Investigation of defect types in tritiated graphene using Raman spectroscopy

Genrich Zeller
Deseada Díaz Barrero, Helmut H. Telle, Magnus Schlösser
Tritium Laboratory Karlsruhe (TLK), Karlsruhe Institute of Technology (KIT), Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen, Germany
genrich.zeller@kit.edu

Interest in tritium-interactions with graphene and graphene-like materials is relatively new. One example is the proposed use of tritiated graphene in the PTOLEMY experiment [1], to serve as the target for capturing relic neutrinos. Although hydrogenation of graphene is well-documented (see e.g. [2]), the use of tritium presents unique challenges and raises unresolved questions due to its radioactive nature.

Over the past two years, our group has successfully demonstrated the adsorption of tritium on graphene [3]. In said experiments samples of monolayer graphene on SiO_2/Si substrates were exposed to T_2 and subsequent to its β-decay chemisorption of tritium atoms onto graphene occurred; the conceptual mechanism is shown in Figure 1. In order to verify successful tritiation, two characterization techniques were applied, namely (i) *in situ* sheet resistance measurements via the Van der Pauw method; and (ii) *ex situ* spatially-resolved Confocal Raman Microscopy (CRM) [4]. Based on all observations, we could conclude that the graphene film had become at least partially tritiated, and had remained structurally intact, despite bombardment from β-decay electrons and energetic primary and secondary ions and radicals.

Here we summarize results from said complementary methods, which confirmed successful graphene tritiation, and present follow-up studies on the tritiated samples. In particular, new Raman measurements were performed with higher spectral resolution, which allowed for insights into the nature of defects, in line with established observations [5].

References

[1] M.G. Betti et al, JCAP, 07 (2019) 047
[2] K.E. Whitener, J. Vac. Sci. Technol. A., 36 (2018) 05G401
[3] G. Zeller et al, Nanoscale Adv, 6 (2024) 2838-2849
[4] D. Díaz Barrero et al, Sensors, 22 (2022), 10013
[5] A. Eckmann et al, Nano Lett., 8 (2012), 3925–3930

Figures

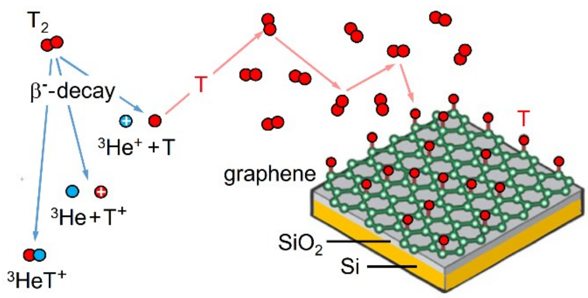

Figure 1: The conceptual mechanism for the tritiation of graphene. Molecular tritium undergoes β-decay, yielding T and ^{3}He in atomic or ionic final-states, and electrons with keV energies; the electrons ionize and dissociate further T_2-molecules. Subsequently, these primary and secondary product T-atoms thermalize in collisions and can chemisorb to the graphene layer.