Reversible and irreversible deterioration caused by electron- and photo- sensitive resist spin coating on graphene

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Graphene has recently attracted much attention due to its potential use in nanoelectronics and spintronics applications. [1-3] The correct fabrication of the graphene devices is the key step to obtain the searched functionality. Following our previous work [4], in the present contribution we assess the impact of different lithography process steps in the physical properties of the graphene flakes. In order to produce electrical contacts to the graphene flakes, one can use techniques such as optical lithography and electron-beam lithography. These techniques imply respectively the use of photo-resists and electron-sensitive resists. We have systematically investigated the changes in the Raman spectra of graphene flakes after spin coating photon-sensitive and electron-sensitive resists. Substantial changes in the intensity of D and G Raman peaks are observed after some of these processes related to the generation of disorder and introduction of impurities in the graphene flakes. As shown in Fig. (1), one can find that the deterioration of graphene can be clearly reflected from the nascent D peak after spin coating the PMMA electron-sensitive resist. Furthermore, even after the process of lift-off, the D peak is preserved as well. Therefore, the deterioration of graphene is unavoidable so long as the e-beam lithography is used for pattern design. However, we can find that the D peak has disappeared and the Raman spectra recover to the general shape of the pristine graphene after annealing the sample in argon atmosphere. It implies that this deterioration for the graphene is reversible. On the contrary, as for the graphene with spin coating of a photo-sensitive resist, as shown in the Fig. (2), the amplitude of the G and 2D peaks are not only attenuated but also their shapes obviously deviate from the standard character of graphene exhibiting a behavior typical of amorphization. In fact, we also measured the Raman spectra of the graphite with photo-sensitive resists on its surface, which shows a similar shape of amorphization. Therefore, even after lift-off, the photo-sensitive resists adsorbed on the surface of graphene are not completely removed. In addition, the same annealing condition previously described was performed on the graphene after spin coating photo-sensitive resists. Even though two main peaks of G and 2D can be clearly observed due to the partial elimination of photo-sensitive resists on the top of graphene, the nascent D peak was still present, implying that the deterioration caused by the used photo-sensitive resist is irreversible.

References

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Figures

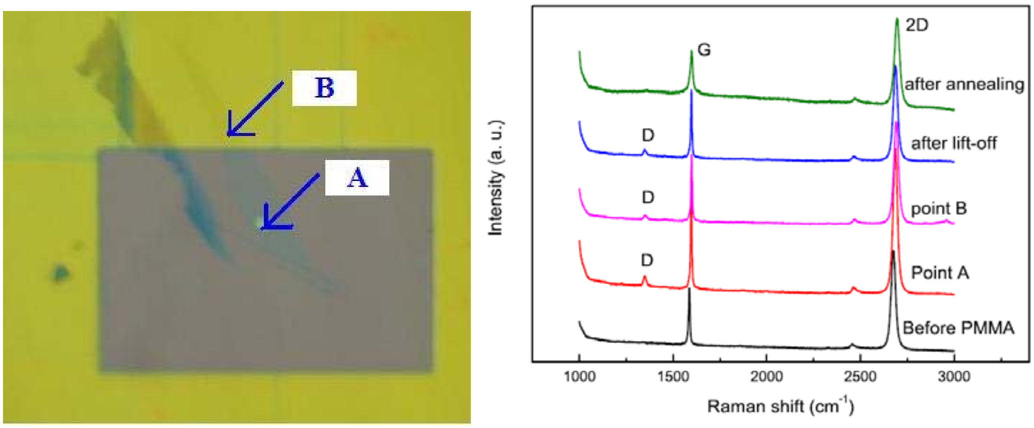

Figure 1. Left: Optical microscope image of graphene with e-beam lithography. Point A is the exposure part of graphene and point B is unexposure part. Right: Raman spectra for different conditions(1)before spin coating PMMA;(2) measurement of point A; (3) measurement of point B; (4)after lift-off with acetone; (5) after annealing

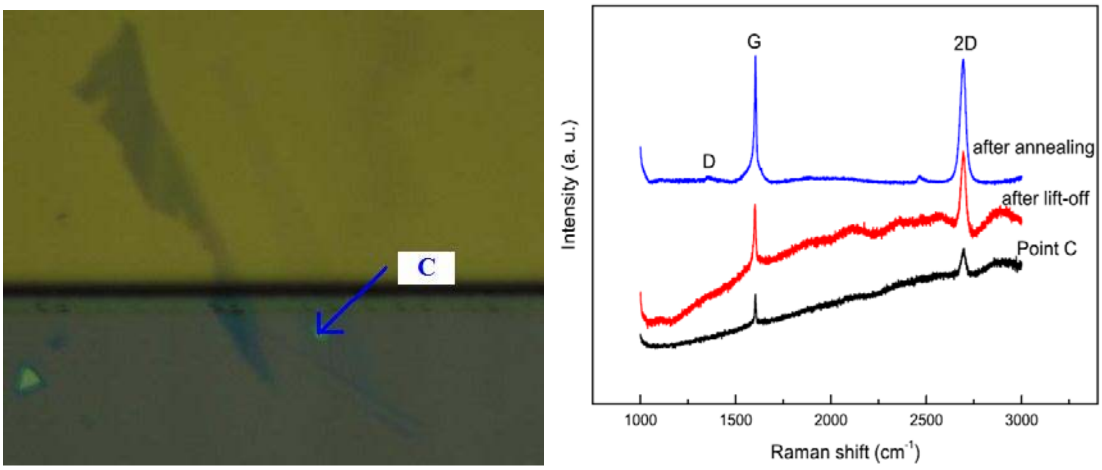

Figure 2. Left: Optical microscope image of graphene with photo lithography, Point C is the exposure part. Right: Raman spectra for different conditions (1) measurement of point C; (2) after lift-off with aceton; (3) after annealing.