Title: Natural flake graphite as an affordable dosimeter for clinical X ray application at dose ranges between 2-20 mGy

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Abstract: The requirement for low-dose mammography is essentially important given the high radiosensitivity of breast tissue, coupled with the fact that screening programs necessitate multiple exposures throughout a patient's lifetime. Consequently, accurate dosimetry within the mammography dose range is crucial to guarantee safety and efficient dose measurement. Thermoluminescence (TL) along with microstructural analyses were performed on natural flake graphite (NFG) to evaluate its potential as a dosimeter for clinical X-ray applications, particularly within mammographic dose ranges (2–20 mGy). The study involved a thorough analysis of TL glow curves, dose-linearity, TL-sensitivity, signal loss, and repeatability. A 532 nm laser Raman spectroscopy and X-ray diffraction (XRD) were utilized to analyze the microstructure of the irradiated NFG. Promising characteristics of the NFG included a high response to dose (R^2 of approximately 0.99 %), enhanced TL-sensitivity at lower level doses, and strong reproducibility (~4 %). Following 28 days of irradiation, the fading rate was roughly 22 % in an ambient light room and 23 % in a dark room condition. Furthermore, the ratios of defect intensity (I_D) to graphite intensity (I_G), represented as I_D/I_G, closely reflected the oscillated pattern perceived in other carbonaceous materials. The structural parameters including crystallite size, dislocation-density, and lattice-strain, were assessed from the XRD pattern, confirming the dose-dependent structural changes and supportive to Raman and PL spectroscopy findings. The findings indicate that NFG might offer a promising candidate for developing a low-cost, hydrophobic, and human tissue-equivalent TL dosimeter, which might serve various applications in the healthcare field.

Keywords: Thermoluminescence Natural flake graphite Dosimeter Clinical X-ray Applications Microstructural analyses

10.1016/j.diamond.2025.113153