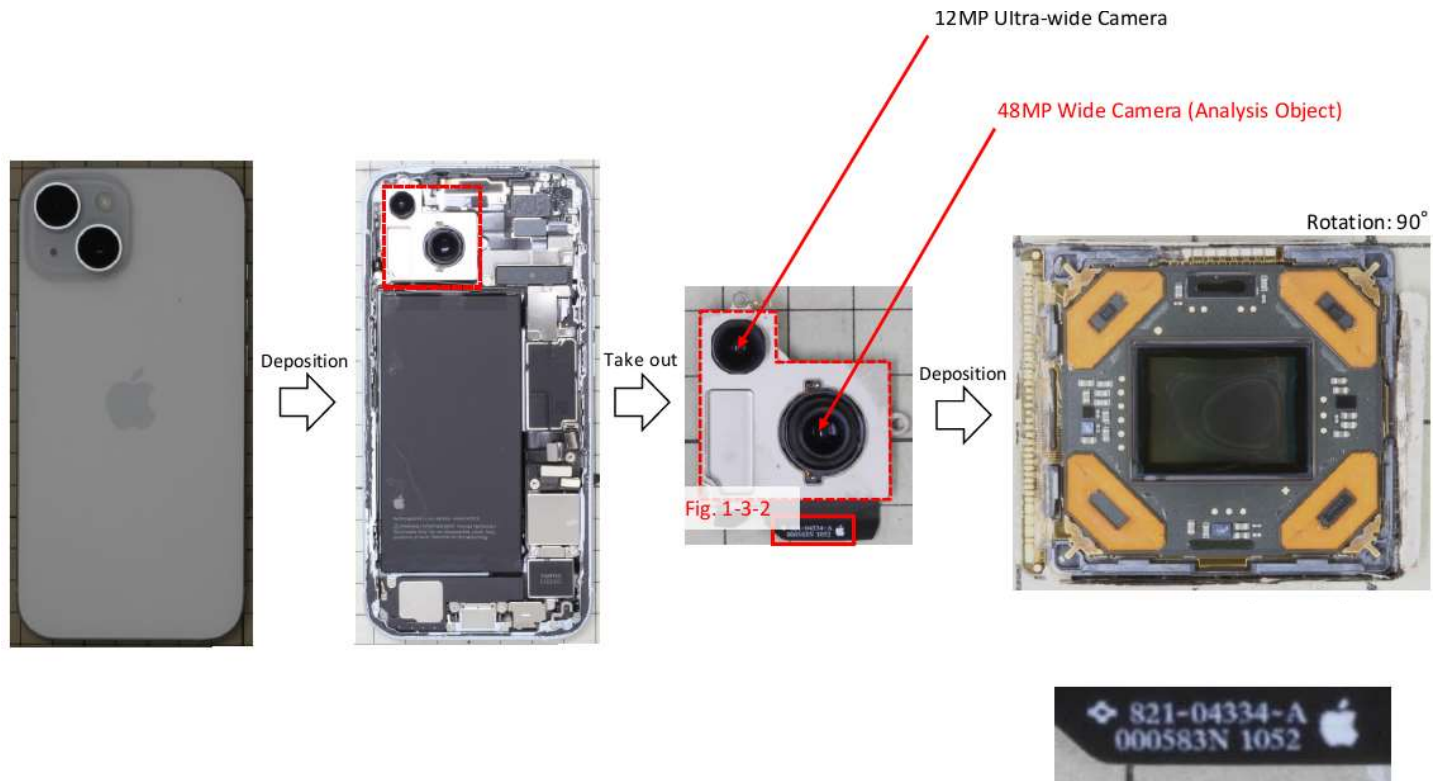


Exhibit D

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

Sony Image Sensor
Apple iPhone 15



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Claim 1: An imager device, comprising:

Claim 1

An imager device, comprising:

Apple devices such as the iPhone 15 comprise an imager device at least because they include a Sony image sensor.

The images below show the Sony image sensor from the Apple iPhone 15.

