



# Synthesis and Study of Erodible Plastics

A. Gadre<sup>\*</sup>, V. Sangawar<sup>a</sup>, G. Yerawar<sup>b</sup>

<sup>\*</sup>Department of Physics, G.H.R.C.E.M. Amravati (M.S.) INDIA

<sup>a</sup>Polymer Research Laboratory, G.V.I.S.H. Amravati (M.S.) INDIA

<sup>b</sup>Department of Physics, Arts, Commerce and Science College, Arvi (M.S.) INDIA

## Abstract:

Accumulation of plastics in our environment is very serious problem. An attempt has been made to synthesize and study erodible plastics. The thin composite films of LDPE + PEG were synthesized by solution evaporation method. The sample was degraded by soil burial technique in compostable soil for 90 days and the samples were characterised by XRD, Fourier Transform IR, and UV – Visual spectroscopy before and after degradation. The degradability is confirmed from crystallinity, carbonyl index and UV – VIS absorption. The LDPE + PEG composite thin films after soil burial of 90 days are found to be degraded. Thus, with the addition of plasticizer like PEG in low density polyethylene (LDPE) makes an environmental friendly erodible material in natural soil environment.

## Key words:

Erodible, LDPE + PEG, Soil burial.

## Introduction:

Plastics a term very familiar us in our day to day life. Plastics are synthetic or semi synthetic, most commonly derived from petrochemicals products by petrochemical industry, but many are partially natural. It refers to their malleability or plasticity during manufacture that allows them to be cast, pressed, or extruded into a variety of shapes. Polyethylene (PE) is a non-degradable polymer being used extensively in many applications. They are used in large scale as packaging material for food and beverages because of low cost and versatile properties. Research is now going towards in replacing some or all kind of synthetic polymers such as PE, to become erodible materials due to their pollution in environment.

The degradation of conventional plastics such as polyethylene, polypropylene, polystyrene, poly (vinyl chloride) and poly (ethylene terphthalate) by the action of natural polymers such as cellulose<sup>[5]</sup>, lignin<sup>[1]</sup>, chitin<sup>[1]</sup>, starch<sup>[4]</sup> is a significant way to accelerate polymer biodegradation. Microorganism breaks the polymeric chain and consumes materials through aerobic and anaerobic process.

The objective of present study is to investigate the biodegradation of LDPE (low density polyethylene) and PEG (polyethylene glycol) added LDPE composite thin films in compostable soil. The effect of plasticizer PEG in erodation of LDPE thin film has been carried out.

## Sample Preparation

The thin films of LDPE and LDPE+PEG with 7% of PEG in LDPE were synthesized by solution evaporation technique<sup>[7]</sup>. Concentration of PEG in LDPE is 7% and the

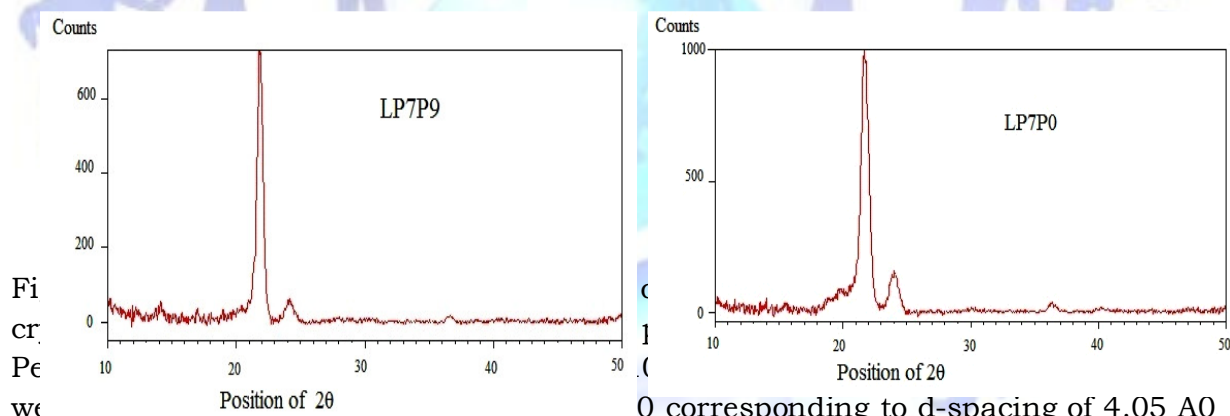


samples are coded as LP7P0 and LP7P9 for before and after 90 days of degradation respectively. Thickness of the film was measured with high accuracy and resolution using compound microscope in conjunction with an oculometer having 'least count' 15.38  $\mu\text{m}$  at magnification of 1:100. A Germal make microscope supplied by Paul Waechter, Model No. 641640 was used [6]. The thickness of the film is in range of 20-25  $\mu\text{m}$ .

