Solvent engineering for controlling of graphene-flowers positioning on diverse substrates

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1. Introduction

Graphene is a unique universal new material used for number of applications in optoelectronic, energy generation and energy storage devices. The derivatives of graphene, the graphene oxide (GO) and reduced graphene oxide (RGO) exhibit superior electronic properties based on its mode of application. To further fine tune the interfacial electronic properties of graphene, its nanostructure has been changed by numerous methodologies in order to increase it's over all surface area so that it can simultaneously accommodate more charge and transfer charge robustly [1-3]. In this work we focused on the study of the nano-structured graphene flowers specifically which were coated on different types of substrates, i.e. glass, silicon dioxide and gold-deposited silicon.

2. Experiment

In this work different solvents such as methanol, ethanol and propanol were used in combination with stabilizers like ethanol amine and ethylene glycol, which was for uniform coating of graphene flowers by spin coating on various substrates of glass, silicon dioxide (SiO_2) and gold deposited wafers. The sample prepared with combination of graphene flowers, ethanol amine and propanol showed uniform coating on SiO_2 substrates. Moreover, detailed morphological studies were carried out by scanning electron microscopy (SEM) and atomic force microscopy (AFM) to check the uniformity and morphologies of graphene flowers on various substrates. The physical properties of graphene flowers coated on various substrates were investigated by Raman spectroscopy.

3. Results and discussion

Figure 1 shows SEM image of graphene flowers coated over SiO_2 substrate. As shown in Fig.1, the bright regions are the edge of graphene flowers, thus flower-like formation can be seen. Figure 2 are the results of Raman spectroscopy measurements. From the ratio of G and 2D peaks, we can deduce that the graphene composed of graphene flowers are multi-layers.

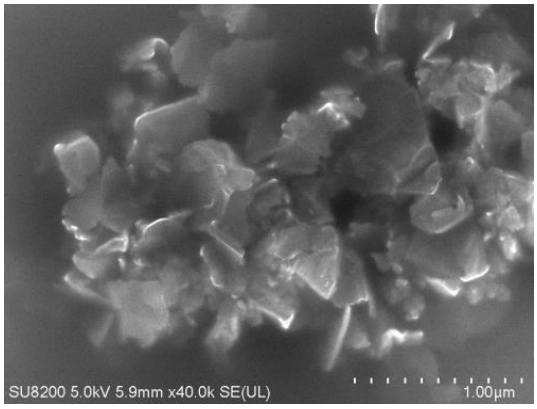

Fig.1 SEM Image of Graphene Flower coated over Sio2 Substrate

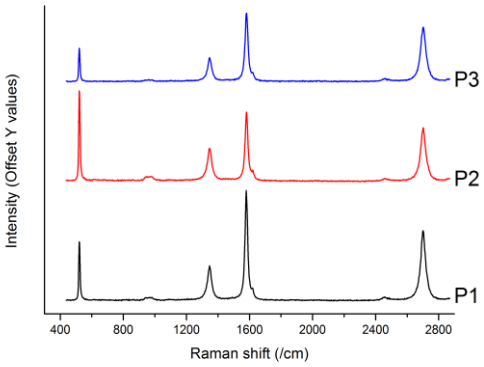

Fig.2 Raman Spectra of grown Graphene Flowers over substrate

4. Conclusion

In this work, we tried to control the position and distribution of graphene flowers based on solvent engineering. Diverse combination of solvent and

substrate showed different results such as uniformity and density of graphene flower bump, the shape of graphene flower bump. Using this engineering, graphene flower can be applicable for solution-processed device on large area

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References

[1] J. Wu et al., Facile Synthesis of 3D Graphene Flowers for Ultrasensitive and Highly Reversible Gas Sensing, *Adv. Funct. Mater.* 26 (41) (2016) 7462–7469.

[2] H. Xia et al., Formation of graphene flowers during high temperature activation of mesocarbon microbeads with KOH, *Microporous and Mesoporous Materials* 234 (2016) 384–391.

[3] F. Tian, H. Li, and M. Li, Synthesis of vertical graphene flowers as a photoelectrocatalyst for organic degradation, *Micro & Nano Letters* 12 (4) (2017) 252–254.