Physics based Device Modeling of GaN High Electron Mobility Transistor (HEMT) for Terahertz Applications

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Abstract- In the present work, undoped AlGaN/AlN/GaN heterostructure has been simulated and physics based device model has been developed for GaN high-electron-mobility transistors (HEMT) based Terahertz applications. The heterostructure properties like electron mobility, 2DEG concentration, polarization charge concentration, conduction band energy have been extracted and compared with our experimental results using different semiconductor characterization tools.

Further, these 2DEG carriers are confirmed within the triangular quantum well generated at the interface between AlGaN and GaN. We have computed self-consistent solution of the Schrödinger and Poisson equations in order to calculate the quantized energy levels of conduction and valence bands. Based on extracted quantized energy levels, inter-sub band emission and absorption phenomenon was studied on AlGaN/AlN/GaN based HEMT for different Al compositions and thickness of AlGaN barrier layer. In addition to it inter-sub band transition energies, gain, emission, absorption and potential has been extracted and showed good agreement with reported literature results.

The current state of art for 100 nm GaN HEMT devices is up to 100 GHz cut off frequency. The present study shows potential of same 100 nm GaN based HEMTs application beyond their cut off frequency limit.
