

EXHIBIT J


Infringement of U.S. Patent No. 10,224,359

ISOCELL HP2 Image Sensor
Samsung Galaxy S23 Ultra



U.S. Patent No. 10,224,359

Claim 1: An imager device, comprising:

| Claim 1 | |
|-------------------------------|--|
| An imager device, comprising: | <p>The Samsung Galaxy S23 Ultra comprises an imager device at least because it includes a Samsung ISOCELL sensor.</p> <p>In particular, the Samsung Galaxy S23 Ultra includes an ISOCELL HP2 sensor. The ISOCELL HP2 is a 200-megapixel image sensor for ultra-high resolution photos. <i>See, e.g.</i>, D-VGT Technology of ISOCELL Image Sensor, Samsung Electronics Corp., June 30, 2023, available at https://semiconductor.samsung.com/news-events/tech-blog/d-vtg-technology-of-isocell-image-sensor/ (last visited March 7, 2024).</p>  <p>Samsung Galaxy S23 Ultra, Samsung Electronics Corp.</p> |

Claim 1(a): at least two adjacent light sensitive image sensor pixels each having a light incident surface, and a backside surface opposite the light incident surface;

| Claim 1(a) | |
|--|---|
| <p>at least two adjacent light sensitive image sensor pixels each having a light incident surface, and a backside surface opposite the light incident surface;</p> | <p>The ISOCELL HP2 sensor includes at least two adjacent light sensitive image sensor pixels each having a light incident surface, and a backside surface opposite the light incident surface.</p> <p>The ISOCELL HP2 sensor includes 200-megapixels with trenches shown here in between each pixel. Further, the image below shows a light incident surface and a backside surface, opposite the light incident surface of each pixel.</p> <div data-bbox="756 438 1617 1047" data-label="Diagram"> </div> <p><i>See, e.g., Sungbong Park, et al., A 64Mpixel CMOS Image Sensor with 0.56μm Unit Pixels Separated by Front Deep-Trench Isolation, 2022 IEEE International Solid-State Circuits Conference, March 17, 2022.</i></p> |

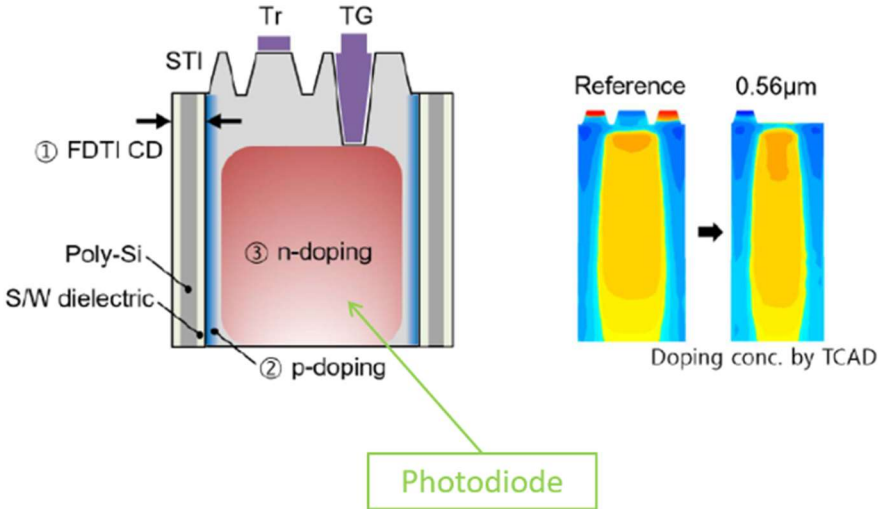
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Claim 1(b): a peripheral isolation element at least partially separating said two adjacent light sensitive pixels;

