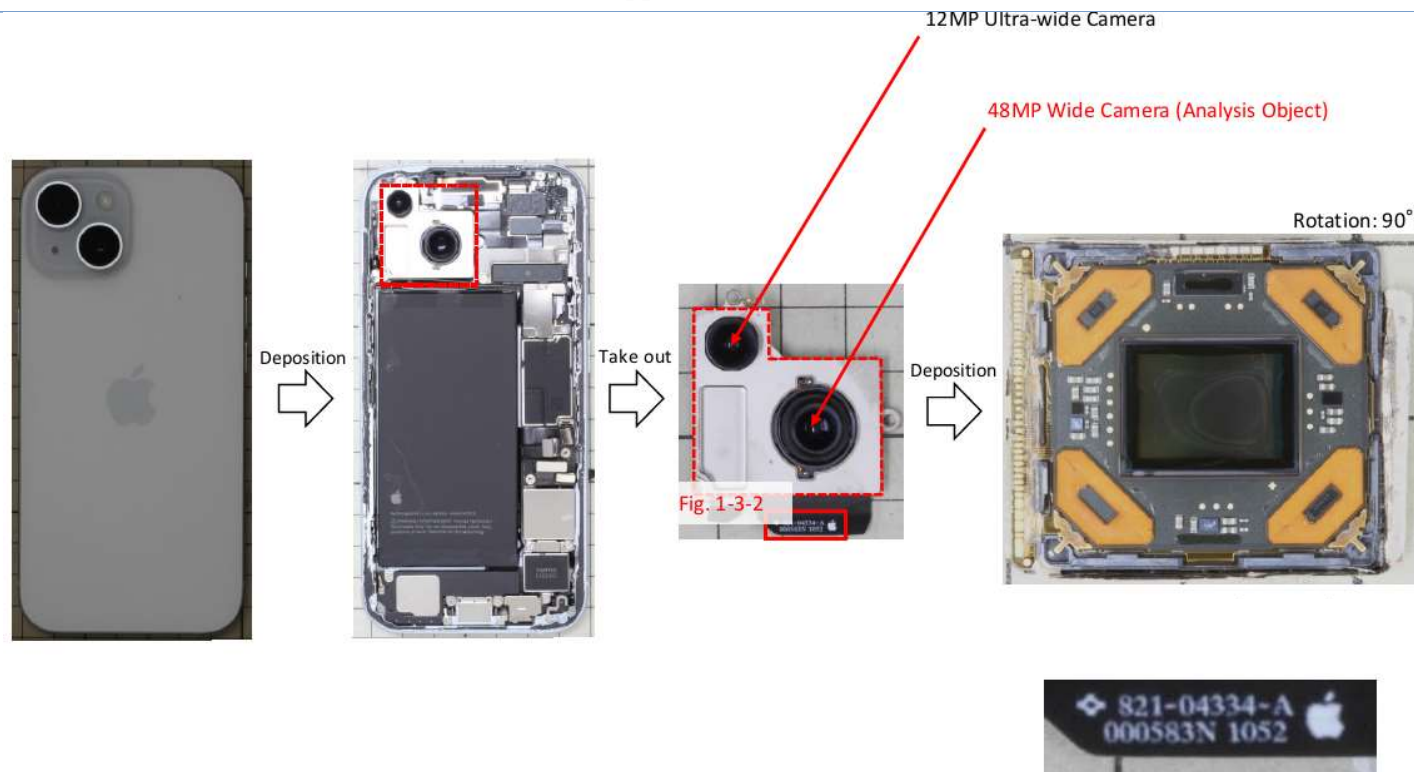


Exhibit F

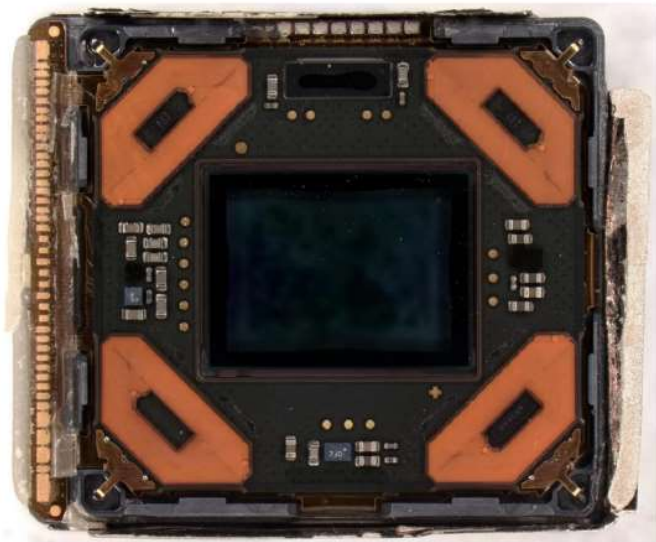
Infringement of U.S. Patent No. 11,721,714

Sony Image Sensor
Apple iPhone 15



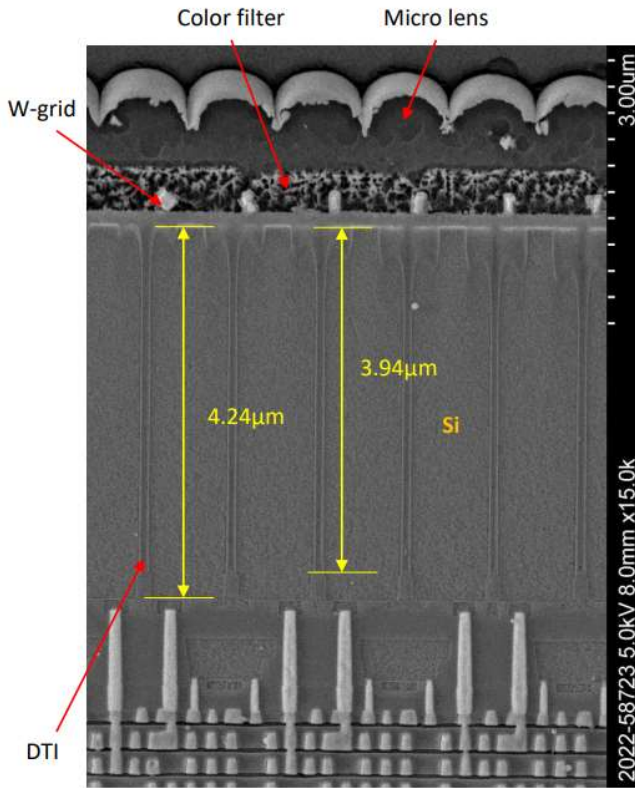
U.S. Patent No. 11,721,714

Claim 1: A light trapping device, comprising:

Claim 1	
<p>A light trapping device, comprising:</p>	<p>Apple devices, such as the iPhone 15 comprise a light trapping device at least because they contain a Sony image sensor.</p> <p>The images below show the Sony image sensor from the Apple iPhone 15.</p> <div data-bbox="520 412 1171 951"></div> <p data-bbox="640 1019 1060 1052">Image sensor appearance (Front)</p> <div data-bbox="1213 412 1875 964"></div> <p data-bbox="1312 1019 1732 1052">Image sensor appearance (Back)</p>

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Claim 1(a): at least one light sensitive pixel having a light incident surface, a backside surface opposite the light incident surface, and a peripheral sidewall disposed into at least a portion of the pixel and extending at least substantially around the pixel periphery;

