Science Journal of Physics
ISSN: 2276-6278
http://www.sjpub.org/sjp.html
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Published By
Science Journal Publication
International Open Access Publisher

Research Article **Volume 2012 (2012), Issue 2, 4 Pages**

The effect of gamma-Irradiation on the absorption spectra and optical energy gap of selenium dioxide thin films

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Accepted 25 January, 2012

Abstract

Thin films of selenium dioxide (SeO_2) were investigated for gamma-irradiation dosimetry purpose. Samples were fabricated using cast method .Thin films of SeO_2 were exposed to a Cs-137 gamma-radiation source at a dose rate 0.56 Gy/min at room temperature .Absorption spectra for SeO_2 films were recorder and the values of the optical band and energies of localized states for no irradiated and gamma-irradiated samples were calculated. it was found that the optical band gap values were decreased as the radiation dose was increased. The observed change in the optical properties suggest that SeO_2 thin film may be considered as an effective material for room temperature real time gamma-radiation dosimetry .

Keywords: gamma-irradiation, optical energy gap, Selenium dioxide, thin film .

Introduction

Irradiation of solids with high energy radiation ,like gamma-rays, electrons or neutrons expected to affect their physical properties .Studies on the changes in optical properties of ferroelectric thin films irradiated with ionizing radiation yield valuable in formations regarding the electronic processes in these material. The radiation effects are strongly dependent on the structure of the absorbing substances. The effect of the gamma irradiation on the thin films of metal oxide and polymers have been studied to find out suitability of these thin films in post-exposure and real-time gamma radiation dosimetry[1,2].many researchers have been studied of abnormal optical properties of ultrathin from different materials[3,4,5,6].In the present contribution we have studied the effect of gamma-rays on the absorption spectra and optical energy gap of SeO_2 thin films.

Experimental

The film samples of the SeO_2 were prepared by using cast method .Selenium dioxide powders, obtained from Merck company. dissolved in dimethylformamide (D M F).The concentration of SeO_2 molecules in a solvent (10 mg/ml) , the mixture was stirred at room temperature for 2h to yield a homogeneous solution .The solution deposited on a glass substrate by casting method at room temperature. The Thickness of films was (2.5μm) measured by Micrometer model(COATING THICKNESS MEASUREMENT EQUIPMENT) from (OXFORD INSTRUMENTS) Structure of the (SeO 2) is shown in Fig. 1.

SeO_2 film were irradiated with Cs-137 gamma source with an exposure rate 0.56 Gy/min .The optical absorption spectra were recorded using a spectrophotometer mark (CE-7200). It is supplied from (CECIL),England .Which is measure for the interval wavelengths from (190-900)nm. During gamma-ray irradiation 3mm thick Plexiglas s was used with each sample in order to attain electronic equilibrium[7].

The films were exposed for different duration to achieve a series of different integrated absorbed doses from 5 KGy to 30 KGy at a rate of 0.56 Gy/min. After irradiation the samples were kept in a refrigerator to prevent thermal decay and to ready for measurements.

Result and discussion

Optical absorption measurement is a standard technique for investigating band structure and it is therefore of interest to study absorption in thin films. The absorption spectra in the lower region (IR) are useful in studying the molecular vibrations. The higher energy region (UV)can be useful to manifest the electronic state of the atoms and other important phenomena affected by irradiation[8].

The wavelength dependence 300-600 nm of the optical absorbance spectra of SeO_2 at different gamma-dose are shown in fig.2 .It is obvious from this figure ,that the increasing of gamma-dose leads to increasing in optical absorbance .the radiation effects are strongly dependent on the structure of the absorbing substances. Ionizing occurs and charged species ,both ionic and free radical , are formed. The dose-response of the optical absorbance from 300-500 nm was studied over the dose range of (5-30) KGy of gamma radiation Cs-137. Fig.3 It is clear that the absorbance increases linearly with absorbed gamma-dose up to 30 KGy, it is evident that the optical absorption spectra distribution is sensitive to the radiation influence. It is believed that ionizing radiation causes structural defects leading to their density change on the exposure to gamma –rays[9].

