Fourier-transform infrared micro-reflectivity as a tool for efficient characterization of hexagonal boron nitride epitaxial layers

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Hexagonal boron nitride (hBN) similar to other III-Nitride materials family has a high mechanical strength and chemical stability. That is why it can be applied in devices that operate at high temperatures as well as in hostile environments. At the same time hBN is the only III-N with a layered structure and with no dangling bonds out of plane. For that reason hBN is compatible with other 2D materials such as transition metal dichalcogenides (TMD). Scientists are eager to combine atomically flat boron nitride in heterostructures consisting of materials with different properties using hBN as an insulating layer. This kind of structures, also called nanoLego, find variety of possible applications in photovoltaics, ultrafast transistors or ultrafast photodetectors.

However, all of these potential applications require large areas of hBN. One promising solution to this problem is based on metalorganic vapor-phase epitaxy (MOVPE). Although large scale growth has already been achieved, the quality of the epitaxial hBN layers is still inferior to flakes exfoliated from bulk crystals and needs to be improved.

In this work, we study high quality MOVPE grown hBN [1] by Fourier-transform infrared micro-reflectivity. A ~70×70 µm measurement area enables the examination of not only large epitaxial layers, but also individual exfoliated flakes. Using Dynamic Dielectric Function (DDF) approach we are able to simulate the whole sprectrum for boron nitride on a sapphire substrate as presented in Fig. 1. The modeled curve, which takes among others the self energy and damping parameter of E_{1u} oscillatory mode into account, provides a set of valuable information about properties such as residual strains and structural quality. Importantly, we can also obtain estimation of the layer thickness (in the range from atomic layers to a few µm). In order to validate the obtained data we compare it with a complementary measurement technique namely x-ray reflectometry (XRR). Advantages, disadvantages and limitations of both methods are discussed. Due to quick FTIR measurement and analysis this characterization method can provide a valuable and fast feedback for the growth of hBN epitaxial layers.

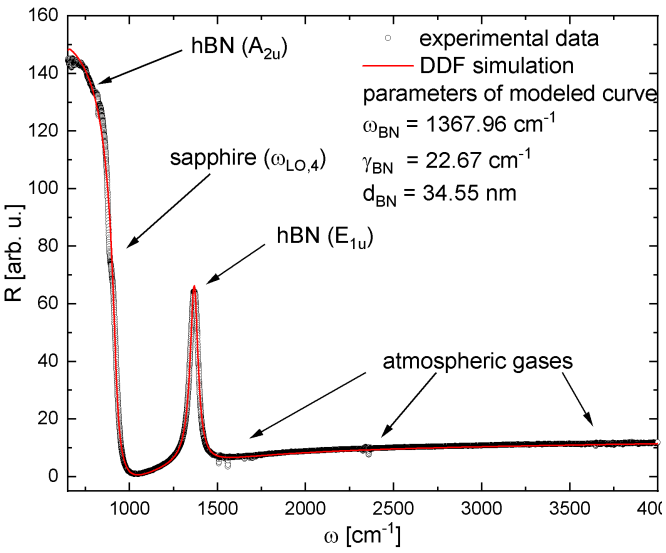

Figure 1: FTIR reflectance spectrum of hBN on sapphire substrate with modeled curve.

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[1] A. K. Dąbrowska et al., *2D Mater.* **8**, 015017 (2021).