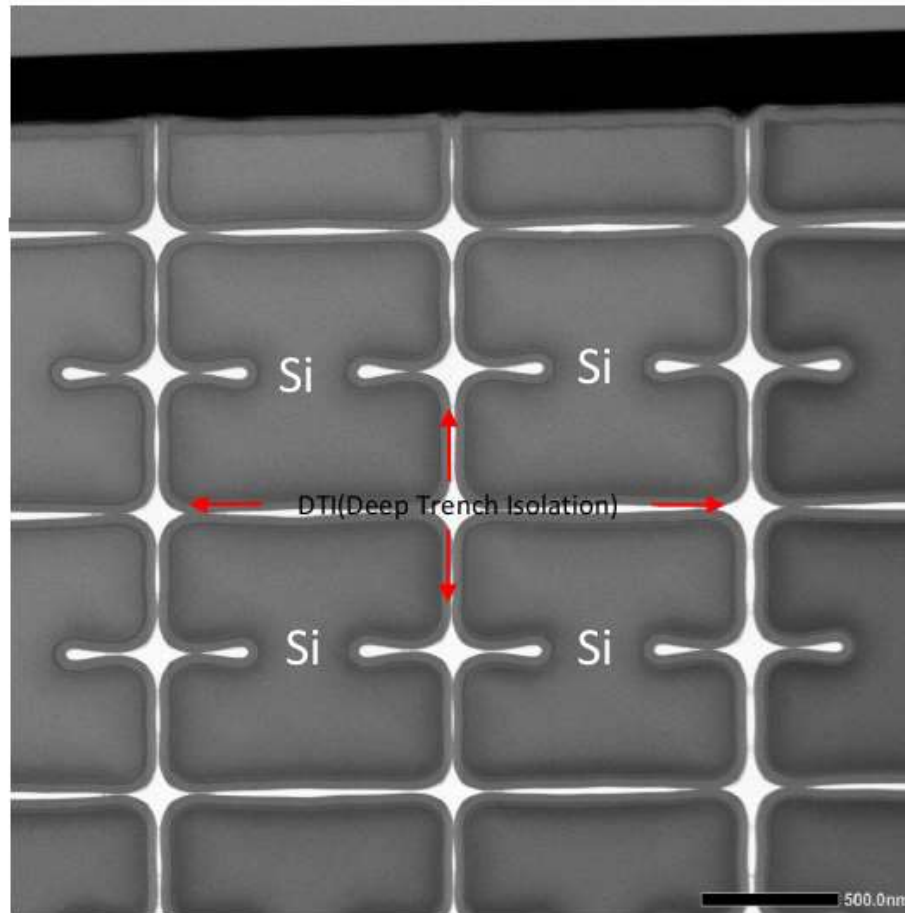
Claim 1(a)	
<p>at least one light sensitive pixel having a light incident surface, a backside surface opposite the light incident surface, and a peripheral sidewall disposed into at least a portion of the pixel and extending at least substantially around the pixel periphery;</p>	<p>The image sensors in Apple's iPhone 15 include at least one light sensitive pixel having a light incident surface, a backside surface opposite the light incident surface, and a peripheral sidewall disposed into at least a portion of the pixel and extending at least substantially around the pixel periphery.</p> <p>The cross section below shows pixels within the Sony image sensor from the iPhone 15. The pixels have a light incident surface (indicated by the "Micro lens[es]"), a backside surface that is opposite the light incident surface, and peripheral sidewalls (indicated by "DTI"), disposed into a portion of the pixel.</p>  <p>SEM cross section</p>

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Claim 1(a): at least one light sensitive pixel having a light incident surface, a backside surface opposite the light incident surface, and a peripheral sidewall disposed into at least a portion of the pixel and extending at least substantially around the pixel periphery;

Claim 1(a)

The top view image of the pixels within the Sony image sensor from the iPhone 15 shows the peripheral sidewall extending at least substantially around the pixel periphery.



