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Microstructure of carbon filled HDPE/EPDM composites studied by positron annihilation spectroscopy**

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Abstract: The microstructure of carbon-black (CB) filled high density polyethylene/Ethylene Propylene Diene Monomer (HDPE/EPDM) composite was studied with positron annihilation lifetime spectroscopy (PALS) and positron annihilation Doppler spectroscopy (PADS). It was found that τ_3 and I_3 of the long lifetime component of the PALS spectra show non-linear relations with the EPDM content. It was also noticed the DBS was very sensitive to the microstructural change in the HDPE(CB)/EPDM composites. The spatial distributions of the EPDM and the CB in the polymer are also discussed.

Introduction

Polymer composite with conductive filler showing positive temperature coefficient (PTC) has been known for a long time. Research and development activities have lead to successful industrial applications, such as self–regulating heaters, current limiters and over current protectors, etc [1]. Despite the extensive studies performed, the understanding is not yet completed [2-4]. It was found in recent years some conductive polymer blends filled with carbon black showed improvement on the electrical and the mechanical properties of the conductive polymer [5-6]. In this paper, with the use of PALS and PADS, we have investigated the free volume property, the CB and EPDM spatial distributions in the HDPE(CB)/EPDM composites with different contents of EPDM.

Experiment

The high density polyethylene(HDPE) with a melt flow rate value of 2.0 g/min was obtained from the Lanzhou petrochemical industries, Ltd. The carbon black (CB) having average size of 40-50 nm and surface area of 60-70 mm^2/g was provided by the Chunan chemistry factory. The Ethylene Propylene Diene Monomer(EPDM) 4045 used was the product of MITSUI petrochemical industries, Ltd. The HDPE containing 20 phr CB was premixed with the EPDM and the EPDM content was varied as 0, 10, 15, 20, and 25 %. The matrix resin and the filler were first premixed in a high-speed mixer in a two–roll mill for 15 min at a temperature of 160^0C. After molded under a pressure of 80 kg/cm^2 at a temperature of 160^0C to form a sample having a thickness of 2 mm, the samples were drawn out to cool down under room temperature. The positron lifetime measurements were performed at room temperature using a fast-fast coincidence system with a timing resolution of fwhm=270ps. Each of the spectrum contained 10^7 counts of annihilation events. The S and W parameters were obtained from the Doppler broadening spectra collected with an ORTEC high purity germanium detector with a resolution of 1.2 keV at 514 keV.

Results and discussions

Analyzed by the source code PATFIT, all the measured positron lifetime spectra were well fitted

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