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, wherein the trenched metal is arranged to define a trenched grid;

attaching the LED structure to a complementary metal-oxide-semiconductor (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, wherein 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 claim 1, wherein the transparent substrate is sapphire.

3. The method 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, wherein the underfill material does not contact the coated sidewall of the transparent substrate; and

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

5. The method of claim 4, wherein the substrate is sapphire.

6. The method of claim 4, wherein the plurality of semiconductor layers are GaN.

7. The method 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;

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 claim 8, wherein the transparent substrate is sapphire.

10. The method of claim 8, wherein the electrical interconnects are electrically conductive pillars.

11. The method of of claim 8, wherein the trenched metal comprises a reflective metal.

12. The method of 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 of claim 12, wherein the pixel pitch is in a range of from 30 µm to 50 µm.

14. The method of claim 8, wherein the semiconductor layers comprise one or more of an N-type layer, an active layer, and a P-type layer.