

Patent Number: US 9,502,612

Patent Title: Light emitting diode package with enhanced heat conduction

Priority Date: September 20, 2009

Filing Date: October 07, 2013

Publication Date: November 22, 2016

Claim 1: A light emitting device, comprising:

a substrate having opposing first and second substrate surfaces;

a semiconductor LED including doped and intrinsic regions thereof, said semiconductor LED having opposing first and second LED surfaces, said first LED surface disposed on the first substrate surface;

a thermally conductive layer disposed on the second LED surface of the semiconductor LED;

a carrier wafer disposed on the thermally conductive layer;

at least one optically reflective surface disposed between said carrier wafer and said semiconductor LED; and

a substantially optically transmissive layer disposed proximal to the second substrate surface,

wherein the carrier wafer and the thermally conductive layer define a relief to expose at least a portion of the second LED surface.

Accused Product: Samsung Galaxy S6

References Used:

Galaxy S6 Teardown

Samsung Flip Chip Technology

Reference Links:

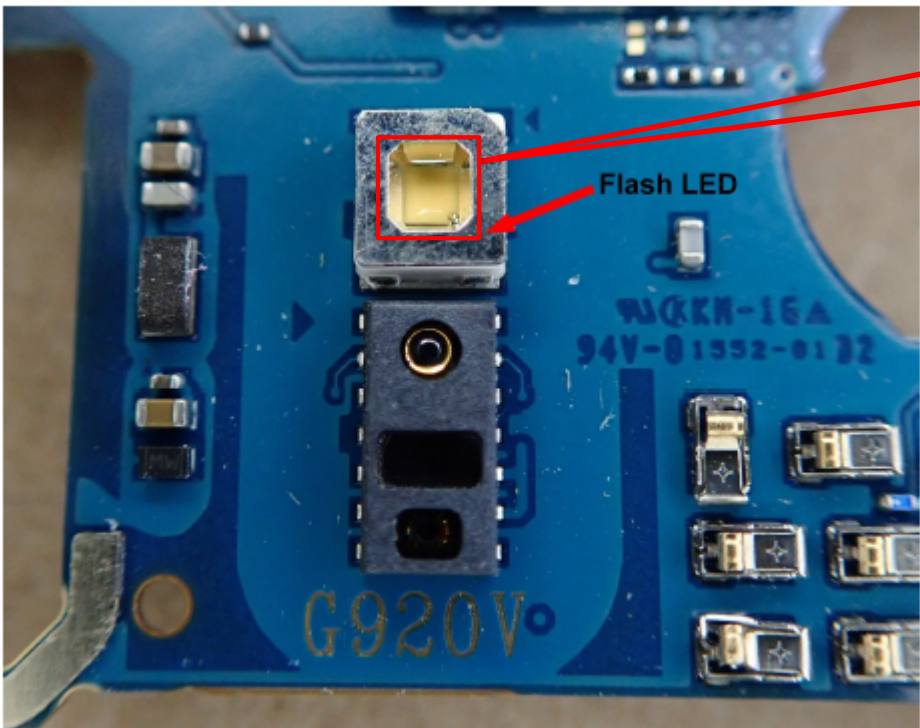
<https://www.samsung.com/led/insights/insights-detail-2/>

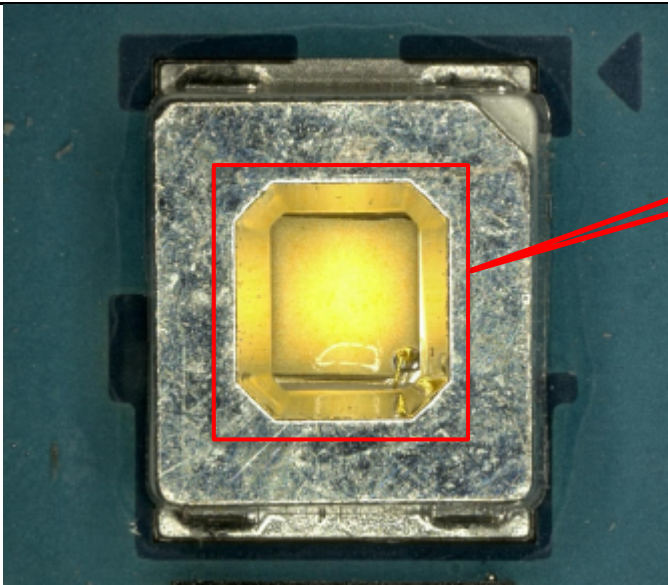
U.S. Patent No. 9, 502, 612 v. Samsung Galaxy S6

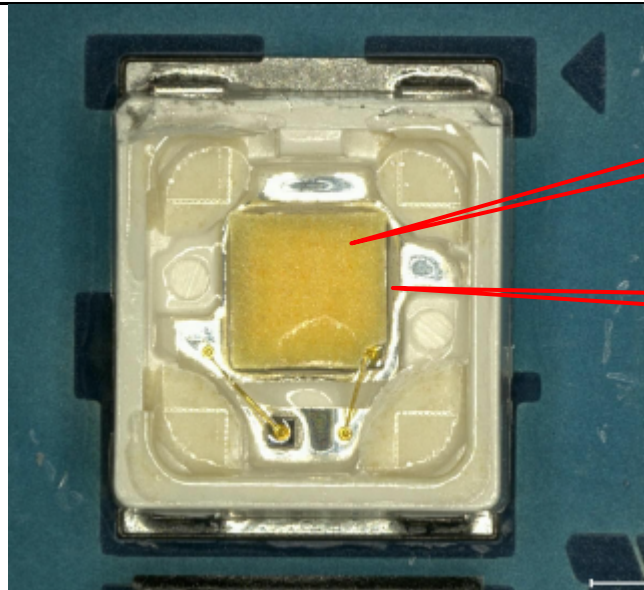
Plaintiff accuses the provision, use, and operation of Samsung (“Defendant” or “Samsung”) of certain “Samsung LEDs” of directly infringing U.S. Patent No. 9,502,612 (the “612 Patent”). The term “Accused System and Method” means Samsung Galaxy S6 and all substantially similar products.

Plaintiff further accuses Defendant of indirectly infringing the ’612 Patent through providing, authorizing and instructing regarding the Accused System and Method to others, including its customers. Installing or activating the Accused System and Method and the operation thereof directly infringe the asserted claims. Defendant intends to cause infringement by its customers and users. Defendant instructs users to use the Accused System and Method in an infringing manner. Defendant enacts contractual protections requiring that the Accused System and Method be used in a manner intended by Defendant. Defendant further instructs users to configure and operate the Accused System and Method in an infringing manner. Defendant also provides support services for the Accused System and Method, including providing instructions, guides, online materials and technical support.

The asserted claims include elements that are implemented, at least in part, by proprietary electronics and manufacturing in the Accused System and Method. The precise manufacturing techniques, designs, chemical composition, processes, deposition, and etching used in them are held secret, at least in part, and are not publicly available in their entirety. An analysis of Defendant’s manufacturing documentation may be necessary to fully and accurately describe all infringing features and functionality of the Accused System and Method and, accordingly, Plaintiff reserves the right to supplement these contentions once such information is made available to Plaintiff. Furthermore, Plaintiff reserves the right to revise these contentions, including as discovery in the case progresses, in view of the Court's final claim construction in this action and in connection with the provision of its expert reports.

| Claims | Exemplary Evidence of Infringement |
|---|--|
| <p>1[Pre] A light emitting device, comprising:</p> | <p>This preamble, if construed as a limitation, is present in the Accused System and Method.</p> <p>The Accused System and Method comprise a light emitting device</p> <p>For Example, the Samsung Galaxy S6 has an LED that serves as the “flash” for the camera, as well as a light source for various applications such as torch.</p> <div data-bbox="464 483 1755 1206">  <p>Samsung Galaxy S6 Flash LED</p> <p>Flash LED</p> </div> <p>Source: Galaxy S6 Teardown</p> |

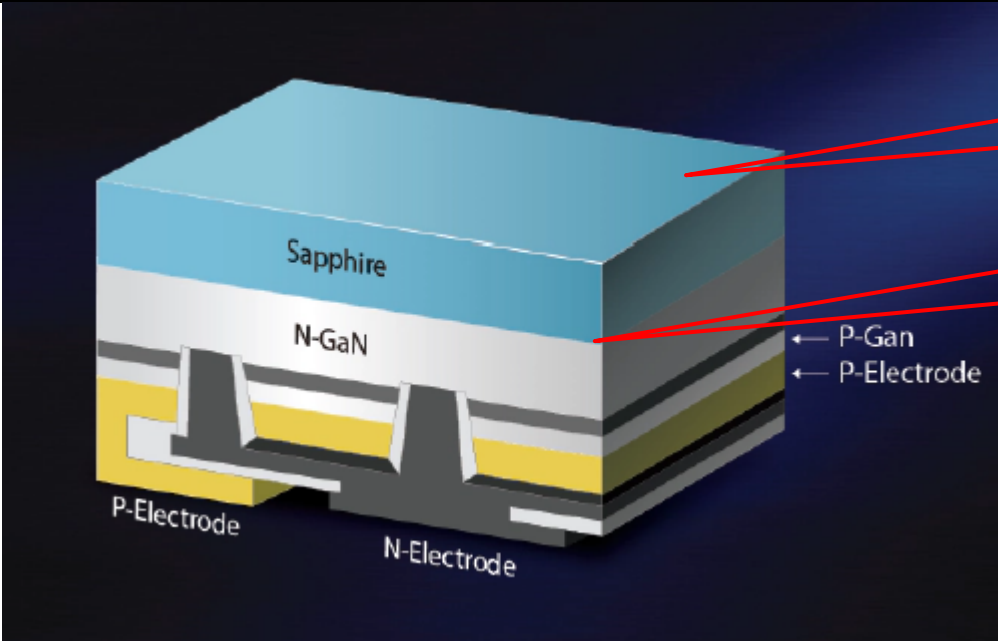
| | |
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| |  <p data-bbox="1209 191 1545 305">Light Emitting Device</p> <p data-bbox="457 776 840 808">Source: Galaxy S6 Teardown</p> |
| <p data-bbox="149 865 432 1008">1[A] a substrate having opposing first and second substrate surfaces;</p> | <p data-bbox="457 865 1827 898">The Accused System and Method comprise a substrate having opposing first and second substrate surfaces.</p> <p data-bbox="457 938 1944 1008">For Example, the Samsung Galaxy S6 including flash LED and LED comprise of the yellowish layer (i.e., substrate) containing phosphor having opposing first and second surfaces.</p> |



