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112-1 Improvement of an exoelectron emission detection system for radiation dosimetry

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Abstract:

Solid-state dosimeters are fundamental components for the areas of radiation metrology, medical radiology, radiotherapy and environmental monitoring. This work explores the promising potential of the phenomenon of exoelectron emission (EE) for applications in these areas. Through an innovative system employing a continuous flow gas proportional detector, a precise and reliable method was developed to measure dose in materials like beryllium oxide (BeO), carbon-doped alumina (Al2O3:C), and calcium sulfate (CaSO4), commonly used in dosimetry. The meticulously designed and constructed system comprises a continuous flow gas proportional detector coupled to a complex electronic circuit. This circuit, incorporating an Amptek charge-sensitive preamplifier and an amplifier and pulse shaper, was carefully calibrated to detect the EE signals emitted by the dosimeters following a radiation exposure. BeO, Al2O3:C, and CaSO4 dosimeters, in the form of 5 mm diameter pellets, were exposed to beta (90Sr/90Y) and alpha (241Am) radiations at varying doses and heated in an electric oven at controlled temperatures. The dosimeter EE signal was measured by the developed system and meticulously analyzed. The results obtained were promising. The heating system exhibited remarkable stability and consistency throughout the measurement process, ensuring the reproducibility of the measurements. The amplifier circuit designed to detect exoelectrons yielded consistent and accurate results for the exposure of the tested dosimeters, demonstrating their ability to measure the absorbed dose. A key advantage of the system lies in its use of a proportional detector, eliminating the need for expensive photomultiplier tube and equipment. Moreover, the developed instrumentation exhibits notable stability over time, minimizing the need for frequent calibrations. This work presents a novel and promising system as an alternative for solid-state dosimetry, utilizing the EE technique and a continuous flow gas proportional detector. The system stands out for its precision, reproducibility, low cost, and stability, making it a valuable tool for applications in radiation metrology and calibrations.

Keywords:

Solid-state dosimetry, Exoelectron emission detection, Dosimeter optimization, Radiation measurement