

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 S7

References Used:

Galaxy S7 Teardown

Samsung Flip Chip Technology

Reference Links:

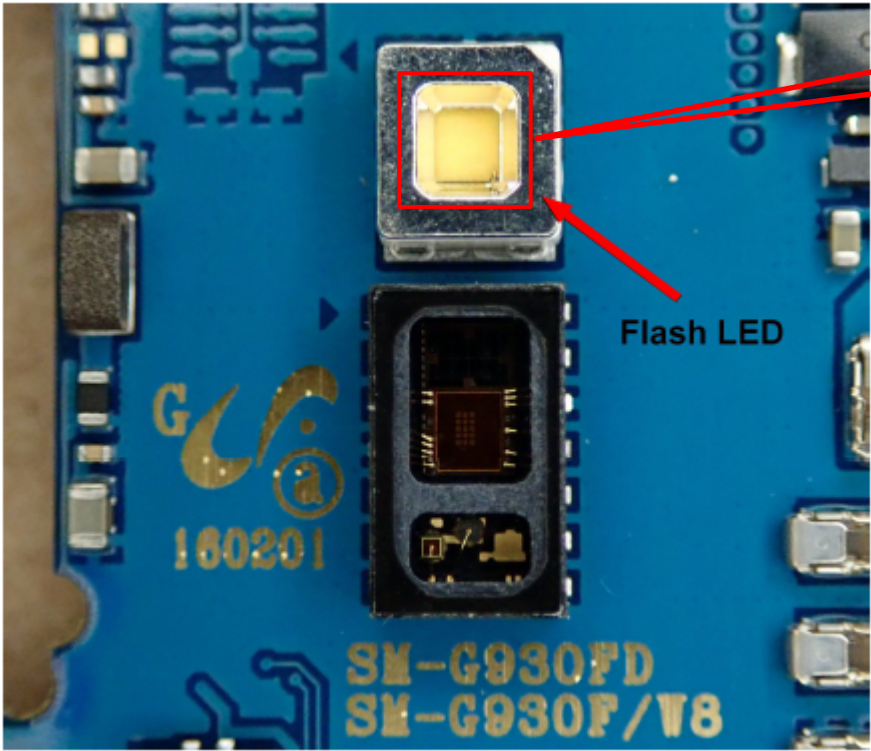
<https://www.samsung.com/led/insights/insights-detail-2/>

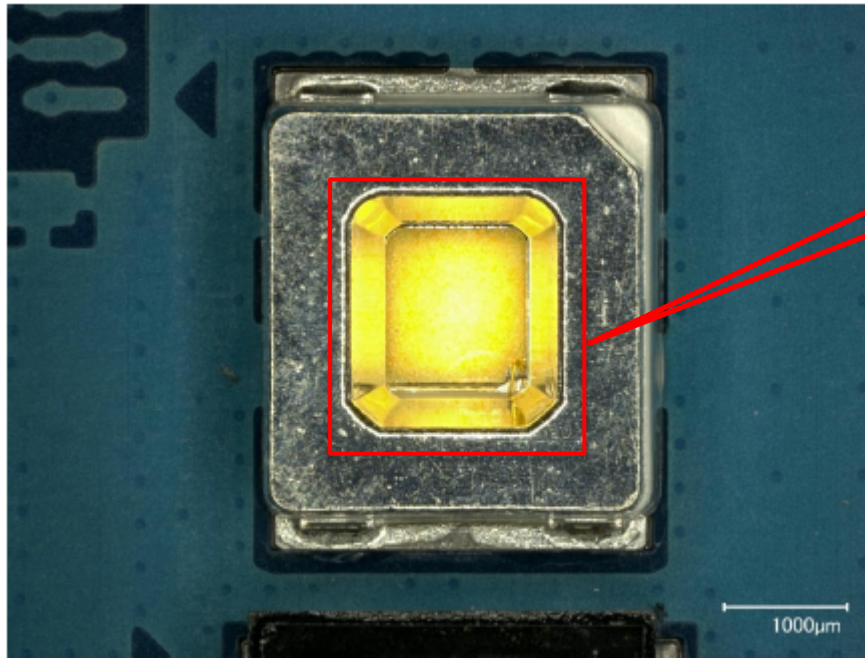
U.S. Patent No. 9, 502, 612 v. Samsung Galaxy S7

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 S7 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 S7 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>  </div> <p>Source: Galaxy S7 Teardown</p>