Second substrate surface

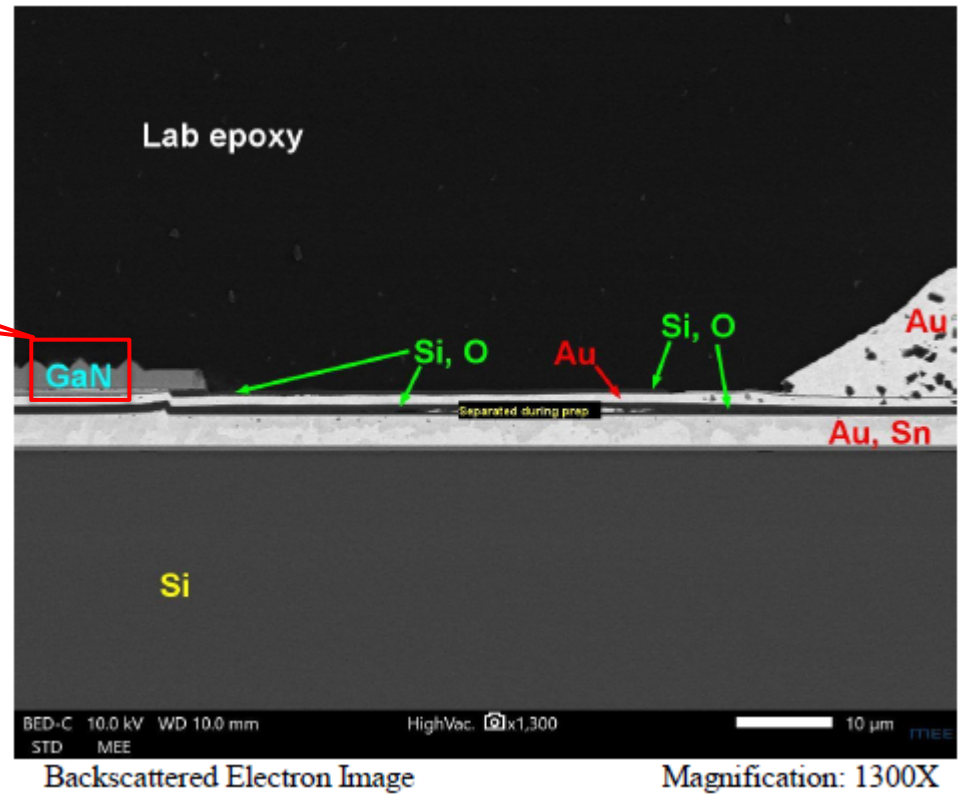
First substrate surface

Source: Galaxy S6 Teardown

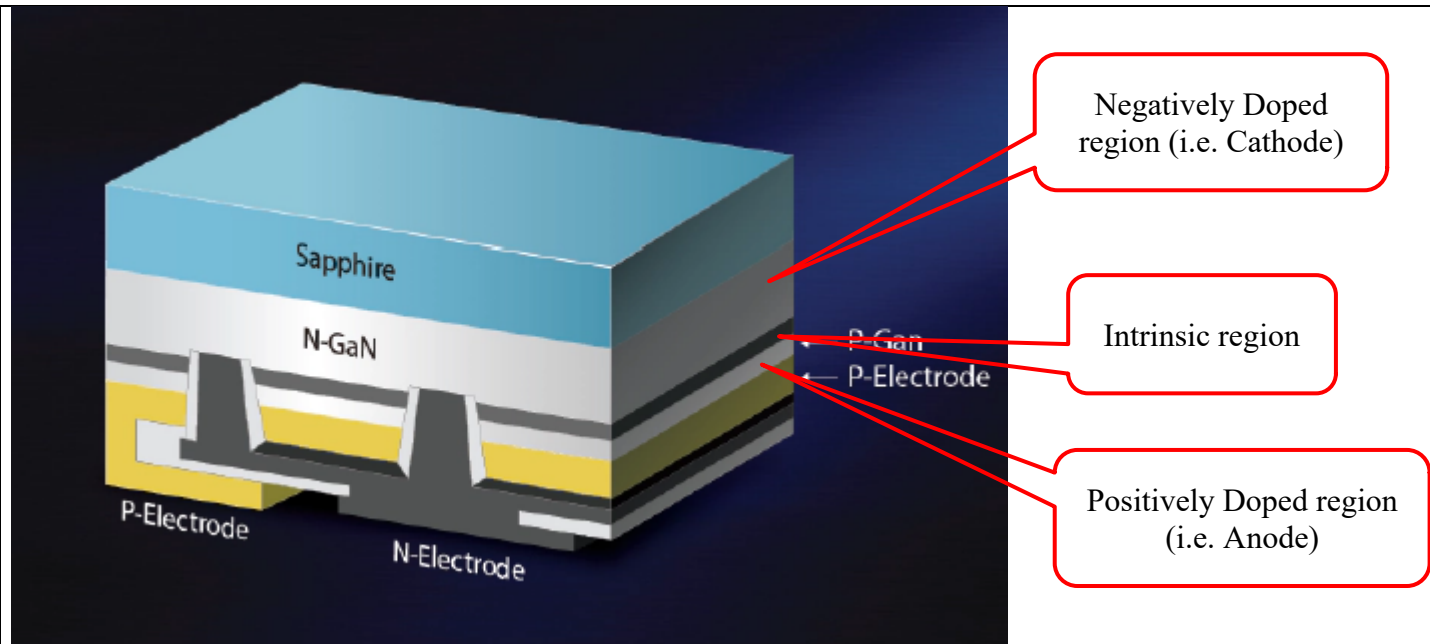
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| |  <p>Source: Samsung Flip Chip Technology, Page 1 https://www.samsung.com/led/insights/insights-detail-2/</p> |
| <p>1[B]a semiconductor LED including doped and intrinsic regions thereof, said semiconductor LED having opposing first and second LED surfaces, said first LED surface disposed on the first substrate surface;</p> | <p>The Accused System and Method comprise a semiconductor LED including doped and intrinsic regions thereof, said semiconductor LED having opposing first and second LED surfaces, said first LED surface disposed on the first substrate surface.</p> <p>For Example, Samsung Galaxy S6 comprise semiconductor LED is a doped GaN LED. The LED has a positively doped region, a negatively doped region, and an intrinsic region between the positively doped region and the negatively doped region. The intrinsic region lies between the two doped regions. The LED GaN layer includes a first surface disposed on the first side of the substrate surface.</p> <p>The negatively doped region of GaN corresponds to the cathode while the positively doped region of GaN corresponds to the anode of the LED. Such doping is required for a LED to function. The intrinsic region lies</p> |

between the two doped regions.

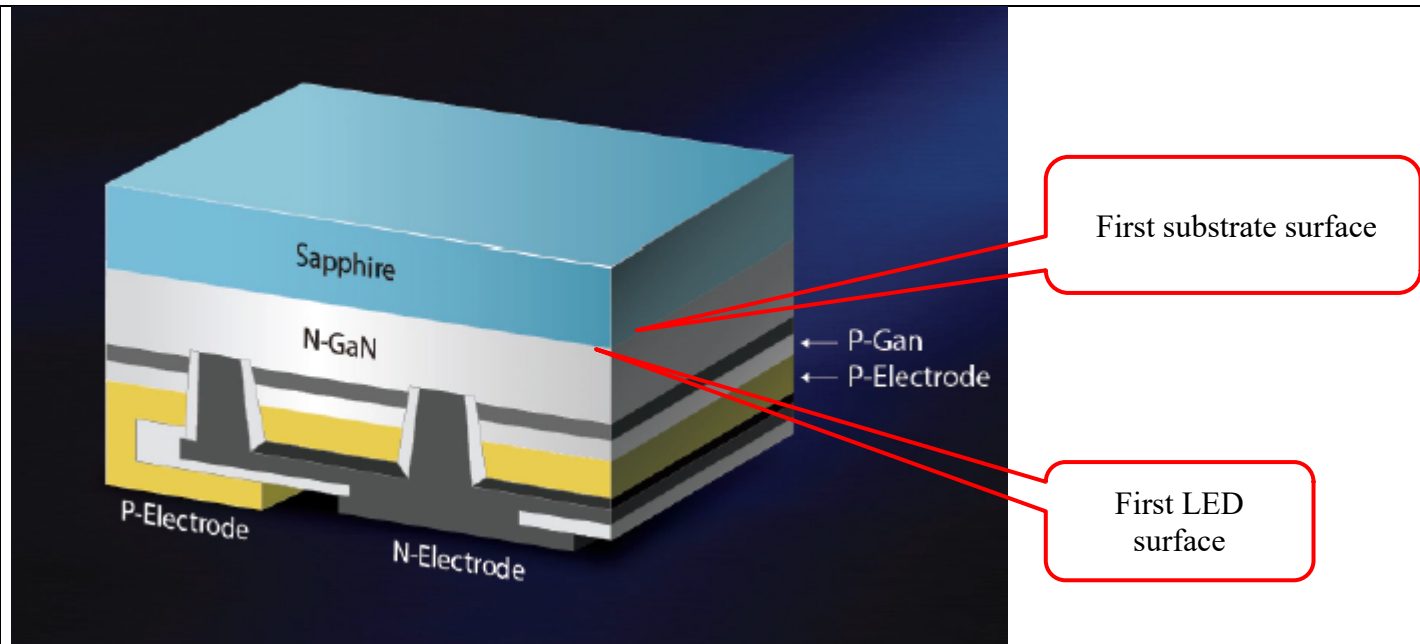
Flash LED includes doped GaN LED.



