

Development of innovative porous silicon-based substrates for Gallium nitride epitaxy industrialization

Lab & Context

The PhD thesis will take place in two labs (UMI-LN2-CNRS and GREMAN) within the framework of a cotutelle between INSA-CVL (Tours - France) and the University of Sherbrooke (Canada).

UMI-LN2-CNRS is a bilateral research unit between France and Canada that has a strong background in wide bandgap semiconductor processing and a remarkable experience of collaboration with prominent corporations in the development of III-V RF and power devices and circuits. The 450 m² class 100 cleanroom of LN2 houses a complete GaN device/circuits fabrication chain including packaging.

GREMAN is a joint research laboratory of Tours University, INSA Centre Val de Loire and CNRS in France. A team works on topics related to porous silicon synthesis and its applications. Porous silicon is an interesting material currently used on research and development for numerous applications such as photonics, microelectronics or biotechnologies. The laboratory is hosted in ST Microelectronics company industrial site in Tours (France) and offers access to the CERTeM technological platform (fully equipped, 400m² class 100 cleanroom).

Objectives

Gallium Nitride (GaN) has become the second most used technology in the semiconductor market, but still far behind Silicon (Si). Their outstanding properties in terms of large bandgap, critical electric field and carrier velocity have allowed the development of critical devices such as visible light emitting diodes (LEDs), power switching devices and RF amplifiers based on High Electron Mobility Transistors (HEMTs). However, the high cost and low availability of GaN substrates makes the hetero-epitaxial growth on foreign substrates necessary. Among these substrates, Silicon is highly preferred to access to infrastructures already available for large diameter substrates. Nonetheless, the hetero-epitaxy of GaN on large diameter low cost Si substrates is still facing difficulties induced by the large mismatch of crystal lattice parameters and thermal expansion coefficients. This project aims at tackling these issues by providing one original Silicon based compliant substrate able to accommodate the huge stress induced by the hetero-epitaxial growth (reducing the bow of the substrate and limiting the risks of layer cracking and substrate breaking). To validate the proof of concept, compliant substrates based on graphene/mesoporous Si nanocomposite will be jointly developed by GREMAN, LN2 and CRHEA. The recruited PhD student will be in charge of the realization of these substrates (mesoporous silicon thin film synthesis, physical characterization and graphene coating). The first experiments will be performed on small samples. Once optimized, this process will be upscaled to 6 in. and 8 in. wafers.

Then, GaN epilayers will be grown at CRHEA. All the partners will bring their expertise to characterize the new substrate and the GaN epi-layers. Transistors and LEDs will be fabricated at LN2 and CRHEA respectively. Both partners and GREYC will perform the device characterizations. Thermal aspects will be studied by GREYC. The first success criteria of this project will be the achievement of a process scalable to substrate with diameter up to minimum 8 in. with better uniformities and reduced residual strain for devices with performances better than their counterparts on standard Silicon substrates. Last, the project aims to use the advantages provided by this new substrate to go further in the optimization of epitaxy for enhancing the device performances.

Profile

The candidate must have a master degree. Moreover, a background in the fields of **material science and/or electrochemistry** is also highly recommended.

Contacts

If you are interested by this proposal and if you need any further information, please contact:

Abderaouf
BOUCHERIF
Professeur, LN2
Abderraouf.Boucherif@USherbrooke.ca

Hassan MAHER
Professeur, LN2
Hassan.maher@usherbrooke.ca

Thomas DEFFORGE
Assistant professor INSA-
CVL
GREMAN
thomas.defforge@univ-tours.fr

Gaël GAUTIER
Professor
GREMAN
gael.gautier@univ-tours.fr

References

- [1] <https://greman.univ-tours.fr>
- [2] <https://certem.univ-tours.fr/>
- [3] <https://www.usherbrooke.ca/ln2/>
- [4] <https://www.usherbrooke.ca/3it/fr>