BF STEM image

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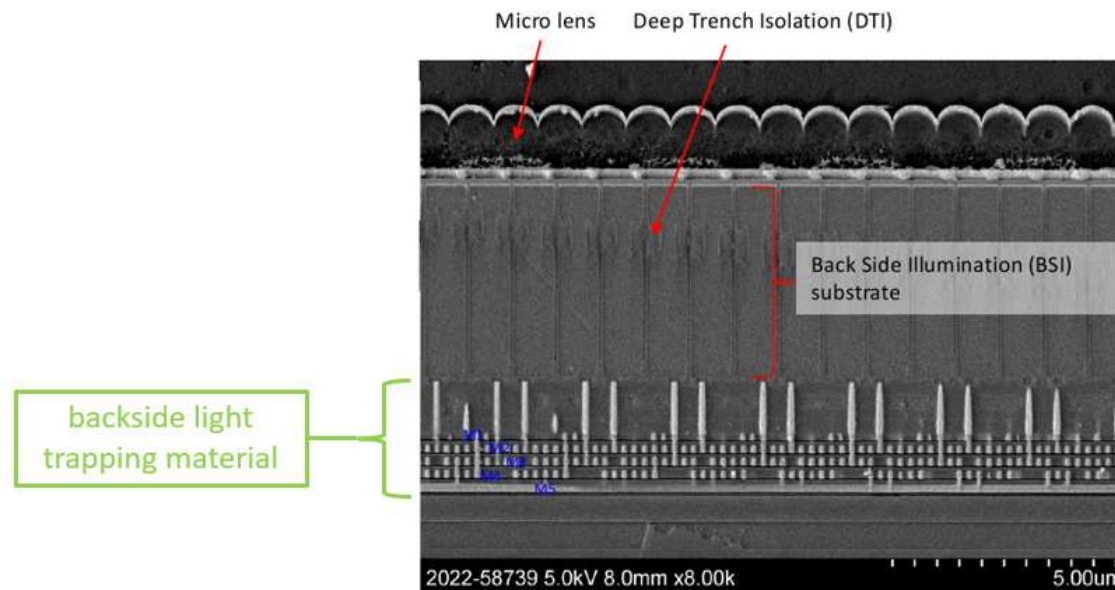
Claim 1(b): a backside light trapping material at least partially covering the backside surface; and

Claim 1(b)

a backside light trapping material at least partially covering the backside surface; and

The image sensors in Apple's iPhone 15 include a backside light trapping material substantially covering the backside surface.

The cross section below shows a backside light trapping material at least partially covering the backside surface.



SEM cross section

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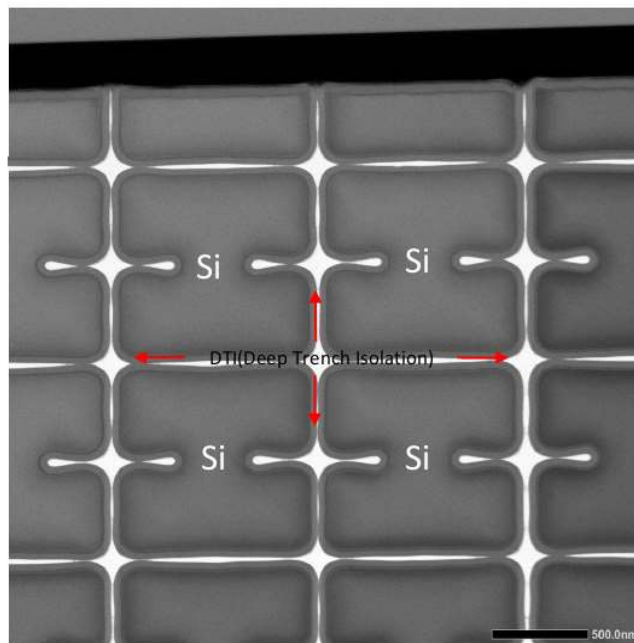
Claim 1(c): a peripheral light trapping material substantially covering the peripheral sidewall;

Claim 1(c)

a peripheral light trapping material substantially covering the peripheral sidewall;

The image sensors in Apple's iPhone 15 include a peripheral light trapping material substantially covering the peripheral sidewall.

Both the top and cross section views of the Sony image sensor below show the light trapping material substantially covering the peripheral sidewalls.

