C3NiT Newsletter: Fall 2021

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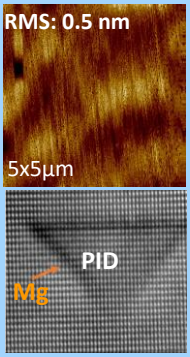
Swedish Center for III-Nitride Technology

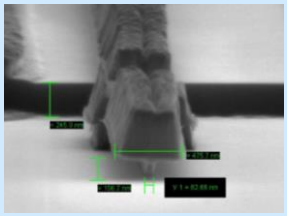
Next Board Meeting February 3rd 2022 via Teams

PROJECT UPDATES

Epitaxial growth development:
Multistep high-temperature process for N-polar GaN with state of the-art RMS of 0.5 nm developed. Graded AlGaN channel HEMTs for highly linear power amplifiers developed in collaboration with Saab and Chalmers and delivered for device processing. Crack-free nano-wire GaN templates on Si developed. Mg-segregation on the sidewalls of pyramidal inversion domain in heavily doped Mg GaN identified.

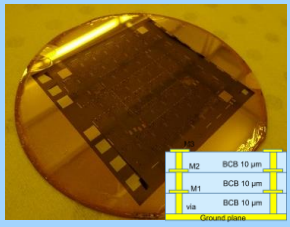


HEMT technology:
Record low contact resistance of 0.13 ohm-mm was achieved on 30% and 50% AlGaN barrier HEMTs. The device with a gate length of 100 nm on a buffer-free structure with a 150 nm GaN channel shows a solid pinch-off and good 2DEG confinement with a DIBL of 7.4 mv/V (V_{DS}= 1 to 25 V). The impacts of recess etching utilizing NF_3 or CF_4 are determined towards establishing a vertical gate downscaling process for reaching W-band.



Vertical GaN power devices:
Altered Mg incorporation via high levels of hydrogen during growth enables free hole density of 2×10^{17} cm^{-3} without annealing. This opens possibilities to develop power devices without the need of post-growth Mg activation. A cost-effective and accurate non-Debye RTA model for thermal conductivity prediction in wide bandgap semiconductors is developed. SBD structures on n-GaN substrate with 2-µm thick n-GaN drift layer delivered for device fabrication. Growth rate of 900 nm/h without degradation of crystal quality is achieved, and threading dislocation density (TDD) of $1.3x10^6$ cm^{-2} demonstrated.

GaN MMIC:
A BCB-based backend process with three metal layers has been developed and circuits have successfully been de-monstrated. Good adhesion, low losses, and good agree-ment between simulations and measurement was observed.



Circuit characterization of MMICs has been performed and gain at V-band confirmed. The next MMIC batch is being fabricated based on HEMTs with a a higher f_{max}.

Developing the next generation high-power β-Ga_2O_3 material:
A cost-effective growth process of state-of-the-art hetero-epitaxial β-Ga_2O_3 layers on sapphire has been developed by reduction of total gas flow and growth pressure. The first homoepitaxial (-201) and (010) β-Ga_2O_3 single-crystalline layers have been demonstrated. A SiH_4 line has been installed enabling controllable doping with Si for power devices.

C3NiT Center Day 11 Nov 2021

90+ C3NiT members, affiliates and visitors met on-line to discuss their research progress. The event featured invited talks by Hiroshi Amano, Farid Medjdoub and Martin Kuball on latest power and rf technology advancements.

New partners

C3NiT board approves the accession of **Volvo Cars** as *a full member* and **Lund University** as a *collaboration partner* of C3NiT.

Recent Publications

M. Stokey et al "*Infrared dielectric functions and Brillouin zone center phonons of α-Ga_2O_3 compared to α-Al_2O_3"*, Phys. Rev. Mat. 5, 004600 (2021).

Manuscript Disclosures

D.Y. Chen et al., "*Impact on in-situ NH3 LPCVD SiN passivation on GAN HEMT performance*", Semicond. Sci. Technol.
H. Zang et al., "*On the polarity determination and polarity inversion N-polar in III-Nitride layers grown on SiC" J. Appl. Phys.*
D. Q. Tran et al., "*Thermal conductivity in AlGaN epitaxial layers"*, Phys. Rev. Materials
M. Schubert et al., "*Terahertz electron paramagnetic resonance generalized spectroscopic Ellipsometry*", Appl. Phys. Lett.

Bachelor Thesis: Shiqi Guo (Linköping University), "AlGaN/GaN HEMTs with varying Al content barrier layer"