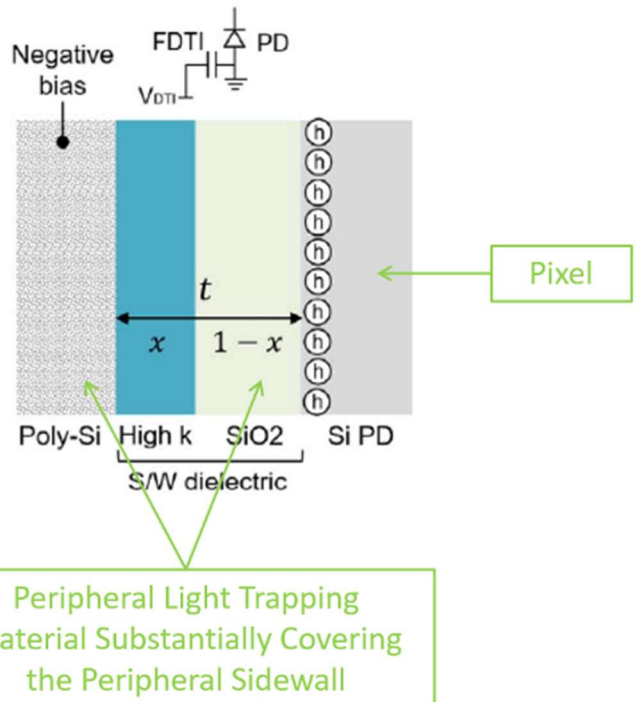
| Claim 1(b) | |
|---|--|
| <p>a peripheral isolation element at least partially separating said two adjacent light sensitive pixels;</p> | <p>The ISOCELL HP2 sensor includes a peripheral isolation element at least partially separating said two adjacent light sensitive pixels.</p> <p>The ISOCELL HP2 includes 200-megapixels, that are separated by peripheral isolation elements that make up the peripheral sidewall as shown below.</p> <div data-bbox="743 446 1654 764" data-label="Diagram"> </div> <p><i>See, e.g.,</i> Hyuncheol Kim, <i>et al.</i>, <i>A 64μm 4-Photodiode 1.28μm 50Mpixel CMOS Image Sensor with 0.98e- Temporal Noise and 20Ke- Full-Well Capacity Employing Quarter-Ring Source Follower</i>, 2023 IEEE International Solid-State Circuits Conference, 2023.</p> |

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Claim 1(c): each of said pixels having at least one doped region disposed on at least one of the light incident surface and the backside surface,