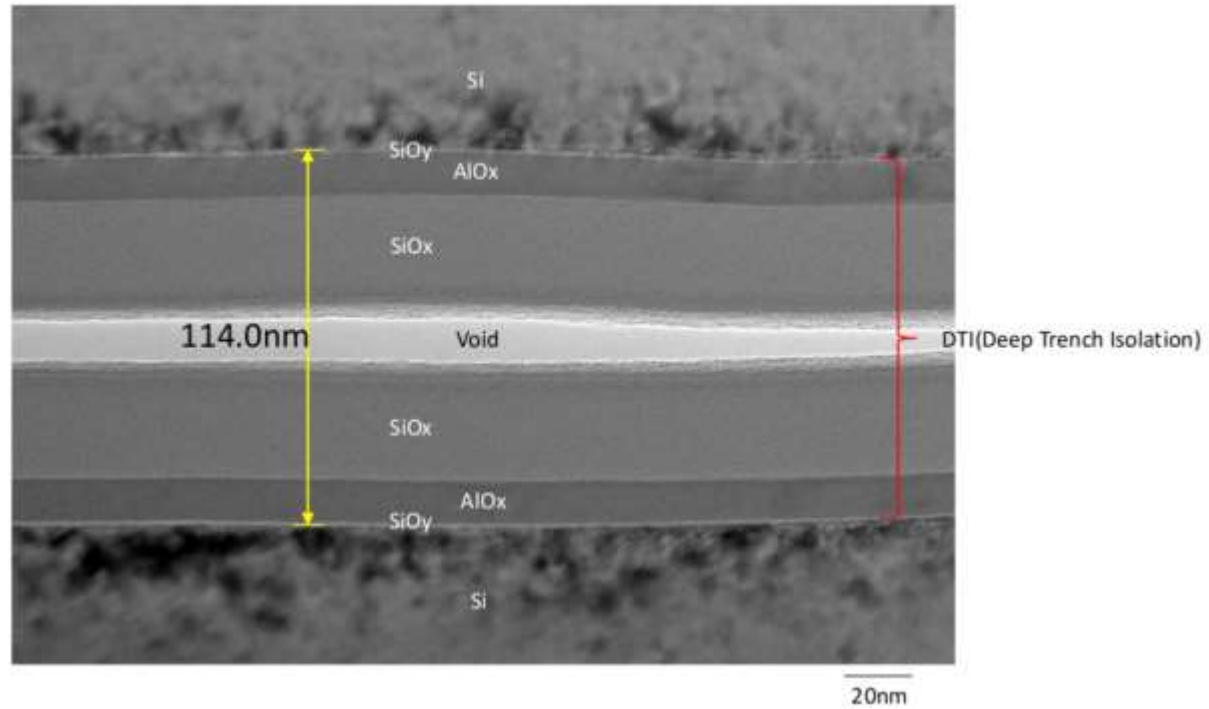


BF STEM image

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Claim 1(c): a peripheral light trapping material substantially covering the peripheral sidewall;

Claim 1(c)



TEM image

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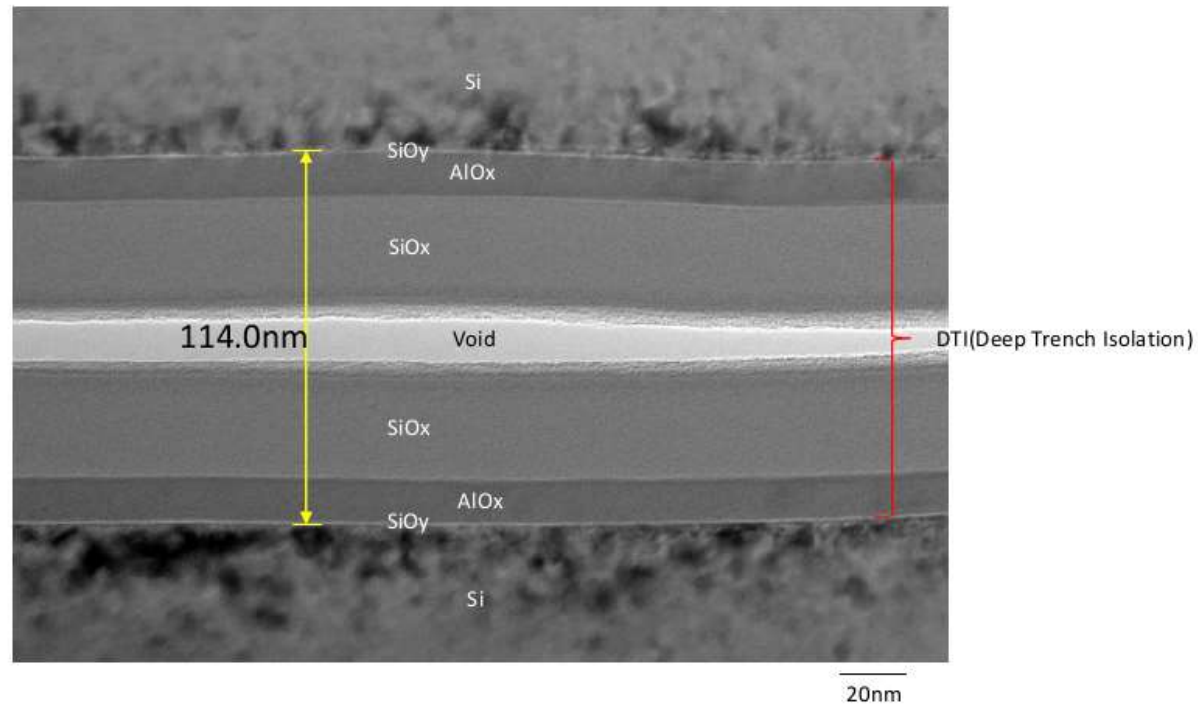
Claim 1(d): wherein light contacting the backside light trapping material or the peripheral light trapping material is reflected back toward the pixel;

