units are combined to create a 3x3 pixel with the same color." Ex. 17 at 1. Specifically, "[i]n nona-binning operation mode, 9 pixels are read simultaneously, signal electrons in shared three PDs are summed in the floating diffusion (FD), and the three vertical outputs are averaged at the voltage domain." Ex. 17 at 1.

70. **Remosaic mode**: Samsung uses remosaic mode, which employs an algorithm to rearrange the pixel array (e.g., 12 MPs) to get a higher resolution (e.g., 108 MPs), as shown in Figure 1 of the 2020 Nonacell Article. In remosaic mode, the photodiode connected to TG1 (or TG2, or TG3) is used individually, while the other two buried photodiodes are sampled until V_{FD} is reset. The reset instruction is performed chip-wise. Each time V_{FD} is reset, the buried photodiodes are reset as well. The 3 metal connections (columns) correspond to one analog-to-digital converter as discussed above (in Fig. 1). To avoid interference between the 3 1x3 shared pixels, only one of them will be selected at any given time. Thus, for instance, the HMI can only produce images with a 12MP resolution at any given time, and the transistors, together, perform the storage, transmission, amplification and signal processing.

71. Therefore, these buried photodiodes never operate as independent pixels from one another, which is why Samsung refers to it as a 1x3 shared pixel in its 2020 Nonacell Article. Although only one of the buried photodiodes is accessed by the electronics during the integration phase of the light absorption, all three buried photodiodes operate as one photodetector.

72. Each of these independent pixels (or photodetectors) includes trenches or in-pillar holes, as further depicted below:



Ex. 17 (2020 Nonacell Article) at Fig. 3 (superimposed diagrams), compared with Ex. 8 (W&W's 2017 Microstructure Article) at Fig. 2.

3. Enhanced Infrared CIS

73. Samsung's Accused Products using backside scattering technology, described below, include trenches or in-pillar holes in each pixel (or photodetector), infringing the '084 Patent.

74. Samsung sells the ISOCELL Vizion 33D, which is an iToF (Indirect Time-of-Flight) sensor. Ex. 18 (https://semiconductor.samsung.com/image-sensor/vision-sensor/isocell-vizion-33d/). iToF sensors are used to measure distances between the camera and the subject. Based on the time it takes for an infrared light signal to travel to and from an object, the devices detect depth information in real-time. This enables 3D imaging and the ability to separate subjects from the background with bokeh effects (e.g., where the background of an image is blurred). To enhance the sensor's quantum efficiency, these devices also use deep trench isolation, along with backside scattering technology (BST), which uses light scattering by shallow deep trench isolation patterns with optimal depth, width, and spacing. Ex. 18. (https://semiconductor.samsung.com/image-sensor/vision-sensor/isocell-vizion-33d/).

75. Samsung described its approach to iToF for its ISOCELL Vizion 33D in its article entitled "A 1.2-Mpixel Indirect Time-of-Flight Image Sensor With 4-Tap 3.5-μm Pixels for Peak

Current Mitigation and Multi-User Interference Cancellation," IEEE, Journal of Solid-State Circuits, Nov 2021 (Samsung's "2021 ToF Article"), attached as Exhibit 19. *See also* Ex. 20 (https://image-sensors-world.blogspot.com/2021/03/isscc-2021-on-line-samsung-isocell.html) (showing "Samsung ISOCELL Vizion presentation at ISSCC 2021").

76. Samsung's ISOCELL Vizion 33D incorporates Samsung's infringing backside scattering technology light absorption structure, as reflected in the 2021 ToF Article, showing multiple holes etched in one single pixel:

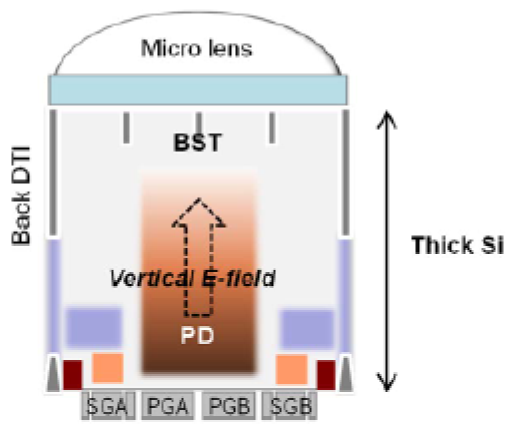


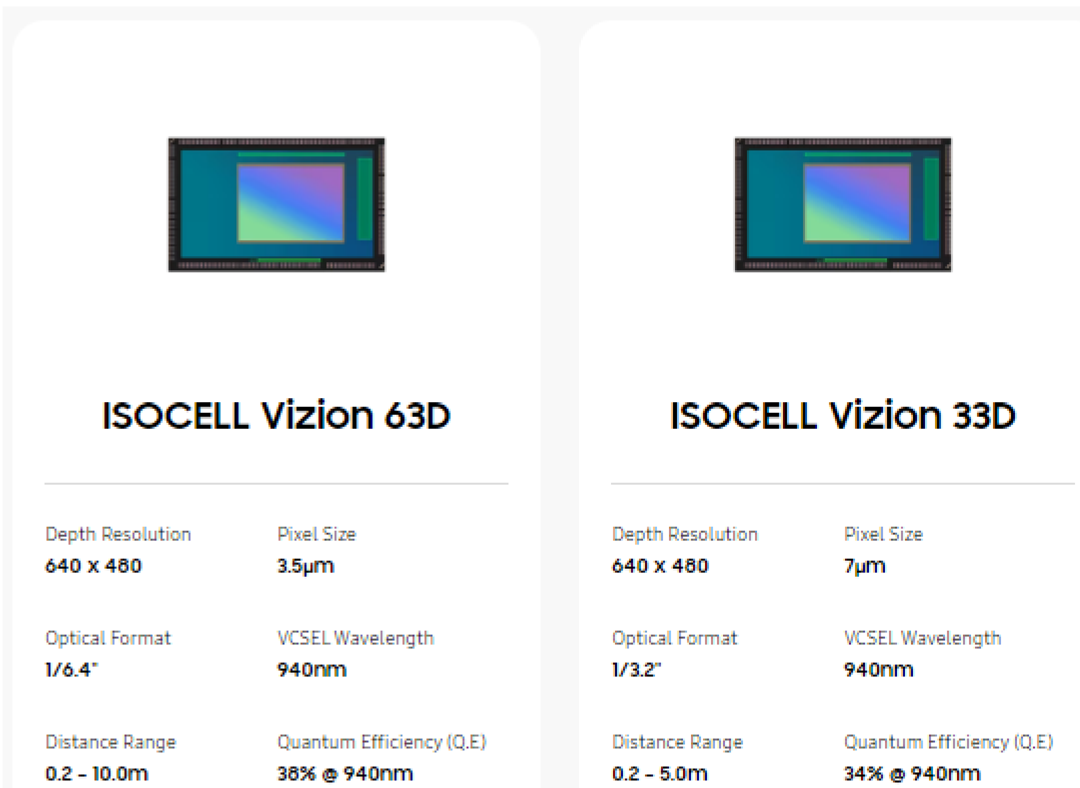
Fig. 4. Vertical cross section of the proposed ToF pixel.

Ex. 19 (2021 ToF Article) at Fig. 4.

77. With less than 5µm thickness of silicon light absorbing layer in Samsung's ISOCELL Vizion 33D, Samsung claims a quantum efficiency of 34% at 940nm, which is consistent with the quantum efficiency reported by W&W in its seminal 2017 Microstructure Article. Ex. 18. (https://semiconductor.samsung.com/image-sensor/vision-sensor/isocell-vizion-33d/) and Ex. 8.

78. Samsung introduced additional iToF products in December 2023, including its ISOCELL Vizion 63D and Vizion 931, which also use deep trench isolation and backside scattering technology. Samsung describes this functionality as follows: "Use cutting-edge

technology to get more out of your devices. ISOCELL Vizion 931 reduces power consumption and heat generated, which makes the overall device experience more pleasant. These features are thanks to front-side deep trench isolation (FDTI) and backside scattering technology (BST), along with an industry-high quantum efficiency (QE) of 60%." Ex. 21 at 3 (https://semiconductor.samsung.com/image-sensor/global-shutter-image-sensor/isocell-vizion-931/). Samsung further represents that with the Vizion 63D, "60% QE is achieved at an infrared wavelength of 850 nm." *Id*.



Ex. 22 at 3-4 (https://semiconductor.samsung.com/image-sensor/tof-sensor/) (showing Vizion 63D and 33D with quantum efficiency of 34% at 940 nm wavelength).

79. In view of silicon's indirect bandgap at long wavelengths, prior to W&W's technology, photodetectors for the iToF sensors were made with GaAs or SiGe materials, which raised manufacturing challenges that resulted in lower yields. Samsung recognized the significant enhancement of light sensitivity in implementing W&W's patented technology by its

use of deep trench isolation and backside scattering technology in its ToF products. For instance, Samsung published an article entitled "Pixel Technology for Improving IR Quantum Efficiency of Backside-illuminated CMOS Image Sensor" in International Image Sensor Workshop (Samsung's "IR QE Article"), attached as Exhibit 23, in which it reported the results of its examination of different pixel structures for IR light harvesting. Samsung found dramatic improvement (70% or higher) in light sensitivity (QE) in the near infrared wavelength range (e.g. 810 nm and 940 nm). Although the paper focuses on near infrared wavelength, the study shows significant improvement (>10%) in the red light (~650 nm) wavelength range as well. The figures below show the enhancement of light absorption by backside scattering technology:

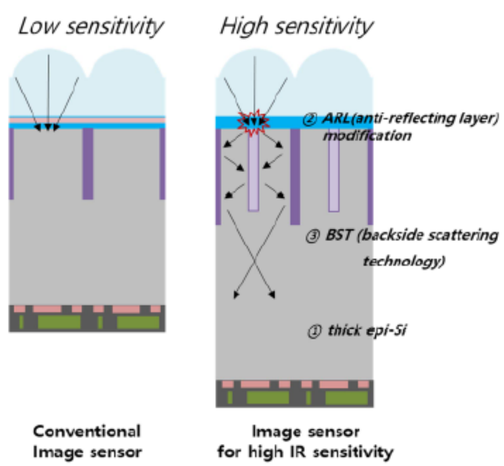


Figure 1. Schematic images of design concept for image sensor having IR sensitivity

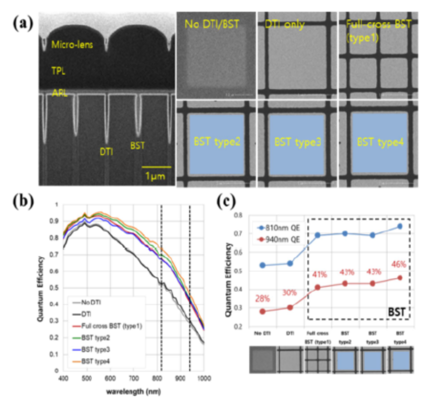


Figure 4. (a) Cross-sectional and top-view SEM images of the pixel structure which consists of backside scattering technology (BST) patterns. (b) QE curves of image sensors with no DTI, only DTI and DTI+BST pixel structures. (c) Quantum efficiencies of image sensors with various DTI and BST patterns at 810nm and 940nm wavelength.

Ex. 23 (Samsung's IR QE Article) at Figs. 1 and 4.

C. Lab Analysis of the Accused Products Confirmed Infringement

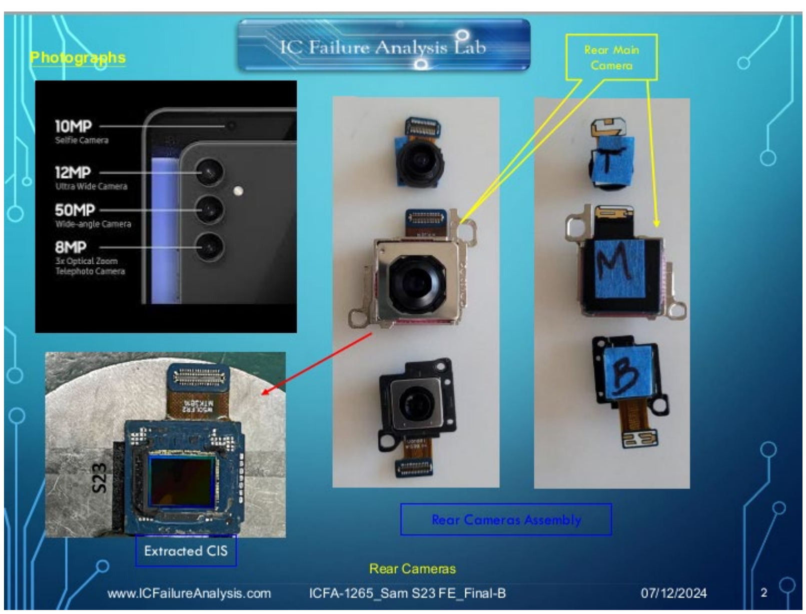
80. W&W had a lab analysis performed on certain Samsung products, which confirmed that the Accused Products infringe the Asserted Patents. Specifically, W&W purchased two Samsung Galaxy S23 FE smartphones and two Samsung Galaxy S24 Ultra smartphones and provided them to IC Failure Analysis Lab (ICFA) located at 3506 W Lake Center Dr, Suite D, Santa Ana, California 92704. ICFA is "a privately held company" whose

"personnel have decades of collective experience in micro analysis and process analysis." https://icfailureanalysis.com/.

81. ICFA's lab analyses confirmed that the GN3, HP2 and other CIS Accused Products, as well as the CIS Accused End Products, satisfy the claim elements of the '871, '360, '543, and '700 Patents, as set forth further below for each of these patents.

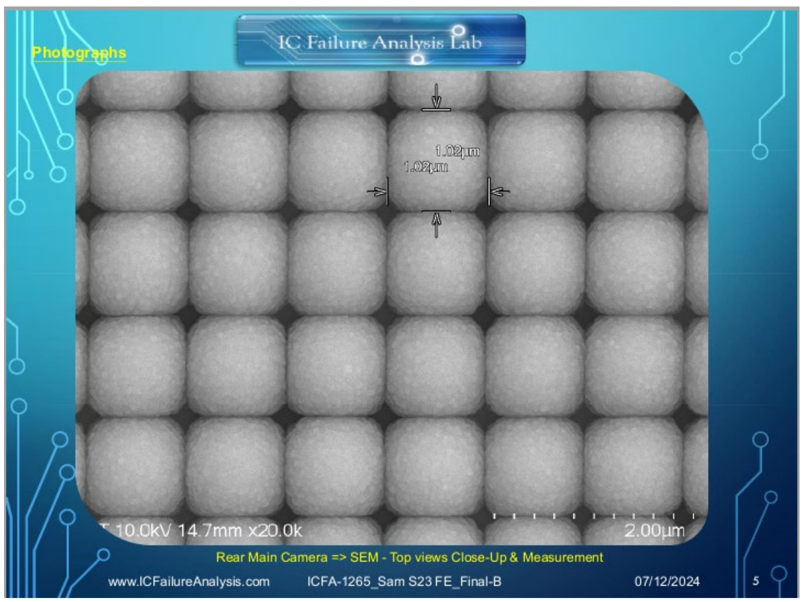
82. ICFA used various techniques to analyze the respective CIS components of these smartphones. These techniques included Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM) and Scanning Capacitance Microscopy (SCM), by which a cross-section view of microstructures and doping profiles could be examined in detail in the sub-micrometer range. ICFA also used energy-dispersive X-ray (EDX) analysis together with SEM to generate information about the chemical composition of the materials. ICFA's reports are attached hereto as Exhibits 25 and 26.

83. With respect to the S23 FE smartphones, ICFA retrieved the ISOCELL GN3 chip (the "GN3") from the wide-angle cameras of these smartphones, as shown below:



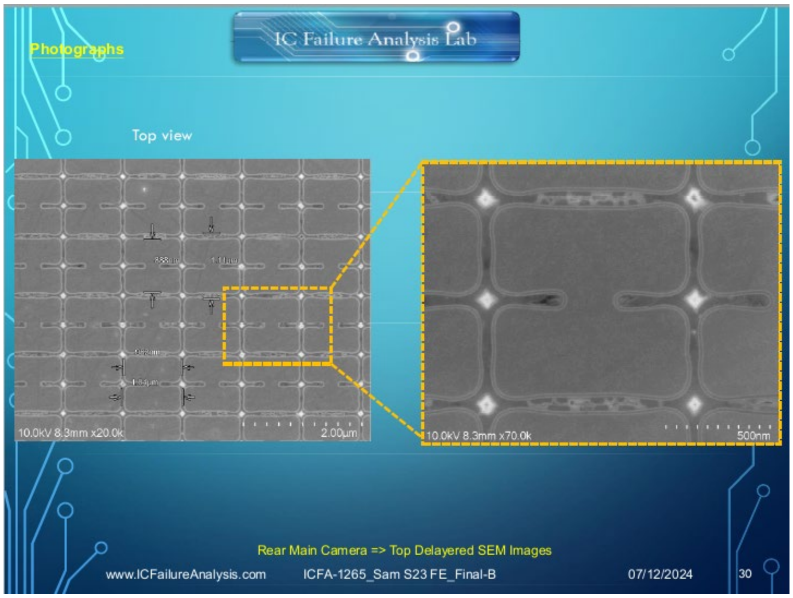
Ex. 25 (ICFA-1265) at Slide 2 (showing the rear main camera retrieved from the S23)

84. Samsung advertises its S23 FE camera as a 50MP camera, consistent with the resolution of the GN3. After retrieving the GN3, ICFA loaded it into an SEM machine. The top view of the GN3 revealed a two-dimensional array of µ-lenses. The spacing of the arrays measured to be 1.02 µm, consistent with the 1 µm pixel size of GN3 within measurement accuracy. The SEM machine yielded images formed by detecting the varying intensities (grey-level) of electrons reflected from the different surfaces, as shown below:



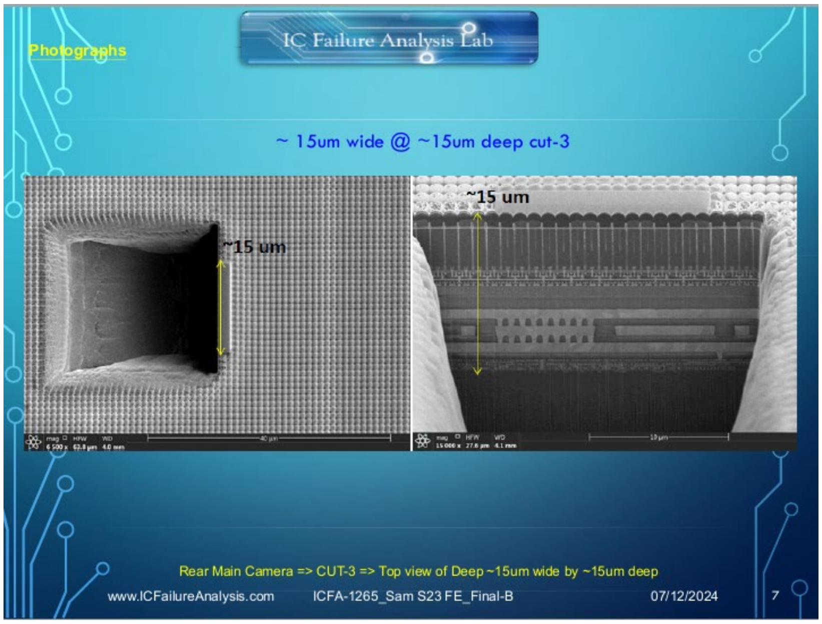
Ex. 25 (ICFA-1265) at Slide 5 (showing the top view of the CIS chip having 1.02µm x 1.02 µm µ-lenses).

85. In order to view the underlying structure below the µ-lenses, ICFA used mechanical polish to remove the materials near the top surface. As shown below, the pixels of the GN3 are separated by square boundaries, and within each pixel, two holes are present:



Ex. 25 (ICFA-1265) at Slide 30 (SEM images after the surface materials are mechanically polished away, revealing the top view of the semiconductor pixels).

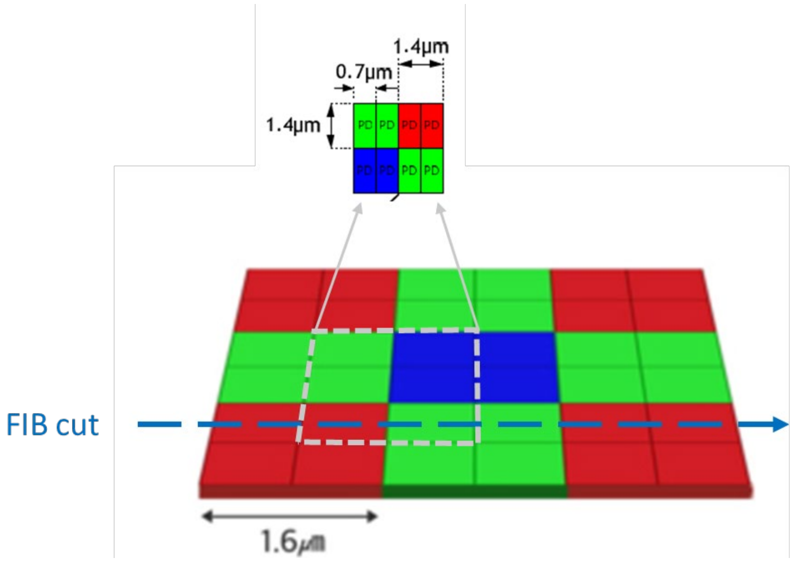
86. To further investigate the device structure of the GN3, ICFA obtained a cross section view by cutting the GN3 with a Focused Ion Beam (FIB), which sputters the materials off by highly energetic Gallium ions. *See, e.g.*, Ex. 27 ("Introduction: Focused Ion Beam Systems" Article); Ex. 28 ("Focused Ion Beam SEM (FIB-SEM)" Article). Using FIB, a cut of ~15 mm wide and 15 mm deep was made along the center line of a vertical array of the µ-lenses to reveal the cross section, as shown below:



Ex. 25 (ICFA-1265) at Slide 7 (showing a portion of material removed by FIB to expose the cross-section of ~15 µm wide and 15 µm deep).

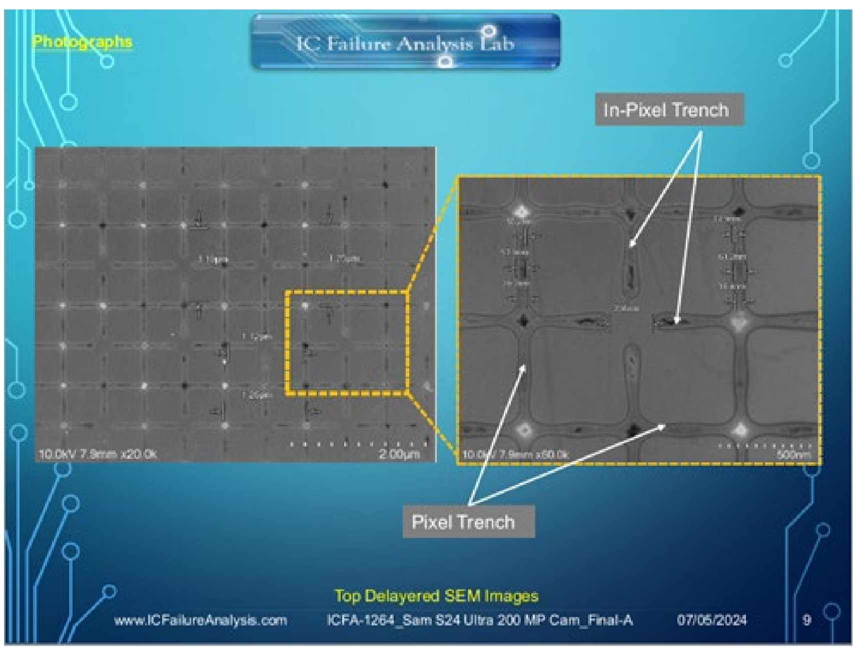
87. The cross section of the GN3 reveals the following features consistent with Samsung's 2020 2PD Article, as shown below:

- Along the cut, there are two types of color filters.
- Under each color filter, there is one Bayer pixel.
- Within a Bayer pixel, there are two sub-pixels which, as set forth above, can be accessed together or sequentially.
- Under each µ-lens is a sub-pixel. To enable dual-PD PDAF, there are two photodiodes in each pixel.

