Improving the growth of monolayer CVD-graphene over polycrystalline iron sheets.

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Abstract

Graphene is a two-dimensional carbon nanomaterial with hexagonal structure. The extraordinary properties of graphene make it an ideal material for a wide variety of applications [1]. Two different strategies can be distinguished for graphene synthesis, such as *Bottom-Up* and *Top Down*. The first one is based on the synthesis of graphene from a carbonaceous gas source. The second one is based on the synthesis of graphene using graphite as the raw material [2]. Within the *Bottom-Up* strategy is included Chemical Vapor Deposition (CVD) method. This method highlights because it is simpler and easier to scale than the other ones. In addition, it is possible to obtain large areas of graphene. Raman spectroscopy is the most widely used technique to perform quickly structural and electronic characterization of graphitic materials, besides being a non-destructive characterization method [3].

The principal aim of this work was the synthesis and optimization of CVD-graphene synthesis using polycrystalline iron as catalyst with the purpose of increase the percentage of monolayer graphene grown over the metal substrate. Although graphene is only one atom thick, it is visible at the optical microscope. In this investigation, four different colors could be distinguished in optical microscope images of the graphene samples, corresponding each one with one type of graphene. To study the quality of the samples, an Excel-VBA application was designed. This application analyzed the optical microscope images obtained and allows to know the percentage of each type of graphene deposited over the iron. Based on those percentages, the Excel-VBA application assigns values between 0 and 1000 to quantify a quality value of the sample. If 100% of the sample is coated with multilayer, few-layer, bilayer or monolayer graphene, the application assigns a value of 1, 10, 100 or 1000, respectively. Therefore, the closer to 1000 is the quality value; the higher the percentage of monolayer graphene coating the metal foil [3].

To achieve the aim of this investigation, different synthesis variables which affect the graphene quality were optimized (reaction time, CH_4/H_2 flow rate ratio and total flow (CH_4+H_2) during the reaction step at different reaction times). It was observed that the percentage of monolayer graphene and thus, the quality of graphene sample increased with the optimization of the synthesis variables, reaching the 62.4% of the sample covered with monolayer graphene and a value of 642 of graphene quality.

References

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[3] Lavin-Lopez, M.P., et al., *Thickness control of graphene deposited over polycrystalline nickel.* New Journal of Chemistry, 2015, **39** (6), p. 4414-4423.

Figures

% MONOLAYER GRAPHENE	**62.4**
% BILAYER GRAPHENE	24.7
% FEW-LAYER GRAPHENE	8.8
% MULTILAYER GRAPHENE	4.3
QUALITY VALUE	642.5

Table 1: Percentage of each type of graphene and quality value of the optimum sample. *(Synthesis conditions: 1025 ºC, CH_4/H_2= 0.25 v/v, 80 Nml/min at 7 min)*

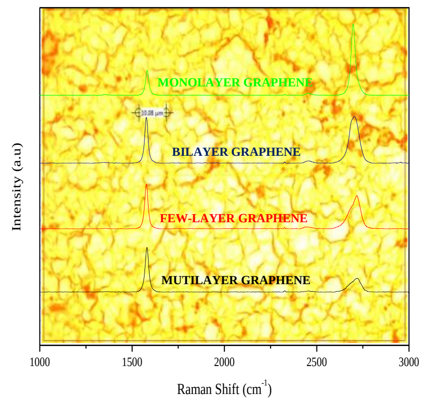

Figure 1: Optical microscopy and Raman spectroscopy of the optimum sample. *(Synthesis conditions: 1025 ºC, CH_4/H_2= 0.25 v/v, 80 Nml/min at 7 min)*