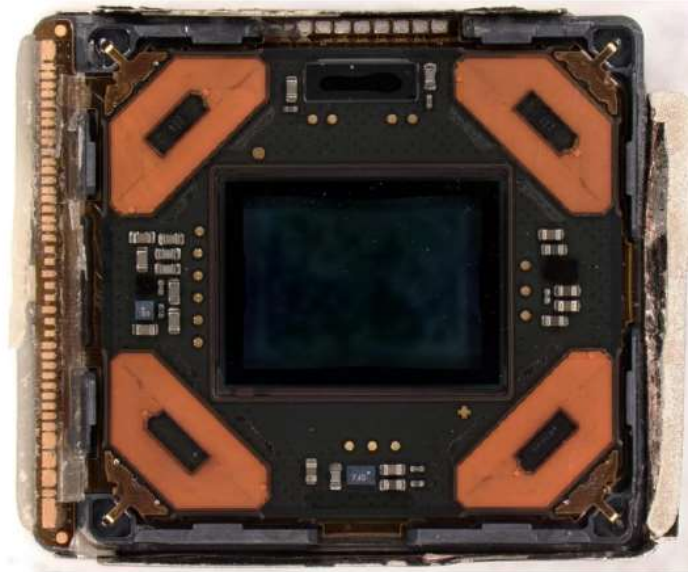


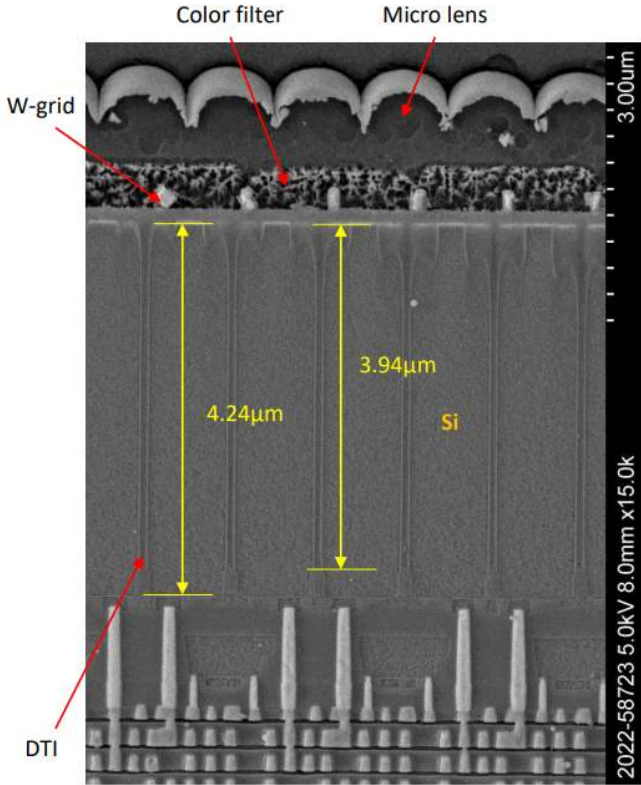
Image sensor appearance (Front)



Image sensor appearance (Back)

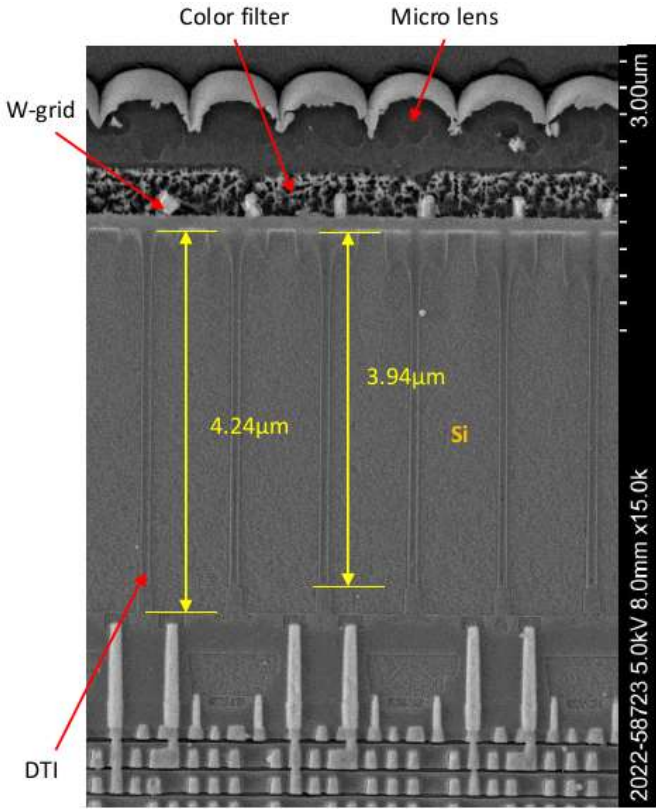
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Claim 1(a): at least two adjacent light sensitive image sensor pixels each having a light incident surface, and a backside surface opposite the light incident surface;

