PLATHINIUM
PLASMA THIN FILM INTERNATIONAL UNION MEETING
13-17 September 2021
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SURF / Plasma - surface interactions

Contributions of grain boundaries in plasma-modified graphene

P. Vinchon, X. Glad, G. Robert Bigras, R. Martel, L. Stafford
Univ. Montréal (CA)

Abstract content
Raman spectroscopy is an efficient method to characterize the graphene structure. The technique gives distinctive features for pristine, damaged and even doped graphene. Raman is however limited by its intrinsic microscopic nature, only being able to probe the area exposed to the laser beam (~ 1 µm). Hyperspectral Raman Imaging (RIMA for Raman Imaging) is a powerful method developed by Photon etc. in collaboration with the group of Prof. Martel [1] in order to obtain qualitative as well as quantitative data on a macroscopic scale. Such instrument enable the study of defects engineering located in grains or at grain boundaries, central to the development of functional materials. Although there is a surge of interest in the formation, migration and annihilation of defects during ion and plasma irradiation of bulk materials, these processes are rarely assessed in low-dimensional materials and remain mostly unexplored. Here, we use a hyperspectral Raman imaging scheme providing high selectivity and diffraction-limited spatial resolution to examine plasma-induced damage in a polycrystalline graphene film. Measurements conducted before and after very low-energy (11–13 eV) ion bombardment show defect generation in graphene grains following a zero-dimensional defect curve, whereas domain boundaries tend to develop as one-dimensional defects. Damage generation is slower at grain boundaries than within the grains, a behaviour ascribed to preferential self-healing [2]. This evidence of local defect migration and structural recovery in graphene sheds light on the complexity of chemical and physical processes at the grain boundaries of two-dimensional materials. Furthermore, evidence of preferential doping at grains boundaries or domains is observed with either Boron or Nitrogen linked with their different migration energy compared to carbon’s.

Thanks/Acknowledgement
This work was financially supported by the National Science and Engineering Research Council (NSERC), PRIMA-Québec, Plasmionique Inc., Photon etc., the Fonds de Recherche du Québec—Nature et Technologies (FRQNT) and the Canada Research Chair programme (L.S. and R.M.).

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