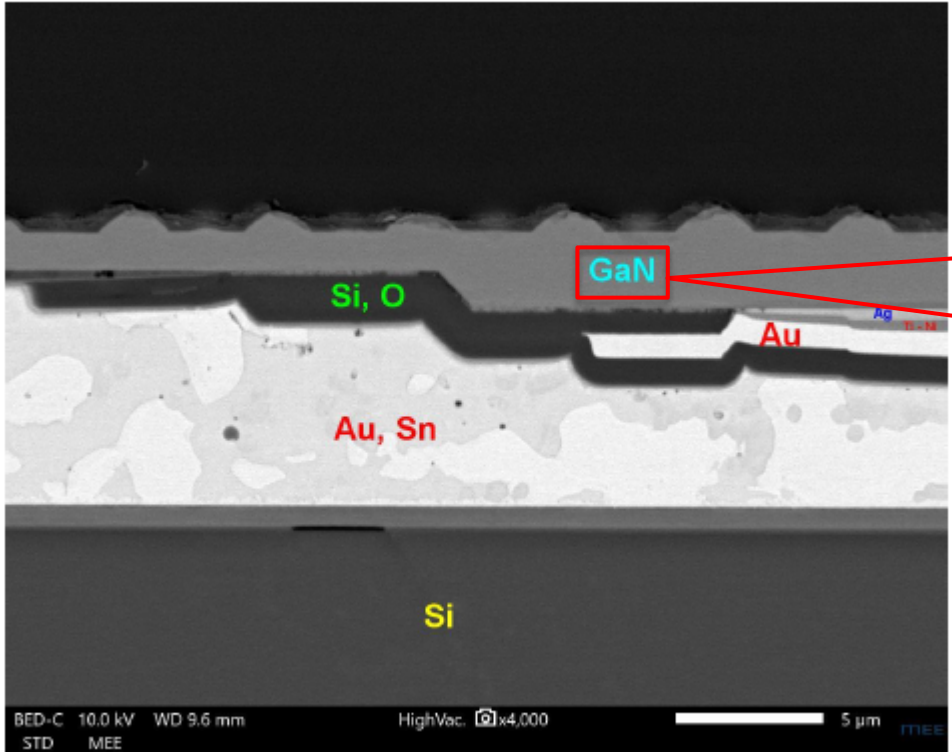
Source: Galaxy S6 Teardown

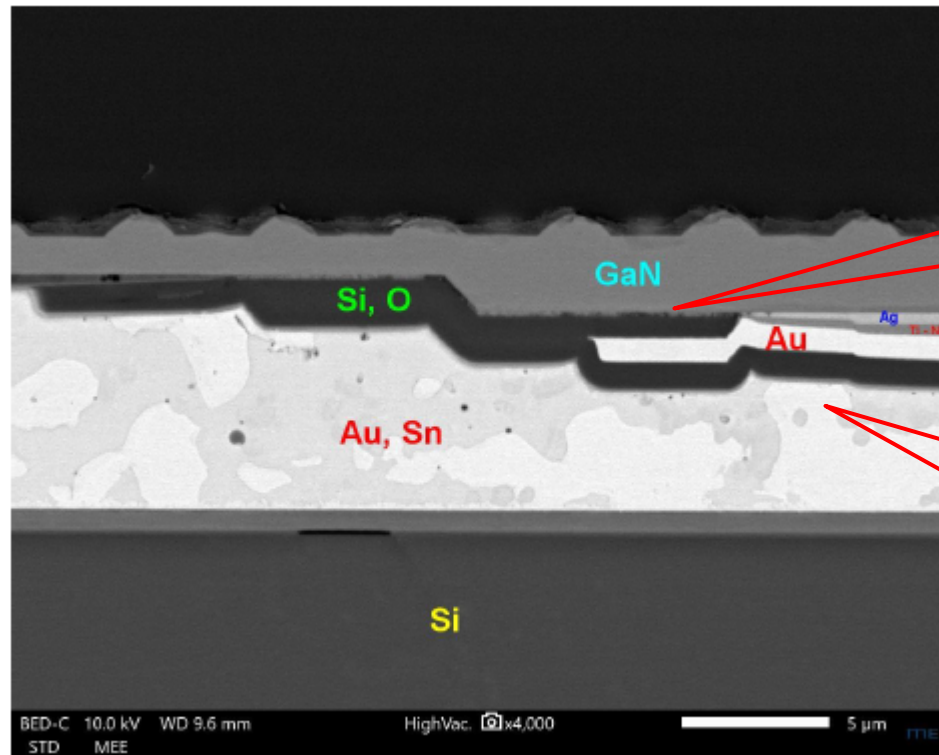


Source: Samsung Flip Chip Technology, Page 1
<https://www.samsung.com/led/insights/insights-detail-2/>



Source: Samsung Flip Chip Technology, Page 1
<https://www.samsung.com/led/insights/insights-detail-2/>

| | |
|--|---|
| |  <p data-bbox="1486 329 1892 505">A negatively doped region of GaN, a positively doped region of GaN and an intrinsic region lies between the two doped regions.</p> <p data-bbox="499 922 873 951">Backscattered Electron Image</p> <p data-bbox="1119 922 1396 951">Magnification: 4000X</p> <p data-bbox="453 1015 840 1044">Source: Galaxy S6 Teardown</p> |
| <p data-bbox="144 1060 428 1271">1[C] a thermally conductive layer disposed on the second LED surface of the semiconductor LED;</p> | <p data-bbox="453 1060 1948 1125">The Accused System and Method comprise a thermally conductive layer disposed on the second LED surface of the semiconductor LED.</p> <p data-bbox="453 1179 1948 1243">For Example, Samsung Galaxy S6 comprises thermally conductive layer disposed on the other (i.e., second LED) surface of the semiconductor LED.</p> |



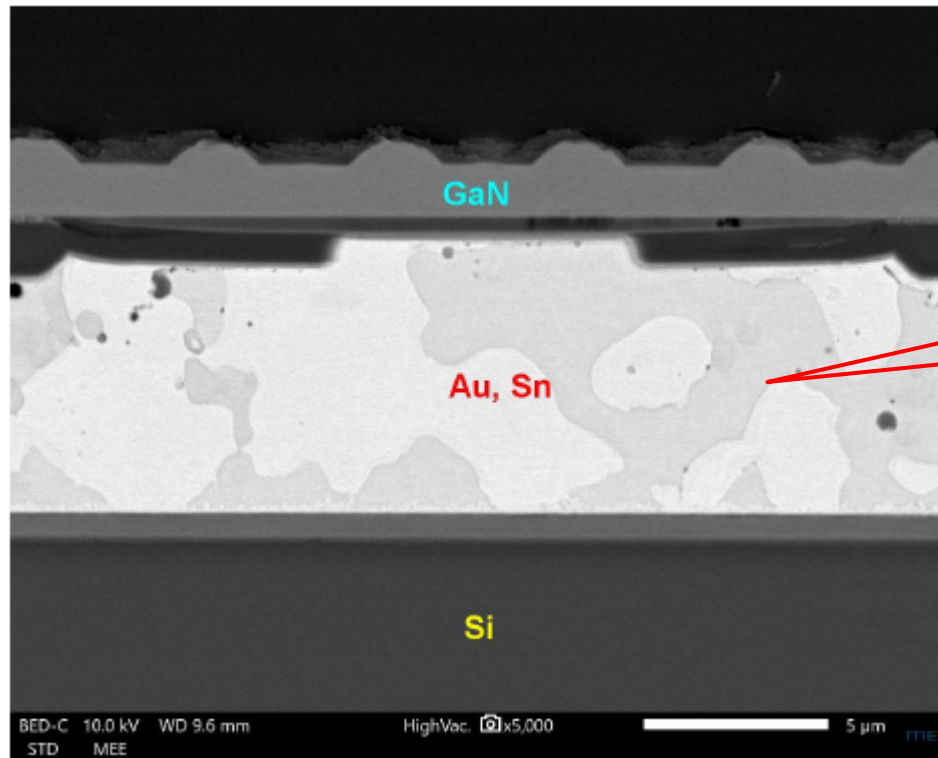
Opposite (i.e., second) surface of the LED

