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Swift Heavy Ion Induced Impedance of PVDC (Poly Vinylidene Chloride)

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Abstract --*Impedance of ion induced PVDC (Poly vinylidene chloride) was 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 1×10^{11} to 3×10^{12} ions/cm². The plot of the imaginary component Z'' versus real component Z' represents the impedance data. The real and complex impedance is evaluated by Nyquist plot (Cole-Cole plot). This impedance spectroscopy technique enables the real and imaginary components and hence provides the structure-property relationship of the sample. The impedance spectrum navigates the conduction mechanism.*

Keywords: *Impedance, SHI, chain scission, Cross linking, PVDC thin films.*

I. INTRODUCTION

Swift heavy ion beams play a vital role in the field of research in material science [1, 2]. The effect of ion beam on the materials depends on the energy of ion beam, fluence and ion species. The ions lose their energy either by nuclear stopping or by electronic stopping. At low energies, the nuclear stopping is dominant and the energy lost in this process is called nuclear energy loss. The other mode of energy loss i.e. electronic stopping is dominant at high energies, where the displacement of atoms due to elastic collisions is unimportant. Swift heavy ions are the heavy ions with energies so high that the electronic energy loss process dominates. Conducting polymers have applications in electronic devices. Several groups have reported that the electrochemical polymerization of the monomer can also occur on an electrode already coated with an ordinary insulating polymer, leading to conducting composites (3-5). Another method to enhance the mechanical and physical properties of the conducting polymer is to synthesize block and graft copolymers containing conventional and conducting sequences (6-8). Our purpose in this study is to investigate the impedance of swift heavy ion induced PVDC polymer.

II. EXPERIMENTAL

Poly vinylidene chloride (PVDC) specimens in the form of flat polished thin films (50 μ m) were procured from Good Fellow Ltd. (England). The samples were irradiated with lithium (50 MeV), carbon (85 MeV), nickel (120 MeV) and silver (120 MeV) ion beams using 15 UD pelletron facility mounted on the sliding ladder for the general purpose scattering chamber (GPSC) under vacuum of $\sim 10^{-6}$ Torr at Inter-University Accelerator Center, New Delhi. The electronic energy losses and ranges, due to irradiation with lithium (50 MeV), carbon (85 MeV), nickel (120 MeV) and silver (120 MeV) ions in PVDC polymer are ~ 6.627 , 23.64 , 455.4 and 780.8 eV/ \AA and 475.57 , 222.89 , 34.57 , 25.77 μ m respectively [9]. The ion beam fluence was varied from 1×10^{11} to 3×10^{12} ions cm⁻². The impedance (Z) of pristine and irradiated samples of poly vinylidene chloride at room temperature in the frequency range 20Hz-1MHz is measured using Precision impedance analyzer 6500B.

III. RESULTS AND DISCUSSION

The impedance of samples was studied. This study enables us to separate the real and imaginary components of the complex impedance [10, 11]. Fig 1 shows the variation of real component of impedance (Z') with the log (frequency). The behavior of Z' is that, its value decreases with the increase in value of frequency. From fig.2 it

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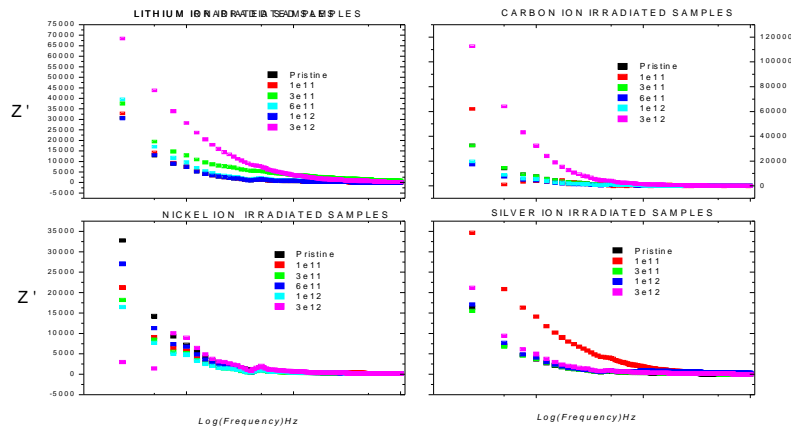


Fig. 1 Impedance spectra of PVDC samples irradiated at varying fluences of lithium, carbon, nickel and Silver ions. is quite clear that the imaginary component of impedance (Z'') also show the similar behavior. The plot of the imaginary component Z'' versus real component Z' represents the impedance data. This impedance spectroscopy technique enables the real and imaginary components and hence provides the structure-property relationship of the sample.