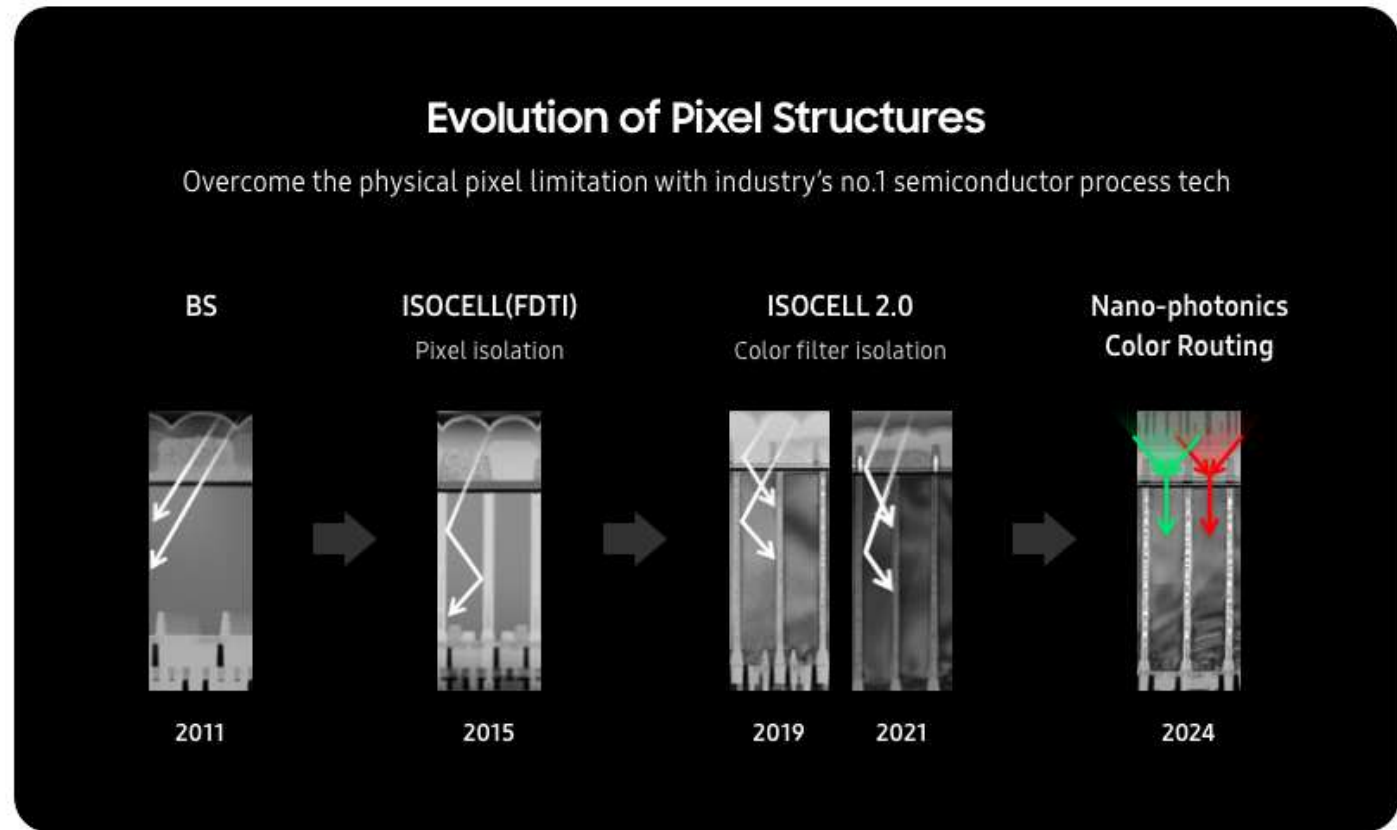
| Claim 1(c) | |
|--|---|
| <p>each of said pixels having at least one doped region disposed on at least one of the light incident surface and the backside surface,</p> | <p>The ISOCELL HP2 sensor includes at least two adjacent light sensitive pixels each of said pixels having at least one doped region disposed on at least one of the light incident surface and the backside surface.</p> <p>The ISOCELL HP2 sensor includes 200-megapixels, each with a doped region making a photodiode, as shown below.</p>  <p>See, e.g., Sungbong Park, et al., <i>A 64Mpixel CMOS Image Sensor with 0.56µm Unit Pixels Separated by Front Deep-Trench Isolation</i>, 2022 IEEE International Solid-State Circuits Conference, March 17, 2022.</p> |

Claim 1(d): wherein the peripheral isolation element comprises at least two materials having different indices of refraction,

| Claim 1(d) | |
|--|--|
| <p>wherein the peripheral isolation element comprises at least two materials having different indices of refraction,</p> | <p>The ISOCELL HP2 sensor includes a peripheral isolation element wherein the peripheral isolation element comprises at least two materials having different indices of refraction.</p> <p>The ISOCELL HP2 sensor includes 200-megapixels with peripheral side walls shown below that contain peripheral light trapping material comprised of at least polysilicon and silicon dioxide.</p>  <p><i>See, e.g., Sungbong Park, et al., A 64Mpixel CMOS Image Sensor with 0.56μm Unit Pixels Separated by Front Deep-Trench Isolation, 2022 IEEE International Solid-State Circuits Conference, March 17, 2022.</i></p> |

Claim 1(d): wherein the peripheral isolation element comprises at least two materials having different indices of refraction,

