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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 $1x10^{11}$ to $3x10^{12}$ ions/cm^2. 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 (50µm) 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 ~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/Å and 475.57, 222.89, 34.57, 25.77 μ m respectively[9]. The ion beam fluence was varied from 1 x 10^{11} to 3 x 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 separates 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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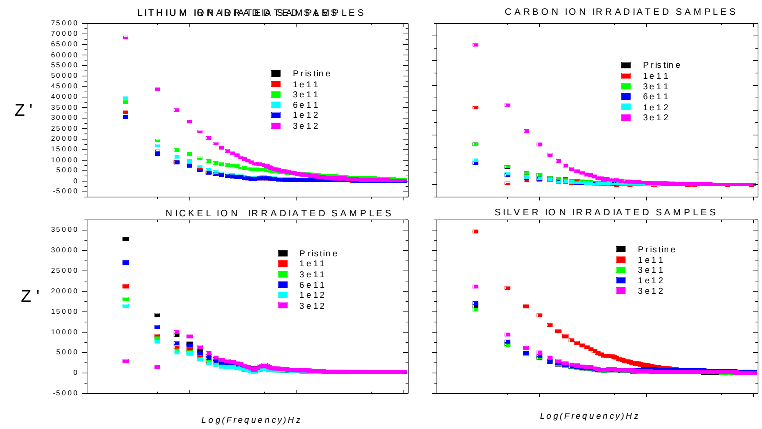

Fig. 1 Impedance spectra of PVDC samples irradiated at varying fluences of lithium, carbon, nickel and Silver ions.

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:

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

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

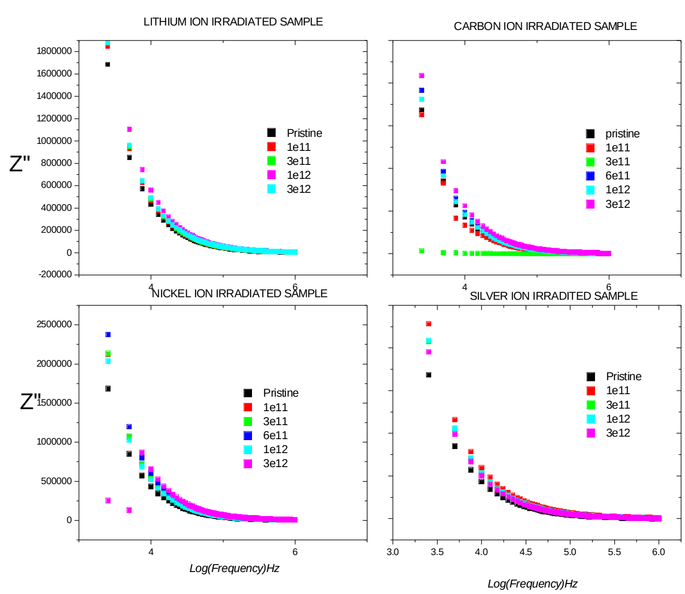

Fig. 2 Impedance spectra of PVDC samples irradiated at varying fluences of lithium, carbon, nickel and Silver ions.

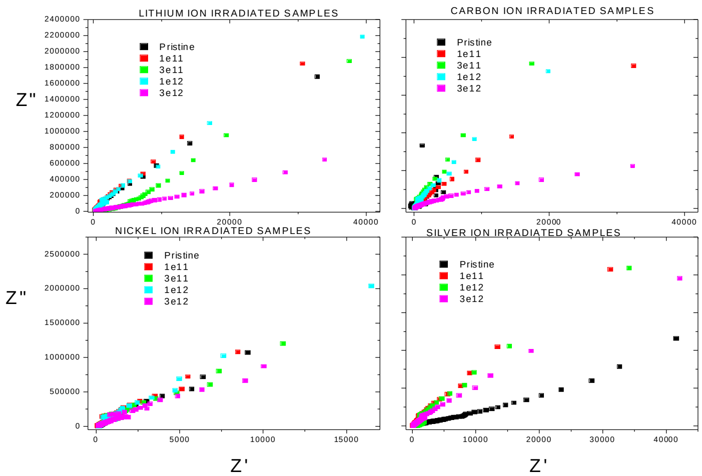

Fig. 3 The impedance spectrum (Z" versus Z') for swift heavy ion irradiated PVDC at varying fluences of lithium, carbon, nickel and Silver ions.

The impedance spectrum (Z" versus Z') for swift heavy ion irradiated PVDC at varying fluences is shown in Fig.3. **T**he 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.

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REFERENCES

[1] R. Singh, K.S. Samra, R. Kumar, and L.Singh, "Microstructural modifications in swift heavy ion irradiated PET," Radiation physics and chemistry, vol. 77, pp. 575-580, May 2008.

[2] K. Devgan, L. Singh, and K.S. Samra, "Structural Modifications of Swift Heavy Ion Irradiated PEN Probed by Optical and Thermal measurements," Radiation Physics And Chemistry, vol.88, pp. 49–55, july 2013.

[3] O. Niwa, and T. Tamamura, "Electrochemical polymerization of pyrrole on polymer-coated electrodes," Journal of Chemical Society Chemical Communication, pp. 817-818, 1984,

[4] M. De Paoli, R. J. Waltman, A. F. Diaz, and J. Bargon, "Inhibition of resonance delocalisation of charge by strong hydrogen bonding," Journal of Chemical Society Chemical Communication, pp. 1014-1015, 1984.

[5] M. De Paoli, R. J. Waltman, A. F. Diaz, and J. Borgan, "An electrically conductive plastic composite derived from polypyrrole and poly(vinyl chloride) ," Journal of Polymer Science Part A: Polymer Chemistry. Ed. 23, pp. 1687-1698, June 1985.

[6] M. L. Hallensleben, and D. Stanke, "Poly (methyl methacrylate) containing pyrrole moieties in the side chains," Macromolecular Chemistry and Physics, vol. 196, pp. 75-83, Jan.1995.

[7] D. Stanke, M. L. Hallensleben, and L. Toppare, "Electrically conductive poly (methyl methacrylate-g-pyrrole) via chemical oxidative polymerization," Synthetic. Metals, vol.55, pp. 1108 -1113, Mar 1993.

[8] D. Stanke, M. L. Hallensleben, and L. Toppare, "Graft copolymers and composites of poly(methyl methacrylate) and polypyrrole Part II," Synthetic. Metals, vol.73, pp. 261 -266, Aug. 1995.

[9] J.F. Ziegler, M.D. Ziegler, and J.P. Biersack, "SRIM – the stopping and range of ions in matter," Nuclear Instruments and Methods in Physics Research Section B, vol. 268, pp. 1818-1823. June 2010.

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[10] C. H. Song, M. Kim, S. M. Lee, H. W. Choi, and Y. S. Yang, “Impedance Analysis and Low-Frequency Dispersion Behavior of Bi4Ti3O12 Glass,” Journal of Korean Physical Society. vol. 56, pp. 462-466 Jan. 2010.

[11] S. K. Barik, R. N. P. Choudhary, and A. K. Singh, “Ac Impedance Spectroscopy And Conductivity Studies Of $Ba_{0.8}Sr_{0.2}TiO_3$ Ceramics,” Advanced Material Letters,vol.2, pp. 419-424, June 2011.

[12] F. B. Dias, S.V. Batty, J. P. Voss, G. Ungar, and P.V. Wright, “Ionic conductivity of a novel smectic polymer electrolyte,” Solid State Ionics, vol. 85, pp.43–49 June 1996.