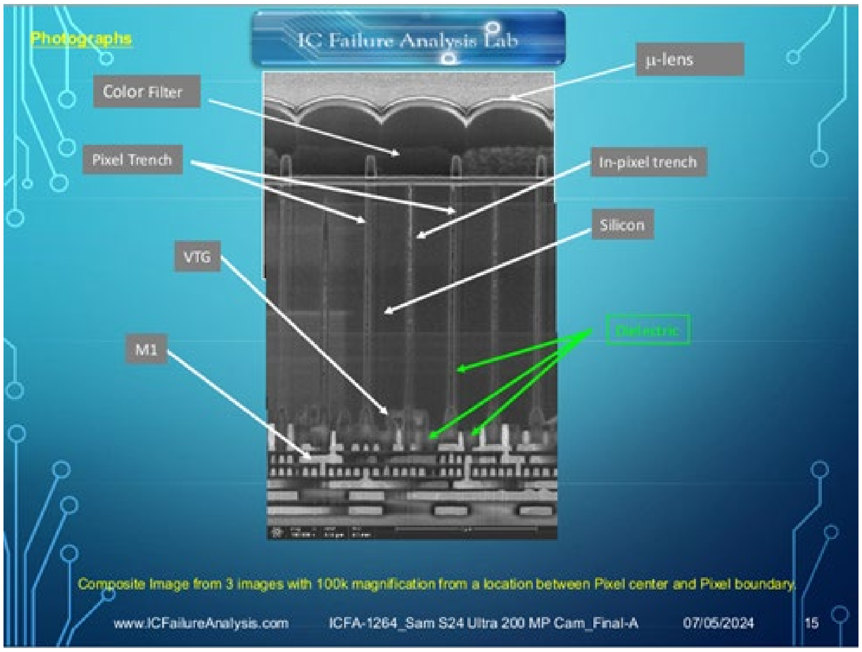


Ex. 16 (Bayer RGB) (cropped and annotated to show two types of color filters along the FIB cut) and Ex. 14 (Samsung's 2020 2PD Article) at Fig. 2 (cropped to show two photodiodes under each color filter).

88. With respect to the S24 Ultras, ICFA retrieved the ISOCELL HP2 chip (the "HP2") from the cameras of these smartphones. As with the GN3, ICFA captured various images of the HP2, including the SEM images shown below:



Ex. 26 (ICFA-1264) at Slide 9 (HP2 top view).



Ex. 26 (ICFA-1264) at Slide 15 (HP2 side view).

89. As with the GN3, ICFA's analysis confirmed the presence of in-pixel trenches in the HP2.

<u>W&W REPEATEDLY DISCLOSED IT PATENTS TO SAMSUNG</u>

90. Samsung's infringement of the Asserted Patents is willful and egregious, warranting enhancement of damages.

91. Samsung is well aware of the Asserted Patents and that it is infringing those patents because W&W repeatedly disclosed its patent portfolio to Samsung, explained the importance of its patented technology that Samsung is now using, and specifically identified to Samsung three of the five Asserted Patents as well as other related patents. Despite W&W's outreach, Samsung never took a license to W&W's patents. Samsung continues to infringe W&W's patents despite its knowledge of the Asserted Patents and that its Accused Products infringe.

92. In an attempt to partner with or license Samsung, W&W contacted multiple Samsung employees regarding W&W's patents and technology. Certain of these communications are attached as Exhibit 29-32.

93. On April 25, 2019, W&W sent a message regarding its patented technology to James Schuessler, Director of Standards Strategy and Vehicle Communications at Samsung. Ex. 29. W&W attached a presentation entitled "Time-of-Flight Solutions for the Next Generation," that set forth details about W&W's technology and patent portfolio. Ex. 33. W&W's presentation specifically identified the '084 Patent, as well as the publication for the '700 Patent (US 2018/0102442 A1) that the Patent Office had allowed at that point but not yet issued. *Id.* at 3. Mr. Schuessler responded the next day and directed W&W to Jonathan Charles and Peter Deane of Samsung Strategy & Innovation Center (SSIC). Ex. 29. SSIC is a division of SEC that works with entrepreneurs and corporate partners to invest in disruptive technologies.

94. On April 27, 2019, W&W provided Mr. Charles and Mr. Deane with messages regarding W&W's technology, also attaching the "Time-of-Flight Solutions for the Next Generation" presentation. Exs. 30-31, 33. On April 28, 2019, Mr. Charles responded, thanking W&W for the information and stating that he would share it with his corporate development team. Ex. 30.

95. In addition, on April 24, 2019, W&W sent a message to James Ting, Advisor and Vice President at SSIC, informing him of W&W's patents and technology. Ex. 32. W&W's message attached the "Time-of-Flight Solutions for the Next Generation" presentation which, as described above, set forth details about W&W's technology and patent portfolio and specifically identified the '084 Patent, as well as the publication for the '700 Patent (US 2018/0102442 A1) that the Patent Office had allowed. Ex. 33.

96. On May 14, 2019, W&W followed up with an email to Mr. Ting explaining that W&W's technology is "compatible with CMOS technology for high speed, high efficiency optical data communications." Ex. 32. W&W attached another presentation entitled "Revolutionizing Optical Connectivity," which discussed W&W's patent portfolio and technology and specifically identified the '084 Patent, as well as the publication for the '700 Patent. Ex. 34.

97. On August 14, 2019, W&W sent separate follow-up emails and LinkedIn messages to Messrs. Ting, Charles, and Deane, describing W&W's technology and attaching three presentations that provided various additional details regarding W&W's patent portfolio and technology. Exs. 30-32; 35-37. On August 15, 2019, Mr. Deane responded and confirmed that he would forward this information to his contacts at Samsung VC funds. Ex. 31.

98. On February 20, 2020, W&W sent Mr. Ting, Mr. Charles and Mr. Deane each an email with additional information about W&W's technology. Exs. 30-32. W&W attached to each of these emails a presentation entitled "Thin Silicon Photosensors For the Next Generation," which described W&W's patent portfolio and technology and specifically identified the '084, '700 and '543 Patents. Ex. 38. W&W also noted in each of these emails that its "light trapping technology to enhance IR sensitivity in thin silicon has been corroborated by Sony," attaching the Sony article entitled "IR sensitivity enhancement of CMOS Image Sensor with diffractive light trapping pixels," published on June 19, 2017. Exs. 30-32.

99. On March 3, 2020, W&W sent Mr. Ting another message and attached a presentation entitled "Thin Silicon Photosensors For the Next Generation," which described W&W's patent portfolio and technology and specifically identified the '084, '700 and '543 Patents. Exs. 32, 38. Mr. Ting responded and requested that they have a call over Zoom. Ex.

32. On March 12, 2020, Mr. Ting met with S.Y. Wang over Zoom to discuss the materials that W&W had provided. During this meeting, Mr. Wang further described W&W's technology and reiterated that it was covered by multiple patents. On March 24, 2020, W&W emailed Mr. Ting, further explaining W&W's technology and patent portfolio and discussing the possibility of Samsung obtaining a non-exlusive license from W&W or acquiring W&W patents. Ex. 32. Mr. Ting responded that day that he would provide this information to Samsung's memory business unit planning group. *Id.*

100. On November 30, 2020, W&W again emailed Mr. Ting, attaching a pre-print version of W&W's 2021 Microhole Article and describing the benefits of W&W's technology as set forth in that article. Ex. 32. On January 4, 2021, W&W again emailed Mr. Ting, attaching the 2021 Microhole Article, as well as an updated version of the presentation entitled "Thin Silicon Photosensors For The Next Generation." Exs. 32, 39. The revised presentation provided updates to W&W's patent portfolio and described the benefits of W&W's microhole innovations. Ex. 39. W&W specifically informed Samsung of its infringement, explaining that it is "using microholes in CIS whos structures are disclosed in W&W IP applications." Ex. 39 at 5. W&W also explained in its email that its focus was now on CMOS image sensors, that the efficacy of its patented technology had been validated by Sony, Samsung and numerous universities, and that it holds an extensive IP portfolio covering these inventions. Ex. 32. W&W again offered to Samsung the possibility of partnership, licensing, or investing in W&W in order for Samsung to be able to use W&W's patented technology for CMOS image sensors. *Id.*

101. As a result of W&W's multiple contacts with Samsung, including communications with multiple senior Samsung individuals responsible for Samsung's CMOS products and business, by no later than 2019 Samsung had notice and knowledge of W&W's

Asserted Patents and technology and that Samsung's CIS products were infringing those patents and benefiting from W&W's technology. Despite these repeated disclosures, Samsung continues to infringe.

102. As is evident by Samsung's ongoing and expanding infringement of W&W's Asserted Patents, W&W is informed and believes that Samsung has undertaken no efforts to avoid infringement of the Asserted Patents, despite Samsung's knowledge and understanding that its products infringe these patents.

103. Given W&W's repeated disclosures, Samsung knew or, at a minimum, was willfully blind to its infringement of W&W's Asserted Patents. Samsung has been and is now infringing, and will continue to infringe, the Asserted Patents in this District and elsewhere in the United States by, among other things, making, using, importing, selling, and offering for sale the Accused Products. Samsung also indirectly infringes the Asserted Patents by inducing others, including customers, purchasers and users of its products, to directly infringe the Asserted Patents.

104. By continuing to infringe and inducing infringement, Samsung has acted with blatant and egregious disregard for W&W's patent rights with an objectively high likelihood of infringement. Samsung's continued infringement after its receipt of this Complaint is further evidence that its infringement is willful.

COUNT I
(Direct Infringement of the '871 Patent)

105. W&W repeats, realleges, and incorporates by reference, as if fully set forth herein, the allegations of the preceding paragraphs, as set forth above.

106. In violation of 35 U.S.C. § 271(a), Samsung directly infringed and continues to infringe at least exemplary Claim 1 of the '871 Patent by making, using, importing, selling, and

offering for sale in the United States the Accused Products. A copy of Claim 1 annotated with the designations used below to identify the elements of Claim 1 is attached as Exhibit 40. For example, "[1.a]" refers to "an array of pillars comprising Si, Ge, and/or SiGe alloy semiconductor material wherein at least some of the pillars are configured as photodetectors."

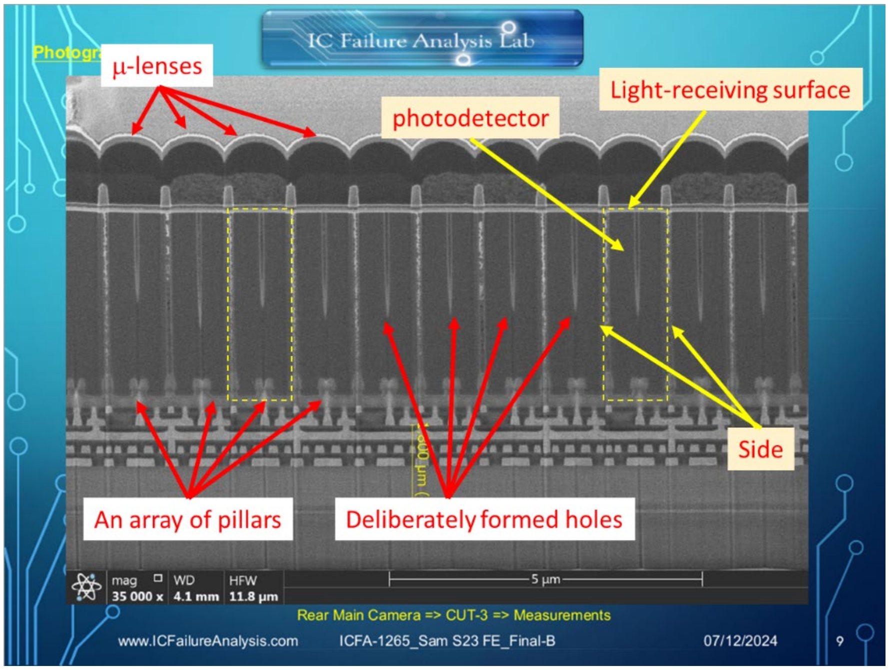
107. Samsung's acts of making, using, importing, selling, and offering for sale infringing products and services have been without the permission, consent, authorization, or license of W&W. Indeed, Samsung declined W&W's request that Samsung take a license.

108. Samsung's infringement is based upon literal infringement or, at the very least, infringement under the doctrine of equivalents.

109. Samsung's infringement includes the manufacture, use, sale, importation, and offer for sale of the CIS Accused Products, and the CIS Accused End Products that contain the CIS Accused Products, which each infringe the '871 Patent because they satisfy each element of claims of the '871 Patent, either literally, under the doctrine of equivalents, or both.

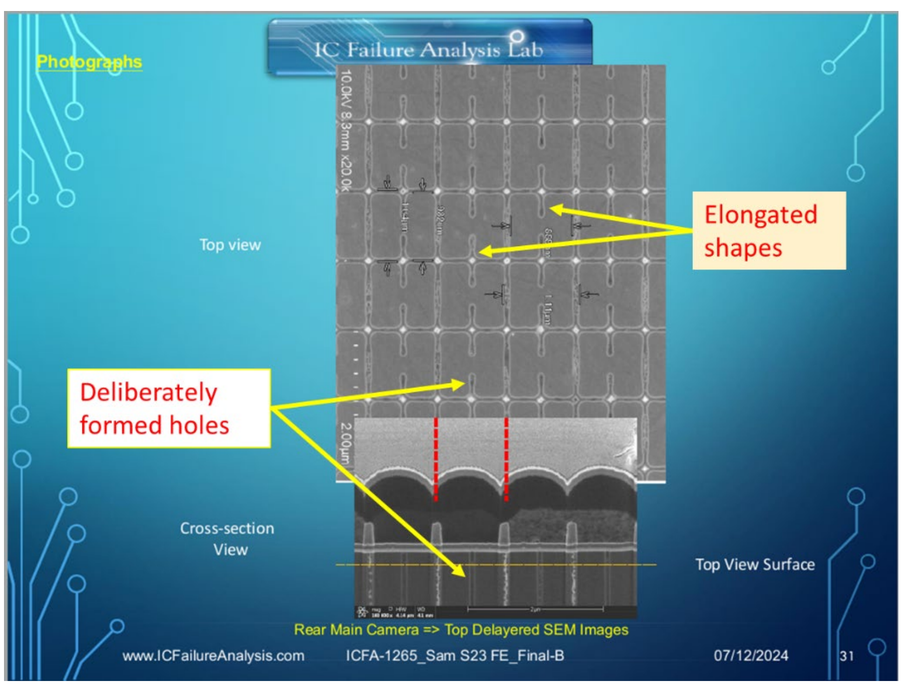
110. Samsung's GN3 CMOS and Samsung's Galaxy S23 smartphone that contains the GN3 CMOS, are representative examples of the various Accused Products that infringe the '871 Patent, including exemplary Claim 1.

111. The GN3 is used as a camera comprising an array of photodetector pixels, that convert lights into electronic data, and is an integrated structure. [1], [1.a]. The ICFA lab analysis, as shown below, confirms that the pixels of the GN3 are separated by deep trenches (DTI) into an array of pillars [1.a]. The pillars comprise light-receiving surfaces and sides [1.a.1]. The photodiodes within the pixel under a μ-lens are separated by holes fabricated as shallow trenches filled with dielectric material [1.b] [1.b.3].

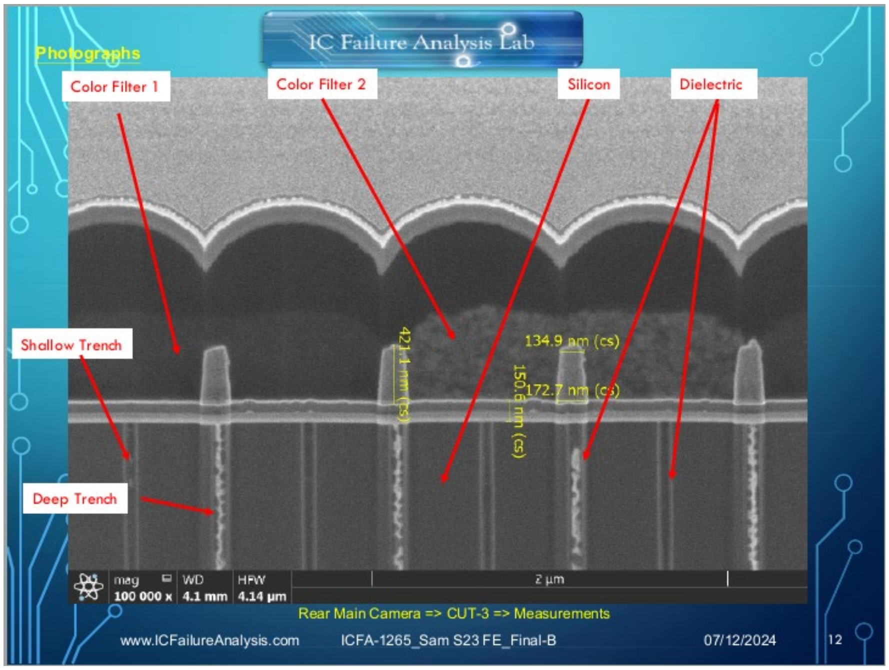


Ex. 25 (ICFA-1265) at Slide 9 (showing an array of pillars having light-receiving surfaces and sides).

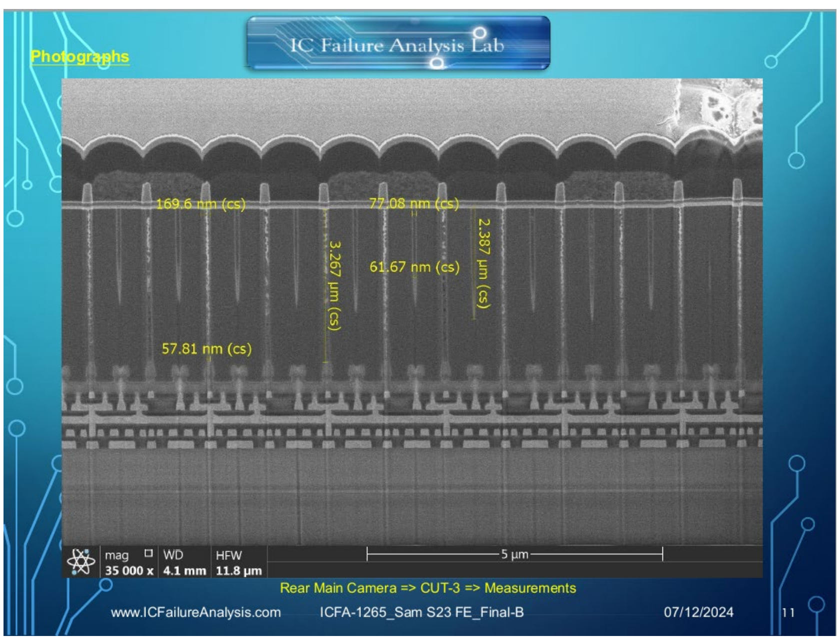
112. The shallow trenches, fabricated in the pillars [1.b], comprise elongated shapes at the light-receiving surface [1.b.1] as shown the SEM image below, which is obtained by polishing the μ-lens away through a delayering process.



Ex. 25 (ICFA-1265) at Slide 31 (showing elongated shapes at light-receiving surface and holes fabricated along the cross sections).



Ex. 25 (ICFA-1265) at Slide 12 (showing dielectric material covering the sidewalls of the pillars and the shallow trenches (fabricated holes))

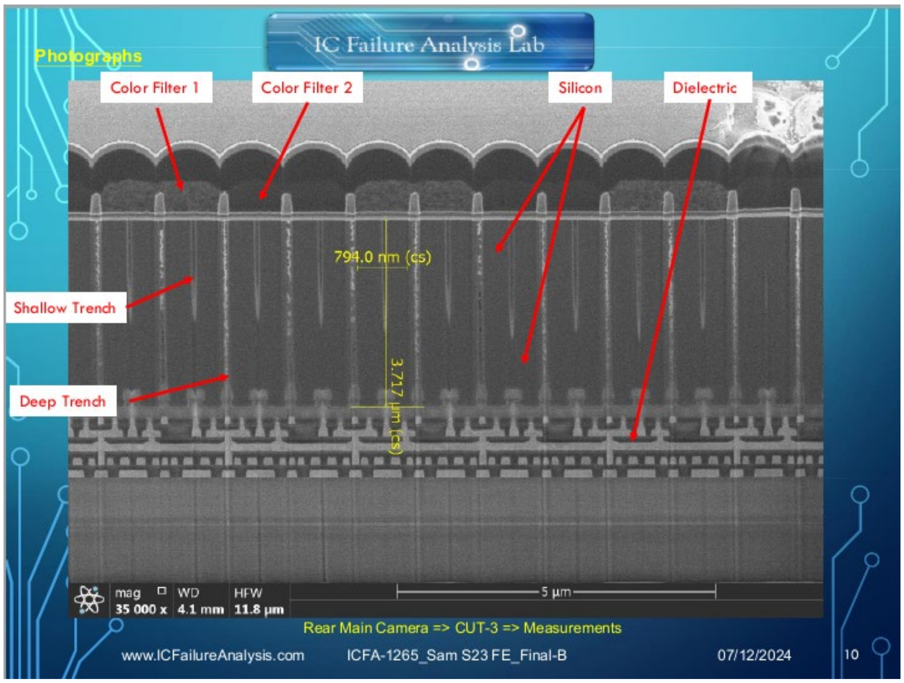


Ex. 25 (ICFA-1265) at Slide 11 (showing a depth of 3.267nm for the pillars).

113. In addition, the walls of the deep trenches are covered by dielectric material [1.c]. The pillars are spaced center to center by 1.02 μm (the dimension of the μ-lens). The height of

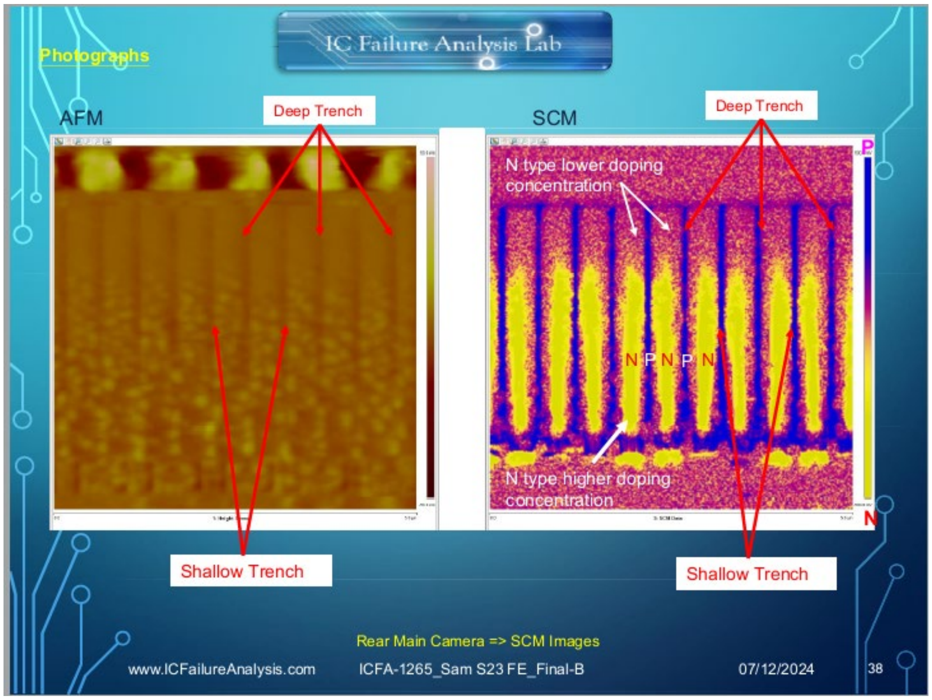
the pillar is about 3.267 µm (3,267 nanometers), and the shallow trench holes, which are about half the pillar height, are between 100-5,000 nanometers in height. [1.b.2].