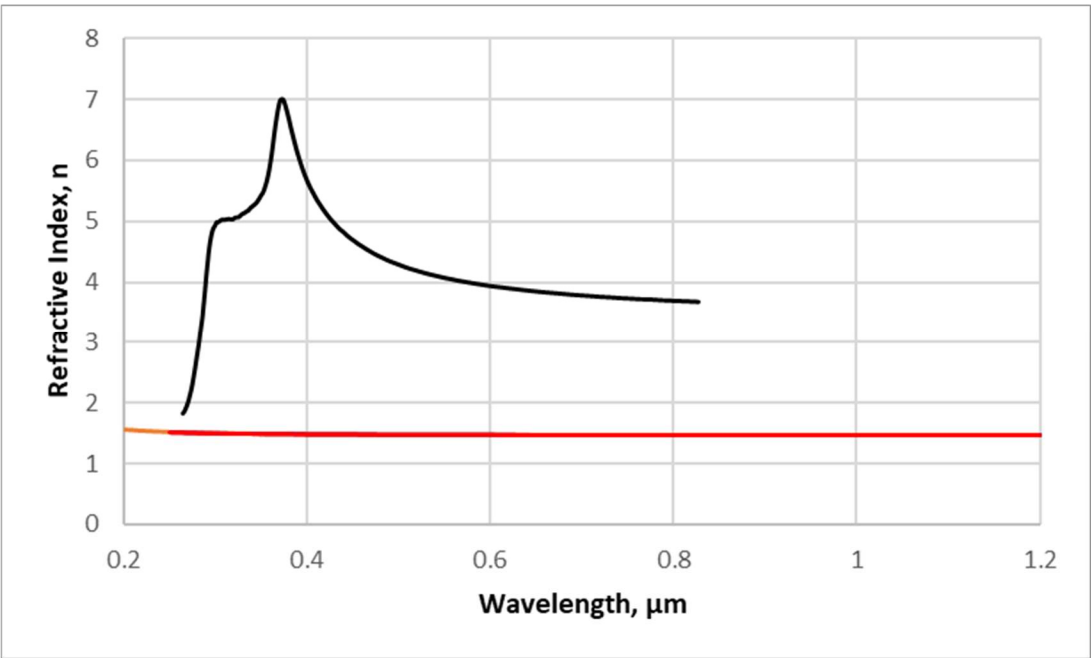
Claim 1(d)



<https://semiconductor.samsung.com/news-events/tech-blog/how-isocell-unlock-the-future-of-camera-experiences/>

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Claim 1(e): wherein said peripheral isolation element comprises a first, a second and a third layer, wherein said third layer is disposed between said first and second layers, and wherein each of said first and second layer exhibits an index of refraction less than an index of refraction of said third layer.

| Claim 1(e) | |
|--|---|
| <p>wherein said peripheral isolation element comprises a first, a second and a third layer, wherein said third layer is disposed between said first and second layers, and wherein each of said first and second layer exhibits an index of refraction less than an index of refraction of said third layer.</p> | <p>The ISOCELL HP2 sensor includes a peripheral isolation element wherein said peripheral isolation element comprises a first, a second and a third layer, wherein said third layer is disposed between said first and second layers, and wherein each of said first and second layer exhibits an index of refraction less than an index of refraction of said third layer.</p> <p>As discussed above, the Samsung ISOCELL HP2 includes a polysilicon layer disposed between SiO_x layers. The index of refraction of polysilicon (black curve) is greater than the index of refraction of silicon dioxide.</p>  <p>Compiled from RefractiveIndex.info (last visited March 8, 2024) (Polysilicon: https://refractiveindex.info/?shelf=3d&book=crystals&page=silicon; Silicon Dioxide: https://refractiveindex.info/?shelf=main&book=SiO2&page=Rodriguez-de_Marcos, https://refractiveindex.info/?shelf=main&book=SiO2&page=Gao, https://refractiveindex.info/?shelf=main&book=SiO2&page=Lemarchand) (last visited March 8, 2024).</p> |

| Claim 18 | |
|-------------------------------|---|
| An imager device, comprising: | <p>The Samsung Galaxy S23 Ultra comprises an imager device at least because it includes a Samsung ISOCELL sensor.</p> <p><i>See Claim 1, supra.</i></p> |

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Claim 18(a): at least two adjacent light sensitive image sensor pixels each having a light incident surface, and a backside surface opposite the light incident surface;

| Claim 18(a) | |
|---|---|
| at least two adjacent light sensitive image sensor pixels each having a light incident surface, and a backside surface opposite the light incident surface; | <p>The ISOCELL HP2 sensor includes at least two adjacent light sensitive image sensor pixels each having a light incident surface, and a backside surface opposite the light incident surface.</p> <p><i>See Claim 1(a), supra.</i></p> |

Claim 18(b): a peripheral isolation element separating said at least two adjacent light sensitive pixels so as to reduce optical crosstalk therebetween, said isolation element comprising at least two materials having different indices of refraction,

