Raman spectroscopy of long isolated graphene ribbons grown on the C face of 6H-SiC

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Graphene has emerged recently as a new material with outstanding electronic properties[1]. This includes mass-less Dirac fermions, ballistic transport properties at room temperature and good compatibility with silicon planar technology[2]. Different techniques have been developed in the last six years to fabricate mono or bi-layer graphene. They range from exfoliated graphite, either mechanically[1] or in a liquid-phase solution[3] to chemical vapor deposition on a metal surface[4], and, more recently, to substrate-free synthesis when passing ethanol into an argon plasma[5]. The method investigated in this work consists in a controlled sublimation of few atomic layers of Si from a single crystal SiC substrate[6]. Such epitaxial growth of graphene (EG) seems to be the most suitable option for industrial applications but, for easy control, it necessitates either a large and homogeneous sheet of monolayer graphene (MLG) or few layers graphene (FLG) covering the full wafer surface.

Basically, on both the Si and C faces of any SiC substrate, graphene grows selectively on some reconstructed parts of the surface. Controlling the growth means then controlling locally the surface reconstruction. At low pressure conditions (below 10^{-6} Torr), it remains challenging to grow FLG with homogeneous domains larger than few hundred nanometers on both faces[7]. The homogeneity can be increased by lowering the sublimation rate. It has been demonstrated on the Si face by working at high pressure under a noble gas atmosphere such as argon[8,9]. In this work[10], the surface reconstruction of the C face during the Si sublimation is modified by covering the SiC substrate with a graphite cap. It leads to a strongly step-bunched morphology with on few selected terraces the growth of long anisotropic graphene ribbons (5 µm wide and up to 600 µm long).

Since the Raman fingerprint of Bernal stacked FLG depends strongly of the number of graphene layers[11] and the absorbtance of FLG is almost independent of the wavelength and proportional to the number of graphene layers[12], we combine micro-Raman spectroscopy with micro-transmission measurements to study the quality and thickness uniformity of these ribbons. We find that most of these ribbons are homogeneous monolayers or bilayers of graphene and that the thermal stress between the graphene layer and the 6H-SiC substrate is relaxed by the formation of wrinkles. This combination of techniques is especially useful to discriminate without any ambiguity between a monolayer graphene and a misoriented bilayer because their Raman fingerprint are identical. The spectra and extinction coefficient of a monolayer, a Bernal stacked bilayer noted AB, and a misoriented bilayer noted AA' are shown in Figure 1.

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Figures:

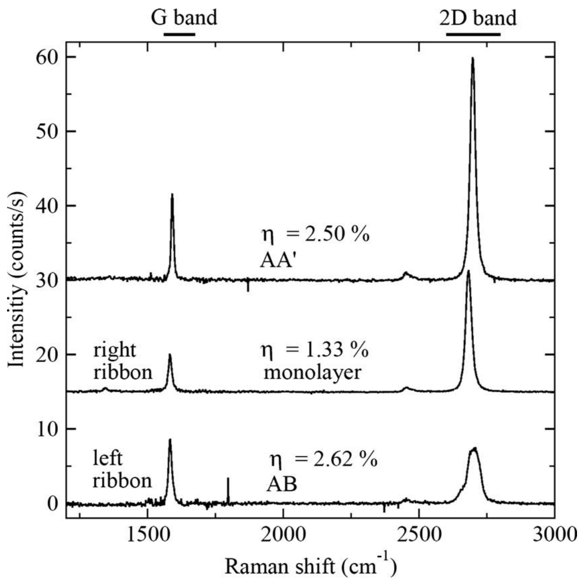

Figure 1 : Raman spectra collected in the middle of different graphene ribbons with the corresponding relative extinction coefficient $\eta=\Delta T/T_0$. From top to bottom a misoriented bilayer (AA'), a monolayer and a Bernal stacked bilayer (AB) from [10].