

CLAIMS:

1. A method of forming a monolithic LED precursor, the method comprising:
 - (a) providing a substrate having a top surface;
 - 5 (b) forming a first semiconductor layer comprising a Group III-nitride on the top surface of the substrate;
 - (c) selectively masking the first semiconductor layer with a LED mask layer, the LED mask layer comprising an aperture defining a LED well through a thickness of the LED mask layer to an unmasked portion of the first semiconductor layer, the LED well
 - 10 comprising LED well sidewalls extending from a top surface of the first semiconductor layer to a top surface of the LED mask layer;
 - (d) selectively forming a monolithic LED stack within the LED well on the unmasked portion of the first semiconductor layer, the monolithic LED stack comprising:
 - a n-type semiconductor layer comprising a Group III-nitride formed
 - 15 on the first semiconductor layer;
 - an active layer formed on the first semiconductor layer comprising one or more quantum well sub-layers, the active layer comprising a Group III-nitride;
 - a p-type semiconductor layer comprising a Group III-nitride formed
 - 20 on the active layer;
- 25 2. A method according to claim 1, wherein selectively masking the first semiconductor layer with a LED mask layer comprises depositing the LED mask layer across the top surface of the first semiconductor layer; and selectively removing a first portion of the LED mask layer through a thickness of the LED mask layer to form the LED well.
- 30 3. A method according to claim 1 or claim 2, wherein the LED well sidewalls extend in a direction generally normal to the top surface of the first semiconductor layer.
- 35 4. A method according to any preceding claim, wherein

a portion of the LED well sidewalls extending between the first semiconductor layer and the top surface of the LED mask layer are inclined with respect to the direction normal to the top surface of the first semiconductor layer.

- 5 5. A method according to claim 4, wherein
the LED sidewalls are inclined such that a cross sectional area of the LED well in a plane parallel to the top surface of the first semiconductor layer decreases in the direction from the top surface of the first semiconductor layer towards the top surface of the LED mask layer.
- 10 6. A method according to claim 5, wherein
the LED well sidewalls are inclined such that a cross sectional area of the LED well in a plane parallel to the top surface of the first semiconductor layer increases in the direction from the top surface of the first semiconductor layer towards the top surface of the LED mask layer
- 15 7. A method according to claim 4 or claim 5, wherein
a collimating portion of each LED well sidewall extending from the first semiconductor layer extends in a direction generally normal to the first semiconductor layer; and
a tapered portion of each LED well sidewall extending between the collimating portion and the top surface of the LED mask layer is inclined such that a cross sectional area of the LED well in a plane parallel to the top surface of the first semiconductor layer decreases in the direction from the top surface of the first semiconductor layer towards the top surface of the LED mask layer.
- 20 8. A method according to any preceding claim, further comprising:
(f) removing a second portion of the LED mask layer from the top surface of the LED mask layer such that the LED mask layer forms a planarised surface with a top surface of the monolithic LED stack.
- 25 9. A method according to claim 8, wherein the second portion of the LED mask layer is removed using a polishing process.
- 35 10. A method according to any of claims 1 to 7, further comprising:

(f) selectively removing all of the LED mask layer following the forming of the monolithic LED stack.

11. A method according to claim 10, further comprising depositing a gap filling insulator
5 on the top surface of the of the first semiconductor layer surrounding the monolithic LED stack, the gap filling insulator forming a planarised surface with a top surface of the monolithic LED stack.
12. A method according to claim 8, 9 or 11, further comprising
10 (g) bonding the planarised surface of the LED precursor to a further substrate comprising backplane electronic devices.
13. A method according to claim 12, further comprising
15 (h) removing the substrate from the first semiconductor layer.
14. A method according to any preceding claim, wherein the LED mask layer comprises a dielectric, for example SiO₂, or SiN_x.
15. A method according to any preceding claim, wherein a cross sectional area of the
20 LED well on the first semiconductor layer is no greater than 100 µm x 100 µm.
16. A method of forming a LED array precursor comprising:
forming a plurality of LED precursors on a substrate according to the method of any
of claims 1 to 15.
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