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PRISM Seminar Series – Spring 2011

PURDUE UNIVERSITY Discovery Park

"Characterization of the Thermal and Mechanical Response of GaN High Electron Mobility Devices"

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3:00 pm, Birck 1001

Abstract: The high power density in AlGaN/GaN high electron mobility devices (HEMTs) leads intense heati ng which is detrimental to their and reliability. The heating is primarily caused by the generation of longitud inal optical phonons which build-up in the channel resulting in the hot phonon effect. Although high thermal conductivity substrates have been used to dissipate heat from these devices (e.g., SiC, diamond), the self he ating in AlGaN/GaN heterostructures remains a critical issue in the success of their commercialization. The l arge phononic band gap provides additional resistance in dissipating the thermal energy from these devices which has received little attention from researchers. In addition, the stress fields induced in AlGaN/GaN HE MTs that includes residual stresses, thermoelastic stresses, and inverse piezoelectric stresses, also significan tly impacts the device reliability. However, there remains few measurements and understanding of the stre ss and temperature fields in devices and how they relate to device reliability.

In this talk, an investigation the temperature rise and stress evolution in AlGaN/GaN HEMTs using micro-Ra man spectroscopy and micro-photoluminescence will be presented. Micro-Raman was utilized to obtain a hi gh spatial resolution temperature profile within the active region by probing changes in the optical phonons in the channel. A method to deconvolute thermoelastic stress and temperature fields in the devices based o n measuring multiple characteristics of phonon peak positions and linewidths will be presented. A comparat ive analysis of the stress measured by means of micro-Raman spectroscopy and micro-photoluminescence was also performed to provide depth dependent stress values down to a 30 nm depth resolution. These dat a are then correlated with electrical performance of the devices. Finally, efforts to model the electro-therm o-mechanical response of the devices will be presented.

Bio: Samuel Graham is an Associate Professor of Mechanical Engineering at the Georgia Institute of Technology where serves as the Associate Director of the NSF Science and Technology Center CMDITR. Prior to this, he was a staff member at Sandia National Laboratories. His research activities includes the characterization of GaN semiconductors for RF and optoelectronic applications, packaging of organic electronics, and thermal management and reliability of electronic devices.

Refreshments will be served. For further information please contact Prof. Alina Alexeenko, alexeenk@purdue.edu
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