Surface control of GaN-based high-frequency and high-power devices

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Although significant progress has been achieved in the GaN-based high-power/high-frequency electronic devices, additional works are still required to solve surface- and interface-related problems such as the gate leakage, trapping effects, etc. In particular, the so-called current collapse effects not only degrade microwave-output performance but also impede reliable operation of the devices.

In this paper, we present our recent results on the control and passivation of surfaces for GaN-based electronic devices. It was found that serious deficiency of N atoms was induced on the GaN and AlGaN surfaces during various kinds of device processings such as high-temperature annealing, plasma cleaning, plasma etching and deposition of metal and insulating films. This resulted in introduction of N-vacancy-related deep levels near E_c, being responsible for excess leakage of Schottky gates and drain current collapse in AlGaN/GaN heterostructure field effect transistors (HFETs) [1-3]. We have developed a novel Al_2O_3-based surface passivation and insulated gate structure formed by the molecular-beam deposition of Al and its electron cyclotron resonance plasma (ECR-plasma) oxidation, realizing collapse-free and low-gate-leakage AlGaN/GaN HFETs [3,4].

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