CLAIMS

1. A method of manufacturing a light emitting diode (LED) device comprising:

forming an LED structure by depositing a plurality of semiconductor layers on a transparent substrate;

placing trenched metal in the plurality of semiconductor layers, with the trenched metal contacting the transparent substrate, the trenched metal is arranged to define a trenched grid;

attaching the LED structure to a CMOS structure with electrical interconnects that define a cavity therebetween;

coating a sidewall of the transparent substrate with an anti-stick material to form a coated sidewall, wherein there is no anti-stick material in the cavity;

depositing an underfill material in the cavity such that the underfill material does not contact the coated sidewall of the transparent substrate;

removing the underfill material from areas outside of the cavity; and

directing laser light to provide laser lift-off of the transparent substrate from the plurality of semiconductor layers.

2. The method of manufacturing a light emitting diode (LED) device of claim 1, wherein the transparent substrate is sapphire.

3. The method of manufacturing a light emitting diode (LED) device of claim 1, wherein the electrical interconnects are electrically conductive pillars.

4. A method of manufacturing a light emitting diode (LED) device comprising:

attaching an LED structure including trenched metal within a plurality of semiconductor layers formed on a transparent substrate to a CMOS structure with electrical interconnects that define a cavity therebetween, the plurality of semiconductor layers and trenched metal arranged into a grid that defines pixels, wherein the trenched metal contacts the transparent substrate;

coating a sidewall of the transparent substrate with an anti-stick material to form a coated sidewall, wherein there is no anti-stick material in the cavity;

depositing an underfill material in the cavity such that the underfill material does not contact the coated sidewall of the transparent substrate;

removing the underfill material from areas outside of the cavity; and

directing laser light to provide laser lift-off of the transparent substrate from the plurality of semiconductor layers.

5. The method of manufacturing a light emitting diode (LED) device of claim 4, wherein the substrate is sapphire.

6. The method of manufacturing a light emitting diode (LED) device of claim 4, wherein the plurality of semiconductor layers are GaN.

7. The method of manufacturing a light emitting diode (LED) device of claim 4, wherein the electrical interconnects are electrically conductive pillars.

8. A method of manufacturing a micro light emitting diode (μLED) device comprising:

depositing a plurality of semiconductor layers on a transparent substrate to form a μLED structure, the transparent substrate having a lateral dimension of less than 100 μm x 100 μm;

placing trenched metal in the plurality of semiconductor layers, with the trenched metal contacting the transparent substrate, the trenched metal arranged to define a trenched grid and defining a plurality of spaced mesas;

attaching the μLED structure to a wafer with electrical interconnects that define a cavity therebetween;

coating a sidewall of the transparent substrate with an anti-stick material to form a coated sidewall, wherein there is no anti-stick material in the cavity;

depositing an underfill material in the cavity;

removing the underfill material from areas outside of the cavity; and

directing laser light to provide laser lift-off of the transparent substrate from the plurality of semiconductor layers.

9. The method of manufacturing a micro light emitting diode (μLED) of claim 8, wherein the transparent substrate is sapphire.

10. The method of manufacturing a micro light emitting diode (μLED) of claim 8, wherein the electrical interconnects are electrically conductive pillars.

11. The method of manufacturing a micro light emitting diode (μLED) of claim 8, wherein the trenched metal comprises a reflective metal.

12. The method of manufacturing a micro light emitting diode (μLED) of claim 8, wherein the plurality of spaced mesas is arranged into pixels with a pixel pitch in a range of from 1 μm to 100 μm.

13. The method of manufacturing a micro light emitting diode (μLED) of claim 12, wherein the pixel pitch is in a range of from 30 μm to 50 μm.

14. The method of manufacturing a micro light emitting diode (μLED) of claim 8, wherein the semiconductor layers comprise one or more of an N-type layer, an active layer, and a P-type layer.