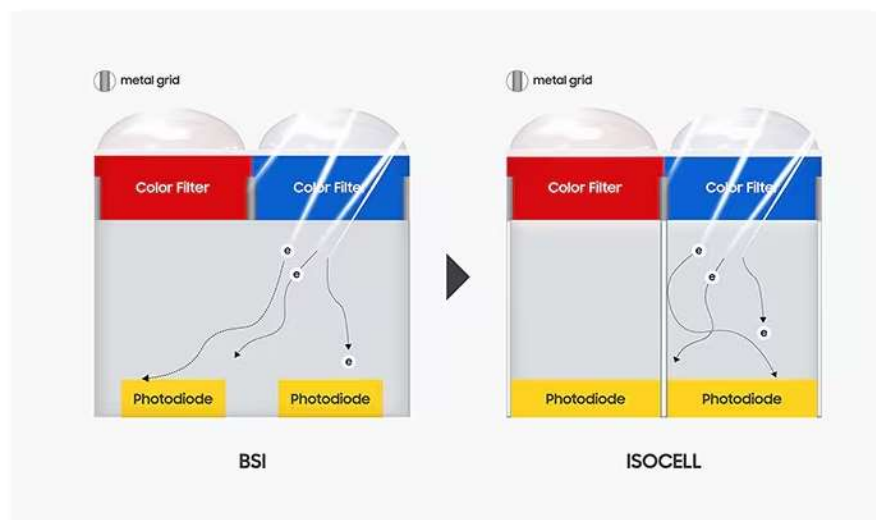
| Claim 18(b) | |
|---|--|
| <p>a peripheral isolation element separating said at least two adjacent light sensitive pixels so as to reduce optical crosstalk therebetween, said isolation element comprising at least two materials having different indices of refraction,</p> | <p>The ISOCELL HP2 sensor includes a peripheral isolation element separating said at least two adjacent light sensitive pixels so as to reduce optical crosstalk therebetween, said isolation element comprising at least two materials having different indices of refraction.</p> <p>The ISOCELL HP2 includes peripheral isolation elements separating at least two adjacent light sensitive pixels.</p> <div data-bbox="625 487 1789 1182"><p>Evolution of Pixel Structures Overcome the physical pixel limitation with industry's no.1 semiconductor process tech</p><p>BS (2011) → ISOCELL(FDTI) Pixel Isolation (2015) → ISOCELL 2.0 Color filter Isolation (2019, 2021) → Nano-photonics Color Routing (2024)</p></div> <p>https://semiconductor.samsung.com/news-events/tech-blog/how-isocell-unlock-the-future-of-camera-experiences/</p> <p>As explained by Samsung, these peripheral sidewalls reduce crosstalk between pixels.</p> |

Claim 18(b): a peripheral isolation element separating said at least two adjacent light sensitive pixels so as to reduce optical crosstalk therebetween, said isolation element comprising at least two materials having different indices of refraction,

Claim 18(b)

The ISOCELL Revolution

With backside illumination already addressing many of the light absorption issues, Samsung's ISOCELL technology addressed the problems created by crosstalk. Engineers designed a physical barrier between neighboring pixels, isolating them and allowing more light to be gathered by the micro-lens and absorbed by the photodiode.



<https://semiconductor.samsung.com/news-events/tech-blog/isocell-plus-leading-the-next-generation-of-image-sensors/>

Claim 18(b): a peripheral isolation element separating said at least two adjacent light sensitive pixels so as to reduce optical crosstalk therebetween, said isolation element comprising at least two materials having different indices of refraction,

