

## **Abstract**

Positron annihilation lifetime (**PAL**) technique has been employed to investigate the effect of low doses of  $\beta$ -irradiation (in air and vacuum) on three types of polymers namely: polymethylmethacrylate (**PMMA**), polystyrene (**PS**) and high density polyethylene (**HDPE**).

A conventional fast-slow coincidence system was used for measuring the positron lifetime spectra. The time resolution of the system was  $422 \pm 20$  ps (the full width at half maximum (FWHM)) at  $^{22}\text{Na}$  energy window.

The lifetime spectra were resolved into three components by using PFPOSFIT program.

The irradiation performed in air (in the presence of oxygen) and under vacuum with  $\beta$ -rays by using ( $^{90}\text{Sr}/^{90}\text{Y}$ ) source at room temperature for ten different total dose, ranging from (0.3-12.3) Gy .

The o-Ps lifetime parameters were used to determine the microstructure properties, namely: free volume hole size ( $V_h$ ) and free volume hole fraction ( $F_h$ ). The parameters were measured as a function of  $\beta$ -irradiation dose for the three types of the polymers.

The results of  $\beta$ -irradiation show that, the influence of  $\beta$ -irradiation on o-Ps lifetime, hence the  $V_h$  and  $F_h$  values for samples irradiated in air are less than their values for samples irradiated under vacuum, due to the effect of peroxy and hydroperoxide radicals formed in the presence of oxygen.

The results show that degradation is the predominant process as a result of  $\beta$ -irradiation **PMMA** and **HDPE**, whereas cross-linking process is predominant for **PS**.

The results are discussed and expressed in view point of  $\beta$ -irradiation induces degradation, cross-linking and increasing crystallinity of the polymer bonds.