C3NiT Newsletter: Spring 2020

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Swedish Center for III-Nitride Technology

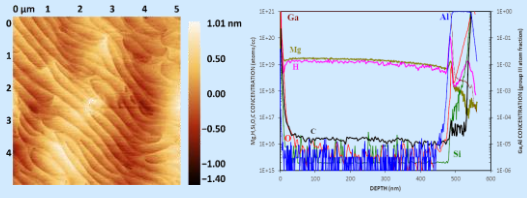
Next Board Meeting 16 June, 2020 in Teams

PROJECT UPDATES

Epitaxial growth development: Epiluvac and SweGaN have together demonstrated improved utilization of the precursors during GaN growth by a factor of 2 - 3. This would reduce cost, increase growth rate and material quality. The process will be further optimized. N-polar GaN with high growth rate of 0.4 μm/h is achieved. HEMT structure on SI off-cut SiC is being optimized for reduced interface roughness and 2DEG properties.

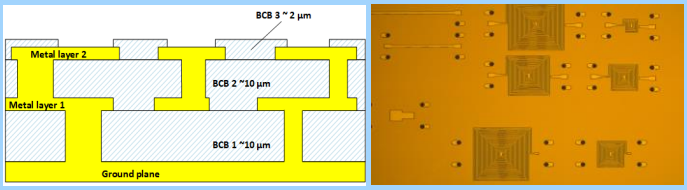
HEMT technology: Successful aggressive downscaling is achieved with good control of gate length down to 30 nm. This enables new HEMTs with thinner barriers and higher Al content for operation above 150 GHz, which are being currently designed. In-situ NH_3 pretreatment before the deposition of SiN passivation by LPCVD on GaN HEMTs is demonstrated to reduce trapping effects. This results in high microwave output power of 3.3 W/mm.

Vertical GaN power devices: Processing is improved to deliver high-quality Ohmic contacts on n-type GaN layers. Stable in-situ Mg doping process is developed to the required level of over 1×10^{19} cm^{-3} in GaN layers. Activation and annealing of Mg acceptors is ongoing. A thorough physical understanding of thermal conductivity behavior of AlGaN layers over the entire compositional range is established. Si doped low-Al content AlGaN for drift layers have been developed and their breakdown voltages will be evaluated in comparison to GaN.



Developing next generation high-power β-Ga_2O_3 material: We successfully demonstrated the first epitaxial Ga_2O_3 films on c-plane sapphire by our new hot-wall MOCVD. Growth process is being further optimized.

GaN MMIC: Two metal layers with passive structures including inductors, capacitors, lines, and circuits (filters and resonators) separated by BCB have been fabricated. The uniformity of 10.0 ± 0.17 μm of the first BCB layer is good. Good connection through the vias has been ensured. The second BCB layer is not as uniform as the first layer: 10 μm ± 0.5 μm due to the topology of the first metal layer. The first microwave measurements on two-layer BCB are expected shortly. A new design-kit needed for the circuit designs in the in-house MMIC process was made available to the industrial partners. Ericsson, Gotmic, and Saab have designed circuits, which were submitted to Chalmers in May. The final design rule check and final layout work are completed and the processing is underway.



RECENT FUNDING: SSF Award of 10 MSEK for 2020-2025

Chalmers in partnership with *LiU* and *National Chiao Tung University* and *Yuan Ze University* in Taiwan will develop Advanced GaN devices for mm and sub-mm communication for future mobile infrastructure, automotive and defense radar systems.

RESEARCH HIGHLIGHTS

D.Q. Tran et al, "Thermal Conductivity of Ultra-Wide Bandgap Thin Layers – High Al-Content AlGaN and β-Ga2O3", *Physica B 579*, 411810 (2020)

H. Zhang et al., "N-Polar AlN Nucleation Layers Grown by Hot-Wall MOCVD on SiC: Effects of Substrate Orientation on the Polarity, Surface Morphology and Crystal Quality" *Physica B 580*, 411819 (2020)

R. Korlacki et al., Comment on "Characteristics of Multi-Photon Absorption in a β-Ga2O3 Single Crystal" *J. Phys. Soc. Jpn. 89*, 036001M (2020)

R. Delgado Carrascon et al., "Optimization of GaN Nanowires Reformation Process by MOCVD for Device-Quality GaN Templates", *Physica Status Solidi B* 257, 1900581 (2020)

D.-Y. Chen et al., "Microwave Performance of 'Buffer-Free' GaN-on-SiC High Electron Mobility Transistors," *IEEE Electron Dev. Lett.* 41, 828 (2020)

J. Bremer et al., "Electric-Based Thermal Characterization of GaN Technologies Affected by Trapping Effects," *IEEE Trans. Electron Dev*. 67, 1952 (2020)

T. Huang et al., "Impact of AlGaN/GaN Interface and Passivation on the Robustness of Low-Noise Amplifiers", *IEEE Trans. Electron Dev*. 67, 2297 (2020)