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Opto-Properties of Silver Ion Induced E-CTFE copolymer

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Abstract

The silver ion induced modifications undergoing in E-CTFE copolymer films were examined with the various doses. Samples of E-CTFE were irradiated by Silver (120 MeV) ions with the fluence in the range of 1 x 10^{11}–3 x 10^{12} ions cm^{-2}in vacuum at room temperature.

Keywords:

E-CTFE;
UV-VIS;
thin films;
Swift Heavy Ion;
Irradiation.

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1. Introduction

Ion irradiation is an proved instrument for altering the chemical structure and physical properties of the polymers [1–4]. The utilization of ion beam radiation is getting high impulse because both chemical composition and the related physical properties of polymers can be altered in a controlled way by factor like the ion fluence, i.e. the number of particles bombarding a given target [5, 6]. It is the primary interaction of radiation with matter, also the fast electrons yielded by the primary particles, which is responsible for the dose being fascinated in an irradiated medium. The interactions of the secondary particles (i.e. low-energy electrons, excited and ground state neutral atoms and molecules, ions and radicals) which are produced by the fast primaries within the irradiated medium are associated to the type and quantity of damage produced for a given dose. Hence, the dose provides the energy absorbed within a given volume. Ion beam irradiation extends to hydrogen release in carbon based materials involving C–H bonds. The interaction of energetic particles with polymers and organic matter forms the foundation of a number of applications in such diverse fields as radiation chemistry [7], dielectric aging [8], lithography [9] and radiobiology [10]. Hydrogen evolution has in particular been a subject of main curiosity in the case of amorphous hydrogenated carbon films [11–14] and also of polymers [15–18] due to the eminent dependence of the properties of these resources upon hydrogen content. In polymers, molecular hydrogen release has been acknowledged as one of the major radiolysis effect under ionising radiation [19].

In the past two decades several experiments at accelerator facilities have significantly enhanced the understanding of the interaction of SHI with matter, and allow nowadays to use ion beams as a instrument for structuring materials. Irradiation of high energy SHI in polymers results to a wide variety of property modifications in the polymers. They are the outcome of irreversible alterations of the structure and chemical composition together with processes such as radical composition, main chain scission, intermolecular crosslinking, creation of unsaturated bonds and loss of volatile fragments [20]. The polymer irradiation contributes to shift in optical absorption edges, which indicates a lowering of the energy-gap. The decrease in energy band-gap entails an increase in conductivity of the irradiated polymers which might be due to the formation of conjugated double bonds or quinonic structures, or due to the formation of clusters with rings [21]. Elman studied the optical properties of the SHI irradiated polymers [22] and the changes stimulated in the optical properties of the polymer has been related with the energy deposition by the encroaching ion beam by Fink et al. [23] and by Davenas et al. [24]. Chemical effects of irradiated polymers are correlated to chain scissions and crosslinks stimulated by energy deposition, which results in the changes of the molecular weight distribution and the solubility. In particular polystyrene endures mainly crosslinking, which causes an increase of average molecular weight after irradiation. After a critical density of crosslinks is created, the solubility in a typical solvent decreases because of the formation of unsoluble or gel material [25, 26]. In general, the chemical yield G i.e. the number of crosslinks produced by the absorption of 100eV of energy; describe the efficiency of an ion beam for making crosslinking in a polymer [27].

E-CTFE is a copolymer of ethylene and chlorotrifluoroethylene., which exhibits the greater strength, stiffness, abrasion resistance. Fully fluorinated polymers such as PTFE, FEP and PFA provide more beneficial thermal and chemical resistance properties than their partially fluorinated corresponding item like ECTFE or PCTFE. All of these fluoropolymers are generally appropriate for a wide variety of industrial and commercial applications. Electrical conductivity in PI has also been reported on increasing the dose of Argon ions [28]. The present paper is about the irreversible alterations introduced in optical properties of ion induced ECTFE.