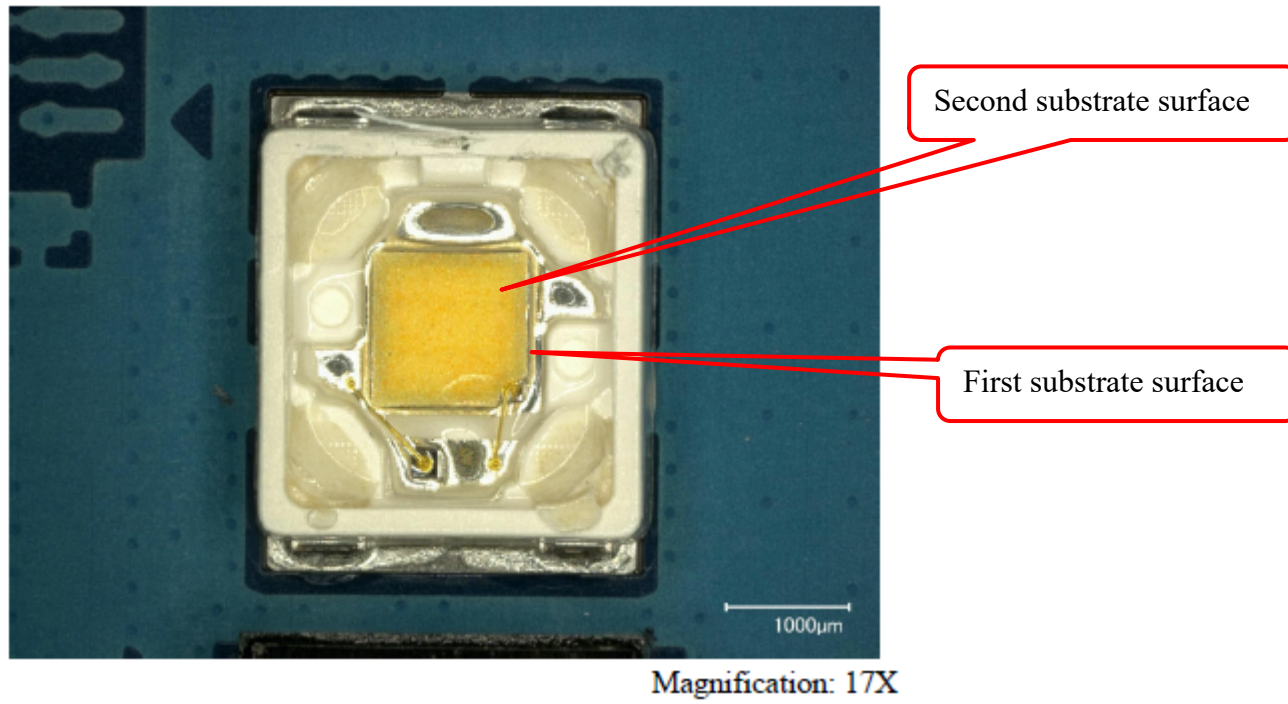
Magnification: 17X

Source: Galaxy S7 Teardown

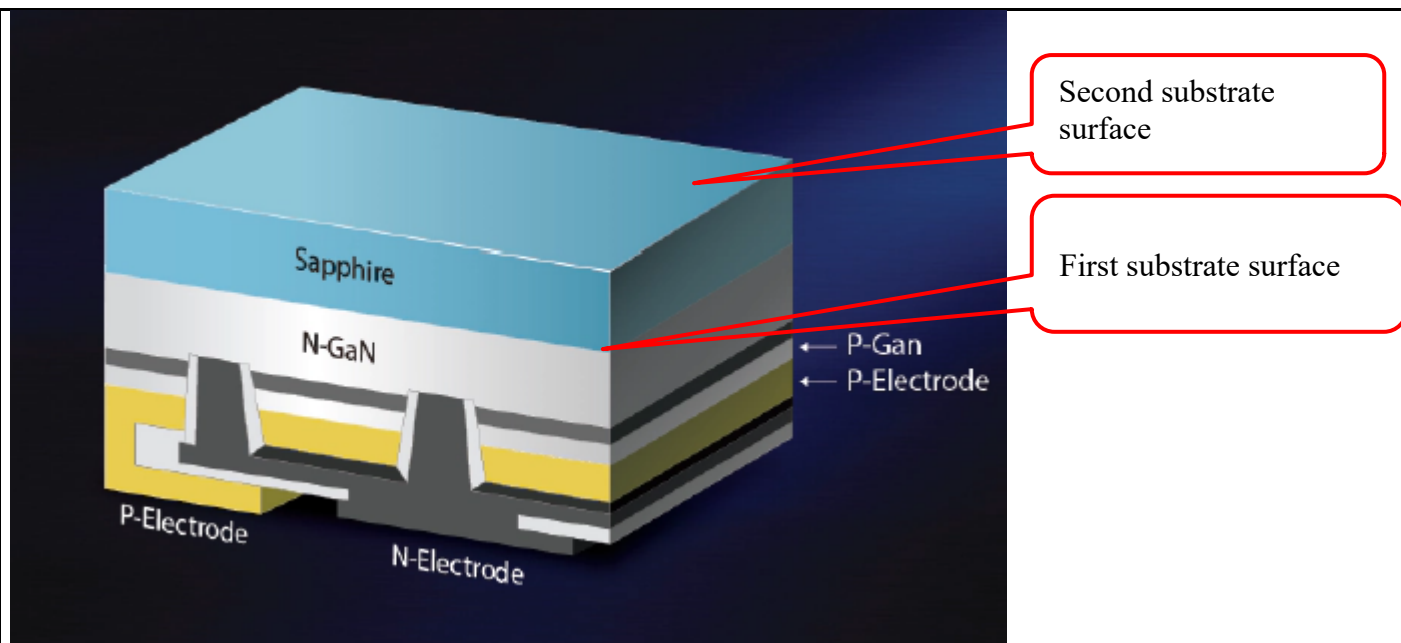
1[A] a substrate having opposing first and second substrate surfaces;

The Accused System and Method comprise a substrate having opposing first and second substrate surfaces.

For Example, the Samsung Galaxy S7 including flash LED and LED comprise of the yellowish layer (i.e., substrate) containing phosphor having opposing first and second surfaces.



Source: Galaxy S7 Teardown



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

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;

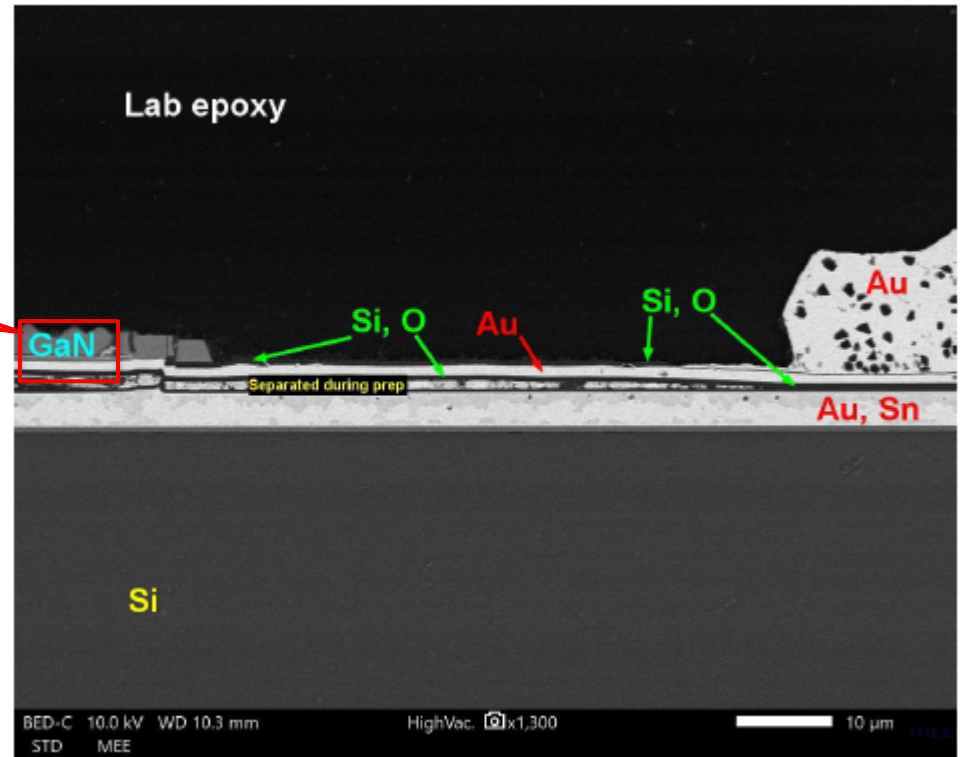
The Accused System and Method comprise a semiconductor LED including doped and intrinsic regions thereof, said semiconductor LED having opposing first and second LED surfaces, said first LED surface disposed on the first substrate surface.

For Example, Samsung Galaxy S7 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.

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.

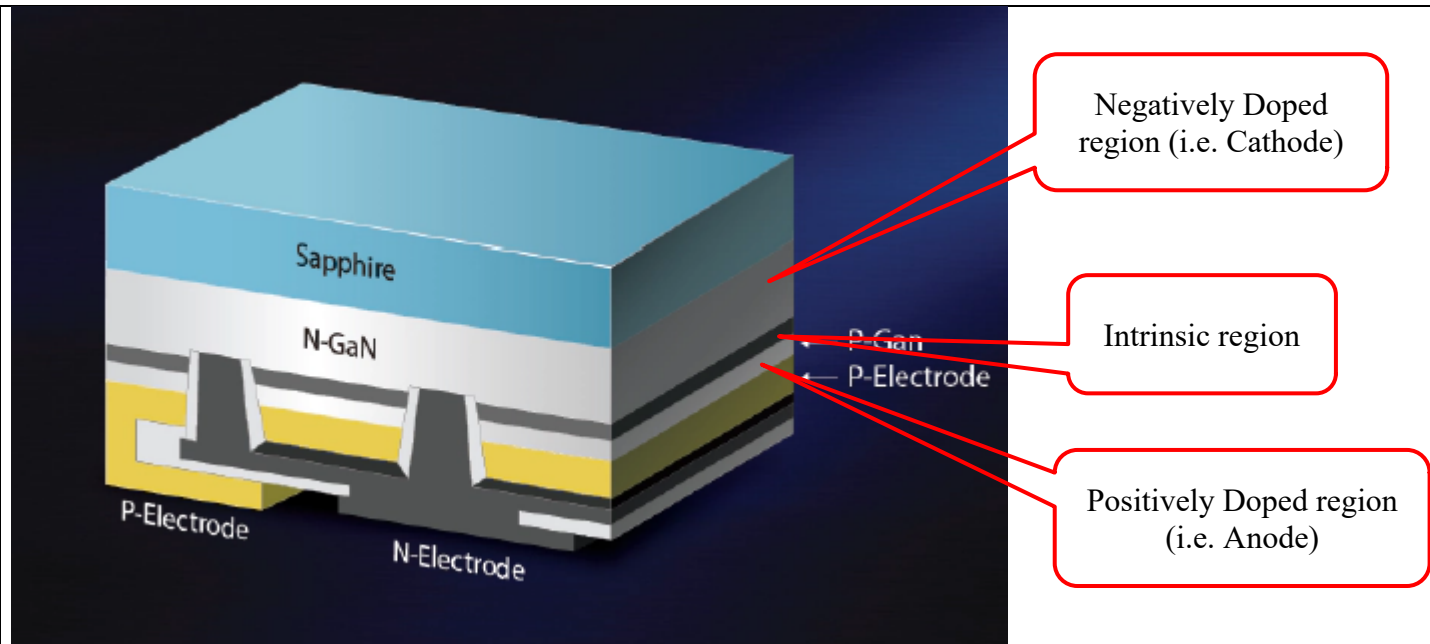
Flash LED includes doped GaN LED.



