Optimization of few-layer black phosphorus for low-temperature magneto-transport studies

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I will review our activities on black phosphorus (bP). We obtain high-quality few-layer bP flakes via mechanical exfoliation in nitrogen atmosphere, liquid phase exfoliation [1], and direct exfoliation in a polymer matrix which also protects the bP flakes at the same time [2].

The bP flakes are structurally characterized by AFM, Raman, and STM. I will present a study of surface modification on exfoliated bP flakes upon subsequent annealing steps, up to 550°C, well above the sublimation temperature. In particular, our attention is focused on the temperature range around 375°C - 400°C, when sublimation starts, and a controlled desorption from the surface occurs with the formation of characteristic well-aligned craters. With atomically-resolved STM images we show that the long axis of the craters is aligned along the [100] (zig-zag) direction of bP [3].

Flakes were also processed into Hall-bar devices. Low-temperature magneto-transport has shown clear evidence for weak localization in these flakes, with a strong in-plane anisotropy due to the crystalline anisotropy of bP [4]. A similar anisotropy was observed for high-field in-plane magnetic fields [5]. Furthermore, the nanocomposite bP/PMMA described above was used to directly fabricate bP devices from it, using the PMMA as an electron beam resist [6].

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