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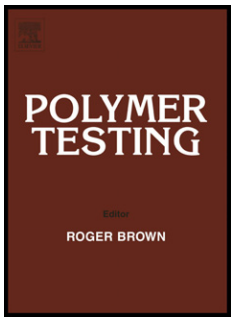

Linear Low Density Polyethylene: microstructure and sealing properties correlation

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Material Properties

Linear Low Density Polyethylene: microstructure and sealing properties correlation

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Abstract: The microstructures of four commercial linear low density polyethylenes (LLDPE) were evaluated and correlated with their sealing properties. Atomic Force Microscopy (AFM), Temperature Rising Elution Fractionation (TREF), Differential Scanning Calorimetry (DSC) and Crystallization Analysis Fractionation (CRYSTAF) experiments revealed that the comonomer distribution is one of the main factors that influence the sealing properties. The superior sealing performance showed by metallocene LLDPE samples in comparison to Ziegler-Natta LLDPE samples can be attributed to their well balanced chemical composition distribution.

Keywords: LLDPE, sealing properties, morphology, comonomer distribution

1. Introduction

Polyethylene is the most widely used thermoplastic polymer in the world, being made into products ranging from clear food wrap and plastic bags to laundry detergent bottles and automobile fuel tanks [1]. Among the different polyethylene types, linear low density polyethylene (LLDPE) represents almost 30% of the total polyethylene global consumption [2]. The structural parameters that generally influence the ultimate properties of LLDPE are: type, amount and distribution of comonomer, average molecular weight and molecular weight distribution [3-5]. The development of new catalysts and process technologies has motivated the continuous improvement of LLDPE properties and the ability to tailor it for a wide range of applications [6-8]. LLDPE is used mainly in film application due to its toughness, flexibility and relative transparency. Product examples range from multilayer films used in food packaging to agricultural films. Among the different properties required in a material to be applied in flexible food packaging, sealing performance is one of the most important, being essential for the integrity of the package. LLDPE with good sealing performance is expected to present low sealing temperature, broad sealing window and high packaging performance, contributing to cost reduction by speeding up the automatic packaging processes.

Heat sealing is a technique of sealing two materials under the combined effect of three parameters: pressure, temperature and time. The sealing process involves melting, interdiffusion and crystallization of macromolecules at the interface of two materials to be sealed. In the case of semicrystalline polymers, the sealing temperature must be near the melting temperature of the polymer to allow macromolecular mobility at the interface. The sealing strength, toughness, failure mode and appearance of these seals after cooling to room temperature are important seal variables [9,10].

Considering that there are many different commercial grades of LLDPE on the market with different sealing properties, it becomes increasingly important to determine which structural features contribute to good sealing performance. Since crystallization kinetics plays an important role in the sealing mechanism, the use of a powerful tool to understand the behavior on the film surface becomes necessary. Atomic Force Microscopy (AFM) has been widely applied to issues regarding polymer crystallization on the surface, allowing observation of crystal growth, melting and reorganization at the lamellar scale, determining how structure evolves and how local conditions influence the crystallization kinetics [11,12].

Few studies regarding polyethylene microstructure and sealing performance correlation are found at the literature [9,10,13-15]. Different from them, in this work, four LLDPE with similar comonomer content were characterized in detail in order to elucidate the influence of their molecular microstructure on the sealing performance.

2. Experimental

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