CVD synthesis of sp^2-hybridized multilayer boron nitride films

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Since graphene isolation in 2004, the 2D materials is a blooming research field. Due to its unique properties, sp^2 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 either as a top layer to protect another 2D material from its environment [1], or as a dielectric interlayer [2] and mostly, as a flat substrate [3]. 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 millimeter scale. In order to develop devices at a wafer scale, it is therefore critical to master the synthesis sp^2 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 sp^2-hybridized multilayer BN films with structural specifications fitting these requirements. We have already successfully obtained heteroepitaxial growth of a few nanometer-thick sp^2 hybridized BN film of well-stacked and flat layers on Ni (111) surface of polycrystalline substrate [4]. Here, we will present our work on Rapid Thermal CVD from Annealsys (www.annealsys.com). We will show how we successfully adapt our growth process to this new reactor on centimeter poly- and monocrystalline nickel substrates. We will detail the crucial step of nickel surface preparation before the synthesis. We will present the results of the structural and quality characterization of the BN films from the macroscale to the nanoscale (OM, SEM, TEM, AFM, Raman and luminescence spectroscopies) on the growth substrate and after transfer onto dedicated substrate.

References

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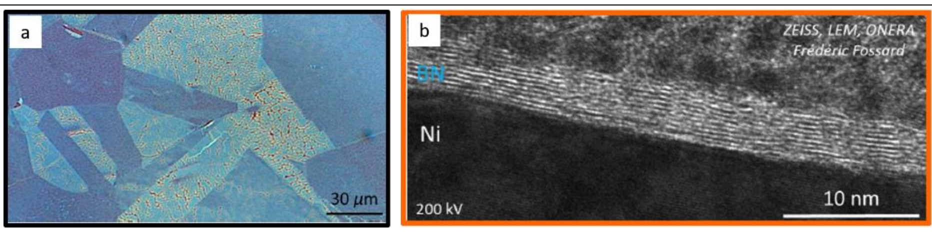
Figures



All the results present here are obtained on the Annealsys RTCVD reactor
(a) Optical microscopy image of a BN film grown on polycrystalline nickel and transferred on SiO_2/Si (coherent with our previous result on other CVD reactor and described in Prevost et al. [4]).
(b) HRTEM image of multilayers BN film grown on nickel (111).