Fabrication of Lightweight and Low Cost Shields for Gamma Ray Attenuation

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Fabrication of Lightweight and Low Cost Shields for Gamma Ray Attenuation

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Abstract

Films of biopolymer (PVA) doped with titanium nanoparticles (Ti NPs) have been prepared with several ratios of PVA and Ti NPs to apply for gamma ray shielding with low unit cost, flexible, lightweight, and high corrosion resistance. The prepared nanocomposites tested for gamma ray shielding. The experimental results showed the PVA/ Ti nanocomposites films have high coefficients of attenuation for gamma ray.

Key Words: Gamma Ray, Attenuation Coefficients, Radiation Shielding, Nanocomposites.

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Introduction

Radiation phenomenon can be defined as the energy that arrives from the source then transfer during the space and can be able to make a way into different matter. The radiation may be divided based on its potential to ionize material into two major classes: nonionizing and ionizing radiations (Chaitali et al, 2021). In medical fields, it has been some years the high energy gamma-rays and X-rays were being employed in the radiotherapy to treat and control cancerous tumors (Kazemi et al, 2019) Nowadays, shielding of radiation is especially crucial section in the programs of radiation protection. Typically, concrete is the mainly general and normally employed matter to the radiation shielding in mainly facilities like hospitals. The huge available quantity and cost efficiency of concrete were its major advantages to use as the shielding material. Though, it has several disadvantages like cracks may happen after long period of time of exposure to radiation and the difficult for transport. The synthetic polymers may be employed to manufacture novel materials may make radiation shielding. Furthermore, their additional advantages like durability, low industrialized cost, and high chemical and thermal stability are amid the preferential traits and quality used for greater shielding (Mahmoud et al, 2020). Moreover, the advantages of polymer materials, like, mold ability, high flexibility, strength are important when combined with the excellent properties of inorganic substances, such as heat strength, thermal stability, chemical resistance, and high strength, when creating composite materials. The nanofillers can be utilized in a widespread range of usages, such as, tissue engineering, wound dressing, manufacturing sensors, filters, catalysis, scaffolds, and their mechanical, electrical properties, magnetic, thermal and optical properties can be improved by incorporating inorganic and organic materials to the structures (Gamal et al, 2015). Biomedical applications will benefit from the production of polymer composites using a matrix of polymer that has high tensile strength and is non-toxic (Kapil et al, 2019). The current work aims to synthesize of PVA/Ti nano-system for radiation shielding.

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Experimental Part

Films of PVA/Ti nanocomposites were fabricated from titanium nanoparticles as additive and polyvinyl alcohol as matrix using the casting method. 1gm of PVA was dissolved in 20 ml of distilled water. The magnetic stirrer used to mix the materials for 1 hour. The Ti NPs added to the PVA with ratios are (2.5, 5 and 7.5) wt.%. The testing of PVA/Ti films as shield for Gamma ray were investigated. The transmitted gamma ray (N) during the films are measured by the Geiger counter.

Results and Discussion

Figures 1-4 show the thickness effect of pure and each ratio of Ti NPs on transmitted gamma ray during the sample. The ratio of transmission radiation is reduced with the rise in thickness and Ti NPs ratio which due to the rise of the radiation attenuation. (Khalid et al, 2019; Ahmed et al, 2018). Figure 5 represents the Ti NPs content effect on transmitted gamma ray for PVA/Ti samples. As shown in the figure 2, the N/N_0 values are reduced with the increase in Ti NPs ratio, this behavior related to the gamma radiation absorption or reflection by nanocomposites shielding materials (Hassan et al, 2018; Ahmed et al, 2018).