114. As shown below, under the array of pillars, the GN3 has a base dielectric region in which multiple layers of metals are present to form electrical interconnect, which connects elements of the circuit. [1.d]. These metal layers facilitate the electrical contact to provide electrical pathways to the photodetectors in reverse biasing for light detection. [1.e, 1.e.1].



Ex. 25 (ICFA-1265) at Slide 10 (showing dielectric material below the pillars).

115. In order to observe the doping profile, the ICFA analysis includes an SCM image with a closer view of the silicon region of the array, as shown below:



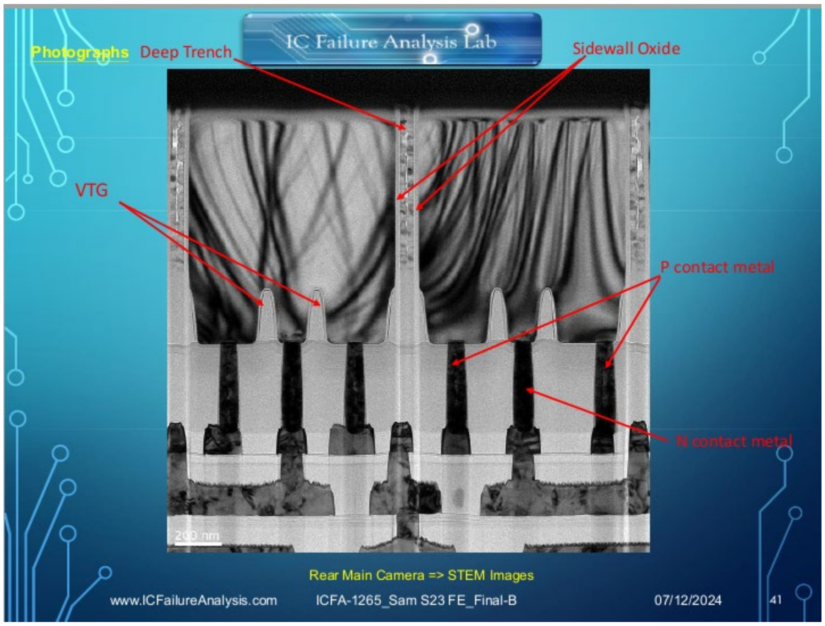
Ex. 25 (ICFA-1265) at Slide 38 (SCM images showing doping profile inside the pillars).

116. In the above SCM image, the doping of the semiconductor material is annotated by the color bar at the right. The blue color indicates regions that are heavily p-type doped. The yellow color indicates regions that are heavily n-type doped. The purple color indicates regions that are lightly n-type doped. Since SCM detects the mobile carrier concentrations of the material, insulating dielectric material appears as very low doped material. To the left of the SCM image is a corresponding image of the surface using an Atomic Force Microscope (AFM).

117. The purple regions in the SCM image annotated as “N-type lower doping concentration” ([1.a.4] regions therebetween) are the regions where the light is focused by the μ-lenses. The yellow regions annotated as “N-type higher doping concentration” (N-doped semiconductor [1.a.3]) are the regions located at the center of each photodiode. The blue region at the top of the N-type lower doping concentration semiconductor [1.a.4] is the P-doped semiconductor [1.a.2]. In addition:

- the N-type lower doping concentration semiconductor material [1.a.4] is between the p-type [1.a.2] and n-type [1.a.3] doped semiconductor materials;
- the N-type lower doping concentration semiconductor material [1.a.4] is less doped than one of the p-type [1.a.2] and n-type [1.a.3] doped semiconductor materials;
- the N-type lower doping concentration semiconductor material [1.a.4] is depleted by the reverse biasing configuration [1.e.1] under the operation of detecting lights [1.a.5] to form a depletion region generating electron-hole pairs (electrical charge carriers); and
- each of the p-type [1.a.2] and n-type [1.a.3] doped semiconductor materials and said intermediate semiconductor material [1.a.4] are made of silicon. [1.a].

118. The p-type and n-type doped regions are electrically reverse biased to function as a photodetector. As shown below, the electrical contacts [1.e] are electrically coupled with the array of pillars [1.a] through a Vertical Transfer Gate (VTG).



Ex. 25 (ICFA-1265) at Slide 41 (TEM image showing two metal contacts which are coupled to n and p regions via a Vertical Transfer Gate (VTG)).

119. As explained by Samsung's IR QE Article and shown below, the quantum efficiency of the photodetectors is enhanced by the in-pillar structures. With these structures, the photo absorption of light of 810nm is increased at least by a factor of 1.32, the photo absorption of light of 940nm is increased at least by a factor of 1.23, and the photo absorption for visible wavelengths between 620nm and 700nm is estimated to be 1.12 (88%/78%) to 1.17 (82%/70%) [1.f]. All improvements in absorption for wavelengths longer than 620nm are larger than 1.1. [1.f].

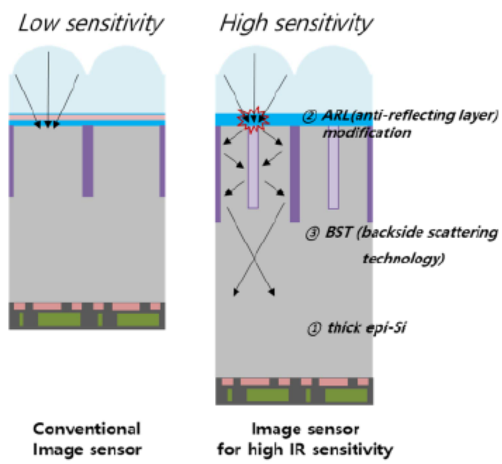


Figure 1. Schematic images of design concept for image sensor having IR sensitivity

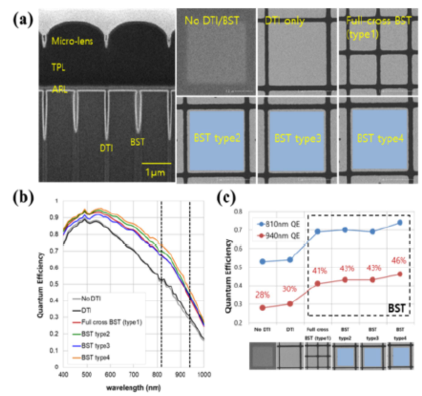


Figure 4. (a) Cross-sectional and top-view SEM images of the pixel structure which consists of backside scattering technology (BST) patterns. (b) QE curves of image sensors with no DTI, only DTI and DTI+BST pixel structures. (c) Quantum efficiencies of image sensors with various DTI and BST patterns at 810nm and 940nm wavelength.

Ex. 23 (IR QE Article) at Figs. 1 and 4 (showing backside scattering technology enhanced light absorption for wavelengths longer than 550nm, which includes green and red spectra).

120. Thus, Samsung's GN3 product satisfies all elements of exemplary Claim 1 of the '871 Patent. Samsung's GN3 product is representative of its other CIS Accused Products, which also satisfy all elements of exemplary Claim 1 of the '871 Patent.

121. Samsung's direct infringement of the '871 Patent has injured and continues to injure W&W in an amount to be proven at trial, but not less than a reasonable royalty.

122. Samsung has had knowledge of W&W's patents since at least as early as 2019 and has had specific knowledge of its infringement of the '871 Patent since at least the date of

this Complaint, if not earlier. Samsung's actions are willful, blatant, and in egregious disregard for W&W's patent rights.

123. Samsung's infringement has caused and is continuing to cause damage and irreparable injury to W&W, and W&W will continue to suffer damage and irreparable injury unless and until that infringement is enjoined by this Court.

124. Samsung acted recklessly, willfully, wantonly, and deliberately engaged in acts of infringement of the '871 Patent, justifying an award to W&W of increased damages under 35 U.S.C. § 284, and attorney's fees and costs incurred under 35 U.S.C. § 285.

125. W&W is entitled to injunctive relief, damages and any other relief in accordance with 35 U.S.C. §§ 283, 284, and 285 for Samsung's direct infringement of the '871 Patent.

COUNT II
(Indirect Infringement of the '871 Patent)

126. W&W repeats, realleges, and incorporates by reference, as if fully set forth herein, the allegations of the preceding paragraphs, as set forth above.

127. As set forth above, Samsung has had knowledge of W&W's patents since at least as early as 2019 and has had specific knowledge of its infringement of the '871 Patent since at least the date of this Complaint, if not earlier.

128. As set forth above, the CIS Accused Products and CIS Accused End Products infringe the '871 Patent. Samsung has actively, knowingly, and intentionally induced and continues to induce direct infringement of the '871 Patent pursuant to 35 U.S.C. §271(b).

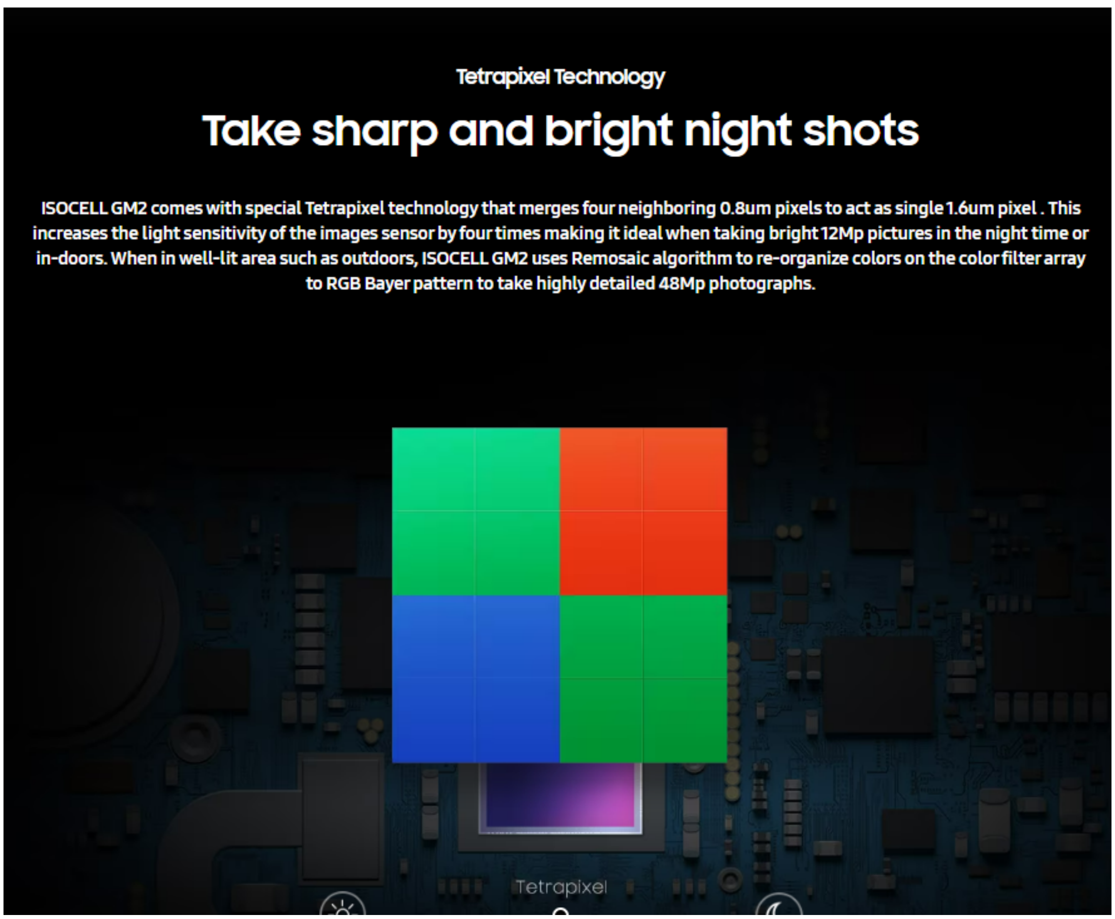
129. For example, Samsung knowingly and actively encourages third parties, including direct and indirect customers of the CIS Accused Products, such as original equipment manufacturers, electronic manufacturing service providers, and other smartphone manufacturers to make, sell, offer to sell, import, and use in the United States end products that include the CIS

Accused Products. In addition, Samsung knowingly and actively encourages third parties, including direct and indirect customers of the CIS Accused Products and CIS Accused End Products, such as distributers and resellers, to sell, offer to sell, and import into the United States the CIS Accused Products and CIS Accused End Products. In addition, Samsung knowingly and actively encourages third parties, including direct and indirect customers, such as smartphone end users in the United States, to use the CIS Accused Products as part of the CIS Accused End Products or third party smartphones that include the CIS Accused Products.

130. Samsung engages in such encouragement by providing instructions and guidance regarding the use and testing of the CIS Accused Products and integration of the CIS Accused Products in the CIS Accused End Products and third party end products; providing information through user manuals, instructions, guidelines, training, videos, tutorials, developer forums, and technical support, and creating and maintaining service centers, which direct and facilitate the use of the CIS Accused Products in the CIS Accused End Products and third party end products; entering into agreements with distributers, resellers, original equipment manufacturers, electronic manufacturing service providers regarding making, testing, selling, offering to sell, and importing into the United States end products that include the CIS Accused Products; and advertising and promoting inclusion and use of the CIS Accused Products in the CIS Accused End Products and third party end products through, marketing materials, websites, press releases, trade shows and sales and distribution channels.

131. As an example of Samsung's active encouragement of direct infringement, Samsung advertises and promotes the infringing features of the CIS Accused Products to customers, specifically emphasizing the "amazing light-sensitivity" and "sharp and bright night shots" that are directly attributable to the infringing features:

Samsung ISOCELL GM2 is an ultra-high 48Mp resolution 1/2.25" image sensor with amazing light-sensitivity with Tetrapixel/Remosaic technology.



Super-PD Auto Focus

Don't miss the moment you love

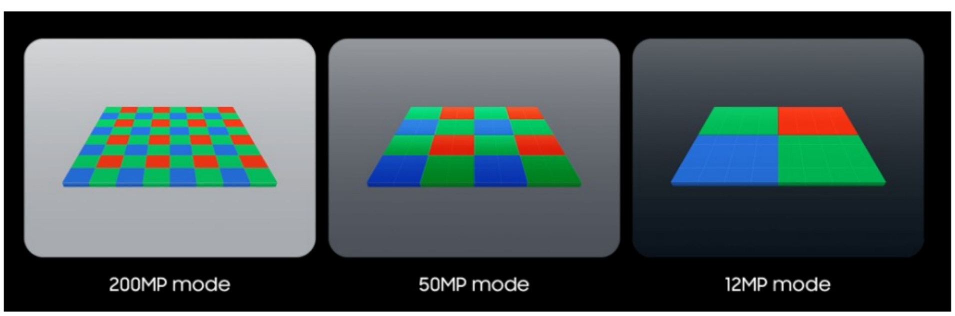
ISOCELL GM2 allows smartphones or mobile cameras to take pictures right off the bat with incredibly fast Super-PD Auto Focus.
Super-PD AF focuses by using a special oval lens over two pixels to work as one of many phase detecting agents in the sensor.
Moving or not, subjects captured will be sharper with Super-PD AF.

Ex. 41 at 1-4 (https://semiconductor.samsung.com/image-sensor/mobile-image-sensor/isocell-bright-gm2/).

Shoot at the Resolution You Need

Do you think that all pictures need to be 200 million pixels? With the versatile ISOCELL, you don't need to worry. Specially designed with the Tetra^{2}pixel technology, the ISOCELL HP2 within the Galaxy S23 Ultra ensures optimal quality by giving users resolutions from which to choose. It combines up to 16 individual pixels together into one, which then operates as one big pixel.

Thus, the ISOCELL HP2 sensor provides 200MP, 50MP and 12MP output options that allow the user to change resolution depending on their needs. In its default mode, the ISOCELL HP2 produces a 12MP image by merging 16 pixels into one big pixel. When you need a photo that has ultra-high quality, you can choose 200MP mode and the ISOCELL HP2 produces the image with rich details.



Ex. 42 at 5 (https://news.samsung.com/global/introducing-isocell-hp2-experience-more-pictures-and-epic-details-on-the-galaxy-s23-ultra).

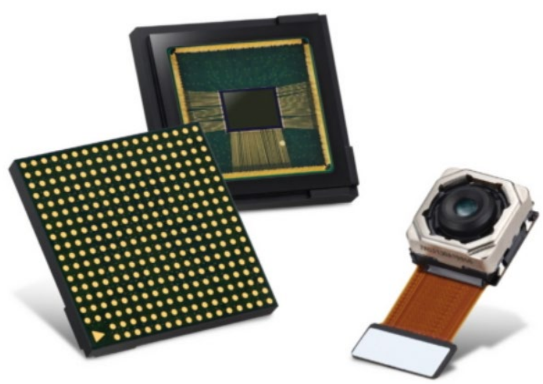
There are various additional examples of Samsung advertising and promoting the infringing features of the Accused Products. *See, e.g.*, Exs. 46-47 (Isocell HP2 and HP3 press releases);

videos currently available at https://www.youtube.com/watch?v=eZMJrJgPuwY (Isocell HP2); https://www.youtube.com/watch?v=kbXY62rC8HA (Isocell HP3); https://www.youtube.com/watch?v=-DsFgBofmQE (Galaxy S23 Ultra with Isocell HP2); https://www.youtube.com/watch?v=11_n3fChK4A (Galaxy S23 Ultra with Isocell HP2).

132. As a further example of Samsung's active encouragement of direct infringement, Samsung creates and promotes aspects of the CIS Accused Products that allow for integration of the infringing features into end products:

Tetrapixel technology and 1.0μm pixel size enable sleekly designed smartphones to take more vivid pictures in darker environments

The ISOCELL Plug & Play solution can save up to four months of development time for manufacturers



The Samsung ISOCELL Slim 3P9 is a 1.0μm 16Mp image sensor with Tetrapixel* technology that allows bright and vivid pictures in today's sleekly designed smartphones. With Tetrapixel, a technology that merges four neighboring pixels, the 3P9 can function as a 2.0μm image sensor for front-facing cameras that can take brighter pictures in low-lit environments.

For faster auto-focusing, the 3P9 adopted an advanced phase detection auto-focus (PDAF) with doubled auto-focus agent density than that of conventional PDAF sensors. In addition, the sensor significantly stabilizes pictures and videos taken while in motion with a gyro-synchronizer that syncs frame exposure time from the sensor with movement data from the device's gyroscope. Once the data is synced, the mobile processor can simply adjust the frames based on movement rather than rigorously analyzing each frame to detect and compensate for angular movement.

Ex. 43 (https://news.samsung.com/global/samsung-makes-image-sensor-integration-easier-with-new-16mp-isocell-slim-3p9-and-plug-and-play-solution).

133. Samsung has known or has been willfully blind to the fact that it is inducing others to infringe one or more claims of the '871 Patent.

134. Samsung's indirect infringement of the '871 Patent has injured and continues to injure W&W in an amount to be proven at trial, but not less than a reasonable royalty.

135. Samsung's indirect infringement has caused and is continuing to cause damage and irreparable injury to W&W, and W&W will continue to suffer damage and irreparable injury unless and until that infringement is enjoined by this Court.

136. Samsung's actions of indirect infringement of the '871 Patent are reckless, willful, wanton, deliberate and in blatant and egregious disregard for W&W's patent rights, justifying an award to W&W of increased damages under 35 U.S.C. § 284, and attorney's fees and costs incurred under 35 U.S.C. § 285.

137. W&W is entitled to injunctive relief, damages and any other relief in accordance with 35 U.S.C. §§ 283, 284, and 285 for Samsung's indirect infringement.

COUNT III
(Direct Infringement of the '360 Patent)

138. W&W repeats, realleges, and incorporates by reference, as if fully set forth herein, the allegations of the preceding paragraphs, as set forth above.

139. In violation of 35 U.S.C. § 271(a), Samsung directly infringed and continues to infringe at least exemplary Claim 1 of the '360 Patent by making, using, importing, selling, and offering for sale in the United States the Accused Products. A copy of Claim 1 annotated with the designations used below to identify the elements of Claim 1 is attached as Exhibit 40.

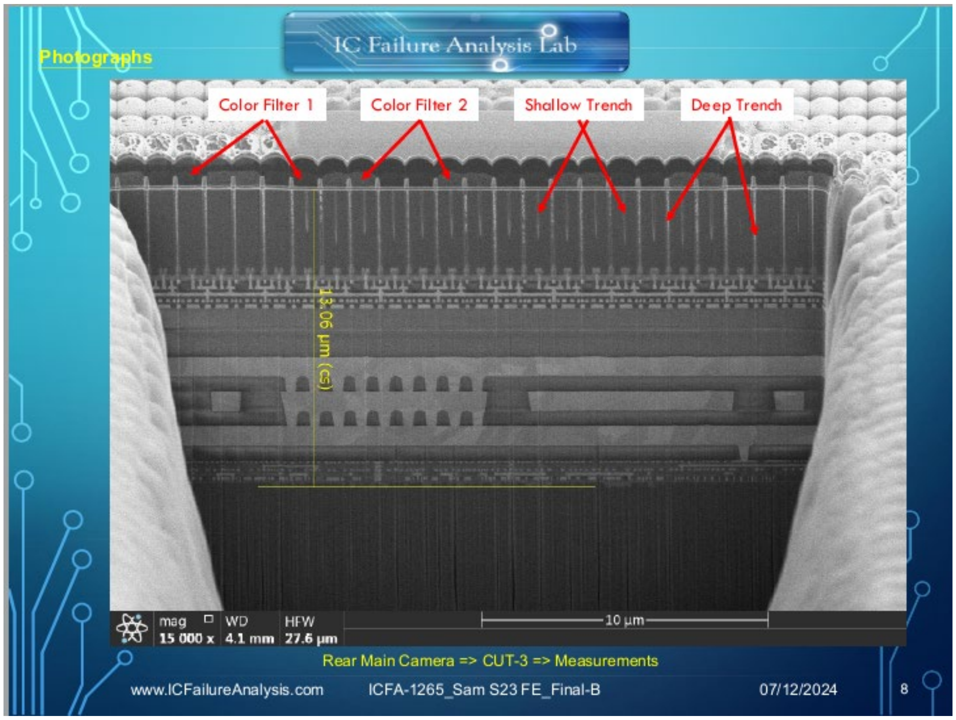
140. Samsung' acts of making, using, importing, selling, and offering for sale infringing products and services have been without the permission, consent, authorization, or license of W&W. Indeed, Samsung declined W&W's request that Samsung take a license.

141. Samsung's infringement is based upon literal infringement or, at the very least, infringement under the doctrine of equivalents.

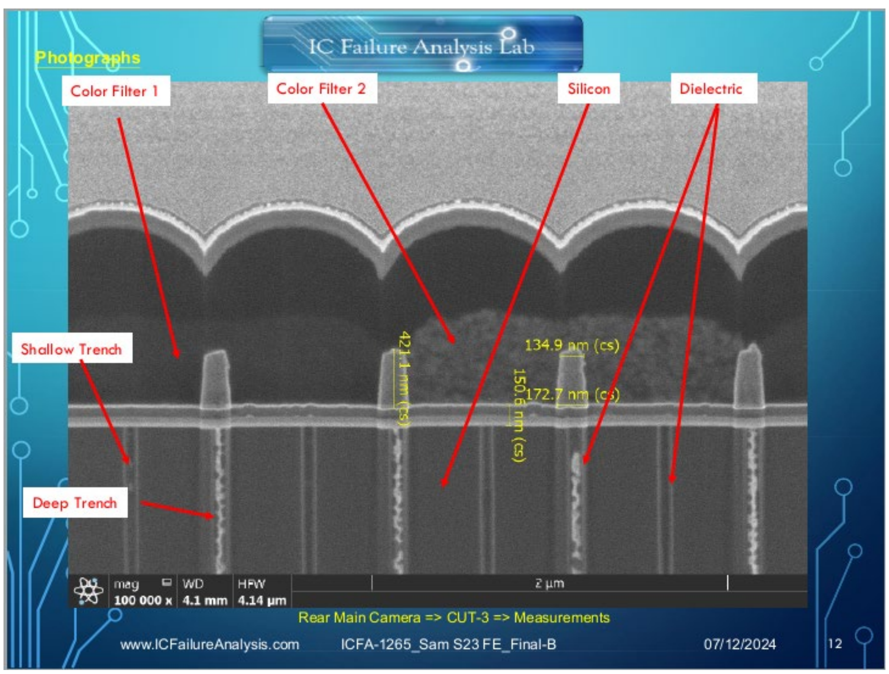
142. Samsung's infringement includes the manufacture, use, sale, importation, and offer for sale of the CIS Accused Products, and the CIS Accused End Products that contain the CIS Accused Products, which each infringe the '360 Patent because they satisfy each element of claims of the '360 Patent, either literally, under the doctrine of equivalents, or both.

