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Controlling shape and number of layers of graphene crystals in CVD process using waste plastic as carbon source

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Graphene is two-dimensional sheet of sp^2 hybridized carbon atom with excellent properties like very high carrier mobility, mechanical strength and transparency. Graphene has been isolated by exfoliation, grown epitaxially on SiC and synthesized by chemical vapor deposition (CVD) on transition metals. Among these methods CVD has been popular due to the possibility of fabrication of large area high quality graphene film. Different experimental parameters such as vapor pressure, temperature, underlying substrate orientation and their interplay determine the morphology of graphene crystal.

In this work we explain the effect of different experimental conditions and their optimization for the growth of single layer and bilayer graphene crystal with round or hexagonal morphology [1]. Waste plastic was used as precursor, which is composed of polyethylene with few amount of polystyrene. Before graphene growth Cu was annealed at 1020^0 C in H_2 atmosphere. Annealing at high temperature not only reduce lattice mismatch and defect but also changes Cu to (111) orientation predominantly which is most favorable orientation for graphene growth [2]. Precursor was heated at low temperature during early stage of growth to minimize nucleation density. During growth precursor flow rate was gradually increased to supply enough carbon atoms for growing crystals. Individual graphene crystal with size as large as 120 μm was observed. Under low precursor flow rate hexagonal graphene was observed with zigzag edges whereas isotropic growth environment produces round shaped graphene crystal. Minimum precursor flow rate produces single layer graphene crystal whereas under slightly increased flow rate nucleation of bilayer graphene is observed. Synthesized graphene film was transferred to fabricate transparent and flexible display. Transferred graphene show metallic properties confirmed by IV characteristics measurement. This method of graphene synthesis can be useful for synthesizing high quality monolayer or stacked bilayer graphene with controllable morphology.

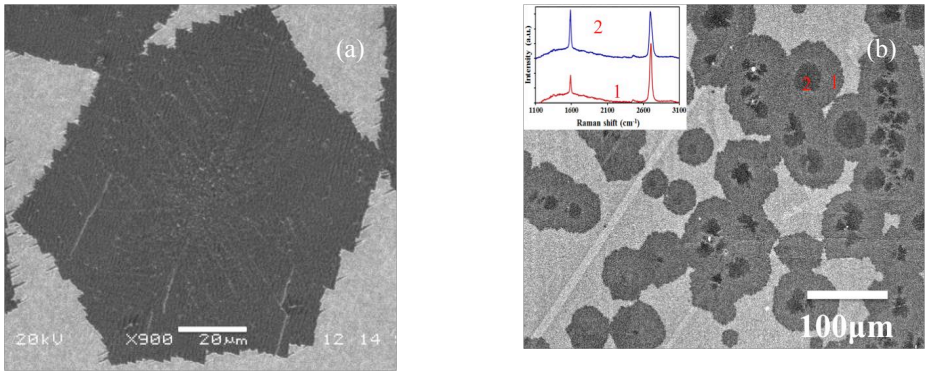

Figure: (a) Hexagonal shaped crystal grown in low precursor flow rate (b) Graphene synthesized high precursor flow rate

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2. S. Sharma, G. Kalita, M.E. Ayhan, K. Wakita, M. Umeno, M. Tanemura, Journal of Materials Science 48 (2013).

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