Development Of Photodegradable Environment Friendly Ldpe Nano Films

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Abstract -In order to minimize the environmental pollution due to littered plastic packaging made of Low Density Polyethylene (LDPE) films, the photodegradation of LDPE films was carried out under natural weathering conditions using oleic acid and closite 10A as prodegradants. Since sunlight (energy source for the photodegradation) is abundantly available, photodegradation has been chosen one among the various degradation technologies. The photodegradation was followed using the simplest analytical techniques like Fourier Transform Infrared Spectroscopy, mechanical properties measurements and Thermogravimetric analysis. The scission of the main chain of LDPE due to effect of added prodegradants oleic acid and nanoclay under the weathering conditions were observed for twenty days. LDPE film containing oleic acid (3%) of various proportions of nanoclay (1%, 3% and 5%) were prepared and exposed to uv radiations. There was no degradation observed after the irradiation of uv light for five days. Photodegradation was observed after ten days of exposure and maximum was found to be in 20 days. The progressive increase of carbonyl absorbance was observed as the days of exposure increases. Among all, the 3% showed maximum degradation and minimum elongation at break after 20 days of exposure. The oleic acid and nanoclay used as prodegradants have a strong influence on the photodegradation behaviour of LDPE and facilitate the UV induced photooxidative degradation.
Keywords:LDPE, weathering, FTIR, TGA

I. INTRODUCTION

Plasticshopping bagshavenowadaysbecomean inseparablepartofourdaily lifeanditsconsumption increases exponentially duetotheir lowcostandlessweight.Polyolefins areone oftheimportantmaterials forpackagingapplications due to theirflexibility,toughness, excellentbarrierproperties andalsoinertnesstowards outside factors like heat, radiation, chemicals and microorganism.

Recently,themorechallenging andinterestingfieldof developing degradable polymersforpackagingand disposalstominimize litterhasresultedinthe availabilityofseveralcommercialized products.Khareetal.andChouzourietal.madeinvestigation towards development ofeco-friendlyplasticsusingbio-active fillers.Photodegradation, photooxidationand autooxidation arethemainpathwaysfortheir degradation.Photooxidationleads toanincreaseinthe lowmolecular weightfractions bychainscission, therebyfacilitatingbiodegradation. Inadditiontothe freelyandabundantly available sunlightasenergy sourcefordegradation,thedevelopment of photodegradableLDPEis thetheme of the present investigation. Thispresent investigationisfocusedontheincorporation of photodegradationpromoting additivesinto LDPE. Vijayakumar et al studied the Development of PhotodegradableEnvironment Friendly Polypropylene films by adding ferric carboxylates. Hence,thepresentstudyinvolvesthe photodegradation ofLDPEfilms under natural weathering conditionsto predicttheeffectsofoleic acid and cloisite 10A(pro- degradants) andweatheringparameters onthe photodegradabilityofLDPE.

II. MATERIALS AND METHODS

Low Density Polyethylene (LDPE) films, the photodegradation of LDPE films were carried out under natural weathering conditions using oleic acid and closite 10A as prodegradants .

III. EXPERIMENTAL

Since sunlight (energy source for the photodegradation) is abundantly available, photodegradation was done in natural weathering conditions.The photodegradation was followed using the simplest analytical techniques like Fourier Transform Infrared Spectroscopy, mechanical properties measurements and Thermogravimetric analysis.

IV. RESULTS AND DISCUSSION

4.1. Thermo Gravimetric Analysis:

The thermal stability of LDPE nanofilms were studied by TGA analysis as shown in Fig 1. From the observation it is clear that the thermal stability of the LDPE films increased with nanomer loading from the initial decomposition temperature of 373.06°C to 481.18°C. The increase in thermal stability of nanofilm is attributed to the

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organic/inorganic interaction between the polymer andnanoclays (Doh and Cho 1998). The enhanced thermal stability is attributed to the strong interactionof base polymer and clay surface through chemical linkage between them. The organoclay delays volatization of the products generated at the temperature of carbon–carbonbond scission of the polymer matrix.
The TGA of various LDPE films are depicted in figure 1which indicates the V-5 has higestTmax among all compositions.

4.2. Photooxidative degradation mechanism
The chemical changes occurring in the material during photooxidative process are very complex and it was generally assumed as a free radical chain mechanism. Due to less stability of hydroperoxide under light and heat, they decompose into alkoxy and hydroxyl radicals. It is an important step since the resultant macro alkoxy radical leads to main chain scission resulting in the formation of ketones. Thus generated ketones undergo reactions and liberate different kinds of photooxidation products like aldehydes, carboxylic acids, ester, lactone, peracid, perester etc.

4.3 Ftir Studies
The FTIR spectra of LDPE films containing 3% Oleic acid (V-0) with various proportions of nano clay (1%, 3% and 5% V-1,V-3, V-5) before weathering are presented in figure

2.

