ABSTRACT

The development of environmentally friendly and efficient lead-free radiation shielding materials has become a critical focus as the utilization of nuclear technology increases across various sectors. This research aims to evaluate polymer composites based on Polyvinyl Alcohol (PVA) with varying concentrations of Bismuth(III) Oxide (Bi_2O_3) and Tungsten(VI) Oxide (WO_3) fillers as an alternative to lead-free radiation shielding. The composites were synthesized using the solution casting method in six varying compositions, ranging from pure PVA (PBW1) to mixtures with varying filler masses (PBW2–PBW6). Comprehensive characterization was conducted, including physical tests (density and thickness), mechanical properties (tensile strength and elongation at break), and an evaluation of radiation shielding parameters, namely the Linear Attenuation Coefficient (LAC), Mass Attenuation Coefficient (MAC), Half Value Layer (HVL), Tenth Value Layer (TVL), and Mean Free Path (MFP). Radiation testing was performed using Am-241 (59.5 keV) and Cs-137 (662 keV) radioisotope sources. The results show a significant increase in density with the addition of fillers, with the highest density of 1.963 g/cm³ achieved by the PBW6 sample. Regarding mechanical properties, the addition of a large amount of filler material reduced tensile strength compared to the pure PVA matrix (10.405 MPa); however, the balanced composition of Bi_2O_3 and WO_3 in PBW4 provided a synergistic effect in stress distribution (6.241 MPa) while maintaining elongation at break stability in the 199–200% range. The evaluation of radiation parameters proves that the addition of fillers increases the material's opacity to radiation. The PBW6 sample demonstrated the best shielding performance, with the highest LAC and MAC values, as well as the lowest HVL, TVL, and MFP values across both energy spectra. The synergy of the PVA composite with Bi_2O_3 and WO_3 fillers is highly potential for application as an efficient, lightweight, and environmentally friendly radiation shielding material.

***Keywords**: Radiation Shielding, Polyvinyl Alcohol, Bismuth Oxide, Tungsten Oxide, Lead-Free Composite, Radiation Attenuation*.