C3NiT NEWSLETTER

Swedish Center for III-Nitride Technology

Spring 2023

UPCOMING EVENTS

PhD defense Rosalia Delgado Carrascon:
"*Epitaxy of group III-nitride materials using different nucleation schemes*"
10:00 – Friday 9th of June 2023, LiU

Master defense Andri Dhora:
"*Thick GaN and AlGaN drift layer development for efficient power conversion*"
10:00 – Monday 21st of August 2023, LU

PUBLICATIONS

EDITOR's PICK: A. Papamichail, et al., "*Tuning composition in graded AlGaN channel HEMTs toward improved linearity for low-noise radio-frequency amplifiers*", Appl. Phys. Lett. **122**, 153501 (2023). link

H. Zhang, et al., "*Polarity Control by Inversion Domain Suppression in N-Polar III-Nitride Heterostructures*", Crystal Growth & Design **23 (2)**, 1049 (2023). link

P. Gribisch, et al., "*Tuning of Quasi-Vertical GaN FinFETs Fabricated on SiC Substrates*", IEEE T. Electron Dev. **70** (5), 2408 (2023). link

D. Q. Tran, et al., "*Thermal conductivity of $Sc_xAl_{1-x}N$ and $Y_xAl_{1-x}N$ alloys*", Appl. Phys. Lett. **122** (18), 182107 (2023). link

H. Zhang, et al., "High quality N-polar GaN optimization by multi-temperature growth process", J. Cryst. Growth **607**, 127002 (2023). link

New projects

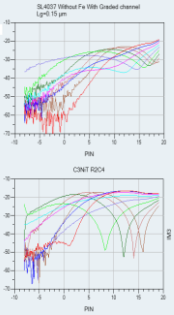
WISE Post Doc, LiU – AlN material platform for efficient power switching and conversion

WISE Ind Post Doc, Hexagem and LU – High performance WBG power electronics at Si cost

WISE Ind PhD student, Veeco and LU – Next generation high power gallium oxide material for an energy efficient smart grid

PROJECT UPDATES

Linear E/W band HEMTs and MMICs



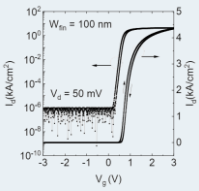
The first large signal measurements in Europe of a graded channel AlGaN/GaN HEMT has been carried out by the industrial PhD student Andreas Divinyi. The linearity figure of merit IM3 was improved by 10 dB compared to a conventional Fe-doped GaN buffer. These results are showing state of the art performance and paves the way for novel highly linear GaN receivers.

High voltage HEMTs and circuits for power and microwave applications

$Sc_xAl_{1-x}N$/GaN HEMTs are promising structures for increased power density compared to $Al_xGa_{1-x}N$/GaN HEMTs. Critical progress has been made by studying the thermal conductivity of the $Sc_xAl_{1-x}N$ alloy. Preliminary results report k=6.2 W/mK and k=3.2W/mK for the compositions x=0.14 and x=0.41, respectively, and for the layer thickness of 1 µm.

Vertical devices for power application

We have sucessfulyl build our first vertical GaN on GaN FinFET transistors, showing normally off behaviour with VT around 0.7V. The device shows excellent performance, with state-of-the-art effective mobility of 160 cm2/(Vs) and ideal inverse subthreshold slopes of 60 mV/decade, at a breakdown voltage of 90V. 650-1200V breakdown voltages are the next goal!



Propulsion/Charger/Converter/Switching applications

C3NiT Volvo Industrial Ph.D. Student Pengpeng Sun has started his research in the area of nonlinear GaN transistor models suitable for the prediction of switching waveforms and losses in power electronic applications. For the initial work, commercially available transistors have been purchased, mounted, and tested through initial DC measurements. Our next step will be to extend the experiments to pulsed dc and high-frequency characterization, which will form the foundation for the modeling work ahead.

Advanced epitaxial concepts for cost reduction

AlGaN/GaN high electron mobility transistors (HEMTs) with high-Al-content ultrathin barrier layers were developed for ultra-high working frequency applications. Control of the thickness and the composition of thin AlxGa1-xN (x= 0.50-0.60) barrier layers is achieved while the HEMT structures were tested for aging with no signs of actual degradation.

State-of-the-art 10 µm GaN and 5 µm AlGaN drift layers with controlled doping and strain engineering have been developed by MOCVD and are currently used for FinFET device fabrication.

Next Board Meeting June 15th 2023 via Teams