Mechanical properties of polymeric ground tire rubber (GTR) composites, with different amounts of GTR and applications for this type of waste composites - Marc Marín-Genescà - Universitat Rovira i Virgili

Marc Marín-Genescà

Abstract

Nowadays the huge proliferation of end-of-life tires is a mass environment problem in the whole countries and suppose a real problem of proliferation of this waste types in natural places like oceans, woods, and landfills, so the decomposition of this waste tires in environment generates a mass of subproducts which contaminate the environment. So, in this regard there are some strategies to control and minimize these impacts, the valorization or recycling of this products is one of the most interesting. So, the integration of GTR particles in some polymeric matrix can contribute to minimize this impacts, and open new possibilities to be used in some new applications. One effort in this direction is this work, where I expose the mechanical properties and mechanical behavior of waste GTR composites studied which can match with industrial and civil engineering applications requirements, in which can be used.

The recycling of worn tires is a big challenge nowadays and it is necessary for environmental and economic reasons: mass production of tires, as well as the difficult storage or elimination is a real environmental problem. Various methods for recycling tires are currently used, such as mechanical grinding, which puts vulcanized rubber, steel and fibers apart. The rubber may be used in several industrial applications as flooring, insulations, footwear, etc. The aim of this paper focuses on finding a new application for the old used tires (GTR). Tires dust and 7 differen t polymers have been mixed, and we have checked the maximum accepted values of GTR that can be admitted while keeping mechanical properties within acceptable values, as well as initial polymer microstructure. This would allow including GTR in industrial applications of recycled polymers. The recycled tire dust which results from the industrial milling processes has been divided by categories according to the size of the particles. This has been mixed with different polymers, in different GTR concentrations in order to establish its conduct through mechanical test. With the present study it is intended to give a second outlet to the tires out of use, demonstrating the feasibility of the mechanical properties analyzed.

The important issue of the accumulation of used tires [1-3] has driven the efforts of the international scientific community to seek solutions for recovery and reuse. Many plastic materials include elastomers to improve its toughness. In general, a thermoplastic or thermosetting polymer acts as a matrix and the elastomer acts as a dispersed phase [4-6]. Moreover, as in other two-phase polymer blends [7-8], the interfacial compatibility between the components is important for achieving the desired properties. In the case of recycled elastomers, expected compatibility is low. One way to increase the compatibility between components is to reduce the degree of cross-linked GTR by devulcanization [9-11]. Significant changes in properties are observed when we change the size of the reinforcement particles [12]. The size of particles is restricted because of the pulverization technical procedures, so we have chosen a simple and cheap way to obtain the classification in the three desired particle sizes (<200µm, 200µm-500µm and >500µm) such as screening, although this method has the disadvantage of using only a part of the initial amount of GTR. It is, therefore, to determine what percentage of GTR can be added to different polymers matrix (PVC, EVA, HDPE, PP, PA, ABS and PS), keeping mechanical properties, as well as the polymer initial microstructure [13-14] within an acceptable range of mechanical values. This would allow to add GTR to various industrial processes. To this end, we have analyzed various concentrations of polymer/GTR (from 0% to 70% of GTR), with the three indicated particle sizes. Finally, we will give some applications that could have these compounds analyzed, there will be a valuation of the residual GTR for applications that may be interesting, and thus give out a waste like the GTR, which today represents a very important problem in developed societies.

The polyvinyl chloride (PVC) with a fluidity index of 1.35 g/min and a density of 1.225 kg/m3. High density polyetilene (HDPE) recycled, with a melt flow index of 1.35 g/min and density of 960 kg/m3 was used in this study. The EVA (Etylene Vinyl Acetate) copolymer, with 18% of vinyl acetate and 82% ethylene, melt flow rate of 0.2 g/min and a density of 937 kg/m3. Polypropylene (PP) with a melting temperature of 165 ºC, a flow rate of 0.55 g/min, and a density of 902 kg/m3. ABS it is made up of 30% acrylonitrile, 20% butadiene, and 50% styrene, its melting temperature is 230 ºC and its density is 1050 kg/m3. Polyamide 6 (PA), also known as Nylon 6, its melting temperature is 220 ºC, its melt flow rate is 1.55 g/min and its density is 1130 kg/m3. Polystyrene, PS, (styrene-butadiene-styrene), its melting temperature is 180°C, its melting index is 1.45 g/min and its density is 1050 kg / m3. On the other hand, the old used tire (GTR), with a particle size less than 700 µm, was verified by TGA analysis that carbon black content was about 35%. The original GTR was separated by sieving into three categories of size particles: <200 µm, 200-500 µm and >500 µm.

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Marc Marín-Genescà

Universitat Rovira i Virgili, Spain, E-mail: almuntaser.ameen@gmail.com