143. Samsung's GN3 CMOS and Samsung's Galaxy S23 smartphone that contains the GN3 CMOS, are representative examples of the various Accused Products that infringe the '360 Patent, including exemplary Claim 1.

144. The GN3 is used as a camera that converts lights into electronic data. [1.d.1]. The ICFA lab analysis, as shown below, confirms that the pixels of the GN3 are separated by deep trenches (DTI) into a laterally extending array of pillars [1.a]. The pixels under respective μ-lenses are separated by shallow trenches filled with dielectric material that are fabricated in the pillars [1.c].



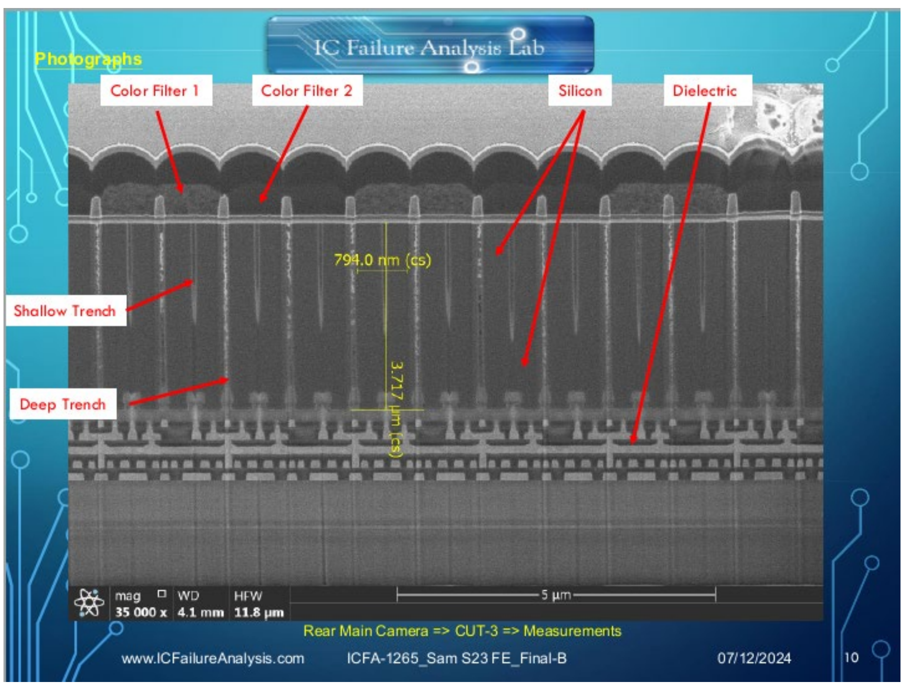
Ex. 25 (ICFA-1265) at Slide 8 (showing an array of pillars separated by deep trenches and in-pillar holes between deep trenches).



Ex. 25 (ICFA-1265) at Slide 12 (showing dielectric material covering the sidewalls of the pillars).

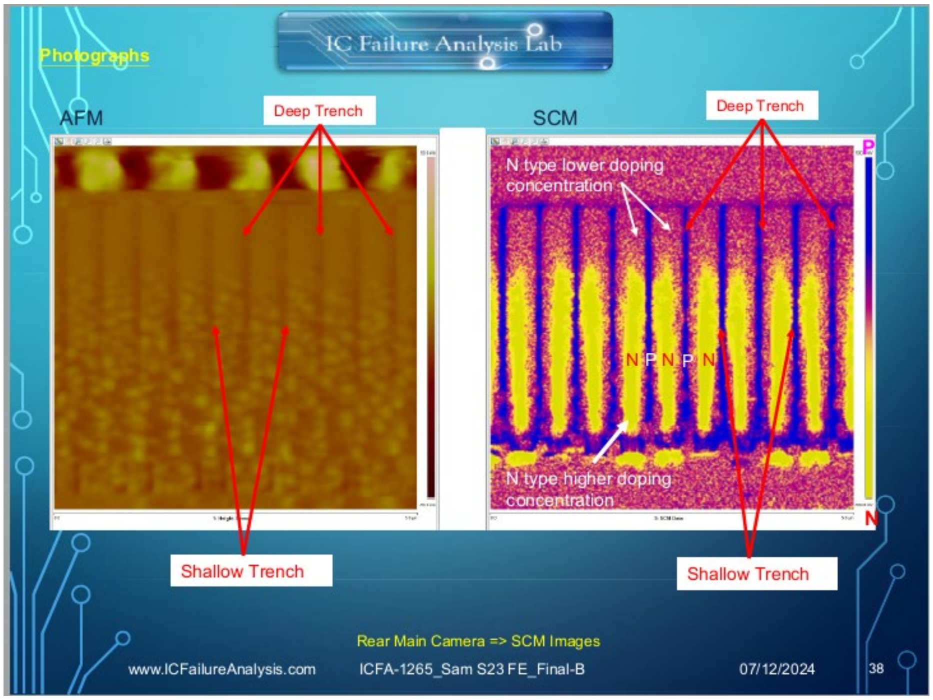
145. The walls of the deep trenches are covered by dielectric material [1.a.3]. The pillars are spaced center to center by 1.02 µm (the dimension of the µ-lens) which is less than 10,000 nanometers (10 µm). [1.e.1]. The height of the pillar is about 3.7 µm (3,700 nanometers) and the intermediate semiconductor material (1.a.2), which is between the first doped semiconductor material (1.a.1) and the second doped semiconductor material (1.b), is 100-5,000 nanometers in height. [1.e.2].

146. Under the array of pillars, as shown below, the GN3 has a base dielectric region in which multiple layers of metals are present to form electrical interconnects, which connect elements of the circuit. [1.e].



Ex. 25 (ICFA-1265) at Slide 10 (showing dielectric material below the pillars).

147. In order to observe the doping profile, the ICFA analysis includes an SCM image with a closer view of the silicon region of the array, as shown below:

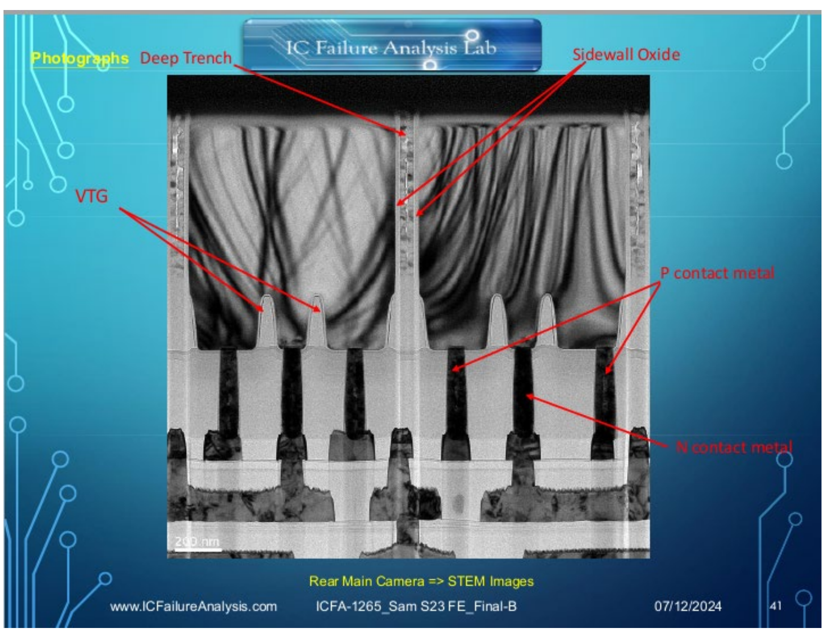


Ex. 25 (ICFA-1265) at Slide 38 (SCM images showing doping profile inside the pillars). In this SCM image, the doping of semiconductor is annotated by the color bar at the right. The blue color annotates the regions that are heavily p-type doped. The yellow color annotates regions that are heavily n-type doped. The purplish color annotates regions that are lightly n-type doped. Since SCM detects the mobile carrier concentrations of the material, a dielectric material, which is an insulator, appears as a very low doped material. To the left of the SCM image is a corresponding image of the surface using Atomic Force Microscope (AFM).

148. The purple regions in the SCM image annotated as “N-type lower doping concentration” (intermediate semiconductor material [1.a.2]) are the regions where the light is focused by the μ-lenses. The yellow regions annotated as “N-type higher doping concentration” ([1.a.1] first doped semiconductor) are the regions located at the center of each photodiode. The blue region at the top of the intermediate semiconductor is the [1.b] second doped semiconductor. In addition:

- the intermediate semiconductor material [1.a.2] is between the first [1.a.1] and second [1b] doped semiconductor materials [1.b.1];
- the first [1.a.1] and second [1.b] doped semiconductor materials are doped to opposite semiconductor type [1.b.2];
- the intermediate semiconductor material [1.a.2] is less doped than at least one of the first [1.a.1] and second [1.b] doped semiconductor materials [1.b.3];
- the degree of doping is the same or different for different positions in the intermediate semiconductor material [1.a.3] [1.b.3]; and
- each of the first [1.a.1] and second [1.b] doped semiconductor materials and said intermediate semiconductor material [1.a.2] are made of silicon [1.b.4].

149. The p-type and n-type doped regions are electrically reverse biased to work as a photodetector. As shown below, top and bottom electrical contacts are electrically coupled with the array of pillars [1.d].



Ex. 25 (ICFA-1265) at Slide 41 (TEM image showing two metal contacts which are coupled to n and p regions).

150. As explained by Samsung's IR QE Article and shown below, the quantum efficiency of the photodetectors is enhanced by the in-pillar structures. With these structures, the photo absorption of light of 810nm is increased at least by a factor of 1.32; the photo absorption of light of 940nm is increased at least by a factor of 1.23; and the photo absorption for visible wavelengths between 620nm and 700nm is estimated to be 1.12 (88%/78%) to 1.17 (82%/70%). All improvements in absorption for wavelengths longer than 620nm are larger than 1.1. [1.f].

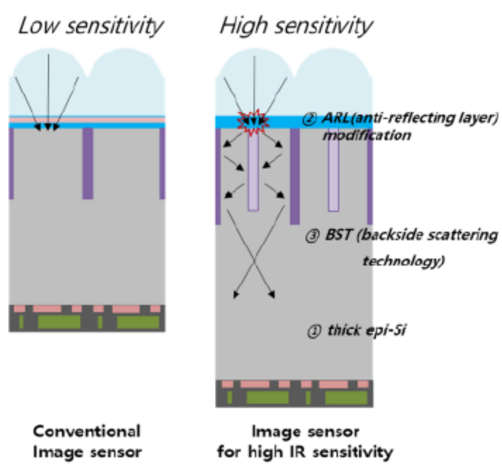


Figure 1. Schematic images of design concept for image sensor having IR sensitivity

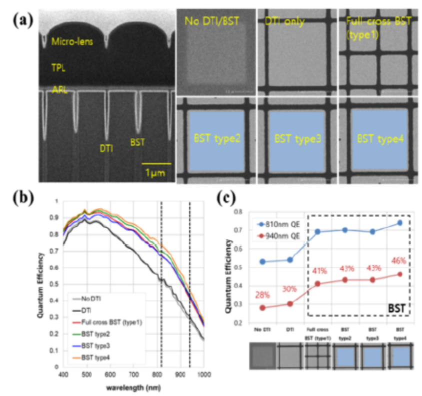
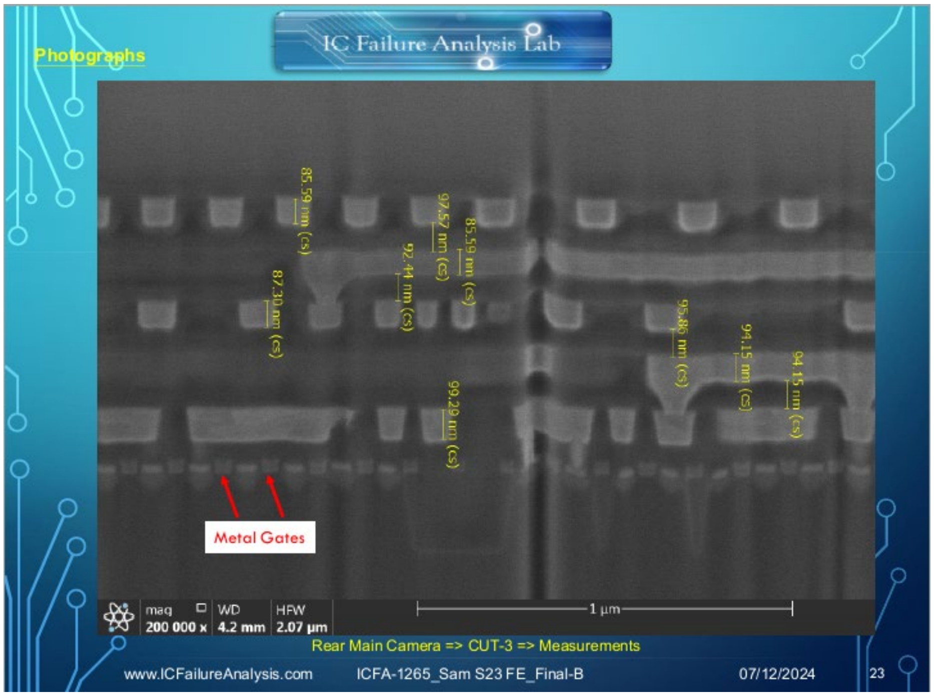


Figure 4. (a) Cross-sectional and top-view SEM images of the pixel structure which consists of backside scattering technology (BST) patterns. (b) QE curves of image sensors with no DTI, only DTI and DTI+BST pixel structures. (c) Quantum efficiencies of image sensors with various DTI and BST patterns at 810nm and 940nm wavelength.

Ex. 23 (IR QE Article) at Figs. 1 and 4 (showing backside scattering technology enhanced light absorption for wavelengths longer than 550nm, which includes green and red spectra).

151. The GN3 chip integrates CMOS transistors (active elements) on the same substrate to perform signal processing and transmission, as explained above and further shown in the figures below. [1.g].



Ex. 25 (ICFA-1265) at Slide 23 (showing CMOS transistors with labels "Metal Gates" as gates for CMOS transistors, and interconnect metal layers).

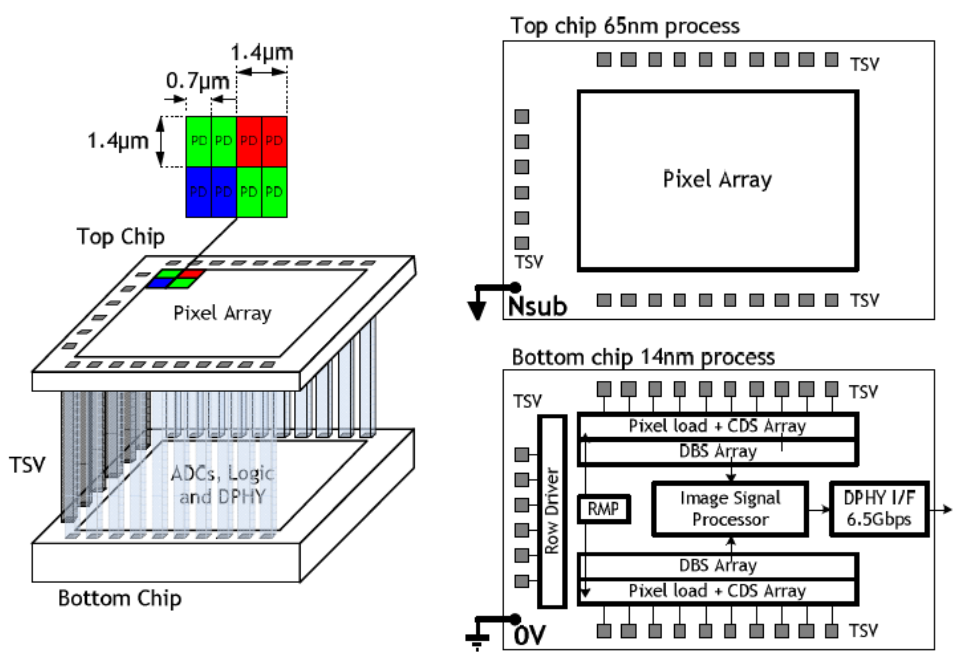


Fig. 2. 65/14nm stacked sensor architecture.

Ex. 14 (Samsung's 2020 2PD Article) at Fig. 2 (showing integrated circuit to perform signal processing and transmission).

152. Thus, Samsung's GN3 product satisfies all elements of exemplary Claim 1 of the '360 Patent. Samsung's GN3 product is representative of its other CIS Accused Products, which also satisfy all elements of exemplary Claim 1 of the '360 Patent.

153. Samsung's direct infringement of the '360 Patent has injured and continues to injure W&W in an amount to be proven at trial, but not less than a reasonable royalty.

154. Samsung has had knowledge of W&W's patents since at least as early as 2019 and has had specific knowledge of its infringement of the '360 Patent since at least the date of this Complaint, if not earlier. Samsung's actions are willful, blatant, and in egregious disregard for W&W's patent rights.

155. Samsung's infringement has caused and is continuing to cause damage and irreparable injury to W&W, and W&W will continue to suffer damage and irreparable injury unless and until that infringement is enjoined by this Court.

156. Samsung acted recklessly, willfully, wantonly, and deliberately engaged in acts of infringement of the '360 Patent, justifying an award to W&W of increased damages under 35 U.S.C. § 284, and attorney's fees and costs incurred under 35 U.S.C. § 285.

157. W&W is entitled to injunctive relief, damages and any other relief in accordance with 35 U.S.C. §§ 283, 284, and 285 for Samsung's direct infringement of the '360 Patent.

COUNT IV
(Indirect Infringement of the '360 Patent)

158. W&W repeats, realleges, and incorporates by reference, as if fully set forth herein, the allegations of the preceding paragraphs, as set forth above.

159. As set forth above, Samsung has had knowledge of W&W's patents since at least as early as 2019 and has had specific knowledge of its infringement of the '360 Patent since at least the date of this Complaint, if not earlier.

160. As set forth above, the CIS Accused Products and CIS Accused End Products infringe the ’360 Patent. Samsung has actively, knowingly, and intentionally induced and continues to induce direct infringement of the ’360 Patent pursuant to 35 U.S.C. §271(b).

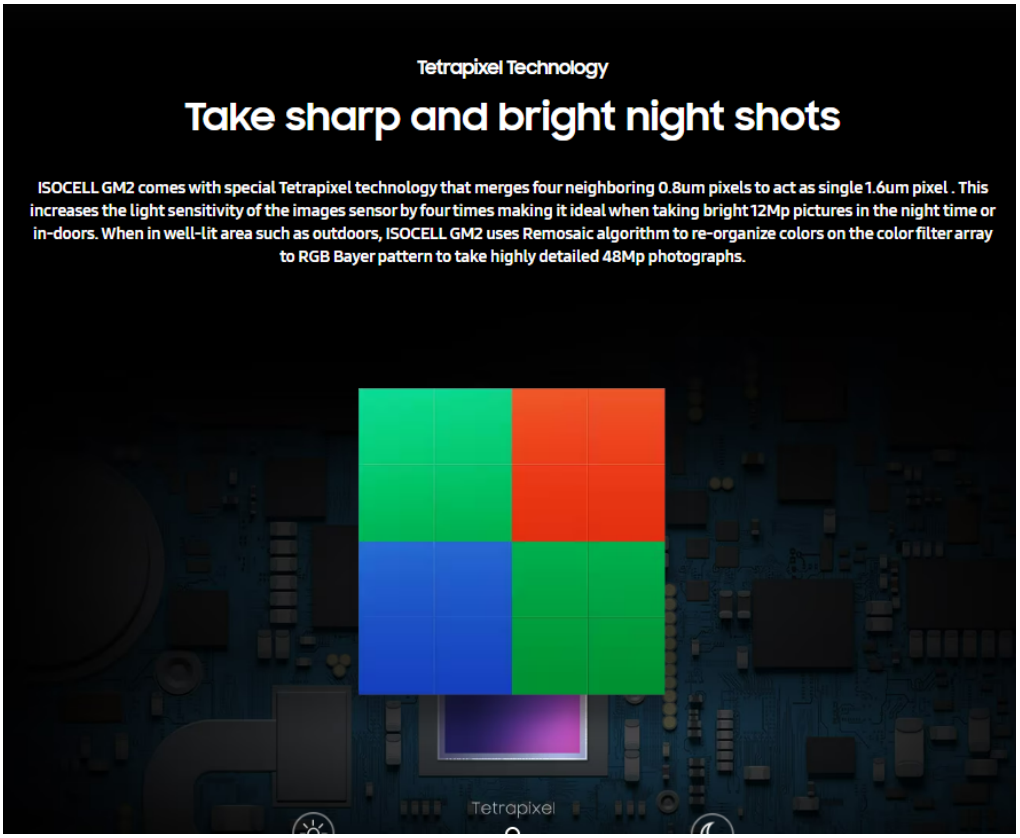
161. For example, Samsung knowingly and actively encourages third parties, including direct and indirect customers of the CIS Accused Products, such as original equipment manufacturers, electronic manufacturing service providers, and other smartphone manufacturers to make, sell, offer to sell, import, and use in the United States end products that include the CIS Accused Products. In addition, Samsung knowingly and actively encourages third parties, including direct and indirect customers of the CIS Accused Products and CIS Accused End Products, such as distributers and resellers, to sell, offer to sell, and import into the United States the CIS Accused Products and CIS Accused End Products. In addition, Samsung knowingly and actively encourages third parties, including direct and indirect customers, such as smartphone end users in the United States, to use the CIS Accused Products as part of the CIS Accused End Products or third party smartphones that include the CIS Accused Products.

162. Samsung engages in such encouragement by providing instructions and guidance regarding the use and testing of the CIS Accused Products and integration of the CIS Accused Products in the CIS Accused End Products and third party end products; providing information through user manuals, instructions, guidelines, training, videos, tutorials, developer forums, and technical support, and creating and maintaining service centers, which direct and facilitate the use of the CIS Accused Products in the CIS Accused End Products and third party end products; entering into agreements with distributers, resellers, original equipment manufacturers, electronic manufacturing service providers regarding making, testing, selling, offering to sell, and importing into the United States end products that include the CIS Accused Products; and

advertising and promoting inclusion and use of the CIS Accused Products in the CIS Accused End Products and third party end products through, marketing materials, websites, press releases, trade shows and sales and distribution channels.

163. As an example of Samsung's active encouragement of direct infringement, Samsung advertises and promotes the infringing features of the CIS Accused Products to customers, specifically emphasizing the "amazing light-sensitivity" and "sharp and bright night shots" that are directly attributable to the infringing features:

Samsung ISOCELL GM2 is an ultra-high 48Mp resolution 1/2.25" image sensor with amazing light-sensitivity with Tetrapixel/Remosaic technology.



Super-PD Auto Focus

Don't miss the moment you love

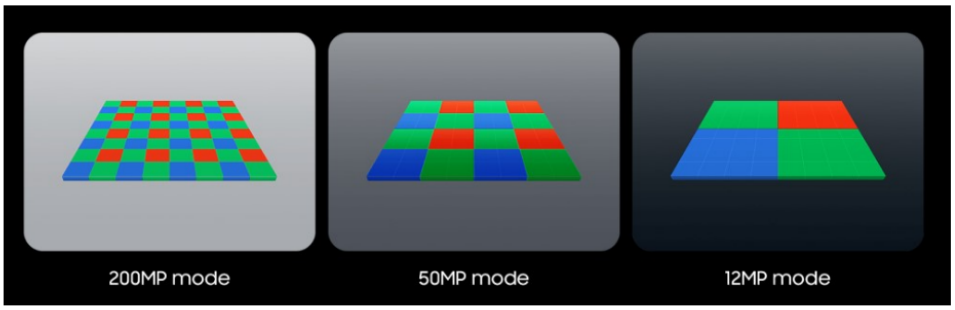
ISOCELL GM2 allows smartphones or mobile cameras to take pictures right off the bat with incredibly fast Super-PD Auto Focus. Super-PD AF focuses by using a special oval lens over two pixels to work as one of many phase detecting agents in the sensor. Moving or not, subjects captured will be sharper with Super-PD AF.

