Effect of carrier gases flow rate on isotropic and anisotropic growth of graphene crystals by chemical vapor deposition

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Introduction: Chemical vapor deposition (CVD) has been widely adopted for synthesis of high quality large graphene crystals. There are various factors that influence the graphene growth on copper catalytic substrate in a CVD process. The effect of growth temperature, carrier gas mixture and oxide surface of copper have significant influence on growth of large individual crystals [1]. In this study, we observed the isotropic and anisotropic growth of graphene crystals by a solid source CVD process by changing the amount of carrier gas mixture (argon and hydrogen).

Experiential: Graphene crystals were synthesized on as received Cu foil by the CVD technique using polyethylene as a solid precursor. The Cu foil was heated upto 1050 ^{0}C with the flow of 50 sccm of Ar and then annealed for 30 min with 50 sccm Ar and 8.5 sccm H_2. Polyethylene was heated upto the melting point (110 ^{0}C) in steps and carbon molecules was introduced in the growth zone along with the carrier gas. Different growth experiment were performed varying amount of carrier gases without changing the ratio of Ar and H_2.

Results and discussion: The synthesized graphene crystals on copper foil was investigated by optical microscopy (OM) analysis to confirm the morphology. Fig. 1a-c show the Optical Microscopic (OM) images of graphene crystals formed at the same growth time but decreasing amount of carrier gases (With Ar:H_2 100:2 sccm, 75:1.5 sccm and 50:1 sccm respectively). The crystal shapes evolve from hexagonal to round shapes with decrease in carrier gases amount without changing the ratio. Furthermore, the number of layers and the quality of graphene synthesized was confirmed by the Raman analysis of the samples transferred onto SiO_2/Si substrates. These result showed that the interaction of precursor molecules on the copper catalyst surface determine the anisotropic and isotopic growth of large graphene domain in the solid source CVD process.

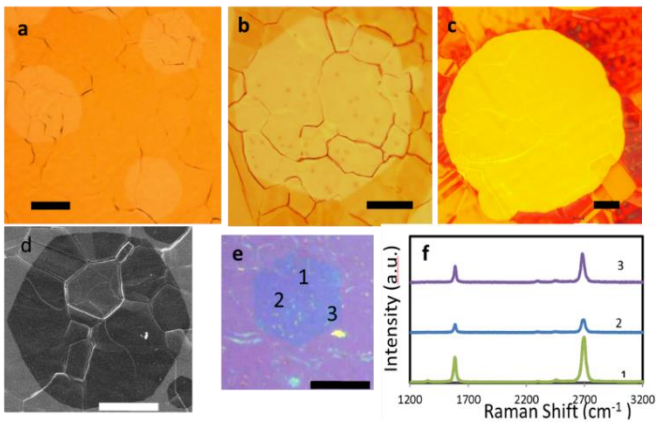

Fig 1. (a-c) OM images of graphene crystals synthesized at different rate of flow of carrier gases, (d) SEM image of average sized graphene crystal synthesized by using 75(Ar):1.5(H_2) sccm, (e) graphene crystal transferred onto SiO_2/Si substrate, (f) Raman spectra at three different points indicated in €. (Scale bar: 50 um.)

References

[1] K. P. Sharma, et al., J. Mater. Sci., 51, 7220 (2016).