

**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 S8

**References Used:**

Galaxy S8 Teardown

Samsung Flip Chip Technology

Samsung Led

**Reference Links:**

<https://www.samsung.com/global/galaxy/galaxy-s8/>

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

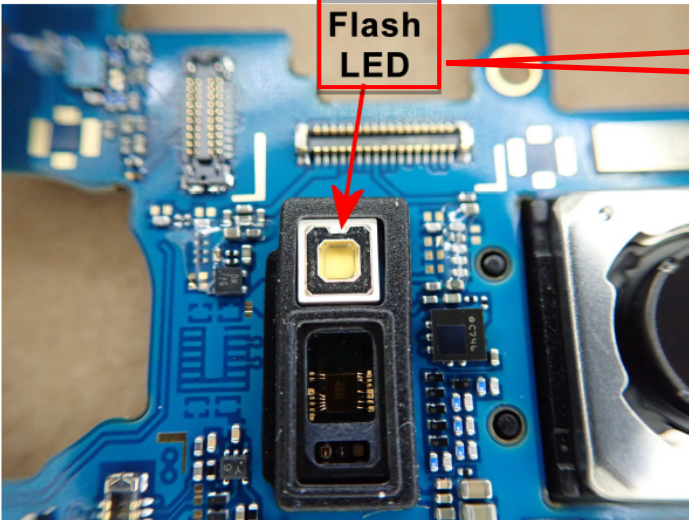
**U.S. Patent No.9, 502, 612 v. Samsung Galaxy S8**

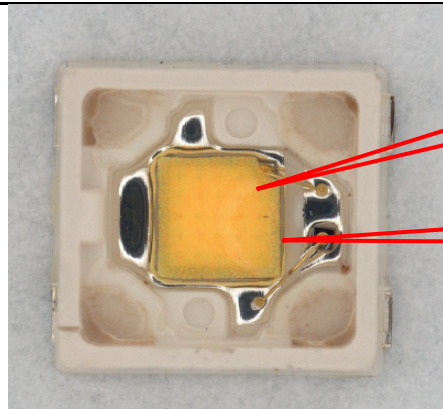
Plaintiff accuses the provision, use, and operation of Samsung (“Defendant” or “Samsung”) of certain “Samsung LEDs” of directly infringing U.S. Patent No. 9,502,612 (the “612 Patent”). The term “Accused System and Method” means Samsung Galaxy S8 and all substantially similar products.

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><b>1[Pre]</b> 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 S8 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="474 451 1656 1224">  <p>Samsung Galaxy S8 Flash LED</p> </div> <p><b>Source:</b> Samsung Led, Page 1  <a href="https://www.samsung.com/global/galaxy/galaxy-s8/">https://www.samsung.com/global/galaxy/galaxy-s8/</a></p>

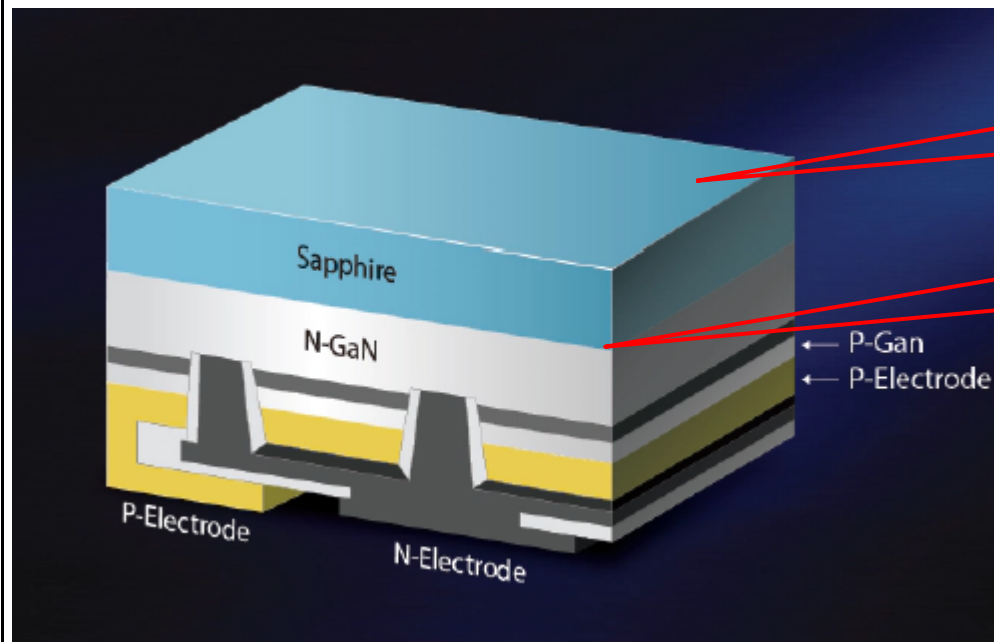
	 <p><b>Flash LED</b></p> <p>Light Emitting Diode</p> <p><b>Source:</b> Galaxy S8 Teardown</p>
<p><b>1[A]</b> a substrate having opposing first and second substrate surfaces;</p>	<p>The Accused System and Method comprise a substrate having opposing first and second substrate surfaces.</p> <p>For Example, the Samsung Galaxy S8 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 S8 Teardown

