Tuning the crystallinity of Boron Nitride using Chemical Vapor Deposition

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2D materials are excellent candidates for current and future electronic devices. Among them, hexagonal boron nitride (hBN) is proving to be a key material for future graphene-based optoelectronic devices,1 as it is an insulator and an isostructural of graphene. It appears to be a substrate of choice to boost the properties of graphene and thus enable the implementation of this later in real-life applications. Recently, it has been shown that controlling the degree of crystallinity of BN can have a significant impact on its intrinsic properties. For example, amorphous BN displays an ultra-low dielectric constant of 1.16, whereas a value of 4.0 at 1MHz is observed for hBN.2 Therefore, tailoring the structure of BN and thus its properties would permit widening its application areas, from isolating interconnects and high-performance electronics in optoelectronic to spintronics.3

Among the synthesis approaches, Chemical Vapor Deposition (CVD) of hBN has been widely reported in the literature and thin films have been obtained from different precursors such as ammonia-borane, diborane, BCl3 and borazine (formula B3N3H6).

In the present contribution, BN films with different degrees of crystallinity deposited by CVD are introduced. The impact of the different growth parameters on the final material is presented using the borazine as a single source precursor. Four different gases are investigated: Ammonia, Nitrogen, Ar/H2 95/5 and Ar/H2 90/10. Particular attention is paid to the influence of the carrier gas flow rate, the type of substrates and the deposition temperature. The obtained films are characterized by ellipsometry, X-ray diffraction, scanning electron microscopy, electron dispersion, Raman and Infra-red spectroscopy.

As expected, the deposition temperature plays a crucial role, although the nature of the carrier gas strongly influences the reactivity of the borazine and thus the final structure of BN. The results show a stoichiometric B:N ratio of 1:1 with very low carbon and oxygen contamination on the films deposited with an Ar/H2 mixture on the copper foil, while higher oxygen impurities and lower crystallinity are noted on Si(100). Films grown at 1000°C show the presence of small crystallites. Control of the crystallinity of BN films can be achieved by regulating the temperature during the process, allowing the deposition of films within a wide range of crystallinity. Not only copper but also Si 100 has been used as a substrate with similar results without cleaning nor treatment of the substrates.

References

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