DOSIMETRIC ASPECTS OF POLY (METHYLMETHACRYLATE), POLY (PHENYLMETHACRYLATE) AND POLY (TRIBROMOPHENYLACRYLATE) BY ESR METHOD

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ABSTRACT

Polyacrylates are important class of plastics having varieties of applications. Prominent among the polyacrylates is Poly (methylmethacrylate) (PMMA), commercially known as Perspex. PMMA is one of the heat and radiation resistant polymers. Polyacrylates have mostly amorphous glass nature; and insoluble in water. When compared to aliphatic polyacrylates, aromatic poly acrylates are also well known for their application. Among the aromatic polyacrylates Poly (phenyl methacrylate) (PPMA) and Poly (tri bromo phenyl acrylate) (PTBPA) are also have different type of applications. In this context, the authors made attempt in this sregard with ESR as experimental technique. ESR spectra of irradiated PMMA,PPMA and PTBPA copolymers have been recorded at various radiation doses .Linearity of ESR intensity against radiation dose has been verified. The results suggest that PMMA, PPMA and PTBPA are excellent materials for dosimetric applications.

Keywords: PMMA, PPMA and PTBPA homopolymers, gamma radiation, ESR spectrum, free radicals**.**

I. INTRODUCTION

Lund et al (1) have reported that the ESR technique is more popular to detect the radiation dose absorbed by the material. These authors have investigated the dosimetric aspects of different molecular system like salts, amino acids and inorganic materials. And found that they are suitable for dosimetric applications.

Whittaker et al (2) have studied the effect of dose rate, temperature time on the radiation dose response of commercial plastic Poly (methyl methacrylate) (PMMA). They have exposed the PMMA to different radiation dose at different temperatures and reported that PMMA is suitable for dosimetric applications.

Commercially available dyed PMMA is called as Sumipex. Sumipex is also found to be suitable for dosimertic aspects. The dyed PMMA is exposed Co 60 gamma source to different radiation dose change in optical absorption of 653 nm absorption band is taken as measure to investigate dosimetric aspects (3).

When Poly Vinyl chloride is exposed to proton beam irradiation, a change in optical absorption spectra has been observed changes in optical absorption bands is monitored and dosimetric aspects of PVC are investigated by Fattah et al (4). These authors have tested the dosimetric aspects in the fluence range of 10^{11}–10^{28} ion cm^{-2}. Using ESR and FTIR techniques, resultant changes have been monitored.

Poly (methylmethacrylate) (PMMA) and Poly (vinyl chloride) (PVC) are two important commercially used plastics sheets. These two polymers were taken and irradiated with gamma rays to a radiation dose of 5–45 KGy. Upon exposure to gamma irradiation, coloration of the polymers was observed. The colored samples normally give optical absorption bands around 305 nm, 314 nm in case of PMMA; while PVC exhibits optical absorption band around 396 nm. Based radiation dose response of the optical absorption bands these two polymers were formed suitable for dosimetric application. The response of PMMA dosimeter has a post irradiation stability of 15 days which for PVC, the post irradiation stability is 30 days. Further post irradiation stability of polymers is investigated in the temperature range of -10 to 55^{0}C (5).

Keeffe et al (6) have used perpex [Poly (methylmethacrylate)] plastic for dosimetric applications. The authors have used PMMA optical fibers for investigating the dosimetric aspect using optical absorption measurements. These authors have observed optical absorption bands centered around 530 nm, 570 nm, 600 nm,650 nm and 680 nm positions, The fibered have shown a linear radiation induced attenuation response. These authors have studied the efficiency of fibers in a very low dose (0-400Gy). They have also investigated post irradiation recovery of the optical fibers. These authors have chosen PMMA because it is easy to make the polymer into any desirable shape. These fibers are expected to available at low cost, having reliability, stability and suitable for on line measurements.

By measuring the length of irradiated and unirradiated fiber, these authors have calculated, radiation induced attenuation of PMMA fiber.

Adriana et al (7) have reported that FTIR spectroscopy is a tool to use Poly (vinyliedene fluoride) (PVDF) copolymer for dosimetric application. Based on intensity variation of 1854 cm^{-1}, 1754 cm^{-1} absorption bands the copolymer is found to be suitable for dosimetric applications in the radiation dose range of 100-1000 KGy. These authors have further confirmed the above results by measuring Differential Scanning Calorimetry (DSC) thermograms of polymers irradiated to different radiation dose. They have become colored due to irradiation and exhibited an optical absorption band.

Marrale et al (8) have investigated the dosimetric aspects of phenol compounds and reported that those materials are suitable for radiation dosimetry. These authors have irradiated the phenol compounds designated as Irganon to different gamma radiation doses with experimental parameters like modulation amplitude and microwave power. The observed spectra are assigned to be due to the free radicals produce on gamma irradiation of pellets. In the investigated radiation dose range of 12-60 KGy, the ESR signal intensity is found to vary linearly with the increase of radiation dose. Therefore these materials are found to fit for low dosimertic application.

