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Design of GaN-based high electron mobility transistors for future high power microwave applications

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In recent years, the efforts of researchers are directed towards the GaN-based high electron mobility transistors (HEMTs). Owing the unique combination of high electron mobility and high breakdown voltages of GaN-based HEMTs, offering a viable solution for next generation high power and high speed applications such as, satellite telecommunications, high power amplifiers for radar, microwave image sensing, military electronic systems and low noise wide bandwidth amplifiers design for future high power microwave communications. The GaN-based high electron mobility transistors (HEMTs) had demonstrated outstanding high power radio frequency performance (RF) that makes an attractive candidate for future high power millimeter wave applications.

In this research, the effort is taken to improve the cut-off frequency of GaN-based HEMT. The main objective is of this research work is to design GaN-based HEMTs for future high power microwave applications and the techniques used for achieving these objectives are gate engineering, bandgap engineering, and source/drain engineering.

Gate Engineering: The gate engineering plays important role in RF characteristics of the device. To achieve the higher current gain cut-off frequency and power gain cut-off frequency, gate access resistance should be small. The T-shaped gate enhances the RF characteristics of the HEMT by reducing the access resistance and capacitance, high electron mobility.

Bandgap Engineering: The optimization of HEMT structures through aggressive scaling together with band gap engineering is a key solution to achieve low noise, high speed, and high power operation. A lattice matched wide bandgap InAlN barrier layer on GaN enables large sheet charge density, improved transconductance, smaller the short channel effects and low leakage current. Moreover, the buffer leakage current can be effectively suppressed by AlGaN or InGaN back-barriers.

Source/Drain Engineering: A very low source/drain contact resistances result in ultra-high RF performance. The heavily GaN doped source/drain regions are used in this research work in order to achieve extremely low contact resistance. The heavily doped GaN source/drain regions also introduce a lateral strain in the channel that leads to the improvement of transconductance, drain current and cut-off frequency.

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