CVD synthesis of Graphene-Boron Nitride heterostructures with optimized properties for optoelectronics devices

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Since graphene isolation in 2004, the 2D materials is a blooming research field. Due to its unique properties, sp² hybridized boron nitride (BN) has been acknowledge as a key towards integration of other 2D materials in devices. Indeed, it is structurally very close to graphene – their lattice mismatch is only 1.7%- a semiconductor, atomically flat and thermally and chemically inert. It is therefore a choice material to be used in the van der Waals heterostructures with other 2D materials (see Figure 1) either as a top layer to protect another 2D material from its environment [1][2], or as a dielectric interlayer [3] and mostly, as a flat substrate [4]. However, these applications have been demonstrated using mechanically exfoliated BN from low defective and highly crystalline single crystals. Yet this process limits the size of the devices that can be created to sub millimetre scale. In order to develop devices at a wafer scale, it is therefore critical to master the synthesis sp² hybridized BN layers at low cost, large scale and high quality.
In that respect, the goal of the researches we have undertaken is to develop the synthesis of sp² hybridized multilayer BN films with structural specifications fitting these requirements. By processing chemical vapour deposition using a dedicated reactor, we aim to control both the structure and the qualities of the film (thickness, roughness, stacking sequence, crystallinity and domain size, impurities and stacking faults). We have already successfully obtained heteroepitaxial growth of a few nanometer-thick BN film of well-stacked and flat layers on single crystalline Ni surface [5]. In this work, we will show how we can better understand the mechanism of nucleation and growth of BN on nickel in order to reach films with optimized quality and structure for each application, through an in-depth study of the impact of synthesis parameters on film structural properties. For that purpose, it is essential to develop and master efficient transfer techniques from the growth substrate to dedicated substrates for devices or characterizations. To access to the structural characteristics and quality of the BN films, the synthesized samples are characterized from the macroscale to the nanoscale via a panel of techniques: optical microscopy, SEM, TEM, AFM, Raman and luminescence spectroscopies, by capitalizing the characterization procedures which have been established on reference BN crystals [6].

References

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Figures

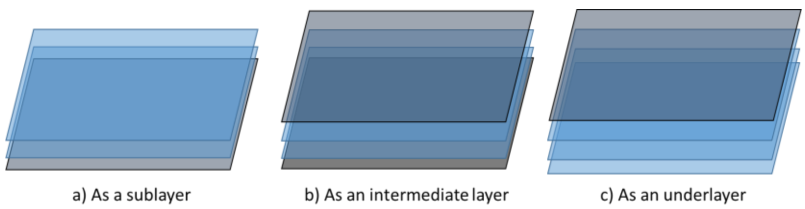

Figure 1: Applications of BN (blue) in an heterostructure with another 2D material (black)