Master / PhD Thesis Project

(In)GaN microdomains on graphene for flexible LEDs

Nitride semiconductors (GaN, AlN, InN) are known for their exceptional light emitting properties. Nitrides are daily employed for lighting (blue/white LEDs) thanks to embedded InGaN quantum wells, which emit intense blue light with excellent efficiencies (>80%). Our laboratory is known for the pioneer work on novel LED based on nanowires with core-shell InGaN quantum wells. Indeed, we achieved the fabrication of flexible LEDs using such nanowires able to emit blue, green and white light [1-3]. We aims to go further in flexible LEDs by developing the growth of defect-free ordered (In)GaN microdomains on amorphous SiO_2 substrates thanks to the Van-der Waal epitaxy on graphene in order to improve efficiency and get red emission.

The project aims to grow organized and transferable GaN or InGaN micro-templates by apply Van Der Waals epitaxy on graphene and to use these templates for the fabrication of micro-LEDs transferable on flexible substrates. The initial substrate consists of nanoscale graphene patterns on an amorphous SiO_2 support. Growth proceeds in three steps, combining MBE and MOCVD methods to benefit from their respective specificities: (1) selective growth of GaN seeds on the graphene patches; (2) lateral growth around these seeds to form defect-free GaN domains of a few tens of µm; (3) growth of the active structure of the LED on the top facet of these micro-domains. Processing the LEDs includes their separation from the original substrate and their collective transfer onto a flexible support. This technology opens a path to all-nitride flexible displays with high brightness, high resolution and long-term stability.

The work is essentially experimental (epitaxy, advanced structural and optical characterization). It will be carried out in close collaboration with the C2N of Paris-Saclay for the ordered MBE seed nucleation on graphene and for flexible LED fabrication in the framework of the FLAGG project.

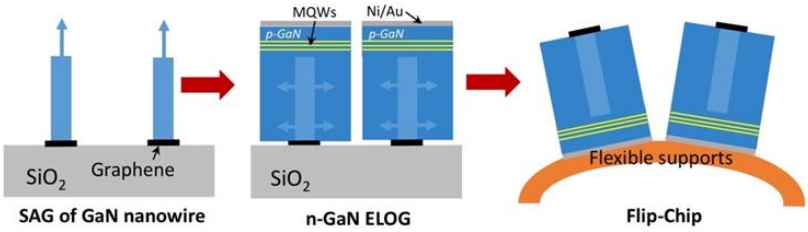

Figure: Schematic of the different fabrication steps of the flexible LEDs.

[1] Dai et al., Nano Lett. 15, 6958 (2015) ; [2] Guan et al., ACS Photonics 3, 597 (2016)
[3] Kapoor et al., Adv. Photonics Res. 3, 2000148 (2021)

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