MAT Ionenstrahlworkshop 2025
September 22-24, 2025 at GSI, Darmstadt

Contribution ID: **82** Type: **Oral**

In-situ Raman Spectroscopy of Ion-Induced Defects in Graphene

Tuesday, September 23, 2025 9:30 AM (20 minutes)

In recent years, two-dimensional (2D) materials and the ion-induced, tailored modification of their structural, optical and electronic properties have attracted increasing attention, driven by the potential application of modified 2D materials in optics and microelectronics. Raman spectroscopy is an established tool to characterize such ion-induced modifications, especially changes in the electronic structure. Particularly graphene, the most extensively studied 2D material, is highly sensitive to defects. However, a persistent challenge in studying ion-solid-interactions lies in distinguishing between the direct effects of ion impacts and the effects arising from the exposure of ion-induced defects to ambient conditions. For example, ex-situ analyses of irradiated graphene often show changes in doping levels, yet the processes driving these changes remain under debate.

In this contribution, we address this challenge by performing in-situ Raman spectroscopy measurements on ion-irradiated graphene under ultra-high vacuum conditions. Our portable Raman spectroscopy setup enables in-situ measurements at multiple irradiation facilities. Specifically, we present results obtained from in-situ Raman spectroscopy measurements on graphene irradiated with swift heavy ions (Au^{75+}, 945 MeV) at the CRYRING target station at GSI, and with slow, highly charged ions (Xe^{30+}, 180 keV) at the HICS beamline at the University of Duisburg-Essen. For both ion species, the Raman-active G- and D- band intensities show a linear increase of the peak area ratio A_D/A_G with fluence, consistent with defect generation. Comparison of in-situ and ex-situ Raman data reveals that changes in doping levels are primarily due to oxygen saturation of ion-induced defects upon exposure to ambient air, rather than a direct consequence of the ion irradiation itself.

Author: FRANK, Carolin (University of Duisburg-Essen)

Co-authors: MAAS, André (University of Duisburg-Essen); LINTZ, Charleen (University of Duisburg-Essen); VOM-SCHEE, Kevin (Uppsala University); Dr KOCH, Frieder (GSI Helmholtzzentrum für Schwerionenforschung); KIRSCH, Leon (GSI Helmholtzzentrum für Schwerionenforschung); HIERZENBERGER, Anke (University of Duisburg-Essen); Prof. SCHLEBERGER, Marika (University of Duisburg-Essen); Dr BREUER, Lars (University of Duisburg-Essen)

Presenter: FRANK, Carolin (University of Duisburg-Essen)

Session Classification: Talks

Track Classification: Annual Workshop on Ion and Particle Beams (Ionenstrahl Workshop)