Hydrogen-Mediated CVD Epitaxy of Graphene on SiC: Implications for Microelectronic Applications

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Abstract

Despite the large body of literature reporting on the growth of graphene (Gr) on 6H−SiC(0001) by CVD [1-3], some important issues have not yet been solved, and full-wafer-scale epitaxy of Gr remains challenging, hampering applications in microelectronics. With this study, we shed light on the generic mechanism which produces the coexistence of two different types of Gr domains: Gr on hydrogen (H-Gr) and Gr on buffer layer ((6 × 6) Gr), whose proportion can be carefully controlled by tuning the H_2 flow rate. We show for the first time that the growth of Gr by CVD under a H_2/Ar flow rate proceeds in two stages [4]. First, the nucleation of free-standing epitaxial Gr on hydrogen (H-Gr) occurs; then, H-atoms eventually desorb from either step edges or defects. This gives rise, for a H_2 flow rate below a critical value, to the formation of (6 × 6) Gr domains. Using the robust and generic X-ray photoelectron spectroscopy (XPS) analysis, we realistically quantify the proportions of H-Gr and (6 × 6) Gr domains of a Gr film synthesized under any experimental conditions. STM supports the XPS measurements. From these results, we can deduce that the H-assisted CVD growth of Gr developed here is a unique method to grow fully free-standing H-Gr in contrast to the method consisting of H-intercalation below (6 × 6) Gr epitaxial layer. Further description will be given in the presentation. These results are of crucial importance for future applications of Gr/SiC(0001) in nano- and microelectronics and in particular for field-effect transistors. We achieve thus a precise identification of new Gr surface structures which provide the groundwork for the use of Gr as an optimal template layer for Van der Waals homo- and heteroepitaxy for optoelectronic applications. In a last part, the two different mechanisms of growth of Silicon on each accurately monitored Gr surface are reported.

References

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Figure

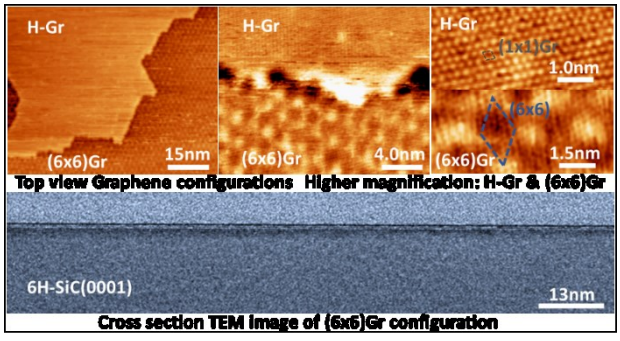

Figure: *STM images showing the interface between H-Gr and (6x6)Gr domains existed in the same surface layer and their atomic structures. Large scale TEM image showing the continuity and homogeneity of (6x6)Gr configuration.*