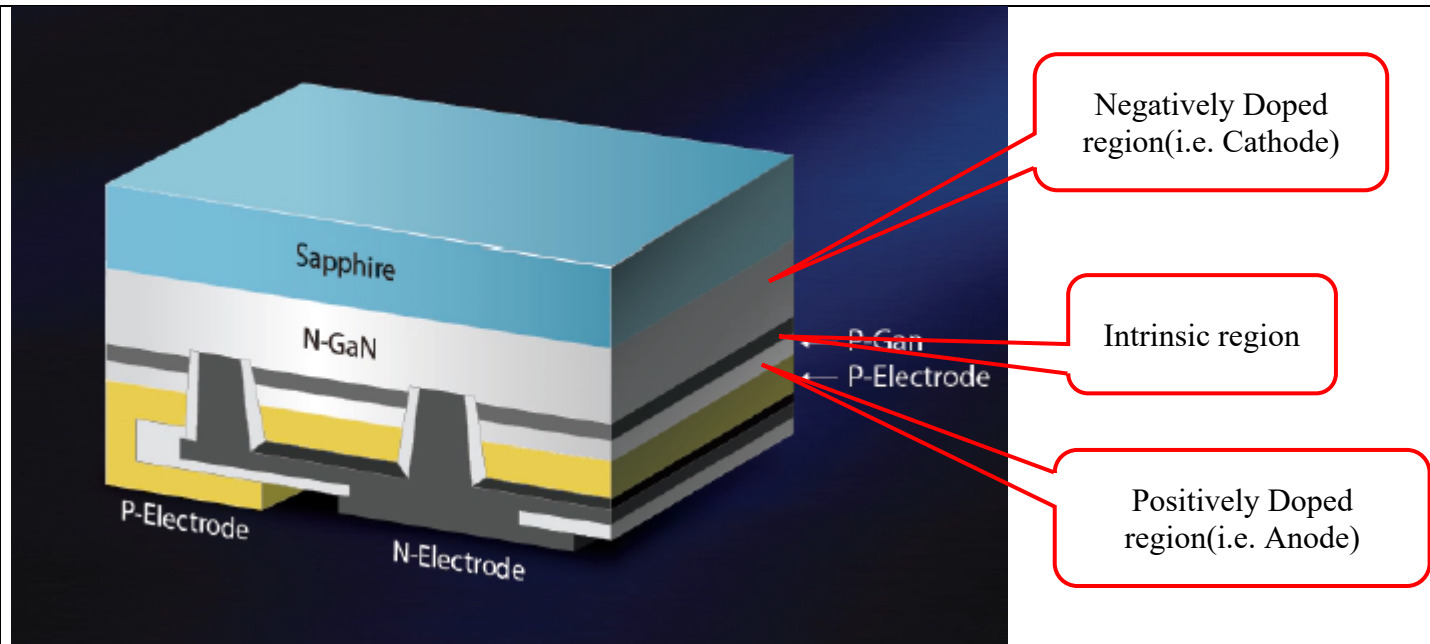


Second substrate surface

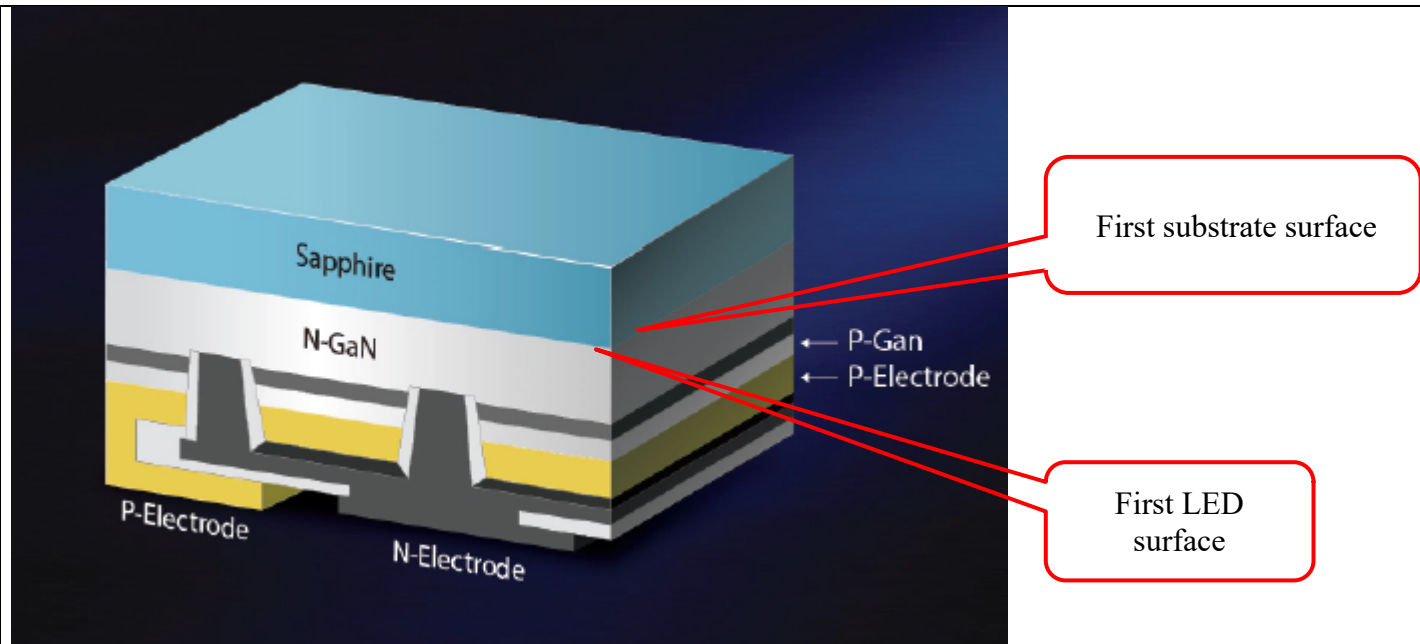
First substrate surface

← P-GaN  
← P-Electrode

	<p><b>Source:</b> Samsung Flip Chip Technology, Page 1  <a href="https://www.samsung.com/led/insights/insights-detail-2/">https://www.samsung.com/led/insights/insights-detail-2/</a></p>
<p><b>1[B]</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 S8 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 between the two doped regions.</p>

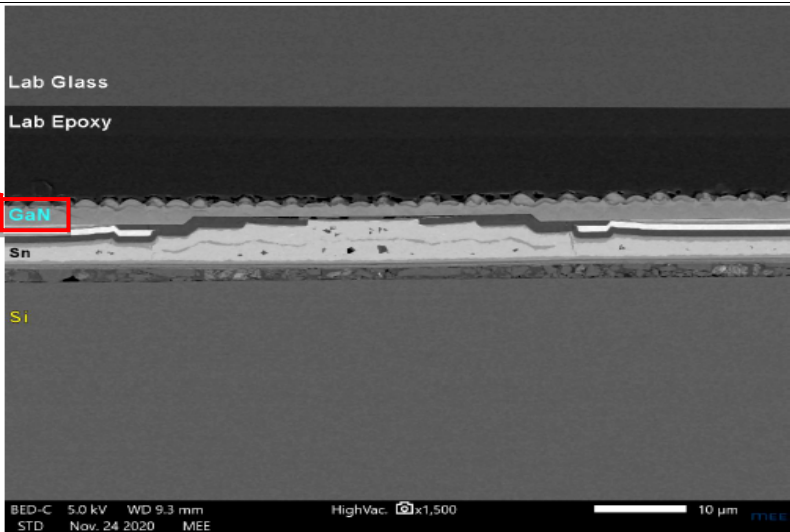


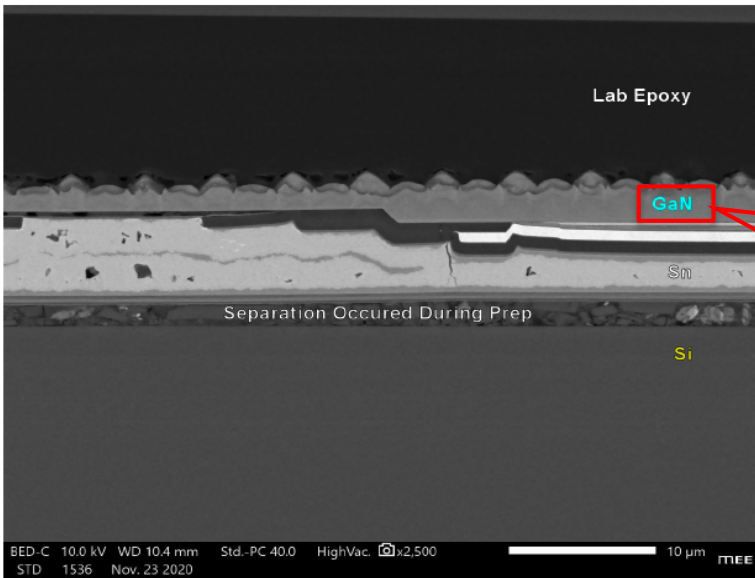
**Source:** Samsung Flip Chip Technology, Page 1  
<https://www.samsung.com/led/insights/insights-detail-2/>

