Impact of germanium substrate orientation on morphological and structural properties of graphene grown by CVD method

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Graphene on germanium was synthesized for the first time in 2013 [1] and since then it has been under extensive investigation due to its possible application in the CMOS technology. The initial research showed that there is a strong correlation between the Ge substrate orientation and morphological, structural and electronic properties of the overlaid graphene [2].
In this work, we present the study of the growth mechanism of graphene synthesized by CVD on undoped (001), (110) and (111) oriented germanium, characterized by SEM and Raman spectroscopy. We determined the distinct differences in the graphene domain shape and nuclei density, revealed by the SEM studies (Fig. 1). Additionally, strain and doping levels in the continuous graphene layer investigated by the Raman spectroscopy indicated that graphene on Ge(001) is the most uniform among all three orientations, while Ge(110) and Ge(111) yield, respectively, highly strained and doped graphene (Fig. 2). All the presented variances can be linked to the different surface reconstruction of germanium both at room and growth temperatures.

References

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[2] B. Kiraly, R. M. Jacobberger, A. J. Mannix, G. P. Campbell, M. J. Bedzyk, M. S. Arnold, M. C. Hersam and N. P. Guisinger, Nano Lett., 15 (2015), 7414–7420

Figures

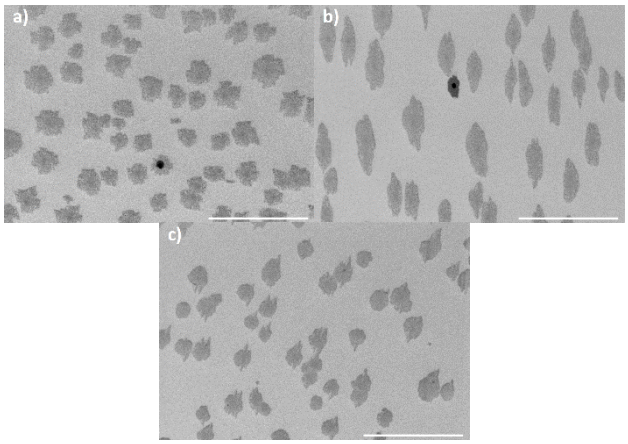

Figure 1: SEM micrographs of graphene nuclei on: a) Ge(001); b) Ge(110); c) Ge(111). Scale bars are 2 μm

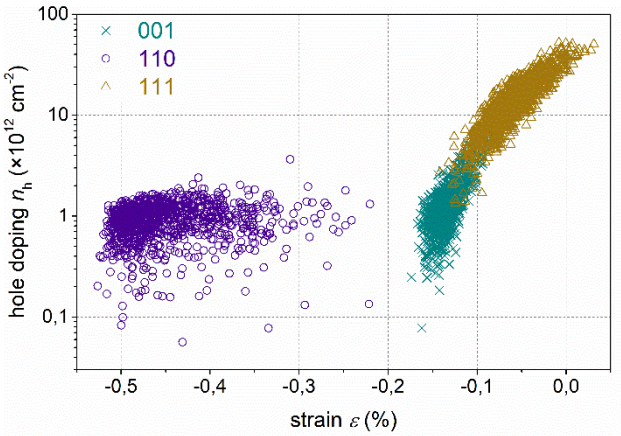

Figure 2: The doping-strain correlation for the three germanium orientations