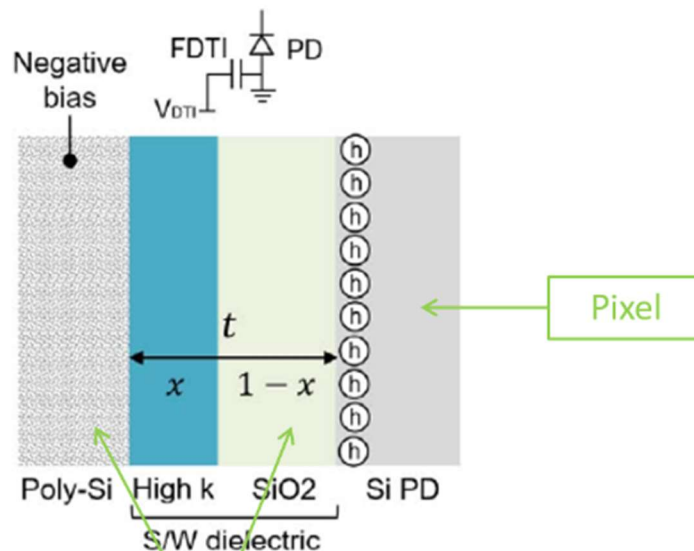
| Claim 18(b) | |
|-------------|---|
| | <p>A fence structure is necessary between each pixel, even though 4 pixels have the same CF. The purpose is three-fold: 1) to increase quantum efficiency (QE) by guiding more light to PDs, 2) to lower optical crosstalk between adjacent pixels with different colors, and 3) to avoid discoloration defects by discharging residual electrons off the optical surface. The purpose 1) and 2) can be realized by adding low refractive index (RI) materials because the larger the index contrast, the lower the critical angle for total internal reflection becomes. Purpose 3), on the other hand, requires metal grids and metal absorption should be minimized to improve QE. Until now, a metal-and-dielectric hybrid fence structure has been used for our sensor products. However, the hybrid fence is insufficient for the 0.56μm pixel because the reflectivity is limited due to small RI contrast between the fence and CFs. To overcome this issue, an air-embedded fence structure is integrated as shown in Fig. 5.8.5. It does not just improve reflectivity from the lower effective RI, but also reduces the metal absorption. As a result, optical crosstalk between colors is reduced by 1.2%. The sensitivity and Y-SNR are improved by 5.5% and 0.30dB respectively. Sample images in comparison with the reference are in Fig. 5.8.6 as well as a summary table of the key pixel performances. The 0.56μm pixel sensor shows comparable performance to the smallest pixels in production. A micrograph of the stacked sensor with a floorplan of the readout chip is shown in Fig. 5.8.7.</p> <p><i>See, e.g., Sungbong Park, et al., A 64Mpixel CMOS Image Sensor with 0.56μm Unit Pixels Separated by Front Deep-Trench Isolation, Samsung Electronics Inc., Samsung Electronics Inc., 2022 IEEE International Solid-State Circuits Conference, March 17, 2022.</i></p> |

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Claim 18(b): a peripheral isolation element separating said at least two adjacent light sensitive pixels so as to reduce optical crosstalk therebetween, said isolation element comprising at least two materials having different indices of refraction,

Claim 18(b)

The peripheral isolation elements are comprised of at least two materials, here SiO₂ and Poly-Si.



Peripheral Light Trapping
Material Substantially Covering
the Peripheral Sidewall

See, e.g., Sungbong Park, et al., *A 64Mpixel CMOS Image Sensor with 0.56μm Unit Pixels Separated by Front Deep-Trench Isolation*, 2022 IEEE International Solid-State Circuits Conference, March 17, 2022.

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Claim 18(b): a peripheral isolation element separating said at least two adjacent light sensitive pixels so as to reduce optical crosstalk therebetween, said isolation element comprising at least two materials having different indices of refraction,

Claim 18(b)

