



FTIR ANALYSIS OF UNIRRADIATED AND IRRADIATED AAAMPS COPOLYMER

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ABSTRACT

Fourier transform infrared (FTIR) technique has been used to characterize chemical changes induced by gamma irradiation of acrylamide (AA)-2-acrylamide-2-methyl propane sulfonic acid (AMPS) (AAAMPS) copolymer. FTIR spectra observed for unirradiated AAAMPS copolymer has shown characteristic absorption bands at 3450, 2930, 1720, 1620, 1450, 1370, 1250, 1080 cm^{-1} positions, which characterize both AA and AMPS monomers. While on irradiation some of the absorption bands are found prone to gamma irradiation. Among them 3450, 1720, 1620 and 1050 cm^{-1} absorption bands are more prominent. As these bands represent sulfonic acid, ester carbonyl and amide carbonyl groups cleavage of these groups is anticipated on irradiation of the copolymer.

Key words: AAAMPS copolymer, FTIR technique, gamma irradiation.

INTRODUCTION

Fourier transform infrared spectroscopy is one of the important experimental technique in material analysis and characterization^{1,2}. The technique is used to study the synthesis of polymers or polymer blends³ and polymer degradation⁴. In this article, the authors attempt to study the gamma irradiation effects of AAAMPS copolymer using FTIR technique. Copolymer formation has been confirmed by comparing the FTIR absorption spectra of homopolymers with that of copolymer. A comparison has also been made between the unirradiated and irradiated copolymer.

EXPERIMENTAL

AAAMPS copolymer in the form of powder has been used in the present studies. Synthesis and characterization of AMPS copolymers has been reported by Rao and Prasad⁵. In order to ascertain the formation of copolymer, FTIR spectra of AA homopolymer and

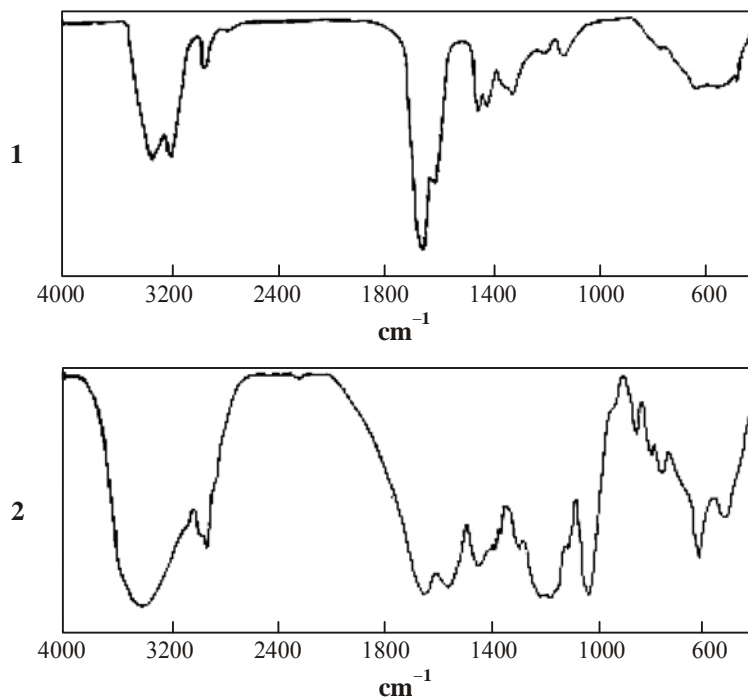
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AMPS homopolymer has been recorded. Gamma irradiation has been made using Cobalt 60 source is having a dose rate of 0.15 Mrad/hr in air at room temperature. FTIR spectra have been recorded on a Perkin Elmer spectrometer. For this purpose the copolymer made into pellet along with potassium bromide (KBr) few milligrams of copolymer is mixed KBr and made into pellet form having thickness of 1-2 mm.

RESULTS AND DISCUSSION

Fourier transform infrared (FTIR) spectra of unirradiated AAAMPS copolymer is shown as curve 3 (Fig. 1). To confirm the formation of copolymer, the FTIR spectra of AA copolymer (curve 1, Fig 1) and AMPS copolymer (curve 2 Fig. 1) are also recorded.

