

## **An Investigation to probe Radiation effects in Polymers**

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### **Abstract**

Degradation and stabilization of some polymers has been investigated by electron spin resonance (ESR) spectroscopy and FTIR (Fourier transform infrared) spectroscopy technique. As an example polypropylene powder has been irradiated with gamma ray and radiation effects has been investigated by recording ESR spectra. PP is mixed with stabilizer and resultant samples have also been irradiated with gamma rays and ESR spectra are also recorded. Reduction in intensity of ESR spectra suggest the stabilization effect of stabilizers degradation effects are evidenced in FTIR spectra.

Key words: Degradation, ESR, FTIR, Free radical, stabilization, gamma irradiation

### **Introduction**

Polymer and plastics are used in different purposes of our daily life. Synthesis of new polymer is always a continuous process to suit various applications. On par with growth of new type of polymer synthesis, degradation of polymer is also gaining world-wide attention. Degradation is a process by which a change in chemical/physical properties of polymer occur, when these materials are exposed to different types of radiation. The polymer degradation is considered to have three important aspects. They are (I) As the

polymers have wide-spread applications, after their use, they are not easily miscible in earth atmosphere and cause environmental degradation. Therefore methods are devised to degrade polymers easily (II) some polymer degrade very rapidly, even at a slightest exposure radiation. In order to retain their physical properties, degradation has to be mitigated in these materials, such process is called stabilization. Therefore stabilization of polymers is one important aspect (III) Degradation of the polymers

induce some advantages. When polymers are reported to undergo change in stereoregularity after irradiation.

### **Experimental Techniques to probe polymer degradation**

Various experimental techniques are prescribed in literature to investigate polymer degradation. It is a practice to employ more than one technique for this purpose. Experimental methods used to study polymer degradation. The following sophisticated instruments are employed to investigate polymer degradation(3).

#### **(I) Spectrophotometric techniques**

- a. UV-visible spectrometry
- b. Fourier transform infrared technique

### **Scope of present work**

The author has investigated radiation effects in polymers and copolymers using the ESR, FTIR techniques. Irradiation of polymers results in generation of wide varieties of radiation products. These products will generate their own signal and total signal of entire polymer is a coalesce of all these components. Therefore the total spectrum of irradiated polymers results in broadened complicated shapes. It is very

While in case of other polymers properties like conduction, adhesion have been induced by radiation. It is well known that the crosslinked polymers were behave like hydrogels(1-2).

In order to ascertain the chemical groups effected by degradation could be done by these techniques

#### **(II) Magnetic resonance spectroscopy**

To elucidate the chemical structure of polymer exposed to radiations these techniques are used. These techniques include

- (c) Electron spin resonance (ESR)
- (d) Nuclear magnetic resonance

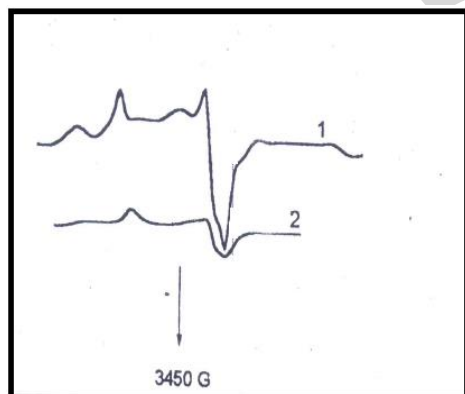
It is also possible to study molecular relaxations in polymers using above techniques.

difficult to ascertain(4-5), the contribution of each radiation product therefore computer simulations are employed for this purpose. A physical model has been considered involving various magnetic parameters. Once choosing initial magnetic parameters, theoretical curves have been simulated and superposed in appropriate proportions to match the experimental spectra. Non- linear statistical methods are employed to obtain the best fit. The magnetic parameters obtained by this method are then physically interpreted.

## Results & Discussion

As an example polypropylene is irradiated with high energy radiation and ESR spectrum is recorded as shown in Fig 1. The spectrum showed some hyper fine structure suggesting the formation of free radicals. Nature and behavior of free radicals in irradiated PP has been investigated by different authors(6-7).

