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ON THE DETERMINATION OF GRAPHENE EDGE CHIRALITY VIA RAMAN SPECTROSCOPY

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The outstanding optical and magnetic properties, as well as the superconductivity, of graphene and related materials depend to a large extent on the edge chirality (zigzag or armchair) [1, 2]. So, after studying the hundreds of mechanically cleaved graphene (MCG) specimens, the authors of work [1] discovered that the angle between the edges in a MCG is multiple to 30^0. This suggests that carbon atoms along the graphene edges are stacked in either the zigzag or the armchair structure. It was also shown in work [1] that, when two adjacent edges make an angle of 30^0, 90^0 or 150^0, these possess different chiralities (one is armchair and another is zigzag). If the angle is 60^0 or 120^0, both edges are characterized by the same type of chirality (zigzag or armchair) [1]. Indeed, according to SEM and TEM data, the graphene edge is not perfectly smooth. Furthermore, the edge structure of graphene is known to induce the peculiar resonance scattering phenomena, such as double resonance [3, 4]. Double resonance processes were carefully studied in graphene and graphite that enabled one to establish their direct role in the activation of D- and 2D-bands in the Raman spectra of graphene [4]. Applying the double resonance theory and considering the one-dimensional edge, the double resonance is shown to be mainly activated by the armchair edge, yielding the higher-intensity D-band, whereas this process is forbidden at the zigzag edge (the D-band tends to zero or vanishes). Hence this speculation seems to be interesting for the determination of the edge chirality of graphene via the Raman spectroscopy.

In this respect, Raman spectroscopy is shown to be a convenient tool for the determination of the edge chirality type in graphene via the analysis of D- and G-bands in various directions within a single layer graphene (SLG), obtained via mechanical exfoliation onto a Si/SiO2 substrate. The intensity variation in both bands, while moving along one or another direction, has enabled one to distinguish the “zigzag” and “armchair” chirality configurations in a sample under consideration.

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