Thermally conductive layer on the opposite (i.e., second) surface of the LED

Backscattered Electron Image

Magnification: 4000X

Source: Galaxy S6 Teardown

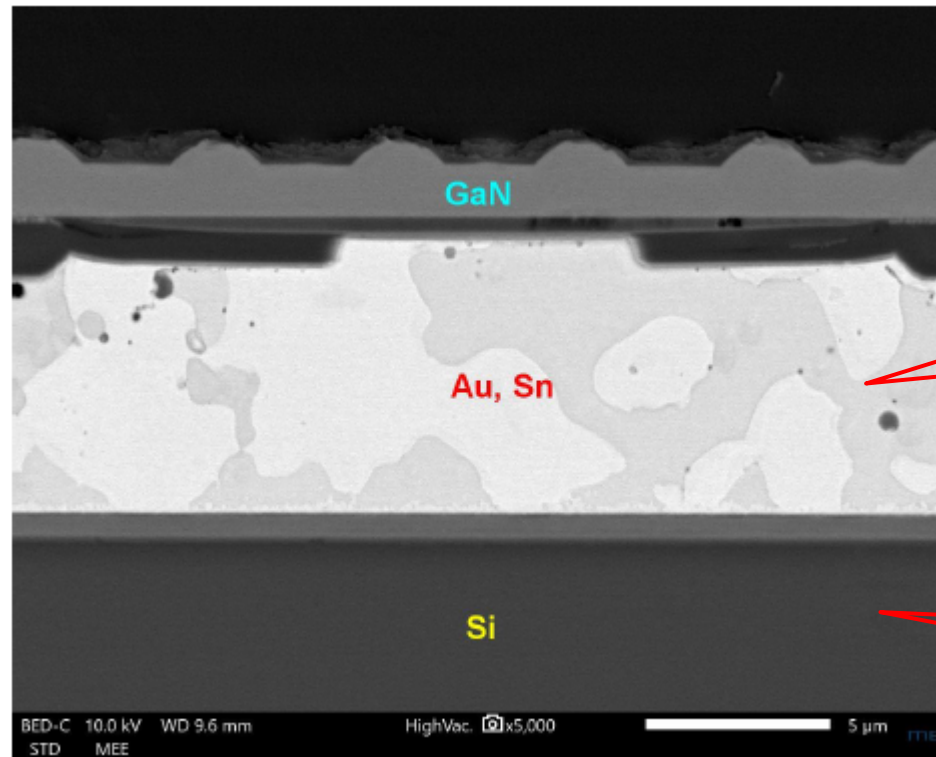


Source: Galaxy S6 Teardown

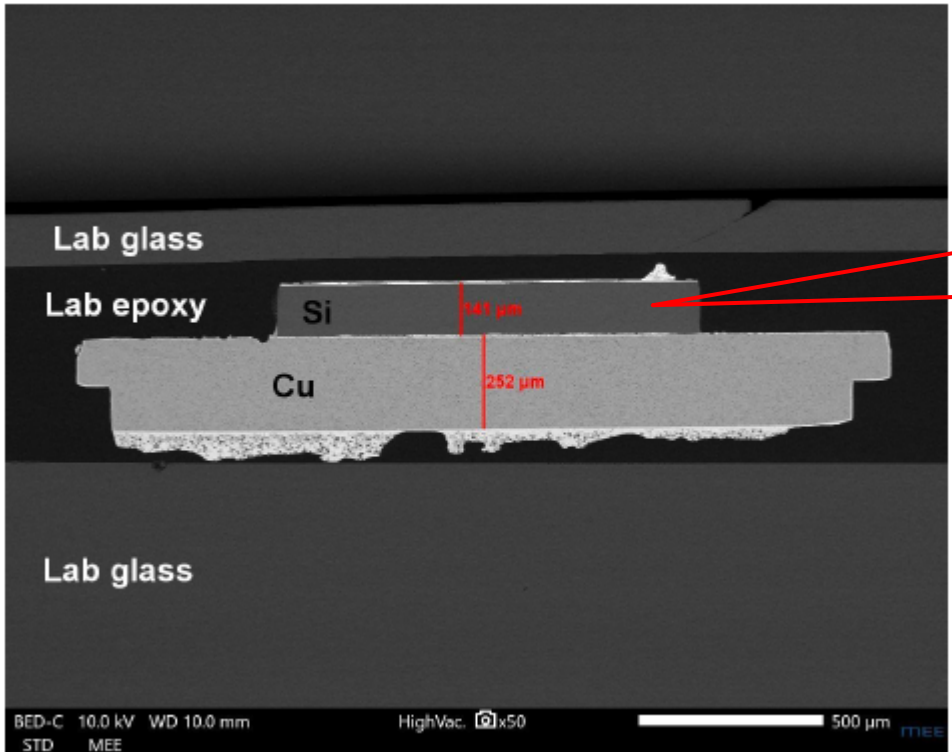
1[D] a carrier wafer disposed on the thermally conductive layer;

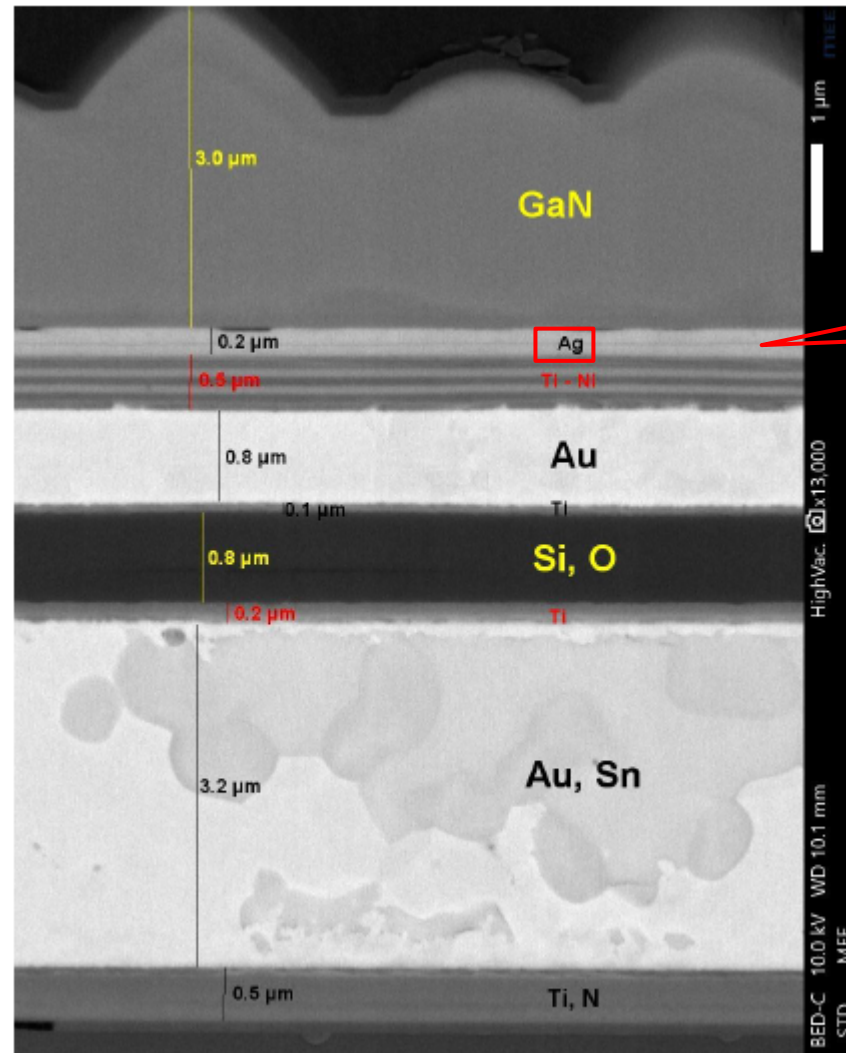
The Accused System and Method comprise a carrier wafer disposed on the thermally conductive layer.

For Example, Samsung Galaxy S6 has a silicon carrier wafer disposed on the thermally conductive layers.



Source: Galaxy S6 Teardown

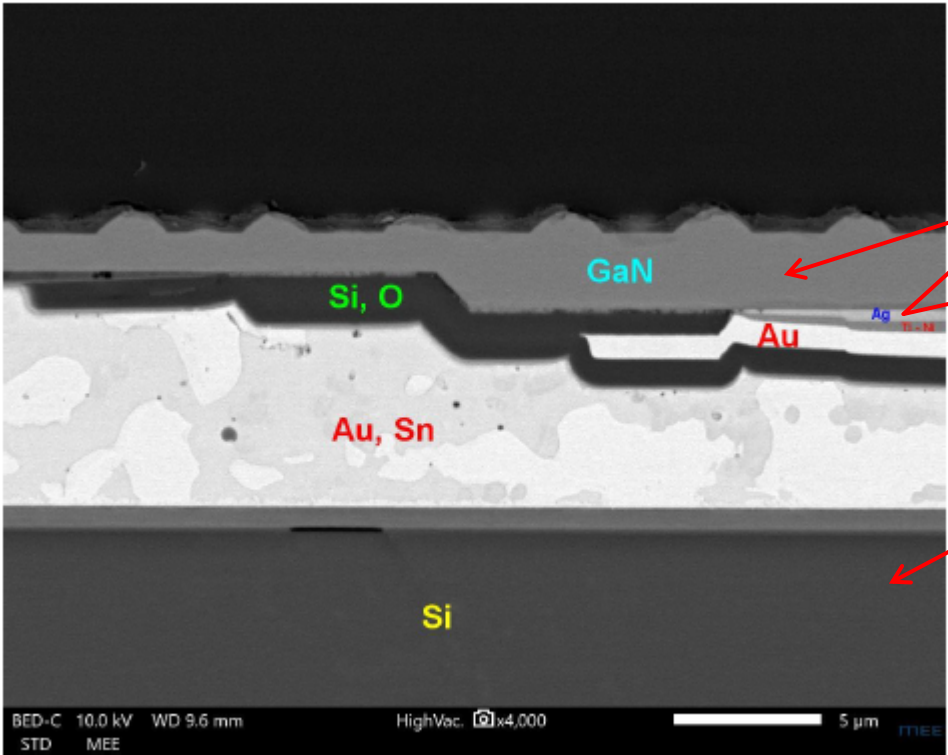
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| |  <p>Si (Silicon) carrier wafer beneath the GaN and thermally conductive layer</p> <p>Lab glass</p> <p>Lab epoxy</p> <p>Si</p> <p>341 μm</p> <p>Cu</p> <p>252 μm</p> <p>Lab glass</p> <p>BED-C 10.0 kV WD 10.0 mm HighVac. 50x50 500 μm</p> <p>STD MEE</p> <p>Backscattered Electron Image</p> <p>Magnification: 50X</p> <p>Source: Galaxy S6 Teardown</p> |
| <p>1[E] at least one optically reflective surface disposed between said carrier wafer and said semiconductor LED; and</p> | <p>The Accused System and Method comprise at least one optically reflective surface disposed between said carrier wafer and said semiconductor LED.</p> <p>For Example, Samsung Galaxy S6 comprise an optically reflective surface (comprising Silver (Ag)) disposed between the carrier wafer and the semiconductor LED.</p> |

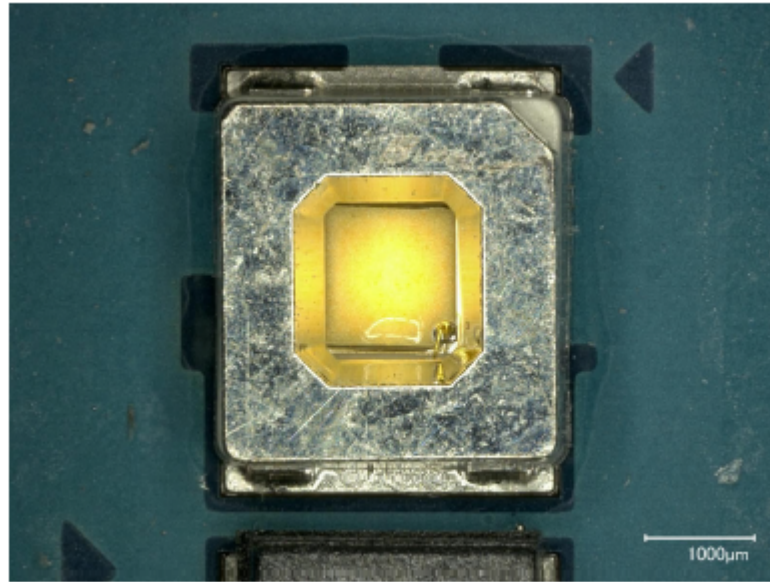


Backscattered Electron Image

Magnification: 13,000X (displayed at 20,333X)