Formation of macro radicals, unsaturated products has been confirmed previously. Formation of free radicals results in depreciation of mechanical and thermal



**Fig-1.** Curve-1 & Curve-2 ESR Spectra of Gamma irradiated PP at sterilization Dose without and with stabilizer.

properties. In order to overcome this the polymer has to be stabilized. PP has been stabilized and irradiated with high energy radiation and ESR Spectra have been recorded for the resultant sample as shown in Fig 1. The results indicate that signal intensity is reduced considerably, suggesting that stabilizer presence.

FTIR spectrum of irradiated PP is as shown in Fig2. The spectrum consists of absorption bands around

2920,1450,1370,1250,1130,1080  $\text{cm}^{-1}$  etc. these bands are assigned to different chemical groups present in the polymer on

irradiation the presence of  $1720\text{ cm}^{-1}$  band indicate formation of carbonyl groups.

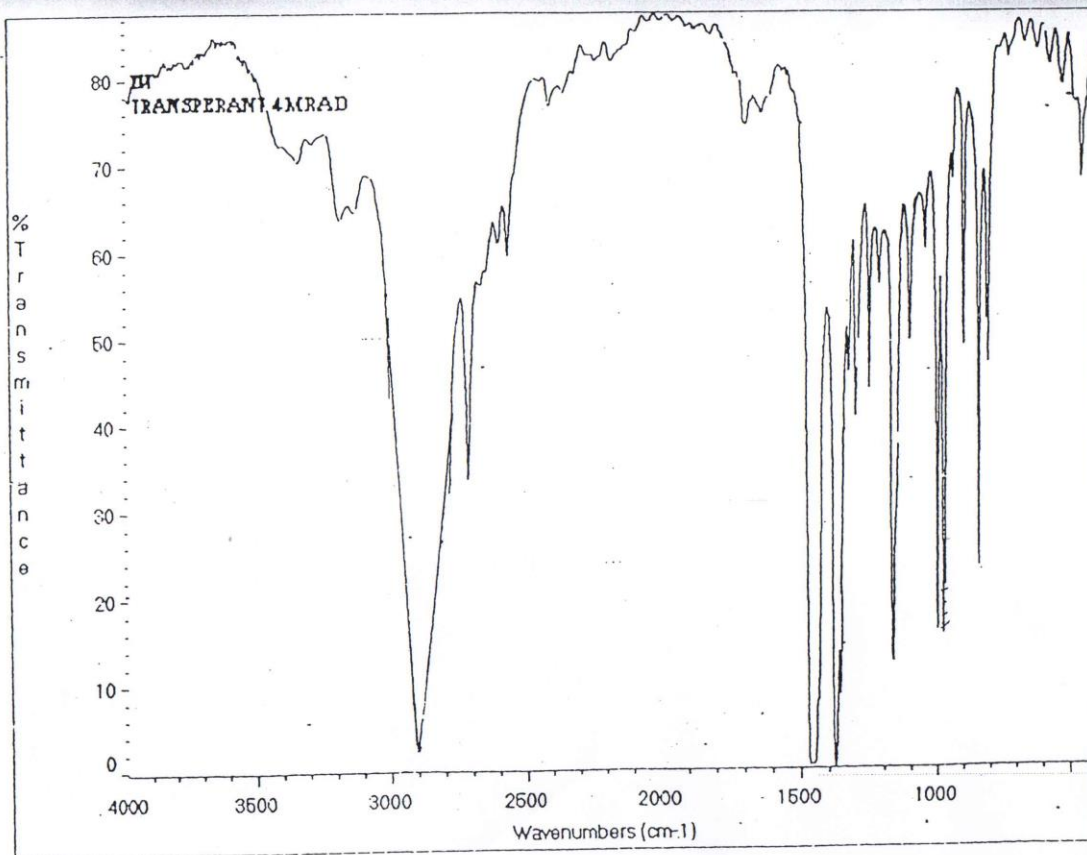


Figure 3.21 : FTIR spectrum of gamma irradiated PP to 4 M rad.

Fig 2. FTIR spectrum of PP

## Conclusion

Gamma irradiation induces formation of free radicals which have been identified by the ESR technique. Stabilization effect has been verified for recording the ESR spectra of irradiated and stabilized polymer.

Degradation effect have been evidenced by FTIR technique.

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