

Optimization of CVD parameters for graphene synthesis through designs of experiments

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Abstract

Graphene has attracted a lot of interest as one of the hottest 2D material, especially with its synthesis on transition metals inside atmospheric pressure Chemical Vapor Deposition (AP-CVD). The optimization process of desired size and quality of graphene domains is usually very tough due to the numerous interdependent parameters in two furnaces process. Here, the method so-called "designs of experiments", similar to Taguchi method¹, is applied to estimate the relative importance and value of some of these parameters and their interactions for the CVD growth of graphene on Cu foil using waste plastic, composed of mixed polyethylene and polystyrene, as a solid source precursor. The precursor is put on a low-temperature furnace, around 500°C, while the Cu foil substrate is in the high-temperature furnace, above 1000°C, while the gas flow is first 100 sccm of H₂ gas and then a mixture of 98 sccm of Ar and 2.5 sccm of H₂ during the growth of graphene.

We obtained that the growth temperature, time, rate of heating and pre-annealing time of the substrate influence significantly on graphene growth. Especially, the growth time and rate of increasing of carbon source's temperature appear as the main factors for the growth of graphene domains, where the manipulation of only these two parameters could dramatically change the size of crystals, as show the contour curves of Fig.1. With the growth time in abscissa and the rate of increasing in ordinate, it is

possible to determine an optimum position around 72 minutes of growth time and 1.4°C/min for the rate of increasing.

Figure 1: Optimization through contour curves from the mathematical model, with the growth time in abscissa and rate of increasing in ordinate.

References

1. Santangelo, S., Messina, G., Malara, A., Lisi, N., Dikonimos, T., Capasso, A., Ortolani, L., Morandi, V., Faggio, G. Diamond & Related Materials 41 (2014) 73-78.

