Enhancement of Breakdown Characteristics of AlGaN|GaN HEMT with Back Barrier plus High-k Passivation Layer

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In this article, a novel breakdown enhanced AlGaN|GaN high electron mobility transistor (HEMT) with the architecture of AlGaN back barrier and high-k passivation layer is investigated by numerical simulation. It is indicated that the off-state voltage of AlGaN|GaN HEMT has increased significantly by inducing the AlGaN back barrier and high-k passivation layer. The breakdown voltage of device has increased by 90.1%, to 616 from 324 V, with a 50-nm high-k passivation layer and 100-nm $Al_{0.05}Ga_{0.95}N$ back-barrier layer. This is mainly due to that the electric field at the drain.gate zone is modulated by high-k passivation layer and becomes smaller in the gate corner. Moreover, the buffer leakage current got effectively reduced due to the introduction of the back-barrier layer, which could also improve the breakdown voltage of the device. In addition, the results also show that the channel current I_{DS} of the device is slightly increased by the back-barrier + passivation structure, while the frequency performance shows no obvious degradation. Simulation results suggest that the AlGaN back barrier plus high-k passivation layer can effectively improve the breakdown voltage of the device without sacrificing the characteristics of the device.

Keywords: GaN HEMT, breakdown voltage, high-k passivation layer, back barrier.

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