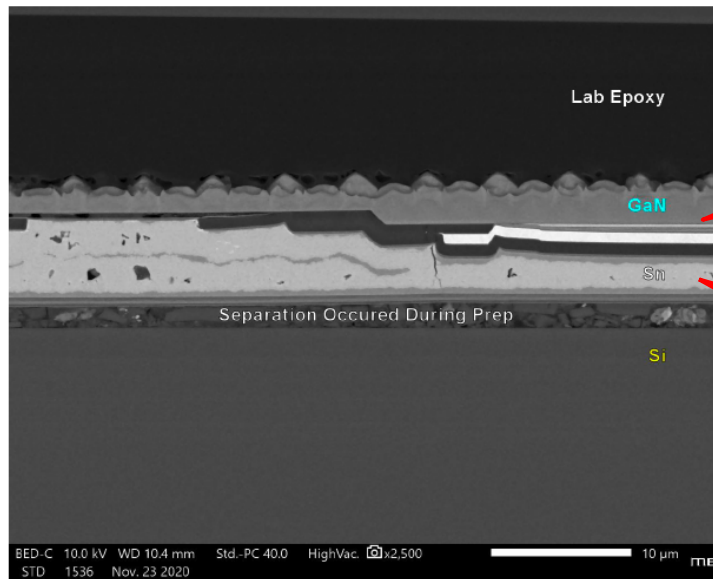


**Source:** Samsung Flip Chip Technology, Page 1  
<https://www.samsung.com/led/insights/insights-detail-2/>



	<div data-bbox="621 217 995 354"><p>Flash LED includes doped GaN LED.</p></div> <div data-bbox="1152 157 1936 716"><p>Lab Glass</p><p>Lab Epoxy</p><p>GaN</p><p>Sn</p><p>Si</p><p>BED-C 5.0 kV WD 9.3 mm HighVac. x1,500 STD Nov. 24 2020 MEE</p><p>Backscattered Electron Image</p><p>Magnification: 1500X</p></div>
	<p>Source: Galaxy S8 Teardown</p>

	 <p><b>Source:</b> Galaxy S8 Teardown</p>
<p><b>1[C]</b> a thermally conductive layer disposed on the second LED surface of the semiconductor LED;</p>	<p>The Accused System and Method comprise a thermally conductive layer disposed on the second LED surface of the semiconductor LED.</p> <p>For Example, Samsung Galaxy S8 comprises thermally conductive layer disposed on the other (i.e., second LED) surface of the semiconductor LED.</p>



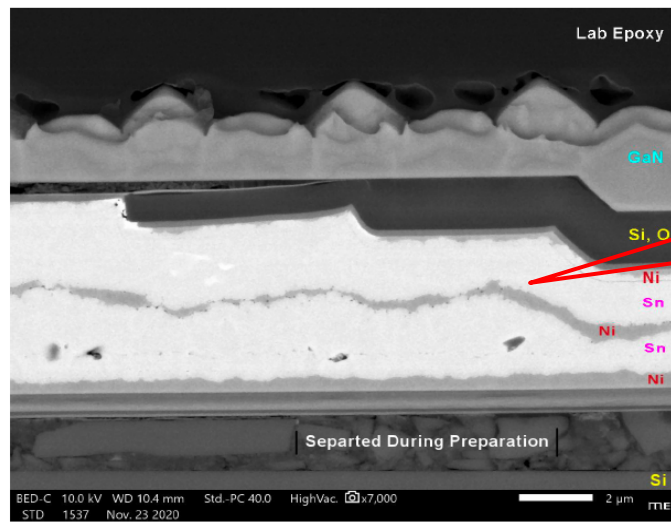
Backscattered Electron Image

Magnification: 2500X

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

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

Source: Galaxy S8 Teardown



Backscattered Electron Image

Magnification: 7000X

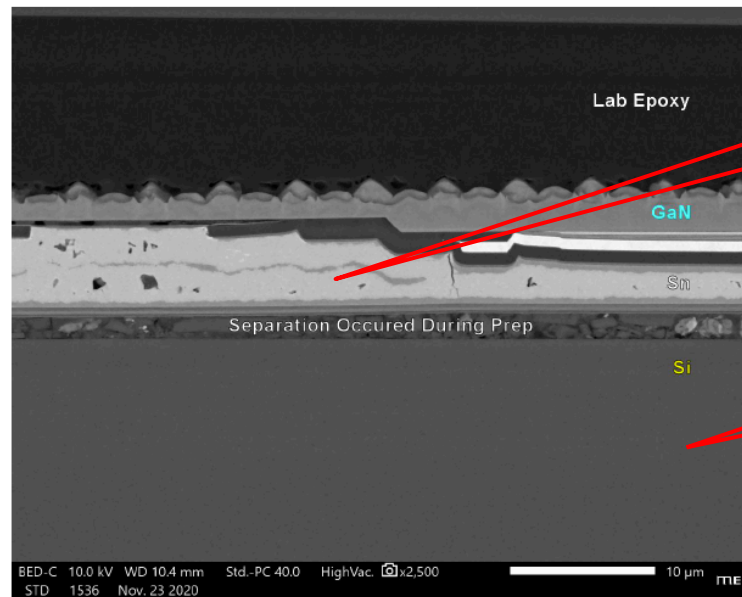
Thermally conductive layer on the opposite (i.e., second) surface of the LED

Source: Galaxy S8 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 S8 has a silicon carrier wafer disposed on the thermally conductive layers.

