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Investigation into the Homoepitaxy of AlGaN/GaN Heterostructure via Molecular Beam Epitaxy

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Abstract : As the production process of self-standing GaN substrates evolves, the commercialization of low dislocation density, large-scale, semi-insulating self-standing GaN substrates is gradually becoming a reality. This advancement has given rise to increased interest in GaN materials' homoepitaxial technology. However, at the homoepitaxial interface, there are considerable concentrations of impurity elements, including C, Si, and O, which generate parasitic leakage channels at the re-growth junction. This phenomenon results in leaked HEMTs that prove difficult to switch off, rendering them effectively non-functional. The emergence of leakage channels can also degrade the high-frequency properties and lower the power devices' breakdown voltage. In this study, the uniform epitaxy of AlGaN/GaN heterojunction with high electron mobility was accomplished through the surface treatment of the GaN substrates prior to growth and the design of the AlN isolation layer structure. By employing a procedure combining gallium atom in-situ cleaning and plasma nitridation, the C and O impurity concentrations at the homoepitaxial interface were diminished to the scale of 10^{17} cm^{-3}. Additionally, the 1.5 nm nitrogen-rich AlN isolation layer successfully prevented the diffusion of Si impurities into the GaN channel layer. The result was an AlGaN/GaN heterojunction with an electron mobility of 1552 cm^2/Vs and an electron density of 1.1×10^{13} cm^{-2} at room temperature, obtained on a Fe-doped semi-insulating GaN substrate.

Keywords : MBE, AlGaN/GaN, homogenerous epitaxy, HEMT
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