Waste Management 148 (2022) 43–49

Contents lists available at ScienceDirect

Waste Management

journal homepage: www.elsevier.com/locate/wasman

Country report

Recycling potential of cathode ray tubes (CRTs) waste glasses based on Bi_2O_3 addition strategies

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A R T I C L E I N F O

Keywords:
CRTs waste
Glass shield
FLUKA
Bi_2O_3
Optical bandgap

A B S T R A C T

Cathode-ray tubes (CRTs) from computer monitors and television sets are considered as one of the main sources of waste materials worldwide. Therefore, a new application for such out of use materials is required to solve the relatively huge amount of this waste. In this paper, the popular melt-quench technique was used to synthesis glass samples with the structure: xBi$_2$O$_3$–(100-x) waste CRTs (where $x = 0$, 10 & 20 wt%) and designated as CRT-Bi0, CRT-Bi10, and CRT-Bi20 accordingly. The physical, structural, optical and radiation absorption competence of the glasses were investigated. The XRD analysis of the glasses reveals an amorphous structure while the mass density increased linearly with the Bi_2O_3 content of the glasses from 2.86 to 3.08 g/cm^3. The optical absorbance of the glasses initially increased and later declined in the visible region as the weight fraction of Bi_2O_3 increased. The direct optical bandgap E_g values were found to be 3.26, 2.72, and 2.64 eV whereas the indirect E_g values were equal to 3.15, 2.30, and 2.26 eV for CRT-Bi0, CRT-Bi10, and CRT-Bi20, respectively. The gamma-ray interaction parameters of the glasses obtained through FLUKA simulations and XCOM computation showed that mass attenuation falls within the range 0.6991–0.0256, 1.1426–0.0276, 1.5860–0.0301 cm^2/g for photon energy range 0.1–10 MeV. Generally, the computed gamma ray interaction quantities show that the gamma ray shielding ability of the CRT-Bi glasses follows the order: CRT-Bi0 < CRT-Bi10 < CRT-Bi20. This order is conserved in the computed interaction cross sections for thermal (25 meV) neutrons. On the other hand the fast neutron removal cross section follows a reverse order with values of 0.0891 cm^{-1}, 0.0867 cm^{-1}, and 0.0850 cm^{-1} for weight fraction of Bi_2O_3 from 0 to 20 wt%. The comparison of the gamma–ray attenuation capacity of the CRT-Bi20 with common shielding materials reveals good potential for shielding application. Out of use CRT glasses may thus be recycled for use as radiation shielding glasses as described in this study for gamma radiation protection applications.

1. Introduction

Recycling has become a major environmental problem due to the increasing amount of waste produced from different industrial activities and the human daily uses. Therefore, a new application for such out of use materials is required to solve the relatively huge amount of this waste. In this regard, several studies are carried out to find different solutions and applications for the CRTs waste (François et al., 2006), (Tian et al., 2016), (Andreola et al., 2005), and (Fernandes et al., 2013). As can be appreciated from the literature studies that a greal deal of efforts have been taken to valorize the solid waste substance within the concept of waste to best (Yao et al., 2018).

The use of a radiation shielding material, on the other hand, has been commonly favored for protecting people from the hazardous effects of irradiations in different application areas such as medical imaging, nuclear medicine, or radiotheuraphy (Kurtulus et al., 2021a) and (Akkurta and Tekin, 2020). For protecting people from the hazardous effects of radiation in different application areas, the use of a shielding material has been commonly favored [(Kurtulus et al., 2021a) and (Akkurta and Tekin, 2020)]. These materials are typically selected according to the shielding requirements such as dose rate, radiation source, size, and energy, budget, available space and so on. [(Tekin et al., 2020) and (Kavaz et al., 2020)]. This implies for example that, in applications where lower energy photons are used, shielding materials such as

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https://doi.org/10.1016/j.wasman.2022.04.033
Received 22 January 2022; Received in revised form 9 April 2022; Accepted 22 April 2022