INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: **Reliability Enhancements in AlGaN/GaN HEMTs through Gate Shaping.**

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SHORT ABSTRACT

Gallium Nitride (GaN), a wide bandgap semiconductor has emerged as the next generation material for semiconductor device applications. Device operation at high frequency with elevated power is simultaneously possible using GaN technology. A High Electron Mobility Transistor (HEMT) is designed using an AlGaN/GaN heterostructure and has proved to have great potential both in high power and Radio Frequency (RF) applications. Existing capability and reliability of the devices can be improved by the use of newer structure and design approaches. Technology Computer Aided Design (TCAD) aids engineers to improve and design newer devices, and to understand the internal phenomenon, thus, improving its capabilities. An AlGaN/GaN HEMTs have been chosen to understand reliability issues that are being currently faced by it in the high power applications. In my thesis, a detailed numerical study is performed to observe the impact of gate shaping (filleting) and the use of an elevated substrate pillar on the performance of an AlGaN/GaN HEMT. It is observed that the converse piezoelectric strain in the AlGaN barrier layer, electron and lattice temperatures get suppressed due to filleting of the gate geometry. To substantiate, a comparison is presented between field plate rectangular gate HEMTs and filleted gate HEMT with and without field plate. In case of HEMTs without field plate, filleted gate has 44 % lower converse piezoelectric strain than the conventional HEMT. For filleted gate HEMTs with and without field plate, the electric field and converse piezoelectric strain is lower by 38% and 30%, respectively, as compared to rectangular gate HEMT with a field plate. With the increase in filleting radius, the gate leakage current reduced by two orders of the magnitude as compared to a conventional HEMT. The reduction in OFF state converse piezoelectric strain and electron temperature are observed due to filleting, which enhances OFF state reliability. Gate shaping and elevated substrate pillar in HEMTs are able to reduce operational temperature by 4 and 19 K, respectively. Analysis presented in this thesis concludes that filleted gate and elevated substrate pillar can help to improve the reliability of HEMTs.