Characterization of graphene grown on copper foil by Chemical Vapour Deposition (CVD) at ambient pressure conditions

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Since the demonstration of its easy isolation in 2004 by Novoselov et al.[1], graphene has been attracting enormous attention in the scientific community. In fact, thanks to its extraordinary and unique physical properties, such as outstanding thermal conductivity[2], high carrier mobility[3], optical[4] and mechanical features[5], it could be used in a wide range of applications as sensors[6, 7], solar cells[8, 9], energy storage[10] and electronic devices[11].
Obviously, graphene films required for commercial devices have to be of high quality, with large domains and free from impurities, and produced optimizing the manufacturing costs. Among all the production techniques used, catalytic chemical vapour deposition (CVD) seems to be the most promising methods to achieve those objectives[12,13]. In that background, this work deeply investigates the synthesis and characterization of graphene grown on copper (Cu) foils by Chemical Vapor Deposition (CVD) at ambient pressure conditions, as already reported in literature [14-16], by using methane (CH_4) as carbon source, diluted in a suitable mixture of argon (Ar) and hydrogen (H_2). Samples were synthesized for different exposure times to carbon precursor ranging from 1 minute up to 1 hour. The quality of the graphene films together with their structural and morphological properties were evaluated by several techniques: Micro-Raman Spectroscopy, Scanning Tunneling Microscopy (STM), Atomic Force Microscopy (AFM) and Scanning Electronic Microscopy (SEM). In particular, samples obtained with shorter growth time (less than 10 min) show a non-uniform coverage of the Cu surface while those synthesized with typical exposure time between 10 and 20 minutes showed a prevalence of well-ordered monolayer graphene domains. Interestingly, we observed two kinds of monolayer graphene, revealed by difference of coloration in the optical microscopy inspection and by appreciable changes in the Raman spectra; these evidences reveal different interactions with the Cu substrate[17]: the more interacting graphene covers most of the surface while only small regions (few tens of micron) show less interacting graphene domains. Another behavior was found for samples obtained by longer deposition times (more than 20 minutes): the area covered by disordered graphene domains increases with respect to the ordered monolayer regions, as confirmed by Raman analysis.

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