Response of Resistivity of lithium ion induced Poly vinylidene chloride (PVDC)

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Abstract— *Resistivity response of lithium ion induced Poly vinylidene chloride (PVDC) was examined. Resistivity decreases with increasing frequency and also decreases due to irradiation.*

Key Words: Irradiation, Polymer, Resistivity, lithium ions, PVDC.

1. INTRODUCTION

Swift heavy ion (SHI) is the method that furnishes a general technique for the modification of physical, chemical, and mechanical properties of the polymer or the polymer composites [1,2]. Heavy -ion irradiation induces a number of chemical changes in polymers, including cross linking, chain scission, formation of alkyne groups, reduction of heteroatoms, e.g. N, S or O [4-7]. Radiation-stimulated modifications in polycarbonate have been studied extensively in the past [8-10]. Due to bombardment of energetic heavy ions on the polymers, vivid changes due to dislocation of the original chemical bonding are observed. This commotion occurs as chain scission, cross linking and carbonisation causing gas evolution. The physical and chemical changes observed in the polymer due to irradiation depend on the total amount of deposited radiation energy density and also on the rate at which this energy is transferred. Dielectric measurements are used for having the important information about the structure and dynamics of polymeric dielectric materials [11–14]. The present study is about the variation of AC electrical resistivity with frequency of lithium ion irradiated PVDC.

2. EXPERIMENTAL DETAILS

The flat polished thin films (50μm) of Poly vinylidene chloride (PVDC) were procured from Good Fellow Ltd. (England). These films were used 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. The electronic energy loss and nuclear energy loss, ion range, of characterize lithium (50 MeV) ions in PVDC polymer is as given in table 1 [15]. The ion beam fluence was varied from 1 x 10^{11} to 3 x 10^{12} ions $cm^{-2.}$ Doses (Table 2) for the given fluence were calculated using the formula [16] as given below.

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

ϕ: Ion fluence, ρ: Density of polymer, $\frac{dE}{dx}$: Stopping power of ion

Table-1: Electronic, Nuclear Energy Loss and Ion Range of PVDC

Polymer	Ion Beam	Ion range (µm)	Electronic Energy loss (eV/Å)	Nuclear Energy loss (eV/Å)
PVDC	Lithium (50MeV)	475.57	6.627	3.304 E-03

Table-2: Doses for given fluence and ion type of studied PVDC

Polymer	Ion Fluence (ions/cm^2)	Lithium (50 MeV) (kGy)
PVDC	Pristine	0.00
	1 x10^{11}	6.51
	3 x10^{11}	19.54
	6 x10^{11}	39.08
	1 x10^{12}	65.13
	3 x10^{12}	195.13

Ihe Precision impedance analyzer 6500B is used to measure variation of resistivity of pristine and irradiated samples of Poly vinylidene chloride at room temperature in the frequency range 20Hz-1MHz.

3. RESULTS AND DISCUSSION

AC electrical resistivity versus frequency is shown in Fig. 1 for pristine and irradiated (at varying fluences of 1×10^{11} to 3×10^{12}ions/cm^2) samples in the logarithmic scale. It was noticed that resistivity decreases with increasing frequency. Fig. 1 shows that the resistivity lessens further due to irradiation. Irradiation is anticipated to convert polymeric structure to a hydrogen exhausted carbon network. It is this carbon network that is supposed to make the polymer more conductive [17].

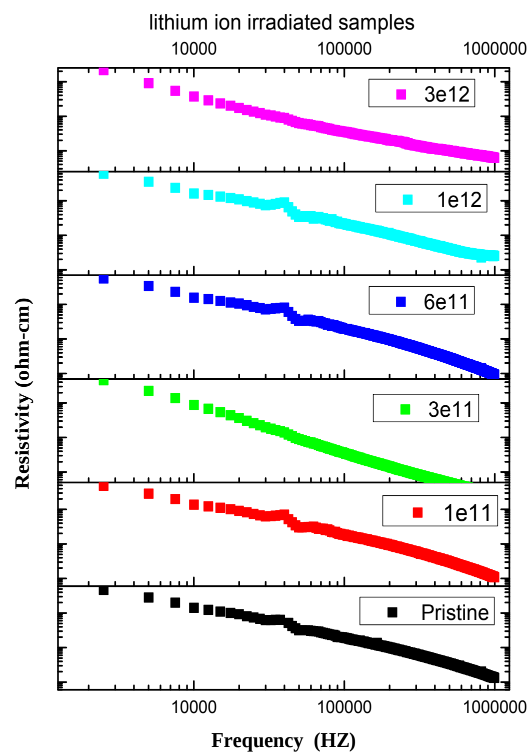

Fig. 1 AC electrical resistivity versus frequency of lithium ion irradiated PVDC at varying fluences

4. CONCLUSIONS

It was concluded that resistivity decreases with increasing frequency. Also irradiation is anticipated to convert polymeric structure to a hydrogen exhausted carbon network.

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