A comparison of the spectra confirm the formation of copolymer, as the spectra of copolymer possess characteristic absorption bands of both AA copolymer (1660, 2980 absorption bands) as well as absorption bands of AMPS homopolymer (3450, 1720, 1050, 1250 cm^{-1} bands). The results are summarized in Table 1. Table 1 shows the characteristic absorption bands corresponding to various chemical groups present in both the monomers. Correspondingly the FTIR spectra of copolymer possess the absorption bands as given in Table 2. Their assignment is also given in Table 2.



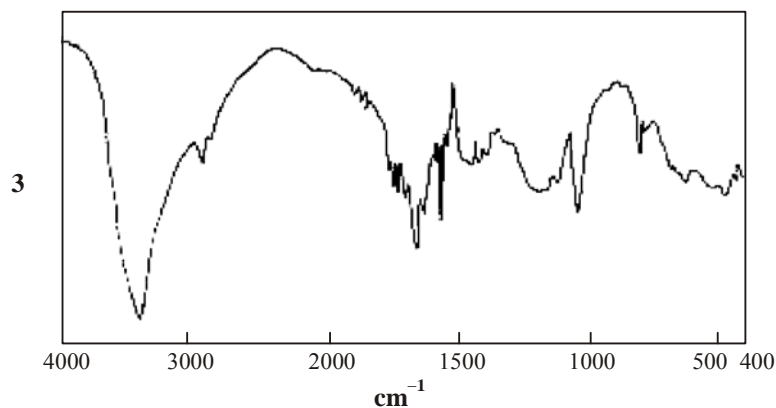


Fig. 1: FTIR spectra of AA, AMPS homopolymers and AAAMPS copolymer

Curve 1: Spectrum of AA homopolymer;

Curve 2: Spectrum of AMPS copolymer

Curve 3: Spectrum of AAAMPS copolymer

Table 1: Band position variation of some fundamental groups present in AAAMPS copolymer

S. No.	Groups		Absorption bands cm^{-1}
I	SO_3H	Sulfonic acid group	a). 3700-3110 \rightarrow 3650-3000 b). 1290-1060 \rightarrow 1290-1130 c). 1090-950 \rightarrow 1070-977 d). 670-600 \rightarrow 633
II	CONH_2	Amide carbonyl	a). 3700-3110 \rightarrow 3650-3000 b). 1735 \rightarrow 1710 c). 1700 \rightarrow 1690 d). 1670 \rightarrow 1655 e). 1640 \rightarrow 1620
III	CONHR		a). 3700-3110 \rightarrow 3650-3000 b). 1735 \rightarrow 1710 c). 1700 \rightarrow 1690 d). 1570 \rightarrow 1555
IV	CH_3 & CH_3 - CH-CH_3		a). 2933 b). 1450-1370 \rightarrow 1450-1377
V	CH_2	Methyl/methyl	2933
VI	CH		2933/1250/1050

FTIR spectra of gamma irradiated AAAMPS copolymer is as shown in Fig 2. The figure indicates a reduction in intensity of some of the absorption bands. Among them 3450, 1720 and 1620 cm^{-1} absorption bands are more prominent. As the 3450 cm^{-1} absorption band is assigned the OH groups of sulfonic acid groups, cleavage of these groups is proposed. The 1720 cm^{-1} absorption band is also found to radiation dependent. As this band is interpreted due to ester carbonyl groups cleavage of C=O groups is also proposed. Therefore random chain scission of AMPS part of the copolymer might have taken place on gamma irradiation.

Table 2: FTIR absorption bands observed in AAAMPS copolymer

Band position in cm^{-1}	Intensity	Interpretation
3700-3110	S	I,II,III
3000-2900	M	IV,V,VI
2933	M	IV,V,VI
2866	M	IV,V,VI
1770-1700	W	II,III,VII
1666	S	II,III
1640	S	II,III
1570	S	III
1566	M	III
1544	M	III
1500	VW	-
1450-1370	S	IV,V,VI
1290-1066	S	I
1060-950	S	I
670-600	S	I

S- Strong, M- Medium, VW-Very Weak

In addition to this, the 1620 cm^{-1} absorption band intensity also reduced on gamma irradiation. As this group characterizes amide carbonyl group (CONH), cleavage of these groups is also proposed. Therefore radiation might also be effected the AA part of the copolymer. FTIR of irradiated copolymer is as listed in Table 3.

