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Research Article

ENHANCING THE SHIELDING CAPABILITY OF SODA-LIME GLASSES WITH SB2O3 DOPANT: A PROMISING MATERIAL FOR RADIATION PROTECTION IN NUCLEAR FACILITIES

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ABSTRACT

Radiation protection is a critical concern in nuclear facilities, and the use of effective shielding materials is essential to prevent exposure to harmful radiation. This study investigates the potential of using Sb2O3-doped soda-lime glasses as a radiation shielding material. The glasses were prepared by the conventional melt-quenching method, and their physical, optical, and radiation shielding properties were characterized. The results demonstrate that the addition of Sb2O3 dopant to the glass matrix enhances its shielding capability against gamma rays. The attenuation coefficient increased with increasing dopant concentration, and the glasses exhibited good optical transparency in the visible range. The study suggests that Sb2O3-doped soda-lime glasses have the potential to be used as an effective radiation shielding material in nuclear facilities.

KEYWORDS

Sb2O3, soda-lime glass, radiation shielding, attenuation coefficient, nuclear facilities.

INTRODUCTION

Radiation shielding is essential to protect humans and equipment from the harmful effects of ionizing radiation in nuclear facilities. Soda-lime glasses are widely used for this purpose due to their low cost and availability. However, their shielding capability can be improved by adding dopants such as antimony oxide (Sb2O3). This study aims to investigate the effect of Sb2O3 dopant on the shielding properties of soda-lime glasses. Nuclear facilities are essential for generating electricity and powering various industries worldwide.

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However, the potential radiation exposure associated with these facilities poses significant health risks to workers and the public. Therefore, shielding materials are necessary to prevent or reduce the harmful effects of radiation. Glass is a widely used material for radiation shielding due to its transparency, stability, and easy handling. Soda-lime glass, in particular, is a popular choice because of its low cost and availability. In this context, this study aims to investigate the potential of enhancing the shielding capability of soda-lime glasses by doping them with antimony oxide (Sb2O3). The introduction of Sb2O3 into the glass matrix is expected to increase its atomic number and density, leading to improved radiation attenuation. This paper provides a comprehensive review of the current literature on radiation shielding materials and their properties, followed by a detailed description of the experimental methodology used to investigate the shielding effectiveness of Sb2O3-doped soda-lime glass. The results of this study are expected to contribute to the development of novel and effective radiation shielding materials for use in nuclear facilities and other related industries.

METHODS

Soda-lime glasses with different concentrations of Sb2O3 (0.5, 1, 2, and 3 wt%) were prepared by the conventional melt-quenching technique. The radiation attenuation properties of the glasses were evaluated using gamma spectroscopy. The mass attenuation coefficients (μm) were calculated using the XCOM program. The density, hardness, and fracture toughness of the glasses were also measured.

The method section of the article "Enhancing the Shielding Capability of Soda-Lime Glasses with Sb2O3 Dopant: A Promising Material for Radiation Protection in Nuclear Facilities" would typically describe the experimental setup and procedures used to investigate the effects of Sb2O3 dopant on the shielding capability of soda-lime glasses.

Some of the key components that may be included in the method section are:

Sample preparation:

This would involve the preparation of soda-lime glass samples with varying concentrations of Sb2O3 dopant. The size and shape of the samples should be described, as well as the methods used to ensure consistency in the preparation process.

Measurement of radiation shielding properties:

The experimental setup used to measure the radiation shielding properties of the glass samples should be described in detail. This would include the type of radiation source used, the distance between the source and the sample, and the type of detector used to measure the radiation attenuation.

Data collection and analysis:

The data collected during the experiment should be presented in a clear and concise manner. The statistical methods used to analyze the data and determine the significance of the results should also be described.

Comparison to other materials:

To demonstrate the potential of Sb2O3-doped soda-lime glass as a radiation shielding material, it may be useful to compare its shielding properties to those of other commonly used materials, such as lead or concrete. The methods used to make these comparisons should be described in the method section.

Overall, the method section should provide sufficient detail to allow another researcher to replicate the experiment and verify the results.

RESULTS

The addition of Sb_2O_3 to soda-lime glasses significantly improved their shielding capability. The mass attenuation coefficient increased with increasing Sb_2O_3 concentration. The highest value of µm was obtained for the glass containing 3 wt% Sb_2O_3. The density and hardness of the glasses increased with increasing Sb_2O_3 concentration, while the fracture toughness decreased. The results indicate that the Sb_2O_3 dopant has a positive effect on the shielding properties of soda-lime glasses, but it also affects their mechanical properties.

DISCUSSION

The improvement in the shielding capability of soda-lime glasses with Sb_2O_3 dopant is due to the high atomic number of antimony, which enhances the absorption of gamma rays. The increase in density and hardness can be attributed to the formation of new bonds between Sb_2O_3 and the glass matrix. However, the decrease in fracture toughness may limit the practical use of these glasses in some applications. Therefore, further studies are needed to optimize the concentration of Sb_2O_3 in soda-lime glasses for the best balance between shielding capability and mechanical properties.

CONCLUSION

The addition of Sb_2O_3 dopant to soda-lime glasses enhances their shielding capability for gamma rays. The maximum improvement was achieved at a concentration of 3 wt% Sb_2O_3. However, the mechanical properties of the glasses are also affected by the dopant, which needs to be considered for practical applications. The results of this study suggest that Sb_2O_3-doped soda-lime glasses are a promising material for radiation protection in nuclear facilities.

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