Effect of substrate polishing on the growth of graphene on 3C-SiC(111)/Si(111) by high temperature annealing

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Abstract
The potential of graphene as a fundamental block for future technology and devices is nowadays more than assessed, its intrinsic properties having been deeply explored and understood.
The actual challenge is finding the route to achieve the production of large-scale, high quality crystals, while keeping the production costs to the minimum, and thermal desorption from SiC(111) thin films epitaxially grown on Si(111) stands as the best compromise among the available growth techniques in this sense.
The aim of this work is to ascertain the effects of polishing and substrate roughness on 3C-SiC(111) epilayers on Si(111) before and after graphene growth, and to provide a clear indication of the ideal surface characteristics to obtain high quality graphene layers.
Three different kinds of 3C-SiC(111) epilayers grown on Si(111) substrates were used to produce epitaxial graphene by annealing in UHV: 250nm thick unpolished (A), 1μm thick polished (B) and 1μm thick unpolished (C). Our studies, a combination of scanning tunneling microscopy, low energy electron diffraction, Raman, valence band and core levels spectroscopies leads to the choice of the best condition for epitaxial graphene growth: thicker polished substrates produce better results in terms of terrace widths and reduced roughness, leading to an improved graphene quality. The roughness of samples as received drops with polishing, while results obtained from XPS analysis on all the three samples would indicate that the number of epitaxial graphene layer is substantially unaffected by the roughness of the substrate. A study of the diffraction pattern on the best sample points out the existence of a single domain over the whole crystal, and the crystallinity of the sample is granted by the presence of a well defined band structure. The electronic valence band state dispersion reveals a long-range ordered sample, even though some defects (also seen via microscopy) are present.

References

[1] B.Gupta, I. Di Bernardo, P. Mondelli, A. Della Pia, M.G. Betti, F. Iacopi, C. Mariani , N. Motta Effect of substrate polishing on the growth of graphene on 3C- SiC(111)/Si(111) by high temperature annealing; Submitted to Nanotechnology (2015).

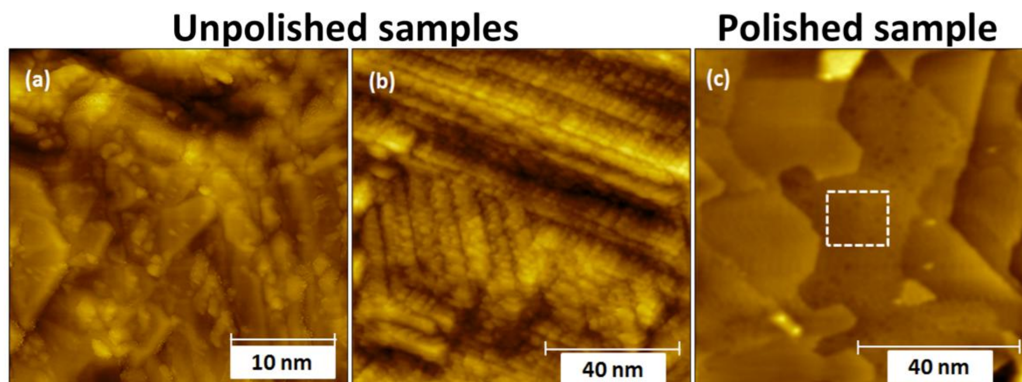

Figure 1 (30 ×30) nm^2
C. (a) Sample A - 250 nm unpolished (Vb: 1.8 *V*; I: 600 *pA*); (b) sample B - 1 µm unpolished (Vb: 1.65 *V*; I: 600 *pA*) and (c) sample C - 1 *µm* polished (Vb: 1.5 *V*; I: 100 *pA*)