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Free-standing graphene monolayers in carbon-based composite obtained from SiC: Raman diagnostics

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The huge application significance of graphene for for advanced electronic and optoelectronic devices, sensors, energy storage, etc. stimulates the development of optimization of their fabrication methods.

There are a number of works reporting the fabrication of graphene from SiC. In one of the most unique publication [1] the thermal splitting of polycrystalline SiC granules was used at temperature of 2000 °C. The exhaust gas was monitored by an online mass spectrometer and the registration of the Si signal indicated the onset of SiC decomposition was disappeared after 30 min when the process was stopped. As a result the grapheme flakes were obtained which was confirmed by TEM/STM and Raman measurement. Authors [1] assumed their graphene to be single-layer and free-standing. But the sizes of specimens were very small (50-300 nm). Beside, the intensity ratio of I_{2D}/I_G Raman bands, which is the main characteristic of graphen and for high quality monolayer graphene heve to be 3-4 [2-3], in their spectra was only of order of 1,0.

In present work, we used the method of thermal decomposition of SiC, optimized in comparison with [1] by using substantially higher temperature (2500 °C) and much longer duration of the sublimation (up to 8 hours). As a result the superior properties of the material obtained and studied in our work, as compared to Ref. [1], are of much larger lateral sizes of graphene sheets (up to tens of microns, evidenced by SEM images) and their better overall structural perfection confirmed by Raman measurements. From the characteristic parameters of the Raman bands, such as the frequency of the G and 2D bands, their intensity ratio ($I_{2D}/I_G \approx 4$), 2D band line shape with extremely small width and complete absence of defect induced D band we conclude that a significant part of obtained graphene flakes to be identified as free-standing graphene monolayers.

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