Raju et al (9) have used PA6 and its copolymers for dosimetric applications. These authors have used PA6 homopolymer investigating the dosimetric aspects using gamma rays to a radiation dose of 1-4M.rad. The ESR signal intensity is found to vary linearly with the increase of radiation dose.

By looking at literature, it is observed that the polymer dosimeters are more suitable for dosimetric applications. Due to that low cost, available in nature in physicals forms like films, pellets, etc., and disposable nature, it is propose to investigate the dosimetric aspects of polymers and copolymers used in the present studies.

II. EXPERIMENTAL

Gamma irradiation of copolymer is carried out using Cobalt 60 gamma source with a dose rate of 0.15 M.rad (15KGy) in air at room temperature. The radiation dose absorbed by the copolymer is measured in terms of time of exposure of the sample. ESR spectra are recorded on VARIAN X – band spectrometer at 100 KHz modulation. Dose absorbed by the material is calibrated to the time of radiation

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III. RESULTS AND DISCUSSIONS

Effect of radiation dose on formation of free radicals has been studied by recording ESR spectra for polymer irradiated to different radiation doses, as shown in the Figures 1, 2 and 3. Curves 1, 2 and 3 represent ESR spectra of polymer irradiated to 10, 20 and 30 M rad dose of irradiation. The studies suggest that free radical formation gradually increase with dose of irradiation. They are assigned to macro radicals and free radicals arise due to the cleavage of side groups. Variation of ESR intensity against radiation dose is depicted in the form of histograms as shown in Fig 4 (PMMA), Fig 5 (PPMA) and Fig 6 (PTBPA). Linear relation is found in all the cases, suggesting that the polymers are suitable for dosimetric applications.

