Structural Investigations of Graphene Layers Grown on 4H-SiC - Buffer Layer Engineering

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Intercalation of the various elements or compounds into the few layer graphene structure shows the way for future graphene electronic applications. That also includes functionalized graphene which may be suitable for the specific applications like bio-sensors, liquid and gas sensors etc. X-ray diffraction and X-ray reflectometry measurements presented here regarding few layer graphene structures are based on standard laboratory X-ray source equipped with parallel beam Bragg reflection mirror and standard Phillips diffractometer [1]. Samples were grown either by Chemical Vapor Deposition (CVD) or sublimation methods at 1600^{o}C under an argon laminar flow in an Aixtron VP508 hot-wall reactor. Graphene growth was preceded by H_2 etching of the SiC substrate. SiC surface was atomically stepped [2], although substrate was nominally on-axis (0001) oriented. Graphene intercalated with hydrogen [1], oxygen [3], and nitrogen, together with graphene oxide are prime examples of such graphene treatments which can led to specific graphene properties necessary for the wide spectra of applications. We have shown that in all samples investigated one can observe presence of non intentional water layers between the SiC and first carbon layer. Positioning and type of bonding of the intercalate, within the few layer graphene structure, is a crucial aspect of the whole functionalization. Using X-ray laboratory setup we have measured standard diffraction pattern as well as low angle reflectometry signal allowing for the precise evaluation of the buffer region above SiC substrate. We have shown that one can manipulate the positioning and presence of the intercalates, within the graphene structure, by thermal treatment and UV light. We have also observed a clear resistance changes upon UV illumination. This may be connected with the presence of water layers within the buffer volume. It will be shown that hydrogen, oxygen and nitrogen intercalate differently and positions itself at completely different lattice sites within the layer. X-ray measurements are compared with Raman spectroscopy, and ATR measurements to cross-reference the presence and positions of the intercalate.

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