

Dissertation Defense Notification

Candidate: Matthew Gaddy

Chair of Committee: Dr. Sergey A. Nikishin

Committee Members: Dr. Ayrton Bernussi and Dr. Andreas Neuber

Time and Date: 4:30 p.m. March 21st

Location: Engineering Center 201

Fabrication and testing of photoconductive switches based on semi insulating GaN

Abstract

Photoconductive Semiconductor Switches (PCSSs) have been widely studied over the last few decades. Wide bandgap materials such as GaN are very promising for the future fabrication of PCSSs. GaN offers a great combination of electrical and optical properties such as its wide bandgap, high breakdown field, fast recombination times, and high thermal conductivity. In addition, the increasing availability of bulk GaN makes this material very attractive.

The goal of this dissertation is the development of GaN PCSSs. This includes all aspects of device development including material characterization, simulation, fabrication, testing, and evaluation. Characterization of GaN materials was used to find the most promising substrates for PCSS fabrication. Initial testing revealed high field enhancements at the triple point that were detrimental to PCSS performance. By simulating the electric field of various geometries and optimizing fabrication it was possible to significantly reduce the field enhancement. Various lateral and vertical PCSSs were fabricated and tested. GaN PCSSs were found to be viable for high voltage (>50 kV) switching, with the best switches fabricated using a lateral $600\text{ }\mu\text{m}$ gap spacing and mesa etching profile. These switches demonstrated a high breakdown field strength $\sim 260\text{ kV/cm}$ with a peak electric field (3.2 MeV) very close to the theoretical breakdown field strength of GaN (3.3 MV/cm).

Publications

1. M. Gaddy, V. Kuryatkov, V. Meyers, D. Mauch, J. Dickens, A. Neuber, and S. Nikishin. Structural, morphological, optical, and electrical properties of bulk (0001) GaN:Fe wafers. *MRS Advances* (2018).
2. I. Gherasoiu, K. Yu, E. Hussein, B. Cui, M. Hawkrige, V. Kuriatkov, M. Gaddy, S. Nikishin, W. Walukiewicz. Synthesis of New Nitride Alloys with Mg by Plasma-Assisted Molecular Beam Epitaxy. *Physica Status Solidi (b)* (2020).
3. M. Gaddy, V. Kuryatkov, N. Wilson, A. Neuber, R. Ness, S. Nikishin. GaN-Based PCSS with High Breakdown Fields. *Electronics* (2021).
4. A. Jafari, M. Gaddy, Y. Ho, C. Uzun, V. Kuryatkov, S. Nikishin, M. Kim, L. Peralta, A. Bernussi. Tunable Near-Infrared Gires-Tournois Resonators Based on Vanadium Dioxide on Gold Film. *Opt. Lett.* 47, 3 (2022).