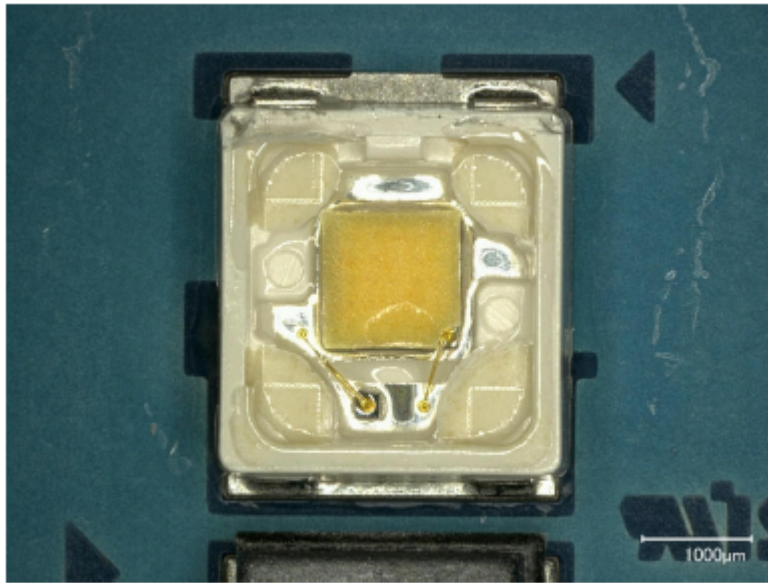
Source: Galaxy S6 Teardown

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| |  <p>Source: Galaxy S6 Teardown</p> |
| <p>1[F] a substantially optically transmissive layer disposed proximal to the second substrate surface,</p> | <p>The Accused System and Method comprise a substantially optically transmissive layer disposed proximal to the second substrate surface.</p> <p>For Example, Samsung Galaxy S6 comprise on the opposing surface of the yellowish phosphor substrate from the LED, there is a substantially optically transmissive layer, the “cover substrate” made of silicon. The optically transmissive layer that covers the substrate may be removed to expose the remaining layers of the LED.</p> |



Magnification: 17X

Source: Galaxy S6 Teardown



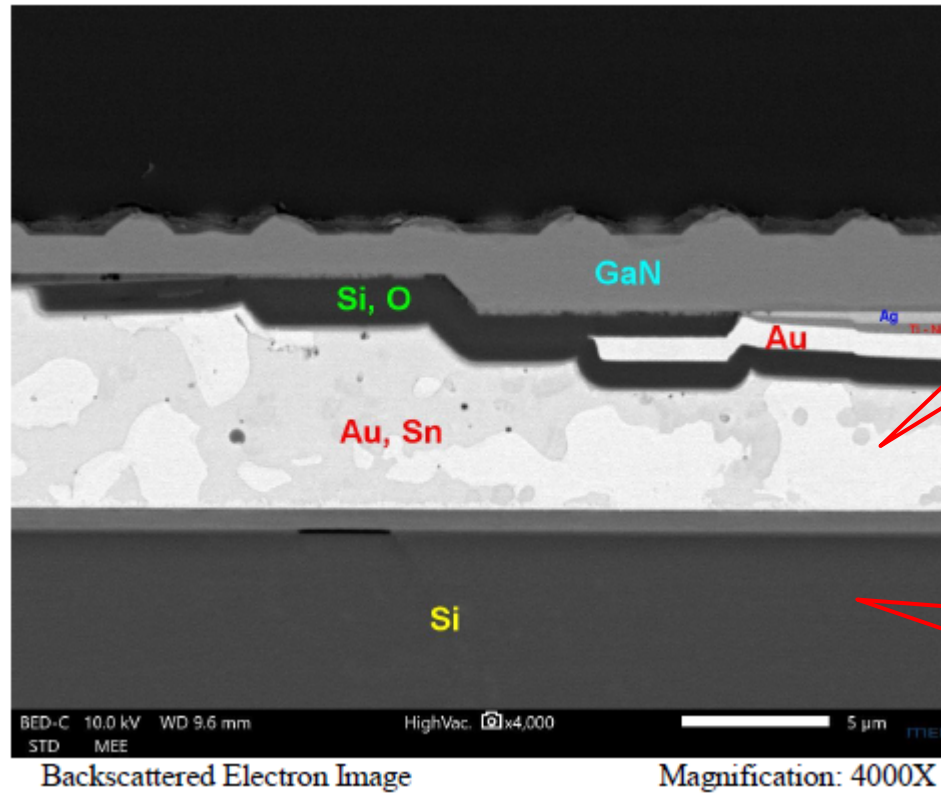
Magnification: 17X

Source: Galaxy S6 Teardown

1[G] wherein the carrier wafer and the thermally conductive layer define a relief to expose at least a portion of the second LED surface.

The Accused System and Method comprise the carrier wafer and the thermally conductive layer defines a relief to expose at least a portion of the second LED surface.

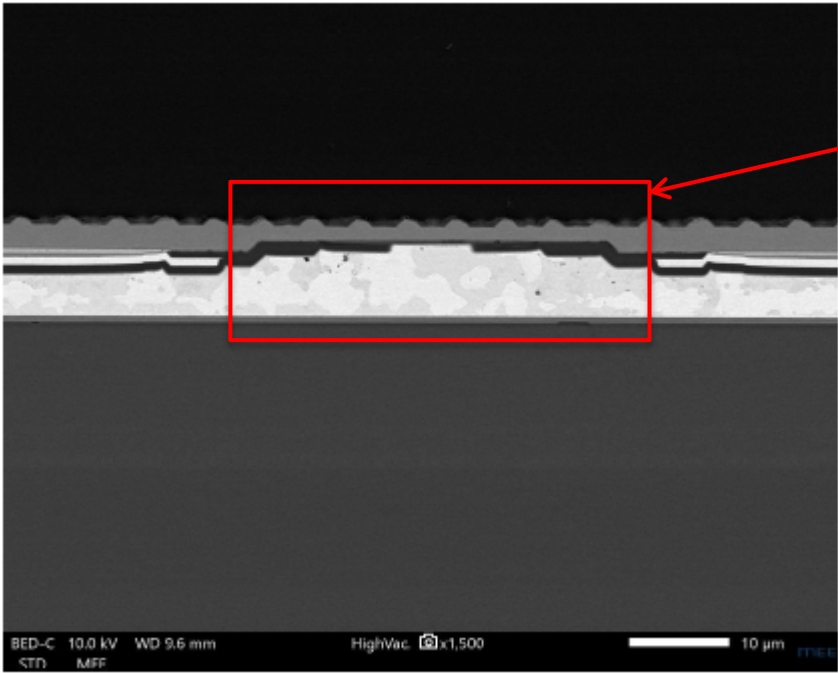
For Example, Samsung Galaxy S6 includes the silicon carrier wafer and the thermally conductive metallic layers are connected to the second LED surface in order to provide relief from heat.

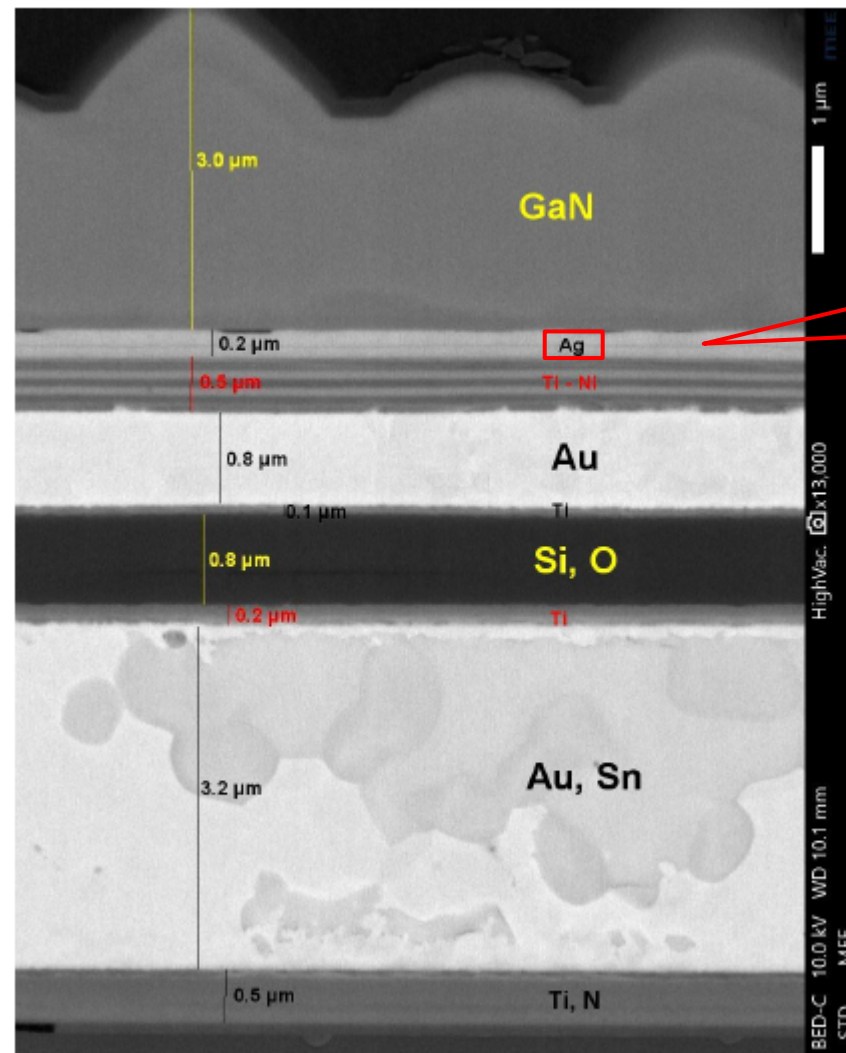


Thermally conductive metallic layer connected to second LED surface to relieve heat

