Direct growth of graphene on $Si_xGe_{1-x}C_{0.02}$ substrate

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It's well known that the direct growth of high-quality graphene on Si substrate is facing grand challenge because of the low carbon diffusivity on Si surface[1], as well as the relatively high carbon solubility in Si. Aforementioned reasons, therefore, hamper the direct growth of single layer graphene on Si. Recently, the direct growth of monolayer graphene on Ge substrate has drawn tremendous attention and dictates that graphene deposition on Ge via a self-limiting and surface-mediated process[2-4]. For such an approach, the deposition temperature of graphene on Ge substrate, is, however, compulsory to be less than 900 ^oC in order to avoid Ge melt since the melting point of Ge is low e.g. 937 ^oC. In this work, using methane and hydrogen gas as precursors, the direct growth of graphene by means of low pressure chemical vapor deposition (LPCVD) on Ge-like $Si_xGe_{1-x}C_{0.02}$ substrate is proposed and investigated. By mixing a certain proportion of silicon into Ge substrate, the $Si_xGe_{1-x}C_{0.02}$ alloy is characterized by a relatively higher melting point than pure Ge. As a result, the direct growth of graphene at higher temperature becomes feasible which is beneficial to the disassociation of methane and to the re-arrangement of carbon atom to form high quality graphene. In Fig. 1, the Raman spectrum[5] of as-synthesized graphene on $Si_xGe_{1-x}C_{0.02}$ substrate with different Si mole fractions (x=0.15, 0.25 and 0.73, left panel) as well as at different growth temperature (Right panel) is elucidated. As seen, as the decrease of Si mole fraction from 0.15 to 0.73, the quality of graphene is becoming better. Meanwhile, the growth temperature also plays an important role in the quality of synthesized graphene and the graphene shows the best quality at 750 ^oC.

References:

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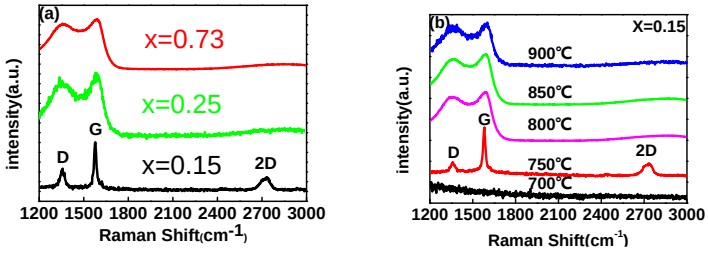

Fig. 1 The Raman spectrum of synthesized graphene on $Si_xGe_{1-x}C_{0.02}$ substrate with different Si mole fractions (x=0.15, 0.25 and 0.73, left panel) and at different growth temperature (Right panel)