In-situ monitoring of monolayer graphene self-healing following very low-energy ion irradiation

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Due to the two-dimensional (2D) nature of graphene, defects in its lattice are bound to provoke significant changes in its properties. Experiments carried out on a setup specifically designed to examine plasma-surface interactions[1] shed light on defect recombination kinetics. *In-situ* Raman spectrometry is used to monitor the evolution of Raman peaks of a monolayer graphene sheet evolution during and immediately after ion irradiation. Figure 1 presents I_D/I_G evolution in the case of 13 eV and 90 eV Argon ions. A sudden decrease is observed right after 13 eV ions irradiation, but not observed at higher energy. While 90 eV ions generate sputtering, subthreshold ions (transmitted energy below 18 eV [2]) are expected to create vacancies and adatoms on graphene's surface[3,4]. Self-healing can be attributed to adatoms' swift diffusion and recombination with vacancies. Furthermore, a comparison of experimental results with a kinetic model shows that self-healing efficiency is limited by adatom dimerization. To properly simulate the progressive defect concentration diminution over time, adatoms interplay with Stone-Wales defects must be considered. The latter acts as a temporary trap for adatoms, releasing them at a low rate and prompting vacancies' healing. Such phenomena are to be considered in future plasma treatments in which sub-threshold ions can interact with graphene.

References

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Figures

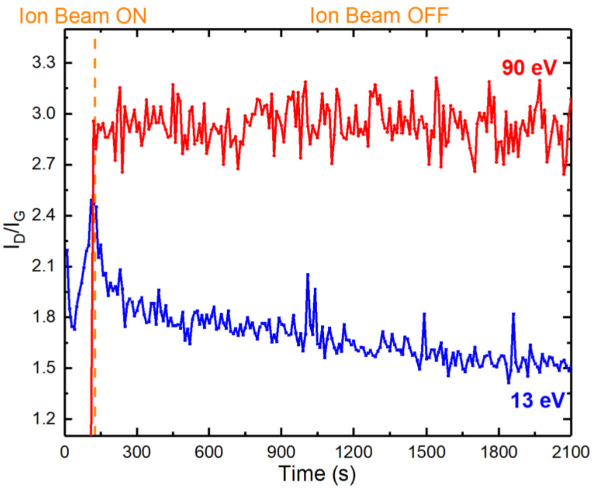

Figure 1: *Temporal evolution of the I_D/I_G intensity ratio during and after exposure to 13 eV (blue curve) and 90 eV (red curve) ion beams. The time scales have been shifted so that the end times of ion irradiation in both cases coincide.*