Therefore gamma irradiation of AAAMPS copolymer results in random chain scission forming the macroradicals, which was confirmed by ESR studies^{6,7}. Similarly FTIR spectra of AAAMPS copolymer irradiated to 3 Mrad radiation dose is shown as curve 2 Fig. 2. A comparison in FTIR absorption band for AAAMPS copolymer irradiated to different doses is as shown in Table 3.

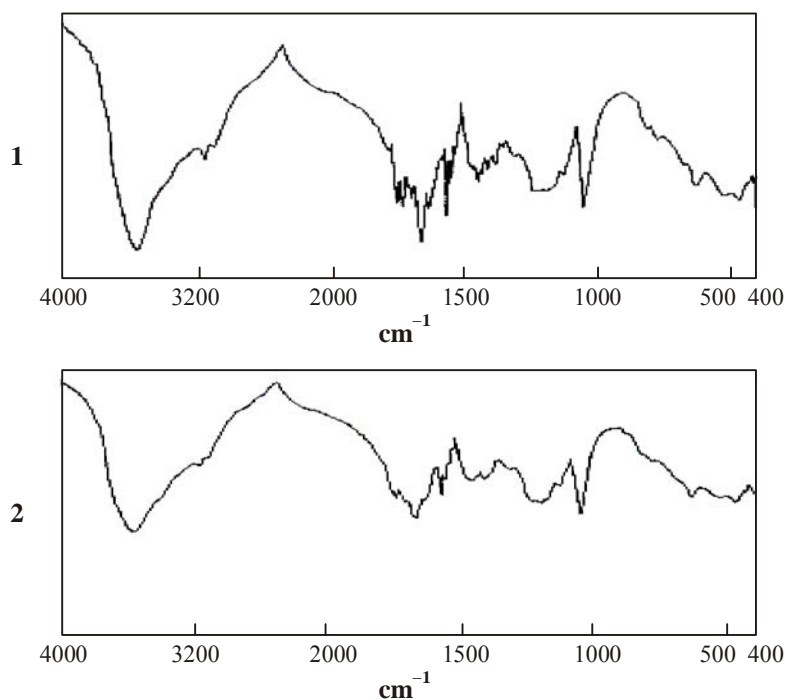


Fig. 2: FTIR spectra of AAAMPS copolymer irradiated to various doses

Curve 1: Spectrum of AAMPS copolymer irradiated to 1 M rad

Curve 2: Spectrum of AAMPS copolymer irradiated to 3 M rad

Table 3: Band position of irradiated AAAMPS copolymer 1 Mrad and 3 Mrad and their interpretation

1 Mrad			3 Mrad		
Band position cm ⁻¹	Intensity	Interpretation	Band position cm ⁻¹	Intensity	Interpretation
3700-3100	S	I,II,III	3650-3000	S	I,II,III
2933	M	IV,V,VI	2933	W	IV,V,VI

Cont...

1 Mrad			3 Mrad		
Band position cm ⁻¹	Intensity	Interpretation	Band position cm ⁻¹	Intensity	Interpretation
1740-1690	M	II,III,VII	1740-1690	W	II,III,VII
1655	S	III	1655	W	III
1633	W	III	1622	VW	III
1555	W	II,III	1555	VW	III
1538	W	III	1544	VW	III
1522	W	III	1524	W	III
1450-1427	S	IV,VI	1450-1422	M	IV,VI
1400-1377	S	VI	1400-1366	M	IV,VI
1288-1066	S	I	1289-1133	S	I
1066-955	S	I	1072-970	M	I
640	S	I	633	W	I

CONCLUSION

In conclusion, FTIR spectra of unirradiated AAAMPS copolymer possess characteristic absorption bands of both AA and AMPS homopolymers, confirming the formation of copolymer. FTIR spectra of gamma irradiated AAAMPS indicate the cleavage of groups on both AA and AMPS parts of the copolymer, indicating that the copolymer undergo random chain scission on irradiation. Formation of macroradicals is also anticipated.

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