iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 3 **Issue:** VI **Month of publication:** June 2015

DOI:

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Dielectric Studies of Ion Induced PVDC (Poly vinylidene chloride)

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Abstract*—Dielectric properties of ion induced PVDC (Poly vinylidene chloride) were analyzed. Lithium (50 MeV), carbon (85 MeV) and nickel (120 MeV) ion beams were used to analyze the modifications induced by swift heavy ions as a function of ion fluence, ranging from $1x10^{11}$ to $3x10^{12}$ ions/cm^2. Dielectric constant (ε′) for pristine and irradiated increases with the increase in ion fluence.

Keywords*— Swift heavy ions, Dielectric constant, Irradiation, Polymer.

I. INTRODUCTION

The properties of polymers get modified due to radiation induced crosslinking and have successfully been used in industries widely. On irradiating the polymers with ionizing radiations, ions and radicals are produced [1]. The chain scission due to irradiation leads to the decrease in molecular weight of polymer due to dispersal of volatile elements (H, O and N) or groups (CH_3, CO and CO_2) from the irradiated zone. The oxidation process uses the oxygen that diffuses into the polymer during or after irradiation. Different studies of effect of ion irradiation on polymers revealed that the modifications occurred in structural and chemical properties such as main chain scission, creation of carbonaceous clusters and formation of volatile fragments [2-6] are due to high electronic energy loss of heavy ions in the target [7]. Effect of swift heavy ion irradiation on Poly vinylidene chloride (PVDC) has rarely been studied, therefore the aim of the present investigation is to study the alterations in dielectric properties of PVDC films caused by lithium (50 MeV), carbon (85 MeV) and nickel (120 MeV) ion irradiation with the help of Dielectric techniques.

II. EXPERIMENTAL DETAILS

The specimens of Poly vinylidene chloride (PVDC) in the form of flat polished thin films (50μm) were procured from Good Fellow Ltd. (England). The samples were mounted on the sliding ladder and irradiated with lithium (50 MeV), carbon (85 MeV) and nickel (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 of characterize lithium (50 MeV), carbon (85 MeV) and nickel (120 MeV) ions in PVDC polymer is ~6.96, 27.85 and 563.3 eV/Å respectively [8]. The ion beam fluence was varied from 1 x 10^{11} to 3 x 10^{12} ions cm^{-2}.The beam current was kept low to suppress thermal decomposition and was monitored intermittently with a Faraday cup. The Precision impedance analyzer 6500B is used to measure dielectric constant (ε′) of pristine and irradiated samples of poly vinylidene chloride at room temperature in the frequency range 20Hz-1MHz.

III. RESULTS AND DISCUSSION

The dielectric constant of pristine and irradiated samples of Poly vinylidene chloride (PVDC) was calculated using

Volume 3 Issue VI, June 2015
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

