a light emitting diode structure including:

a first material layer of a first conductivity type;

a second material layer of a second conductivity type; and

a light emitting layer disposed in between the first material layer and the second material layer;

wherein a surface of the first material layer has a plurality of generally ordered photonic nanostructures formed thereat using a self-assembled template for enhancing light extraction efficiency of the vertical light emitting diode, the self-assembled template comprising generally ordered nanoparticles on said surface of the first material layer to function as a mask for forming the photonic nanostructures at said surface of the first material layer.

According to another aspect of the present invention, there is provided a vertical light emitting diode comprising:

a light emitting diode structure including:

a first material layer of a first conductivity type;

a second material layer of a second conductivity type; and

a light emitting layer disposed in between the first material layer and the second material layer;

wherein the first material layer has a first surface facing the light emitting layer disposed in between the first material layer and the second material layer and a second surface opposite the first surface, and wherein the second surface of the first material layer has a plurality of generally ordered photonic nanostructures formed thereat through which light generated by the light emitting layer is emitted for enhancing light extraction efficiency of the vertical light emitting diode.

Preferably, the vertical light emitting diode further comprises a first electrode formed on the second material layer, and a second electrode formed on the first material layer, wherein the first and second electrodes are configured to receive a bias voltage for providing power to the light emitting layer to generate light.

Preferably, the first material layer is selected from a group consisting of an n-type GaN, an n-type AlGaN, and an n-type InAlGaN, the second material is selected from a group consisting of a p-type GaN, a p-type AlGaN, and a p-type InAlGaN, and the

light emitting layer comprises one or more quantum wells of indium gallium nitride and gallium nitride (InGaN/GaN) heterostructures.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the present invention will be better understood and readily apparent to one of ordinary skill in the art from the following written description, by way of example only, and in conjunction with the drawings, in which:

Fig. 1A schematically depicts an exemplary LED structure initially formed on a sacrificial SOI substrate according to an example embodiment of the present invention;

CLAIMS

1. A vertical light emitting diode comprising:

a light emitting diode structure including:

a first material layer of a first conductivity type;

a second material layer of a second conductivity type; and

a light emitting layer disposed in between the first material layer and the second material layer;

wherein the first material layer has a first surface facing the light emitting layer disposed in between the first material layer and the second material layer and a second surface opposite the first surface, and wherein the second surface of the first material layer has a plurality of generally ordered photonic nanostructures formed thereat through which light generated by the light emitting layer is emitted for enhancing light extraction efficiency of the vertical light emitting diode.

2. The vertical light emitting diode according to claim 1, further comprises a first electrode formed on the second material layer, and a second electrode formed on the first material layer, wherein the first and second electrodes are configured to receive a bias voltage for providing power to the light emitting layer to generate light.

3. The vertical light emitting diode according to claim 1, wherein the first material layer is selected from a group consisting of an n-type GaN, an n-type AlGaN, and an n-type InAlGaN, the second material is selected from a group consisting of a p-type GaN, a p-type AlGaN, and a p-type InAlGaN, and the light emitting layer comprises one or more quantum wells of indium gallium nitride and gallium nitride (InGaN/GaN) heterostructures.