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Research Article

Neutron Shielding Properties of Cellulose Acetate CdO-ZnO Polymer Composites

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Abstract:

In this work, the neutron shielding ability of Cellulose Acetate-CdO-ZnO Polymer Composites of different concentrations of CdO and ZnO were investigated. Cellulose acetate is a biodegradable good matrix and the used metal oxides are good for absorbing radiation. The neutron attenuation coefficient was calculated by Phy-X computer code for all the samples.

1. Introduction

Radiation shielding in many facilities such as medical practice requires materials that have superior attenuation properties than the conventional alloys, metals, glasses and polymeric materials currently used for radiation shielding [1-15]. This preferred as lead-free, lighter, lower price and transparency are of high interest [16–24]. The use of polymer composite materials for radiation shielding can fill this gap and a composite material can be a multiphase material that shows a significant portion of its constituent phases so that better properties could be achieved [25-35].
The radiation protection means protecting the employees and the public by ensuring that they get as low as possible radiation dose.
In this work, the neutron shielding ability of Cellulose Acetate-CdO-ZnO Polymer Composites of different concentrations of CdO and ZnO were investigated. Cellulose acetate is a biodegradable good matrix and the used metal oxides are good for absorbing radiation. The neutron attenuation coefficient was calculated by Phy-X computer code for all the samples.

2. Material and Methods

As material the CdO-ZnO-Ca composition have been used to obtain polymer composite material and chemical compositions are given in table 1. It can be seen from this table that Ca rate was kept constant and CdO and ZnO rate were changed in different rate.

Table 1. *Chemical composition of material.(w%)*

Table	CdO	ZnO	Ca
S1	0	30	70
S2	10	20	70
S3	20	10	70

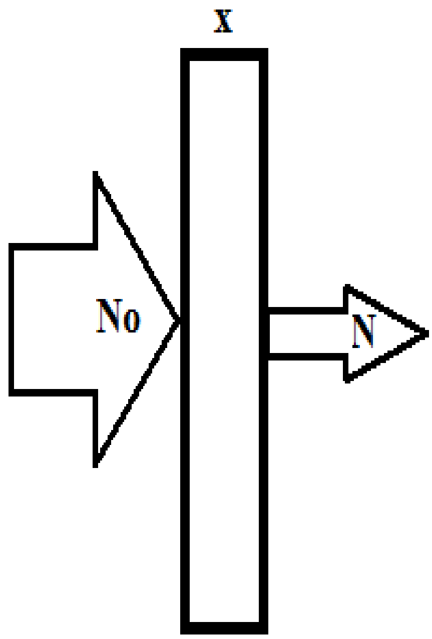

Figure 1. *Schematic view of the attenuation in radiation.*

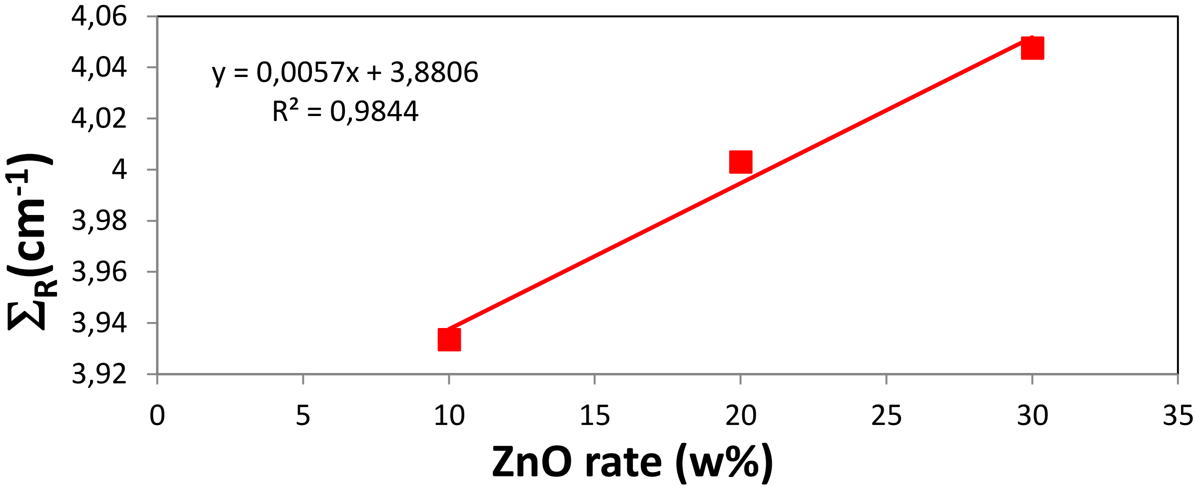

Figure 2. *Neutron attenuation coefficients of composite materials*

Radiation may be attenuated by any material putting between source and detector system. The radiation attenuation in the same direction of the incidence due to absorption and scattering of beams is shown schematically in Figure 1. The radiation penetration and absorption properties of the materials are determined according to the Beer-Lambert law and given in Equation 1 [36-45].

$$N = N_o e^{-\Sigma_R x} \qquad (1)$$

Here, x is the material thickness and S is the linear attenuation coefficient for neutron, *N* and *No* are the radiation intensity passing through the material and collected in the detector without the material, respectively (Fig.1). If *N* =*No* this means there is no material between the source and the detector and none of radiation is attenuated. The neutron attenuation coefficient was calculated by Phy-X computer code [46] for all samples.

3. Results and Discussions

The neutron shielding properties of polymer composite materials (CdO-ZnO-Ca) have been calculated. The obtained results were displayed in Figure 2 as a function of ZnO rate in composite. As can be seen in this figure that the neutron shielding properties have been increased with the increasing ZnO rate in composite. This can be explained by atomic number of Zn is less than Cd as neutron can be captured by low atomic number elements.

4. Conclusions

The neutron shielding properties of polymer composite materials (CdO-ZnO-Ca) have been obtained in this paper. It was found that the ZnO rate is important in selected polymer composite combination in terms of neutron shielding properties.

Author Statements:

- **Ethical approval:** The conducted research is not related to either human or animal use.
- **Conflict of interest:** The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper

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- **Data availability statement:** The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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