Ex. 41 at 1-4 (https://semiconductor.samsung.com/image-sensor/mobile-image-sensor/isocell-bright-gm2/).

Shoot at the Resolution You Need

Do you think that all pictures need to be 200 million pixels? With the versatile ISOCELL, you don't need to worry. Specially designed with the Tetra²pixel technology, the ISOCELL HP2 within the Galaxy S23 Ultra ensures optimal quality by giving users resolutions from which to choose. It combines up to 16 individual pixels together into one, which then operates as one big pixel.

Thus, the ISOCELL HP2 sensor provides 200MP, 50MP and 12MP output options that allow the user to change resolution depending on their needs. In its default mode, the ISOCELL HP2 produces a 12MP image by merging 16 pixels into one big pixel. When you need a photo that has ultra-high quality, you can choose 200MP mode and the ISOCELL HP2 produces the image with rich details.



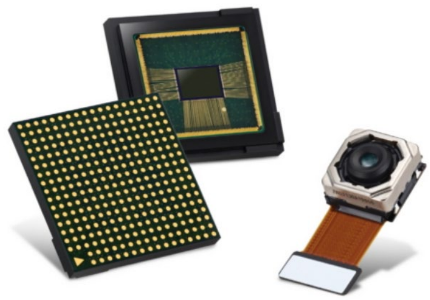
Ex. 42 at 5 (https://news.samsung.com/global/introducing-isocell-hp2-experience-more-pictures-and-epic-details-on-the-galaxy-s23-ultra).

There are various additional examples of Samsung advertising and promoting the infringing features of the Accused Products. *See, e.g.*, Exs. 46-47 (Isocell HP2 and HP3 press releases); videos currently available at https://www.youtube.com/watch?v=eZMJrJgPuwY (Isocell HP2); https://www.youtube.com/watch?v=kbXY62rC8HA (Isocell HP3); https://www.youtube.com/watch?v=-DsFgBofmQE (Galaxy S23 Ultra with Isocell HP2); https://www.youtube.com/watch?v=11_n3fChK4A (Galaxy S23 Ultra with Isocell HP2).

164. As a further example of Samsung's active encouragement of direct infringement, Samsung creates and promotes aspects of the CIS Accused Products that allow for integration of the infringing features into end products:

Tetrapixel technology and 1.0μm pixel size enable sleekly designed smartphones to take more vivid pictures in darker environments

The ISOCELL Plug & Play solution can save up to four months of development time for manufacturers



The Samsung ISOCELL Slim 3P9 is a 1.0μm 16Mp image sensor with Tetrapixel* technology that allows bright and vivid pictures in today's sleekly designed smartphones. With Tetrapixel, a technology that merges four neighboring pixels, the 3P9 can function as a 2.0μm image sensor for front-facing cameras that can take brighter pictures in low-lit environments.

For faster auto-focusing, the 3P9 adopted an advanced phase detection auto-focus (PDAF) with doubled auto-focus agent density than that of conventional PDAF sensors. In addition, the sensor significantly stabilizes pictures and videos taken while in motion with a gyro-synchronizer that syncs frame exposure time from the sensor with movement data from the device's gyroscope. Once the data is synced, the mobile processor can simply adjust the frames based on movement rather than rigorously analyzing each frame to detect and compensate for angular movement.

Ex. 43 (https://news.samsung.com/global/samsung-makes-image-sensor-integration-easier-with-new-16mp-isocell-slim-3p9-and-plug-and-play-solution).

165. Samsung has known or has been willfully blind to the fact that it is inducing others to infringe one or more claims of the '360 Patent.

166. Samsung's indirect infringement of the '360 Patent has injured and continues to injure W&W in an amount to be proven at trial, but not less than a reasonable royalty.

167. Samsung's indirect infringement has caused and is continuing to cause damage and irreparable injury to W&W, and W&W will continue to suffer damage and irreparable injury unless and until that infringement is enjoined by this Court.

168. Samsung's actions of indirect infringement of the '360 Patent are reckless, willful, wanton, deliberate and in blatant and egregious disregard for W&W's patent rights,

justifying an award to W&W of increased damages under 35 U.S.C. § 284, and attorney's fees and costs incurred under 35 U.S.C. § 285.

169. W&W is entitled to injunctive relief, damages and any other relief in accordance with 35 U.S.C. §§ 283, 284, and 285 for Samsung's indirect infringement.

COUNT V
(Direct Infringement of the '543 Patent)

170. W&W repeats, realleges, and incorporates by reference, as if fully set forth herein, the allegations of the preceding paragraphs, as set forth above.

171. In violation of 35 U.S.C. § 271(a), Samsung directly infringed and continues to infringe at least exemplary Claim 1 of the '543 Patent by making, using, importing, selling, and offering for sale in the United States the Accused Products. A copy of Claim 1 annotated with the designations used below to identify the elements of Claim 1 is attached as Exhibit 40.

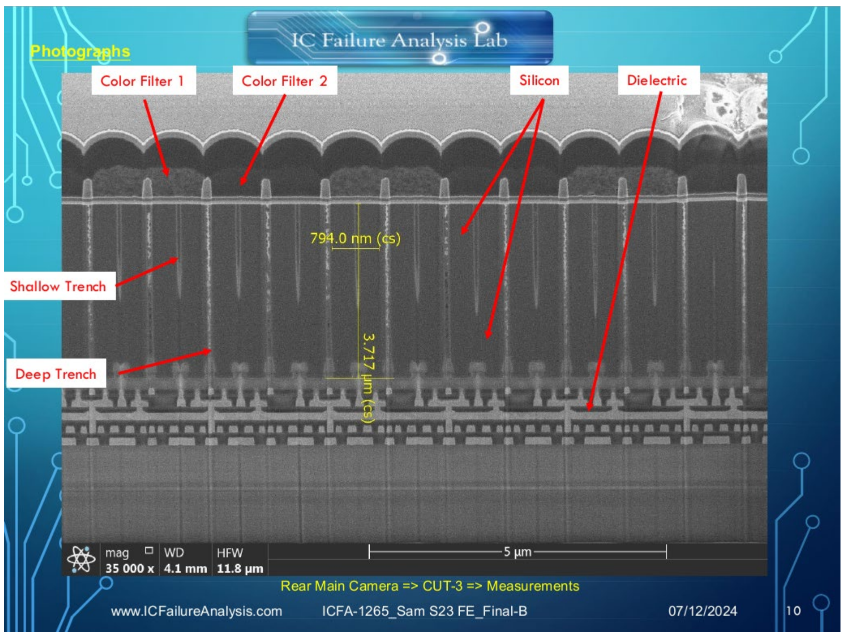
172. Samsung' acts of making, using, importing, selling, and offering for sale infringing products and services have been without the permission, consent, authorization, or license of W&W. Indeed, Samsung declined W&W's request that Samsung take a license.

173. Samsung's infringement is based upon literal infringement or, at the very least, infringement under the doctrine of equivalents.

174. Samsung's infringement includes the manufacture, use, sale, importation, and offer for sale of the CIS Accused Products, and the CIS-Included Accused Products that contain the CIS Accused Products, which each infringe the '543 Patent because they satisfy each element of claims of the '543 Patent, either literally, under the doctrine of equivalents, or both.

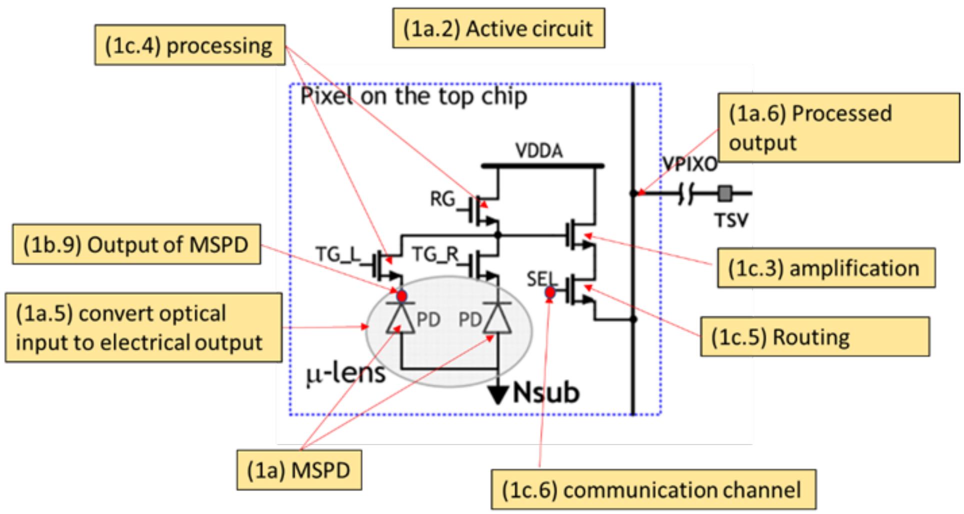
175. Samsung's GN3 CMOS and Samsung's Galaxy S23 smartphone that contains the GN3 CMOS, are representative examples of the various Accused Products that infringe the '543 Patent, including exemplary Claim 1.

176. Samsung's GN3 is a CMOS image sensor that converts light (optical input) to an electrical output. [1a, 1.a.5]. As confirmed by the ICFA lab analysis, as shown below, the pixels of the GN3 are separated by deep trenches (DTI) into a laterally extending array of pillars. The pixels comprise microstructure-enhanced photodetectors (MSPD) and have shallow trenches filled with dielectric material, which are microstructures to enhance photo sensitivity. [1a].



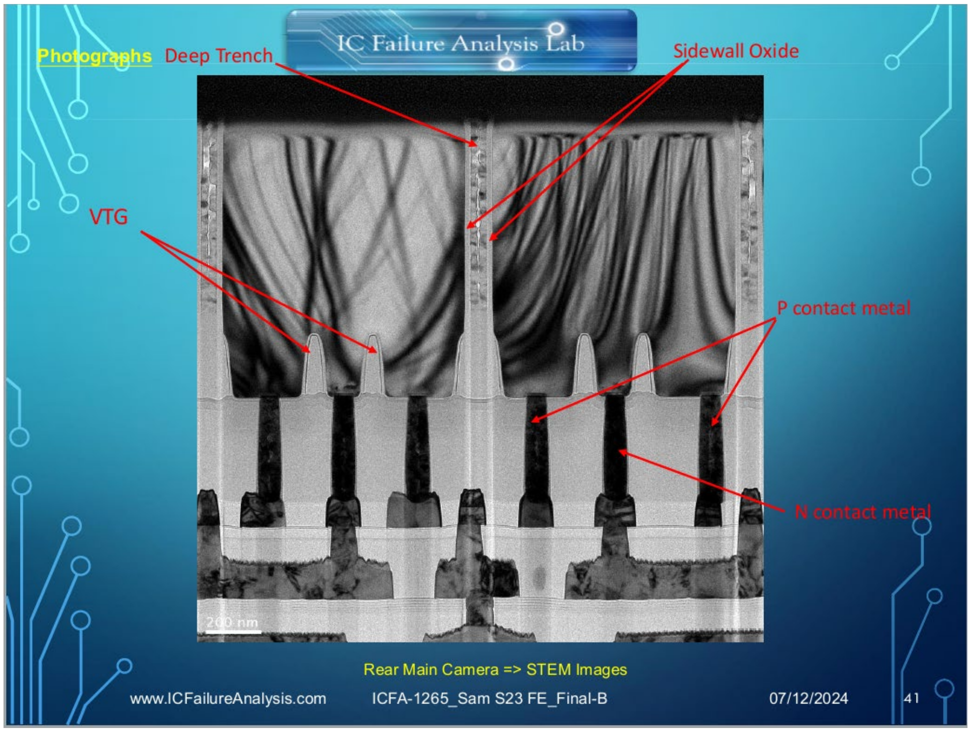
Ex. 25 (ICFA-1265) at Slide 10 (showing shallow trenches covered with dielectric materials).

177. These MSPDs are reverse biased for detecting lights. Ex. 14 (Samsung's 2020 2PD paper). The cathodes of the MSPDs are biased to a positive voltage, VDDA, when integrated active electronics RG, TG_L and TG_R are turned on, as shown below:



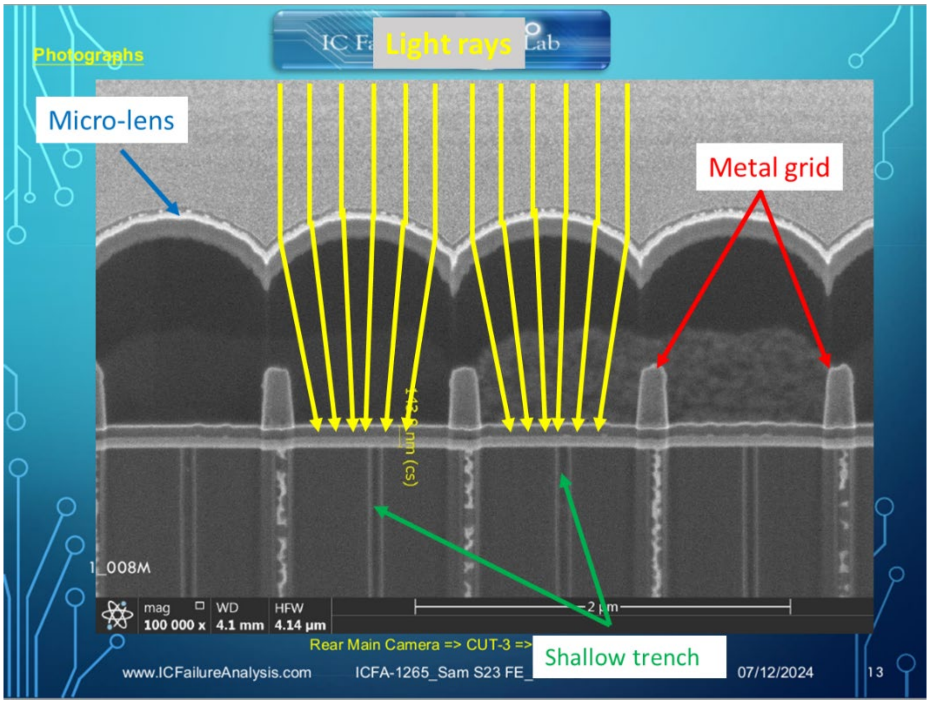
Ex. 14 (Samsung's 2PD Article) at Fig. 3 (annotated schematics of pixel circuit).

178. Specifically, the transistor symbols denoted by RG, TG_L, TG_R, SEL, and etc., are for n-MOSFETs, which are a type of transistor. When RG, TG_L and TG_R are turned on, a positive voltage is applied to the cathodes of the MSPDs, causing reverse biasing to MSPDs. [1a.1]. The transistors TG_L and TG_R, labeled as VTG (i.e., vertical transfer gate) in the TEM (i.e., Transmission Electron Microscopy) picture below, are an active electronic circuit integrated into the MSPDs. [1a.2]. Both the MSPDs and the active electronic circuit are formed on a single substrate. [1a.3]. The P-contact and N-contact provide the electric connections to the MSPDs for reverse biasing. [1c].



Ex. 25 (ICFA-1265) at Slide 41 (TEM showing VTG's (vertical transfer gates) are integrated into the photodetector; the P-contact and N contact facilitates reverse biasing of the photodetector).

179. Each pixel has an μ-lens to focus light to the input portion of the MSPD, which is substantially continuous spatially [1a.4], as illustrated below. The μ-lens bends the light rays away from the metal grids which provide optical isolation between color filters. The focused light rays enter the photo-detecting regions having holes (shallow trenches) fabricated therein. [1b.5], [1b.8].

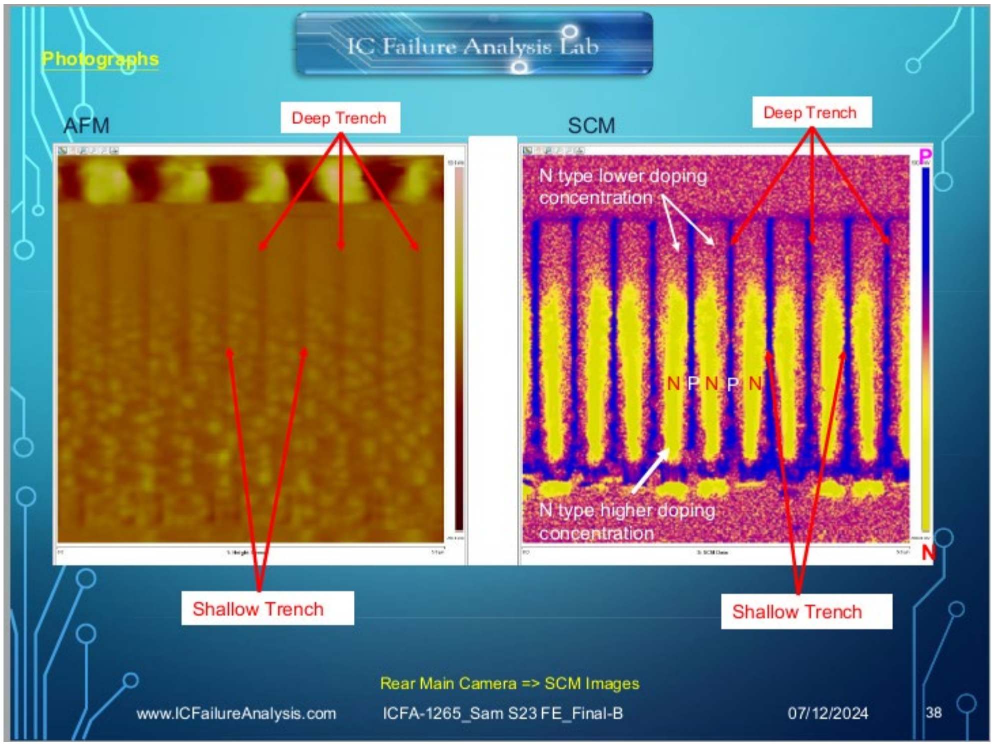


Ex. 25 (ICFA-1265) at Slide 13 (annotated to illustrate the effect of the µ-lenses to focus the light rays to the MSPDs).

180. As shown in the Scanning Capacitance Microscopy (SCM) image below, the silicon inside the MSPD is doped into multiple regions. The purple regions annotated as "N-type lower doping concentration" (intermediate semiconductor) are the regions where the light is focused by the µ-lenses. The yellow regions annotated as "first (n-type) doped semiconductor" are the regions located at the center of each photodiode. The blue region at the top of the intermediate semiconductor is the second (p-type) doped semiconductor. These semiconductor regions have the following characteristics:

- The intermediate semiconductor material [1b.1] is between the first [1b.2] and second [1b.3] doped semiconductor materials;
- The first [1b.2] and second [1b.3] doped semiconductor materials are doped semiconductors [1b.6];

- The intermediate semiconductor material [1b.1] is less doped than at least one of the first [1b.2] and second [1b.3] doped semiconductor materials [1b.7], and
- Each of the first [1b.2] and second [1b.3] doped semiconductor materials and intermediate semiconductor material [1b.1] comprises silicon [1b.4].



Ex. 25 (ICFA-1265) at Slide 38 (SCM images showing doping profile inside the pillars, where the yellow region is highly doped n-type, the blue region is highly doped p-type and the purple region is lightly doped n-type).

181. After light enters the photo-detecting regions, it is converted into electrical output (photo-generated charges). The circuitry of Samsung's GN3 processes the photo-generated charges into a processed output [1a.6], [1b.9], as explained by Figure 3 in Samsung's 2020 2PD Article. As shown in Figure 3, there are two separate portions of active electronics. The first portion is located in each pixel on the top chip and the second portion is located in the bottom chip. These two chips are manufactured separately using different technologies and subsequently bonded together to form an integrated combination.

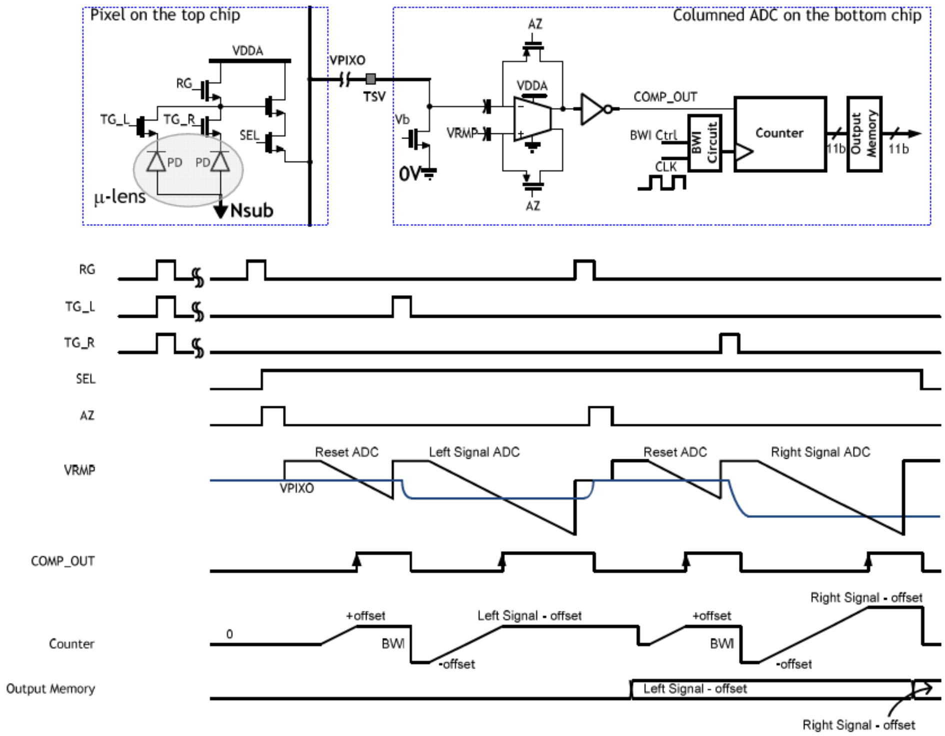
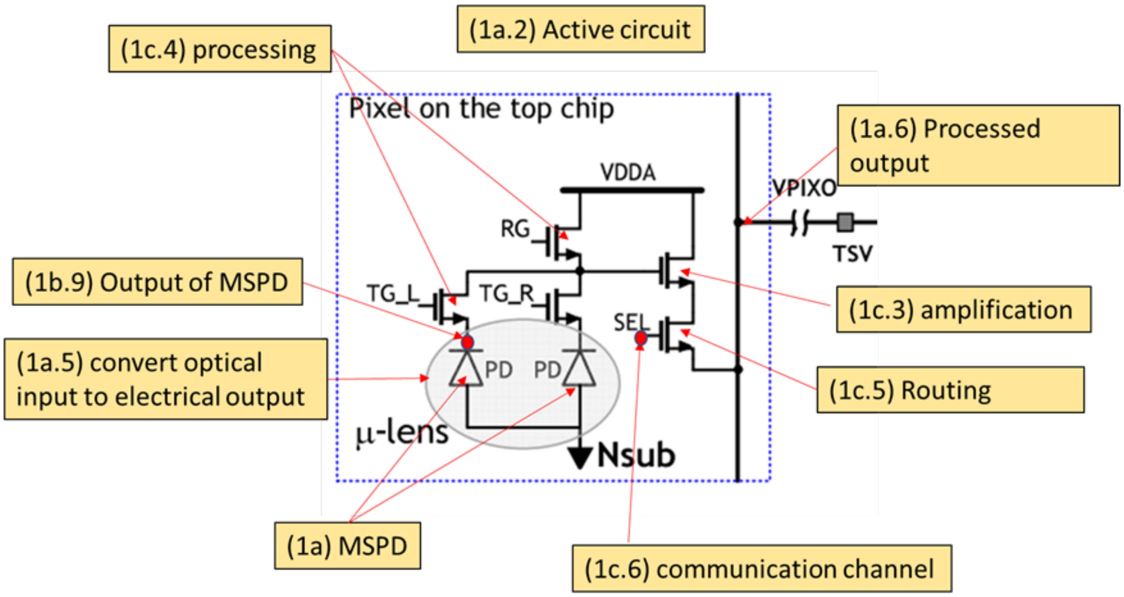


Fig. 3. Column ADC with timing diagram.