2. Experimental section

The specimens of E-CTFE, in the form of flat polished films were procured from Good Fellow Ltd. (UK) having thickness range 25μm. The films of E-CTFE were used as-received form without any further treatment in the size of 1 cm x 1 cm. The samples were mounted on the sliding ladder and irradiated with silver (120 MeV) ion beams using 15 UD pelletron facility for the general purpose scattering chamber (GPSC) under vacuum of ~10^{-6} Torr at Inter-University Accelerator Center, New Delhi, India. The ion range, electronic energy loss and nuclear energy loss of characterize silver (120MeV) ions in E-CTFE polymer is shown in table 1 [29]. The ion beam fluence was varied from 1 x 10^{11} to 3 x 10^{12} ions $cm^{-2.}$ In order to expose the whole target area, the beam was scanned in the x-y plane. The beam current was kept low to suppress thermal decomposition and was monitored intermittently with a Faraday cup. The samples were analyzed with UV-VIS spectroscopy using Lambda 35 Perkin Elmer UV-Vis spectrophotometer in the range 200-800 nm to observe the variation in optical properties of the polymer. Doses for the given fluence and different studied ion types were calculated using the formula [30] as given below.

$$\text{Dose} = 1.602 \times 10^{-10} \times \frac{1}{\rho} \times \frac{dE}{dx} \times \phi \qquad (1)$$

ϕ : Ion fluence,

ρ: Density of polymer,

$\frac{dE}{dx}$: Stopping power of ion

TABLE 1

ELECTRONIC, NUCLEAR ENERGY LOSS AND ION RANGE OF POLYMER				
Polymer	**Ion Beam**	**Ion range (μm)**	**Electronic Energy loss (eV/Å)**	**Nuclear Energy loss (eV/Å)**
ECTFE	Silver (120MeV)	27.70	1050.3	2.781 E+00

TABLE 2

DOSES FOR GIVEN FLUENCE AND ION TYPE OF STUDIED POLYMER		
Polymer	**Ion Fluence (ions/cm^2)**	Silver (120 MeV) (kGy)
E-CTFE	Pristine	0.00
	1 x10^{11}	1000.29
	3 x 10^{11}	3000.86
	6x10^{11}	6001.71
	1x10^{12}	10002.86
	3 x 10^{12}	30008.57

3. Results and discussion

Fig.1 depicts the UV-Visible spectra of pristine and silver ion irradiated E-CTFE polymer films. From ultraviolet to visible region a shift in absorption edge from is observed, the reason for this shift may be due to swift heavy ion irradiation.

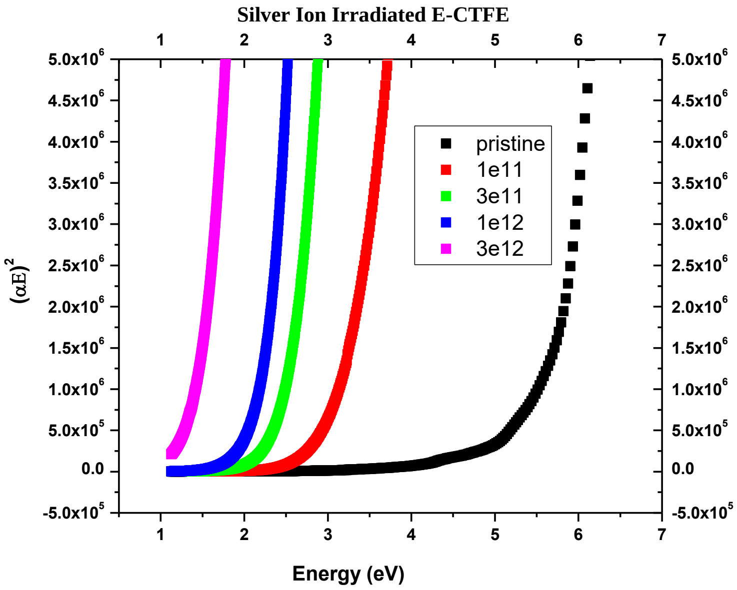

Fig 1. UV-VIS spectra of silver ion irradiated E-CTFE at varying fluence.

With increasing ion fluencies, there is observation of decreasing trend of the optical band gap in case of the silver ion beam [31].

4. Conclusion

This research paper concludes that there is optical degradation polymer E-CTFE due to silver ion irradiation. This degradation depends upon the ion fluencies.

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