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 image sensors in Apple’s iPhone 15 include 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 cross section below shows image sensor pixels within the Sony image sensor from the iPhone 15. The pixels have a light incident surface (the light incident surface is indicated by the “Micro lens[es]”) and a backside surface opposite the light incident surface.</p>  <p style="text-align: center;">SEM cross section</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 image sensors in Apple’s iPhone 15 include a peripheral isolation element at least partially separating said two adjacent light sensitive pixels.</p> <p>The cross section below shows peripheral isolation elements (indicated by “DTI”) at least partially separating two adjacent pixels within the image sensor.</p>  <p style="text-align: center;">SEM cross section</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)

Similarly, the top view image below shows the peripheral isolation element at least partially separating two adjacent light sensitive pixels.

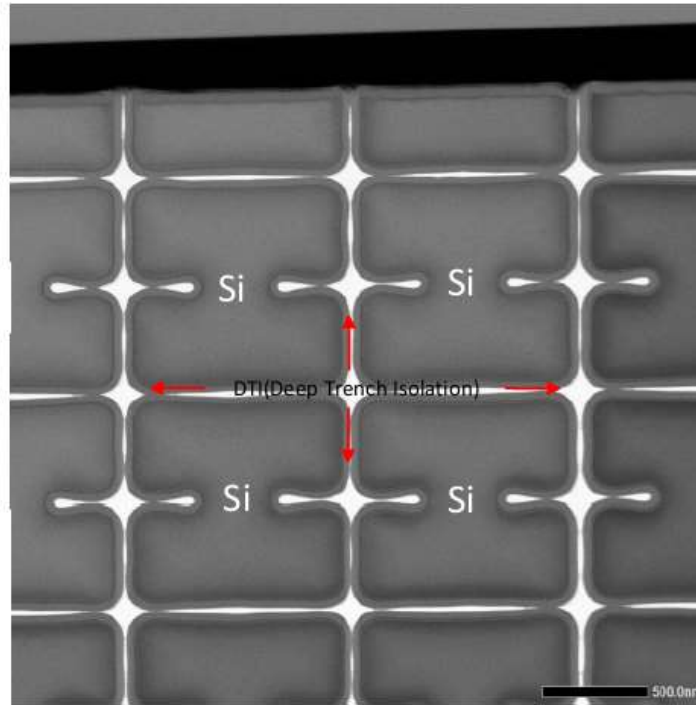


Fig. 4-2 BF STEM image

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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>Each of said pixels in the image sensors in Apple’s iPhone 15 have at least one doped region disposed on at least one of the light incident surface and the backside surface.</p> <p>Sony’s image sensors are CMOS image sensors, which include pixels having at least one doped region disposed on at least one of the light incident surface and the backside surface.</p> <div> <p>The image is a scanning electron microscope (SEM) cross-section of a CMOS image sensor (CIS) and an image signal processor (ISP). The top layer is labeled 'Si' (silicon). Below it is the CIS, followed by a 'Joint layer' which is highlighted with a red double-headed arrow. Below the joint layer is the ISP, also labeled 'Si'. The bottom layer is another 'Si' layer. The image includes a scale bar at the bottom right indicating 10.0um. The text '2022-58721 5.0kV 8.0mm x4.00k' is visible at the bottom left of the image.</p> </div> <p>SEM cross section</p>