Claim 1(d)

wherein light contacting the backside light trapping material or the peripheral light trapping material is reflected back toward the pixel;

The image sensors in Apple's iPhone 15 include a peripheral light trapping material substantially covering the peripheral sidewall, wherein light contacting the backside light trapping material or the peripheral light trapping materials is reflected back toward the pixel.

The image below shows at least the peripheral sidewalls and/or the backside surface containing light trapping material to reflect light back toward the pixel.



TEM image

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Claim 1(d): wherein light contacting the backside light trapping material or the peripheral light trapping material is reflected back toward the pixel;

Claim 1(d)

On information and belief based on the below, light contacting the backside light trapping material or the peripheral light trapping material is reflected back toward the pixel. For example:

The trench between the photodiodes isolates each diode electrically and optically. As well, trench backfill material selection increases well capacity and reduces dark current noise. Samsung typically uses Front Trench Isolation for mobile pixels, while Sony and OmniVision (TSMC) use Back Deep Trench Isolation. Fig. 6 shows trench depth versus

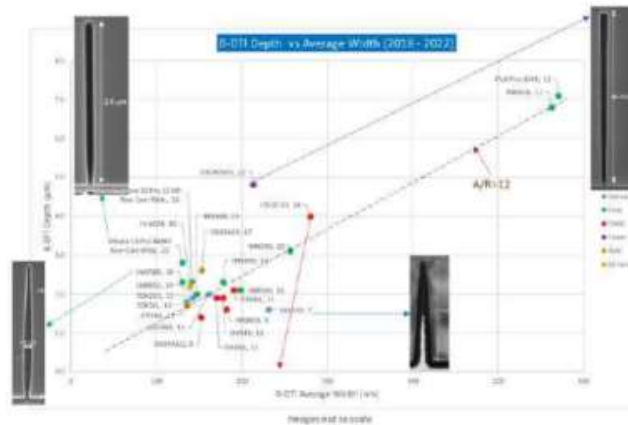


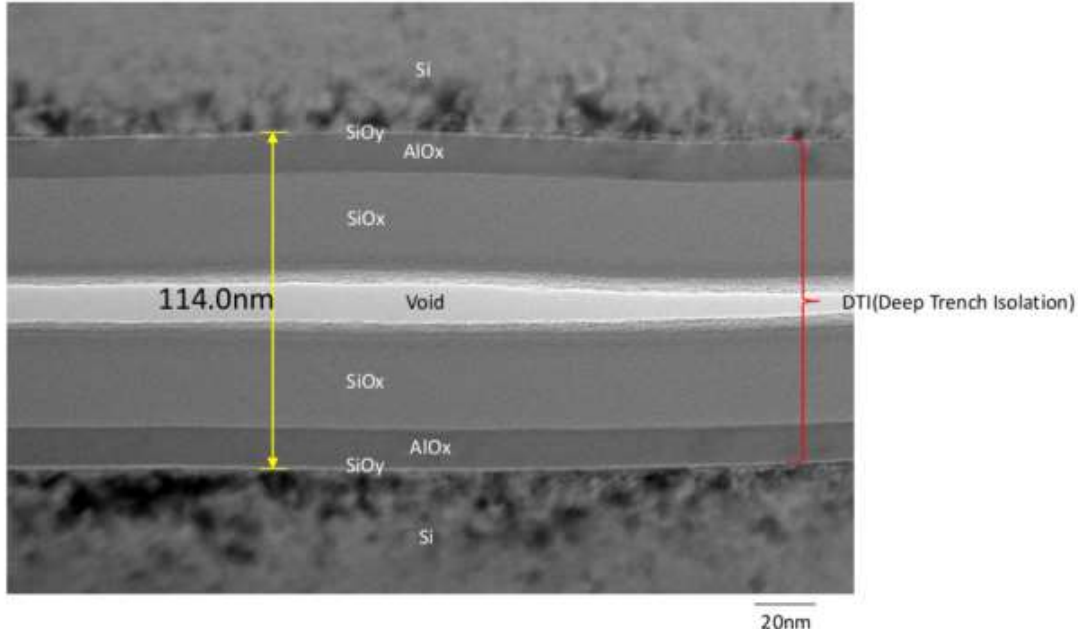
Fig. 6. Back Deep Trench Depth vs Average Width.