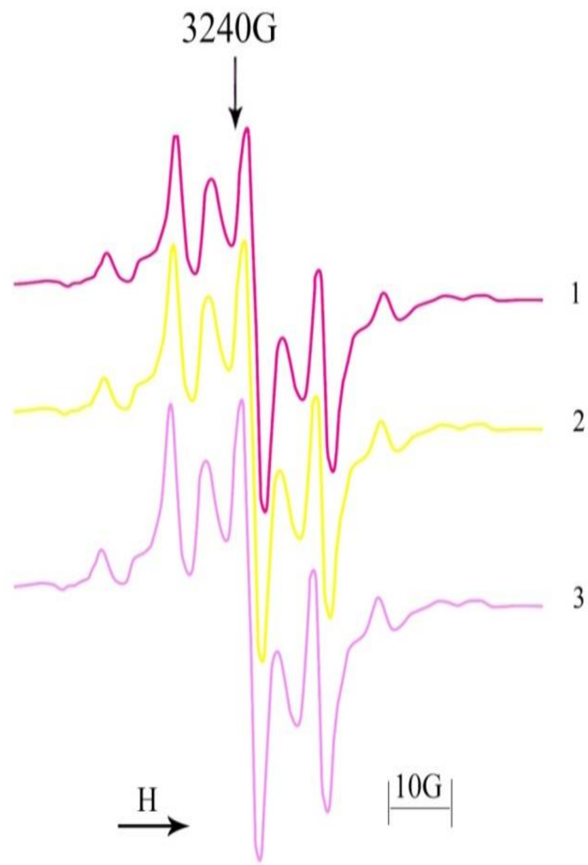

Fig 1 : ESR Spectra of irradiated PMMA at different doses

Curve 1: 10 M rad
Curve 2: 20 M rad
Curve 3: 30 M rad

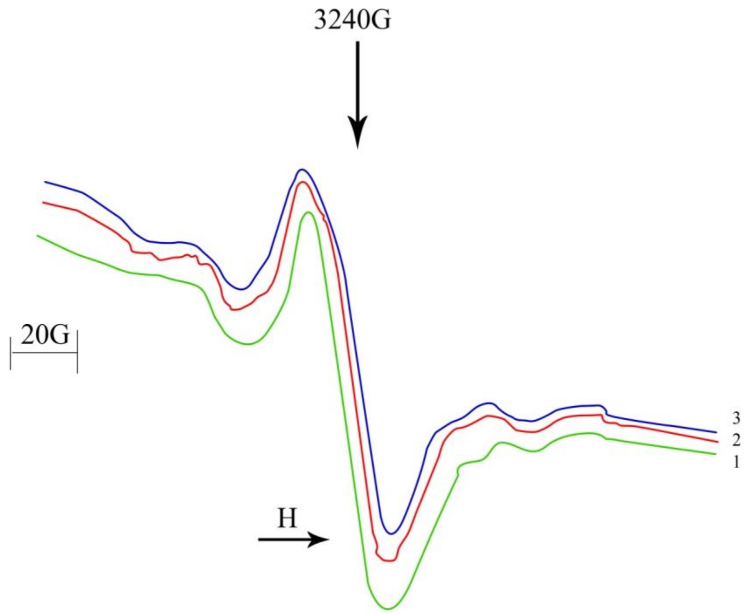

Fig 2: ESR Spectra of irradiated PPMA at different doses

Curve 1: 10 M rad Curve 2: 20 M rad Curve 3: 30 M rad

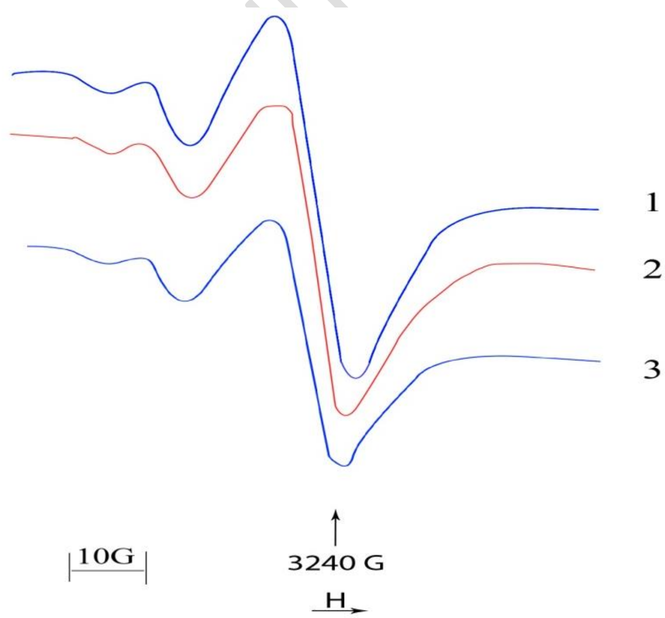

Fig 3: ESR Spectra of irradiated PTBPA at different doses

Curve 1: 10 M rad Curve 2: 20 M rad Curve 3: 30 M rad

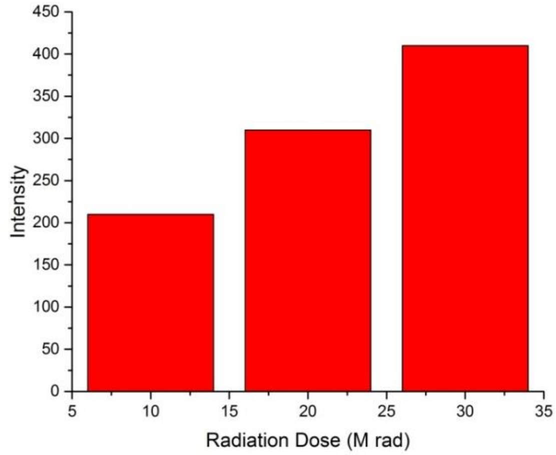

Fig 4: Variation of PMMA ESR Intensity against Radiation Dose

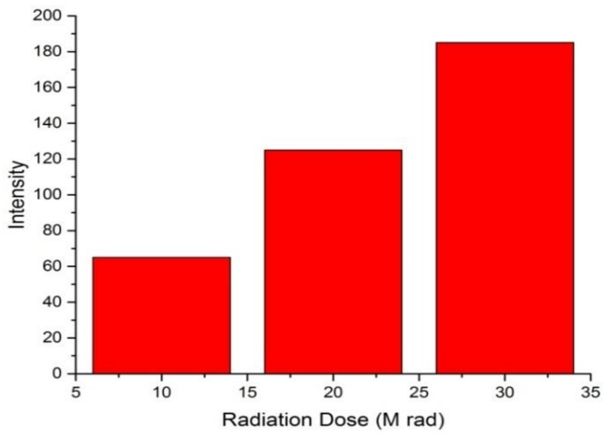

Fig 5: Variation of PPMA ESR Intensity against Radiation Dose

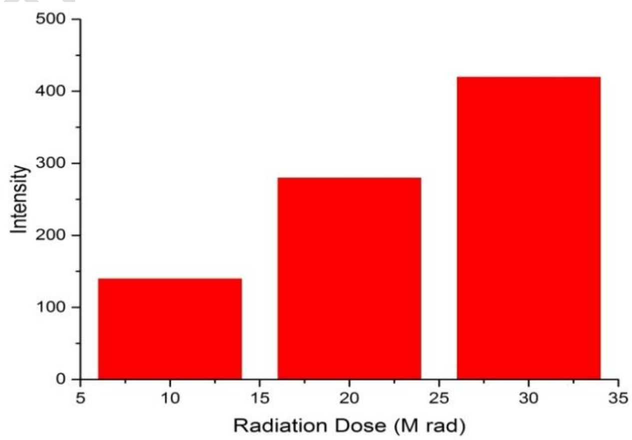

Fig 6: Variation of PTBPA ESR Intensity against Radiation Dose

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IV. CONCLUSION:

ESR studies are used to probe dosimetric aspects of PMMA, PPMA and PTBPA. The studies reveal that the polymers used in the present studies are suited for dosimertic applications within the given radiation dose ranges. The ESR intensity variation at different radiation doses also suggest that the PMMA, PPMA and PTBPA dosimeters have thermal stability also.

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