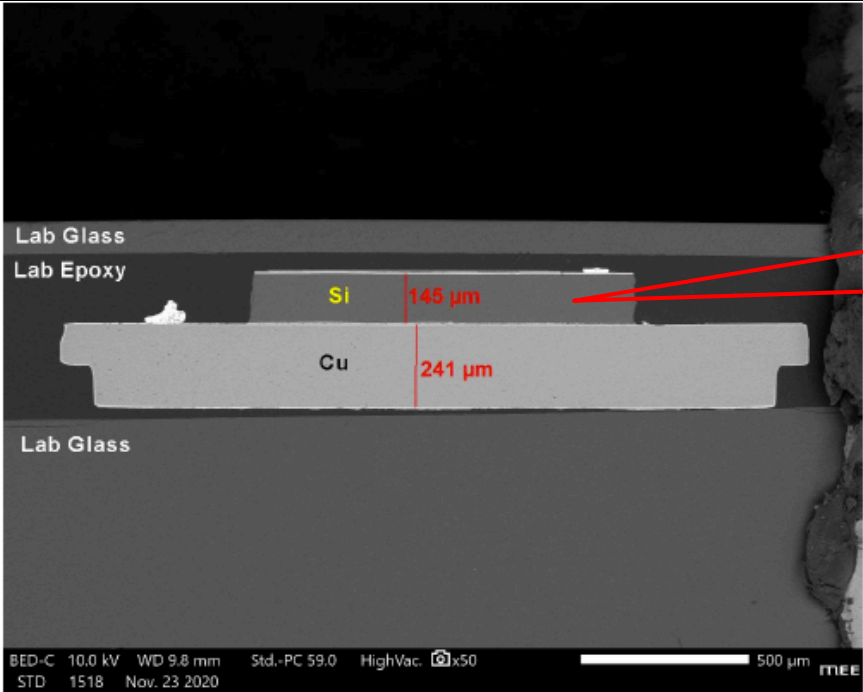


Backscattered Electron Image

Magnification: 2500X

**Source:** Galaxy S8 Teardown

Si (Silicon) carrier wafer  
beneath the GaN and  
thermally conductive  
layer



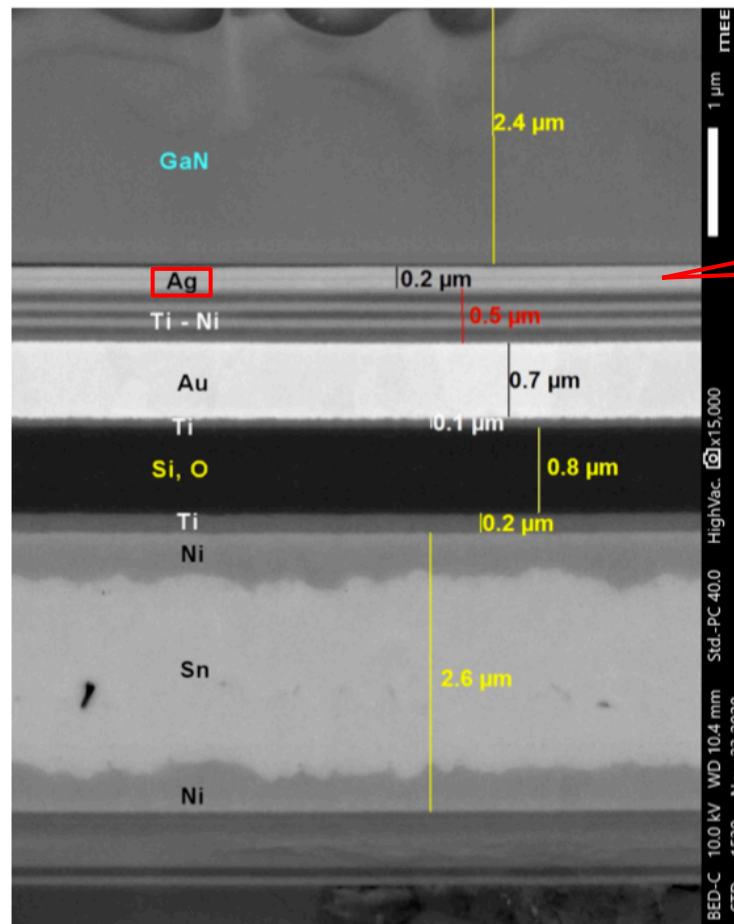
Backscattered Electron Image  
(b) SEM Image of Section

Source: Galaxy S8 Teardown

1[E] at least one optically reflective surface disposed between said carrier wafer and said semiconductor LED; and

The Accused System and Method comprise at least one optically reflective surface disposed between said carrier wafer and said semiconductor LED.

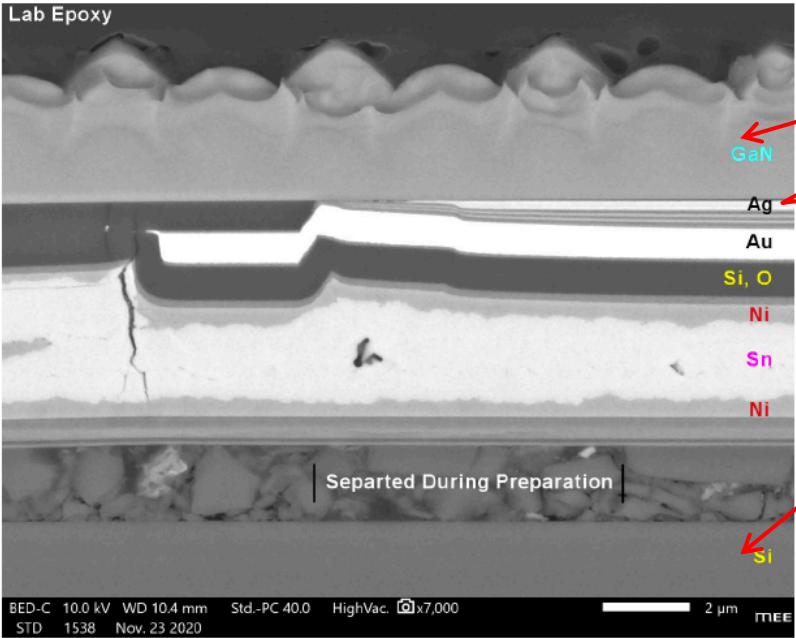
For Example, Samsung Galaxy S8 comprise an optically reflective surface (comprising Silver(Ag)) disposed between the carrier wafer and the semiconductor LED.



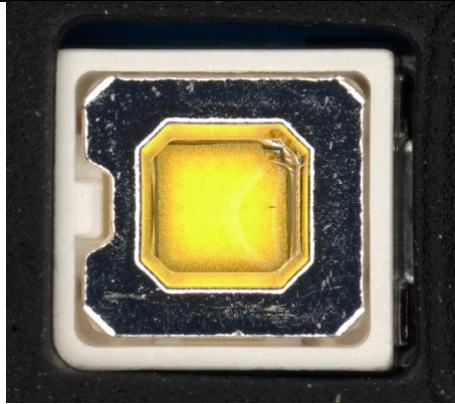
Backscattered Electron Image

Magnification: 15,000X (displayed at 24,000X)

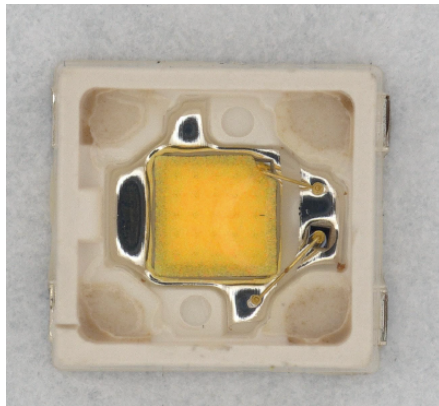
**Source:** Galaxy S8 Teardown

	 <p><b>Source:</b> Galaxy S8 Teardown</p>
<p><b>1[F]a</b> 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 S8 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>





**Source:** Galaxy S8 Teardown



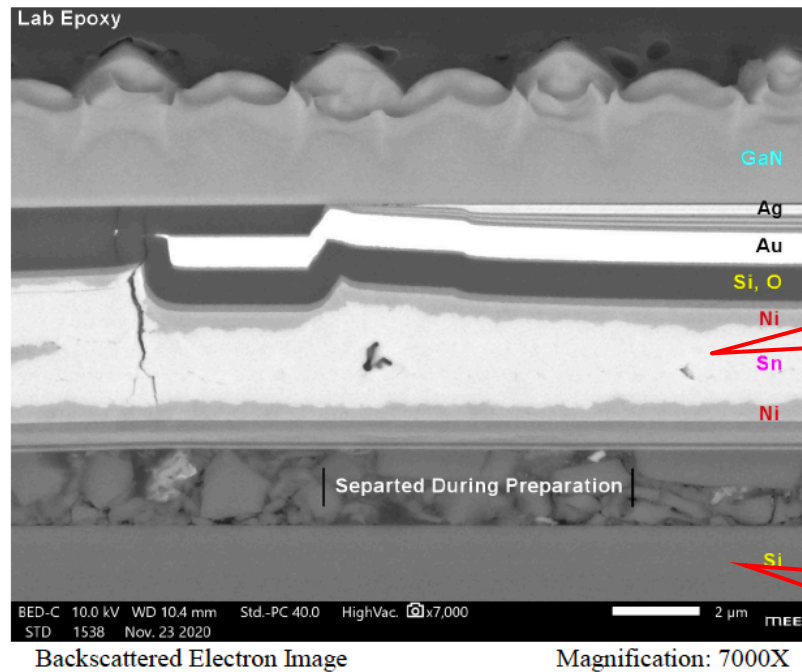
**Source:** Galaxy S8 Teardown

**1[G]**wherein the carrier wafer and the thermally conductive

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.

layer define a relief to expose at least a portion of the second LED surface.