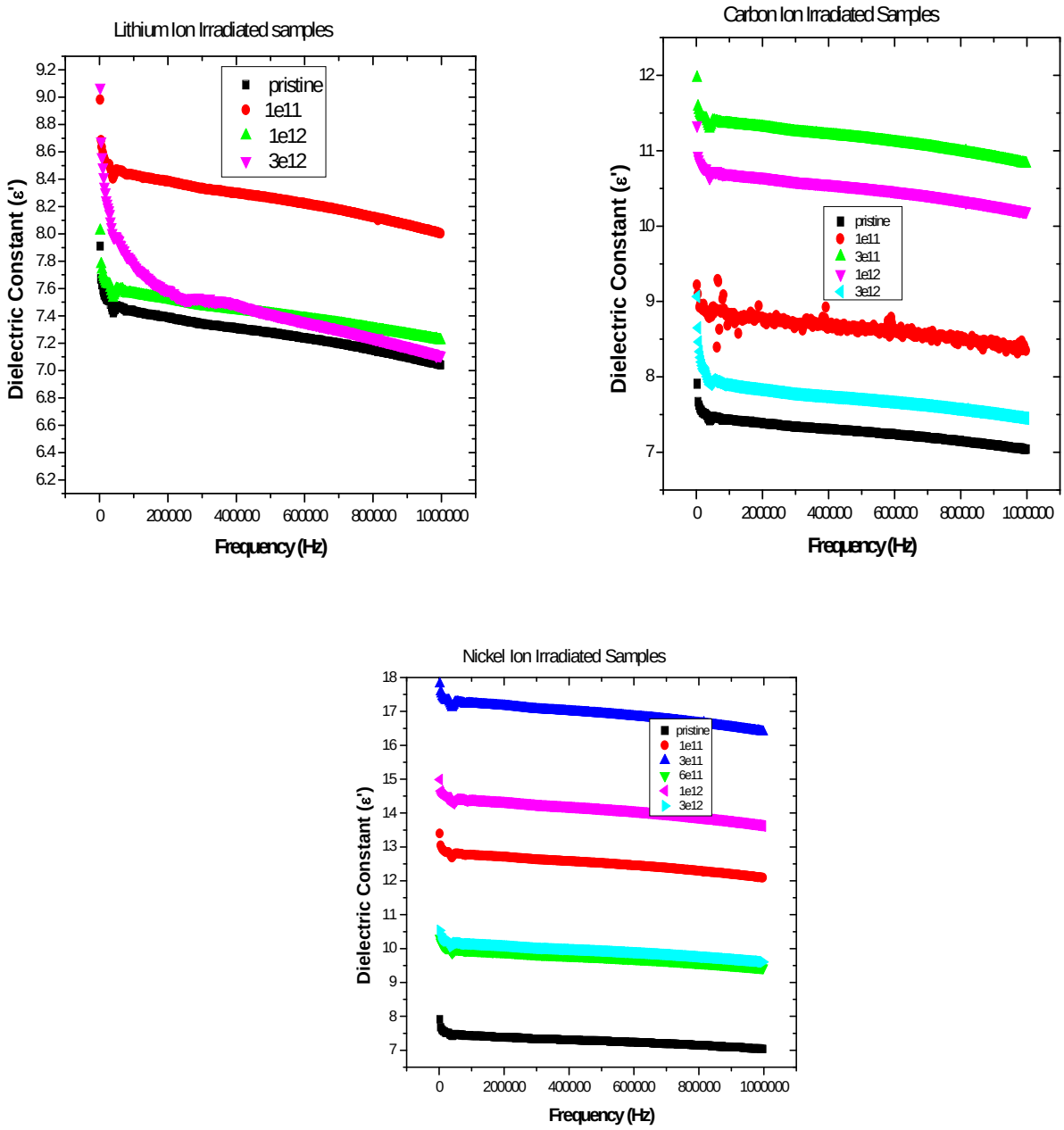

Fig. 1 Dielectric spectra of Poly vinylidene chloride (PVDC) samples irradiated with different fluences of lithium, carbon and nickel ions.

the relation $\varepsilon' = C_p/C_0$, where C_p is capacitance measured using impedance analyzer 6500B; $C_o = \varepsilon_o A/t$, where ε_o is the permittivity in vacuum. The graphs for variation of dielectric constants with frequency for pristine and irradiated samples of Poly vinylidene chloride (PVDC), irradiated with lithium ions, carbon ions and nickel ions are shown in Fig. 1. It is observed from the plots that dielectric constant (ε') decreases with increase in frequency. This may be due to the fact that the charge carriers migrate through the dielectric and get trapped against a defect site, hence opposite charge is induced, which slow down the motion of charge carriers, which in turn decreases the value of dielectric constant (ε'). It is also observed from Fig. 1 that the value of dielectric constant (ε') of irradiated samples of Poly vinylidene chloride (PVDC) is more than dielectric constant (ε') of pristine sample. This is due an

increase in number of free radicals occurred due to chain scission process [9]. The increase in dielectric constant (ε′) with increase in ion fluence contributes to the increase in rigidity of polymer due to irradiation [10].

IV. CONCLUSION

The dielectric constant (ε′) irradiated samples of Poly vinylidene chloride (PVDC) is more than the pristine sample, which contributes to the increase in rigidity of polymer.

