MODIFIED CHEMICAL VAPOR DEPOSITION TECHNOLOGY TO PRODUCE GRAPHENE WITH VERY-LOW-PRESSURE PULSES OF METHANE

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Abstract

Chemical vapor deposition (CVD) is probably the most 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 a new way of growing graphene on copper over silicon by means of thermally activated chemical vapor deposition using a very low precursor pressure. Growing processes were performed in a reactor with a quartz tube oven at high vacuum conditions. The activated copper substrates were 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 were formed and large areas of graphene were grown (10^4 μm^2, Fig. 1). The characterization by Raman spectroscopy, Energy-dispersive X-Ray spectroscopy (EDS) and Scanning Electron Microscopy (SEM) evidenced that large-areas of the samples appeared 99% 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 ≥ 1 (Fig. 2). Removing Ni/Cu after annealing results in samples of graphene on silicon wafers or on silicon oxide. This facilitates the application of lithographic processes and the possibility to produce graphene-based electronic devices.

References

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Figures

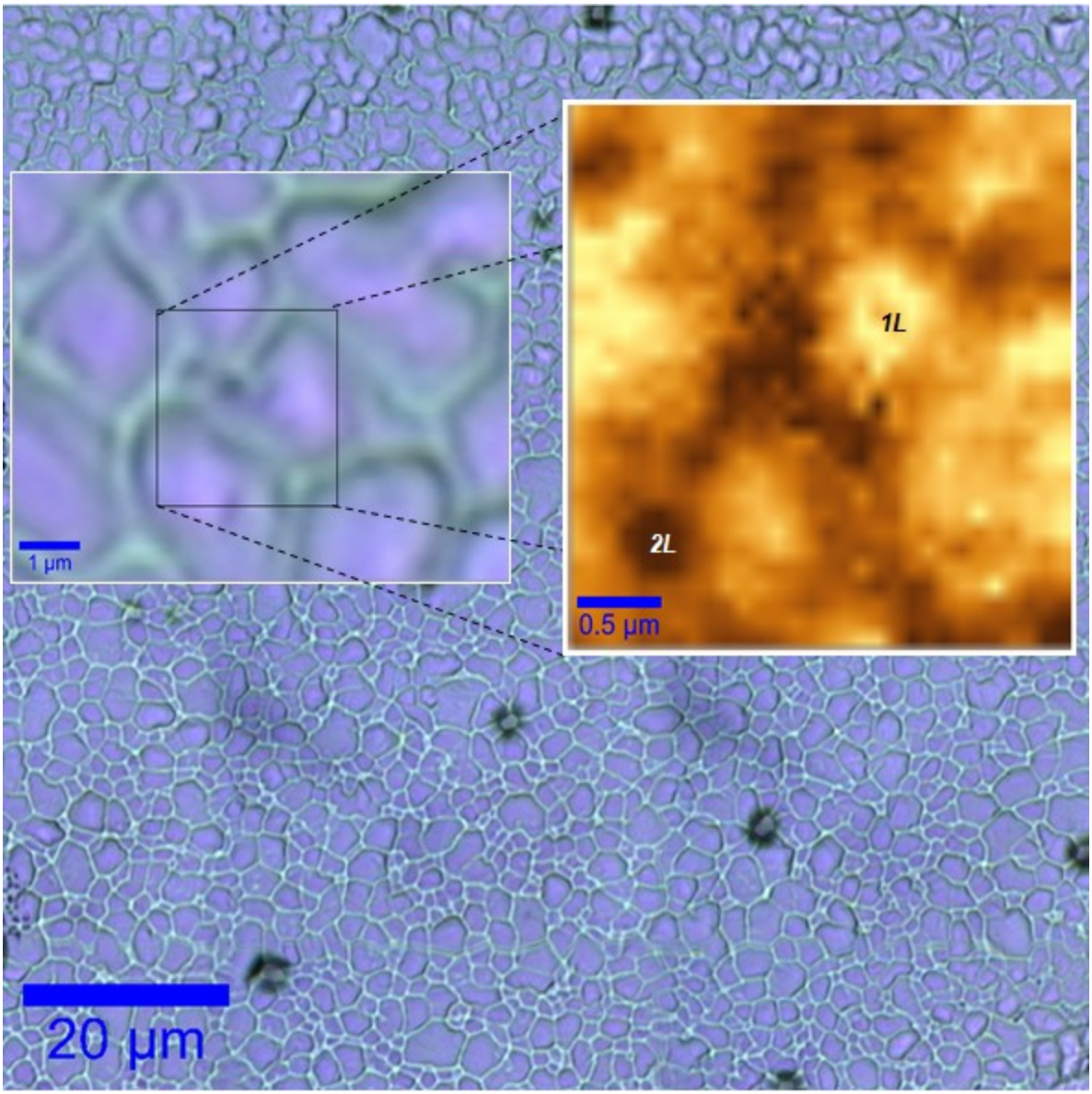

Fig. 1. Raman mapping of areas about 10^4 μm^2. 99% of the surface is covered with 80% monolayer graphene and 20% of bilayer graphene.

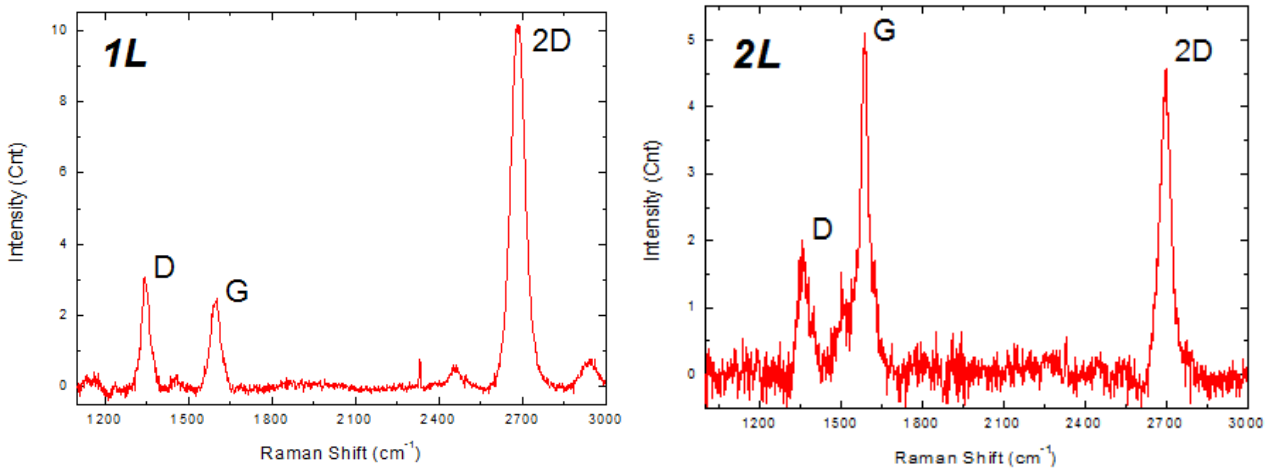

Fig. 2. Raman spectra of monolayer and mono-bilayer graphene. Ratio between 2D/G peaks are much bigger than 1 in most of monolayers. Still appeared some defects (D peak) due to the non-crystalline sputtered copper surface.