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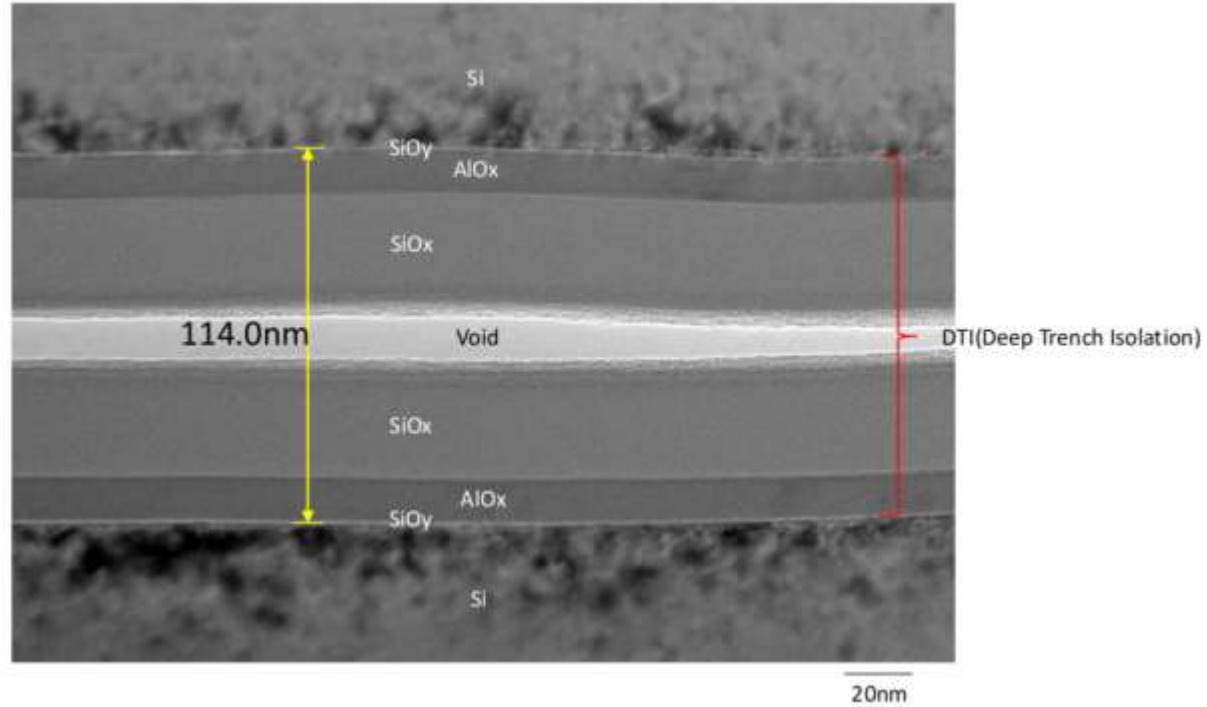
Claim 1(d): wherein the peripheral isolation element comprises at least two materials having different indices of refraction,

Claim 1(d)

wherein the peripheral isolation element comprises at least two materials having different indices of refraction,

The image sensors in Apple’s iPhone 15 include a peripheral isolation element wherein the peripheral isolation element comprises at least two materials having different indices of refraction.

The image below shows the peripheral isolation element with at least two materials.



