Large-area high-quality graphene on Ge(001)/Si(001) substrates

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In order to widen the range of possible graphene applications, it is desirable to grow graphene films directly on arbitrary insulator or semiconductor surfaces instead of on a most commonly used copper substrate. Recently, as an alternative Ge substrates have been proposed. What is important, germanium substrates allow merging graphene into Si technology and integrated circuit manufacturing. However, to date no reliable results obtained for large-area graphene on Ge have been reported.
Here, we present large-area high-quality graphene films synthetized by the CVD method on Ge(001)/Si(001) wafers, which are already compatible with the complementary metal oxide semiconductor technology. The results deduced from the research performed on a large scale, including SEM (fig.1 a) and Raman spectroscopy (fig. 1 b**)**, show prefect uniformity and also a small spatial spread, both in charge doping and strain, which signifies a high homogeneity of the graphene layer. Interestingly, a more detailed investigation using STS/CITS demonstrated a highly linear behavior, characteristic of freestanding graphene on Ge(001) terraces. This means that graphene layers formed in these places were not disturbed by interaction with the substrate. Moreover, LEED measurements indicated the existence of well-oriented graphene domains which lead to a relatively well-oriented large-area layer. Additionally, XPS spectroscopy revealed that a carbon layer creates a well-developed sp^2 bonded system.

a) b)

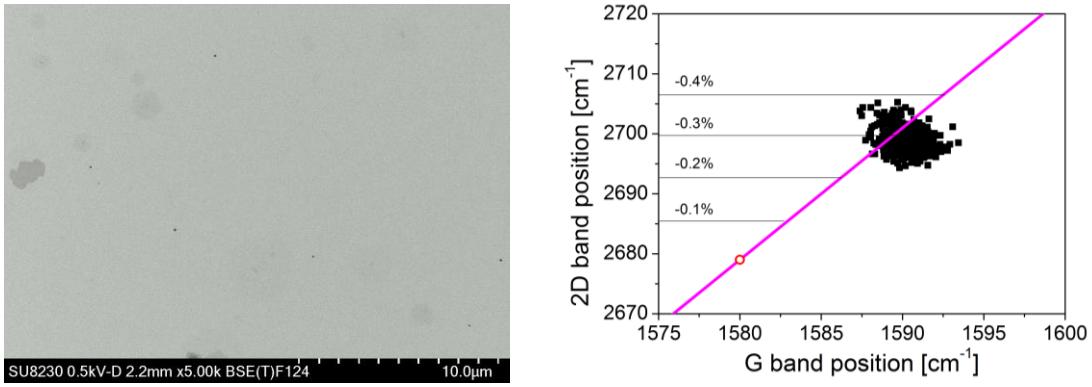

Figure 1. a) SEM images of material contrast of graphene grown on Ge(001)/Si(001) wafers. b) Plot of the position of the 2D band in relation to the position of the G band. The magenta-colored solid line with slop of 2.2 represents the effect of strain on the graphene lattice.