Micro-Raman analysis of the influence of hydrogen intercalation on the epitaxial graphene grown on 4H-SiC(0001) substrate

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It is commonly accepted that properties of epitaxial graphene (EG) grown on SiC are determined by interaction with substrate. It was found, that hydrogen intercalation of EG grown on SiC(0001) substrates by sublimation is a promising method to increase the mobility of carriers [1]. As verified by Raman spectroscopy [2] sublimation grown samples show much stronger interaction with the SiC substrate than epitaxial graphene grown using Chemical Vapor Deposition (CVD) method [3]. In order to achieve better understanding of the effects induced by hydrogenation strain analysis for graphene grown by Si sublimation and CVD technique was performed. In this study random fluctuations of the G and the 2D peaks were used to analyze strain nature in epitaxial graphene grown on terraces of the SiC(0001) substrate.

Two types of EG samples grown on 4H-SiC(0001) have been investigated: graphene grown by Si sublimation and grown by CVD. Micro-Raman mapping were used to analyze the influence of strain fluctuation on the relative shifts of the G and 2D peaks. The data were collected from terraces avoiding regions of multisteps. It was found that of the G peak position plotted as a function of the 2D band position shows linear correlation with the slope of 0.42 and 0.37 for EG grown by Si sublimation and by CVD, respectively.

It was already shown in previous studies the correlation of the Raman G peak versus the 2D peak position provides information about the nature of stress existing in graphene [4,5]. It can be deduced, that in the case of freestanding material, uniaxial strain induces a shift of the Raman G peak being of about 0,33 of the 2D peak position change [4]. On the other hand, in the case of biaxialy strained samples the average energy shift of the Raman G peak is of about 0.45 of the 2D peak position change.

Our results indicate that graphene grown by Si sublimation predominantly biaxialy strained, whereas for CVD grown samples uniaxial component is dominant.

Important change of the measured slopes takes place after hydrogenation. The slope of the G versus the 2D peak position is strongly reduced for the Si sublimated EG from the value of 0.42 to 0.29. Reduction of the measured slope indicates that after hydrogenation the dominant stress becomes the axial one. This result is in agreement with a common believe that hydrogenation process causes decoupling of the graphene from the SiC substrate. The remaining uniaxial strain is the most likely resulting from influence of steps on terraces regions. For the CVD grown EG the corresponding slope is only slightly reduced from 0,37 to 0.33. This small change of slopes indicates that CVD grown layers are not so strongly bound to the SiC substrates before hydrogenation. In this case hydrogenation process only slightly reduces residual biaxial strain of the CVD grown layers, keeping as a dominant the uniaxial part of the strain most likely resulting from the influence of steps.

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