Synthesis and characterization of one-dimensional Van der Waals Heterostructures

In line with the spectacular improvement and emergence of new physical properties in 2D Van der Waals (VdW) heterostructures, the curvature and confinement effects provided by the reduced dimensionality of 1D VdW heterostructures make them highly attractive. These new 1D materials are of particular interest for applications ranging from sensing and quantum optics, to biological labeling. The PhD project aims at the controlled synthesis of freestanding 1D hexagonal Boron Nitride (hBN)/Carbon nanotube (CNTs) VdW heterostructures and at the investigation of their structural properties. The project will focus on the understanding of the controlled growth of hBN by atomic layer deposition (ALD) onto/into suspended single wall CNTs as well as on the investigation of the relationship between the structure and the physical properties, especially the optical ones. Particular attention will be paid at developing highly-controlled method of hBN deposition inside and outside CNTs, studying the growth mechanism and the resulting interaction at the nanoscale. In this regard, single-wall carbon nanotubes (SWCNTs), used as support, will be coated with a thin (from a few nm down to one monolayer) hBN film using ALD. By means of advanced analytic transmission electron microscopy, the relationship between the deposited hBN and the graphitized carbon support will be deeply investigated as the function of the fabrication parameters. Understanding of the BN growth on the inner and outer part of the SWCNT wall is indeed the key for a fine tuning of VdW heterostructure interfaces.

The PhD subject is a joined project between LMI (Univ. Lyon 1) and CEA-IIRIG (Grenoble) and will be granted by the ANR project HETEROBN-C, starting on the 1st of January 2021. The candidate will work in both institutions. He/she must be graduated in Chemistry and be motivated by an interdisciplinary work ranging from material synthesis to chemico-physical characterizations. Strong background in chemistry as well as autonomy, organization in work and good English knowledge are sought after.

Techniques:

Synthesis techniques: synthesis under inert atmosphere (glovebox, schlenk line), Atomic layer deposition, inorganic synthesis.

Characterization techniques: advanced analytic transmission electron microscopy (HRTEM, EELS, STEM…), NMR (mainly 1H and 11B NMR), IR and UV spectroscopies, thermal analysis (TGA, DSC), XPS.

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