Driving with temperature the synthesis of graphene on Ge(001) and Ge(110) substrates

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Abstract

"Real-world" technological applications of graphene in opto-electronics with full exploitation of its innovative properties still need a further improvement towards the growth of high quality metal contamination-free graphene [1]. To this end, CVD graphene grown directly on Ge substrates can represent a significant advancement toward the full compatibility with CMOS-technology, while for the enhancement of the graphene quality the influence of temperature and the early stage of growth should be further investigated to shed light on the growth mechanism of graphene [2].

By combining Atomic Force (AFM) and Scanning Tunnelling Microscopies (STM) with Raman and X-ray photoelectron spectroscopies (XPS), we find that, in our growth conditions, the structural quality of graphene films depends critically on the growth temperature and improves significantly by increasing the deposition temperature in the 910–930 °C range. We attribute this abrupt temperature dependence to the formation of a quasi-liquid Ge surface that favors the formation of high-quality graphene, thanks to the increased diffusivity and sublimation rate on the liquid Ge surface which promotes more effective diffusion of carbon species and desorption of the defective ones from the growing graphene films. In addition, we show that this incomplete melting of Ge is pivotal in explaining the characteristic nanofaceting of the Ge(001) surface developing underneath the growing graphene film[3], while in the case of the Ge(110) surface the presence of the quasi-liquid Ge adlayer favors the formation of wide terraces and a low density of surface steps which appears to be promising as a template for the growth of ribbon nanostructures [4].

References:

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