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Recycled high-density polyethylene plastics added with lead oxide nanoparticles as sustainable radiation shielding materials

Mahmoud, M.E.[a], El-Khatib, A.M.[b], Badawi, M.S.[b,c], Rashad, A.R.[a], El-Sharkawy, R.M.[a,d], Thabet, A.A.[e]

[a] Chemistry Department, Faculty of Science, Alexandria University, Alexandria, Egypt

[b] Physics Department, Faculty of Science, Alexandria University, Alexandria, Egypt

[c] Department of Physics, Faculty of Science, Beirut Arab University, Beirut, Lebanon

[d] Basic Science Department, Faculty of Engineering, Pharos University in Alexandria, Alexandria, Egypt

[e] Department of Medical Equipment Technology, Faculty of Allied Medical Sciences, Pharos University in Alexandria, Alexandria, Egypt

Abstract:

This work investigates the γ-ray shielding characteristics of composite materials based on recycled high-density polyethylene (r-HDPE). The designed shielding materials are low-cost and sustainable plastic wastes with different fractions of lead oxide nanoparticles (PbO NPs) and bulk powder. The composite samples were prepared via compression molding technique and characterized by Fourier transform infrared spectrophotometer (FT-IR), thermogravimetric analysis (TGA), scanning electron microscope (SEM), field emission-transmission electron microscope (FE-TEM), Brunauer–Emmett–Teller surface area (BET), and X-ray diffraction (XRD). The γ-rays attenuation-coefficients were measured as a function of the percentage of lead oxides for several γ-ray energies using point sources [^{241}Am, ^{133}Ba, ^{137}Cs, and ^{60}Co]. The experimental results show that r-HDPE with both bulk PbO and PbO NPs composites are better shielding for γ-ray than r-HDPE itself. The composites-loaded-PbO NPs were the best shielding materials for γ-ray compared to that filled with bulk PbO. The theoretical values of the linear-attenuation (μ) were extracted from the mass-attenuation coefficient (μ/ρ) and calculated using the XCOM program. The proposed composites when compared to conventional shielding materials implement as strong rivals to barite, steel and concrete particularly at higher filler wt% and for low energy γ-ray.

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