Ellipsometry Study of Hexagonal Boron Nitride Grown on CMOS-compatible Substrates via CVD

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Hexagonal boron nitride (hBN) has a range of promising applications, including deep ultraviolet optoelectronics and passivation layers for high-mobility graphene. For integration into Si technology, growth of hBN thin films directly on CMOS-compatible substrates, such as silicon, germanium or dielectrics, is desirable. In particular, germanium has proven suitable for chemical vapor deposition (CVD) growth of high-quality 2D materials [1], due to its catalytic activity. In fact, low pressure CVD growth of polycrystalline hBN monolayers on Ge using ammonia borane as the precursor has been reported previously.[2] We grow few-layer hBN thin films on epitaxial Ge(001)/Si substrates via CVD, using borazine as a single-source precursor.[3] Characterization of the grown films is of utmost importance for growth studies, but can be quite challenging in the case of 2D materials. Transmission electron microscopy (TEM) analysis provides comprehensive insight into the crystalline structure and revealed a film thickness of 1-5 nm, dependent on growth time and borazine partial pressure, with an interlayer distance of 3.35 Å (Fig. 1a). However, TEM analysis is very time consuming and higher throughput methods are needed. Here, we focus on multiangle spectroscopic ellipsometry (SE) in the DUV-VIS range to assess thickness and optical constants of hBN. First SE investigations show that hBN films grown on Ge(001)/Si can be detected starting at ~2 nm thickness. The obtained ellipsometry spectra are fitted using a Tauc-Lorentz oscillator model and the refractive index n and extinction coefficient k are extracted, see Fig. 1b-c. Noticeably, the extinction coefficient near the fundamental absorption edge (>5 eV) indicates a good quality material with a bandgap close to 6 eV. The refractive index at 633 nm (1.96 eV) is in the range of 1.7-2.5, depending on the specifics of the samples.

References

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Figures

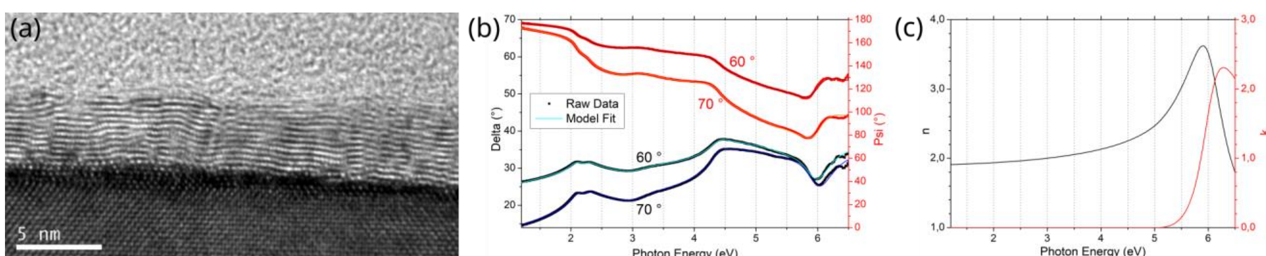

Figure 1: (a) TEM image of hBN film grown on Ge(001)/Si, (b) fitted ellipsometry spectra and c) determined optical constants n and k.