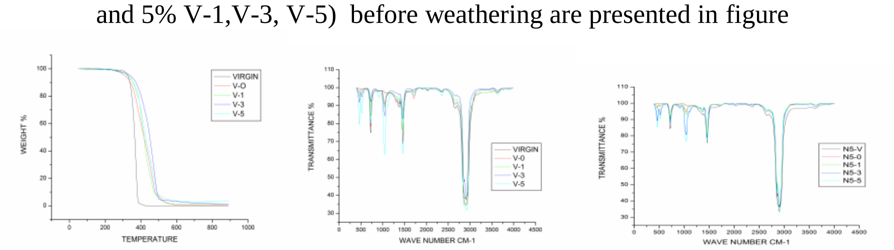

Figure.1 TGA of LDPE films. Figure 2& 3FTIR before weathering and 5days after weathering

The FTIR spectra for the five days naturally weathered LDPE film containing 3% Oleic acid (N5-0) with various proportions of nano clay (1%, 3% and 5%ie N5-1, N5-3, N5-5) are presented in figure 3. There was no significant changes observed after the irradiation of uv light for five days (No charecteristics peak in the carbonyl and hydroxyl group region).
The FTIR spectra for the naturally weathered LDPE film containing 3% oleic acid (N10-V0) and various proportions of nano clay (1%, 3% and 5%ie N10-V1, N10-V3, N10-V5) after 10 days

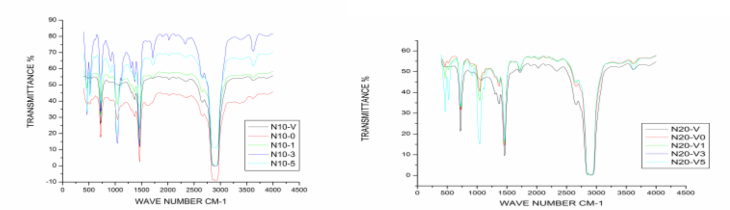

Figure 4& 5 FTIR of 10 and 20 days weathered samples

exposure are presented in figure 4. A strong peak was noted in the carbonyl and hydroxyl group region in the FTIR spectra of ten days weathered LDPE nanofilms.The FTIR spectra for the 20 days naturally weathered LDPE film containing 3% oleic acid (N20-V) and various proportions of nano clay (1%, 3% and 5%ie N20-V1, N20-V3, N20-V5) after 20days exposure are presented in figure 5 which showed that the 3% LDPE nanofilms have undergone photooxidative degradation leading to the formation of carbonyl and hydroxyl group compounds. The maximum was found to be for 3% LDPE nanofilms after irradiation with uv light for 20 days.

4.4 Carbonyl Index
The most used parameter, carbonyl index, to evaluate the extent of degradation of LDPE was calculated using the formula given below and is depicted in Figure 6. The carbonyl index value increased with increasing exposure period only after five days of exposure and this period may be considered as the induction period for the photo oxidative degradation behaviour.

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From Figure 6, one can easily see the progressive increase of Carbonyl absorbance as the days of exposure increases.Carbonyl index = absorbance at 1715cm-1/absorbance at 1456cm-1
Compared to all compositions 3% LDPE nanofilms (V3%) exhibit highest carbonyl index after 20 days of weathering.

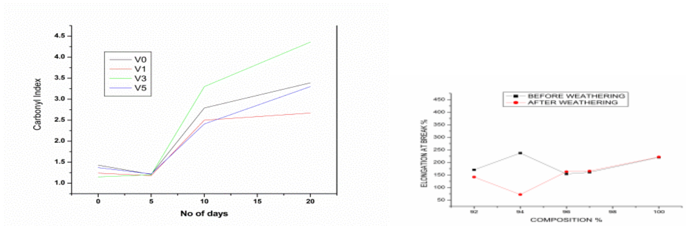

Figure 6 & 7 carbonyl index&Elongationat break of LDPE nanofilms before and after weathering

4.5 Elongation At Break
The elongation at break of LDPE nanofilms before and after weathering are depicted in Fig 7and it was found to be minimum for 3% LDPE nanofilms (N20- V3) after 20 days ofweathering

V. CONCLUSION

The scission of the main chain of the LDPE due to the effect of added prodegradants oleic acid and nanoclay under the weathering conditions were observed for twenty days. The FTIR spectra for the five days naturally weathered LDPE film containing Oleic acid (3%) and various proportions of nanoclay (1%, 3% and 5%) were prepared and exposed to uv radiations. There was no significant changes observed after the irradiation of uv light for five days. Photo degradation was observed after ten days of exposure and maximum was found to be in 20 days. The progressive increase of Carbonyl absorbance as the days of exposure increases was observed. Among all the the 3% LDPE nanofilms showed maximum degradation and minimum elongation at break after 20 days of exposure.

VI. REFERENCES

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