5 - 17　Electrical Properties and Defect Evolution of Graphene Field Effect Transistors under Swift Heavy Ion Irradiation and Thermal Annealing*

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Carbon-based semiconductor is regarded as one of the disruptive technologies in the post-Moore era, which is expected to break through the bottleneck of traditional semiconductor devices and replace traditional silicon integrated circuits in the future. However, carbon-based devices pose new challenges to the investigation of radiation damage effects of the devices due to new low-dimensional device materials, new device structures, more complex circuits and physical mechanisms[1−4]. At present, the research on the heavy ion irradiation effect of carbon-based devices is still in its infancy, and the radiation resisance performance and radiation damage mechanism of carbon-based devices are still unclear.

In this work, we report the serious performance degradation of graphene field effect transistors (GFETs) induced by swift heavy ion (SHI) irradiation. The evolution of defects in graphene, SiO_2, Au layers and the interface of SiO_2/Si after the irradiation and the thermal annealing at different temperature were investigated. The result shows that SHI irradiation induced permanent radiation damage in graphene and SiO_2/Si layer could not be recovered by thermal annealing even at the temperatures as high as 1 100 ℃. The main role of thermal annealing in irradiated GFET was degassing effect, and the influence of thermal annealing decreased with the increasing irradiation fluences (as shown in Fig. 1). Our work gives a good understanding of radiation damage mechanism in GFETs, which is also crucial importance to other 2D materials-based devices work under the harsh radiation environment.

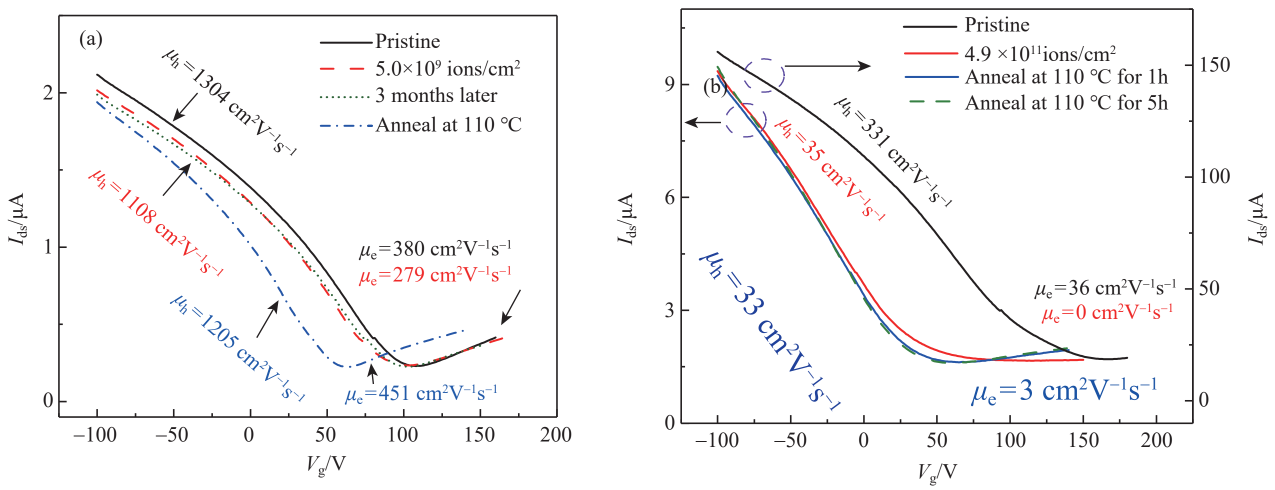

Fig. 1　(color online) Transfer curves of the pristine GFET and GFET irradiated with fluence of (a) 5.0×10^{9} ions/cm^2, (b) 4.9×10^{11} ions/cm^2.

References

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