**Soil Burial Technique:** A soil burial technique is carried out in natural environment to degrade the sample. For this, a thin rectangular sheet of sample (about 2.5cm  $\times$  12 cm) of 20-25  $\mu\text{m}$  thickness is buried at the depth of 5cm in compostable soil (1:1 proportion) having pH 7.72 for 90 days. The moisture content was maintained by adding water in soil after regular interval. The samples were removed from soil after 90 days and washed with distilled water and then acetone bath and dried at room temperature. The sample were characterised by XRD, FTIR and UV absorption spectroscopy.

## Result and Discussion:

**X-ray Diffraction (XRD):** X-ray diffraction of sample LP7P0 and LP7P9 were recorded on XPERT-PRO 11023505 SAIF PU, Chandigarh and are shown in Figures (i) and (ii) respectively.



XRD pattern of LP7P0 [Fig.(i)] shows very sharp, small, prominent peaks at  $2\theta = 21.800$  and  $2\theta = 24.100$  corresponding to d-spacing of 4.07  $\text{\AA}$  and 3.69  $\text{\AA}$  and XRD pattern of LP7P9 [Fig.(ii)] shows very sharp, small, prominent peaks at  $2\theta = 21.650$  and  $2\theta = 23.850$  corresponding to d-spacing of 4.08  $\text{\AA}$  and 3.69  $\text{\AA}$ . XRD pattern of LP7P0 and LP7P9 thin films also suggest small crystalline phase along with amorphous phases but addition of PEG in LDPE matrix changes the crystallinity. The crystallinity was higher for pure LDPE sample but composite of LDPE and PEG changes the crystalline phase and increases amorphous phase. Thin film sample LP7P0 shows decrease in crystalline phase and increase in amorphous phase than undoped and fresh LDPE. The 90 days soil burial sample (LP7P9) shows somewhat more reduction in crystalline phase and more increase in amorphous phase than undoped and fresh LDPE and LP7P0 samples. Thus, it has been found that physically hinder crystal growth resulting in lowering the polymer crystallinity [9] [10].

**Fourier Transform Infrared Spectrometer:** FTIR Spectra of thin film samples LP7P0 and LP7P9 was recorded in wavelength region 400-4000  $\text{cm}^{-1}$  FTIR model Perkin Elmer Spectrum RX1, RC SAIF PU, Chandigarh.

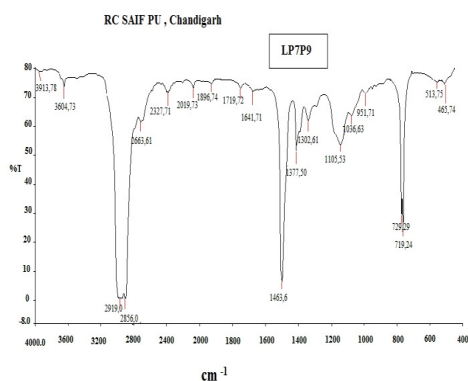


Fig. (iii) FTIR of LP7P0

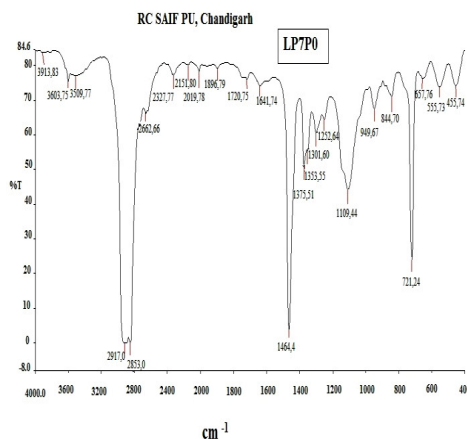
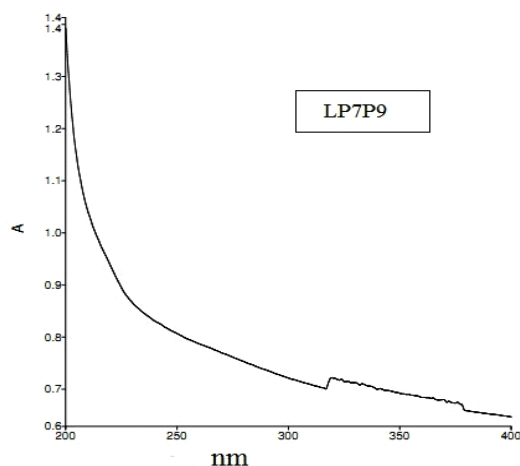


