15.5 MeV Proton Irradiation Treatment of Liquid Phase Exfoliated Graphene

Narek Margaryan[a], Hovhannes Badalyan[a], Tigran Ohanyan[a], Eduard Aleksanyan[a], Astgik Hovhannisyan[b]
[a] *A. Alikhanyan National Science Laboratory (Yerevan Physics Institute), Yerevan 0036, Armenia*
[b] *Scientific Technological Center of Organic and Pharmaceutical Chemistry, 26, Azatutian ave., Yerevan, 0014, Armenia*
n.margaryan@yerphi.am

Exceptional Physical properties, including lightweight nature of graphene make it a highly promising material for space applications [1,2]. However, the impact of proton irradiation, a common phenomenon in space environments, on the structural integrity and functional properties of graphene remains a critical area of research. This study aims to fill this gap by investigating the effects of proton irradiation on liquid-phase exfoliated graphene. We focus specifically on the alterations in infrared spectra and structural characteristics of graphene induced by irradiation with 15.5 MeV protons [3]. Our analysis reveals that organic molecules and functional groups adsorbed on graphene during exfoliation elevate the Fermi level, suppressing graphene's infrared absorption through the Pauli blocking effect. We demonstrate that proton irradiation, at fluences up to 1×10^{15} proton/cm^2, effectively removes adsorbed molecules and functional groups, thereby eliminating Pauli blocking effect. These findings contribute to a better understanding of the behaviour of graphene under proton irradiation, essential for its utilization in space-centric applications such as thermal coatings, electronics, and optical devices.
The research was supported by the Higher Education and Science Committee of MESCS RA, in the frames of the research project No. 23- 2DP-1C010

References

[1] K. Novoselov, A. Geim, S. Morozov, D. Jiang, Y. Zhang, S. Dubonos, I. Grigorieva, A. Firsov, Science 306 (2004)666–669.
[2] N. Margaryan, N. Kokanyan, E. Kokanyan, J. Saudi Chem. Soc. 23 (2019) 13–20.
[3] N. Margaryan et al., Diamond & Related Materials 146 (2024) 111224.