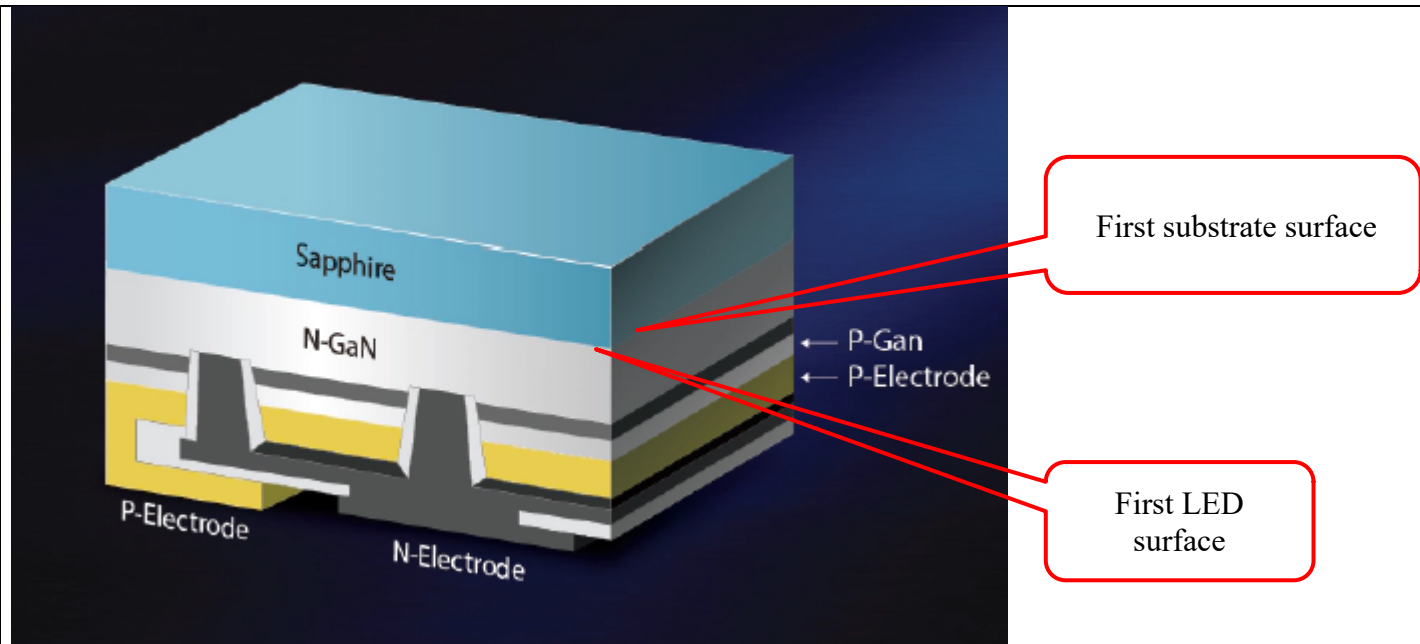
Backscattered Electron Image

Magnification: 1300X

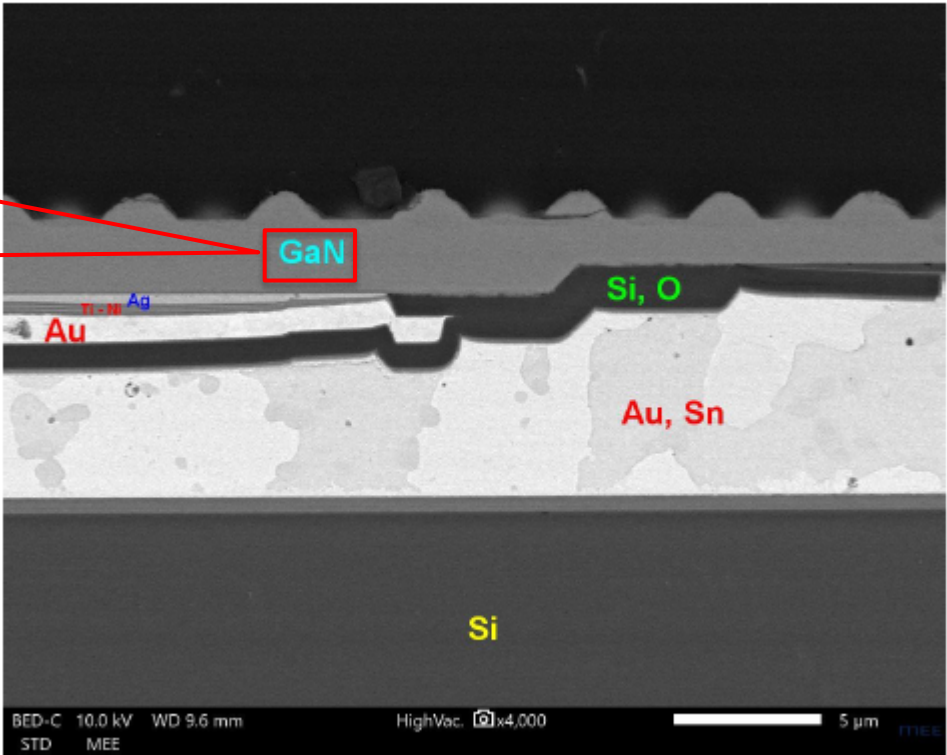
Source: Galaxy S7 Teardown



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

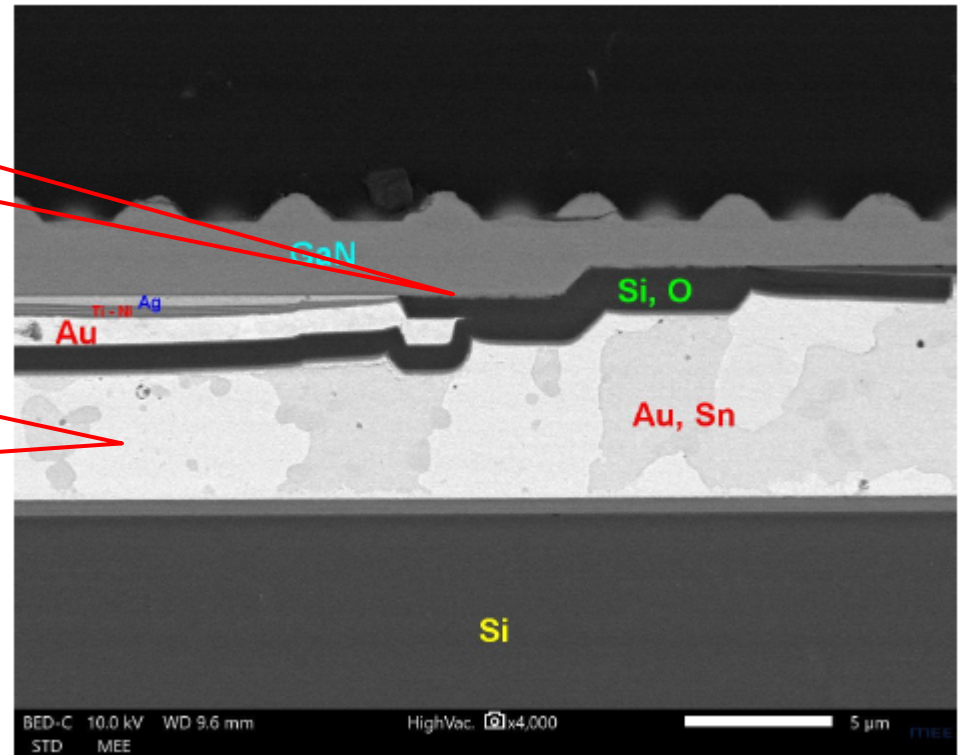


Source: Samsung Flip Chip Technology, Page 1
<https://www.samsung.com/led/insights/insights-detail-2/>

