Single Crystal Graphene Growth on Reusable Iridium/Sapphire Substrates

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Abstract

Iridium (Ir) is a favourable metal catalyst for chemical vapour deposition (CVD) growth of graphene because of the low C solubility, high melting temperature and chemical stability. In this study, we investigated epitaxial growth of single-crystal graphene sheets by CVD on Ir films on sapphire and demonstrated reusability of the Ir/sapphire substrates [1]. Ir films were prepared by RF magnetron sputtering on α-Al_2O_3(0001) (c-plane sapphire) substrates. X-ray diffraction measurements showed that Ir(111) was epitaxially grown on sapphire. Graphene sheets, which were grown by low-pressure CVD on Ir(111)/sapphire at a growth temperature of 1000˚C using CH_4 and H_2 gases, were characterized as high quality and mono-layer graphene by Raman spectroscopy (Fig.1(a)). Reflection high energy electron diffraction observation revealed that graphene was epitaxially grown on Ir(111) as graphene $<1\bar{1}00>$ // Ir $<11\bar{2}>$ / sapphire $<11\bar{2}0>$ (Fig.1(b)) and was quasi-single crystal. A transfer technique, which utilized electrochemical H_2 bubble generation at the graphene/Ir interface in a NaOH aqueous solution [2], was applied and the graphene transfer onto SiO_2/Si(100) was demonstrated. Repeated CVD growth and electrochemical transfer of graphene using the same Ir(111)/α-Al_2O_3(0001) in three cycles were demonstrated (Fig.1(c)) and high quality of the three transferred graphene sheets was confirmed by Raman spectroscopy (Fig. 1(d)). The high melting temperature and chemical stability of Ir can inhibit the morphological change of the Ir surfaces during CVD growth and transfer processes, which may lead to good reusability of the substrates. The results suggest a possibility for applications to practical graphene production using reusable Ir/sapphire substrates.

References

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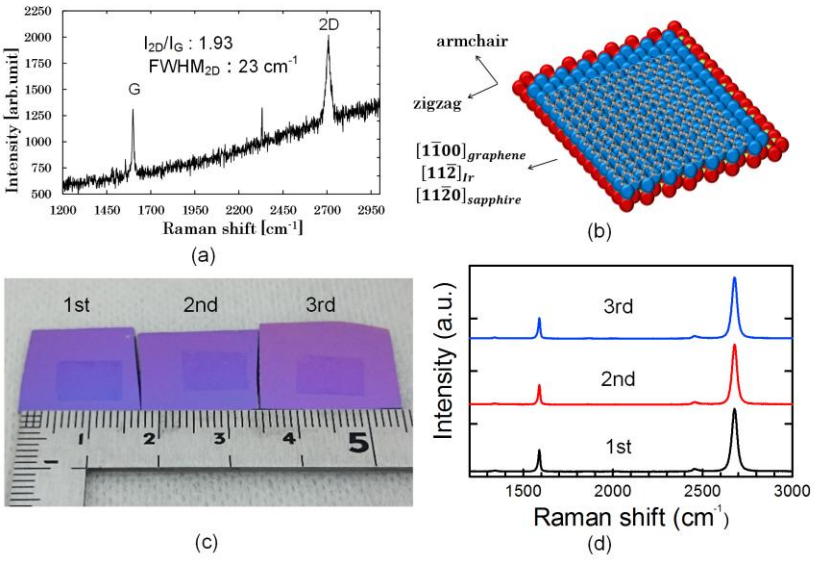

Fig. 1: (a) Raman spectrum of graphene on Ir(111). (b) Schematic of the in-plane crystal orientation relationship. (d) Three graphene sheets fabricated using the same Ir(111)/sapphire substrate (d) Raman spectra of the three transferred graphene sheets in the three cycles.

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