Control of graphene deposition on SiC by *ex situ* and *in situ* surface conditioning of SiC

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As early as in 2004 the intentional synthesis of graphene onto SiC wafers by thermal treatment had been demonstrated. Owing to the vapor pressure difference of Si and C, high temperature annealing promotes atomic Si sublimation leaving atomic C supersaturation on the SiC surface, which tends to crystallize in graphitic form. As the formation of graphene is extrinsic, based on the decomposition of the SiC support, the graphene-on-SiC has serious intrinsic limitations [1]. Efforts have been done to model the growth so that the basics of the formation, the conditions for nucleation and growth propagation, could be understood [2]. However, the complexity of the problem still makes it difficult to apply the results of simulations towards experimental graphene synthesis optimization. We propose the establishment of universal synthesis conditions based on atomically flat SiC, which ultimately may enable the standardization of a graphene-on-SiC technology.

In this work, the study of graphene formation is based on the use of atomic step SiC substrates, which are obtained by our particular chemical mechanical polishing (CMP), CMP-SiC (Fig.1 a, b), in comparison with commercial epi ready SiC substrates, epi-SiC (Fig. 1 c). We have previously demonstrated [3] the growth of highly anisotropic long isolated graphene ribbons on the C face of graphite-capped 6H-SiC by the use of a graphitic cup which controls the dynamics of the SiC decomposition and its surface reconstruction, therefore, strongly determining the formation of the graphene flakes. The same induced-anisotropy is found for the C face of 6H-SiC CMP-SiC substrate [4].

Most remarkable effect of CMP (*ex situ* surface conditioning) is observed when modifying the thermal treatment used for the anisotropic graphene flake deposition. Laying aside the preliminary stage of the thermal treatment (*in situ* surface conditioning), at a temperature below the onset of massive atomic Si sublimation [3], single layer graphene isotropic deposition is found all over the Si face of 6H-SiC, for both CMP-SiC and epi-SiC (Fig. 2). However, the characteristics of the SiC support (terraces width and smoothness, step height, edge shape, etc.) strongly differ for CMP-SiC vs. epi-SiC (Fig. 2). Very regular reconstruction of CMP-SiC (Fig. 2 a) and Raman scattering analysis suggest that the characteristics of graphene and the fabrication of graphene-on-SiC electronic devices would be better by using CMP, i.e. having more homogeneous properties while more reliable electronic device performance is expected.

References

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Figures

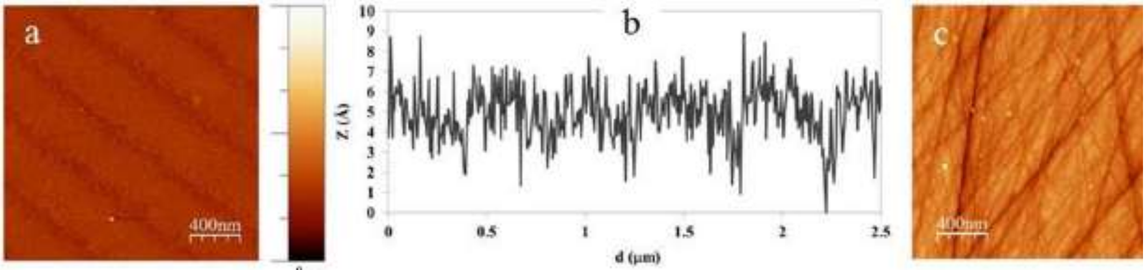

Fig. 1 Topography signal AFM images of a) CMP 6H-SiC, Si face, on-axis cut b) its profile along the diagonal showing atomic step finishing, and c) Mechanical polishing of 6H-SiC off-axis cut C face (Z scale = 10 nm).

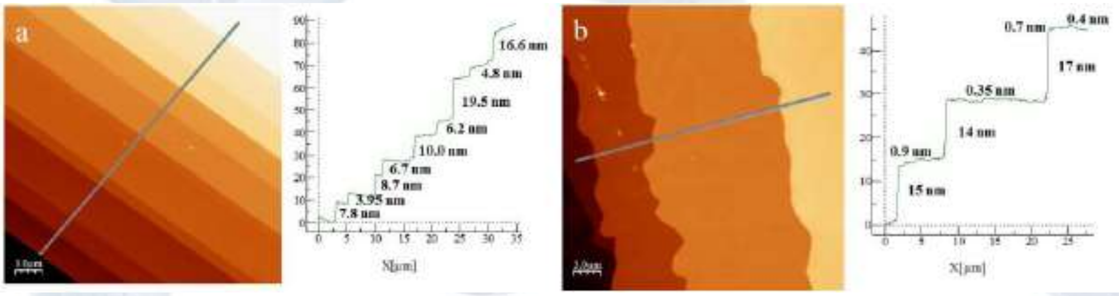

Fig. 2 Topography signal AFM images and profile of a) graphene on CMP 6H-SiC, Si face, on-axis cut sample and b) graphene on the Si face of epi-SiC 6H-SiC, off-axis cut sample, which presents random irregular SiC islands upon the terraces.