Silicon carrier wafer connected to second LED surface to relieve heat

Source: Galaxy S6 Teardown

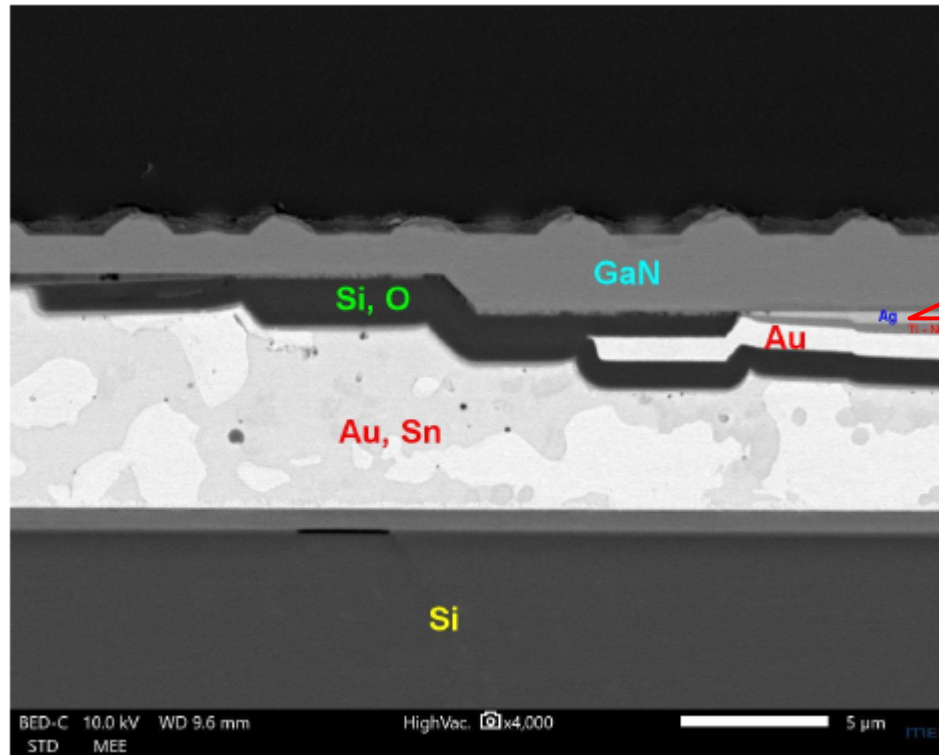
| | |
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| |  <p>Thermally conductive layer and carrier wafer define a relief to expose at least a portion of the second LED surface.</p> <p>BED-C 10.0 kV WD 9.6 mm HighVac. x1,500 10 µm</p> <p>Backscattered Electron Image Magnification: 1500X</p> <p>Source: Galaxy S6 Teardown</p> |
| <p>2. The light emitting device of claim 1, said at least one optically reflective surface comprising metal</p> | <p>The Accused System and Method comprise at least one optically reflective surface comprising metal.</p> <p>For Example, Samsung Galaxy S6 has optically reflective surface comprising metal (Silver (Ag))</p> |



Backscattered Electron Image

Magnification: 13,000X (displayed at 20,333X)

Source: Galaxy S6 Teardown

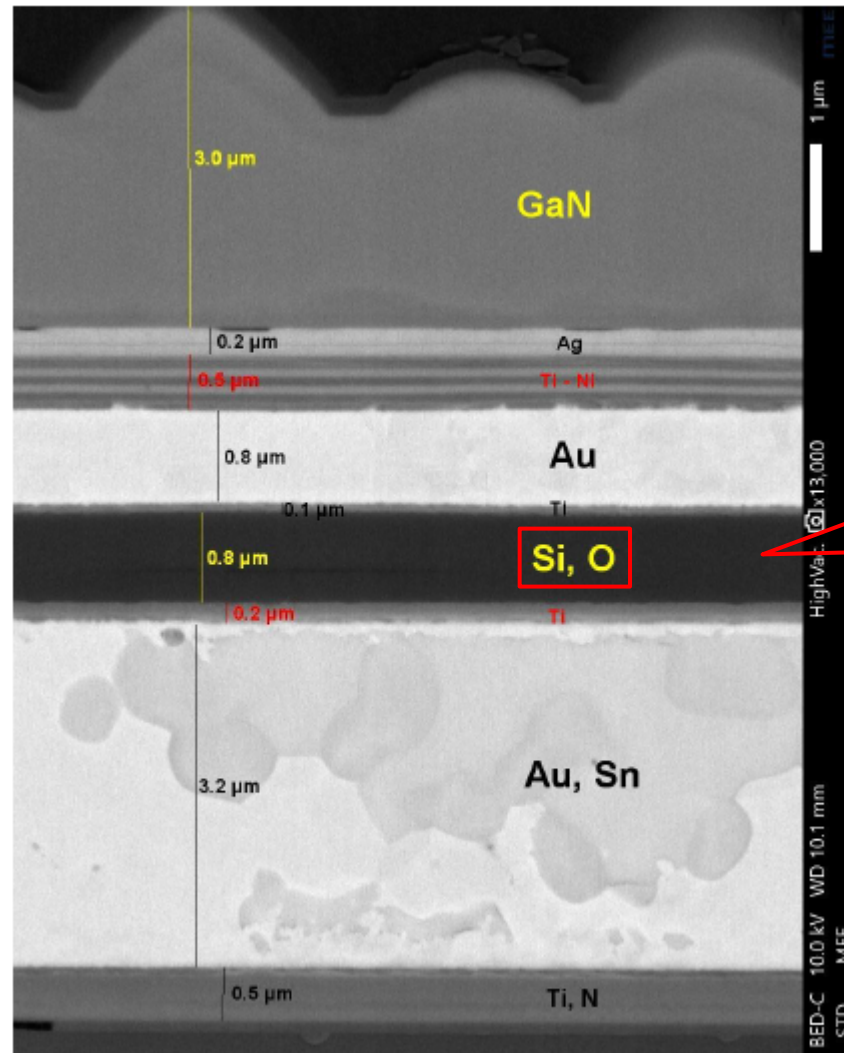


Source: Galaxy S6 Teardown

3. The light emitting device of claim 1, said at least one optically reflective surface comprising a dielectric stack.

The Accused System and Method comprise at least one optically reflective surface comprising a dielectric stack.

For Example, Samsung Galaxy S6 has light emitting device include an optically reflective surface comprising a dielectric stack.



Backscattered Electron Image

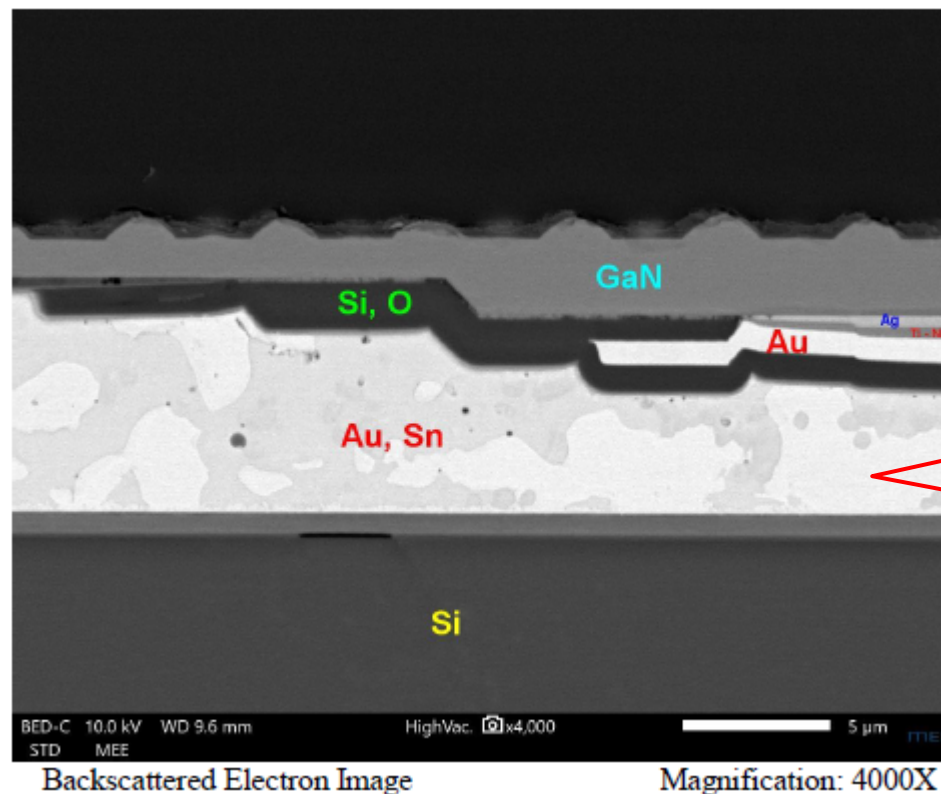
Magnification: 13,000X (displayed at 20,333X)

Source: Galaxy S6 Teardown

4. The light emitting device of claim 1, wherein said semiconductor LED is affixed to said carrier wafer with an adhesive material which has the property of high thermal conductivity.

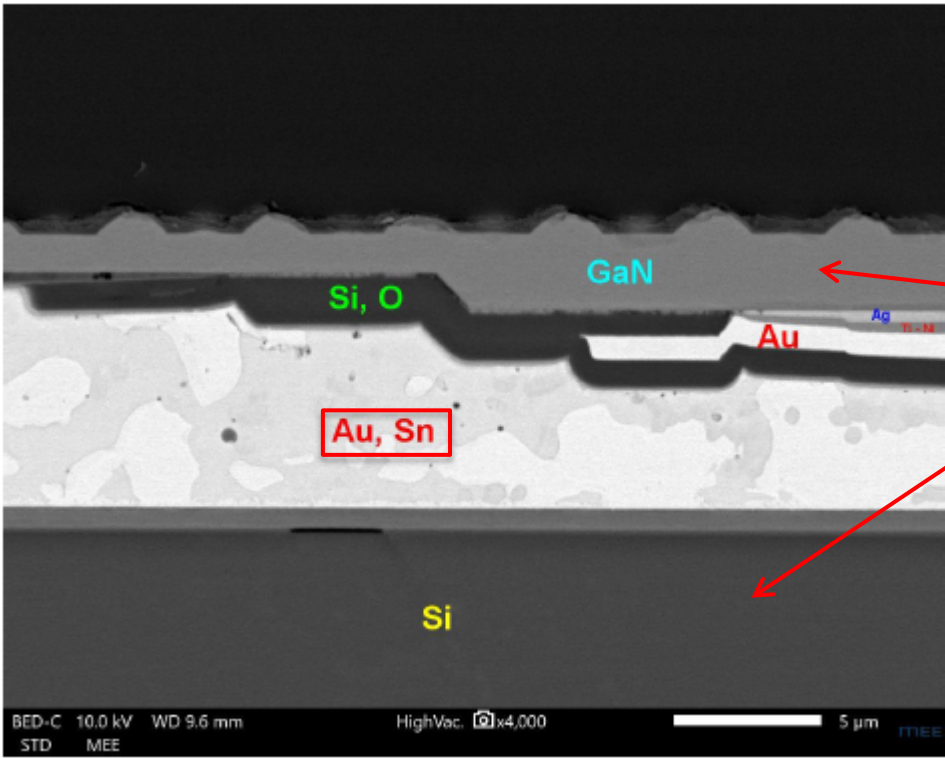
The Accused System and Method comprise semiconductor LED is affixed to said carrier wafer with an adhesive material which has the property of high thermal conductivity.

For Example, Samsung Galaxy S6 comprise semiconductor LED affixed to the carrier wafer (i.e., Si carrier wafer) with an adhesive material having the property of high thermal conductivity.

