Effect of a balanced concentration of hydrogen on a high quality graphene CVD growthS. Chaitoglou*,E. Bertran J.L. Andújar and E. Pascual

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Abstract

The extraordinary properties of graphene make it one of the most interesting materials for future applications in electronics, optics and structural materials. Between the different synthetic methods, chemical vapor deposition (CVD) is the one that permits to obtain large areas of monolayer graphene without defects. To achieve this, it is important to find the appropriate conditions for each experimental system. In our CVD reactor working at low pressure, important factors appear to be the pretreatment of the copper substrate, considering both its cleaning and its annealing before the growing process. The carbon precursor/ hydrogen flow ratio and it's modification during the growth is significant in order to obtain large area graphene crystals without defects. Copper substrate is usually exposed to methane and hydrogen gases and, the growth is taking place at 1040°C. In this work, we have focused on the study of the methane and the hydrogen flows to control the production of monolayer graphene as well as the growth time. . In particular, we observe that hydrogen concentration increases during a usual growing process (keeping stable the methane/ hydrogen flow ratio) resulting in etched and not continuous domains. But, a modification of the hydrogen flow in order to balance this increase results in the growth of smooth hexagonal graphene domains. This is a result of the etching effect that hydrogen performs on the growing graphene. It is important, therefore, to study the moderated presence of hydrogen, which allows the form of large hexagonal domains. Also, by increasing the growth time we observe an increase in the nucleation density of the crystals.

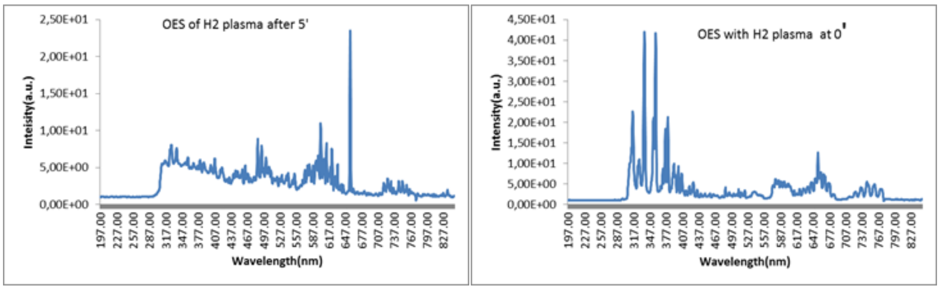

Figure 1: Optical emission spectra where can be seen the reduction of the OH radical peak

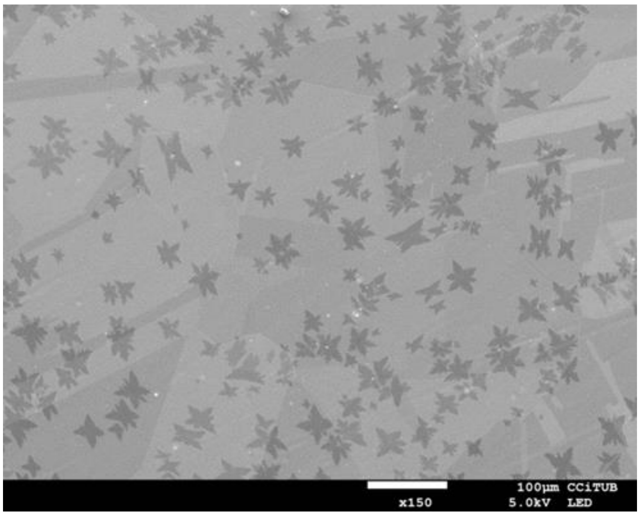

Figure 2: scanning electron microscope pictures of graphene crystals on copper foil after 20’ growth (sample A)

