Two Stage Epitaxial Growth of Boron Nitride – Advantages and Prospects

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Sp^2-hybridized boron nitride (BN) is a wide bandgap (about 6 eV) two-dimensional material, very resistant to harsh external conditions [1]. These properties enables its use in a wide range of applications, for example: deep UV light sources, one of the building blocks in van der Waals heterostructures, protective layer etc. [2]. In order for the created structures to be as effective as possible, it is necessary to develop a growth method that will result in the formation of a material with good optical and structural properties on the large scale.

Metal Organic Vapour Phase Epitaxy (MOVPE) is the method that could fulfil all of these requirements. In this technique, the BN growth is carried out on sapphire substrates with triethylboron (TEB) and ammonia as precursors of boron and nitrogen, respectively. The proposed new growth mode - two stage epitaxy - allows to avoid the chaotic nucleation on the substrate, characteristic for Flow-rate Modulation Epitaxy (FME) by introducing a thin (a few nanometers), pre-ordered, Continuous Flow Growth buffer layer [3]. This new growth method leads to the formation of boron nitride with an almost ideal lattice constant and to the reduction of the concentration of point like defects in the structure. Interestingly enough, in depth studies revealed the correlation between the properties and growth conditions of the CFG stage with structural properties and smoothness of the whole two stage sample (Fig. 1). In this communication the influence of the nitridation, temperature, pressure and the growth time on the properties of the two stage samples is discussed.

Our studies show that the high quality, two stage samples may have even better structural and optical properties. Achieving boron nitride comparable to the bulk material on the large scale is within the scope of our possibilities and a further fine tuning of the method brings us closer to practical applications. The proposed growth method shows great potential for the production of high-quality, smooth, epitaxial hBN which is crucial for large scale optoelectronic applications based on 2D materials.

REFERENCES

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FIGURES

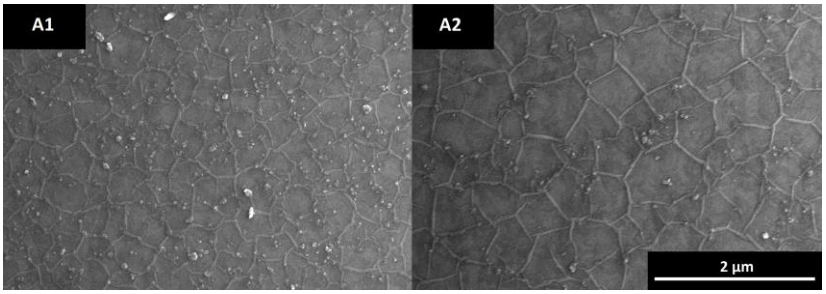

Figure 1: Scanning Electron Microscopy (SEM) image of the two stage samples grown in the same conditions but annealed and stabilized before the growth in nitrogen (A1) and hydrogen (A2).

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