Ex. 14 (Samsung's 2020 2PD Article) at Fig. 3 (schematics of pixel circuit and other active electronics to perform processing of the electrical output from the detector).

182. The schematics of the first portion of electronics (expanded below) show that there are two photodiodes in each pixel under one μ-lens. These two photodiodes are used to compute the status of focusing (the value of Output Memory in Figure 3), as explained in Samsung's 2020 2PD Article.



Ex. 14 (Samsung's 2020 2PD Article) at Fig. 3 (schematics of pixel circuit, annotated with claim elements of Claim 1 of the '543 Patent).

183. As shown in Figure 3 of Samsung's 2020 2PD Article, the GN3's circuitry performs the following functions:

- turning on the Reset Gate (RS) and Transfer Gate (TG_L or TG_R), such that VDDA is applied to the MSPD so that MSPD's cathode is biased with more positive voltage to establish electric fields in the P-N junction to sweep the photo-generated charges [1c.1];
- turning off the Reset Gate (RS) and Transfer Gate (TG_L or TG_R), such that photo-generated charges are swept by the electric field, causing the positively charged holes to move to Nsub and the negatively charged electrons to the cathode of the MSPD [1b.9]; and
- turning on the Transfer Gate (TG_L or TG_R) only, such that the photo-generated charges are transferred to the gate of the source-follower circuit and the current is amplified [1c.3].

184. The GN3's circuitry also performs processing in addition to amplification to form the output [1c.4]. For example, the controls of the reset transistor (RG) and the transfer transistors (TG_L, TG_R) determine the integration of the photo-generated current by the following sequence of operations:

- the reset transistor brings the gate voltage of the amplifier [1c.3] to VDDA during the reset period;
- at the same time, reverse bias voltage is applied to the MSPD. After being reset, the transfer transistor (transfer gate) discharges the gate capacitor of the amplifier according to the photogenerated current in MSPD; and
- when the transfer transistor is turned off (after an integration time period), the discharging stops. The amount of the change of the gate voltage of the amplifier [1c.3] is proportional to the photocurrent multiplied by the integration time.

185. The GN3's circuitry also performs routing to one or more selected destinations. [1c.5]. The row driving signal [1c.6] coupled to the select switch determines which pixel in one column to be read to the column output. By sequentially turning out the select transistor of each cell row by row, the data of each row in the same column can be read out one by one. The row driving signal is a communication channel, driven by a timing control circuit on-chip or off-chip to select a row of pixels to be read to off-chip column analog-to-digital converter via column metal trace VPIXO, as shown in the figure above. [1c.6].

186. Thus, Samsung's GN3 product satisfies all elements of exemplary Claim 1 of the '543 Patent. Samsung's GN3 product is representative of its other CIS Accused Products, which also satisfy all elements of exemplary Claim 1 of the '543 Patent.

187. Samsung's direct infringement of the '543 Patent has injured and continues to injure W&W in an amount to be proven at trial, but not less than a reasonable royalty.

188. Samsung has had knowledge of W&W's patents since at least as early as 2019 and has had specific knowledge of its infringement of the '543 Patent since at least February 2020, if not earlier. Samsung's actions are willful, blatant, and in egregious disregard for W&W's patent rights.

189. Samsung's infringement has caused and is continuing to cause damage and irreparable injury to W&W, and W&W will continue to suffer damage and irreparable injury unless and until that infringement is enjoined by this Court.

190. Samsung acted recklessly, willfully, wantonly, and deliberately engaged in acts of infringement of the '543 Patent, justifying an award to W&W of increased damages under 35 U.S.C. § 284, and attorney's fees and costs incurred under 35 U.S.C. § 285.

191. W&W is entitled to injunctive relief, damages and any other relief in accordance with 35 U.S.C. §§ 283, 284, and 285 for Samsung's direct infringement of the '543 Patent.

COUNT VI
(Indirect Infringement of the '543 Patent)

192. W&W repeats, realleges, and incorporates by reference, as if fully set forth herein, the allegations of the preceding paragraphs, as set forth above.

193. As set forth above, Samsung has had knowledge of W&W's patents since at least as early as 2019 and has had specific knowledge of its infringement of the '543 Patent since at least February 2020, if not earlier.

194. As set forth above, the CIS Accused Products and CIS Accused End Products infringe the '543 Patent. Samsung has actively, knowingly, and intentionally induced and continues to induce direct infringement of the '543 Patent pursuant to 35 U.S.C. §271(b).

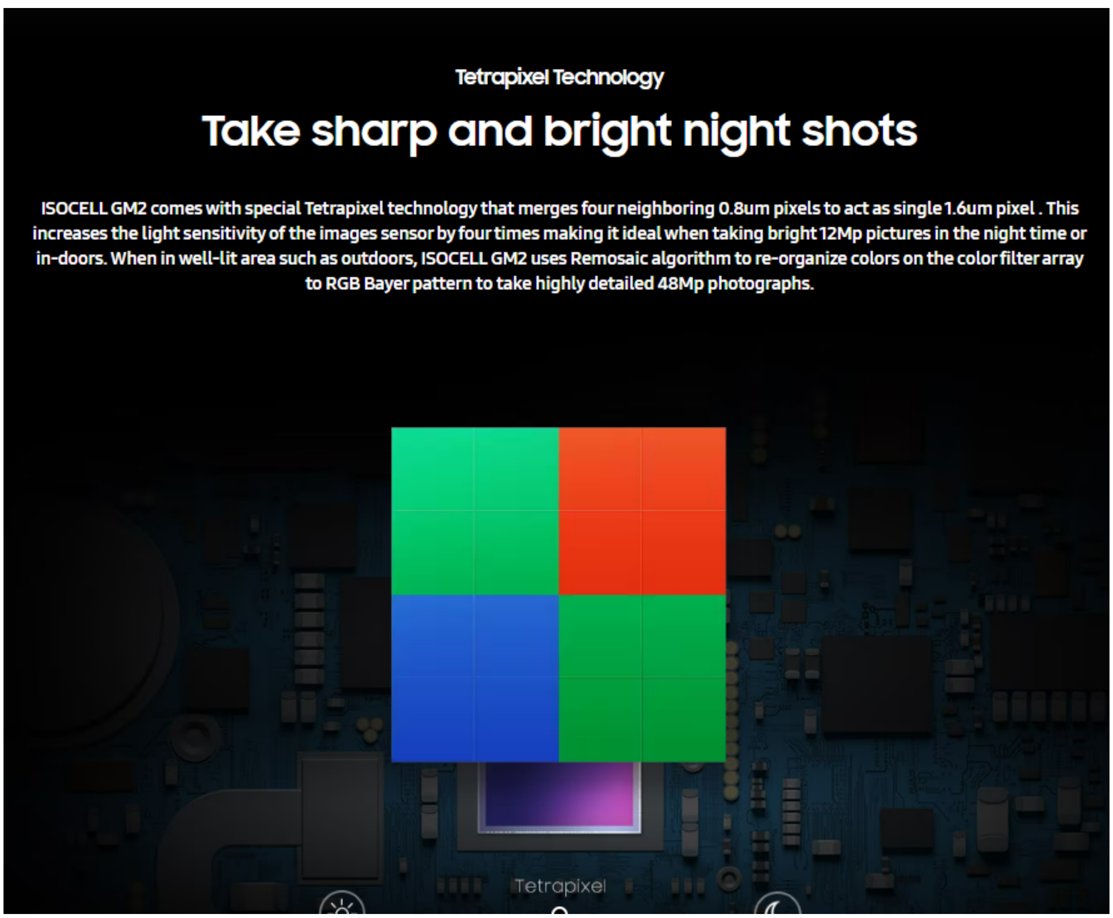
195. For example, Samsung knowingly and actively encourages third parties, including direct and indirect customers of the CIS Accused Products, such as original equipment manufacturers, electronic manufacturing service providers, and other smartphone manufacturers to make, sell, offer to sell, import, and use in the United States end products that include the CIS Accused Products. In addition, Samsung knowingly and actively encourages third parties, including direct and indirect customers of the CIS Accused Products and CIS Accused End

Products, such as distributers and resellers, to sell, offer to sell, and import into the United States the CIS Accused Products and CIS Accused End Products. In addition, Samsung knowingly and actively encourages third parties, including direct and indirect customers, such as smartphone end users in the United States, to use the CIS Accused Products as part of the CIS Accused End Products or third party smartphones that include the CIS Accused Products.

196. Samsung engages in such encouragement by providing instructions and guidance regarding the use and testing of the CIS Accused Products and integration of the CIS Accused Products in the CIS Accused End Products and third party end products; providing information through user manuals, instructions, guidelines, training, videos, tutorials, developer forums, and technical support, and creating and maintaining service centers, which direct and facilitate the use of the CIS Accused Products in the CIS Accused End Products and third party end products; entering into agreements with distributers, resellers, original equipment manufacturers, electronic manufacturing service providers regarding making, testing, selling, offering to sell, and importing into the United States end products that include the CIS Accused Products; and advertising and promoting inclusion and use of the CIS Accused Products in the CIS Accused End Products and third party end products through, marketing materials, websites, press releases, trade shows and sales and distribution channels.

197. As an example of Samsung's active encouragement of direct infringement, Samsung advertises and promotes the infringing features of the CIS Accused Products to customers, specifically emphasizing the "amazing light-sensitivity" and "sharp and bright night shots" that are directly attributable to the infringing features:

Samsung ISOCELL GM2 is an ultra-high 48Mp resolution 1/2.25" image sensor with amazing light-sensitivity with Tetrapixel/Remosaic technology.



Super-PD Auto Focus

Don't miss the moment you love

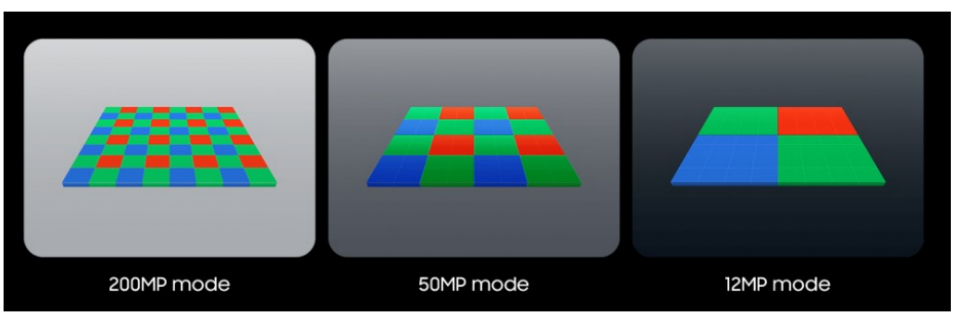
ISOCELL GM2 allows smartphones or mobile cameras to take pictures right off the bat with incredibly fast Super-PD Auto Focus. Super-PD AF focuses by using a special oval lens over two pixels to work as one of many phase detecting agents in the sensor. Moving or not, subjects captured will be sharper with Super-PD AF.

Ex. 41 at 1-4 (https://semiconductor.samsung.com/image-sensor/mobile-image-sensor/isocell-bright-gm2/).

Shoot at the Resolution You Need

Do you think that all pictures need to be 200 million pixels? With the versatile ISOCELL, you don't need to worry. Specially designed with the Tetra^{2}pixel technology, the ISOCELL HP2 within the Galaxy S23 Ultra ensures optimal quality by giving users resolutions from which to choose. It combines up to 16 individual pixels together into one, which then operates as one big pixel.

Thus, the ISOCELL HP2 sensor provides 200MP, 50MP and 12MP output options that allow the user to change resolution depending on their needs. In its default mode, the ISOCELL HP2 produces a 12MP image by merging 16 pixels into one big pixel. When you need a photo that has ultra-high quality, you can choose 200MP mode and the ISOCELL HP2 produces the image with rich details.



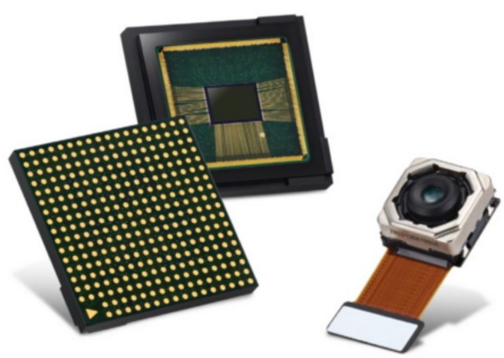
Ex. 42 at 5 (https://news.samsung.com/global/introducing-isocell-hp2-experience-more-pictures-and-epic-details-on-the-galaxy-s23-ultra).

There are various additional examples of Samsung advertising and promoting the infringing features of the Accused Products. *See, e.g.*, Exs. 46-47 (Isocell HP2 and HP3 press releases); videos currently available at https://www.youtube.com/watch?v=eZMJrJgPuwY (Isocell HP2); https://www.youtube.com/watch?v=kbXY62rC8HA (Isocell HP3); https://www.youtube.com/watch?v=-DsFgBofmQE (Galaxy S23 Ultra with Isocell HP2); https://www.youtube.com/watch?v=11_n3fChK4A (Galaxy S23 Ultra with Isocell HP2).

198. As a further example of Samsung's active encouragement of direct infringement, Samsung creates and promotes aspects of the CIS Accused Products that allow for integration of the infringing features into end products:

Tetrapixel technology and 1.0μm pixel size enable sleekly designed smartphones to take more vivid pictures in darker environments

The ISOCELL Plug & Play solution can save up to four months of development time for manufacturers



The Samsung ISOCELL Slim 3P9 is a 1.0μm 16Mp image sensor with Tetrapixel* technology that allows bright and vivid pictures in today's sleekly designed smartphones. With Tetrapixel, a technology that merges four neighboring pixels, the 3P9 can function as a 2.0μm image sensor for front-facing cameras that can take brighter pictures in low-lit environments.

For faster auto-focusing, the 3P9 adopted an advanced phase detection auto-focus (PDAF) with doubled auto-focus agent density than that of conventional PDAF sensors. In addition, the sensor significantly stabilizes pictures and videos taken while in motion with a gyro-synchronizer that syncs frame exposure time from the sensor with movement data from the device's gyroscope. Once the data is synced, the mobile processor can simply adjust the frames based on movement rather than rigorously analyzing each frame to detect and compensate for angular movement.

Ex. 43 (https://news.samsung.com/global/samsung-makes-image-sensor-integration-easier-with-new-16mp-isocell-slim-3p9-and-plug-and-play-solution).

199. Samsung has known or has been willfully blind to the fact that it is inducing others to infringe one or more claims of the '543 Patent.

200. Samsung's indirect infringement of the '543 Patent has injured and continues to injure W&W in an amount to be proven at trial, but not less than a reasonable royalty.

201. Samsung's indirect infringement has caused and is continuing to cause damage and irreparable injury to W&W, and W&W will continue to suffer damage and irreparable injury unless and until that infringement is enjoined by this Court.

202. Samsung's actions of indirect infringement of the '360 Patent are reckless, willful, wanton, deliberate and in blatant and egregious disregard for W&W's patent rights, justifying an award to W&W of increased damages under 35 U.S.C. § 284, and attorney's fees and costs incurred under 35 U.S.C. § 285.

203. W&W is entitled to injunctive relief, damages and any other relief in accordance with 35 U.S.C. §§ 283, 284, and 285 for Samsung's indirect infringement.

COUNT VII
(Direct Infringement of the '700 Patent)

204. W&W repeats, realleges, and incorporates by reference, as if fully set forth herein, the allegations of the preceding paragraphs, as set forth above.

205. In violation of 35 U.S.C. § 271(a), Samsung directly infringed and continues to infringe at least exemplary Claim 1 of the '700 Patent by making, using, importing, selling, and offering for sale in the United States the Accused Products. A copy of Claim 1 annotated with the designations used below to identify the elements of Claim 1 is attached as Exhibit 40.

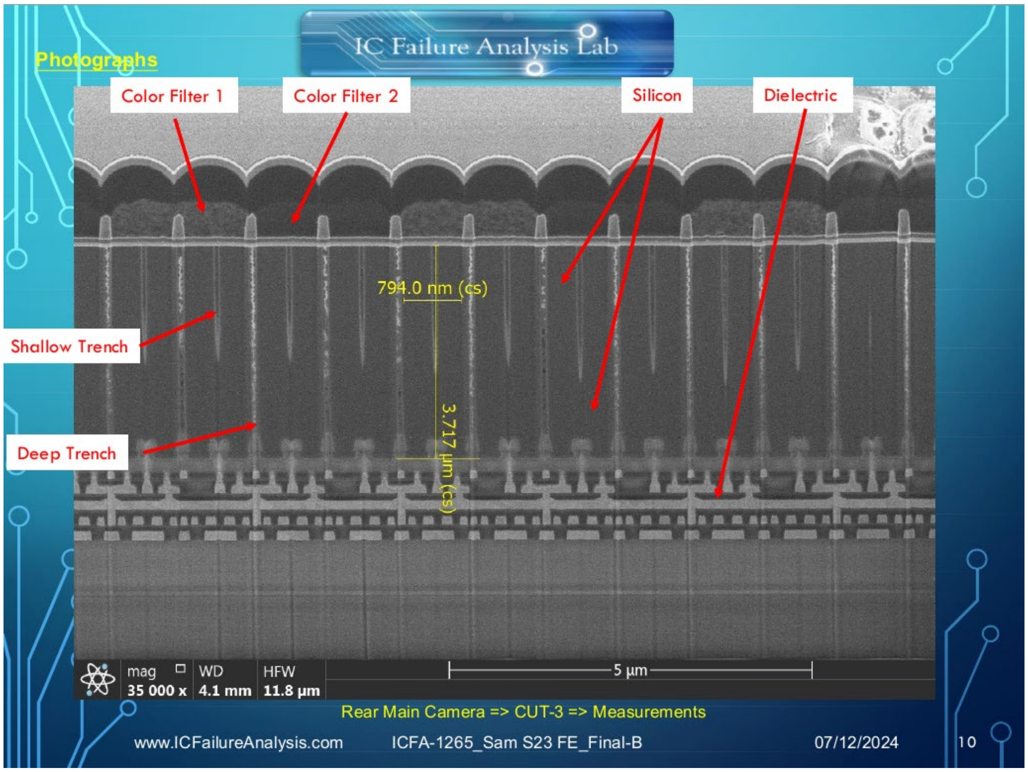
206. Samsung' acts of making, using, importing, selling, and offering for sale infringing products and services have been without the permission, consent, authorization, or license of W&W. Indeed, Samsung declined W&W's request that Samsung take a license.

207. Samsung's infringement is based upon literal infringement or, at the very least, infringement under the doctrine of equivalents.

208. Samsung's infringement includes the manufacture, use, sale, importation, and offer for sale of the CIS Accused Products, and the CIS-Included Accused Products that contain the CIS Accused Products, which each infringe the '700 Patent because they satisfy each element of claims of the '700 Patent, either literally, under the doctrine of equivalents, or both.

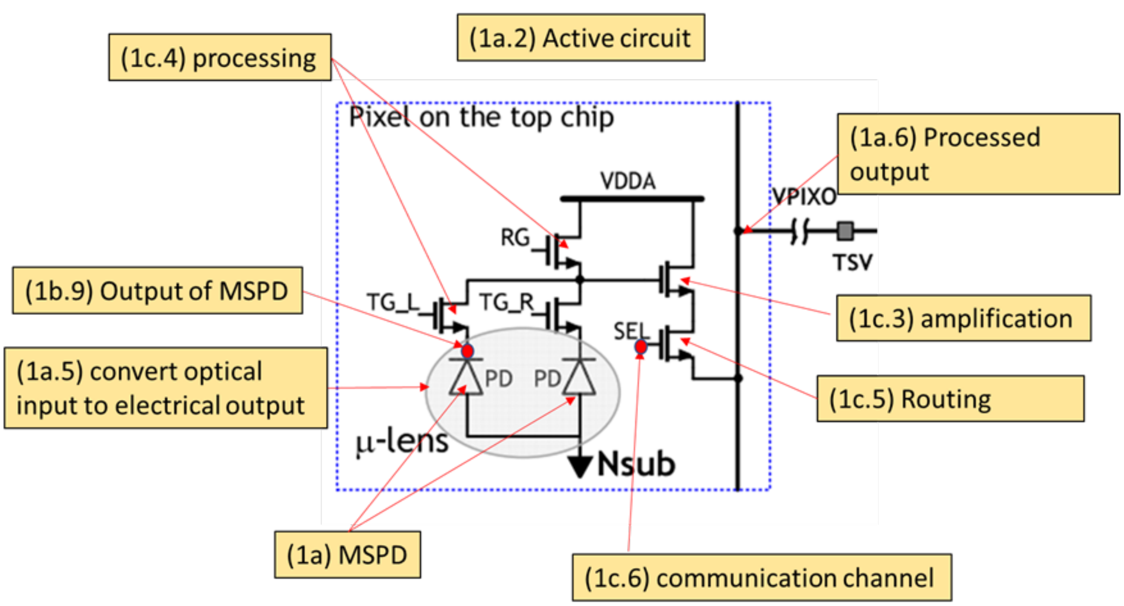
209. Samsung's GN3 CMOS and Samsung's Galaxy S23 smartphone that contains the GN3 CMOS, are representative examples of the various Accused Products that infringe the '700 Patent, including exemplary Claim 1.

210. Samsung's GN3 is a CMOS image sensor that converts light (optical input) to an electrical output. [1a, 1.a.5]. As confirmed by the ICFA lab analysis, as shown below, the pixels of the GN3 are separated by deep trenches (DTI) into a laterally extending array of pillars. The pillars with microstructure-enhanced photodetectors (MSPD) have shallow trenches filled with dielectric material, which are microstructures to enhance photo sensitivity. [1a].



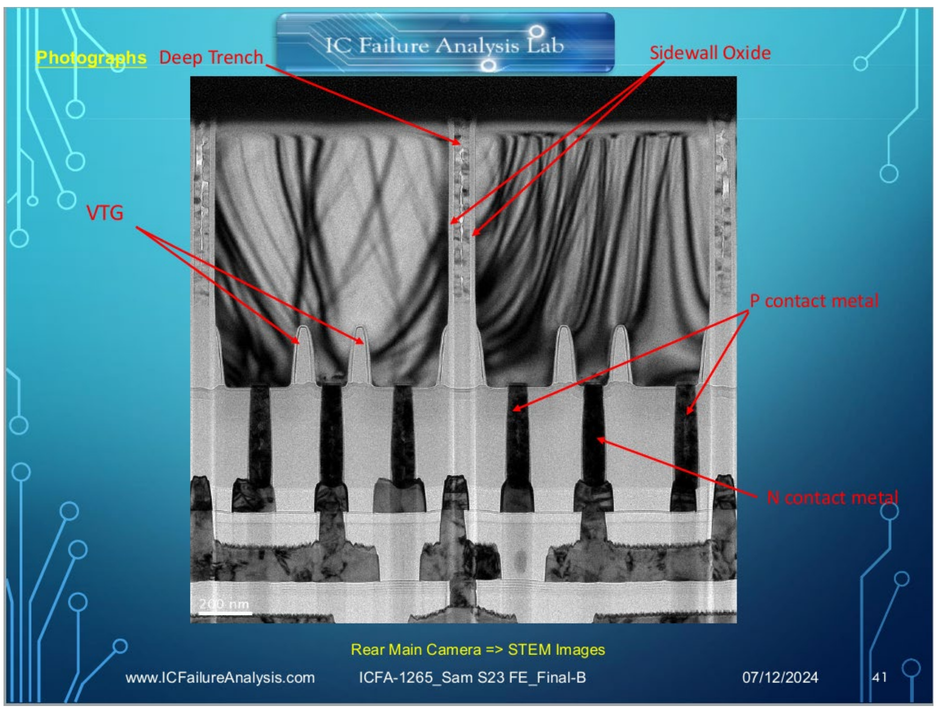
Ex. 25 (ICFA-1265) at Slide 10 (showing shallow trenches covered with dielectric materials).

