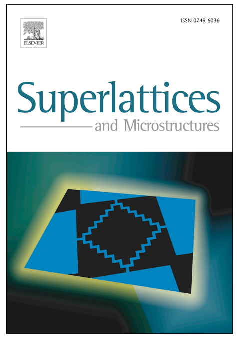

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DC and Microwave Characteristics of 20 nm T-Gate InAlN/GaN High Electron Mobility Transistor for High Power RF Applications

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Abstract

The DC and microwave characteristics of 20nm gate length (L_g) InAlN/GaN High electron mobility transistor (HEMT) on SiC substrate with heavily doped source and drain region have investigated for both depletion mode (D-mode) and Enhancement mode (E-mode) operation using Synopsys TCAD tool. The simulation is performed at room temperature by using drift-diffusion model. The device having the features of recessed T - gate structure, InGaN back barrier and Al_2O_3 passivated device surface. The proposed novel Lg=20 nm, W=2X40 µm D-mode (E-mode) HEMT exhibited a peak drain current density (I_{dmax}) of 2.7 (2.6) A/mm, transconductance (g_m) of 1.04 (1.63) S/mm , current gain cut-off frequency (f_t) of 310 (343) GHz and power gain cut-off frequency (f_{max}) of 364(236) GHz . The measured carrier mobility (µ), sheet charge carrier density (n_s) and breakdown voltage are 1580 (1615) cm^2/V-s, $1.9X10^{13}$ (1.93) cm^{-2} and 10.7 (12.8) V respectively. The superlatives of the proposed HEMTs are bewitching competitor for future sub-millimeter wave high power RF VLSI circuit applications.

Keywords

HEMT, back-barrier, Recessed gate, cut-off frequency and short channel effects.

1. Introduction

The preeminent physical property of GaN such as larger band gap (3.44 eV) , breakdown field ($3.3X10^6$ V/cm), higher saturation velocity ($2.7X10^7$ Cm/s), good thermal conductivity (1.95 $WCm^{-1}c^{-1}$)and higher mobility (μ_n=2000 and μ_h=200 Cm^2/V-s) has captivated the raptness attentions to develop high power, high frequency very large scale integration (VLSI) circuits for next generation RF applications such as broadband communications, high power amplifiers for space research, microwave image sensing and low noise wide bandwidth amplifiers design . In the last two decade's several research progresses have been made to enhance the DC and Microwave characteristics of GaN based HEMTs [1-37]. Initially AlGaN/GaN based HEMTs are developed for high power applications such as solid state power amplifiers and high power switching applications [1-6]. To extent the