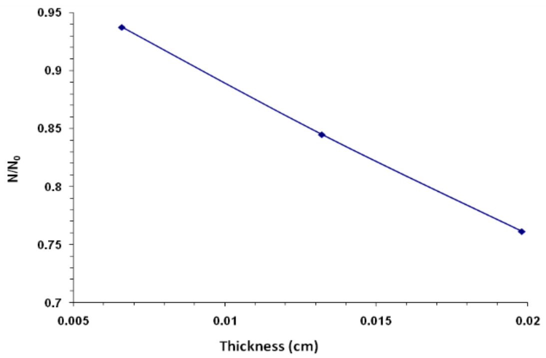

Figure 1. N/N_0 variation with thichness for pure polymer

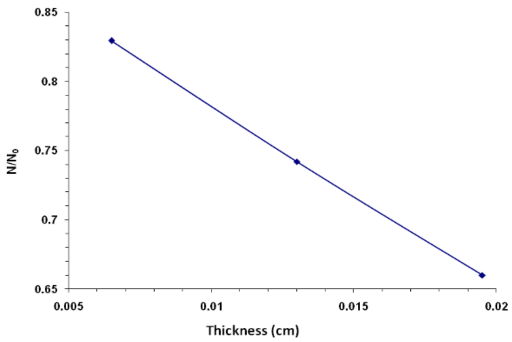

Figure 2. N/N_0 Variation with thichness for 2.5 wt.% Ti NPs

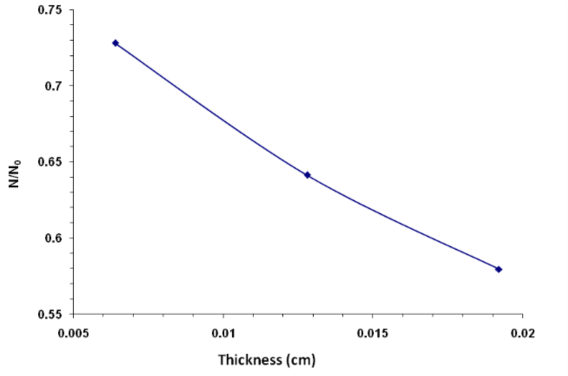

Figure 3. N/N_0 Variation with thichness for 5 wt.% Ti NPs

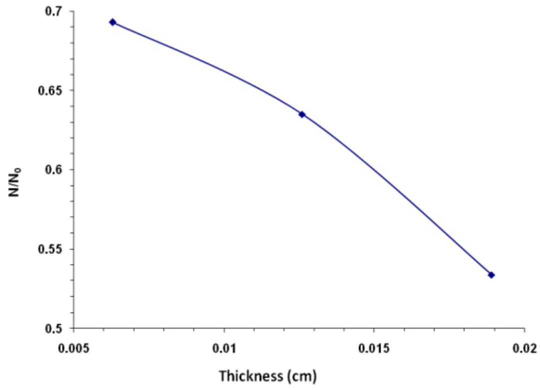

Figure 4. N/N_0 Variation with thichness for 7.5 wt.% Ti NPs

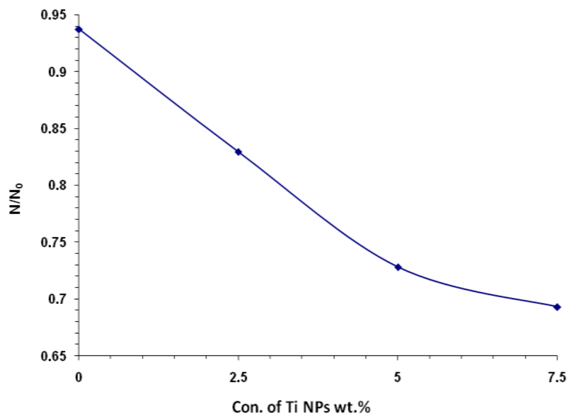

Figure 5. N/N_0 Variation with Ti NPs content

Conclusions

1. The transmitted ray ratio was reduced with the rise in thickness and Ti NPs content.
2. The attenuation coefficients were increased with the rise in Ti NPs ratio.
3. The prepared materials have low cost, lightweight and flexible.

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