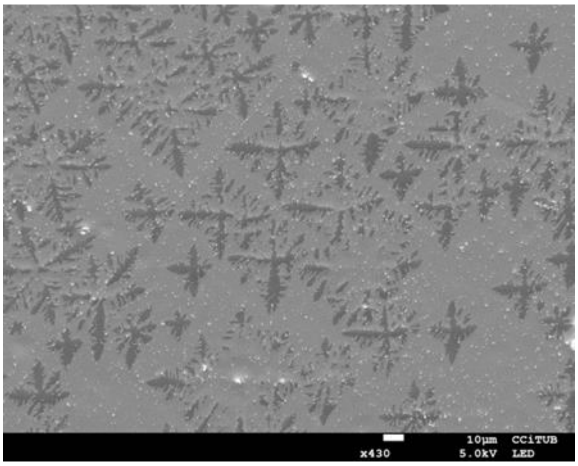

Figure 3: scanning electron microscope pictures of graphene crystals on copper foil after 40’ growth (sample B)

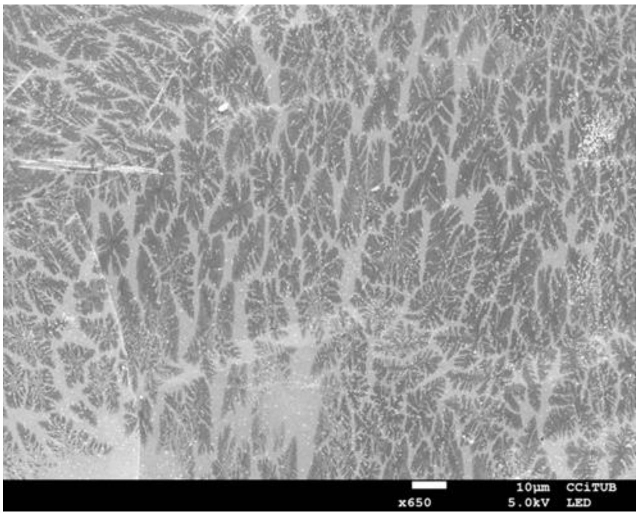

Figure 4: scanning electron microscope pictures of graphene crystals on copper foil after 40’ growth with reduced hydrogen flow (sample C)

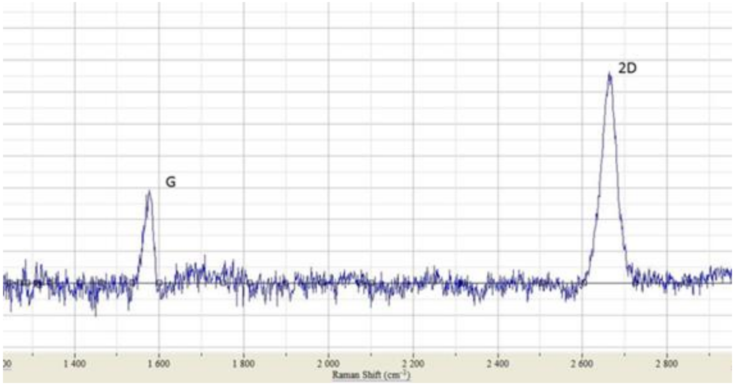

Figure 5: Raman spectra of the obtained graphene referring to sample C

References

- Li, Xuesong, Cai, Weiwei, An, Jinho, et ál,"Large-Area Synthesis of High-Quality and Uniform Graphene Films on Copper Foils",SCIENCE , 324 , 5932 ,2009 , 1312-1314

-Sreekar Bhaviripudi et al, '' Role of Kinetic Factors in Chemical Vapor Deposition Synthesis of Uniform Large Area Graphene Using Copper Catalyst'', NANO LETTERS , 10 , 10 , 2010, 4128-4133

- Li, Xuesong; Magnuson, Carl W.; Venugopal, Archana; et al.,''Graphene Films with Large Domain Size by a Two-Step Chemical Vapor Deposition Process'', NANO LETTERS , 10 , 11, 2010 , 4328-4334

-S. Hussain et al,'' RF-PECVD growth and nitrogen plasma functionalization of CNTs on

copper foil for electrochemical applications'', Diamond & Related Materials, 49, 2014, 55–61