allied academies

3rd International Conference on

Applied Physics

August 23-24, 2018 | London, UK

Growth technology of InGaN/GaN nanocolumn-array LED crystals on 2-inch AlN/Si substrates useful for integrated micro-LED fabrication

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Using uniform arrays of GaN nanocolumns, monolithic integration of four-color InGaN-based nanocolumn LEDs has been demonstrated. Two-dimensional arrangement of such RGB micro-LEDs will, in principle, enable the fabrication of a semiconductor video panel, which function as a micro-LED display. The extended projection of the video image on a screen is expected to form a widescreen LED display. One of the basic technologies for achieving such micro-LED displays is the fabrication of InGaN-based nanocolumn LEDs on a wide-area, for example 2-inch size or more, Si substrates. Si is easily removed from InGaN/GaN heterojunction crystals grown on them, enabling the flip-chip process of nanocolumn LED crystals. The wiring on top and bottom of the LED is suitable for a high-density integration of micro-LED pixcels, and cost-effective fabrication of LED panels. In this study, triangular-lattice nanopillar-array templates with a lattice constant of 280 nm and with AlN disks on top of the underlying Si pillars were prepared on 2-in. AlN/Si substrates through nanoimprint lithography and dry etching. Regularly arranged GaN nanocolumn arrays with a 220-nm diameter were grown on the templates to fabricate wide-area emission InGaN/GaN nanocolumn LEDs. An LED chip with an ITO electrode with an area of 3 × 4 mm2 operated at a current of 100 mA emitted blue-green light (504 nm in wavelength) from the entire surface of the large emission area. The growth technology developed here will contribute to the fabrication of two-dimensionally arranged integrated nanocolumn micro-LEDs.

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