First Latin-American Congress
on Solid State Dosimetry and Radiation Measurements
13-17 September, 2021

THE EFFECT OF γ - IRRADIATION ON OPTICAL PROPERTIES OF $Cd_{1-x}Fe_xS$ THIN FILMS

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Introduction: Ionizing radiations are employed in several fields including industry, medicine, military, particle accelerator based research, nuclear power plants, etc. It is essential that the radiation levels in these fields should be below the permissible limit and be controlled by proper dosimeters. In fact, deep understanding of the changes in the physical properties of semimagnetic semiconductors (SMSC) thin films exposed to ionizing radiations is necessary to design and develop the thin film based gamma radiation dosimeters.

This paper is aimed to report on optical properties and optical band gap changes induced by gamma irradiation of the $Cd_{1-x}Fe_xS$ (x=0.05) SMSC thin films. The evaluation is made for different γ- irradiation at doses of 10–100 kGy.

Material and method: $Cd_{1-x}Fe_xS$ (x=0.05) SMSC thin films of thickness 1.5 μm were deposited on cleaned glass substrates at the rate of υ=18-20 Å/s by a molecular beam condensation technique. All technical details of the preparation methodology were given in our earlier works.

The films were irradiated with γ-rays obtained from a ^{60}Co source of E=1.17MeV, E=1.33MeV energies.

The structure and phase purity of the as-deposited and irradiated films were checked at room temperature by means of X-ray powder diffraction (XRD) using a BRUKER XRD D8 ADVANCE.

The optical transmittance (T) of the irradiated films were measured at normal incident using a double beam spectrophotometer UV-Visible SPECORD 210 PLUS.

Results: The variation of the transmittance T(λ) versus wavelength λ, as measured at normal incidence for the as-deposited and γ-irradiated $Cd_{1-x}Fe_xS$ (x=0.05) thin films, is investigated. The samples showed a sharp transmittance drop at the fundamental absorption band edge. This sharp edge corresponds to electron excitation from the valence band to conduction band and is related to the nature and value of the optical band gap. Furthermore, the transmission spectra show a cleared-shifting the absorption region with the increase in radiation dose.The optical absorption coefficient α of as-deposited and irradiated $Cd_{1-x}Fe_xS$ (x=0.05 thin films with different doses is evaluated from the experimental data of transmittance through the film/glass layered structure. The optical band gap E_g of the thin films is determined from optical measurements. It was determined that the direct optical band gap E_g decreases as doses of γ –irradiation increase from 10 to 100 kGy.

The decrease in band gap energy with increasing dose may be attributed to increase in structural disorder and/or defects of the irradiated films. It is well known that exposure of the film to γ- irradiation induces defects, resulting in disorder in the structure of the thin film. Moreover, the decrease of E_g can also be explained by the fact that the binding energy of the Cd–S bonds (208kJ/mol) is smaller than that of the Fe–S (322kJ/mol). In consequence, it is expected that Cd–S bonds are more sensitive to γ- irradiation, accordingly, upon γ-irradiation some of the Cd–S bonds are broken. Accordingly, one can expect that defects can be formed which produce localized states that change the effective Fermi level due to an increase in carrier concentrations. This increase in carriers in localized states will lead to a decrease in the transition probabilities into the extended states, resulting in additional absorption and reduction in the gap.

Conclusions: The transmission spectra of γ-irradiated $Cd_{1-x}Fe_xS$ (x=0.05) thin films were carried out to study the effect of γ-irradiation upon optical properties and dispersion parameters. It was found that the optical properties of $Cd_{1-x}Fe_xS$ thin films were highly affected by the exposure to γ-irradiation. The optical absorption spectra showed that the absorption mechanism is a direct allowed transition. The optical energy gap increases with the increase in irradiation dose.The values of optical constants were affected obviously with the increase in irradiation dose.