C3NiT Newsletter: Spring 2019

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Swedish Center for III-Nitride Technology

Next Board Meeting 12 June, 2019 at Chalmers

New C3NiT members: **Jawad ul Hassan** (LiU) leads the project on β-Ga_2O_3 for power applications; **Ragnar Ferrand-Drake Del Castillo** (Chalmers) is a new PhD student within the HEMT project; and **Nermin Trnjanin** (Chalmers) works on BCB process development.

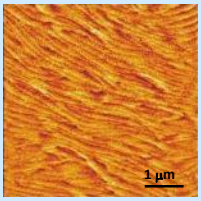
Muhammad Nawaz from ABB is appointed as an Adjunct Professor at LiU from 1st of March. Muhammad will be involved in student supervision, teaching, and device simulation and electrical characterization.

PROJECT UPDATES

Epitaxial growth development: 2DEG in $Al_{0.8}Ga_{0.2}N$/AlN HEMT structures is demonstrated with 2DEG density of 7.2×10^{12} cm^{-2} and a mobility of 270 cm^2/Vs at 7 K.

N-polar AlN and mixed polarity GaN heterostructures on on-axis SiC have been achieved. Currently, the parameter window for 2D growth mode and 2DEG properties are being optimized.

HEMT technology: Enhanced mobility of 1900 cm^2/Vs in InAlN barrier structures is achieved by inserting an extra GaN layer in the barrier (InAlN/GaN/AlN/GaN). We propose that the improvement in *mobility* is due to either suppression of fluctuations in the quantum well subband energies, or to reduced Coulomb scattering, both related to compositional variations in the InAlN.



Vertical GaN power devices: Good quality GaN on SiC with an RMS roughness of 0.8 Å, (002) and (105) rocking curve FWHMs of ~200 arcsec has been achieved. Impurity levels remain low (O: 5×10^{15} cm^{-3}, Si: 2×10^{16} cm^{-3}, C: 3×10^{16} cm^{-3}) for high growth rates up to 3.5 µm/h.

GaN MMIC: Chalmers and Gotmic are currently characterizing and modeling the HEMTs that will be used for the first GaN MMIC round. The devices will be suitable for PAs at least up to V-band.

Mulilayer BCB ICs: The process development of 3 layer BCB stack with 2-3 µm metallization layers is on-going, where spin-speed, exposure dose, and development time are being optimized.

TWO NEW C3NiT PROJECTS

Developing next generation high-power β-Ga_2O_3 material: β-Ga_2O_3 has a breakdown electric field of 9 MV/cm, which combined with the availability of affordable native substrates makes the material very attractive for high power applications. In this project we will develop hot-wall MOCVD of β-Ga_2O_3, and related alloys, and will design, fabricate and characterize power field effect transistors and Schottky barrier diodes.

Education and outreach: In this project we will organize and structure outreach and education activities, including PhD and Master student courses, and carrier development. Main focus will be also to provide better visibility of the center.

RESEARCH HIGHLIGHTS

Manuscript Disclosures

High-Performance AlGaN/AlN/GaN HEMTs with a Thin Buffer Layer by Chalmers, SweGaN and LiU (Electron Device Letters)

Recent Publications

A. Malmros, P. Gamarra, M. Thorsell, H. Hjelmgren, C. Lacam, S. L. Delage, H. Zirath, N. Rorsman, “Impact of Channel Thickness on the Large-Signal Performance in InAlGaN/AlN/GaN HEMTs With an AlGaN Back Barrier”, IEEE TED vol. 66, pp.364-371, 2019.

A. Malmros, Jr-Tai Chen, H. Hjelmgren, J. Lu, L. Hultman, O. Kordina, E. Ö. Sveinbjörnsson, H. Zirath, and N. Rorsman, “Enhanced Mobility in InAlN/AlN/GaN HEMTs using a GaN interlayer”, accepted in IEEE Transactions on Electron Devices, 2019.

Master Thesis: Kevin Ohlsson (SweGaN, Epiluvac, LiU) – ”Optimization of gas flow uniformity in enhancement of Metal Organic Chemical Vapor Deposition growth for III-nitride”, LiU Feb 15th 2019

PhD Thesis: Nerijus Armakavicus (LiU) –"Free charge carrier properties in group III nitrides and graphene studied by THz-to-MIR ellipsometry and optical Hall effect“, LiU March 27th 2019