Understanding the growth of hexagonal Boron Nitride crystals for nanosheets generation

Development of next generation two-dimensional (2D) transistors or photo-electronic devices is closely linked to advances in 2D materials. Due to its outstanding properties (insulating, stable, inert, transparent, isostructural to graphene…), hexagonal boron nitride (hBN) crystal and in particular its exfoliated nanosheets form, is a choice material to fabricate sensors or plasmonic and photonic devices. However, a wide development of these heterostructures still suffers from a lack of large samples and in ample supply. In this context, LMI and MATEIS labs join their efforts to develop a fabrication process leading to large exceptional quality hBN single crystals of more than few millimeters lateral size by using polymer route combined with a sintering process. This dual process is based on two steps: the preceramic precursor synthesis and the crystals growth using a pressure-controlled furnace.

To go further, synthesis/processing mechanisms (reactivity between the preceramic precursor and dopants, control and understanding of crystal growth, significance of nucleation sites number and distribution...) have to be better understood and mastered in order to control and improve the h-BN crystals synthesis. To manage these stages, a fine characterization of each step of the process is proposed during the PhD, in order to highlight critical steps.

The PhD candidate will be in charge of the synthesis of precursors, crystal growth from the resulting powder mix by controlling the heating conditions (temperature, pressure…), and characterization of the crystals. The global investigation (XRD, Raman and IR spectroscopies, cathodoluminescence...) will be completed by a more local complementary approach (SEM, TEM, AFM...). The key-parameters governing the quality of BN-based will be then identified and modified so that to obtain large, pure, defect-free BNNs.

Keywords
Polymer Derived Ceramics route, crystal growth process, hexagonal boron nitride, environmental SEM and TEM, 2D-nanomaterial, chemical synthesis, microstructural and chemical characterization

PhD Supervision
The PhD's program can be structured into three different parts: first, synthesis of preliminary solid polymer-like BN by the PDCs route, then, the crystal growth, followed by the crystal characterization. Therefore, the PhD will be conducted in two laboratories of Lyon city (France):

- Laboratoire des Multimatériaux et Interface (LMI, Université Claude Bernard Lyon1, UMR CNRS 5615),
- Laboratoire MATEriaux Ingénierie et Science (MATEIS, INSA de Lyon, UMR CNRS 5510).

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Reference
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