Swift Heavy Ion Induced Modifications in Carbon Nanotubes and Graphene

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Swift heavy ions (SHI) of MeV to GeV kinetic energy have become an important tool for modifying various nanomaterials for a wide range of applications in the last two decades [1,2]. This is mainly due to the high energy deposition into a small volume along the ion track. Based on the material type and ion beam parameters, the SHI-induced modifications concerns not only the structure but also mechanical, electronic and magnetic properties of the irradiated materials. Among the investigated samples, carbon-based nanomaterials have attracted great interest mainly due to the tremendous variety of novel applications, such as in nanoelectronics, gas detectors, and solar cells. Here, we present recent results on SHI-induced modifications in carbon nanotubes and graphene. The carbon nanomaterials were irradiated with 5-40 MeV iodine and 1.16 GeV gold ions of different fluences, from the tandem accelerator at HZDR (Dresden) and UNILAC at GSI (Darmstadt), respectively.

Single-Walled Carbon Nanotubes

The irradiated single-walled carbon nanotubes (SWCNs), deposited on Si substrates, were investigated using scanning force microscopy (SFM). The changes in topography were studied as a function ion beam parameters, see Figure 1. In addition, Raman spectroscopy was performed. Comparing the spectra of virgin and irradiated samples, we see a change of the ratio of the intensities of D band (disorder-induced band) and G band (graphite and/or defect-free carbon band) as a function of ion fluence for ions having the same energy loss.

Graphene

Structural modifications induced by MeV iodine ions in graphene were studied using Raman spectroscopy. It was confirmed that ion-irradiation leads to the creation of defects in graphene, which was demonstrated by the appearing of D peak of the Raman spectra for the ion-irradiated samples, as shown in Figure 2.

References

[1] L. Madauß, J Schumacher, et al., Nanoscale 9 (2017) 10475.
[2] O. Peña-Rodríguez, A. Prada, , et al., Sci. Rep. 7 (2017) 922.

Figures

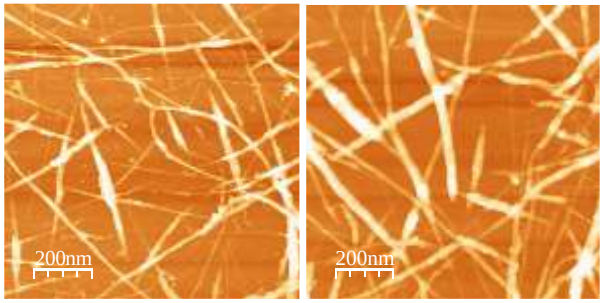

Figure 1: SFM topographic images of virgin (left) and 20 MeV iodine ion irradiated (right) SWCNs (fluence is 5 x 10^{13} ions/cm^2).

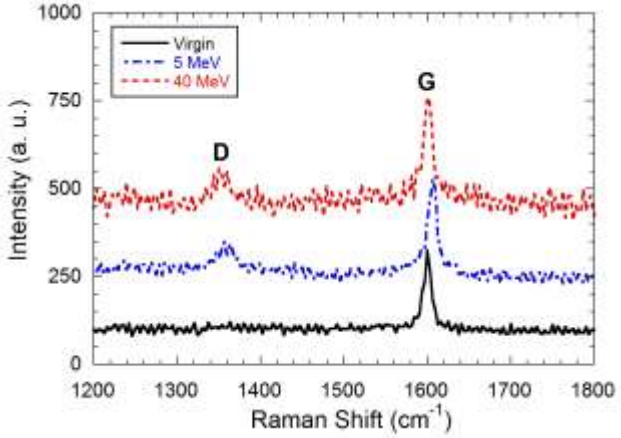

Figure 2: Raman spectra of virgin and Iodine ion-irradiated (5 and 40 MeV, 10^{12} ions/cm^2) graphene.

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