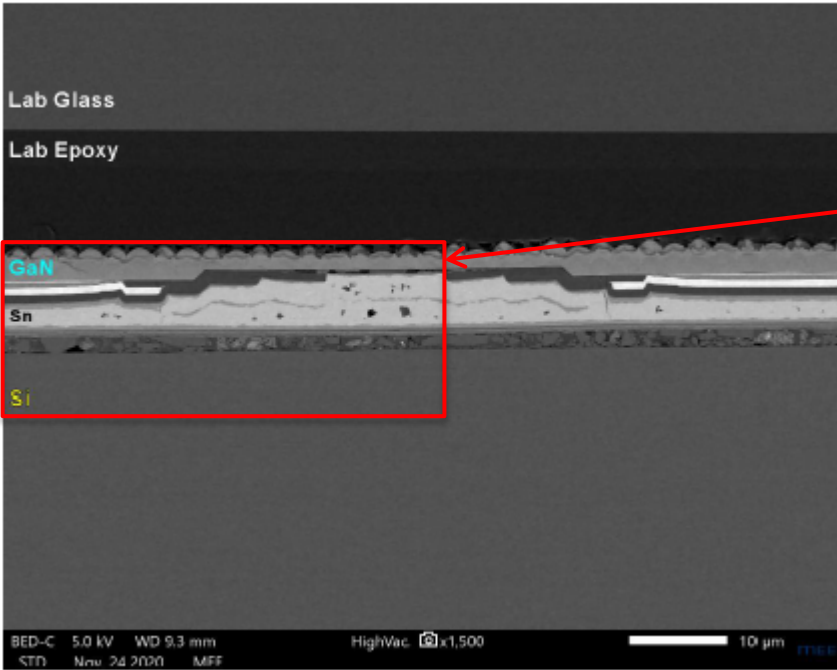
For Example, Samsung Galaxy S8 includes the silicon carrier wafer and the thermally conductive metallic layers are connected to the second LED surface in order to provide relief from heat.

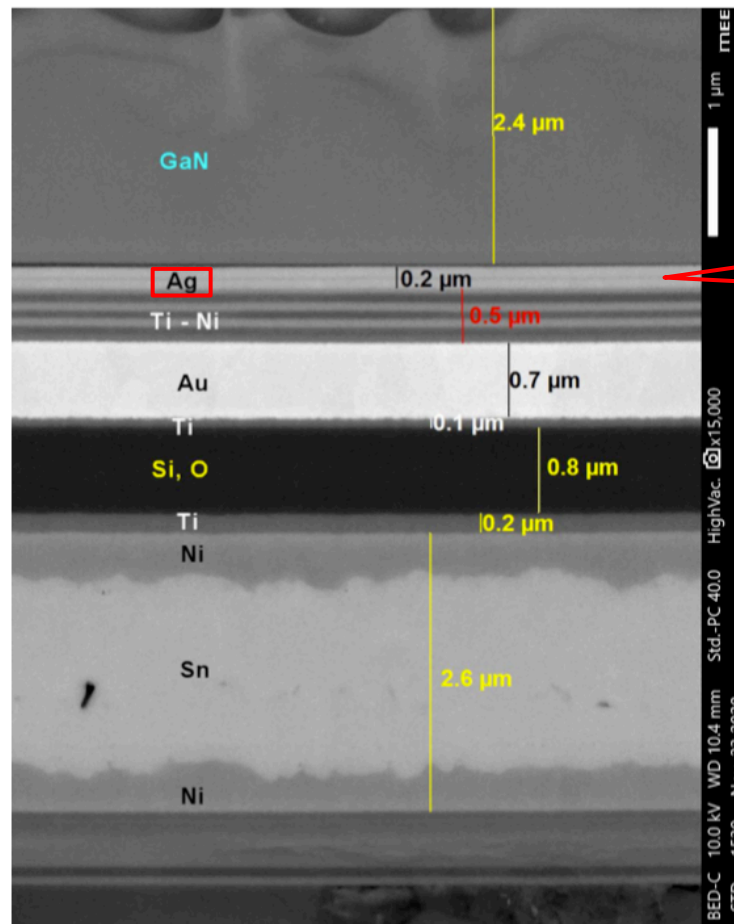


Thermally conductive metallic layer connected to second LED surface to relieve heat

Silicon carrier wafer connected to second LED surface to relieve heat

Source: Galaxy S8 Teardown

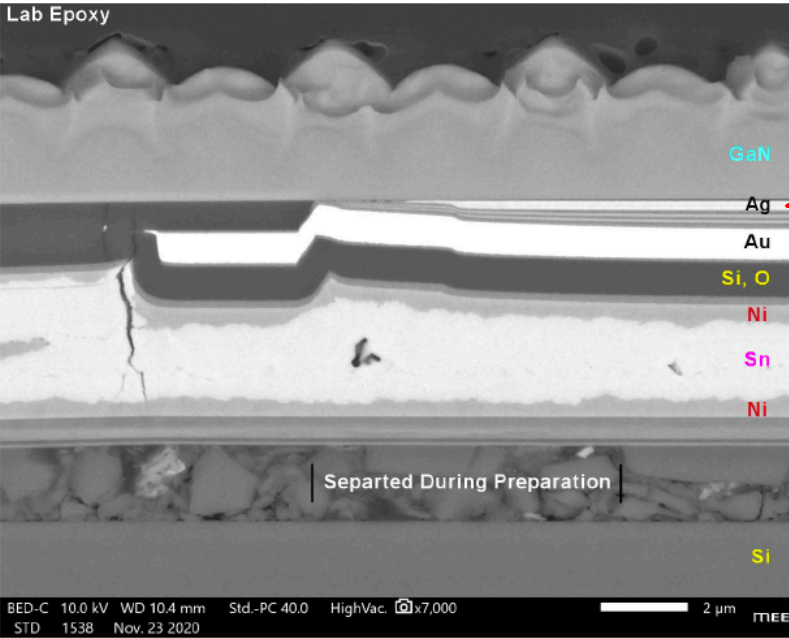
	 <p data-bbox="468 251 583 272">Lab Glass</p> <p data-bbox="468 305 590 326">Lab Epoxy</p> <p data-bbox="468 423 520 444">GaN</p> <p data-bbox="468 477 499 498">Sn</p> <p data-bbox="468 553 499 574">Si</p> <p data-bbox="468 797 951 818">BED-C 5.0 kV WD 9.3 mm HighVac. x1,500 10 µm</p> <p data-bbox="468 818 688 833">STD Nov 24 2020 MFF</p> <p data-bbox="491 841 821 862">Backscattered Electron Image</p> <p data-bbox="1037 841 1283 862">Magnification: 1500X</p> <p data-bbox="1390 277 1749 451">Thermally conductive layer and carrier wafer define a relief to expose at least a portion of the second LED surface.</p> <p data-bbox="457 914 840 935">Source: Galaxy S8 Teardown</p>
<p data-bbox="149 987 428 1192">2. The light emitting device of claim 1, said at least one optically reflective surface comprising metal</p>	<p data-bbox="457 987 1745 1008">The Accused System and Method comprise at least one optically reflective surface comprising metal.</p> <p data-bbox="457 1073 1696 1094">For Example, Samsung Galaxy S8 has optically reflective surface comprising metal (Silver (Ag))</p>