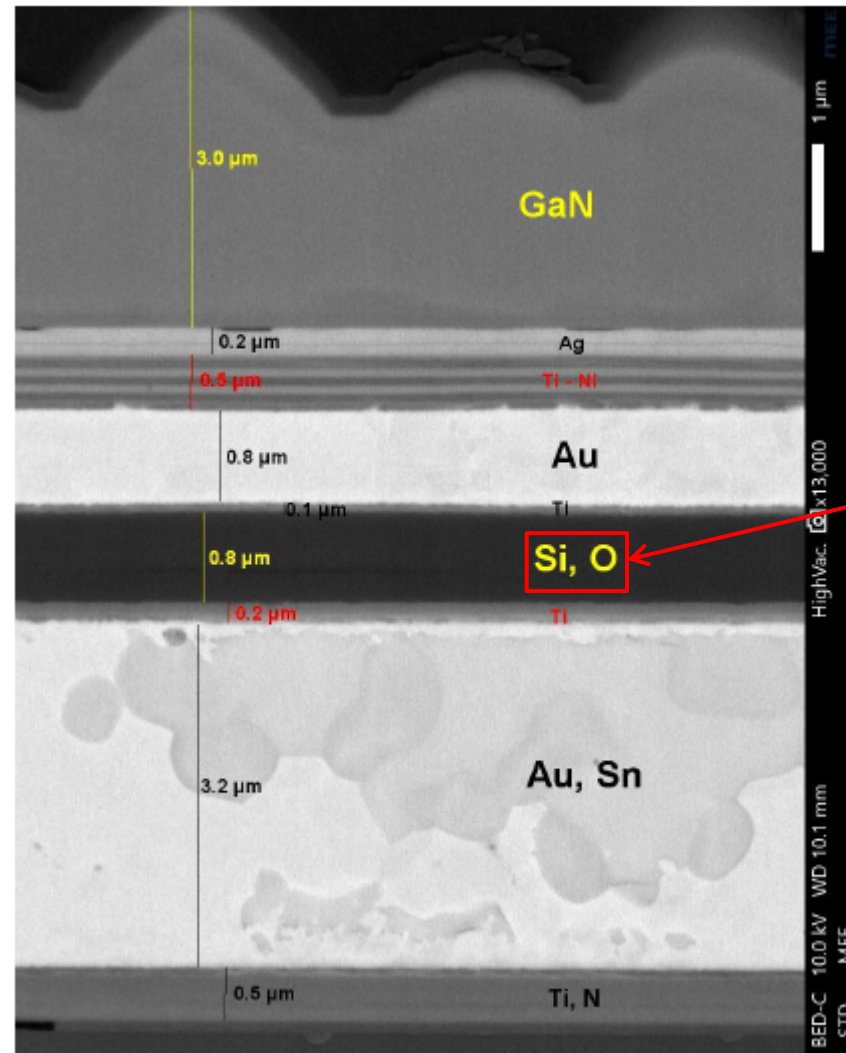


Adhesive material
(Tin (Sn)) with
thermal conductive
property

Source: Galaxy S6 Teardown

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| |  <p>LED affixed to Si carrier wafer with an adhesive material (Tin (Sn)) having the property of thermal conductivity</p> <p>Backscattered Electron Image Magnification: 4000X</p> <p>Source: Galaxy S6 Teardown</p> |
| <p>5. The light emitting device of claim 1, wherein said semiconductor LED is affixed to said carrier wafer with an adhesive material which has the</p> | <p>The Accused System and Method comprise semiconductor LED is affixed to said carrier wafer with an adhesive material which has the property of optical diffusion.</p> <p>For Example, Samsung Galaxy S6 comprise semiconductor LED affixed to the carrier wafer (i.e., Si carrier wafer) with an adhesive material. Upon information and belief, adhesive material has the property of optical diffusion.</p> |

property of optical diffusion.

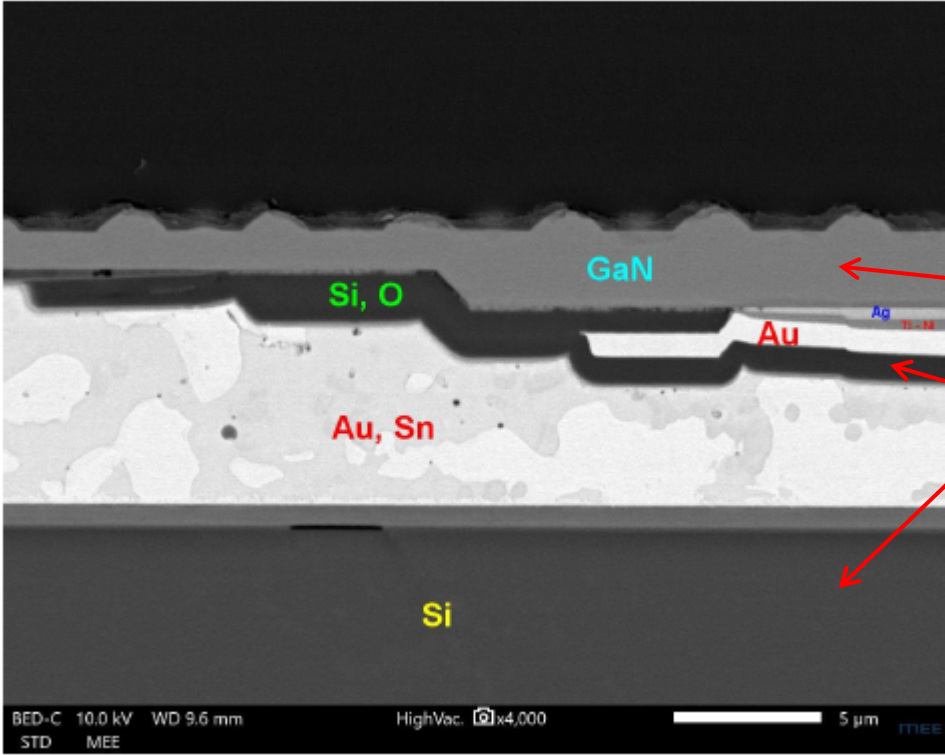


Adhesive material (Si, O) having the property of optical diffusion.

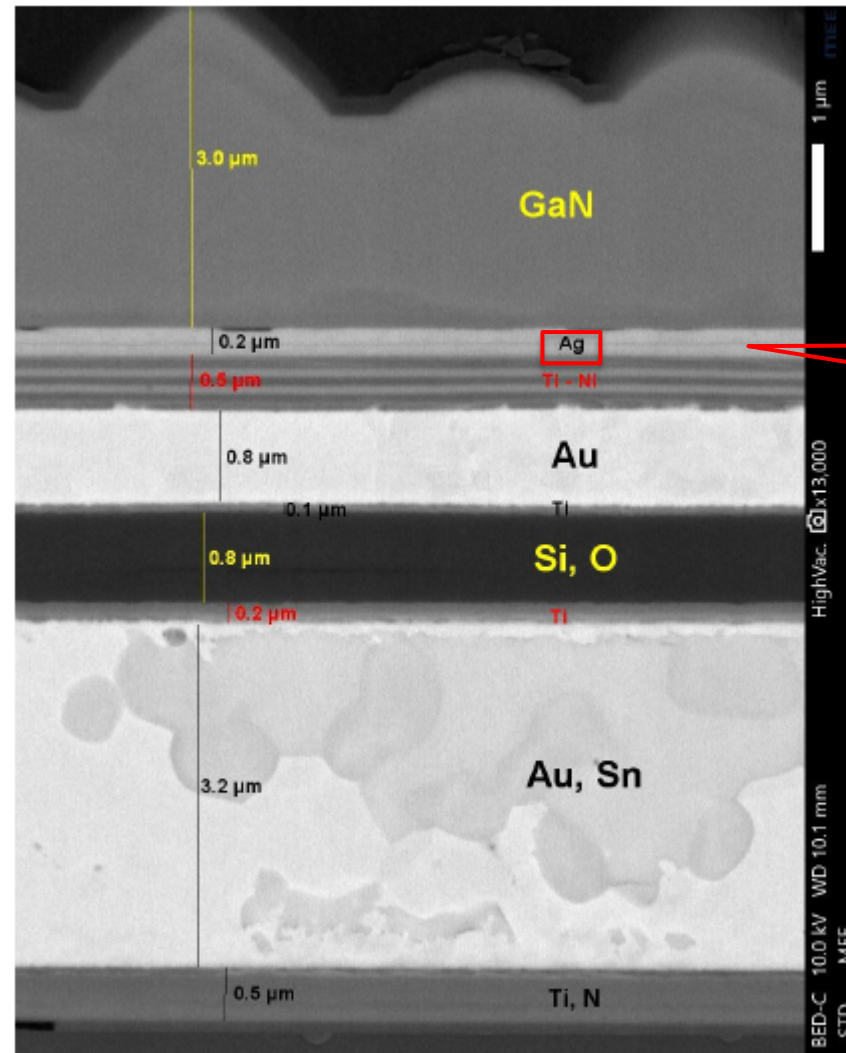
Backscattered Electron Image

Magnification: 13,000X (displayed at 20,333X)

Source: Galaxy S6 Teardown

| | |
|---|--|
| |  <p>Source: Galaxy S6 Teardown</p> |
| <p>6. The light emitting device of claim 1, wherein said semiconductor LED is affixed to said carrier wafer with an adhesive material which has the</p> | <p>The Accused System and Method comprise semiconductor LED is affixed to said carrier wafer with an adhesive material which has the property of optical reflection.</p> <p>For Example, Samsung Galaxy S6 comprise semiconductor LED affixed to the carrier wafer (i.e., Si carrier wafer) with an adhesive material having the property of optical reflection.</p> |

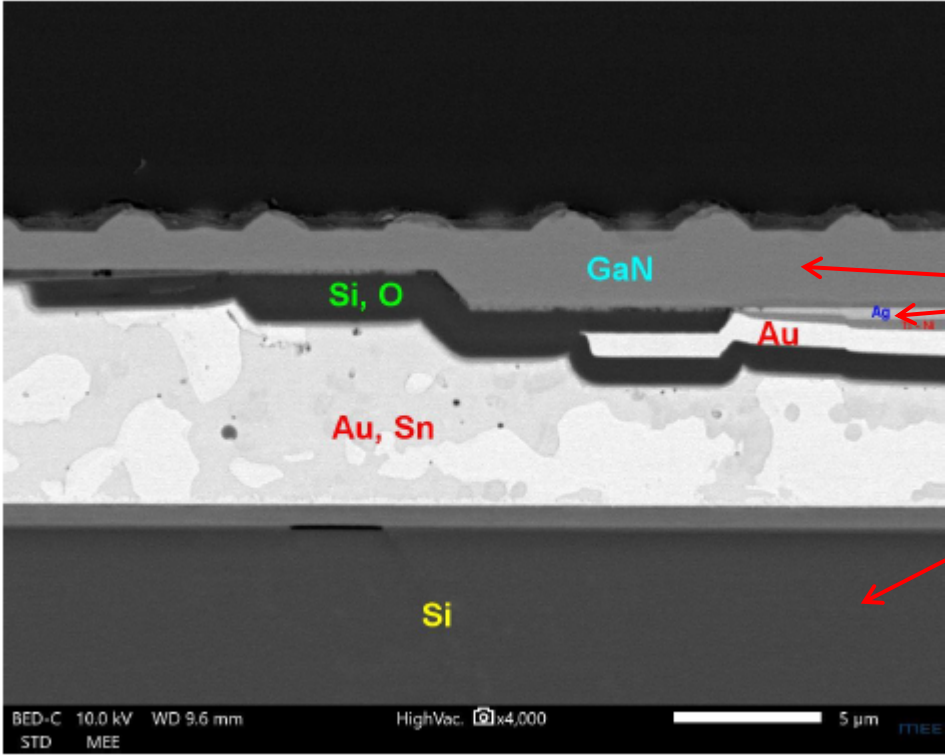
property of optical reflection.



