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Preparation of environmentally friendly photodegradable polymer blends using locally available raw materials

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Abstract

Polymers can be produced from natural or synthetic materials. Most of them are typically made from petroleum based products. The use of engineering polymers, especially polyethylene has increased significantly in recent decades largely due to their low cost, good mechanical properties and light weight. However, this increase in usage has also created many challenges associated with disposal and their impact on the environment. The environmental impact of persistent polymer wastes is raising general global concern, and disposal methods are limited. Incineration may generate toxic air pollution, satisfactory landfill sites are limited, and recycling methods for commingled waste are expensive and often energy - intensive. In addition, petroleum resources are finite and are becoming limited. It will be important to find durable polymer substitutes, especially in short - term packaging and disposable applications. This is because polyethylene does not easily degrade in the natural environment and hence the need for degradable polyethylene has become a major topic of research. Degradable polyethylene based products are designed to retain functionality as a commodity plastic for the required service life but degrade to non-toxic end products in a disposal environment. The continuously growing public concern in the problem has stimulated research interest in photodegradable polymers as alternatives to conventional non degradable polymers such as polyethylene. Photodegradable polymers: are those that break down through the action of ultraviolet (UV) light, which degrades the chemical bond or link in the polymer or chemical structure of the plastic. This process can be assisted by the presence of UV-sensitive additives in polymer. The objective of this research was to prepare environmentally friendly photodegradable polymer blends using light-sensitive chemical additives which can be extracted from locally available raw materials. Titanium dioxide is an UV-sensitive additive which was available in rutile. Rutile and ilmenite are highly available in enormous concentrations in the Pulmoddai beach in Sri Lanka. Fine powder of titanium dioxide was obtained from rutile by subjecting chemical reactions. Extracted products were analyzed by chemical analysis to verify the extracted product. Photodegradable polymer blends were prepared by mixing Low Density Polyethylene (LDPE) and Titanium dioxide by varying Titanium dioxide concentration in a laboratory scale internal mixture. Hydraulic press was used to prepare the LDPE – TiO_2 photodegradable polymer sheets. Degradability of the developed blends was measured with the help of Ultraviolet (UV) exposure test, tensile test, Fourier Transform Infrared Spectroscopy (FTIR), water absorption measurements and weight loss measurements. Results showed that tensile strength and percentage elongation gradually reduced with increase of UV exposure time. Weight loss and water absorption properties gradually increased during the degradation in all TiO_2 containing blends. However, pure LDPE did not show the significant degradation during the test. These experiment results showed that LDPE – TiO_2 blends efficiently photodegraded in UV environment in comparison with pure LDPE.

Key words: LDPE, rutile, TiO, photodegradable