V. ACKNOWLEDGMENT

The author wishes to thanks IUAC (Inter-University Accelerator Center), New Delhi, for providing the swift heavy ion facility. The Department of Electronics Technology, Guru Nanak Dev University, Amritsar is gratefully acknowledged for Dielectric studies.

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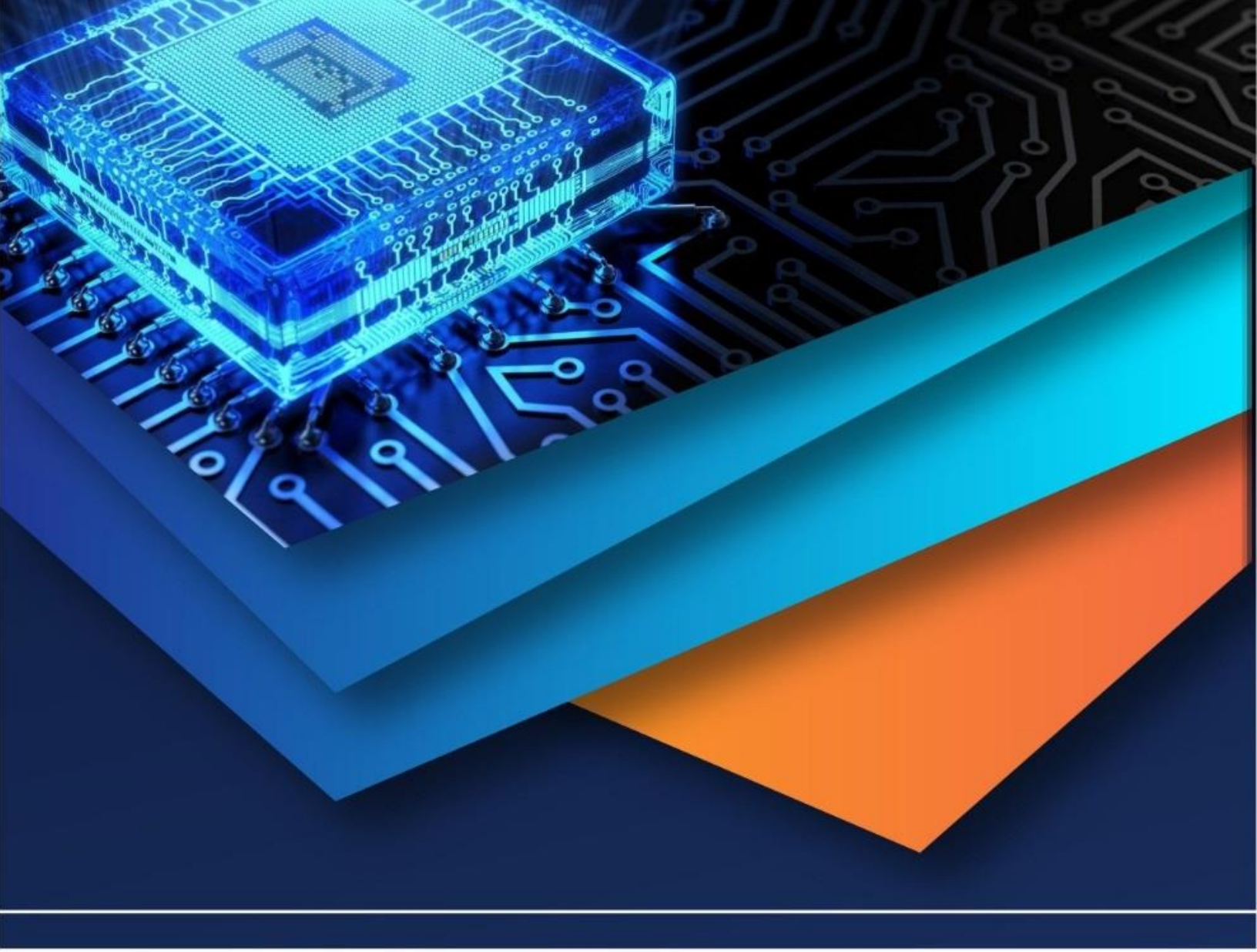

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