	<p>A negatively doped region of GaN, a positively doped region of GaN and an intrinsic region lies between the two doped regions.</p>  <p>Backscattered Electron Image</p> <p>Magnification: 4000X</p> <p>Source: Galaxy S7 Teardown</p>
<p>1[C] 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 S7 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

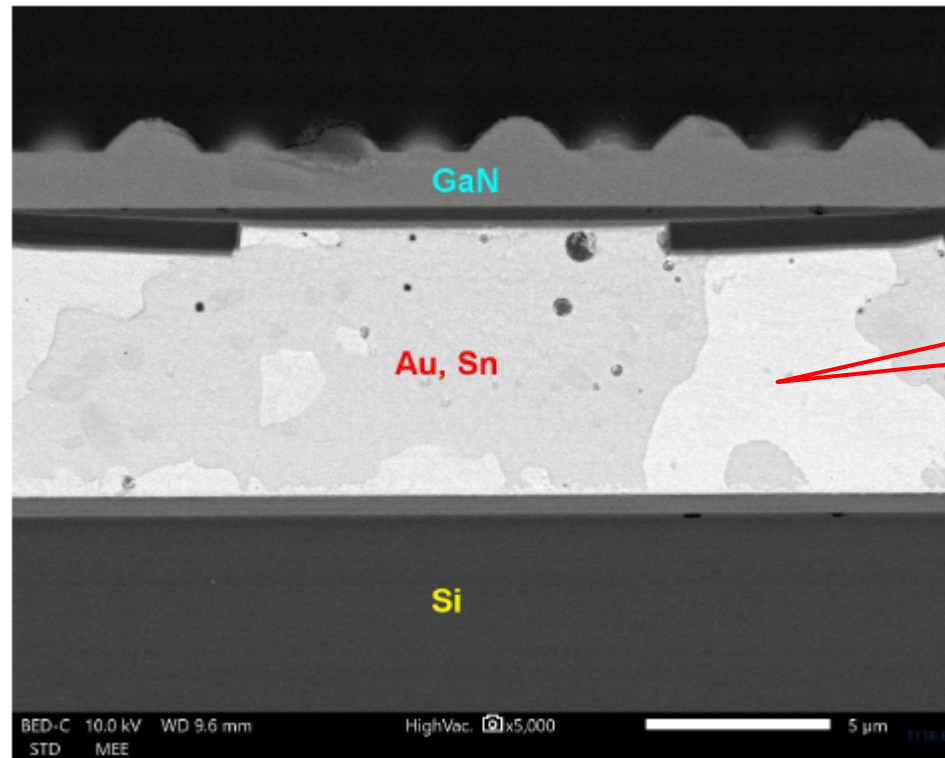
Thermally conductive layer on the opposite (i.e., second) surface of the LED



Backscattered Electron Image

Magnification: 4000X

Source: Galaxy S7 Teardown



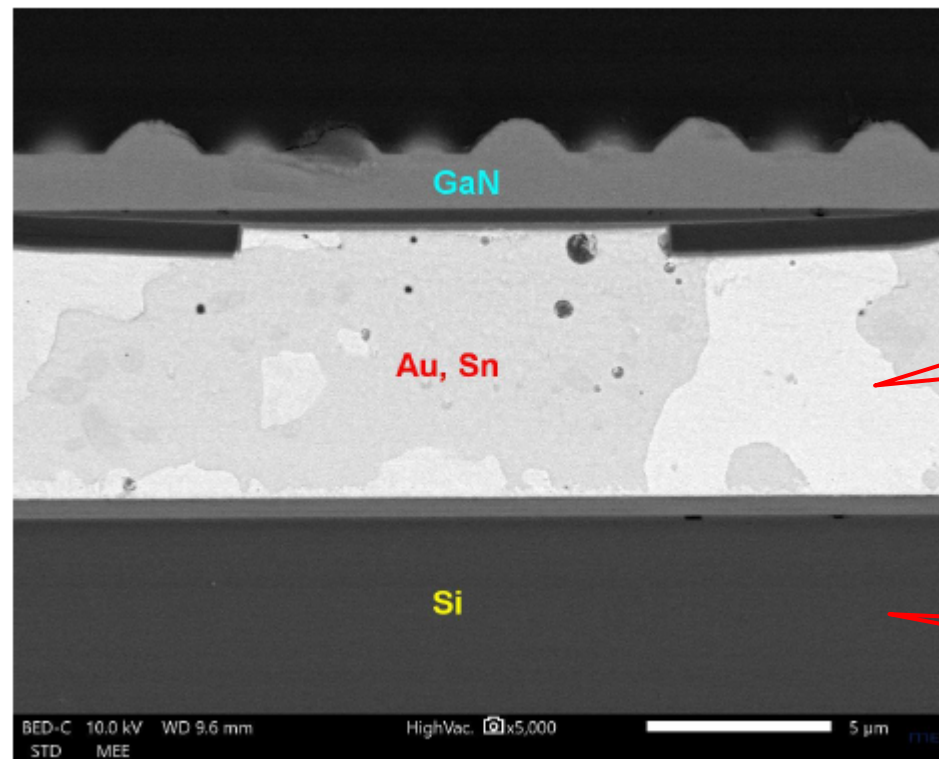
Thermally
conductive layer

Source: Galaxy S7 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.

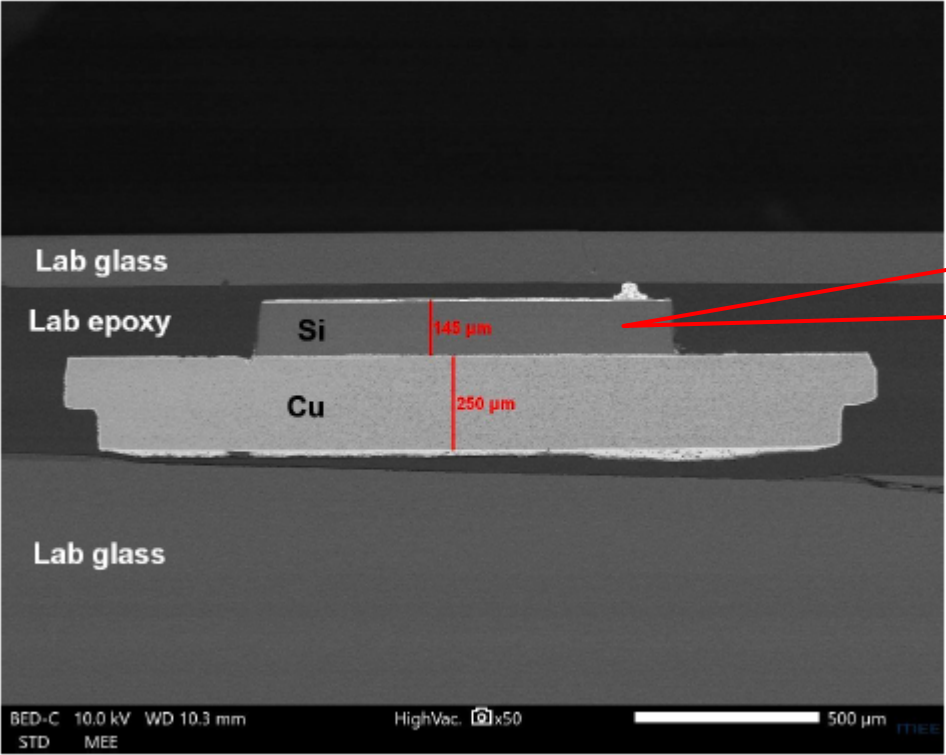
For Example, Samsung Galaxy S7 has a silicon carrier wafer disposed on the thermally conductive layers.

