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Laser-induced etching of few-layer graphene synthesized by Rapid-Chemical Vapour Deposition on Cu thin films

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Abstract

The outstanding electrical and mechanical properties of graphene make it very attractive for several applications, Nanoelectronics above all. However a reproducible and non destructive way to produce high quality, large-scale area, single layer graphene sheets is still lacking. Chemical Vapour Deposition of graphene on Cu catalytic thin films represents a promising method to reach this goal, because of the low temperatures ($T < 950°C-1000°C$) involved during the process and of the theoretically expected monolayer self-limiting growth. On the contrary such self-limiting growth is not commonly observed in experiments, thus making the development of techniques allowing for a better control of graphene growth highly desirable. Here we report about the local ablation effect, arising in Raman analysis, due to the heat transfer induced by the laser incident beam onto the graphene sample.

Keywords: CVD graphene, Copper, Laser induced etching, Heating ablation effects

PAC Codes: 61.80.Ba, 81.15.Gh, 61.48.Gh, 81.05.ue

Background

Graphene (a single bidimensional layer of carbon atoms arranged in an hexagonal lattice) has attracted a major interest in the last few years because of its astonishing electrical (Castro Neto et al. 2009; Peres 2010; Peres et al. 2006), mechanical (Lee at al. 2008) and chemical properties (Elias et al. 2009; Wang et al. 2009a), that make it a good candidate for the future development of nanoelectronics devices. Although the main properties of this material are nowadays well known from a theoretical point of view, an efficient and highly reproducible method to grow high quality, large-scale area, single layer graphene films, suitable for practical applications, is still lacking. For this reason, several techniques have been developed in the last years in order to achieve this goal: the most important are the epitaxial growth of graphene by thermal sublimation of SiC (de Heer et al. 2007; Emtsev et al. 2009; Hass et al. 2008; Sprinkle et al. 2009; Varchon et al. 2007), the Chemical Vapour Deposition (CVD) synthesis of graphene on various metal catalysts (Reina et al. 2009; Lee et al. 2010; Liu et al. 2010; Kim et al. 2012; Nandamuri et al. 2010; Somani et al. 2006; Li et al. 2009a; 2009b; Tao et al. 2012) and the chemical reduction of graphene oxide (Gilje et al. 2007; Lee at al. 2009; Paredes et al. 2008; Schniepp et al. 2006). Among these, CVD technique seems to be one of the most promising methods because of the reported possibility (Liu et al. 2010) of obtaining highly uniform, defect-free graphene flakes as large as $\sim 100\ \mu m^2$ in a reproducible, highly accessible and inexpensive way.

Since CVD synthesis needs a catalyst to activate the chemical decomposition of the carbon precursor (usually methane or ethylene) used for graphene growth at low temperatures ($T < 950°C - 1000°C$), the use of many metals (Ir (Coraux et al. 2008), Ru (Martoccia et al. 2008), Pt (Sasaki et al. 2000; Starr et al. 2006), Fe (Kondo et al. 2010), Ag (Di et al. 2008), Ni (Liu et al. 2010; Kim et al. 2009; Obraztsov et al. 2007), Cu (Bae et al. 2010; Li et al. 2009a; Tao et al. 2012) as catalysts during the process has been reported in literature. Cu is one of the most promising catalyst (Mattevi et al. 2011) because of the low C solid solubility in it

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