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The values of the optical band gap for not irradiated and gamma –irradiated films were estimated using the Mott and Davis model [10] for the direct allowed transition using the relation were is the absorption coefficient ,E_{opt} is the optical energy band gap ,hv is the energy of the incident photons and *B* is a constant .In this study ,the calculated optical band gap value for not irradiated films of SeO_2 was found to be 3.48 ev .Fig .4 demonstrates a decrease in the value of the optical energy gap for SeO_2 thin films as a result of gamma-radiation influence . the decrease in optical energy gap lead to a shift in the adage band towards the higher energy region .The influence of post –irradiation storage on the absorbance of selenium dioxide thin films was investigated .Fig.5 represent the samples were measured immediately after irradiation at 10 kGy up to 30 days ,no fading of the absorbance of the radiation induced absorption after a storage time 30 days has been noticed.

Conclusion

From the study of the absorbance as a function of wavelength for unirradiated samples as well as samples exposed to various gamma-doses ,we came out with the following conclusion:

1-the absorbance increases linearly with increasing absorbed gamma-dose .

2- the optical gap energy decreases with increasing absorbed gamma-dose .

3-no fading of the intensity of the irradiation induced absorption after storage time one month.

Upon the results obtained ,it is possible to use SeO2 thin film as a dosimeter to measure the average dose rate of gamma-rays within the range (5-30)kGy .

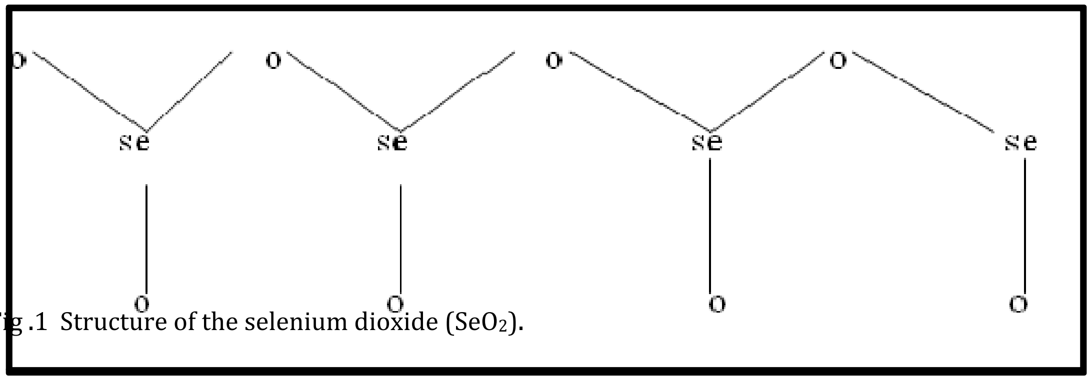

Fig .1 Structure of the selenium dioxide (SeO_2).

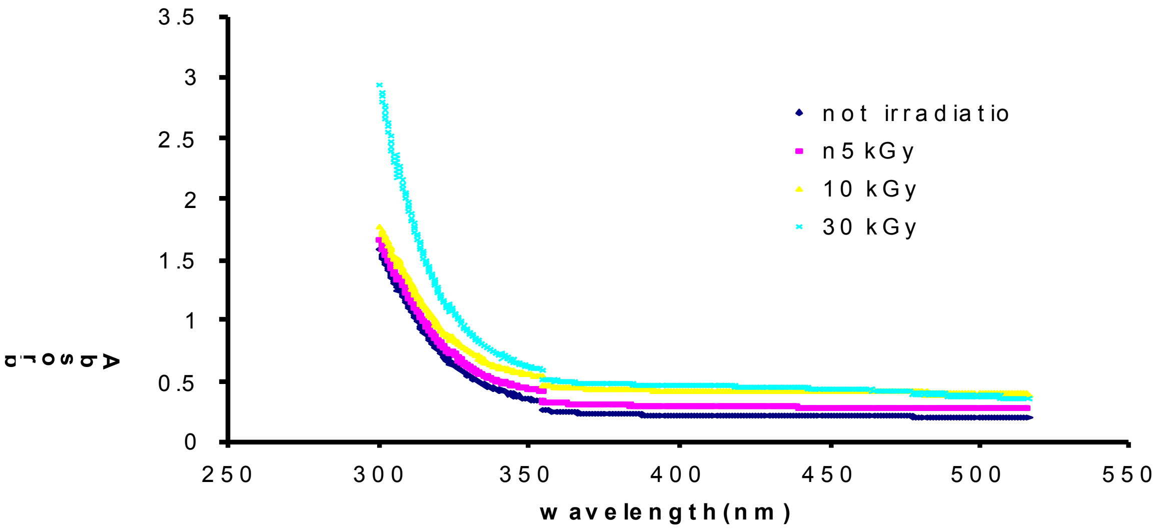

Fig.2 The absorption spectra for not irradiated and irradiated 100 nm SeO_2 thin films