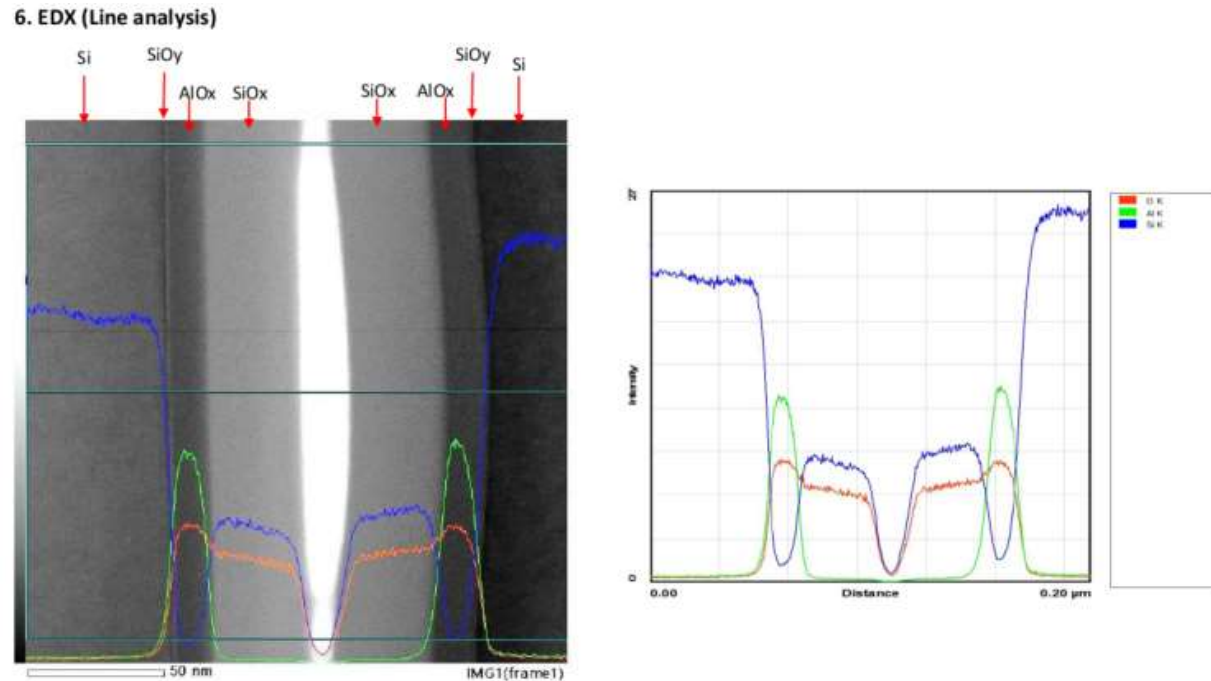
TEM image

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

Claim 1(d)

The energy-dispersive x-ray spectroscopy below shows the materials that the peripheral isolation element is comprised of.



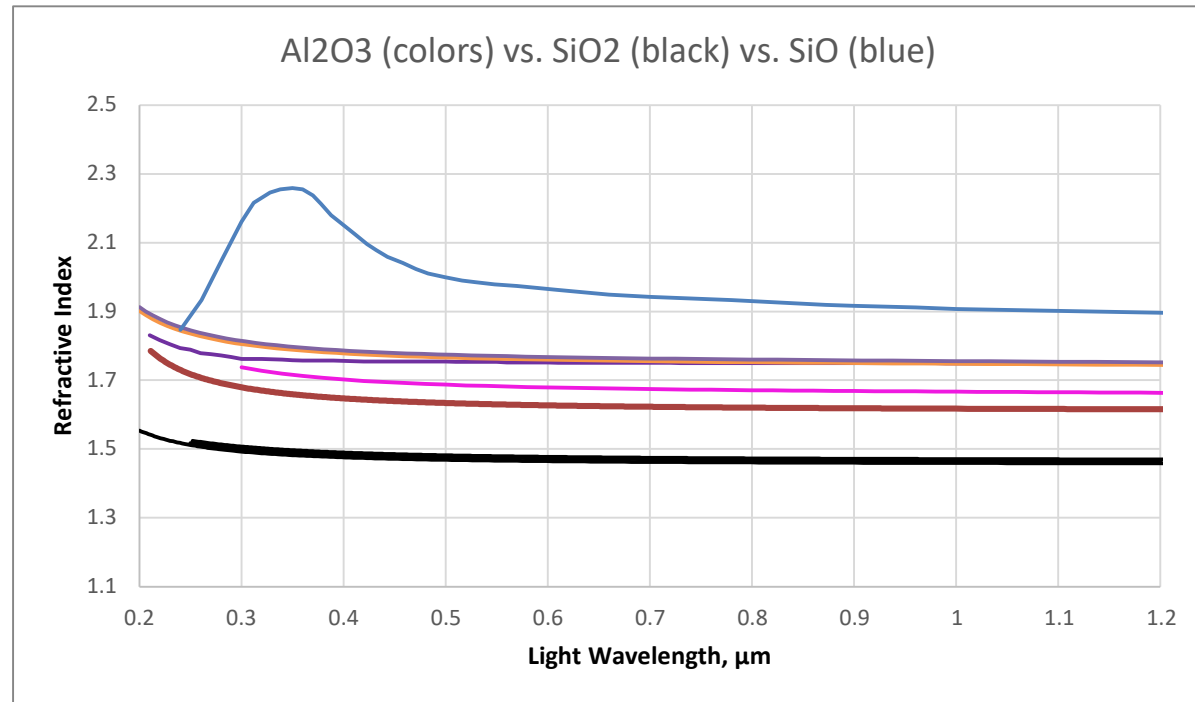
Raw test data (number of atoms detected)

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

Claim 1(d)

As shown above, for example, AlOx is disposed between SiOx and SiOy. Upon information and belief, the index of refraction for silicon dioxide (black curves), silicon monoxide (blue curve), and aluminum oxide (colored curves) are different.