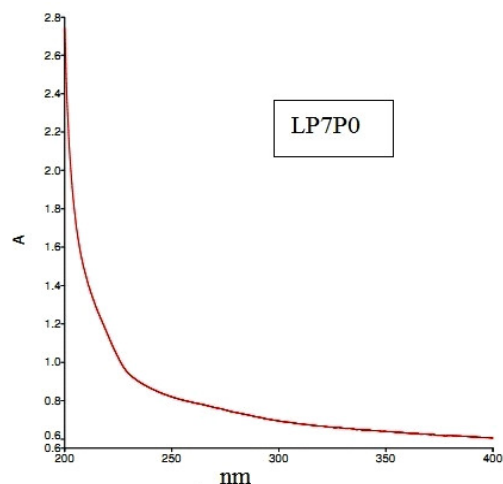
Fig. (iv) FTIR of LP7P9

Figure. (iii) shows the FTIR spectra of LDPE with 7% PEG (LP7P0) before degradation and Fig. (iv) Shows the FTIR spectra of (LP7P9) after 90 days soil burial sample. The spectrum of LP7P0 shows peak at 2917.0  $\text{cm}^{-1}$  and 2853.0  $\text{cm}^{-1}$  due to asymmetric and symmetric  $\text{CH}_2$  stretching vibration. The Peak at 1464.4  $\text{cm}^{-1}$  and 721.24  $\text{cm}^{-1}$  corresponds to C-H bending and racking amorphous of  $\text{CH}_2$  group respectively. The band at about 3509.77  $\text{cm}^{-1}$  belongs to O-H stretching vibration. The peaks at 1720.75  $\text{cm}^{-1}$  and 1641.74  $\text{cm}^{-1}$  are due to  $\text{C}=\text{O}$  stretching of carbonyl group and vinyl group respectively may be due to introduction of carboxylic acid. The spectra of LP7P9 shows peaks at 2919.0  $\text{cm}^{-1}$  and 2856.0  $\text{cm}^{-1}$  are due to asymmetric and symmetric  $\text{CH}_2$  stretching vibration of LDPE. The Peaks at 1463.6  $\text{cm}^{-1}$  and 719.24  $\text{cm}^{-1}$  correspond to C-H bending and racking amorphous of  $\text{CH}_2$  group respectively. The band at about 3604.73  $\text{cm}^{-1}$  belongs to O-H stretching vibration. The peaks at 1719.72  $\text{cm}^{-1}$  and 1641.71  $\text{cm}^{-1}$  are due to  $\text{C}=\text{O}$  stretching of carbonyl group and vinyl group may be due to introduction of carboxylic acid. The appearance of these oxidative products on the surface of weathered sample was an indication of oxidative photo degradation [3]. The increase in carbonyl and vinyl group formation for polyethylene after weathering is indication of cross linking and chain scission. [9]

**UV-VIS Absorption:** UV-VIS Spectral analysis of sample LP7P0 and LP7P9 has been carried out by using a Hitachi-330 UV-VIS Spectrometer 200-400 nm at SAIF PU, Chandigarh.



**Fig. (v) UV-VIS spectrum of LP7P0**



**Fig. (vi) UV-VIS spectrum of LP7P9**

Figure (v) shows UV-VIS absorption spectra of LDPE with 7% PEG(LP7P0) before degradation and Figure (vi) shows UV-VIS absorption spectra of (LP7P9) after 90 days soil buried sample. The spectrum of LP7P0 shows very low UV absorption in the region 200-300 nm. The spectra of LP7P9 show some changes in UV absorption in region 200-300 nm. This may be due to presence of few chromophoric groups such as hydro-peroxides, carbonyl and certain catalyst residues which absorb UV radiation in the wavelength range 200-300 nm. [2]

### Conclusion:

The XRD, FTIR and UV study of LDPE and LDPE+PEG degraded (for 90 days) sample revealed that addition of plasticizers PEG affect nature and structure of LDPE and it also helps LDPE to become erodible material in natural soil environment.

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