The real and complex impedance is evaluated by Nyquist plot (Cole-Cole plot) by using following formalism:

$$Z^*(\omega) = (Z' - jZ'') \quad (1)$$

$$\text{Where, } Z' = |Z| \cos \theta \text{ and } Z'' = |Z| \sin \theta$$

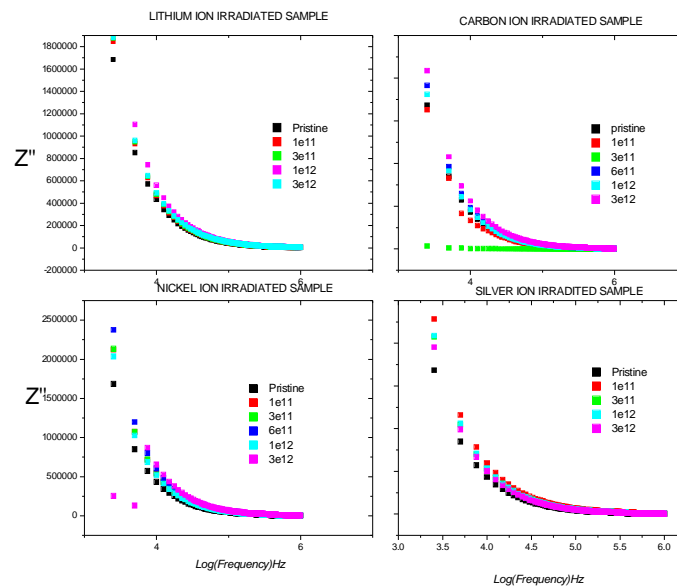


Fig. 2 Impedance spectra of PVDC samples irradiated at varying fluences of lithium, carbon, nickel and Silver ions.

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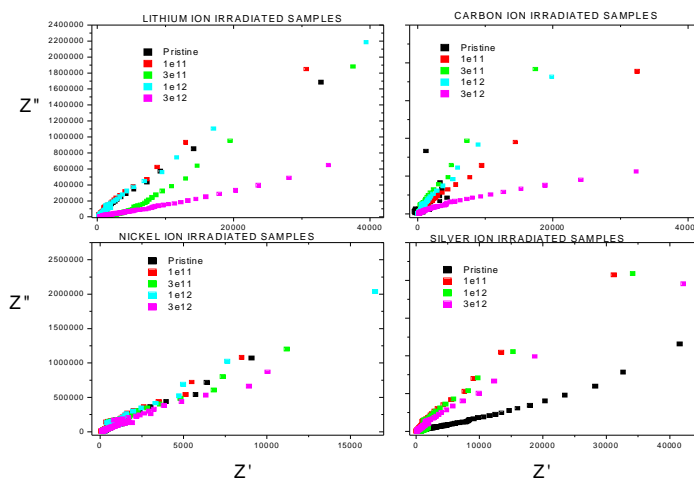


Fig. 3 The impedance spectrum (Z'' versus Z') for swift heavy ion irradiated PVDC at varying fluences of lithium, carbon, nickel and Silver ions.

The impedance spectrum (Z'' versus Z') for swift heavy ion irradiated PVDC at varying fluences is shown in Fig.3. The exact semicircular pattern was not obtained which represents the low DC conductivity of the ion induced polymer / homogeneity of the system, which agrees well with the reported one [12]. The exact semicircle might be due to ionic conduction. The intercept of the semicircle with the real axis (Z') at low frequency (end) give rise to the bulk (ionic) resistance of the material. Therefore the impedance spectrum navigates the conduction mechanism.

IV. CONCLUSION

The exact semicircular pattern of the impedance variation plot of irradiated samples of Poly vinylidene chloride (PVDC) was not obtained, which represents the low DC conductivity of the ion induced polymer / homogeneity of the system.

V. ACKNOWLEDGMENT

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