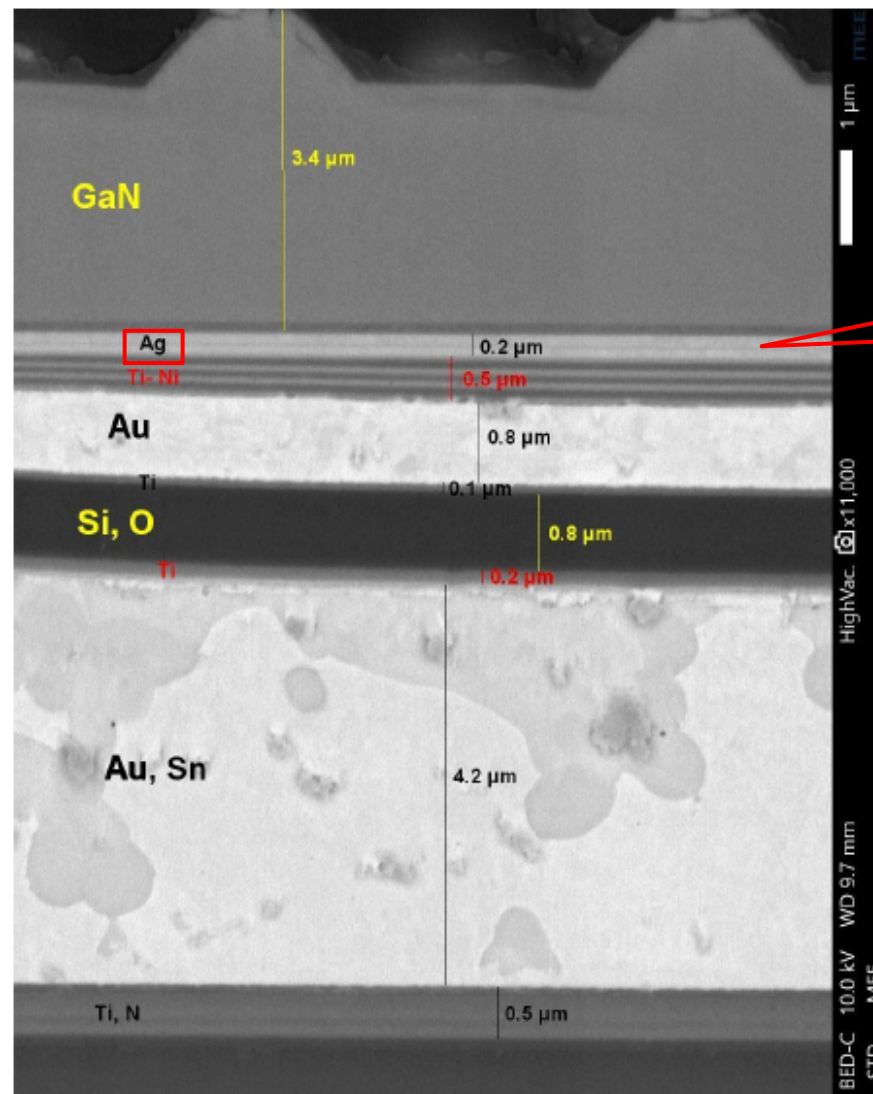


Thermally conductive layer

Si (Silicon) carrier wafer

Source: Galaxy S7 Teardown

	 <p>Si (Silicon) carrier wafer beneath the GaN and thermally conductive layer</p> <p>Lab glass</p> <p>Lab epoxy</p> <p>Si 145 μm</p> <p>Cu 250 μm</p> <p>Lab glass</p> <p>BED-C 10.0 kV WD 10.3 mm HighVac. x50 STD MEE</p> <p>500 μm</p> <p>Backscattered Electron Image Magnification: 50X</p> <p>Source: Galaxy S7 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 S7 comprise an optically reflective surface (comprising Silver (Ag)) disposed between the carrier wafer and the semiconductor LED.</p>

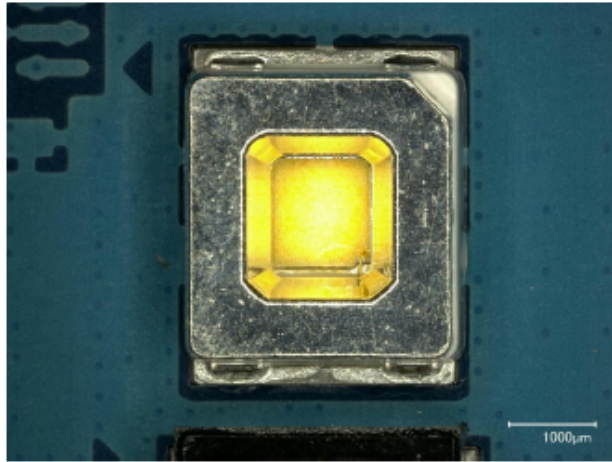


Backscattered Electron Image

Magnification: 11,000X (displayed at 17,200X)

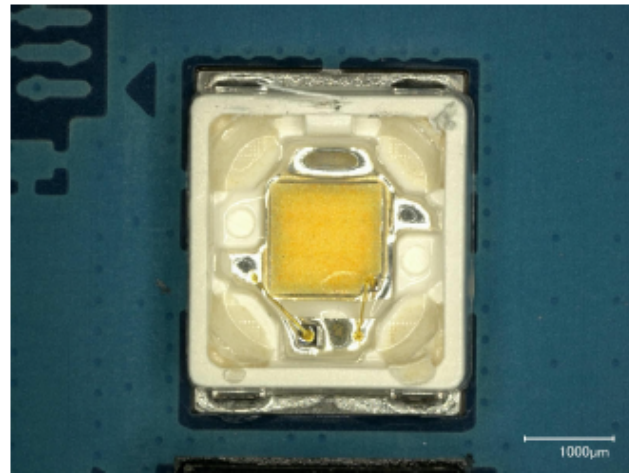
Source: Galaxy S7 Teardown

	<div> <p>Optically reflective surface (comprising Silver (Ag)) disposed between the carrier wafer (i.e., Si carrier wafer) and the semiconductor LED (i.e., GaN LED).</p> </div> <div> </div> <div> <p>Backscattered Electron Image Magnification: 4000X</p> </div>
<p>1[F] a substantially optically transmissive layer disposed proximal to the second substrate surface,</p>	<p>Source: Galaxy S7 Teardown</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 S7 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>