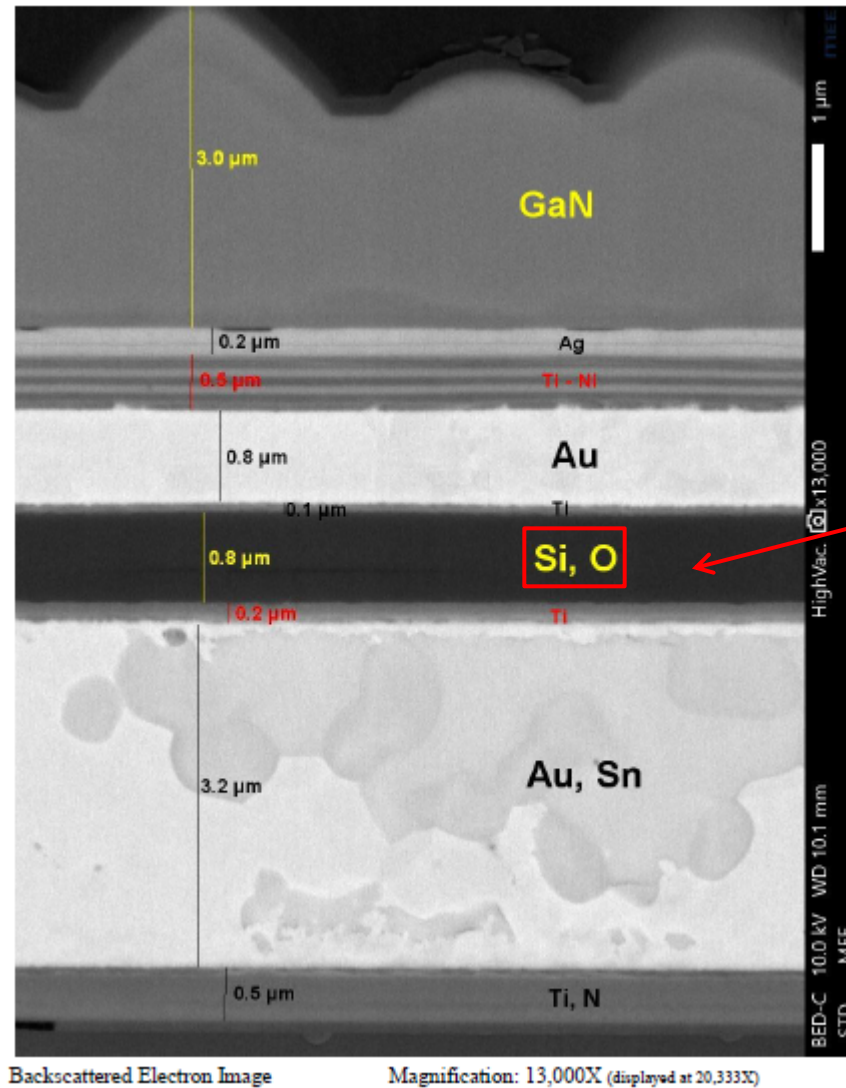
Backscattered Electron Image

Magnification: 13,000X (displayed at 20,333X)

Source: Galaxy S6 Teardown

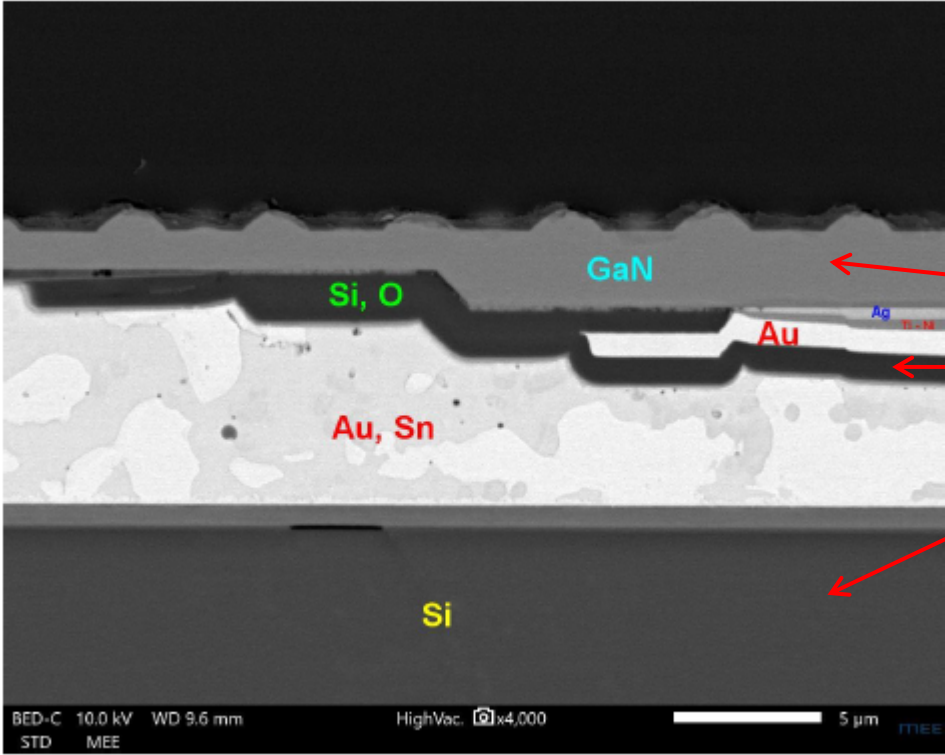
| | |
|---|---|
| |  <p>LED affixed to Si carrier wafer with an adhesive material (Ag) having the property of optical reflection.</p> <p>Backscattered Electron Image Magnification: 4000X</p> <p>Source: Galaxy S6 Teardown</p> |
| <p>7. The light emitting device of claim 1, wherein said semiconductor LED is affixed to said carrier wafer with an adhesive material which has the</p> | <p>The Accused System and Method comprise semiconductor LED is affixed to said carrier wafer with an adhesive material which has the property of optical transmissivity.</p> <p>For Example, Samsung Galaxy S6 comprise semiconductor LED affixed to the carrier wafer (i.e., Si carrier wafer) with an adhesive material. Upon information and belief, adhesive material has the property of optical transmissivity.</p> |

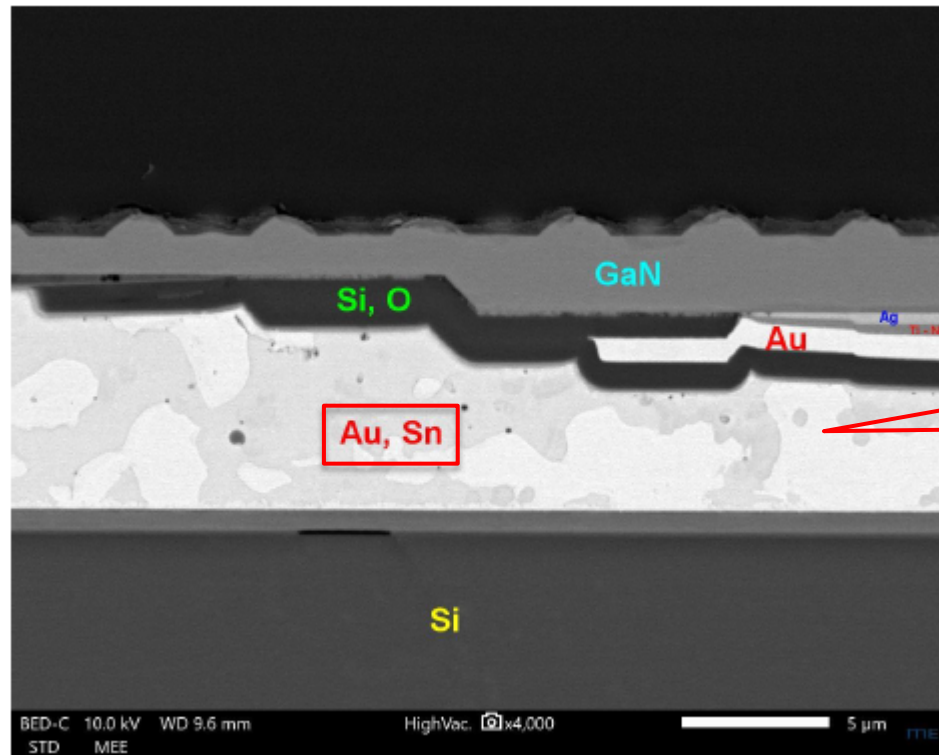
property of optical transmissivity.



Adhesive material (Si, O) having the property of optical transmissivity.

Source: Galaxy S6 Teardown

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| |  <p>Backscattered Electron Image Magnification: 4000X</p> <p>Source: Galaxy S6 Teardown</p> |
| <p>9. The light emitting device of claim 1, said thermally conductive layer comprises metal.</p> | <p>The Accused System and Method comprise thermally conductive layer comprises metal.</p> <p>For Example, Samsung Galaxy S6 has light emitting device include thermally conductive layer comprises metal (Tin (Sn)).</p> |



Backscattered Electron Image

Magnification: 4000X

Source: Galaxy S6 Teardown