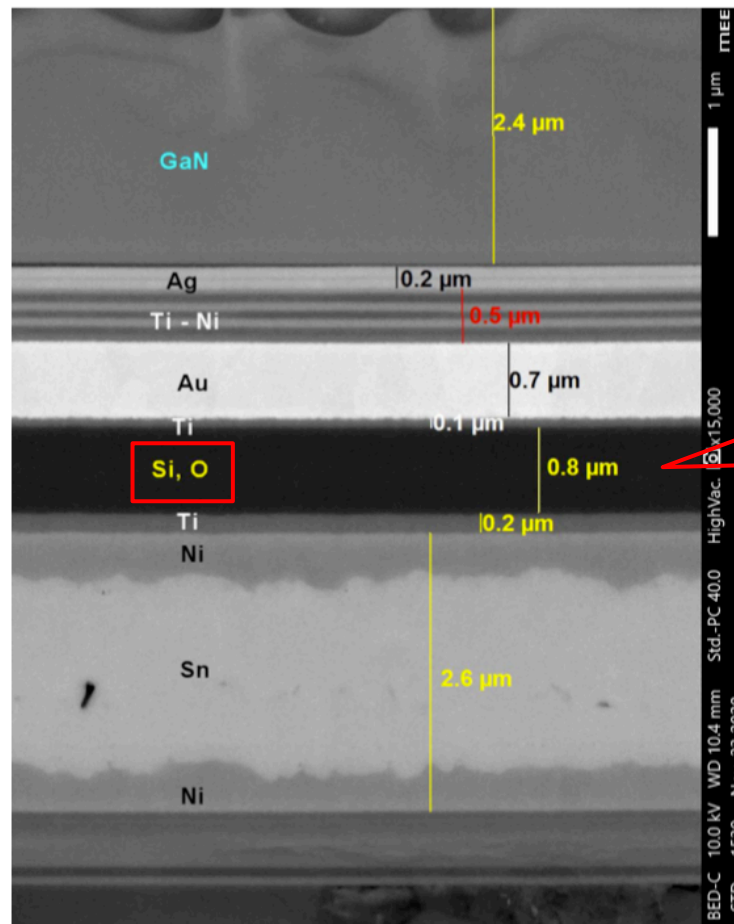


Optically reflective surface comprising metal (Silver (Ag))

Backscattered Electron Image Magnification: 15,000X (displayed at 24,000X)

Source: Galaxy S8 Teardown

	 <p><b>Source:</b> Galaxy S8 Teardown</p>
<p>3. The light emitting device of claim 1, said at least one optically reflective surface comprising a dielectric stack.</p>	<p>The Accused System and Method comprise at least one optically reflective surface comprising a dielectric stack.</p> <p>For Example, Samsung Galaxy S8 has light emitting device include an optically reflective surface comprising a dielectric stack.</p>



Backscattered Electron Image

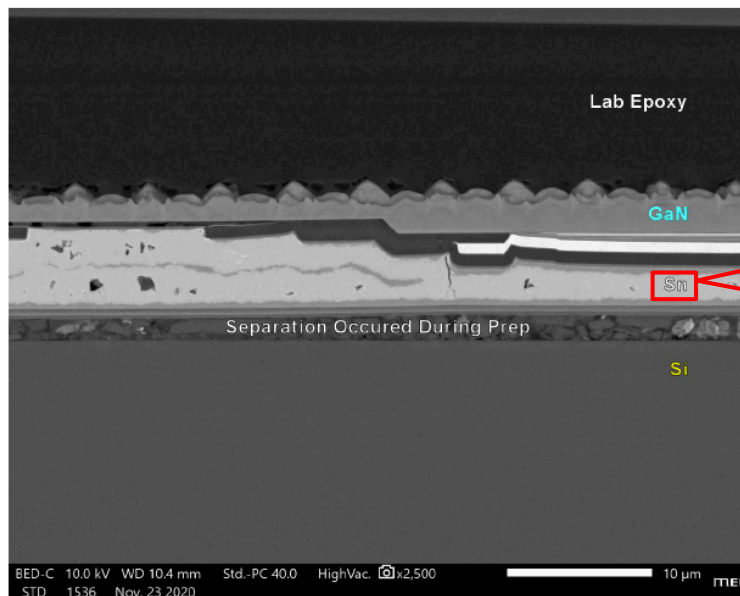
Magnification: 15,000X (displayed at 24,000X)

**Source:** Galaxy S8 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.

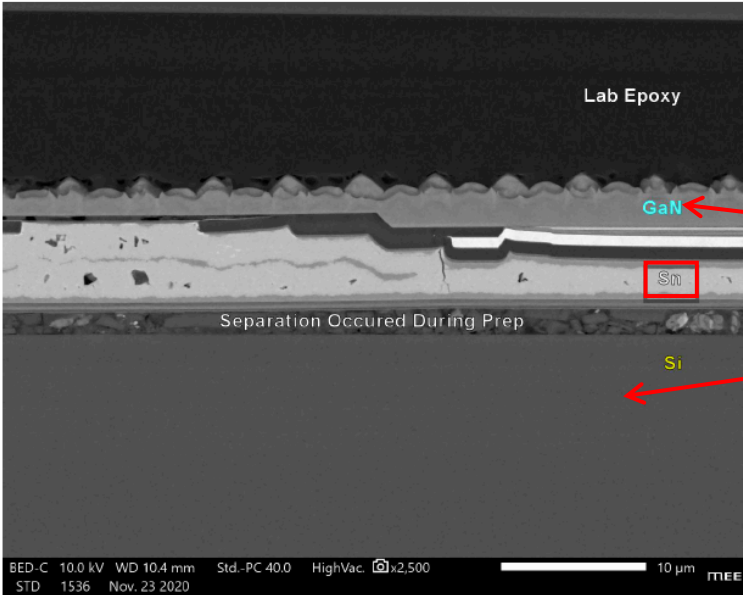
For Example, Samsung Galaxy S8 comprise semiconductor LED affixed to the carrier wafer(i.e., Si carrier wafer) with an adhesive material having the property of high thermal conductivity.



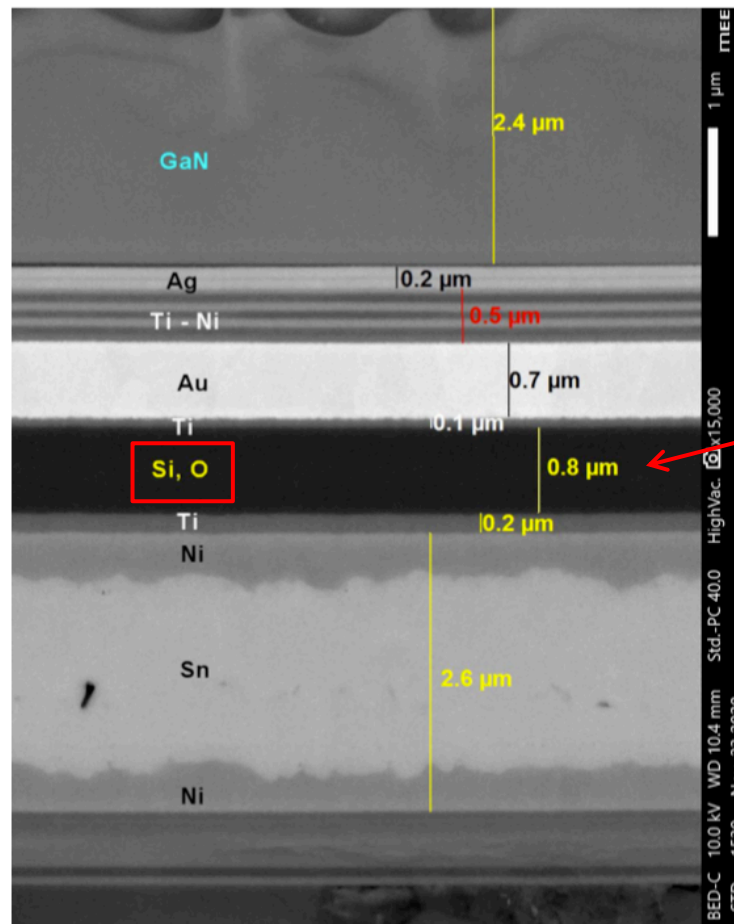
Backscattered Electron Image

Magnification: 2500X

**Source:** Galaxy S8 Teardown

	 <p>LED affixed to Si carrier wafer with an adhesive material (Tin (Sn)) having the property of thermal conductivity</p> <p>Source: Galaxy S8 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 property of optical diffusion.</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 S8 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>