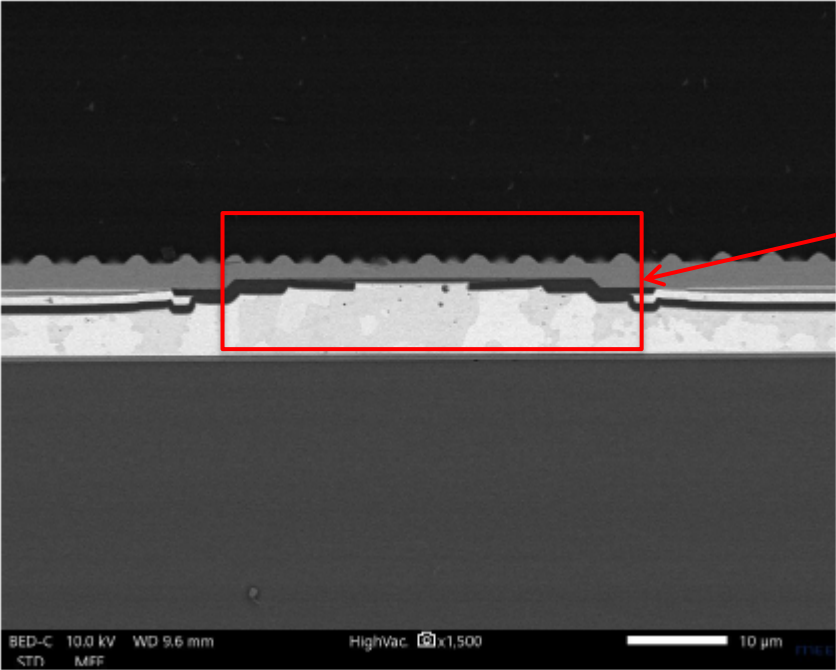
Magnification: 17X

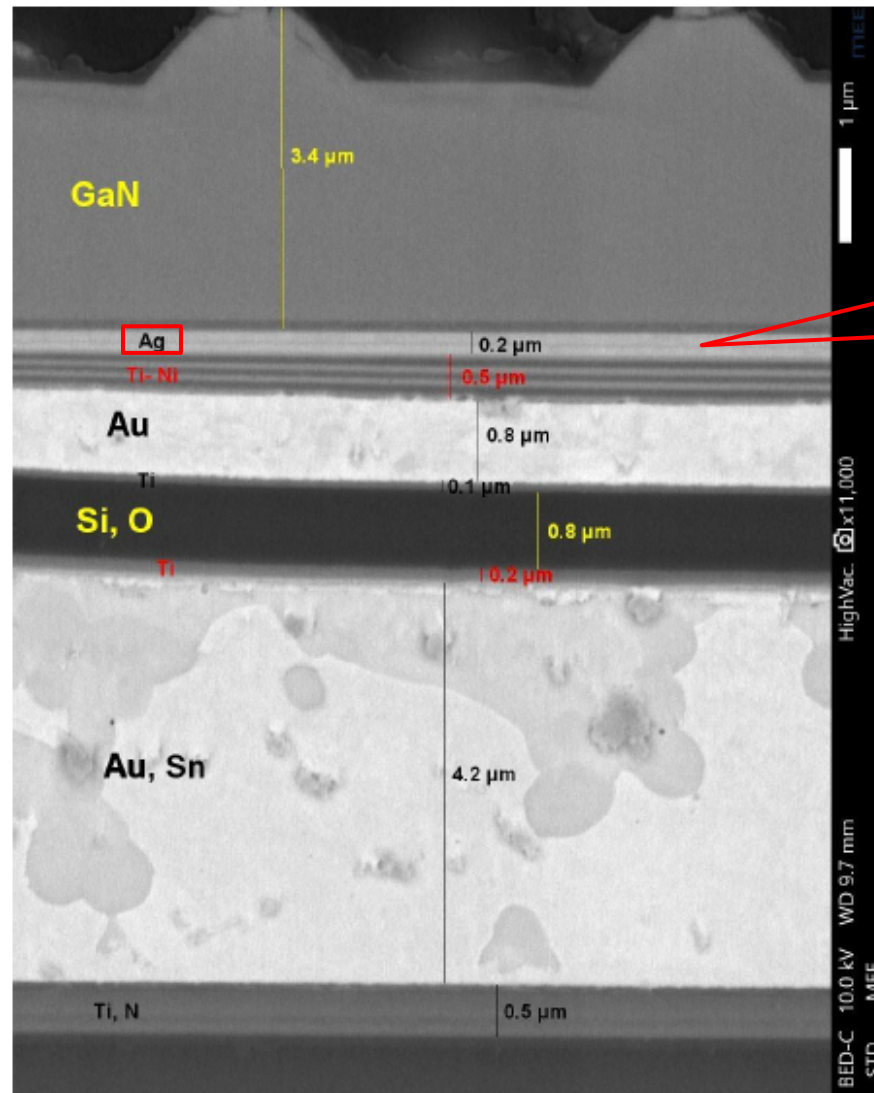
Source: Galaxy S7 Teardown



Magnification: 17X

	<p>Source: Galaxy S7 Teardown</p>
<p>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.</p>	<p>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.</p> <p>For Example, Samsung Galaxy S7 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.</p> <div> <p>Backscattered Electron Image</p> <p>Magnification: 4000X</p> </div> <div> <p>Thermally conductive metallic layer connected to second LED surface to relieve heat</p> </div> <div> <p>Silicon carrier wafer connected to second LED surface to relieve heat</p> </div> <p>Source: Galaxy S7 Teardown</p>

	 <p>Thermally conductive layer and carrier wafer define a relief to expose at least a portion of the second LED surface.</p> <p>Backscattered Electron Image Magnification: 1500X</p> <p>Source: Galaxy S7 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 S7 has optically reflective surface comprising metal (Silver (Ag))</p>



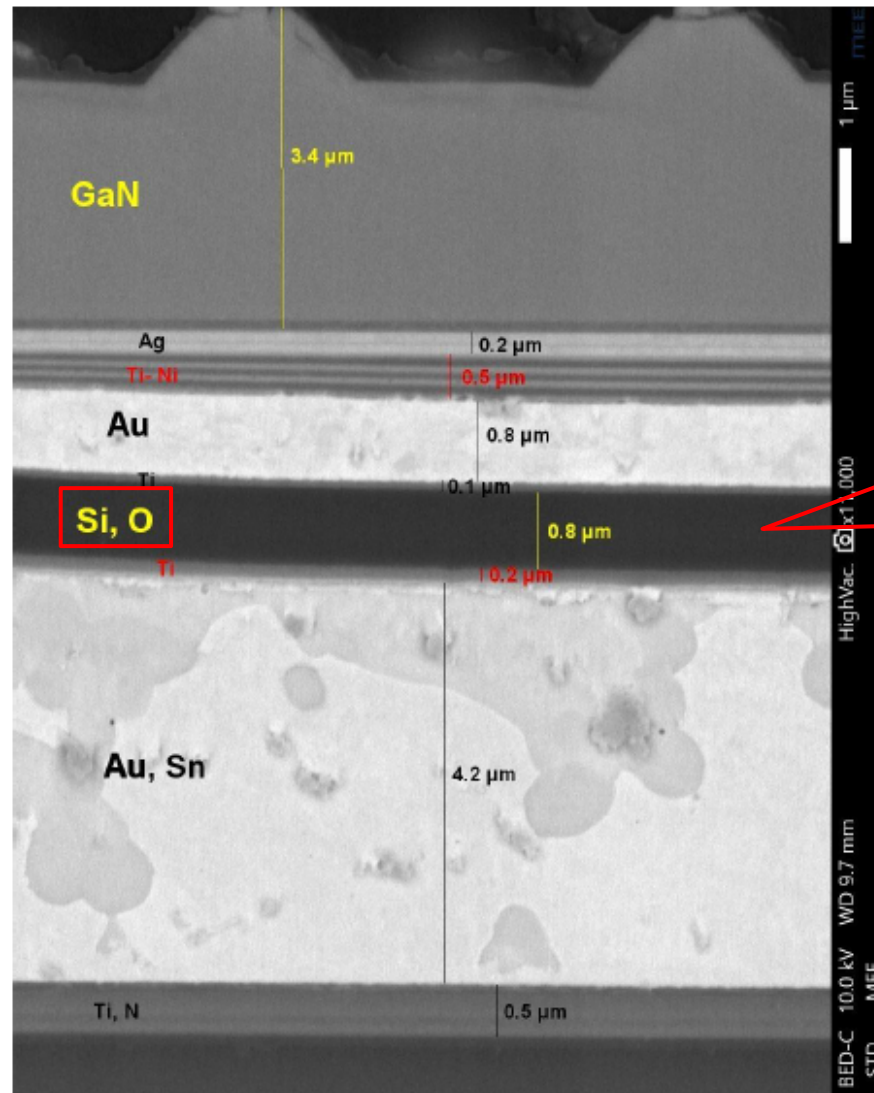
Optically reflective surface comprising metal (Silver (Ag))

Backscattered Electron Image

Magnification: 11,000X (displayed at 17,200X)

Source: Galaxy S7 Teardown

	<div> <p>Optically reflective surface comprising metal (Silver (Ag))</p> </div> <div> <p>A backscattered electron (BSE) image showing a cross-section of a layered material. The layers are labeled with chemical symbols: 'GaN' (cyan) at the top, followed by a thin layer with 'Si, O' (green) and 'Au' (red) labels. Below this is a thicker layer labeled 'Au, Sn' (red). The bottom-most layer is labeled 'Si' (yellow). A red callout box points to a small feature in the 'Au' layer. Technical data at the bottom reads: 'BED-C 10.0 kV WD 9.6 mm HighVac. x4,000 STD IMFF 5 μm'. The caption below the image is 'Backscattered Electron Image' and 'Magnification: 4000X'.</p> </div> <p>Source: Galaxy S7 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 S7 has light emitting device include an optically reflective surface comprising a dielectric stack.</p>



