Influence of (MO)CVD Process Parameters on the Quality of Single Layer Graphene and Hexagonal Boron Nitride grown on C-plane Sapphire

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Metal organic chemical vapor deposition (MOCVD) has established as a powerful method for deposition of large-scale, high-quality homogeneous 2D layers. Recently, the growth of 2D films on sapphire as technologically relevant Cu-free substrate material has attracted interest. Here we present results of our growth studies of single layer graphene (SLG) and few layer hBN films deposited on c-plane sapphire in an AIXTRON CCS 6x2'' cold-wall reactor at growth temperatures of 1400 °C and 1280 °C, respectively. The ratios of precursor flows, in detail CH_4 (methane)/H_2 for graphene and TEB (triethylborane)/NH_3 for hBN, were systematically varied and their effect on film growth and quality was studied. The quality of the SLG films was defined from the sp^2/sp^3 ratio of the carbon 1s core level photoemission spectra for the as-grown films (Figs. 1 c and d). This measure also relates to the carrier mobility data obtained from electrical characterization of as-grown and transferred SLG layers. For hBN a suppression of 3D island growth in favour of 2D growth was obtained if the TEB/NH_3 flow ratio was increased (Fig. 1e). The insulating properties of the films were characterized after transfer of the layers onto conducting substrate materials. In addition, effects of the growth temperature and of the surface termination of sapphire are addressed. Film characterization was performed by various microscopic, spectroscopic, and electrical techniques such as SEM, AFM, XPS, Raman, Raman mapping and electrical measurements (see Figs. 1a-h). The results will be discussed in this presentation.

Figures

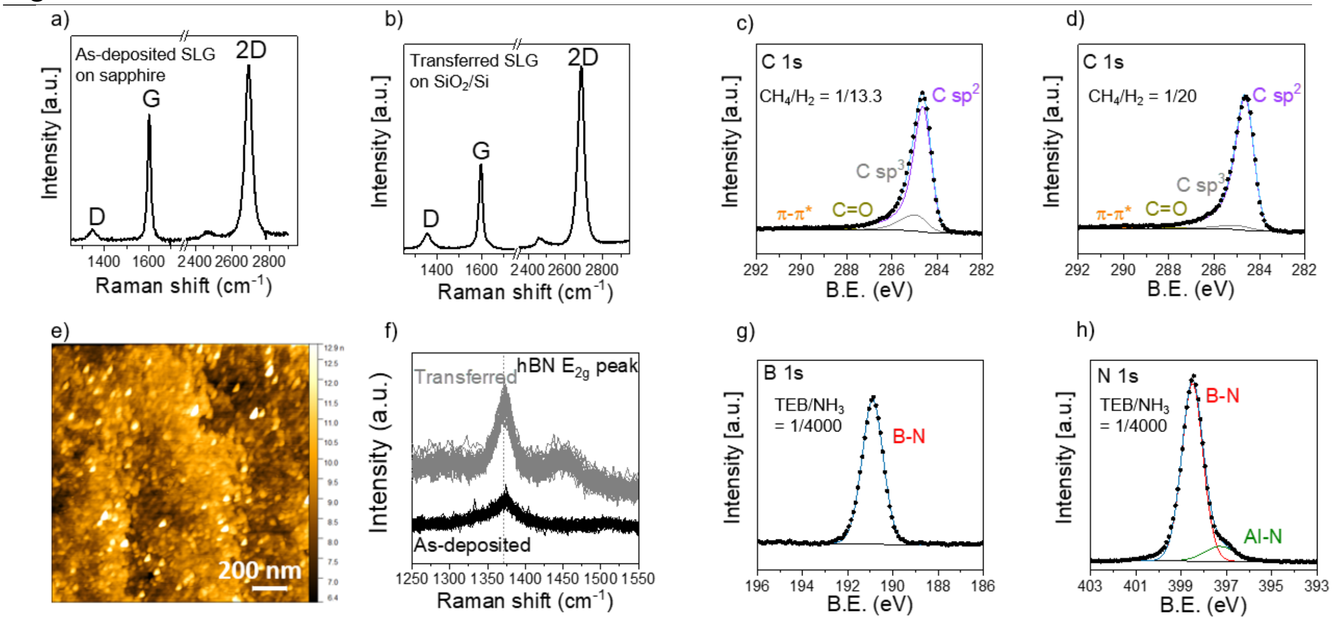

Figure 1: (a),(b) Raman spectra of SLG/sapphire and SLG/SiO_2/Si. (c),(d) XPS C 1s core level spectra with component analysis for different CH_4/H_2 flow ratios. (e) AFM 1.5 x 1.5 µm² area of hBN/sapphire. (f) Raman spectra hBN/sapphire and hBN/SiO_2/Si. (g), (h) XPS B 1s and N1s core level spectra and component analysis of as-deposited hBN/sapphire.