average trench width for different applications and foundries. Each data point is labelled by the device and aspect ratio of depth to width; most devices have an aspect ratio of approximately 12.

Scott-Thomas, John, *Trends and Developments in State-of-the-Art CMOS Image Sensors*, International Image Sensor Society, <https://www.imagesensors.org/Past%20Workshops/2023%20Workshop/2023%20Papers/R1.pdf>

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Claim 1(e): wherein at least one of the backside light trapping material or the peripheral light trapping material includes a high refractive index material sandwiched between two low refractive index materials.

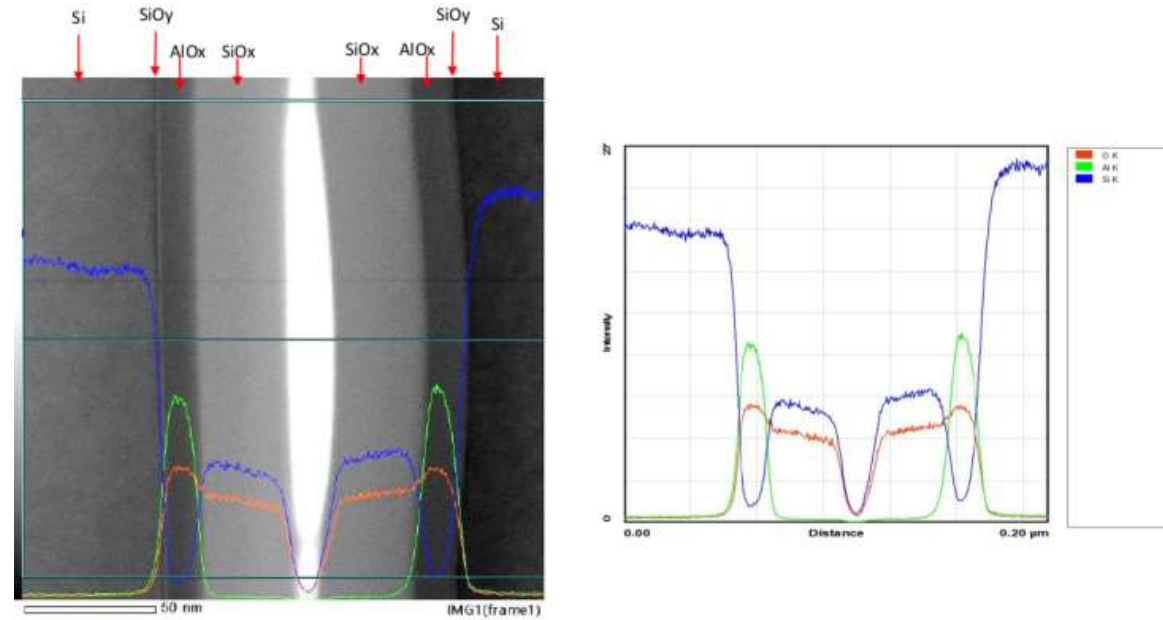
Claim 1(e)	
<p>wherein at least one of the backside light trapping material or the peripheral light trapping material includes a high refractive index material sandwiched between two low refractive index materials.</p>	<p>The image sensors in Apple's iPhone 15 include a peripheral light trapping material substantially covering the peripheral sidewall, wherein at least one of the backside light trapping material or the peripheral light trapping material includes a high refractive index material sandwiched between two low refractive index materials.</p> <p>The image below shows the peripheral light trapping materials substantially covering the peripheral sidewall in the Sony image sensor in the iPhone 15.</p>  <p>TEM image</p>

