

Title: h-BN layered material: A new frontier in radiation dosimetry

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Abstract: This study explores the potential of hexagonal boron nitride (h-BN) nanostructures for dosimetry of diverse ionizing radiation. We focus on the crucial thermoluminescence (TL) properties of h-BN, including glow curve, dose-response, reproducibility, sensitivity, and fading, within the conventional framework of TL dosimetry. The h-BN powder samples were exposed to different ionizing radiations, including ^{60}Co gamma-rays with a mean energy of 1.25 MeV, electrons (6 MeV), and photons (6 MV), at levels of dose familiar in radiotherapy ranging from 2 Gy to 15 Gy. The h-BN's effective atomic number of 6.25, similar to human tissue, opens up exciting possibilities for applications in medical imaging and dosimetry. Notably, h-BN demonstrates a linear response within the dose range of interest, showcasing excellent sensitivity, particularly at low doses and low photon energies. Additionally, h-BN samples exhibit remarkable reproducibility, with a standard deviation of less than 2.4%, albeit accompanied by significant fading. Regarding the trapping parameters underpinning the manifestation of the glow curves of the irradiated samples, use was made of the peak shape method with different models to estimate the order of kinetics (b), activation energy (E), and frequency factor (s) or escape probability and trap lifetime (τ). The data suggest that the TL glow peaks of the h-BN obey general-order kinetics. These findings underscore the transformative potential of h-BN layered material in advancing radiation dosimetry, particularly in medical physics fields. The inherent characteristics of h-BN, coupled with its effective atomic number, excellent linearity over a wide range of radiation doses especially for electron irradiation and better reproducibility, positioned it as a suitable tool for precise and reliable dose measurement in medical imaging and therapy, heralding a new frontier in radiation dosimetry.

Keywords: Hexagonal boron nitride (h-BN), Thermoluminescence (TL), Dosimetry, Ionizing radiation, Radiation therapy, Medical imaging

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