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Vibrational Analysis of Modified and Unmodified Polystyrene

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Abstract

Radiation induced modified polystyrene(PS) has been investigated by vibrational (Fourier transform infrared) spectroscopy. FTIR spectrum of unmodified PS has shown absorption bands around 3050cm^{-1},2550 cm^{-1},1245cm^{-1},1580 cm^{-1},1465cm^{-1},1370 cm^{-1},1060cm^{-1},1028 cm^{-1},751 cm^{-1} positions. On irradiation a change in intensity of the absorption bands is observed together with a band shift Reasons for these changes are explained based on chemical changes induced by gamma irradiation.

Key words: PS(polystyrene), FTIR (Fourier transform infrared) spectroscopy, Gamma irradiation

Introduction

Vibrational spectroscopy (Fourier transform infrared) is one of the important tools to detect chemical changes induced by different modes(1,2). PS is one of the important industrial polymer used as various appliances. During its use the polymer is being exposed to different types of radiation. Therefore effect of gamma irradiation on PS is investigated using vibrational spectroscopy. In this context the authors made an attempt in this regard to probe PS modified by gamma irradiation.

Experimental

Polystyrene in the form of granules is of commercial origin. It is dissolved in tolune and thin film of PS with different thickness are prepared by slow evaporation of concentrated solutions of PS. Gamma irradiation are carried out using Cobalt 60 γ-radiation source at a dose rate of 15kGy/hr in air at room temperature, the dose administered to the sample is controlled by time of exposure of sample to radiation. FTIR spectra are recorded on PERKIN Elmer model spectrometer for thin films of PS.

Results and Discussion

Fourier transform infrared spectrum of unmodified PS is as shown in Fig1. The spectrum posses various absorption bands as given in Table1.

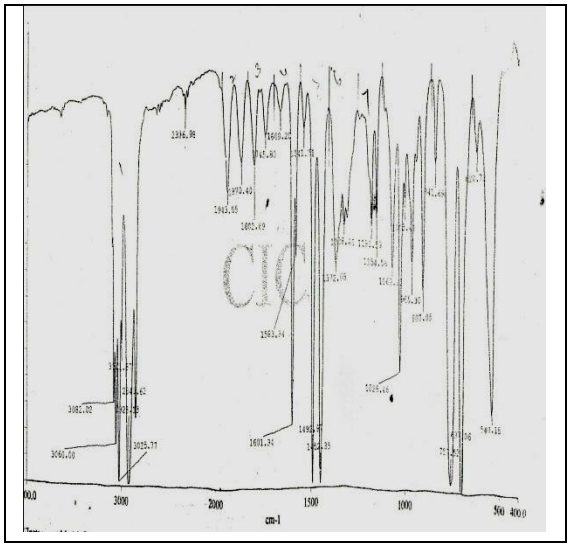

Fig 1. FTIR spectrum of PS

S No	Wave length	Intensity
1	3084 3025	strong
2	2841	medium
3	1941	medium
4	1807	medium
5	1745 1660	medium
6	1582	strong
7	1501	strong
8	1495	strong
9	1462	strong
10	1372	medium
11	1181	weak
12	1060	strong
13	1028	strong
14	907	Medium
15	751	strong

Table-1. FTIR absorption bands observed for Unmodified of PS

These absorption bands are assigned (3) to various chemical moities as given in Table2. FTIR spectrum of modified PS is as shown in Fig2.

S No	Absorption band position	Functional group
1	1640-1570 1530-1450 1190-1140 1100-1070 1060-1030 750-60	Meta/phenyl group
2	2930-2820	CH_2/CH_3 group
3	1250-1350	CH,CH_2 group

Table2. Functional group analysis of PS

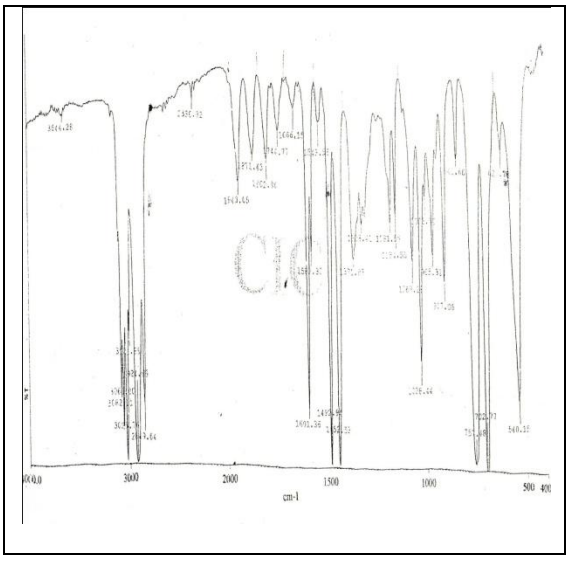

Fig2. FTIR spectrum of PS modified by gamma irradiation

Some of the absorption bands are found to shift while intensity in some of the absorption bands is observed. On gamma irradiation the following changes in FTIR spectra have been observed

1. No change in intensity of 1640,1530,1190cm^{-1} absorption bands indicating the aromatic groups are not effected by irradiation.

2. A reduction in intensity of 2830cm^{-1},1250cm^{-1} absorption bands is observed. This indicate cleavage of CH_2/CH groups are influenced by irradiation.

Considering the chemical structure of PS the chain cleavage do not occur on pendent aromatic groups, instead the chain cleavage occur at the methyne group of polymer. The result is inconsistent with ESR spectra observed by various authors(4,5) who proposed the chain cleavage occurs at the protonic position of PS main chain forming ~CH_2-Ċ(C_6H_5)-CH_2~ (I) radicals.

Formation of such type of free radicals(I) will make the polymer to undergo cross linking type reaction rather than degradation. In an cross linked form the mechanical strength of PS will improve making it to suitable for high stress applications.

Conclusion

In conclusion modification of PS by gamma irradiation leads to the formation of radical(I). In the event of I, the PS preferably undergo cross linking reactions. The PS in its cross linked form have more mechanical properties making it suitable for high stress applications.

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