Structural and Dislocation Density Alterations in Graphene Oxide Exposed to Gamma Radiation

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Graphene oxide (GO) has emerged as a highly significant material in recent years, boasting tunable band gap values and high electrical conductivity among its notable properties, which facilitate a broad spectrum of applications. A critical area of investigation is the reduction process of GO and its changing physical properties under external influences. Specifically, the impact of gamma radiation on GO samples is of considerable interest.

GO was synthesized using a modified Hummers method. The resulting GO samples were exposed to varying doses of gamma radiation (10, 500, and 1500 kGy). Structural analysis, both pre- and post-radiation exposure, was conducted, including the calculation of dislocation density. Figure 1 presents the X-ray diffraction patterns of the samples. Figure 1a corresponds to the non-irradiated sample, showing three distinct XRD peaks. The peaks at approximately 11.98° and 42.03° are characteristic of GO, while the peak at 2ϴ = 26.30° indicates residual graphite that did not convert to GO during synthesis [1]. Figures 1b, 1c, and 1d display the XRD spectra of GO irradiated with gamma doses of 10, 500, and 1500 kGy, respectively. The spectra reveals that the residual graphite peaks disappear after gamma irradiation, indicating the decomposition and oxidation of residual graphite due to gamma radiation.

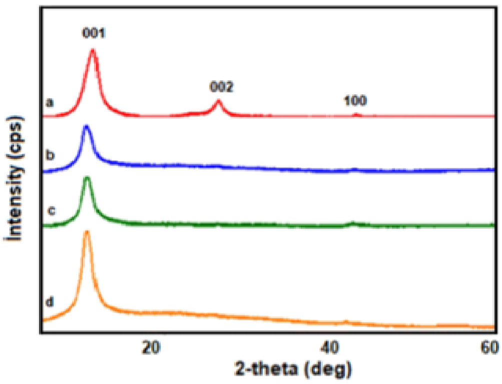

Figure 1. XRD pattern for GO: a-0 kGy; b-10 kGy; c-500 kGy; d-1500 kGy

Dislocation density for the samples was determined using the relation ρ = 1/D^2, where D represents the crystallite size. For the original sample, the dislocation density was found to be 0.0498 nm^{-2}. The calculations indicate a decrease in dislocation density to 0.0338 nm^{-2} with an initial gamma radiation dose of 10 kGy. However, as the radiation dose increases, the dislocation density rises, reaching its maximum value of 0.1998 nm^{-2} at 1500 kGy. This behavior is attributed to the dual effects of gamma radiation, which both generates new dislocations and annihilates existing ones.

1. Muradov M, Baghirov MB, Eyvazova G, Gahramanli L, Mammadyarova S, Aliyeva G, Huseynov E, Abdullayev M. Radiation Physics and Chemistry. 2023 Jul 1;208:110926.
2. Sutapa IW, Wahid Wahab A, Taba P, Nafie NL. InJournal of Physics: Conference Series 2018 Mar 1 (Vol. 979, p. 012021). IOP Publishing.