Announcing the Final Examination of ANUPAMA YADAV for the Degree of Doctor of Philosophy in Physics

Date: Wednesday, November 4, 2015
Time: 11:30 a.m.
Room: PSB 160
Dissertation title:
Impact of Gamma-Irradiation on the characteristics of III-N/GaN based High Electron Mobility Transistors

Abstract:

In this study, the fundamental properties of AlGaN/GaN based High Electron Mobility Transistors (HEMTs) have been investigated in order to optimize their performance in radiation harsh environment. AlGaN/GaN HEMTs were irradiated with ^{60}Co gamma-rays to doses up to 1000 Gy, and the effects of irradiation on the devices' transport and optical properties was analyzed. Understanding the radiation affects in HEMTs devices, on carrier transport, recombination rates and traps creation play a significant role in development and design of radiation resistant semiconductor components for different applications.

Electrical testing combined with temperature dependent Electron Beam Induced Current (EBIC) that we used in our investigations, provided critical information on defects induced in the material because of gamma-irradiation. It was shown that at low gamma-irradiation doses, the minority carrier diffusion length in AlGaN/GaN exhibits an increase up to ~ 200 Gy. The observed effect is referred to longer minority carrier (hole) life time in the material's valence band as a result of an internal irradiation by Compton electrons, created in interaction of GaN with external gamma irradiation. However, for larger doses of gamma-irradiation (> 200 Gy), deteriorations in transport properties and device characteristics were observed. This is consistent with the higher density of deep traps in the material's forbidden gap induced by larger doses of gamma-irradiation. In addition for each device under investigation, the temperature dependent minority carrier diffusion length measurements were carried out. These measurements allowed the extraction of the activation energy for the temperature-induced enhancement of the minority carrier transport, which (activation energy) bears a signature of defect levels involved the carrier recombination process. Comparing the activation energy before and after gamma-irradiation identified the radiation-induced defect levels and their dependences.

To complement EBIC measurements, spatially resolved Cathodoluminescence (CL) measurements were carried out at variable temperatures. Similar to the EBIC measurements, CL probing before and after the gamma-irradiation allowed the identification of possible defect's levels generated as a result of gamma-bombardment. Trapping the Compton electron on deep levels, generated by the gamma irradiation, prevents the radiative recombination of the conduction band electrons through these levels. Based on these findings, the decay in the near-band-edge intensity was explained as a consequence of increased non-equilibrium carrier lifetime.

Outline of Studies:
Major: Physics

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Dr. Robert Peale
Dr. Samuel Richie (External Committee Member)

Approved for distribution by Dr. Elena Flitsiyan, Committee Chair, on October 22, 2015.

The public is welcome to attend.