The Effect of Injection Moulding Temperature on PET Particles/Fibrils in Blends and MFCs

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Abstract. The microfibrillar composites of polypropylene (PP)/poly(ethylene terephthalate) (PET) have been prepared by twin-screw extrusion, followed by cold drawing. The employed stretch ratio was 4. Further processing was done by injection moulding at three different processing temperatures (210ºC, 230ºC, 280ºC) on PP/PET blends with wt% 70/30 Samples were subjected to extensive characterization in each step of MFC preparing. Fourier Transform Infrared (FTIR) spectroscopy was employed to determine the nature of the interaction between the polymers in the composites.. Thermogravimetric Analysis (TGA) were used to investigate degradation of polymers. The crystallization, melting behaviour and the crystallization morphology were investigated by Dynamic Scanning Calorimetry (DSC) and Polarized Optical Microscopy (POM). Influence of processing temperature on morphology was investigated by using Scanning Electron Microscopy (SEM). The observations from the fracture surfaces were discussed and compared with the mechanical properties, and the results have shown a significant influence of the injection moulding temperature on the morphology development and mechanical properties.

Keywords: microfibrillar reinforced composites, injection moulding, morphology, mechanical properties, polypropylene, poly(ethylene terephthalate).
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INTRODUCTION

The goal of this research is to investigate the effect of injection moulding temperature on the properties of the PP/PET injection moulding blends (IMBs) and microfibrillar composites (MFCs). It has already been shown that an improvement of mechanical properties can be obtained by the MFC concept [1, 2, 3], although not much attention has been dedicated to the specific influence of processing temperature during the injection moulding. However, some researchers have reported about the influence of screw speed [4], barrel temperatures [4], cooling time during moulding and the mould temperature [5]. Still, these researchers [3, 6, 7] have done studies on other compositions like PE/PET, PE/PEN blends and composites. Generally, in polymer processing it is of primary importance to understand the formation of dispersed phase, establish the relationships with morphology and with mechanical properties [2, 8, 9].

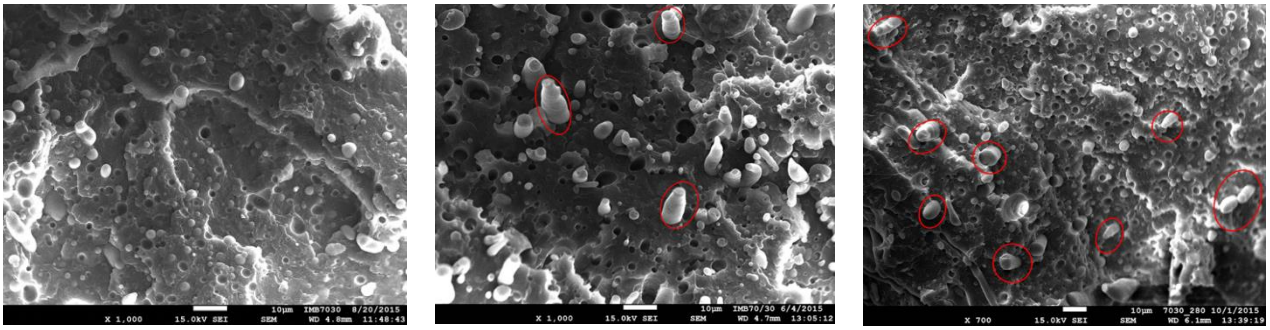
In present work, we represent the results of non-compatibilized blends and composites as we would like to explain how it affects the main morphology and mechanical properties made from two virgin polymers without additives, compatibilizers, fillers etc.

Methodology

In this work, PP was used as a matrix, and PET as a reinforcing element. PP/PET IMBs and MFCs were prepared in the weight ratio 70/30. The sample preparation was divided into IMB and MFC preparation, respectively. The IMBs were prepared by extrusion and injection moulding, while for the preparation of MFCs an additional stretching step was introduced between extrusion and injection moulding. In order to study effect of injection moulding temperature, the final processing was done at three different temperatures (210, 230 and 280°C). The relevant mechanical and thermal properties were investigated. Scanning Electron Microscopy (SEM) was used to investigate the morphology of the samples under the influence of different injection moulding temperatures.

Results

From the observation (Figure 1), it can be seen that discrete domains of minor phase are dispersed within continuous phase of major phase without adhesion between the different phases, which indicates completely immiscible blend [2, 10]. Furthermore, the appearance of some bigger ellipsoidal particles was found which probably come from the coalescence effect, (see the red circles on Figure 1 b and c).



(a) (b) (c)

FIGURE 1. SEM micrographs of freeze-fracture surface under liquid nitrogen 70/30 IMB at (a) 210ºC, (b) 230ºC and (c) 280ºC

The effect of coalescence is the merging of two or more particles into one new larger particle which is not often in spherical shape. The coalescence effect is very dependent on the injection moulding temperature. It was found that at 210ºC the diameter of the particles were 1-2.5 μm, while the particle size at 280ºC can reach diameters up to 7 μm. Probably, the specimens processed at lower temperature of processing maintained the morphology formed by twin-screw extrusion, as the PET particles were in solid during processing at low T.

It can be seen a huge influence of processing temperature on PET particles. During processing at higher temperatures, there is a strong possibility that PET particles are melted again, as the phenomenon of coalescence was present in those samples. Similar conclusions have found other authors [3, 6].

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