WAXS study of oriented polymer filled with GNP

Rodolfo Cruz-Silva,[1] Roque Sanchez,[1,2]
Seung Kang,[3] Morinobu Endo,[1] and Mauricio Terrones.[4]
1. Aqua Center of Innovation Shinshu University and Institute of Carbon Science, Faculty of Engineering, Shinshu University, Nagano, Japan.
2. Instituto Potosino de Ciencia y Tecnologia, SLP, Mexico.
3. Korean Institute of convergence, KCTech,
4. Department of Materials Science, Pennsylvania State University.

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1. Background and research purpose

In recent years, a lot of attention has been paid to new materials than can repair autonomeusly, extending its service life without human intervation.[1] Typical behavior involves the dissapearance of cracks and scratch as well as the restoration of the original mechanical properties.[2] This materials are known as self-healing materials and their microsctructure is key to explain how they reconstruct upon damaging. Polyethylene filled with graphite nanoplatelets has long been known as a self healing material.[3] Graphite nanoplatelets are a good alternative to carbon nanotubes. In this work, we analyze several samples of graphite nanoplatelets filled polyethylene as a promising material for self-healing applications.

2. Experiment contents

Polyethylene was melt-mixed with graphite nanoplatelets in different mass fractions. Then, samples were prepared by compression molding under 10 T of force into a sheet of about 800 micron thick. Samples of about 1 mm of radius were cut from this material and analyzed by WAXS and SAXS at the Aichi Synchrothron facility at the BL8S3 line in different orientations. The resulting patterns were analyzed using Fit2D software.[4]

3. Results and discussion

The Figure 1 shows the WAXS patterns obtained for the plain polyethylene material (Figure 1a) and the graphene nanoplatelet filled polyethylene containing 8 wt% of the nanoplatelets (Figure 1b). Polyethylene show the typical rings due to the (110) and (200) reflections. After adding the graphite nanoplatelets, we observed a new ring in the composite due to the highly crystalline graphite material embedded in the composite. The 002 peak of graphitic carbon has a clear orientation indicating that the layers of graphite are parallel to the beam, which indicates an in-plane orientation during the hot-pressing process. However, the SAXS patterns (not shown) indicate a reduction of the spherulite size upon addition of the graphitic nanoplatelets. The WAXS patterns show a clear in-plane orientation due to the flow of polymer during the compression molding. This orientation affect is markedly higher in the graphite nanoplatelets reinforced sample shown in the Figure 1b. It is well known that compression molding induce biaxial orientation in the films due to the radial flow of the molten thermoplastics. The peak-to-peak ratio of the crystalline peaks to the amorphous phase area shows a large increase after adding the graphite nanoplatelets, 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 graphite nanoplatelets are well dispersed and aligned within the polyethylene matrix and support a possible improvement on the mechanical properties and the possibility to generate a self-healing behavior.

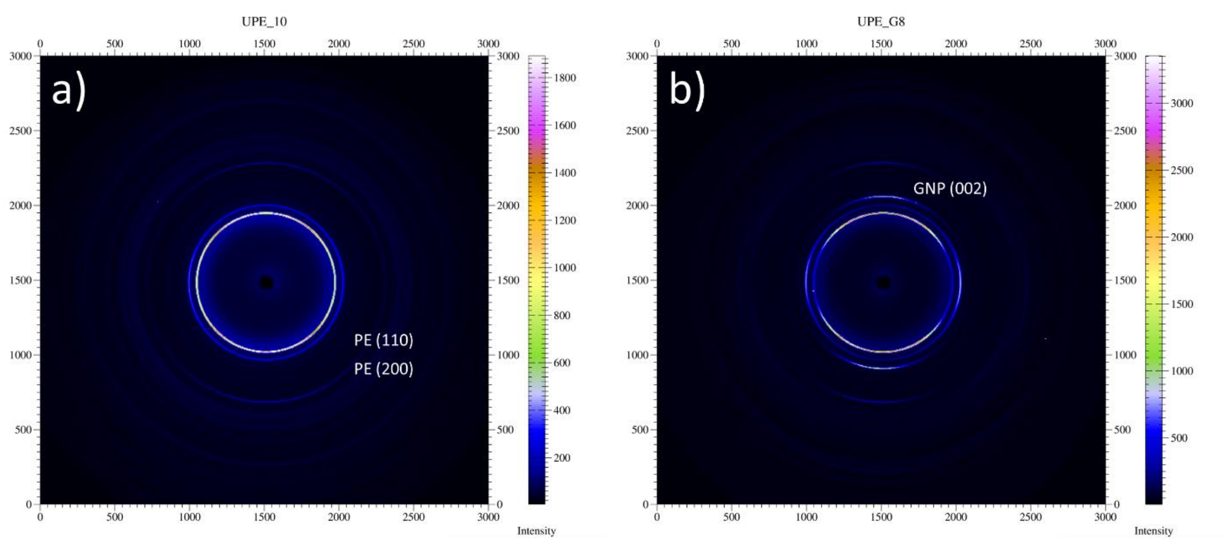

Figure 1. Radially integrated Wide-angle X-ray scattering patterns of a) polyethylene and b) polyethylene filled with graphite nanoplatelets nanocomposite (8 wt % loading).

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