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# INFLUENCE OF POLYPROPYLENE SURFACE MORPHOLOGY IN THE ADHESION OF INJECTION MOLDED PARTS

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### KEYWORDS

Morphology, crystallinity degree, molecular orientation, FTIR, IR dichroism

### ABSTRACT

The influence of the surface morphology, such as the degree of crystallinity and the molecular orientation, of an isotactic polypropylene on its adhesive properties was studied. FTIR spectroscopy analysis was carried out to assess the crystallinity degree and the molecular orientation distribution along the thickness of the samples. The adhesion assessment was probed through water contact angle. A correlation between the microstructure of the sample and the adhesive properties was found.

### INTRODUCTION

Most polymers are hydrophobic with a low surface energy. They are therefore difficult to bond to other materials. Adhesion is promoted either by surface modification, mechanically or chemically roughened surfaces, etc. Processing conditions play also a relevant role in adhesion as they constrain the development of the interphase morphology. Crystallinity has been reported to have an effect on adhesive properties (Boucher et al. 1996) and also on the contact angle (Pu and Severtson 2009). It is also expected that flow conditions should have an influence on the interphase morphology and therefore in the adhesion.

The aim of this work is to correlate the interphase morphology of the polypropylene samples with its adhesive properties.

### MATERIALS AND METHODS

Specimens were produced by injection moulding on a standard cavity for impact test specimens. The material used was an homopolymer polypropylene .

From a rectangle (5mm width) removed off the specimen, like depicted in Figure 1, a 10 $\mu$ m layer, transversal to the flow direction, was sliced and analysed by polarized light microscopy in order to assess the morphology and crystalline structure development through the thickness. Afterwards, 10 sections with 10 $\mu$ m thickness and 200 $\mu$ m apart, longitudinal to the flow direction, were also sliced (Figure 1).

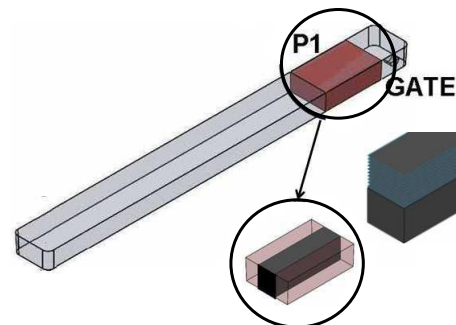


Figure 1: Injection moulded sample geometry with rectangle used to prepare specimens.

### RESULTS AND DISCUSSION

#### Crystallinity

FTIR spectroscopy analysis was carried out to assess the crystallinity degree,  $X_c$ , by applying the Lambert and Beer's law to selected absorbance peaks (Lamberti and Brucato 2003; Lamberti et al. 2003):

$$X_c = \frac{a_r}{a_{cr}} \cdot \frac{A_{cr}}{A_r} \quad (1)$$

where  $A_{cr}$  and  $A_r$  are the absorbancies,  $a_{cr}$  and  $a_r$  the absorption coefficients of the crystalline phase and reference peak, respectively.



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### Molecular Orientation

The molecular orientation was determined by infrared dichroism (Lamberti and Brucato 2003; Lamberti et al. 2003; Samuels 1981; Mendoza et al. 2003). FTIR spectra was collected by polarized beam with the polarization axis parallel and perpendicular to the flow direction. Herman's orientation functions were determined by:

$$f = \left[ \left( \frac{D-1}{D+2} \right) \left( \frac{D_0+2}{D_0-1} \right) \right]_v = \left( K_v \frac{D-1}{D+2} \right)_v \quad (2)$$

with the dichroic ratio,  $D=A_\pi/A_\sigma$ ,  $A_\pi$  and  $A_\sigma$  are the absorbancies polarized along parallel and perpendicular directions, respectively, and  $D_0=2.\cotg^2\alpha_v$  is the dichroic ratio of an ideally oriented polymer.

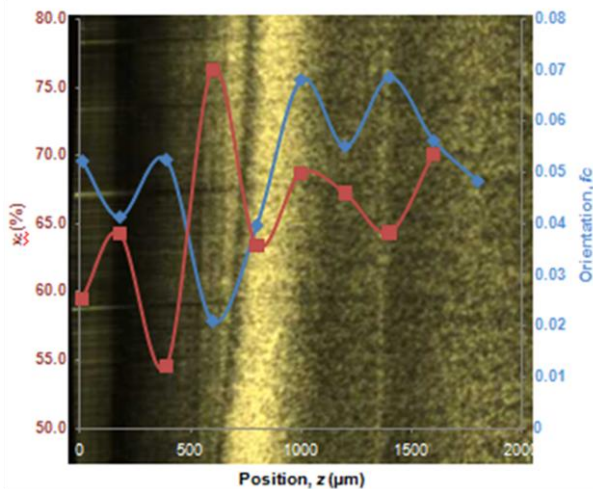


Figure 2: Crystallinity degree vs molecular orientation over the thickness.

### Contact Angle Measurements

The wetting properties of the samples were evaluated by contact angle measurements. Figure 3 shows the correlation between the water contact angle and crystallinity degree with the molecular orientation over the thickness of the moulded specimen.

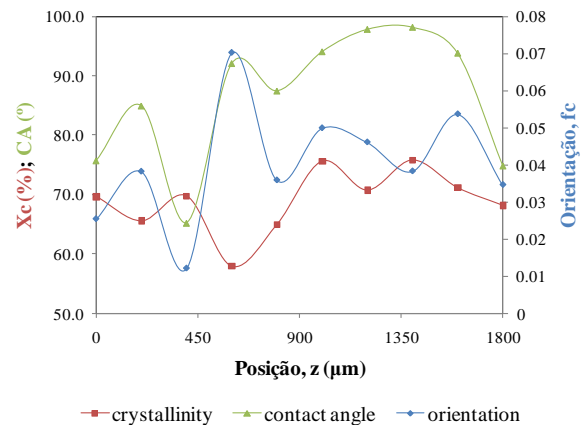


Figure 3: Crystallinity degree and contact angle vs molecular orientation over the thickness.

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