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# FTIR STUDY FOR STRUCTURAL PATTERN CHANGES DUE TO IRRADIATION IN PE-PP BLOCK COPOLYMER

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**Abstract-** In the present investigation, the FTIR has been used as a structural pattern recognition tool to study the effect of gamma irradiation on the PE-PP block copolymer. The polymer has been subjected to gamma irradiation from 100 to 500 Mrad dosages. Characterization of the polymer using XRD and FTIR was done both before irradiation and after irradiation in each step. FTIR study shows that the sample loses C – C stretching mode of vibration and gains C=C stretching mode of vibration after irradiation.
**Key words** - FTIR, Gamma irradiation, PE-PP block copolymer, Structural pattern recognition.

## Introduction
Fourier transform infra-red spectroscopy (FTIR) is one of the important experimental tools that are available for the structural pattern recognition study of molecules. In this technique, digital signatures of the presence of different types of chemical bonds are obtained by looking at the IR frequency modes arising due to different stretching modes of chemical bonds.
FTIR spectroscopy is a measurement technique that allows one to record infrared spectra. Infrared light is guided through an interferometer present in the instrument and then through the sample (or vice versa). A moving mirror inside the apparatus alters the distribution of infrared light that passes through the interferometer. The signal is recorded directly and is called an 'interferogram'. It represents light output as a function of the mirror position. A data-processing method called 'Fourier transform technique' turns this raw data into the desired result, which comes out as a spectrum with light output as a function of infrared wavelength (or wave number). The sample's spectrum is always compared to a reference [1].
Looking at the wave numbers at which peaks are observed in the spectrum, one gets information about the presence of particular mode of vibration associated with the respective bond.

## Study of Polymers
### *Importance of study*
Polymer has become an important component in the modern electrical, electronic and mechanical industry. Many modern machines and electronic components have polymers as one of the ingredient. Employing polymers in designing machines and electronic components has resulted in lowering the weight of those items and also the cost of their production [2].
But it is better to take care while using such machines and electronic components made of polymers in presence of radiations. It is because; radiations induce several changes inside the polymer matrix [3,4]. Radiation causes scission of chains, cross-linking and bring in several modifications in the structural parameters of the polymers. During the early part of research on polymers itself [5] it has been found that radiation can even change the crystallinity of the semi-crystalline polymer and thus strongly affect the physical, chemical, electrical and mechanical properties of the polymer.
Thus, study of polymers giving radiation treatment has a greater importance [6-8]. It gives us an idea of the changes that take place in the polymer matrix due to irradiation, looking at which one can decide whether to use them in the radiation environment or not and also one gets an idea of the threshold level of radiation up to which the polymer and hence the machines and electronic goods that are made of those polymers will survive [9]. Radiation is found to induce solid state polymerization in several cyclic oligomers of formaldehyde [10,11].

### *PE-PP block copolymer*
The potential use of block copolymers in emerging technologies like nano technology and nano lithography are enormous. In the present investigation we have selected PE-PP block copolymer because of its potential use in making several products used for medical applications such as fabrication of medical disposables such as syringes, catheters and dialysis units. These

items are usually sterilized using radiation treatment before usage. PE-PP block copolymer also finds application in injection moulding of parts of automobiles [12,13]. Thus investigation on finding the effect of gamma irradiation on the PE-PP block copolymer is highly significant.

## Experimental

### *Irradiation*

Gamma irradiation of the sample was done using Cobalt-60 source at Indira Gandhi Centre for Atomic Research, Kalpakkam. Irradiation was done for dosages of 100Mrad, 200 Mrad, 300 Mrad, 400 Mrad and 500 Mrad with irradiation dose rate of 0.25 Mrad/hr.

### *FTIR measurements*

The infrared spectra of polymer compounds were recorded in the range of 4000 - 400 $cm^{-1}$ using FTIR, JASCO 460 Plus spectrophotometer in the Department of Studies in Geology, Manasagangotri, Mysore. The sample holder of the instrument has provision for the measurement of blank KBr as well as for the sample. The sample is prepared by mixing thoroughly KBr with the sample whose FTIR is to be recorded in the ratio of 100: 3. The background measurements were recorded for blank KBr before measuring the sample. The programme of the instrument has provision for automatic correction for background in the sample measurements

## Results and Discussion

In order to know the functional group of the compound and to look at the various modes of stretching, the FTIR spectrum was recorded for each sample. All the spectra thus recorded for un irradiated and irradiated samples have been shown in Figs. 1 to 6. They clearly show the changes induced due to irradiation. We can observe the absence of a peak and onset of a new peak in the spectra after irradiation. Observations made from the FTIR data are tabulated in Table I.

