Cubic AlGaN/GaN Hetero-Junction Field-Effect Transistors - Fabrication and Characterisation

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Abstract

Hetero-junction field-effect transistors made of metastable cubic AlGaN/GaN represent an alternative for devices made of stable hexagonal III-nitrides. Due to the absence of spontaneous and piezoelectric fields, cubic AlGaN/GaN provides an incentive for fabrication of hetero-junction field-effect transistors with both normally-on and normally-off characteristics.

In this work, field-effect transistors were fabricated of cubic AlGaN/GaN grown on carbonized silicon (3C-SiC/Si) and free standing Ar^+ implanted 3C-SiC substrates by molecular beam epitaxy. For electrical device isolation, a carbon doped GaN:C buffer was investigated. For this purpose, a new CBr_4 gas source was used and optimized.

Device structuring is performed by photolithography, liftoff process, reactive ion etching, and plasma enhanced chemical vapour deposition. Cubic AlGaN/GaN hetero-junction field-effect transistors with normally-on and normally-off output characteristics depending on the doping of the AlGaN barrier were demonstrated. The devices are characterized by electrical dc current-voltage and capacitance-voltage measurements. The measurement data were analysed using a 1D-Poisson solver and the ATLAS device simulation program. Finally, sample structures for improved cubic AlGaN/GaN field-effect transistor devices were developed.