EXPLORING NEW WAYS OF CHEMICAL VAPOR DEPOSITION TECHNOLOGY TO PRODUCE GRAPHENE

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Abstract

Chemical vapor deposition (CVD) is a very popular technology to produce monolayer graphene. However, this technology is associated with relatively high temperatures and supersaturation carbon precursor conditions to produce a graphene monolayer. The goal of this work is to explore different ways of growing graphene on copper over silicon by means of thermally activated chemical vapor deposition using a low precursor pressure. Growing processes were performed in a reactor with a quartz tube oven at high vacuum conditions. The activated copper substrate was exposed to methane gas at a low pressure and annealed below 1000 ºC. Results indicate a possible solution of Cu on a Ni barrier (grown in order to avoid diffusion of Cu into c-Si) forming a polycrystalline surface Cu/Ni thin layer, which favors the nucleation of graphene. During the annealing Ni/Cu drops are formed clearing large areas of silicon substrate (10^4 μm^2, Fig. 1). The characterization by Raman spectroscopy, X-Ray spectroscopy (EDS) and scanning electron microscopy (SEM) evidenced that large-areas of crystalline silicon appeared 99% copper free and coated by graphene. The Raman analysis of these areas assessed the only presence of graphene of one-two layers by showing the characteristic 2D band and the ratio $2D/G \geq 1$ (Fig. 2). The direct growth of graphene on silicon wafers without transferring facilitates the application of lithographic processes and the possibility to produce graphene-based electronic devices.

References

[1] K.S. Novoselov et al., Science, **306** (2004) 666.
[2] J. Sun et al., IEEE Transactions on Nanotechnology, **11** (2012) 255
[3] X. Li et al., Science, **324** (2009) 1312
[4] C. A. Howsare et al., Nanotechnology, **23** (2012) 135601
[5] Z. Ni et al., Nano. Res., **1** (2008) 273
[6] V.-M. Freire et al., Jpn. J. Appl. Phys., **52** (2013) 01AK02