Optically reflective surface comprising a dielectric stack (Silicon Oxide (SiO))

Backscattered Electron Image

Magnification: 11,000X (displayed at 17,200X)

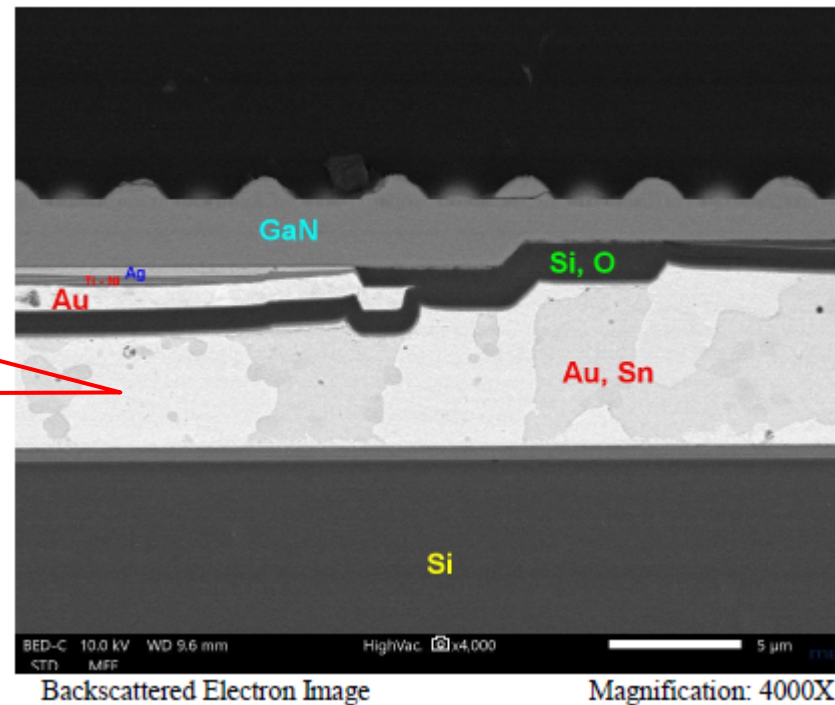
Source: Galaxy S7 Teardown

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.

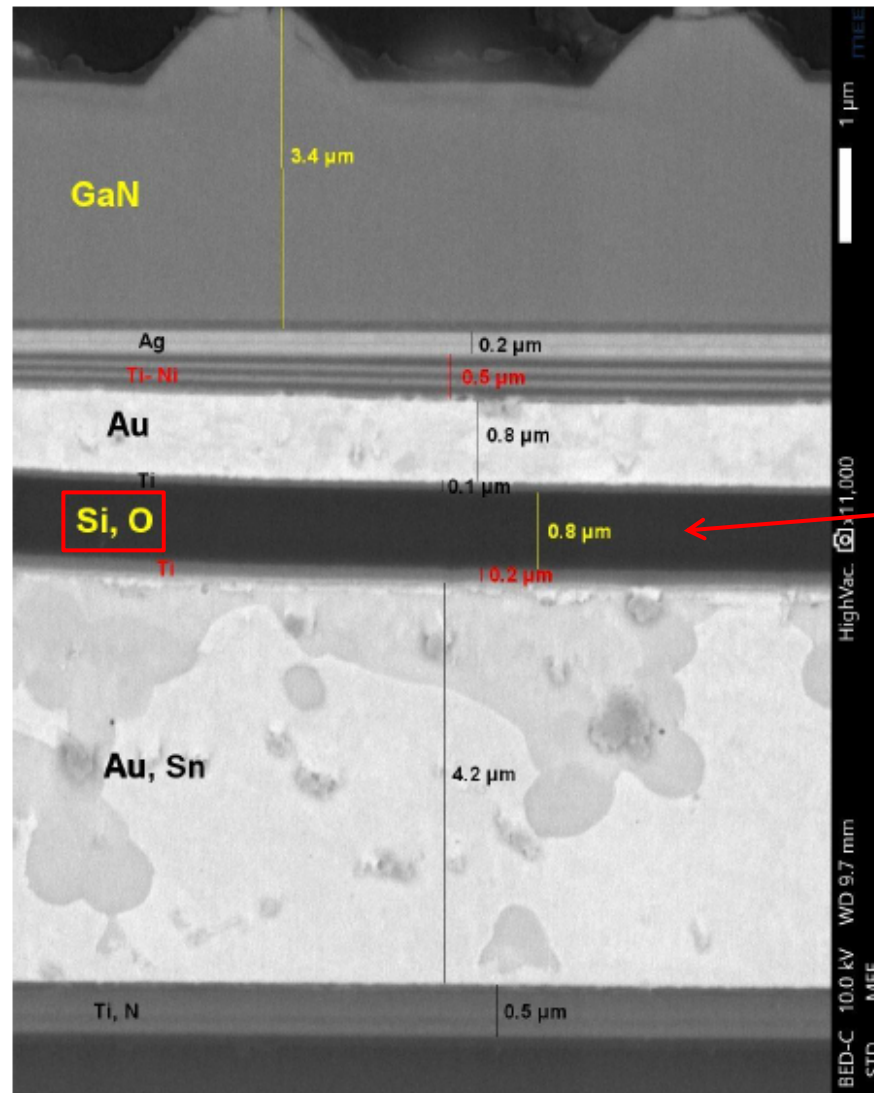
For Example, Samsung Galaxy S7 comprise semiconductor LED affixed to the carrier wafer (i.e., Si carrier wafer) with an adhesive material having the property of high thermal conductivity.

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



Source: Galaxy S7 Teardown

	<div> <p>LED affixed to Si carrier wafer with an adhesive material (Tin (Sn)) having the property of thermal conductivity</p> </div> <div> </div> <p>Source: Galaxy S7 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 S7 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>



