EX-SITU AND IN-SITU STUDIES OF CVD GRAPHENE GROWTH WITH THE USE OF RAMAN AND REFLECTANCE SPECTROSCOPY

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ABSTRACT

Since the first isolation of graphene by K. Novoselov and A. Geim in 2004 [1], a new family of exotic new materials has surfaced. Nowadays, two-dimensional (2D) materials are starting to be used with exponential rate in many technological applications due to their unique properties. The main production processes for these materials are, but not limited to, mechanical exfoliation [2] and epitaxial growth on a catalytic substrate. Lately, emphasis has been given to the mass production of these materials, namely large-scale synthesis for integration in advanced applications. For that reason, mechanical exfoliation is not preferred due to its complications and weight is given to epitaxial growth and more specific, Chemical Vapor Deposition (CVD).

CVD, for the production of graphene, is based on the decomposition of hydrocarbon molecules and their nucleation on a catalytic surface at high temperatures [3]. The pressure, the temperature and the flow rates of precursors are major parameters, which must be regulated in order to produce continuous defect-free graphene sheets, so its outstanding properties can be exploited. However, there is no clear theory about how and when graphene starts developing. This is happening because of the difficulty to monitor the growth steps in real time because of the high temperatures inside the reactor chamber. One option with promising potential for in-situ observation during CVD growth, is with the use of spectroscopic ellipsometry through a reflectometer.

In this study, the production of graphene sheets is taking place in a CVD reactor, with the use of a mixture of Methane (CH_4) as carbon source, Hydrogen (H_2) and Argon (Ar) onto copper (Cu) foils at high temperatures (~ 1270K) [4]. The goal is to obtain good quality graphene, so it is important to be found the conditions that CVD must take place. Spectroscopic analysis is carried out with the use of Raman spectroscopy and reflectance spectroscopy in order to identify the presence and the quality of graphene films [5], [6]. More specific, UV-Raman spectroscopy has been adopted for a direct characterization/quality control of graphene grown on copper substrate without transferring it to a dielectric substrate. Additionally, a reflectometer was used for the in-situ monitoring of surface changes during graphene growth. The results shown that the reflectometer can be successfully adopted for in-situ characterization during CVD growth and its results can be used for estimation of the thickness of CVD graphene from the measured differential reflectance.

REFERENCES

[1] Geim, A.K. and Novoselov, K.S. (2007) The Rise of Graphene. Nature Materials, 6, 183-191.
[2] Novoselov, K.S. & Geim, A.K. & Morozov, S & Jiang, Dingde & Zhang, Yanshui & Dubonos, S.V. & Grigorieva, Irina & Firsov, Anatoly. (2004). 306. 666-9. 10.1126/science.1102896.
[3] C.-M. Seah, S.-P.Chai, A.Mohamed. (2014) Carbon 70 1.
[4] C. Mattevi, H. Kim And M. Chhowalla, J. Mater. (2011) Chem. 21 3324.
[5] A.C. Ferrari and D.M. Basko, (2013) Nature Nanotech. 8 235.
[6] A.C. Ferrari, J.C. Meyer, V. Scardaci, C. Casiraghi, M. Lazzeri, F. Mauri, S. Piscanec, D. Jiang, K.S. Novoselov, S. Roth, and A.K. Geim. (2006). Phys. Rev. Lett., 97(18):187401.