211. These MSPDs are reverse biased for detecting lights. Ex. 14 (Samsung's 2020 2PD paper). The cathodes of the MSPDs are biased to a positive voltage, VDDA, when integrated active electronics RG, TG_L and TG_R are turned on, as shown below:



Ex. 14 (Samsung's 2020 2PD Article) at Fig. 3 (annotated schematics of pixel circuit).

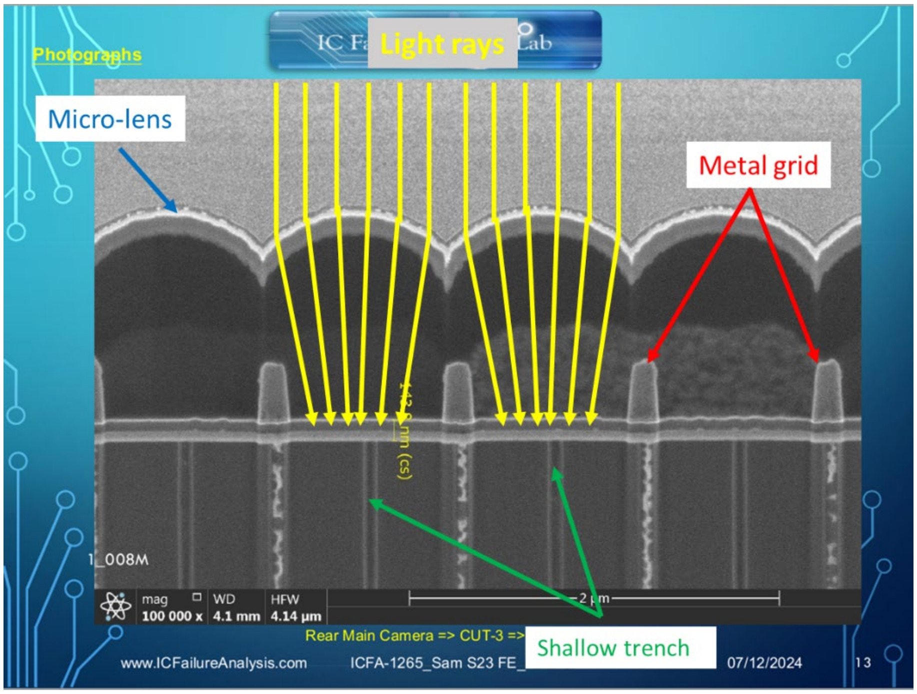
212. Specifically, the transistor symbols denoted by RG, TG_L, TG_R, SEL, and etc., are for n-MOSFETs, which are a type of transistor. When RG, TG_L and TG_R are turned on, a positive voltage is applied to the cathodes of the MSPDs, causing reverse biasing to MSPDs. [1a.1]. The transistors TG_L and TG_R, labeled as VTG (i.e., vertical transfer gate) in the TEM (i.e., Transmission Electron Microscopy) picture below, are an active electronic circuit integrated into the MSPDs. [1a.2]. Both the MSPDs and the active electronic circuit are formed on a single substrate. [1a.3]. The P-contact and N-contact provide the electric connections to the MSPDs for reverse biasing [1c] and are free of a pattern of openings that matches said holes [1b.5] [1c.1].



Ex. 25 (ICFA-1265) at Slide 41 (TEM showing VTG's (vertical transfer gates) are integrated into the photodetector; the P-contact and N contact facilitates reverse biasing of the photodetector).

213. Each pixel has an μ-lens to focus light to the input portion of the MSPD, which is substantially continuous spatially [1a.4], as illustrated below. The μ-lens bends the light rays away from the metal grids which provide optical isolation between color filters. The focused

light rays enter the photo-detecting regions having holes (shallow trenches) fabricated therein extending in directions transverse to the layers. [1b.5], [1b.8].

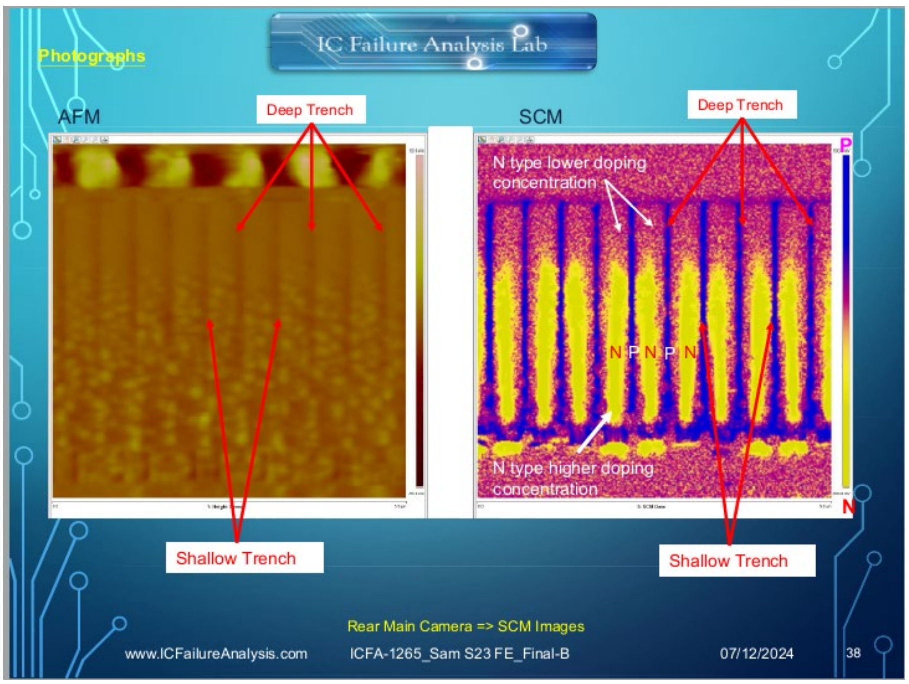


Ex. 25 (ICFA-1265) at Slide 13 (annotated to illustrate the effect of the µ-lenses to focus the light rays to the MSPDs).

214. As shown in the Scanning Capacitance Microscopy (SCM) image below, the silicon inside the MSPD is doped into multiple regions. The purple regions annotated as "N-type lower doping concentration" (intermediate semiconductor) are the regions where the light is focused by the µ-lenses. The yellow regions annotated as "first (n-type) doped semiconductor" are the regions located at the center of each photodiode. The blue region at the top of the intermediate semiconductor is the second (p-type) doped semiconductor. These semiconductor regions have the following characteristics:

- The intermediate semiconductor material [1b.1] is between the first [1b.2] and second [1b.3] doped semiconductor materials;

- The first [1b.2] and second [1b.3] doped semiconductor materials are doped semiconductors [1b.6];
- The intermediate semiconductor material [1b.1] is less doped than at least one of the first [1b.2] and second [1b.3] doped semiconductor materials [1b.7], and
- Each of the first [1b.2] and second [1b.3] doped semiconductor materials and intermediate semiconductor material [1b.1] comprises silicon [1b.4].



Ex. 25 (ICFA-1265) at Slide 38 (SCM images showing doping profile inside the pillars, where the yellow region is highly doped n-type, the blue region is highly doped p-type and the purple region is lightly doped n-type).

215. After light enters the photo-detecting regions, it is converted into electrical output (photo-generated charges). The circuitry of Samsung's GN3 processes the photo-generated charges into a processed output [1a.6], [1b.9], as explained by Figure 3 in Samsung's 2020 2PD Article. As shown in Figure 3, there are two separate portions of active electronics. The first portion is located in each pixel on the top chip and the second portion is located in the bottom

chip. These two chips are manufactured separately using different technologies and subsequently bonded together to form an integrated combination [1a, 1.a.2].

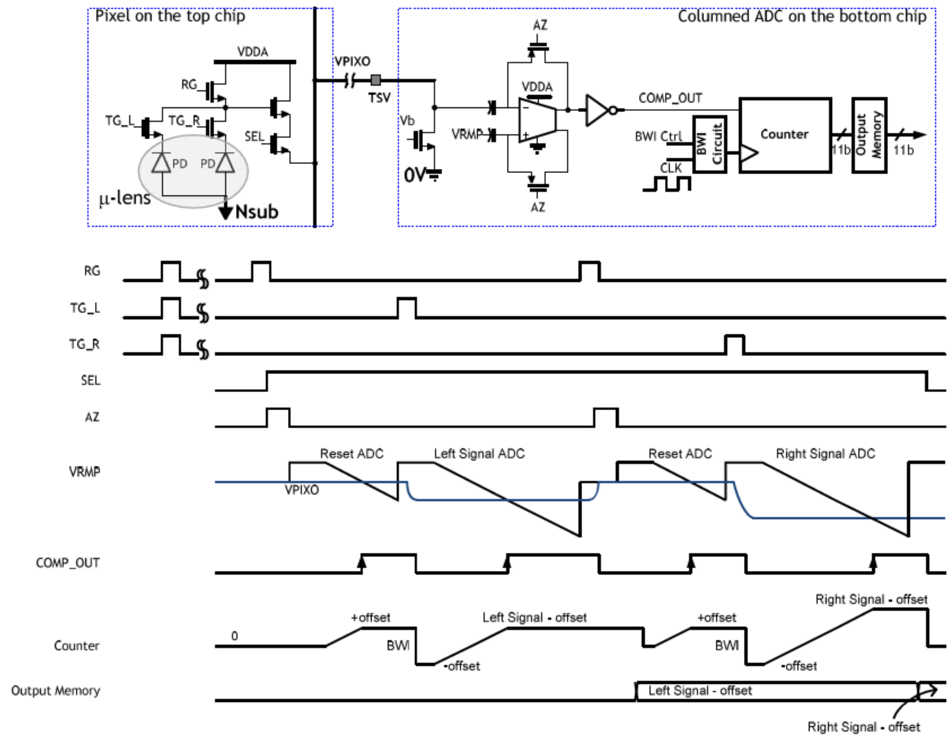
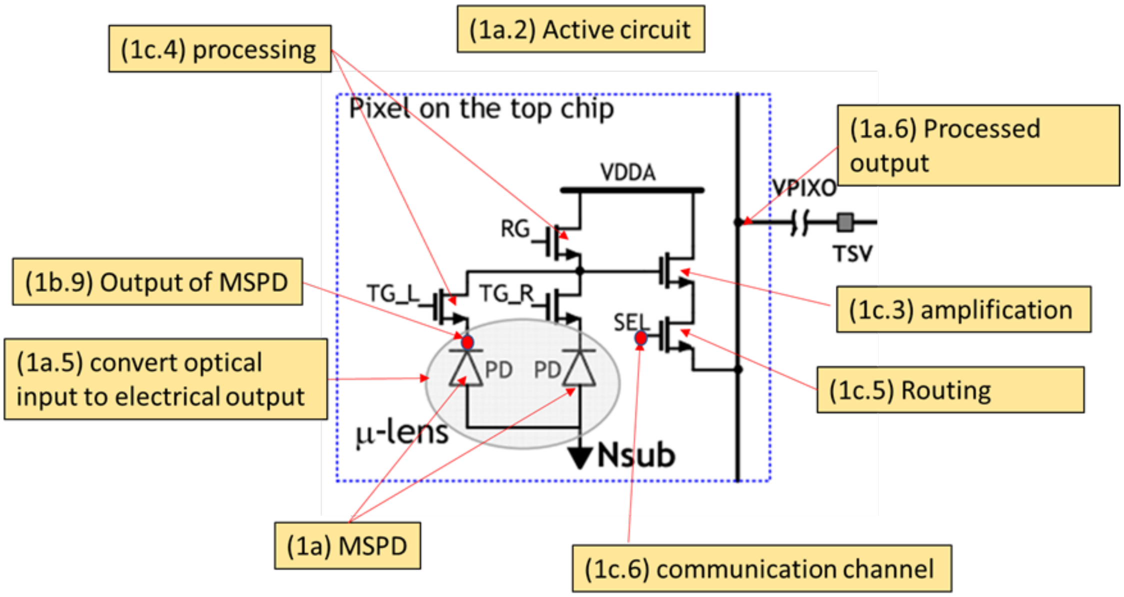


Fig. 3. Column ADC with timing diagram.

Ex. 14 (Samsung's 2020 2PD Article) at Fig. 3 (schematics of pixel circuit and other active electronics to perform processing of the electrical output from the detector).

216. The schematics of the first portion of electronics (expanded below), show that there are two photodiodes in each pixel under one μ-lens. These two photodiodes are used to compute the status of focusing (the value of Output Memory in Figure 3), as explained in Samsung's 2020 2PD Article.



Ex. 14 (Samsung's 2020 2PD Article) at Fig. 3 (schematics of pixel circuit, annotated with claim elements of Claim 1 of the '700 Patent).

217. As shown in Figure 3 of Samsung's 2020 2PD Article, the GN3's circuitry performs the following functions:

- turning on the Reset Gate (RS) and Transfer Gate (TG_L or TG_R), such that VDDA is applied to the MSPD so that MSPD's cathode is biased with more positive voltage to establish electric fields in the P-N junction to sweep the photo-generated charges [1c.1];
- turning off the Reset Gate (RS) and Transfer Gate (TG_L or TG_R), such that photo-generated charges are swept by the electric field, causing the positively charged holes to move to Nsub and the negatively charged electrons to the cathode of the MSPD [1b.9]; and
- turning on the Transfer Gate (TG_L or TG_R) only, such that the photo-generated charges are transferred to the gate of the source-follower circuit and the current is amplified [1c.3].

218. The GN3's circuitry also performs processing in addition to amplification to form the output [1c.4]. For example, the controls of the reset transistor (RG) and the transfer transistors (TG_L, TG_R) determine the integration of the photo-generated current by the following sequence of operations:

- the reset transistor brings the gate voltage of the amplifier [1c.3] to VDDA during the reset period;
- at the same time, reverse bias voltage is applied to the MSPD. After being reset, the transfer transistor (transfer gate) discharges the gate capacitor of the amplifier according to the photogenerated current in MSPD; and
- when the transfer transistor is turned off (after an integration time period), the discharging stops. The amount of the change of the gate voltage of the amplifier [1c.3] is proportional to the photocurrent multiplied by the integration time.

219. The GN3's circuitry also performs routing to one or more selected destinations. [1c.5]. The row driving signal [1c.6] coupled to the select switch determines which pixel in one column is to be read to the column output. By sequentially turning out the select transistor of each cell row by row, the data of each row in the same column can be read out one by one. The row driving signal is a communication channel, driven by a timing control circuit on-chip or off-chip to select a row of pixels to be read to off-chip column analog-to-digital converter via column metal trace VPIXO, as shown in the figure above. [1c.6].

220. Thus, Samsung's GN3 product satisfies all elements of exemplary Claim 1 of the '700 Patent. Samsung's GN3 product is representative of its other CIS Accused Products, which also satisfy all elements of exemplary Claim 1 of the '700 Patent.

221. Samsung's direct infringement of the '700 Patent has injured and continues to injure W&W in an amount to be proven at trial, but not less than a reasonable royalty.

222. Samsung has had knowledge of W&W's patents since at least as early as 2019 and has had specific knowledge of its infringement of the '700 Patent since at least February 2020, if not earlier. Samsung's actions are willful, blatant, and in egregious disregard for W&W's patent rights.

223. Samsung's infringement has caused and is continuing to cause damage and irreparable injury to W&W, and W&W will continue to suffer damage and irreparable injury unless and until that infringement is enjoined by this Court.

224. Samsung acted recklessly, willfully, wantonly, and deliberately engaged in acts of infringement of the '700 Patent, justifying an award to W&W of increased damages under 35 U.S.C. § 284, and attorney's fees and costs incurred under 35 U.S.C. § 285.

225. W&W is entitled to injunctive relief, damages and any other relief in accordance with 35 U.S.C. §§ 283, 284, and 285 for Samsung's direct infringement of the '700 Patent

COUNT VIII
(Indirect Infringement of the '700 Patent)

226. W&W repeats, realleges, and incorporates by reference, as if fully set forth herein, the allegations of the preceding paragraphs, as set forth above.

227. As set forth above, Samsung has had knowledge of W&W's patents since at least as early as 2019 and has had specific knowledge of its infringement of the '700 Patent since at least February 2020, if not earlier.

228. As set forth above, the CIS Accused Products and CIS Accused End Products infringe the '700 Patent. Samsung has actively, knowingly, and intentionally induced and continues to induce direct infringement of the '700 Patent pursuant to 35 U.S.C. §271(b).

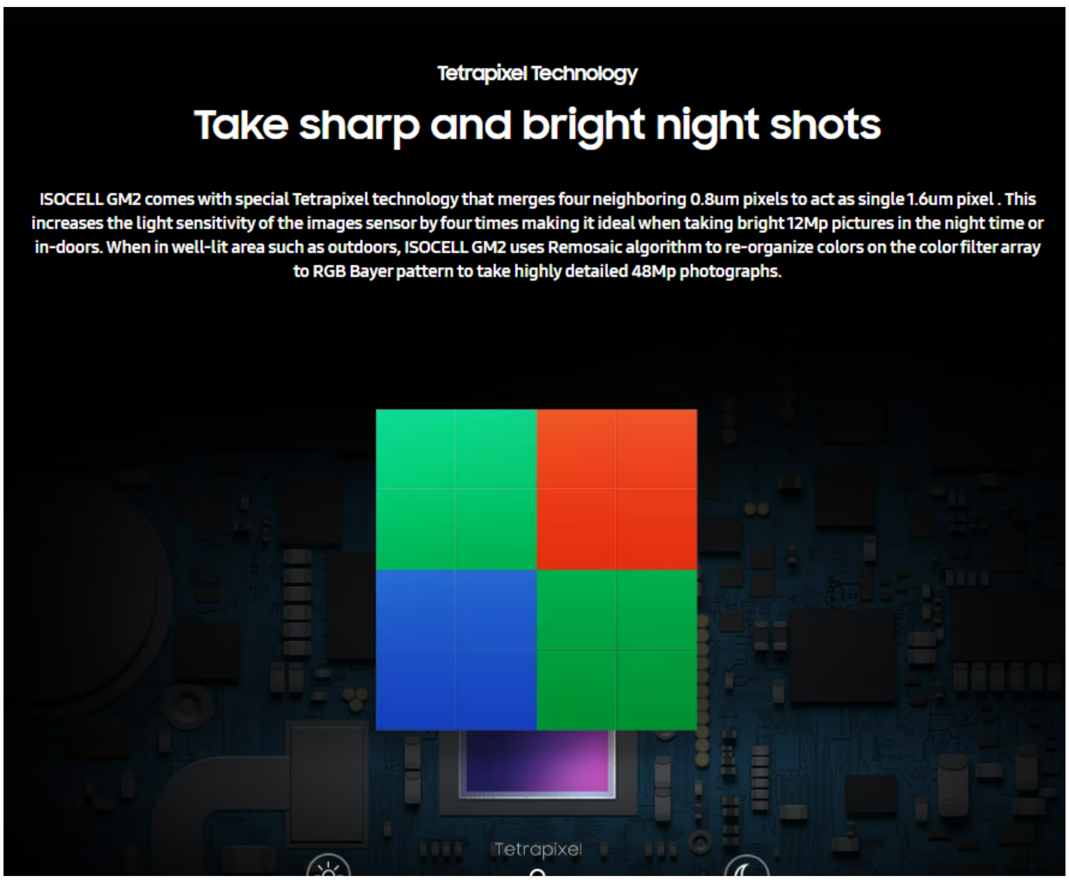
229. For example, Samsung knowingly and actively encourages third parties, including direct and indirect customers of the CIS Accused Products, such as original equipment manufacturers, electronic manufacturing service providers, and other smartphone manufacturers to make, sell, offer to sell, import, and use in the United States end products that include the CIS Accused Products. In addition, Samsung knowingly and actively encourages third parties, including direct and indirect customers of the CIS Accused Products and CIS Accused End

Products, such as distributers and resellers, to sell, offer to sell, and import into the United States the CIS Accused Products and CIS Accused End Products. In addition, Samsung knowingly and actively encourages third parties, including direct and indirect customers, such as smartphone end users in the United States, to use the CIS Accused Products as part of the CIS Accused End Products or third party smartphones that include the CIS Accused Products.

230. Samsung engages in such encouragement by providing instructions and guidance regarding the use and testing of the CIS Accused Products and integration of the CIS Accused Products in the CIS Accused End Products and third party end products; providing information through user manuals, instructions, guidelines, training, videos, tutorials, developer forums, and technical support, and creating and maintaining service centers, which direct and facilitate the use of the CIS Accused Products in the CIS Accused End Products and third party end products; entering into agreements with distributers, resellers, original equipment manufacturers, electronic manufacturing service providers regarding making, testing, selling, offering to sell, and importing into the United States end products that include the CIS Accused Products; and advertising and promoting inclusion and use of the CIS Accused Products in the CIS Accused End Products and third party end products through, marketing materials, websites, press releases, trade shows and sales and distribution channels.

231. As an example of Samsung's active encouragement of direct infringement, Samsung advertises and promotes the infringing features of the CIS Accused Products to customers, specifically emphasizing the "amazing light-sensitivity" and "sharp and bright night shots" that are directly attributable to the infringing features:

Samsung ISOCELL GM2 is an ultra-high 48Mp resolution 1/2.25" image sensor with amazing light-sensitivity with Tetrapixel/Remosaic technology.



Super-PD Auto Focus

Don't miss the moment you love

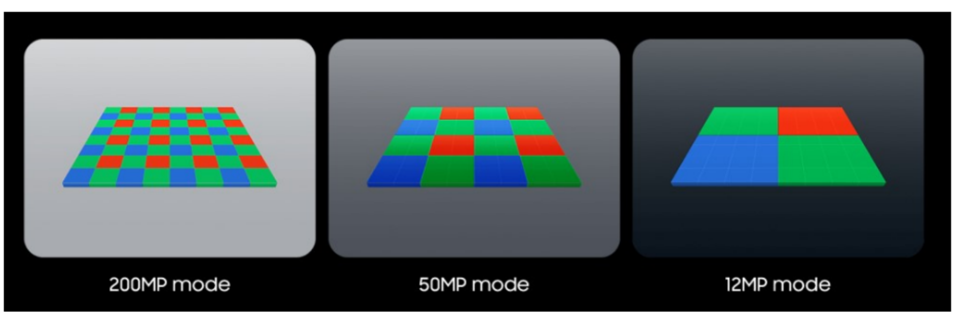
ISOCELL GM2 allows smartphones or mobile cameras to take pictures right off the bat with incredibly fast Super-PD Auto Focus. Super-PD AF focuses by using a special oval lens over two pixels to work as one of many phase detecting agents in the sensor. Moving or not, subjects captured will be sharper with Super-PD AF.

Ex. 41 at 1-4 (https://semiconductor.samsung.com/image-sensor/mobile-image-sensor/isocell-bright-gm2/).

Shoot at the Resolution You Need

Do you think that all pictures need to be 200 million pixels? With the versatile ISOCELL, you don't need to worry. Specially designed with the Tetra^{2}pixel technology, the ISOCELL HP2 within the Galaxy S23 Ultra ensures optimal quality by giving users resolutions from which to choose. It combines up to 16 individual pixels together into one, which then operates as one big pixel.

Thus, the ISOCELL HP2 sensor provides 200MP, 50MP and 12MP output options that allow the user to change resolution depending on their needs. In its default mode, the ISOCELL HP2 produces a 12MP image by merging 16 pixels into one big pixel. When you need a photo that has ultra-high quality, you can choose 200MP mode and the ISOCELL HP2 produces the image with rich details.



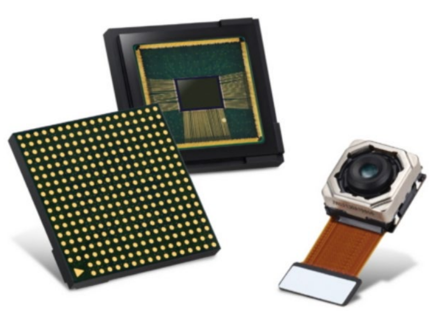
Ex. 42 at 5 (https://news.samsung.com/global/introducing-isocell-hp2-experience-more-pictures-and-epic-details-on-the-galaxy-s23-ultra).

