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Simulation study of DC characteristics of double quantum well AlGaN/GaN double gate HEMT structure

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Due to their great combination of physical properties GaN based HEMTs (High Electron Mobility Transistors) are the focus of vivid research and development action in the context of high-speed, high-power and high-temperature transistors [1-3]. The key invoke of GaN-based materials for microwave power HEMTs occupy with their wide bandgaps and the high electron density in the channel (2-DEG) associated with hetrostructure channel [4]. In spite of high 2DEG density and high electron mobility in AlGaN/GaN HEMT, one of the new challenges for these transistors is to increase the frequency of operation.

The aim of this work is to simulate and analyze the current-voltage characteristics of double quantum well AlGaN/GaN double gate HEMT (High Electron Mobility Transistor) structure with the variation of spacer layer, doping layer thickness and delta doping. To study the effect of these variations we use Atlas Tcad-Silvaco numerical simulation software. The drift-diffusion model has been taken for simulating the proposed device. We have performed the characterization study of 2-DEG (Two Dimensional Electron Gas), threshold voltage (V_{th}), and transconductance (g_m) of the double quantum DG-HEMT structure. As a result of this study the double quantum well DG-HEMT structure has been seen to low threshold voltage and highest transconductance peak.

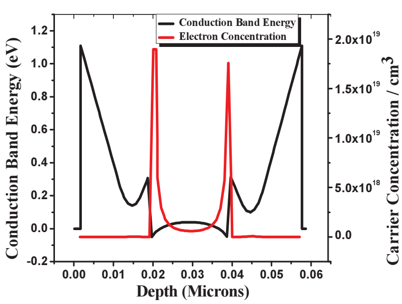

Figure 1: Conduction Band Energy with Carrier Concentration and band bending due to doping.

The two dimensional electron gas (2- DEG) or quantum wells shown in Figure 1 which is formation at the interface between AlGaN and GaN due to their bandgap difference. The effect of drain voltage on drain current and transconductance with gate voltage is shown in Figure 2. From the graph is observe that the transconductance and drain current both increasing with drain voltage. The highest transconductance which obtained from simulation is 1218 mS/mm. This result is obtained by taking 1 nm spacer layer thickness, 2 nm donor layer thickness and the doping concentration of the donor layer is 4×10^{19} / cm^3.

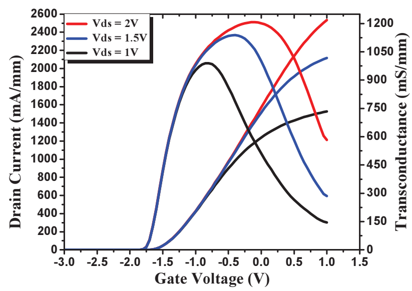

Figure 2: Effect of the variation of drain voltage on Drain current and Transconductance with Gate voltage.

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