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BL8S3

WAXS and SAXS study of low-fouling carbon nanotube - polypropylene nanocomposites

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1. Background and research purpose

In recent years, a lot of attention has been paid to low-fouling materials that can find use in technologies such as biomedical materials, food technology, membrane and marine coatings.[1] Among the most common materials we find polypropylene, a commodity polymer with a low cost and excellent mechanical properties and processability. Several studies have shown that modification of this polymer with nanofillers help to reduce the fouling.[2, 3] In our group, we prepared a composite containing carbon nanotubes and it has shown promising results. As a complementary part of the fouling study, we must understand the microstructure of the composite and corelate the surface composition with the fouling performance.

2. Experiment contents

Polypropylene was melt-mixed with carbon nanotubes in different mass fractions. Then, net-like samples with a shape typical of a membrane spacer were injected. Samples of about 1 mm of radius were cut from this material and analyzed by WAXS and SAXS at the Aichi Synchrtrohon facility at the BL8S3 line. The resulting patterns were analyzed using Fit2D software.[4]

3. Results and discussion

The Figure 1 shows the WAXS patterns obtained for the plain polypropylene material (Figure 1a) and the carbon nanotube composite containing 15 wt% of the nanotubes (Figure 1b). We observed a higher scattering in the composite due to the highly crystalline CNT material embedded in the composite and a possible increase in crystallinity. The 001 peak of graphitic carbon is absent due to the perpendicular orientation of the nanotubes to the beam, so it might be very weak and/or overlapped by the polymer peaks. However, the SAXS patterns (not shown) evidence a reduction of the spherulite size upon addition of the carbon nanotubes. The WAXS patterns before integrations show a clear biaxial orientation due to the orientation of the polymer during the injection flow. This orientation affect is markedly higher in the carbon nanotubes as evidenced in the Figure 1b. Indeed, carbon nanotubes have been shown to orient during injection due to shear stress,[5] improving in this way the mechanical properties of the nanocomposite. The peak-to-peak ratio of the crystalline peaks to the amorphous phase area shows a large increase after adding the carbon nanotubes, suggesting a nucleating effect. These samples will be examined by calorimetry in order to calculate the crystallinity degree and compare with the

values obtained by X-ray diffraction. These results shown that carbon nanotubes are well dispersed and aligned within the polypropylene matrix and support a possible improvement on the mechanical properties.

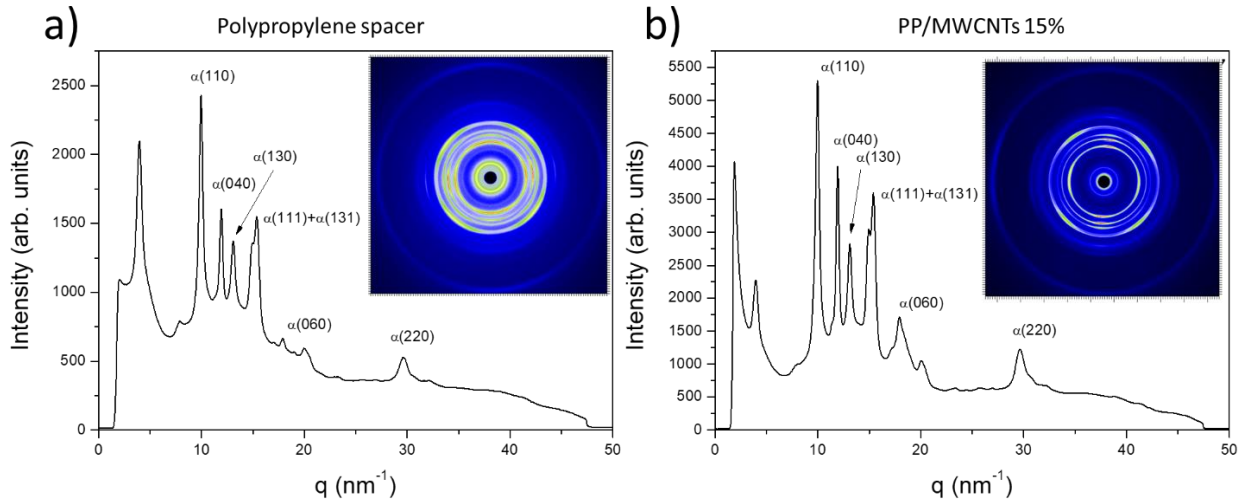

Figure 1. Radially integrated Wide-angle X-ray scattering patterns of a) plain polypropylene and b) polypropylene and carbon nanotubes nanocomposite (15 wt % loading). The insets show the original WAXS patterns before integration.

4. References

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