There are various additional examples of Samsung advertising and promoting the infringing features of the Accused Products. *See, e.g.*, Exs. 46-47 (Isocell HP2 and HP3 press releases); videos currently available at https://www.youtube.com/watch?v=eZMJrJgPuwY (Isocell HP2); https://www.youtube.com/watch?v=kbXY62rC8HA (Isocell HP3); https://www.youtube.com/watch?v=-DsFgBofmQE (Galaxy S23 Ultra with Isocell HP2); https://www.youtube.com/watch?v=11_n3fChK4A (Galaxy S23 Ultra with Isocell HP2).

232. As a further example of Samsung's active encouragement of direct infringement, Samsung creates and promotes aspects of the CIS Accused Products that allow for integration of the infringing features into end products:

Tetrapixel technology and 1.0μm pixel size enable sleekly designed smartphones to take more vivid pictures in darker environments

The ISOCELL Plug & Play solution can save up to four months of development time for manufacturers



The Samsung ISOCELL Slim 3P9 is a 1.0μm 16Mp image sensor with Tetrapixel* technology that allows bright and vivid pictures in today's sleekly designed smartphones. With Tetrapixel, a technology that merges four neighboring pixels, the 3P9 can function as a 2.0μm image sensor for front-facing cameras that can take brighter pictures in low-lit environments.

For faster auto-focusing, the 3P9 adopted an advanced phase detection auto-focus (PDAF) with doubled auto-focus agent density than that of conventional PDAF sensors. In addition, the sensor significantly stabilizes pictures and videos taken while in motion with a gyro-synchronizer that syncs frame exposure time from the sensor with movement data from the device's gyroscope. Once the data is synced, the mobile processor can simply adjust the frames based on movement rather than rigorously analyzing each frame to detect and compensate for angular movement.

Ex. 43 (https://news.samsung.com/global/samsung-makes-image-sensor-integration-easier-with-new-16mp-isocell-slim-3p9-and-plug-and-play-solution).

233. Samsung has known or has been willfully blind to the fact that it is inducing others to infringe one or more claims of the ’700 Patent.

234. Samsung’s indirect infringement of the ’700 Patent has injured and continues to injure W&W in an amount to be proven at trial, but not less than a reasonable royalty.

235. Samsung’s indirect infringement has caused and is continuing to cause damage and irreparable injury to W&W, and W&W will continue to suffer damage and irreparable injury unless and until that infringement is enjoined by this Court.

236. Samsung’s actions of indirect infringement of the ’700 Patent are reckless, willful, wanton, deliberate and in blatant and egregious disregard for W&W’s patent rights, justifying an award to W&W of increased damages under 35 U.S.C. § 284, and attorney’s fees and costs incurred under 35 U.S.C. § 285.

237. W&W is entitled to injunctive relief, damages and any other relief in accordance with 35 U.S.C. §§ 283, 284, and 285 for Samsung’s indirect infringement.

COUNT IX
(Direct Infringement of the ’084 Patent)

238. W&W repeats, realleges, and incorporates by reference, as if fully set forth herein, the allegations of the preceding paragraphs, as set forth above.

239. In violation of 35 U.S.C. § 271(a), Samsung directly infringed and continues to infringe at least exemplary Claim 1 of the ’084 Patent by making, using, importing, selling, and offering for sale in the United States the Accused Products. A copy of Claim 1 annotated with the designations used below to identify the elements of Claim 1 is attached as Exhibit 40.

240. Samsung’s acts of making, using, importing, selling, and offering for sale infringing products and services have been without the permission, consent, authorization, or license of W&W. Indeed, Samsung declined W&W’s request that Samsung take a license.

241. Samsung's infringement is based upon literal infringement or, at the very least, infringement under the doctrine of equivalents.

242. Samsung's infringement includes the manufacture, use, sale, importation, and offer for sale of ToF Accused Products, such as the ISOCELL Vizion 33D, Vizion 63D, and Vizion 931, and any CIS Accused End Products that contain these ToF Accused Products. Each of the ToF Accused Products infringe the '084 Patent because they satisfy each element of claims of the '084 Patent, either literally, under the doctrine of equivalents, or both.

243. The ToF Accused Products are primarily used for infrared applications, such as obtaining 3-dimensional profiles using indirect ToF.

244. As explained in Samsung's 2021 ToF Article, the light sources (TX as shown below) are typically infrared lasers that are modulated with a high frequency signal. The ToF sensor computes the distance by detecting the phase change of this high frequency signal. [1b.1]. The phase change requires high speed computation for each pixel, as shown below. Thus, the photodetectors must be as close as possible to the circuitry and are integrated on the same substrate as the circuitry when numerous pixels are processed [1b] [1b.2].

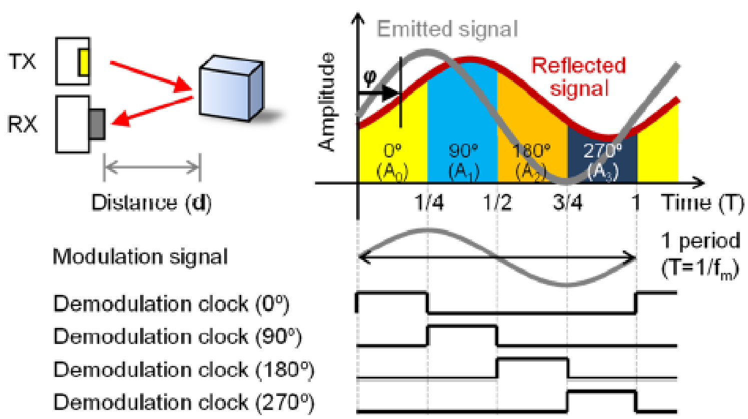


Fig. 1. Indirect ToF sensor system with a 4-tap demodulation pixel. The TX emits modulated light signal and the RX samples the reflected signal with four-phase demodulation clocks.

Ex. 19 (Samsung's 2021 ToF Article) at Fig. 1.

245. As explained above, Samsung fabricates holes near the surface of the ToF Accused Products in the manner set forth in the ’084 Patent, by its use of backside scattering technology, in order to enhance the infrared light sensitivity of the ToF Accused Products.

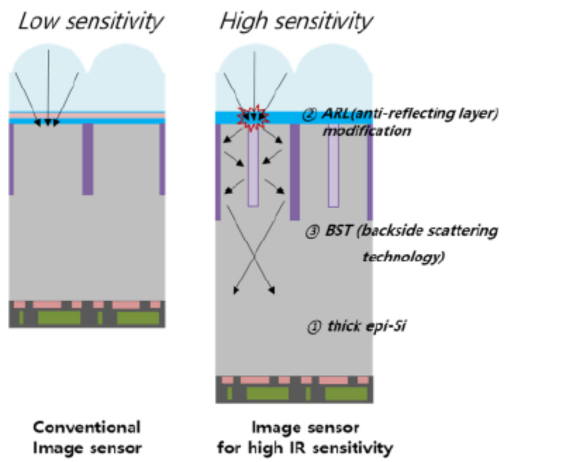


Figure 1. Schematic images of design concept for image sensor having IR sensitivity

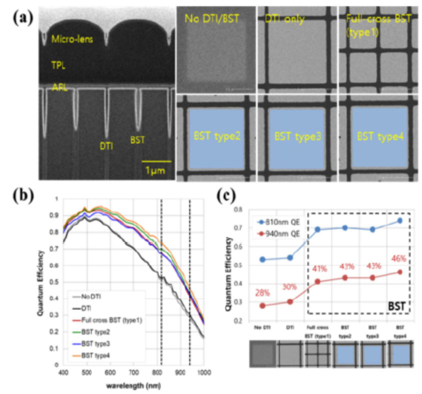


Figure 4. (a) Cross-sectional and top-view SEM images of the pixel structure which consists of backside scattering technology (BST) patterns. (b) QE curves of image sensors with no DTI, only DTI and DTI+BST pixel structures. (c) Quantum efficiencies of image sensors with various DTI and BST patterns at 810nm and 940nm wavelength.

Ex. 23 (Samsung’s IR QE Article) at Figs. 1 and 4 (showing that backside scattering technology near the surface enhances the light absorption).

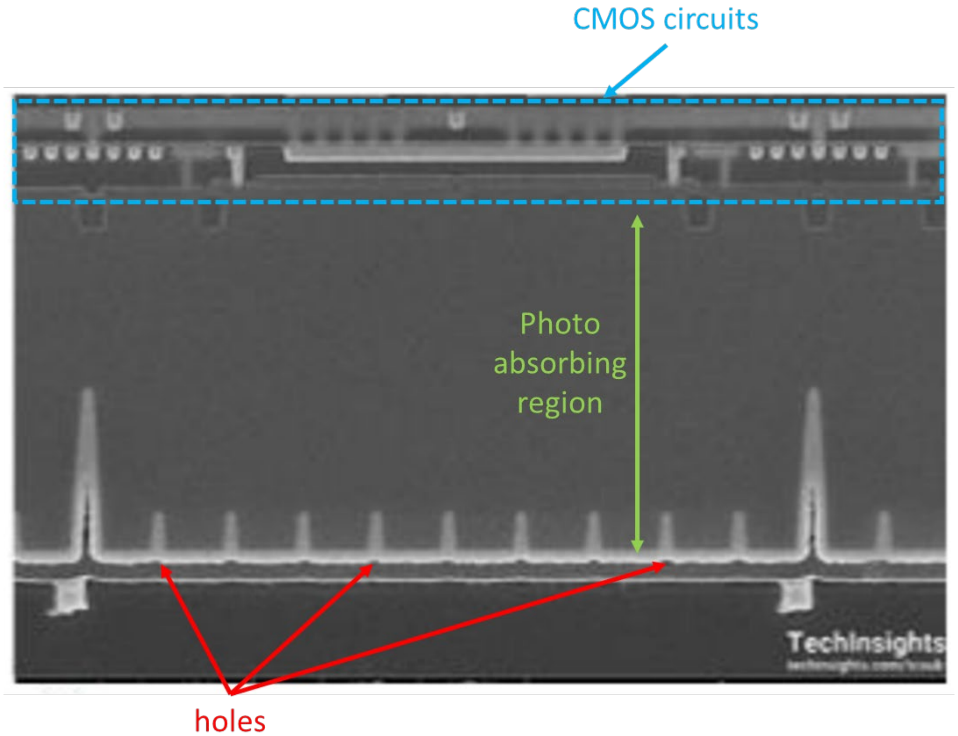
246. Samsung touts the benefits of its backside scattering technology feature on its website:

> A new era of depth sensing features is here. As a high-resolution VGA ToF solution, the ISOCELL Vizion 33D produces depth images with unrivalled precision. In both indoor and outdoor conditions, the sensor can detect the depth of an object within up to 5m with high accuracy. ISOCELL’s pixel technology, coupled with high resolution, enables the sensor to accurately separate objects from the background with 3D bokeh effect. Deep Trench Isolation technology (DTI) maximizes isolation between pixels to reduce crosstalk, while ***Backside Scattering Technology (BST) enhances the sensor’s quantum efficiency***. With high-precision depth images, the ISOCELL Vizion 33D delivers next-level 3D applications, such as facial authentication for payment services.

Ex. 18 at 3 (https://semiconductor.samsung.com/image-sensor/tof-sensor/isocell-vizion-33d/) (emphasis added).

247. TechInsights, a company that performs analysis of technology and market information for the semiconductor and microelectronics industry, including reverse engineering

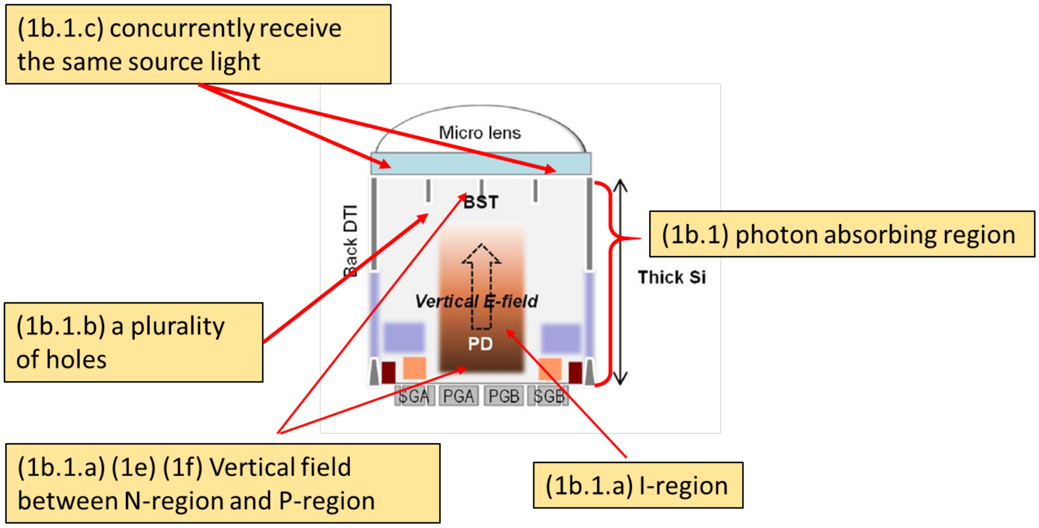
of microelectronics, noted in 2021 that it "observed" a "shallow trench grid" in Samsung's "7.0 μm pixel-pitch, i-ToF image sensor," as shown below:



Ex. 6 at 20 (2021 International Image Sensor Workshop (IISW) by TechInsights) at Fig. 15 (annotated to show holes fabricated inside the photodetector, the photon absorbing region and a portion of the CMOS circuit).

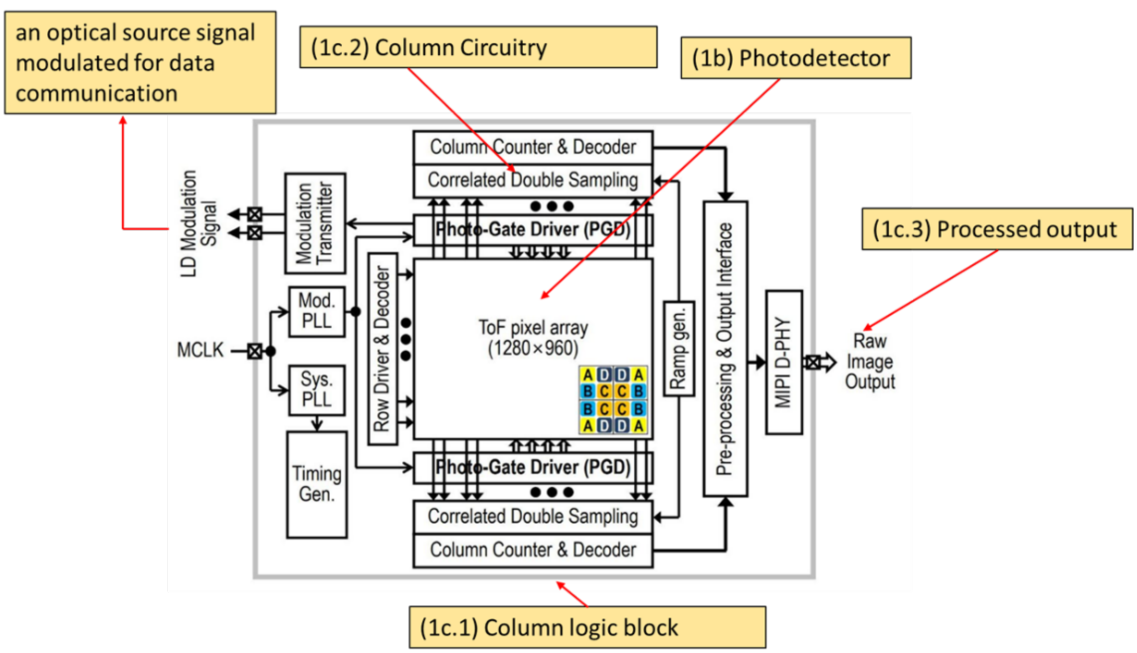
248. For example, in Samsung's Vizion 33D sensor, under the μ-lens, each photodetector has an absorbing region [1b.1], as shown below, that comprises an I-region that is between an N-region and a P-region [1b.1.a] and a substantially continuous layer interrupted by a plurality of holes extending in the I-region toward the substrate [1b.1.b] and configured to concurrently receive the same source signal (from TX above) at a plural number of the holes [1b.1.c]. The photon absorbing [1b.1] and portion of CMOS circuit [1c] have thicknesses of the same order of magnitude [1d]. The photon absorbing region also has a cathode region and an anode region operatively associated with it [1e]. Reverse biasing circuitry is configured to apply

a voltage between the cathode and anode regions such that said cathode region is driven to a more positive voltage than said anode region [1f], to generate vertical E-field.



Ex. 19 (Samsung's 2021 ToF Article) at Fig. 4 (annotated).

249. Samsung's Vizion 33D has an integrated circuitry [1c] on the same substrate as the photodetector that performs the calculation of phase delay using its 4-Tap approach.



Ex. 19 (Samsung's 2021 ToF Article) at Fig. 5 (annotated).

250. Thus, Samsung's Vizion 33D product satisfies all elements of exemplary Claim 1 of the '084 Patent. Samsung's Vizion 33D product is representative of its other ToF Accused Products, which also satisfy all elements of exemplary Claim 1 of the '084 Patent.

251. Samsung's direct infringement of the '084 Patent has injured and continues to injure W&W in an amount to be proven at trial, but not less than a reasonable royalty.

252. Samsung has had knowledge of W&W's patents since at least as early as 2019 and has had specific knowledge of its infringement of the '084 Patent since at least April 2019, if not earlier. Samsung's actions are willful, blatant, and in egregious disregard for W&W's patent rights.

253. Samsung's infringement has caused and is continuing to cause damage and irreparable injury to W&W, and W&W will continue to suffer damage and irreparable injury unless and until that infringement is enjoined by this Court.

254. Samsung acted recklessly, willfully, wantonly, and deliberately engaged in acts of infringement of the '084 Patent, justifying an award to W&W of increased damages under 35 U.S.C. § 284, and attorney's fees and costs incurred under 35 U.S.C. § 285.

255. W&W is entitled to injunctive relief, damages and any other relief in accordance with 35 U.S.C. §§ 283, 284, and 285 for Samsung's direct infringement of the '084 Patent

COUNT X
(Indirect Infringement of the '084 Patent)

256. W&W repeats, realleges, and incorporates by reference, as if fully set forth herein, the allegations of the preceding paragraphs, as set forth above.

257. As set forth above, Samsung has had knowledge of W&W's patents since at least as early as 2019 and has had specific knowledge of its infringement of the '084 Patent since at least April 2019, if not earlier.

258. As set forth above, the ToF Accused Products infringe the ’084 Patent. Samsung has actively, knowingly, and intentionally induced and continues to induce direct infringement of the ’084 Patent pursuant to 35 U.S.C. §271(b).

259. For example, Samsung knowingly and actively encourages third parties, including direct and indirect customers of the ToF Accused Products, such as original equipment manufacturers, electronic manufacturing service providers, and other manufacturers, to make, sell, offer to sell, import, and use in the United States end products that include the ToF Accused Products. In addition, Samsung knowingly and actively encourages third parties, including direct and indirect customers of the ToF Accused Products, such as distributers and resellers, to sell, offer to sell, and import into the United States the ToF Accused Products In addition, Samsung knowingly and actively encourages third parties, including direct and indirect customers, such as end users in the United States, to use the ToF Accused Products as part of products that include the ToF Accused Products.

260. Samsung engages in such encouragement by providing instructions and guidance regarding the use and testing of the ToF Accused Products and integration of the ToF Accused Products in third party end products; providing information through user manuals, instructions, guidelines, training, videos, tutorials, developer forums, and technical support, and creating and maintaining service centers, which direct and facilitate the use of the ToF Accused Products in end products; entering into agreements with distributers, resellers, original equipment manufacturers, electronic manufacturing service providers regarding making, testing, selling, offering to sell, and importing into the United States end products that include the ToF Accused Products; and advertising and promoting inclusion and use of the ToF Accused Products in end

products through, marketing materials, websites, press releases, trade shows and sales and distribution channels.

261. As an example of Samsung's active encouragement of direct infringement, Samsung advertises and promotes the infringing features of the ToF Accused Products to customers, specifically emphasizing the improved performance attributes that are directly attributable to the infringing features:

The ISOCELL Vizion 63D, a time-of-flight sensor, captures high-resolution 3D images with exceptional detail

The ISOCELL Vizion 931, a global shutter sensor, captures dynamic moments with clarity and precision

Thanks to backside scattering technology (BST) that enhances light absorption, the Vizion 63D sensor boasts the highest level of quantum efficiency in the industry, reaching 38% at an infrared light wavelength of 940 nanometers (nm). This enables enhanced light sensitivity and reduced noise, resulting in sharper image quality with minimal motion blur.

The ISOCELL Vizion 931 also achieves the industry's highest level of quantum efficiency, delivering an impressive 60% at 850nm infrared light wavelength. This feat was made possible by incorporating Front Deep Trench Isolation (FDTI) which places an insulation layer between pixels to maximize light absorption, in addition to the BST method used in the ISOCELL Vizion 63D.

Ex. 44 at 1-3 (https://news.samsung.com/global/samsung-unveils-two-new-isocell-vizion-sensors-tailored-for-robotics-and-xr-applications).

262. To encourage integration of the ToF Accused Products into end products, Samsung notes that "Samsung ISOCELL Vizion 63D and ISOCELL Vizion 931 sensors are currently sampling to OEMs worldwide." Ex. 44 at 3 (https://news.samsung.com/global/samsung-unveils-two-new-isocell-vizion-sensors-tailored-for-robotics-and-xr-applications).

263. Samsung has known or has been willfully blind to the fact that it is inducing others to infringe one or more claims of the ’084 Patent.

264. Samsung’s indirect infringement of the ’084 Patent has injured and continues to injure W&W in an amount to be proven at trial, but not less than a reasonable royalty.

265. Samsung’s indirect infringement has caused and is continuing to cause damage and irreparable injury to W&W, and W&W will continue to suffer damage and irreparable injury unless and until that infringement is enjoined by this Court.

266. Samsung’s actions of indirect infringement of the ’084 Patent are reckless, willful, wanton, deliberate and in blatant and egregious disregard for W&W’s patent rights, justifying an award to W&W of increased damages under 35 U.S.C. § 284, and attorney’s fees and costs incurred under 35 U.S.C. § 285.

267. W&W is entitled to injunctive relief, damages and any other relief in accordance with 35 U.S.C. §§ 283, 284, and 285 for Samsung’s indirect infringement.

PRAYER FOR RELIEF

WHEREFORE, W&W prays for judgment and relief as follows:

A. An entry of judgment holding that Samsung has infringed and is infringing the ’871, ’360, ’543, ’700, and ’084 Patents, and has induced infringement and is inducing infringement of the ’871, ’360, ’543, ’700, and ’084 Patents;

B. A preliminary and permanent injunction against Samsung and its officers, employees, agents, servants, attorneys, instrumentalities, and those in privity with them, from infringing, directly or indirectly, the ’871, ’360, ’543, ’700, and ’084 Patents, and for all further and proper injunctive relief pursuant to 35 U.S.C. § 283;

C. An award to W&W of damages to be proven at trial to compensate W&W for Samsung's infringement of the '871, '360, '543, '700, and '084 Patents that will account for infringement up to trial based on the relevant information and financials produced, where said damages will be no less than a reasonable royalty;

D. An award to W&W of increased damages under 35 U.S.C. § 284 based on, *inter alia*, Samsung's willful infringement of the '871, '360, '543, '700, and '084 Patents;

E. A finding that this case is "exceptional" and an award to W&W of its costs and reasonable attorneys' fees, as provided by 35 U.S.C. § 285;

F. An accounting of all infringing sales and revenues from the first date of infringement of the '871, '360, '543, '700, and '084 Patents;

G. Post judgment interest and prejudgment interest; and

H. Such further and other relief as the Court may deem proper and just.

Respectfully submitted

Dated: October 21, 2024

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