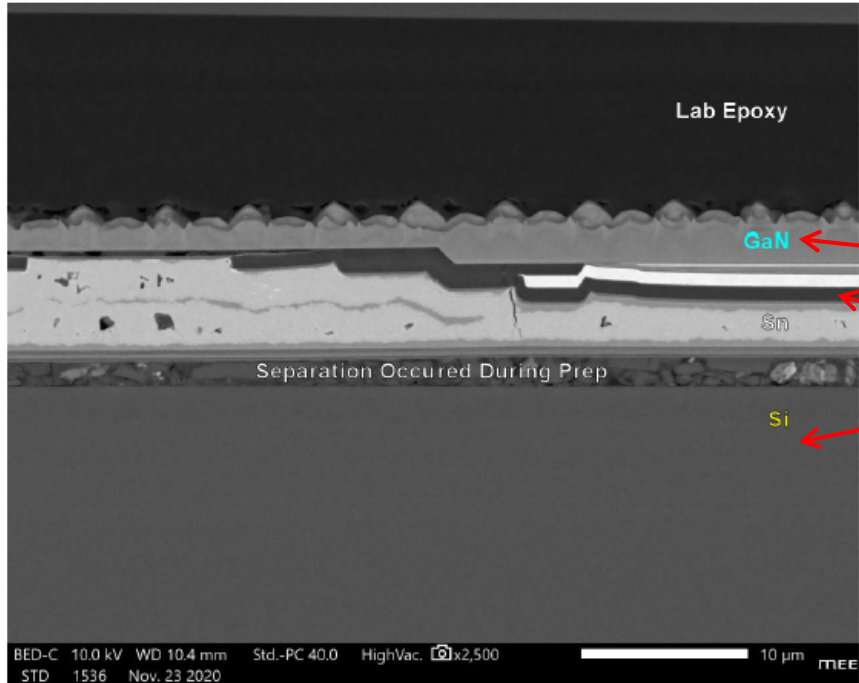


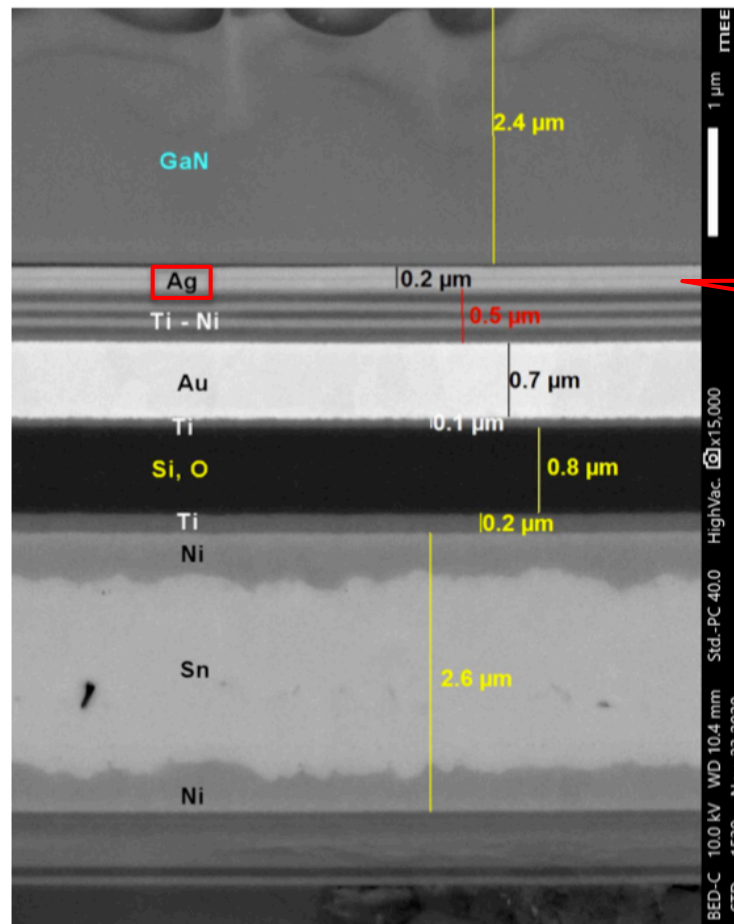
Backscattered Electron Image

Magnification: 15,000X (displayed at 24,000X)

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

**Source:** Galaxy S8 Teardown

	 <p>Backscattered Electron Image      Magnification: 2500X</p> <p><b>Source:</b> Galaxy S8 Teardown</p> <p>Semiconductor LED is affixed to Si carrier wafer with an adhesive material (Si, O) having the property of optical diffusion.</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 property of optical reflection.</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 S8 comprise semiconductor LED affixed to the carrier wafer (i.e., Si carrier wafer) with an adhesive material having the property of optical reflection.</p>

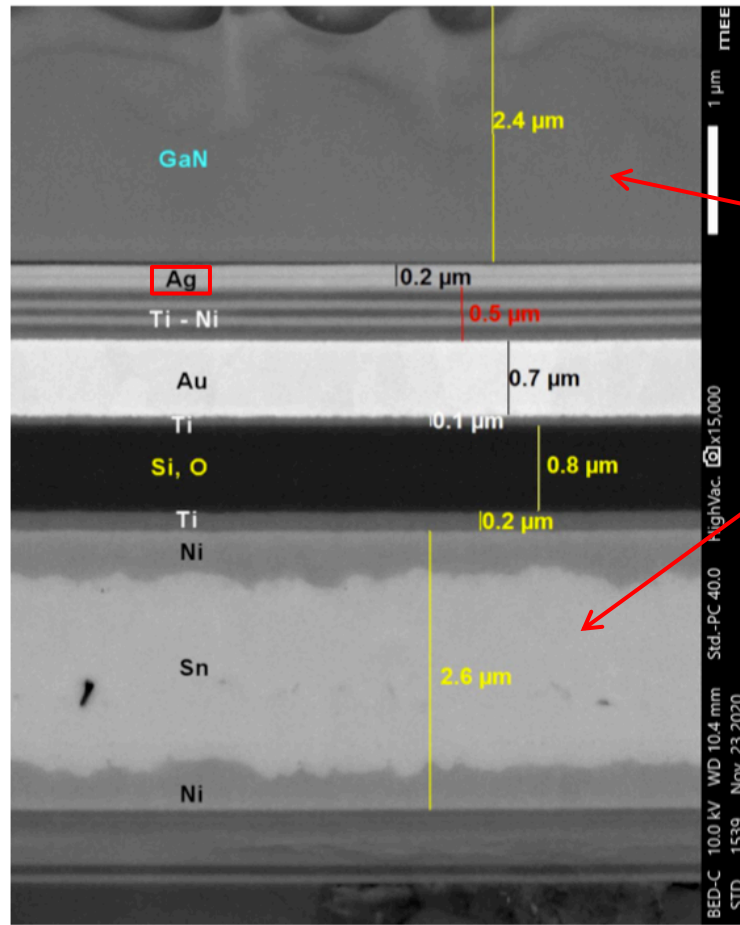


Adhesive material (Ag) with optical reflection property

Backscattered Electron Image

Magnification: 15,000X (displayed at 24,000X)

**Source:** Galaxy S8 Teardown



Backscattered Electron Image

Magnification: 15,000X (displayed at 24,000X)

LED affixed to Si carrier wafer with an adhesive material (Ag) having the property of optical reflection.

