

Elasticity and Rheology of Recycled Plastic Solid Wastes

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Abstract

The quantity of plastics released by 2015 estimated around five billion tons, which is sufficient to include the earth thoroughly as a layer and anticipated to rise as six layers in end of 2050. In developing countries the recycling rates of Plastic Solid Wastes (PSW) emerged to be around 95-75% while it is a very low percentage in civilized nations. However, it is not very easy to recede the quality of recycled SWP in terms of their physical appearance, performance, elasticity and rheology. Therefore, we tried to explain the modification procedures by current editorial paper as reviewing recent studies in this field.

Keywords: Plastics; Elasticity; Rheology

The first industrial scale of plastics generation implemented in 1940 using the raw materials such as Naphta extracted from crude oil refining operations. Plastics origin refers to raw materials comprising petroleum, natural gas, carbon, etc. Nowadays, plastics are nearly made up from petrochemicals derived from fossil oil, of which around 4% is employed for plastic generation globally. Feedstock can be either processed in the state of a powder which can endure the operational processes to form a solid framework, or deposited in situ as a thin film on an electrode through electrochemical polymerization. Post-synthesis can be conducted through of the soluble polymer formation: dopant complex, redesign and reproduction by plasma facilities [1,2].

Biodegradable Plastics (BPs) usually include both plastics which are bio and fossil-derive in three various aspects; (1) bio-based and non-biodegradable, (2) bio-based and biodegradable or (3) fossil-based and bio-degradable. BPs are bio-based products, usually easy biodegradable, derived from renewable resources (bio starch and starch mixtures (74.5%); fermentation (13%) and petrochemicals products (12.5%). BPs generation practices comprise (1) BP made of starch: corn, potato, wheat, rice, beets, cellulose etc. (2) renewable resources: Poly lactic acid, Poly glycolic acid, Poly caprolactone. (3) Microorganisms or genetically modified: Poly-hydroxy alkanooates, Poly hydroxy butyrate and Poly-hydroxy butyrateco-valerate. (4) Mixtures with biodegradable polymers: Polyvinyl alcohol, Poly caprolactone [3].

The huge demands attributed to plastic materials consumption resulted to release immense quantities of PSW and recycling method has recognized as a prominent strategy in terms of waste management. The current technologies for recycling PSW could be classified into five major categories such as (1) Primary (re-extrusion) via injection molding, (2) Secondary (mechanical) based on cutting/shredding, milling and grinding, (3) Tertiary (chemical) using pyrolysis, gasification, hydrogenation, catalytic cracking, condensation polymers, smelting by blast furnace, degradation, incineration, hydrolysis, glycolysis, hydroglycolysis, aminolysis and fractionation (4) Quaternary (Energy recovery) (5) Plasma based technologies (especially using chemical vapor deposition procedures) [2,4].

It has a worth to mention that elasticity and rheology tests can provide parameters related to the mechanical properties of a system and its rheological behavior. In the case of suspensions and polymer melts, the obtained results offer information about how the material flow and deform through the interpretation of parameters such as viscosity, shear stress and shear rate. By the way, comparison of virgin and regenerated Polyvinylchloride and municipal properties of model polymers before and after recycling processes for low density Polyethylene (PE), high density Polyethylene and Polypropylene (PP) based on impact strength by falling weight, thermal shrinkage, appearance after heating at 150°C,

strength of welder corners and tensile stress at max load and at yield, elongation at break and elastic modulus revealed same, analogues and close performance properties [5]. Also, achievements were similar for Polycarbonates/Acrylonitrile Butadiene Styrene plastics in terms of strain at break, tensile, charpy impact, aesthetic inspection, candle frame, vertical burn and impact tests [6].

Lee et al. [7] reported that even a very short time plasma treatment of the surface of recycled carbon fiber induced oxygenated functional groups on the surface and resulted to fortified adhesion and promoted the surface activity. These characteristics can pave the way to recede the drawbacks by refraining mechanical and chemical characteristics to levels approaching those of fresh carbon fiber-reinforced plastics. Escalating the compatibility of various rigid and flexible products in injection molding process by plasma treatment created low-cost PP, ABC and various plastics and polymers as well as cut down one third of outlays.

The appropriate surface treatment expands the use of plastics as a replacement to metals in industrial applications. However, the morphological investigations upon the both of non-compatible blends and composites revealed poor interfacial adhesion in recycling process. Many processing practices have been developed in order to design and retrieve plastics based on required and available feedstock, energy resources and plastics applications. The appropriate physical appearance and performance of virgin and regenerated plastics assigned plasma base techniques for plastic generation operations particularly re-extrusion via injection molding. The recycled plastics and BPs can be exploited as matrices which are led to design analogous mechanical properties for products in comparison with virgin or petro-chemical based polymers [8-10].

Active Cross-Linking (ACL) or grafting followed by etching technologies may be employed for the modification of synthetic polymeric surfaces in combination with plasma treatment. Polymeric surfaces made of PE, PP, Poly ethylene terephthalate, etc. are devoid of reactive functional groups; thus, pre-activation by plasma, corona or other modification techniques, is indispensable to procure the material for ACL treatment and consequently modification operations.

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