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Non-polar and Semi-polar InGaN LED Growth on Sapphire Substrate

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Group Ⅲ-nitride semiconductors have been widely studied as the materials for growth of light emitting devices. Currently, GaN devices are predominantly grown in the (0001) c-plane orientation. However, in case of using polar substrate, an important physical problem of nitride semiconductors with the wurtzite crystal structure is their spontaneous electrical polarization. An alternative method of reducing polarization effects is to grow on non-polar planes or semi-polar planes. However, non-polar and semipolar GaN grown onto r-plane and m-plane sapphire, respectively, basically have numerous defects density compared with c-plane GaN. The purpose of our work is to reduce these defects in non-polar and semi-polar GaN and to fabricate high efficiency LED on non/semi-polar substrate. Non-polar and semi-polar GaN layers were grown onto patterned sapphire substrates (PSS) and nano-porous GaN/sapphire substrates, respectively. Using PSS with the hemispherical patterns, we could achieve high luminous intensity. In case of semi-polar GaN, photo-enhanced electrochemical etching (PEC) was applied to make porous GaN substrates, and semi-polar GaN was grown onto nano-porous substrates. Our results showed the improvement of device characteristics as well as micro-structural and optical properties of non-polar and semi-polar GaN. Patterning and nano-porous etching technologies will be promising for the fabrication of high efficiency non-polar and semi-polar InGaN LED on sapphire substrate.