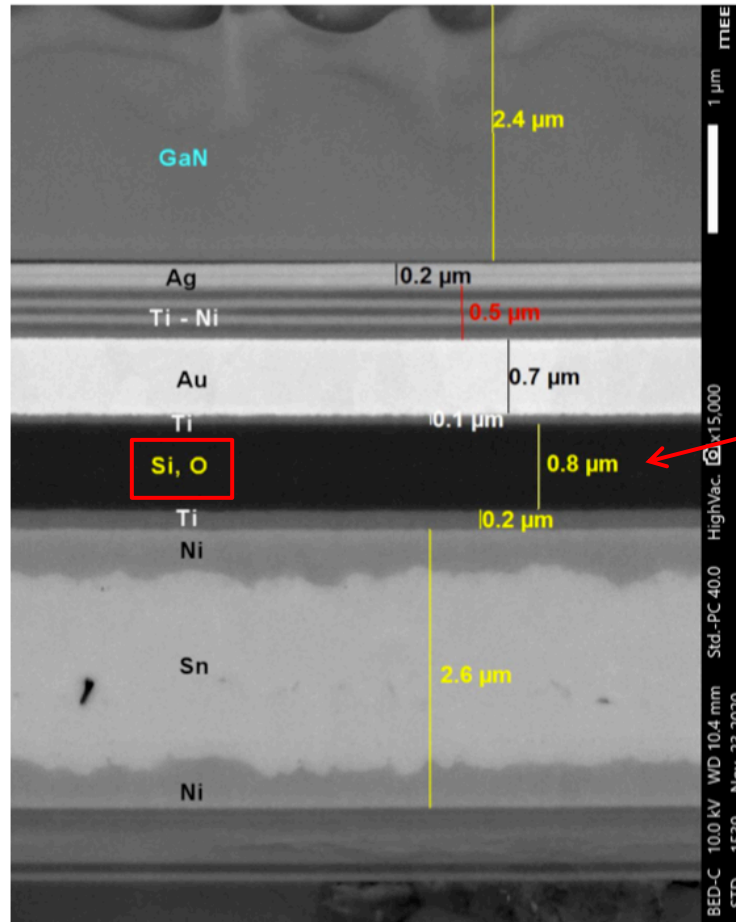
**Source:** Galaxy S8 Teardown

7. The light emitting device of claim 1, wherein said

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.

semiconductor LED is affixed to said carrier wafer with an adhesive material which has the property of optical transmissivity.

For Example, Samsung Galaxy S8 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.

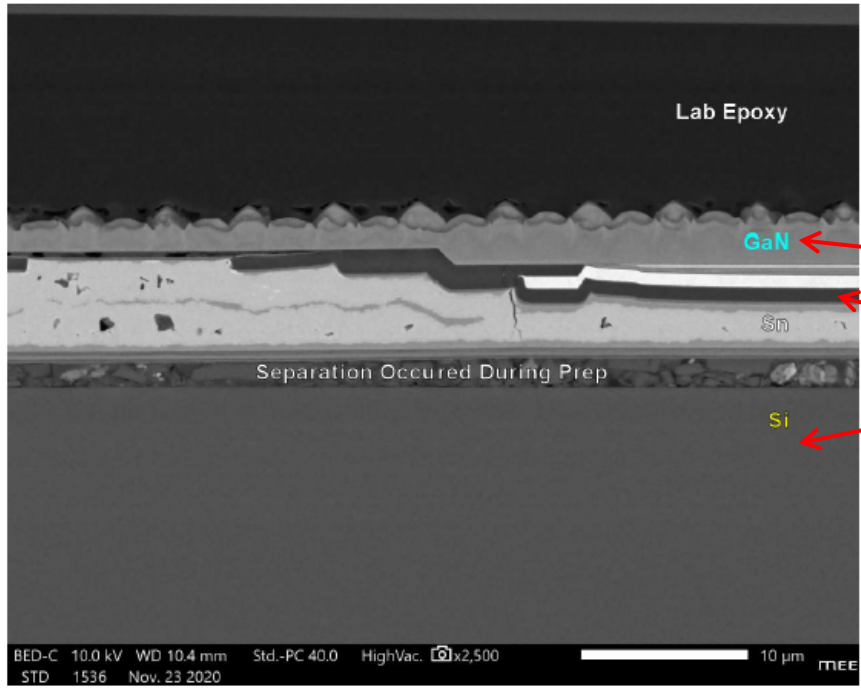


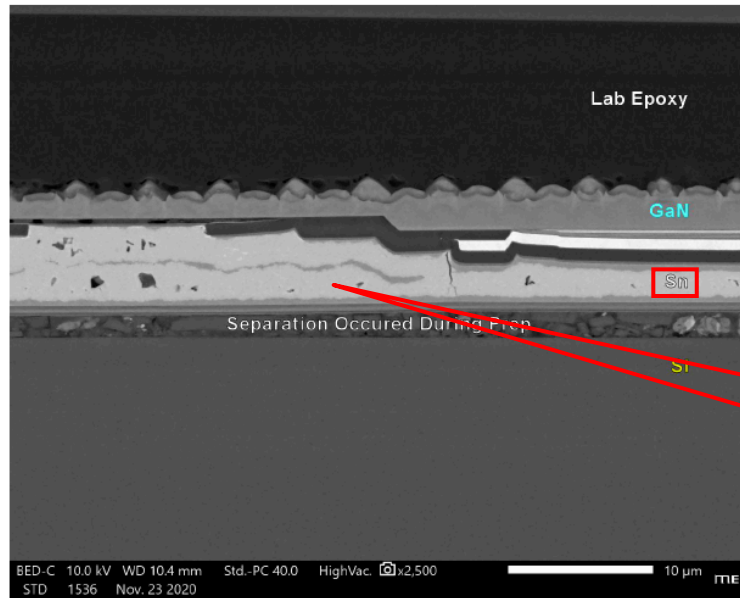
Backscattered Electron Image

Magnification: 15,000X (displayed at 24,000X)

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

**Source:** Galaxy S8 Teardown

	 <p>Backscattered Electron Image      Magnification: 2500X</p> <p><b>Source:</b> Galaxy S8 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 S8 has light emitting device include thermally conductive layer comprises metal (Tin (Sn)).</p>



Backscattered Electron Image

Magnification: 2500X

Thermally conductive layer comprises metal (Tin (Sn))

**Source:** Galaxy S8 Teardown