Real measurement of the height of the different kind of graphene grown on 6H-SiC(0001)

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Direct growth of graphene on insulators would widen the application scope of graphene in functional architectures, photovoltaics, functional ceramics, etc. Yet the growth of graphene by chemical vapor deposition (CVD) or by sublimation on the 6H-SiC(0001) surface gives many different structures : the zero layer graphene (ZLG) is chemically linked to the silicon plane, the epitaxial monolayer graphene (EMLG) grows on top of this ZLG, and the quasi-freestanding monolayer graphene (QFMLG) lies on top of the Si-H hydrogenated silicon plane [1]. Their specific height has been measured by different techniques such as scanning tunnelling microscopy (STM) [2] or normal incidence x-ray standing wave (NIXSW) [1]. STM does not provide a real height measurement due to electronic effect arising from the difference in the local density of states between the substrate and the graphene layer. NIXSW is a non-local technique that provides a height averaged over the probed area.
We present here real height measurements of these three kinds of graphene obtained by no contact atomic force microscopy (NC-AFM) coupled to Kelvin probe force microscopy (KPFM) under ultra high vacuum. We measure simultaneously the height and the difference of the work function of a layer deposited on a substrate (see figure 1). Two types of samples have been studied : 1) nano-islands of graphene grown by CVD on 6H-SiC(0001) [3] and 2) graphene layers obtained by high temperature sublimation of 6H-SiC(0001), with a partial surface coverage. The line by line profile analysis with a specific fitting function yields height measurement with a precision below 0.2 Å. Our method is precise enough to provide an unambiguous identification of the QFMLG (4.09 ± 0.11 Å), the ZLG (2.62 ± 0.2 Å) and bi-layer graphene (6.87 ± 0.14 Å). The analysis of the KPFM images shows that the difference of work functions between these different kinds of graphene is between 200 and 400 meV.

References

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Figures

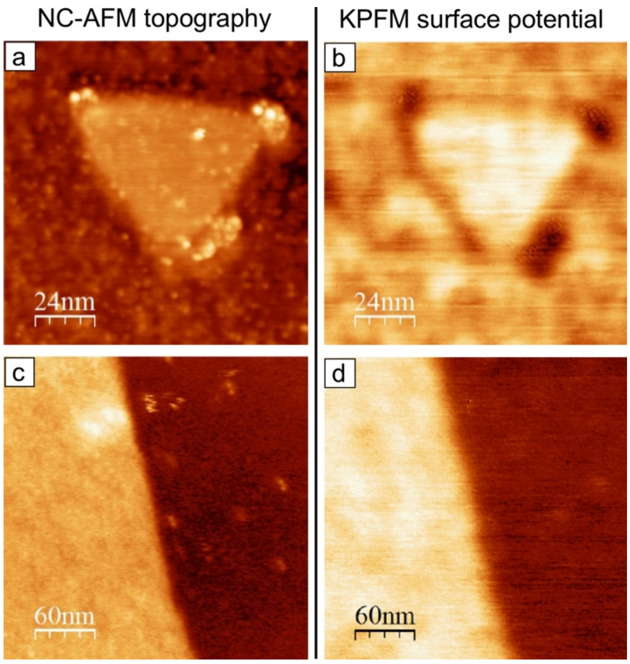

Figure 1: NC-AFM topography and KPFM surface potential of a nano-island of graphene grown by CVD (a and b) and of a graphene layer obtained by sublimation (c and d).