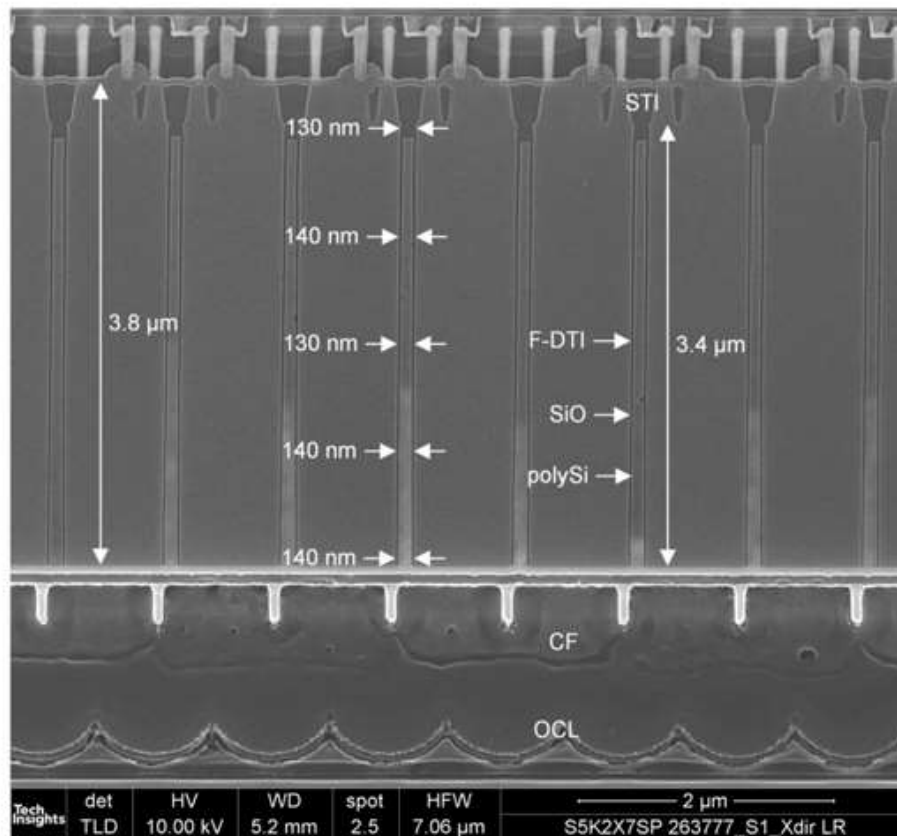


Figure 4-0.90μm pixel ISOCELL Gen 3 F-DTI-SEM

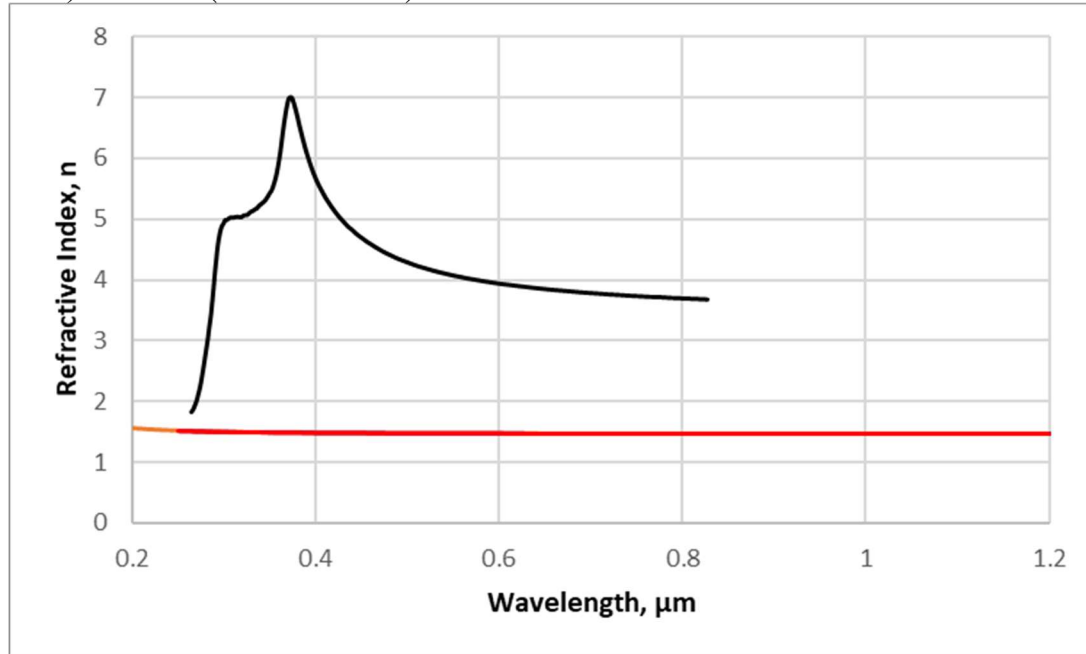
<http://zhuanlan.zhihu.com/p/605284749>

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Claim 18(b): a peripheral isolation element separating said at least two adjacent light sensitive pixels so as to reduce optical crosstalk therebetween, said isolation element comprising at least two materials having different indices of refraction,

Claim 18(b)

Poly-Si (black curve) and SiO₂ (colored curves) have different indices of refraction.



