

The Gamma Ray Attenuations Of Superabsorbent Copolymer Poly(AA-co-Kry22 DM) Sorbed Se And Pb Atoms

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Extended Abstract

The aim of this work is investigation on efficiency of superabsorbent copolymer, poly (AA-co-Kry22 DM) sorbed Se, Pb atoms for gamma radiation protection. The poly (acrylic acid-copolymer-Kryptofix-22-DM) superabsorbent copolymer, poly(AA-co-Kry22-DM), was synthesized by the reaction of 4,13-dimethylacryloyl-1,7,10,16-tetraoxa-4,13 diazacyclooctadecane (Kryptofix-22-DM) and acrylic acid (AA) by solution polymerization under vacuum in the Schlenk system. Characterization of the polymers was achieved by FTIR and ¹H NMR, SEM, TGA techniques. After this process we have investigated experimental gamma ray mass attenuation coefficients of “poly (AA-co-Kry22-DM) with Lead and Selenium composites as a function of gamma ray energy starting from ~120 keV to ~1410 MeV. The results show that occurrences of Se and Pb elements in the structure of copolymers increase the total attenuation coefficients of copolymer dramatically between the gamma energy ranges of ~120-800 keV. This result gives a clue for synthesizing of new polymer structures for producing radiation protective materials.

Based on the progress of nuclear science and technology applications, many studies are devoted to develop radiation protective materials. In particular lead is commonly used for protection from gamma ray because it is cheap and easily shaped and also it has high attenuation coefficient against gamma ray. On the other hand polymers are used in many technological applications and also there can be found many daily used materials produced by using various polymer structures. It can be considered that adding some elements with high gamma ray mass attenuation coefficients (σ_m) on polymers can provide useful and flexible material against gamma radiation. By considering this point we have investigated effect of adding Se and Pb atoms on poly (AA-co-Kry22-DM) for σ_m as a function of gamma energy.

The poly (AA-co-Kry22 DM) superabsorbent used in the gamma radiation study was synthesized [1] by us in the Polymer Chemistry Laboratory of Karadeniz Technical University using the similar method in the literature [2]. FTIR and ¹H NMR figures of Kry22-DM and Poly(AA-co-Kry22-DM) superabsorbent copolymer are presented in the literature [1]. The characterization of Kry22-DM was achieved by FTIR and ¹H NMR techniques.¹ ¹H NMR spectrum of Kry22-DM shows the characteristic peaks at 1620 cm⁻¹ for -C=O- groups, at 1110 cm⁻¹ for -C=O- groups, at 2868–2980 cm⁻¹ for -CH₃ and -CH₂ groups, at 2850 cm⁻¹ for -C-N- groups, and at 1350–1370 cm⁻¹ for methyl symmetrical deformation peaks. FTIR spectrum¹ of the crosslinked poly(AA-co-Kry22-DM) superabsorbent copolymer shows the characteristic peaks at 1713 cm⁻¹ for -C=O- groups, at 1161 cm⁻¹ for -C-O-groups, at 2648 cm⁻¹ for -C-N- groups, at 2700–3500 cm⁻¹ for -COOH groups, at 2840–2950 cm⁻¹ for -CH₃ and -CH₂ groups, and 1406 cm⁻¹ for methyl symmetrical deformation peaks. In this work, the absorption of gamma radiation of poly(AA-co-Kry22-DM)-matrix composites with reinforcing set numbers are following :

1. poly(AA-co-Kry22-DM) superabsorbent
2. poly(AA-co-Kry22-DM) superabsorbent + Se (10%)
3. poly(AA-co-Kry22-DM) superabsorbent + Se (30%)
4. poly(AA-co-Kry22-DM) superabsorbent + Pb (10%)
5. poly(AA-co-Kry22-DM) superabsorbent + Pb (30%)

For experimental determination of σ_m of the mentioned composites HPGe detector system at Nuclear Physics Laboratory of Karadeniz Technical University has been used. Also Eu point radiation source with 121.8 keV, 244.7 keV, 344.3 keV, 778.9 keV, 964 keV, 1112.1 keV and 1408 keV gamma energy has been used. For data analysis Gamma Vision computer program was used. For determination of σ_m of these composites sample weight and area have measured.

For each gamma energy of Eu point source detector counts with sample and without sample had been taking into account for calculating of σ_m .

In the present study σ_m values for all examples have decreased when gamma energy increased as one can expected [3]. It can be clearly observed that adding lead and selenium on poly superabsorbent has increased the σ_m values dramatically in the present study. For this, the best example of this study obtained for poly(AA-co-Kry22-DM) superabsorbent + Pb (30%) sample. For pure poly (AA-co-Kry22-DM) superabsorbent sample σ_m values 0.332 cm²/g, 0.326 cm²/g, 0.701 cm²/g, 0.638 cm²/g, 0.422 cm²/g, 0.054 cm²/g and 0.222 cm²/g are determined for the gamma energy values 121.8 keV, 244.7 keV, 344.3 keV, 778.9 keV, 964 keV, 1112.1 keV and 1408 keV, respectively. However, for poly(AA-co-Kry22-DM) superabsorbent + Pb (30%) composite σ_m values 2.709 cm²/g, 2.177 cm²/g, 1.827 cm²/g, 1.094 cm²/g, 0.873 cm²/g, 0.432 cm²/g and 0.225 cm²/g are determined for the gamma energy values 121.8 keV, 244.7 keV, 344.3 keV, 778.9 keV, 964 keV, 1112.1 keV and 1408 keV, respectively. Particularly this study can possibly indicate that occurrences of Pb elements in the structure of copolymers increase the total attenuation coefficients of copolymer dramatically between the gamma energy ranges of ~120-800 keV. From this point one can conclude that poly (AA-co-Kry22-DM) superabsorbent + Pb (30%) composite can be used for gamma radiation protection material because it has flexible character and easy production.

Keywords: Superabsorbents and Metal Composites, Gamma Radiation, Mass Attenuation Coefficient, Radiation Protection.

References

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