Figures

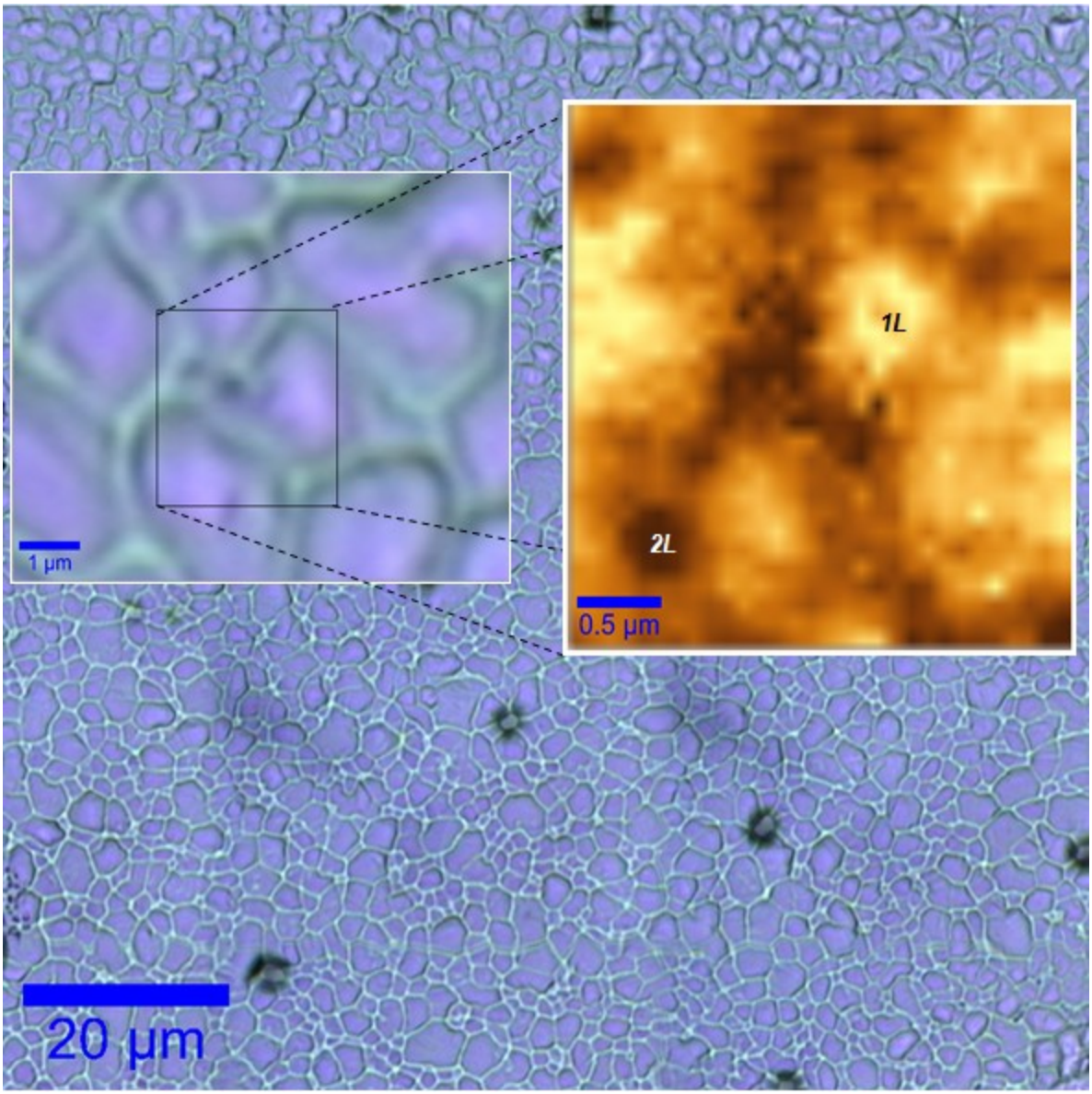

Fig. 1. Raman mapping of areas about 10^4 µm^2. The surface is covered with 80% monolayer graphene and 20% of bilayer graphene.

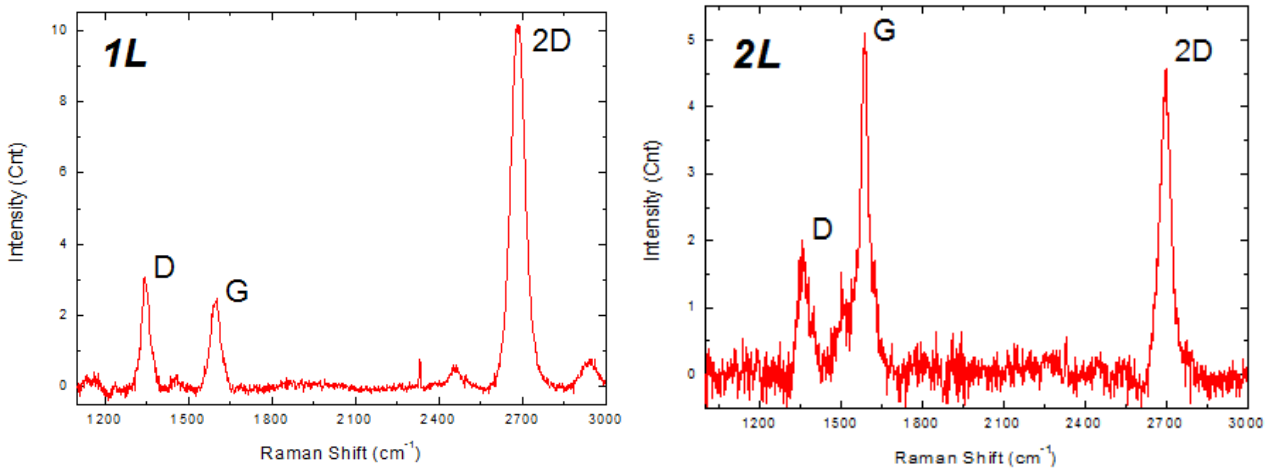

Fig. 2. Raman spectra of monolayer and bilayer graphene. Ratio between 2D/G peaks are much bigger than 1 in most of monolayers.