Compiled from RefractiveIndex.info (last visited March 8, 2024) (Polysilicon: <https://refractiveindex.info/?shelf=3d&book=crystals&page=silicon>; Silicon Dioxide: [https://refractiveindex.info/?shelf=main&book=SiO₂&page=Rodriguez-de_Marcos](https://refractiveindex.info/?shelf=main&book=SiO2&page=Rodriguez-de_Marcos), [https://refractiveindex.info/?shelf=main&book=SiO₂&page=Gao](https://refractiveindex.info/?shelf=main&book=SiO2&page=Gao), [https://refractiveindex.info/?shelf=main&book=SiO₂&page=Lemarchand](https://refractiveindex.info/?shelf=main&book=SiO2&page=Lemarchand)) (last visited March 8, 2024).

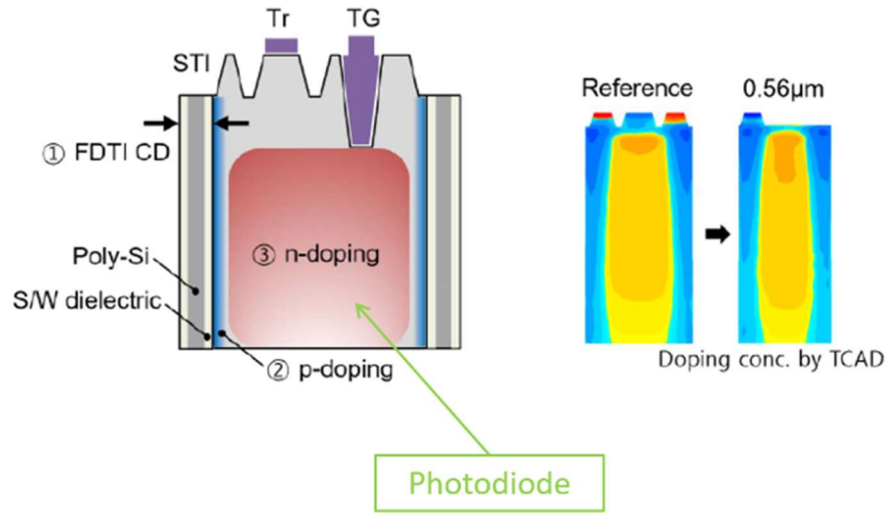
Claim 18(c) at least one doped region disposed on at least one of the light incident surface and the backside surface,

Claim 18(c)

at least one doped region disposed on at least one of the light incident surface and the backside surface,

The ISOCELL HP2 sensor includes at least one doped region disposed on at least one of the light incident surface and the backside surface.

The ISOCELL HP2 sensor's pixels include at least one doped region.



See, e.g., Sungbong Park, et al., *A 64Mpixel CMOS Image Sensor with 0.56µm Unit Pixels Separated by Front Deep-Trench Isolation*, 2022 IEEE International Solid-State Circuits Conference, March 17, 2022.

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Claim 18(d) wherein said peripheral isolation element comprises a first, a second and a third layer, wherein said third layer is disposed between said first and second layers, and wherein each of said first and second layers exhibits an index of refraction less than an index of refraction of said third layer.

| Claim 18(d) | |
|---|--|
| <p>wherein said peripheral isolation element comprises a first, a second and a third layer, wherein said third layer is disposed between said first and second layers, and wherein each of said first and second layers exhibits an index of refraction less than an index of refraction of said third layer.</p> | <p>The ISOCELL HP2 sensor includes a peripheral isolation element wherein said peripheral isolation element comprises a first, a second and a third layer, wherein said third layer is disposed between said first and second layers, and wherein each of said first and second layers exhibits an index of refraction less than an index of refraction of said third layer.</p> <p><i>See Claim 1(e), 18(b), supra.</i></p> |