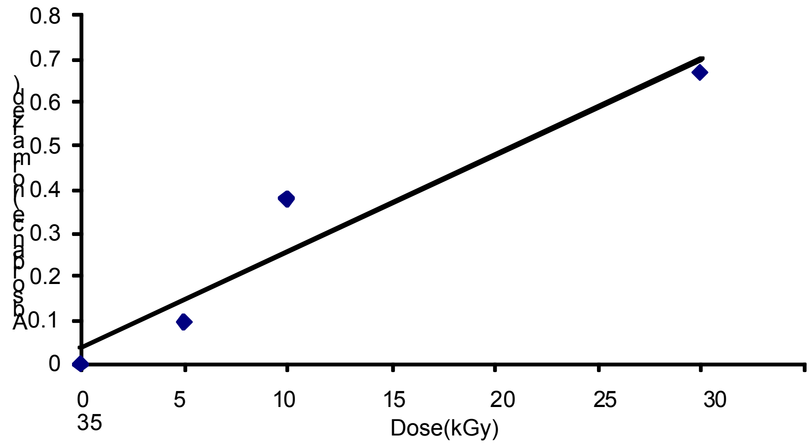

Fig 3. Dose response curve of SeO_2

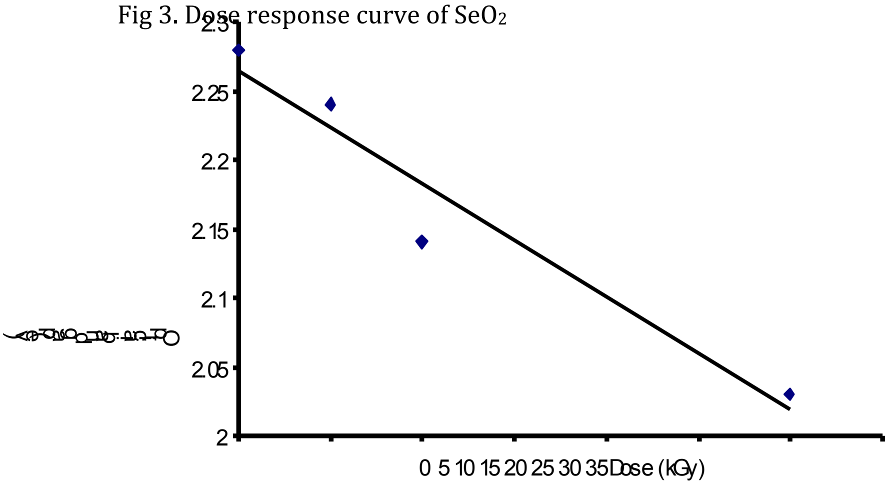

Fig 4. Decrease in the optical band gab values as a result of gamma-radiation influence.

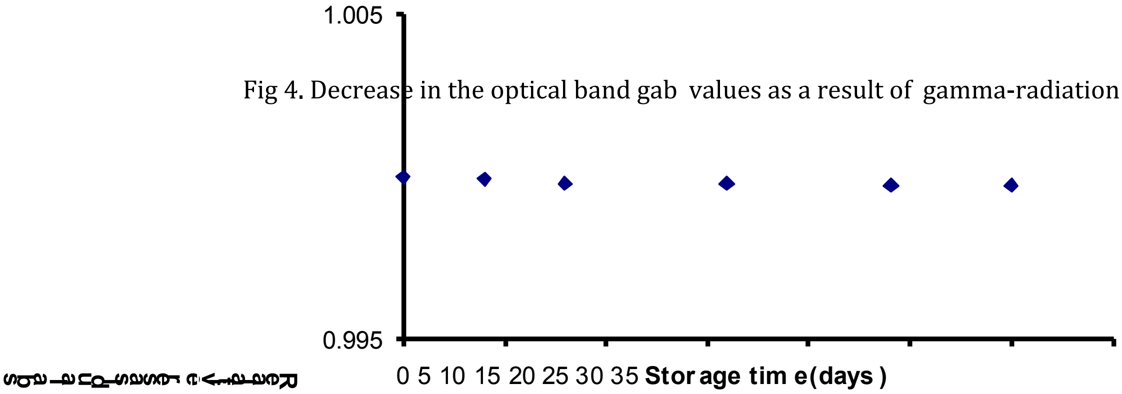

Fig 5. Absorbance fading of selenium dioxide thin films after storage time at room temperature.

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