disposed between the n-type layer 120 and a p-type layer 140. The result is an LED formed by the n-type layer 120, the active region 130, and the p-type layer 140. A first contact 160 provides an electrical connection to the n-type layer 120 and a second contact 150 provides another electrical connection to the to the p-type layer 140. These contacts may be opaque to the wavelength of light emitted by the LED and, as a result, may diminish the overall amount of light available from the LED. Thus, only the area between the first contact 160 and the second contact 150 may produce significant amounts of light. The physical layout of the second contact 150 relative to the n-type layer 120 may cause current crowding in the current flowing between the p-type layer 140 and the n-type layer 120. In addition, the physical layout may require that both p and n-type contacts are disposed on an upper surface of the LED structure, wherein such a physical layout may require removal of a portion of the device layers to expose regions for contacting. The removal of a portion of the device layers may increase the complexity of device fabrication, may reduce the area available for light generation and may also decrease device yield.

[0008] In view of the above, and for other reasons discussed below, there is a need for a substrate technology that provides a suitable base substrate for donated material from a donor structure. Moreover, there is a need for devices and methods that provide a support substrate with a closely matching Coefficient of Thermal Expansion (CTE) with that of an engineered substrate.

BRIEF SUMMARY

[0009] The various embodiments of the present invention generally relate to engineered substrates and methods of producing the engineered substrates that provide a suitable base substrate with a CTE that closely matches a CTE of the engineered substrate.

[0010] This summary is provided to introduce a selection of concepts in a simplified form that are further described in the detailed description below of some example embodiments of the invention. This summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used to limit the scope of the claimed subject matter.

[0011] ~~In some embodiments, the present invention includes methods of fabricating a semiconductor substrate, the methods include forming a weakened zone in a donor structure at a predetermined depth to define a transfer layer between an attachment surface and the weakened zone and a residual donor structure between the weakened zone and a surface opposite the attachment surface. A metallic layer is formed on the attachment surface and provides a matched~~

~~Coefficient of Thermal Expansion (CTE) for the metallic layer that closely matches a CTE of the transfer layer, and sufficient stiffness to provide structural support to the transfer layer. The transfer layer is separated from the donor structure at the weakened zone to form a composite substrate comprising the transfer layer and the metallic layer.~~According to a first aspect of the present invention, there is provided a method of fabricating a semiconductor substrate, comprising: forming a weakened zone in a donor structure at a predetermined depth to define a transfer layer between an attachment surface and the weakened zone and a residual donor structure between the weakened zone and a surface opposite the attachment surface; depositing a metallic layer on the attachment surface and forming a metallic support structure comprising the metallic layer on the attachment surface, wherein the metallic layer provides: a matched Coefficient of Thermal Expansion (CTE) for the metallic layer that closely matches a CTE of the transfer layer; and sufficient stiffness to provide structural support to the transfer layer; and separating the transfer layer from the donor structure at the weakened zone to form a composite substrate comprising the transfer layer and the metallic layer.

[0012] There are also disclosed~~In additional embodiments, the present invention includes~~ methods of fabricating a semiconductor substrate, the methods include forming a weakened zone in a donor structure at a predetermined depth to define a transfer layer between an attachment surface and the weakened zone and a residual donor structure between the weakened zone and a surface opposite the attachment surface. An ohmic contact is formed between the transfer layer and a contact layer disposed thereon. A low impedance coupling is formed between a refractory metal layer and the contact layer, wherein the refractory metal layer provides a structural support for the semiconductor substrate. The methods also include separating the transfer layer from the donor structure at the weakened zone to form a composite substrate comprising the transfer layer the contact layer, and the refractory metal layer.

[0013] ~~In other embodiments, the present invention comprises a semiconductor substrate including a metallic support substrate configured to provide a sufficient stiffness to the semiconductor substrate. The semiconductor substrate also includes a transfer layer comprising a semiconductor material in contact with an attachment surface of the metallic support substrate, wherein the transfer layer is detached from a donor structure comprising the semiconductor material and including a weakened zone in the donor structure at a predetermined depth from the attachment surface to define the transfer layer between the attachment surface and the weakened zone. A matched CTE of the metallic support substrate closely matches a CTE of the transfer layer.~~According to a second aspect of the present invention, there is provided a semiconductor substrate, comprising: a metallic support substrate configured to provide a sufficient stiffness to the semiconductor substrate; and a transfer layer comprising a semiconductor material in contact with an attachment surface of the metallic support substrate, wherein the transfer layer is detached from a donor structure comprising the semiconductor material and including

a weakened zone in the donor structure at a predetermined depth from the attachment surface to define the transfer layer between the attachment surface and the weakened zone; wherein a matched Coefficient of Thermal Expansion (CTE) of the metallic support substrate closely matches a CTE of the transfer layer; and wherein the metallic support substrate comprises: a contact layer adjacent the attachment surface and providing a conductive contact with the transfer layer; and a refractory metal layer conductively coupled with and adjacent the contact layer, wherein the refractory metal layer provides the sufficient stiffness to provide structural support for the semiconductor substrate and provides the matched CTE.

[0014] Further aspects, details, and alternate combinations of the elements of embodiments of the invention will be apparent from the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] The present invention may be understood more fully by reference to the following detailed description of example embodiments of the present invention, which are illustrated in the appended figures in which:

[0016] FIG. 1 is a simplified cross-section drawing of a conventional LED structure;