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=Query>), Refractive index of Al₂O₃ (Aluminium sesquioxide, Sapphire, Alumina) - Malitson-o, Refractive index of Al₂O₃ (Aluminium sesquioxide, Sapphire, Alumina) - Malitson-e).

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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.

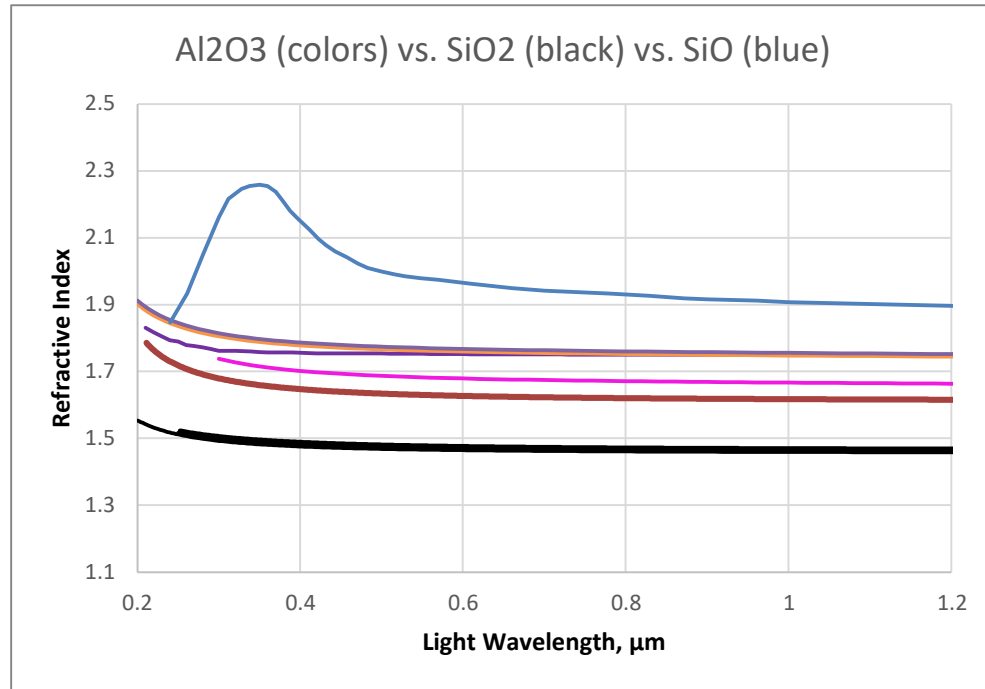
Claim 1(e)	
<p>wherein said peripheral isolation element comprises a first, a second and a third layer, wherein said third layer is disposed between said first and second layers, and wherein each of said first and second layer exhibits an index of refraction less than an index of refraction of said third layer.</p>	<p>The image sensors in Apple’s iPhone 15 include 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>The energy-dispersive x-ray spectroscopy shows the materials that the peripheral isolation element is comprised of.</p> <div> <p>6. EDX (Line analysis)</p> <p>Labels: Si, SiO_y, AlO_x, SiO_x, SiO_x, AlO_x, SiO_y, Si</p> <p>Scale: 50 nm</p> <p>Graph axes: Intensity vs. Distance (0.00 to 0.20 μm)</p> <p>Legend: Si (red), Al (green), SiO_x (blue)</p> </div> <p>Raw test data (number of atoms detected)</p>

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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)

Upon information and belief as shown below, for example, the index of refraction for the materials used have different indices of refraction.



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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>SiO_x/SiO_y is either silicon dioxide or silicon monoxide. Upon information and belief based on the above, there is 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>

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Claim 18: An imager device, comprising:

Claim 18	
An imager device, comprising:	<p>The image sensors in Apple's iPhone 15 comprise an imager device at least because it includes a Sony image sensor.</p> <p><i>See supra</i>, Claim 1.</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)	
<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 image sensors in Apple’s iPhone 15 include 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 supra</i>, Claim 1(a).</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)	
<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 image sensors in Apple’s iPhone 15 include 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><i>See supra</i>, Claims 1(b) & 1(d).</p>

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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 image sensors in Apple's iPhone include at least one doped region disposed on at least one of the light incident surface and the backside surface. <i>See supra</i> , Claim 1(c).

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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 image sensors in Apple’s iPhone 15 include 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 supra, Claims 1(e) & 18(b).</i></p>