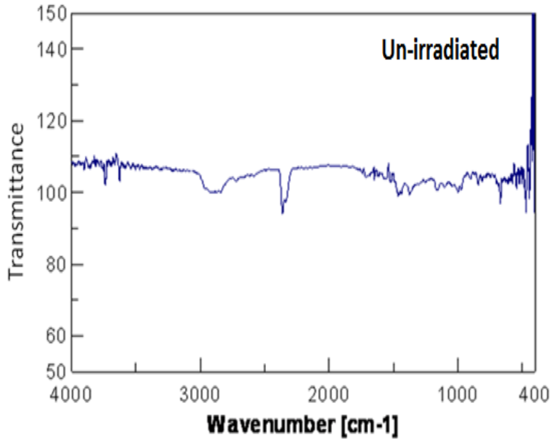


Fig. 1. FTIR spectrum for the un irradiated sample

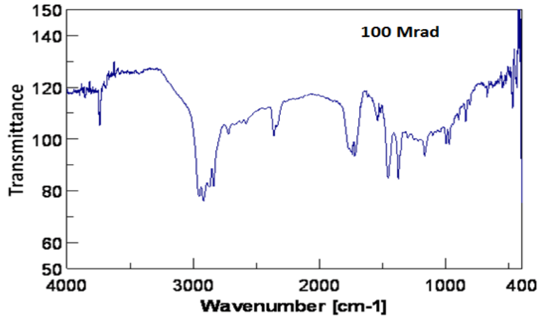


Fig. 2. FTIR spectrum for the sample irradiated with a dosage of 100 Mrad

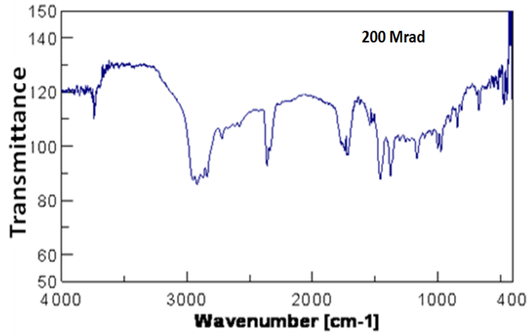


Fig. 3. FTIR spectrum for the sample irradiated with a dosage of 200 Mrad

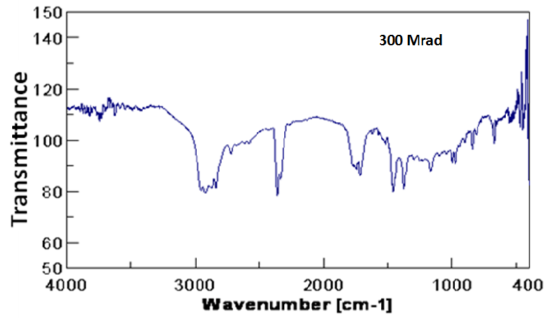


Fig. 4. FTIR spectrum for the sample irradiated with a dosage of 300 Mrad

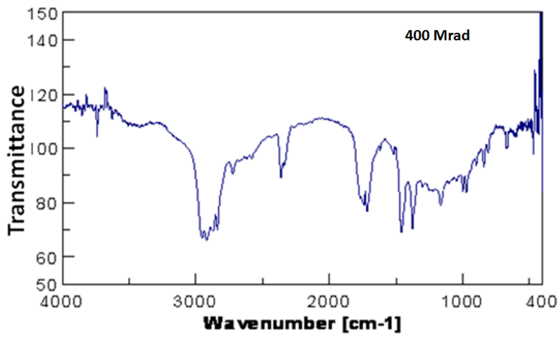


Fig. 5. FTIR spectrum for the sample irradiated with a dosage of 400 Mrad

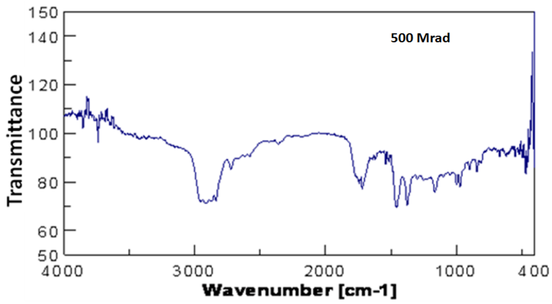


Fig. 6. FTIR spectrum for the sample irradiated with a dosage of 500 Mrad

TABLE I- Different modes of stretching in the sample as observed from FTIR data

| Mode of vibration | Un-irradiated sample | Irradiated sample | Wave number ($cm^{-1}$) |
|---|---|---|---|
| C-H stretching | Present | Present | 2972-2860 |
| $CH_3$ symmetric bending | Present | Present | 1370 |
| $CH_3$ asymmetric bending | Present | Present | 1462 |
| C-H out of plane bending | Present | Present | 980-960 |
| C-C stretching | Present | Absent | 2362 |
| C=C stretching | Absent | Present | 1675 |

Based on FTIR studies, it can be seen that as the dosage level increases, the sample loses C–C stretching mode of vibration (2362 $cm^{-1}$) and gains C=C stretching mode of vibration (1675 $cm^{-1}$) after irradiation. Authors have also carried out dc electrical conductivity measurement and X-ray diffraction studies of the un irradiated and irradiated samples and have reported the results [14,15]. From those studies it has been observed that the percentage of crystallinity of the sample decreases as a function of radiation dosage. The dc electrical conductivity increases as a function of radiation dosage [16,17]. Increase in electrical conductivity shows the formation of free radicals due to gamma irradiation [18]. The side chains which would cause for the decrease in the value of electrical conductivity are broken due to irradiation and thus resulting in the increase of the value of electrical conductivity. Though the electrical conductivity increases in the material, it undergoes degradation and shows brittleness due to irradiation. Hence it is suggested to take more care while using the products made of this material in the radiation environment.

## Conclusion

FTIR study shows that the sample loses C – C stretching mode of vibration and gains C=C stretching mode of vibration after irradiation. Also, conjugated double bonds and free radicals are formed due to the degradation of the sample due to irradiation. Same has been confirmed by XRD and electrical conductivity measurements.

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