CVD synthesis of isolated pentagonal h-BN single crystals

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Hexagonal boron nitride (h-BN), a structural analogue of graphene, is a wide bandgap 2D insulating layered material, consisting of alternating sp^2–bonded boron and nitrogen atoms [1]. h-BN shows appealing properties such as thermally stable in air up to 800ºC, chemical inertness, stable thermal conductivity, and superior elastic properties, and hence has drawn significant attention as a promising material in frontier applications [2]. Although chemical vapor deposition (CVD) technique has developed as the most scalable process to synthesize h-BN on transition metals, the formation of various polygonal-shaped single domain is unclear and are still limited to few microns in their edge length [3, 4]. In this research, we investigated the isolated pentagonal h-BN crystals in single crystallinity prospective.

For h-BN crystals synthesis, bare Cu foils were heated at 26 ºC/min to 1050 ºC with 100 sccm Ar in horizontal tubular furnace. After annealing the Cu foil for 30 min with 100 sccm Ar, ammonia borate (AB) was evaporated with 100:2 mixtures of Ar and H_2. To grow h-BN, 2 mg of AB was heated for various growth intervals with different supply rate to study the morphological transition and rapidly cooled down within 30 min. As synthesized h-BN crystals were analyzed by optical microscopy (OM), Raman spectroscopy, FESEM, XPS, AFM, EBSD, and HRTEM.

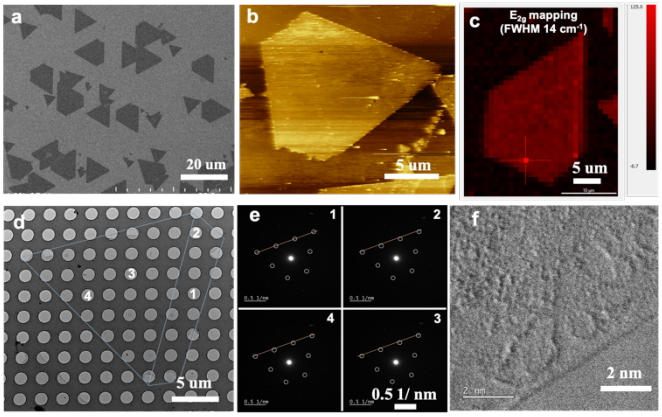

Figure 1. (a) FESEM, **(b)** AFM, **(c)** Raman mapping (E_{2g} vibration mode), and **(d)** TEM images of typical pentagonal h-BN crystals grown for 38 min with AB heated for 60-65ºC. **(e)** shows SAED taken around 1-4 spot in **(d)** and **(f)** shows HRTEM image on edge.

Pentagonal shaped (most dominance) along with regular triangular shaped h-BN crystals (**Fig. 1(a)**) were grown for 38 min with AB heated for 60-65ºC. **Fig. b-d** shows the uniformity of pentagonal crystal with sharp and step edges comprising longer and shorter arms respectively. It is believed that merging of small triangular h-BN crystals in different fashion produced most of polygonal h-BN crystals and could be polycrystalline[3-4]. SAED were taken from 1-4 of an isolated pentagonal crystal shows no distinct difference in crystallographic orientations (see **Fig. (e)**) and HRTEM image shows its high crystallinity.

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References

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