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Rheological Characterization of Thermoplastic Elastomers (TPE) Based on PP and Recycled EPDM

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Abstract:
The rheological behavior of thermoplastic elastomers (TPE) based on 50/50 recycled ethylenepropylene-diene monomer (r-EPDM)/polypropylene (PP) was studied to determine the effect of feeding strategy when preparing these blends using twin-screw extrusion. In particular, small and large deformation characterizations have been performed to better understand the relationships between sample preparation and final properties of the blends. It was found that small changes in blend morphology (particle size and interfacial adhesion) are better distinguished in rheological properties (melt state) under large deformation (LAOS and step shear) compared to small deformation (SAOS).

Key words:
Polypropylene, recycled EPDM, thermoplastic elastomers, large deformation.

1 INTRODUCTION

Thermoplastic elastomers (TPE) are polymer blends that can be processed at high temperature like thermoplastics (melt processing), but have mechanical properties similar to elastomers (high elasticity) at low temperature. Depending on the polymers and processing methods used, different families of TPE can be produced [1]. TPE prepared by physical melt mixing of a polyolefin with an elastomer gained considerable attention because their macroscopic mechanical properties (impact strength, elongation at break) can be modified over a wide range by simple control of composition [1–3]. Today, polypropylene (PP) is one of the main polymer used as the matrix because of its low density, balanced mechanical properties, and processing behavior. It is also easy to modify (molecular weight distribution, branching, tacticity, copolymer, etc.) to meet the requirements for several applications in terms of general performances [4]. Consequently, PP is widely used in automobile, household appliance, and construction industry. Nevertheless, the use of PP alone is restricted due to its brittleness (low impact strength), especially at low temperature. In the last decades, several methods have been developed to modify PP toughness such as blending with elastomers leading to the development of TPE based on PP and ethylene-propylene-diene monomer (EPDM). These blends have been very successful due to structural compatibility between both polymers and several investigations have been published dealing with their morphology and mechanical properties [1, 4–10]. Due to the growing importance of TPE, melt rheology of thermoplastic blends was proposed as a tool to understand the relationships between structural properties (morphology), processability, and mechanical behavior. Therefore, the rheological properties of TPE have been extensively studied, but mostly under small deformation in oscillatory shear as these measurements correlate linear mechanical data with processing in the non-linear regime [2, 3, 7, 11–14].

Over the last decade several attempts to use recycled rubber in TPE formulations were investigated because of environmental concerns and cost reduction [15–23]. Although the mechanical properties of PP/recycled EPDM (r-EPDM) blends are well-known, very little attention has been paid to their rheological behavior in the melt state [24]. This information is highly important to understand their processing and relate morphology

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