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Claim 1(e): wherein at least one of the backside light trapping material or the peripheral light trapping material includes a high refractive index material sandwiched between two low refractive index materials.

Claim 1(e)

Energy-dispersive x-ray spectroscopy line analysis further shows the materials that make up the peripheral light trapping material.



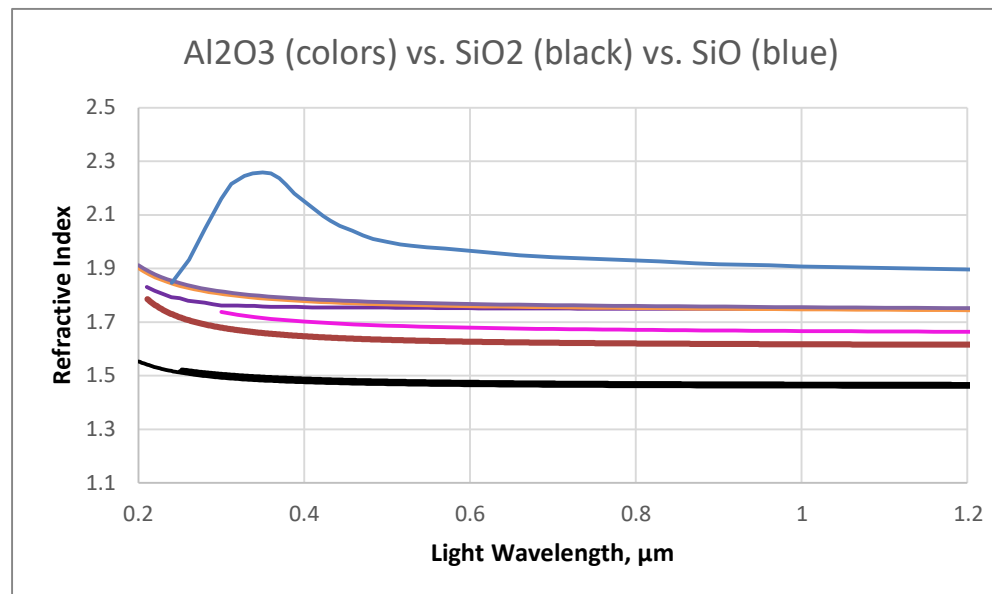
Raw test data (number of atoms detected)

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Claim 1(e): wherein at least one of the backside light trapping material or the peripheral light trapping material includes a high refractive index material sandwiched between two low refractive index materials.

Claim 1(e)

The graph below shows the refractive indices for each light trapping material imaged above. SiO_x and SiO_y are either silicon dioxide (black curves) or silicon monoxide (blue curve). Upon information and belief based on the below, the backside light trapping material or peripheral light trapping material include a high refractive index material sandwiched between two low refractive index materials.



Compiled from RefractiveIndex.info (last visited September 2, 2024) (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>; Silicon Monoxide: <https://refractiveindex.info/?shelf=main&book=SiO&page=Hass>; Aluminum oxide: <https://refractiveindex.info/?shelf=main&book=Al2O3&page=Boidin>, <https://refractiveindex.info/?shelf=main&book=Al2O3&page=Zhukovsky>, <https://refractiveindex.info/?shelf=main&book=Al2O3&page=Querry>), Refractive index of Al₂O₃ (Aluminium sesquioxide, Sapphire, Alumina) - Malitson-o, Refractive index of Al₂O₃ (Aluminium sesquioxide, Sapphire, Alumina) - Malitson-e).