Van der Waals epitaxy of InGaN on graphene for red LEDs application

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Abstract

The strain during the growth of InGaN on GaN limits the In incorporation in the alloy [1] and therefore makes it difficult to manufacture efficient In-rich InGaN red LEDs required, for instance, for nitride-based RGB microdisplay applications. However, the growth of an InGaN layer on a 2D material could potentially induce a strain-free growth of the III-N compound allowed by the dangling bonds-free surface. A homogeneous high In content InGaN layer could be obtained to reach commercial specifications. Here is presented the nucleation and the growth of InGaN on graphene. The latter is synthesized via propane based CVD on 6H-SiC (0001) substrate. Thorough characterizations demonstrate a continuous high quality monolayer graphene film over the entire substrate. The nucleation of InGaN by MBE on the epitaxial graphene gives rise to the formation of dendrite-like islands weakly bonded with the fully preserved graphene layer (**Fig.1**). Further growth of the InGaN nuclei leads to the formation of a non-fully coalesced film. The InGaN layer is in partial epitaxial relationship with the 6H-SiC substrate (**Fig.2**) underlying the graphene layer, as already observed in the literature for other materials systems [2,3].

References

[1] L. Lymperakis et al., Phys. Rev. Mater., **2** (2018), 011601(R).
[2] Y. Kim et al., Nature, **544** (2017), 340–343.
[3] W. Kong et al., Nat. Mater., **17** (2018), 999–1004.

Figures

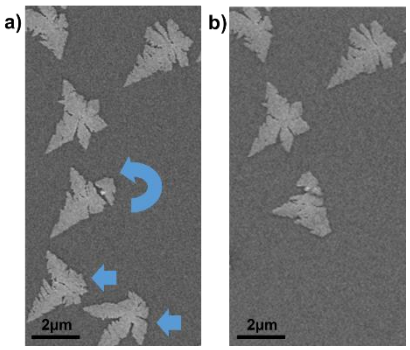

Figure 1: SEM images of InGaN islands on graphene (a) before and (b) after local AFM scanning in contact mode of the bottom part of the image. The blue arrows show the displacement of the nuclei confirming their weak bonding with the substrate.

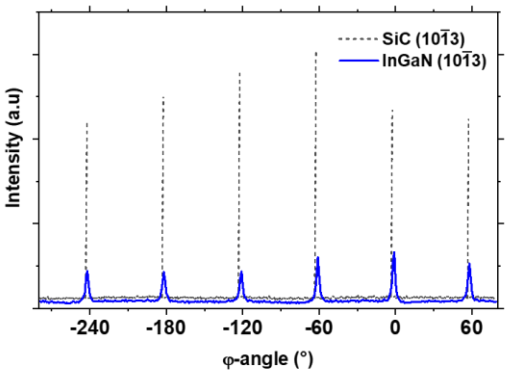

Figure 2: XRD φ-scan performed on the (10$\bar{1}$3) reflection of the InGaN (blue curve) and the 6H-SiC (black dashed curve) substrate showing their epitaxial relationship.