Structural Investigations of sp^2 - Hybridized BN Layers Grown on Sapphire/AlN Substrates by Low Pressure MOVPE

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The hBN is an attractive material for deep ultraviolet device application. Despite of large band gap, comparable to AlN, hBN doped with Mg shows relatively small p-type resistivity, around 2Ωcm at 300K [1], what is very promising for deep UV optoelectronic devices. Hexagonal structure is similar to graphene and can be also useful for electronics based on layered materials [2].

Epitaxy of sp^2 BN layers is still poorly developed and sparsely described in literature. The sp^2–hybridized boron nitride (sp^2 BN) can appear in three different phases: hexagonal (hBN), rhombohedral (rBN) and also as turbostratic version of it (tBN). Hexagonal and rhombohedral versions have common lattice spacing within the basal plane (a=2.501 Å) but due to the different stacking sequence (AB versus ABC) their c-axis lattice spacing is 6.656 Å and 10,000 Å respectively. Turbostratic phase (tBN) basal plane lattice spacing follows the hBN and rBN value but since stacking sequence is lost in this structure only distance between basal planes may be recovered from the specific measurements and compared to standard 3.33 Å value for hBN and rBN.

One of BN epitaxial growth method is metalorganic vapor phase epitaxy (MOVPE), with triethylboron (TEB) and ammonia (NH3) used as precursors. Main problems in epitaxy of BN are connected with low efficiency of the synthesis [3], and poor crystallographic quality of the BN layers.

In this communication high temperature MOVPE sp^2 BN growth on sapphire substrates with foregoing low temperature (LT) AlN intermediate layer growth, to increase adhesivity of the BN layer, is presented. Process conditions were investigated at wide range to increase growth efficiency and quality of the layers. Crystallographic structure of the sp^2 BN investigated by X-ray diffraction measurements presented here are based on standard laboratory X-ray source equipped with parallel beam Bragg reflection mirror and standard Phillips Diffractometer. Raman spectroscopy was also employed to confirm the crystallographic structures present in the sp^2 BN layers. Scanning Electron Microscopy (SEM) studies allowed distinguishing specific morphology of the layer top surface as well as cross sectional features of sp^2 BN deposited on sapphire/AlN substrate. The obtained results shed more light on the processes responsible for the formation of different BN phases and provide important information enabling optimization of the rBN growth process.

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