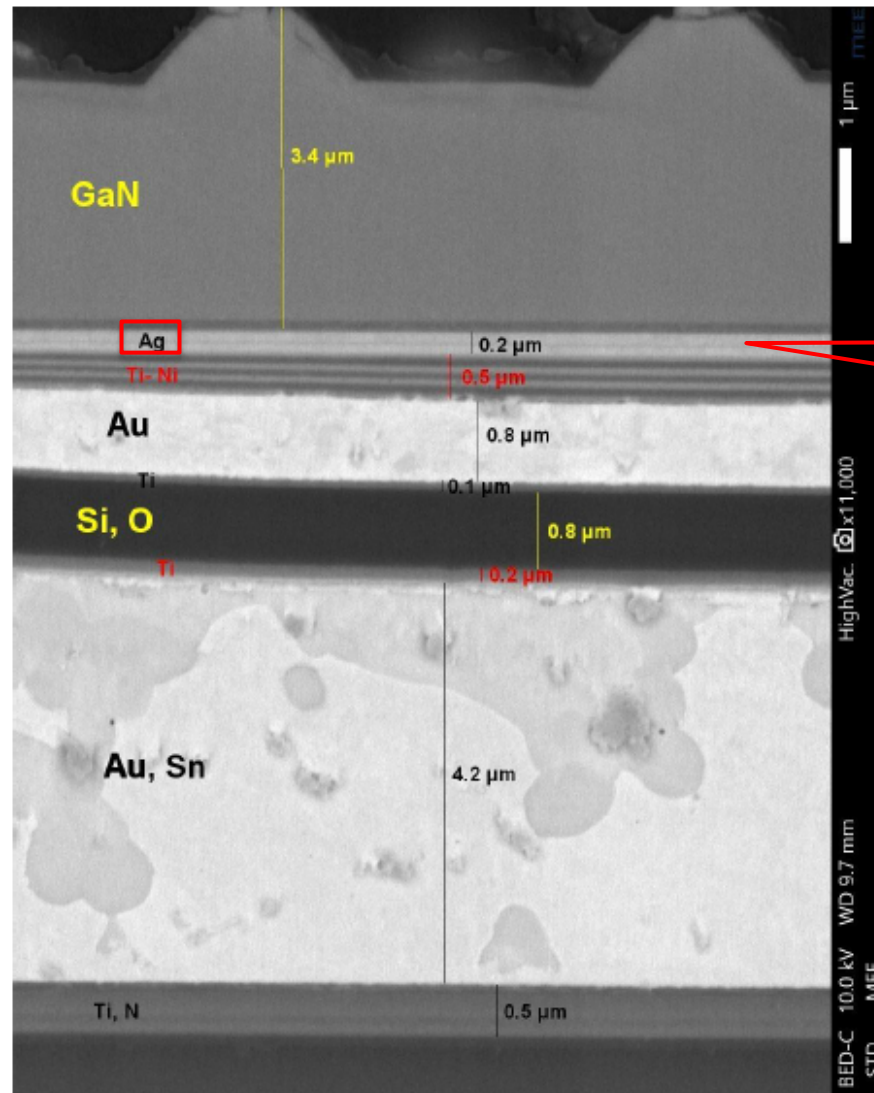
Backscattered Electron Image

Magnification: 11,000X (displayed at 17,200X)

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

Source: Galaxy S7 Teardown

	<div> <p>Semiconductor LED is affixed to Si carrier wafer with an adhesive material (Si, O) having the property of optical diffusion.</p> </div> <div> </div> <div> <p>Source: Galaxy S7 Teardown</p> </div>
<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 S7 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

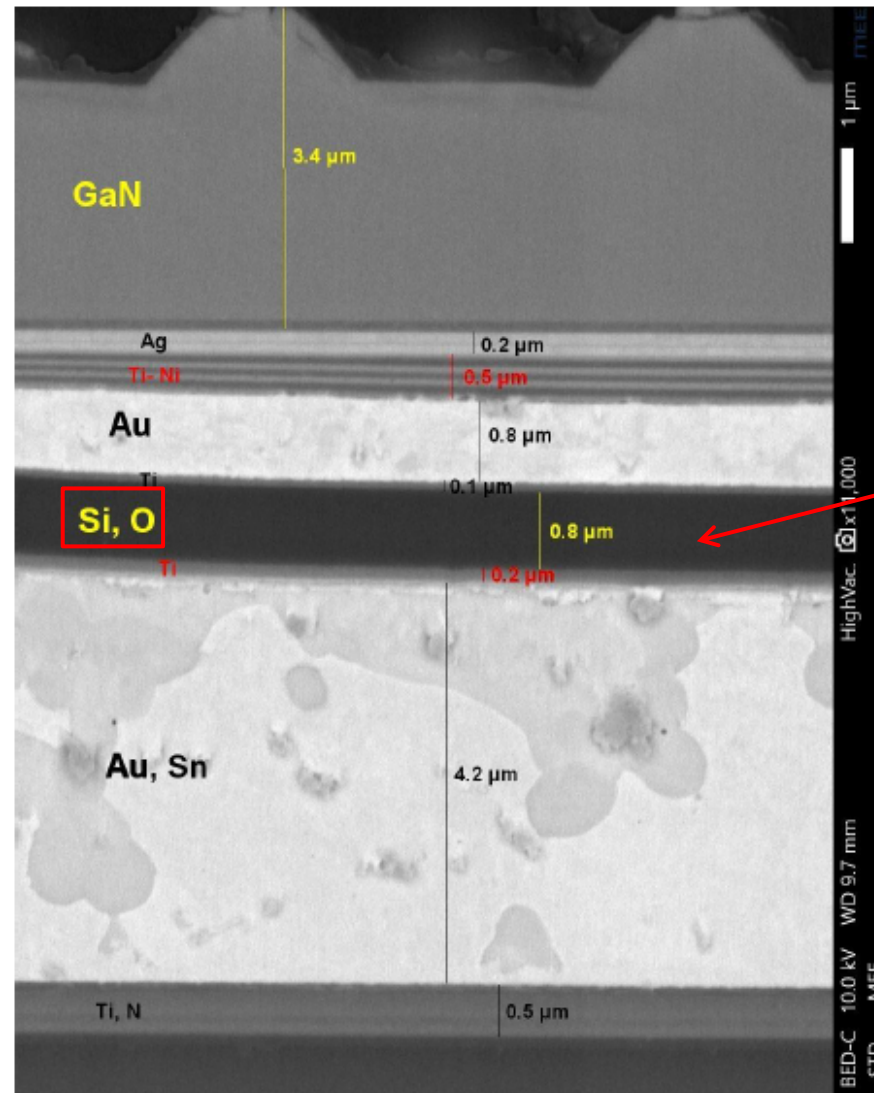
Backscattered Electron Image

Magnification: 11,000X (displayed at 17,200X)

Source: Galaxy S7 Teardown

	<div> <p>LED affixed to Si carrier wafer with an adhesive material (Ag) having the property of optical reflection.</p> </div> <div> </div> <p>Source: Galaxy S7 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 property of optical</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 S7 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>

transmissivity.



Backscattered Electron Image

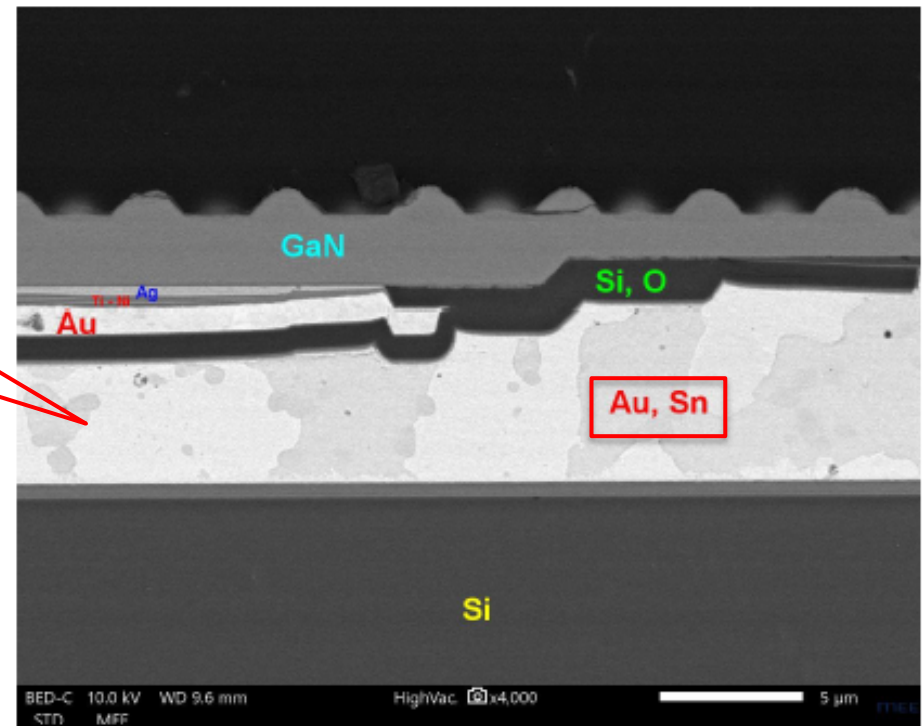
Magnification: 11,000X (displayed at 17,200X)

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

Source: Galaxy S7 Teardown

	<div> <p>Semiconductor LED is affixed to Si carrier wafer with an adhesive material (Si, O) having the property of optical transmissivity.</p> </div> <div> </div> <div> <p>Source: Galaxy S7 Teardown</p> </div>
<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 S7 has light emitting device include thermally conductive layer comprises metal (Tin (Sn)).</p>

Thermally conductive
layer comprises metal
(Tin (Sn))



Backscattered Electron Image

Magnification: 4000X

Source: Galaxy S7 Teardown