Radiation Resilience of Graphene Based Heterostructures – Insights from Multimodal Structure Characterization

Wiktoria Reddig[1,*], Tymoteusz Ciuk[2], Maciej Szary[1], Jakub Jagiełło[2], Artur Dobrowolski[2], Rafał Prokopowicz[3], Marek Weiss[1], Marek Wzorek[2], Semir El-Ahmar[1]

[1] Institute of Physics, Faculty of Materials Engineering and Technical Physics, Poznan University of Technology, Piotrowo 3, 60-965 Poznan, Poland
[2] Łukasiewicz Research Network - Institute of Microelectronics and Photonics, Aleja Lotników 32/46, 02-668 Warsaw, Poland
[3] National Centre for Nuclear Research, 05-400 Otwock, Poland

[*] Corresponding author: wiktoria.reddig@doctorate.put.poznan.pl

Enhancing the durability of magnetic field diagnostic electronics under fast-neutron irradiation requires materials capable of withstanding extreme defect formation. Dimensionality reduction offers a potential route, as two-dimensional systems inherently limit the development of collision cascades responsible for radiation damage in bulk materials. Graphene, with its two-dimensional nature and low neutron-collision cross section, embodies this concept. Yet, when integrated into a heterostructure, can it maintain its intrinsic radiation resilience [1]?

We explore the neutron radiation tolerance of an a-Al_2O_3/graphene/H-intercalated SiC(0001) heterostructure [2, 3], combining reduced dimensionality with a conventional substrate platform. Using high-resolution transmission electron microscopy, Raman spectroscopy, electrical characterization and other techniques, we assess the material's structural and functional stability under fast-neutron fluences up to 2×10^{18} n cm^{-2}. Our findings show, the graphene layers exhibit negligible structural damage in comparison to bulk elements [4].

Showing that graphene retains its structural integrity and electronic performance even under extreme neutron exposure, we suggest a viable route toward radiation-resilient sensor technologies. Such resilience is particularly crucial for future fusion energy systems, where long-term, reliable magnetic diagnostics will be key to successful reactor operation.

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