Highly Controlled CVD Synthesis of Monolayer and Multilayer h-BN for 2D Materials Applications

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Two-dimensional (2D) materials have attracted great interest because of their unique and excellent physical properties which promise a wide variety of applications. Hexagonal boron nitride (h-BN) is a key material which boosts physical and optical properties of various 2D materials, promoting the electronic and photonic applications. However, due to difficulty in synthesizing large-area h-BN, most of the current studies utilize exfoliated h-BN flakes made from bulk crystal.

In this talk, I will demonstrate the aligned growth of monolayer h-BN using epitaxial Cu(111) and Ni(111) films that are deposited on c-plane sapphire substrates [1,2]. In particular, the high temperature CVD growth on the Ni(111) gave very large and aligned monolayer h-BN grains with a lateral size up to 0.5 mm (Figure 1a,b). Furthermore, we have developed a method to synthesize multilayer h-BN (Figure 1c,d) which is essential for developing applications of 2D materials. The Fe-Ni alloy catalyst allowed to tune the solubility of B and N atoms and also suppress the structural transformation seen in pure Fe metal catalyst. Monolayer WS_2 grown on our multilayer h-BN showed enhanced PL with narrow linewidth, indicating the effectiveness of the CVD-grown multilayer h-BN as a template of 2D materials.

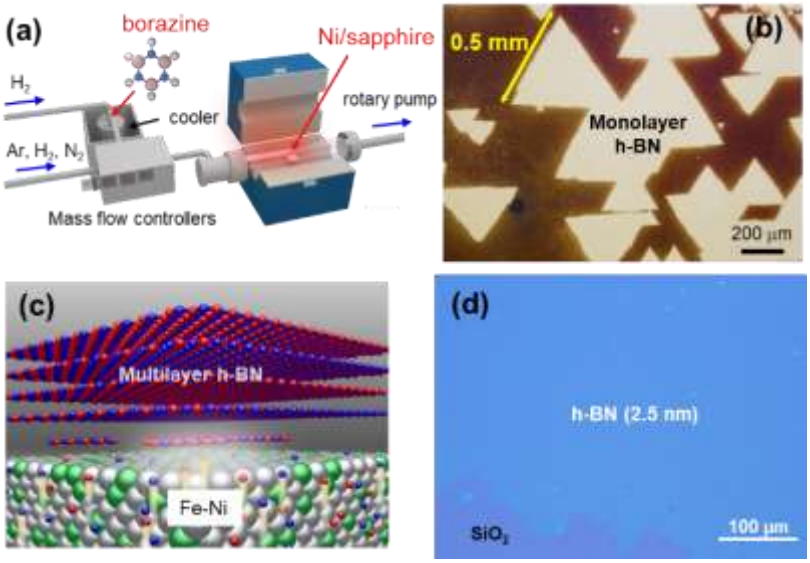

Figure 1: (a) CVD setup used to grow monolayer h-BN. (b) Very large monolayer h-BN grains grown on Ni(111)/sapphire surface. (c) Schematic of multilayer h-BN growth on Fe-Ni alloy catalyst. (d) Optical micrograph of multilayer h-BN transferred on SiO_2 substrate.

Our recent studies on chemical doping of WSe_2 [4], and the controlled CVD synthesis and applications of monolayer and bilayer graphene [5-7] as well as their 2D heterostructures [8,9] will be also presented.

References

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