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Mechanical Analysis and Near-Infrared Spectroscopy of Natural and Artificial Weathering of HIPS

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The term weathering was introduced to describe all the possible changes, that a polymeric material can suffer at molecular level during use conditions[1,2]. These changes refer to the mechanical properties, and also aesthetic changes as color, transparency and shine loss[3]. Test methods have been developed to simulate natural weather at an accelerated rate, so that long term weathering effects can be estimated in a shorter time. However, such artificial tests do not necessarily give the exact response that a plastic material will exhibit in actual use. Studies of properties such as composition, refraction index, viscosity etc, using the Near Infrared Spectroscopy (NIR) has been described in the literature[4]. This work shows the effect of the natural and artificial weathering of High Impact Polystyrene (HIPS), a commodity polymer used in packing, toys, automotive components and other applications on mechanical properties and the NIR spectrum. The goal is to obtain a NIR spectral correlation between the two kinds of photo-degradation process. Test specimens of the HIPS polystyrol 446 N from BASF, were obtained in an injection machine Batlenfeld 1980, in the usual shape for mechanical tests. The test specimens were exposed in the Natural Ageing Station of the Instituto de Pesquisas Tecnológicas (IPT) gone back to the north at São Paulo, located at S Latitude: 23° 34' and W Longitude: 46°44', in an angle of 45° with the horizontal, in the period of January of 2000 to July of 2000 for 0, 30, 60, 90, 120, 150 and 180 d. Plates of 65 mm x 150 mm and 3 mm thickness, with one face exposed to the lamps were used. A Weather O'Meter Model 65 WRC - WOM-001 equipped with a xenon lamps (6500 W) with internal and external borosilicate glass filters was used. The radiation was the natural radiation of the day and the temperature on black panel was (63 ± 3)°C. The cycle consisted of 102 min of irradiation without water and 18 min of water spray. Time exposition of 0, 15, 30, 45, 60, 75 and 90 d. The NIR reflectance spectra from 12000 to 4500 cm^{-1} were obtained in a FT-IR spectrometer Bomem model MB 155S,

with DTGS detector and dual source (tungsten/halogen) with 4 cm^{-1} resolution.

The tensile strength and elongation at break properties of HIPS submitted to natural and artificial weathering are presented in the Figure 1. In the HIPS submitted to both natural and artificial weathering, a decrease in tensile strength with the increase in exposition time was observed, from 17,7 MPa (0 d) to 15 MPa (180 d) and (90 d), respectively. The elongation at break follows the same behavior decreasing form 3,5% (0 d) to 1% (180 and 90 d), respectively.

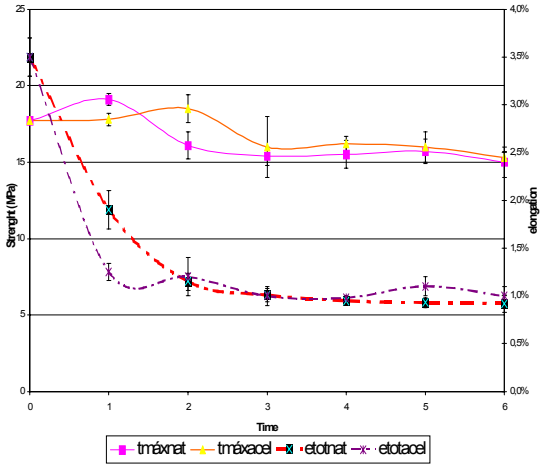

Figure 1. The tensile strenght (t) and elongation at break (e) to natural (nat) and artificial (acel) weathering. Where 1 = 30 d (nat) and 15 d (acel) and so on.

These results from Figure 1, show that the artificial weathering has accelerated the degradation in approximately 2 times. The NIR spectra of HIPS exposed to natural (0, 180 d) and artificial (90 d) weathering are showed in Figure 2. As shown in Figure 2, the mostly spectral differences observed between the NIR spectra are the intensity ratio. As the absorption observed in the NIR spectrum came from CH vibrations, the difference in the intensity can be attributed to the sample degradation with the increase of time of exposition and this degradation is higher in the artificial weathering.

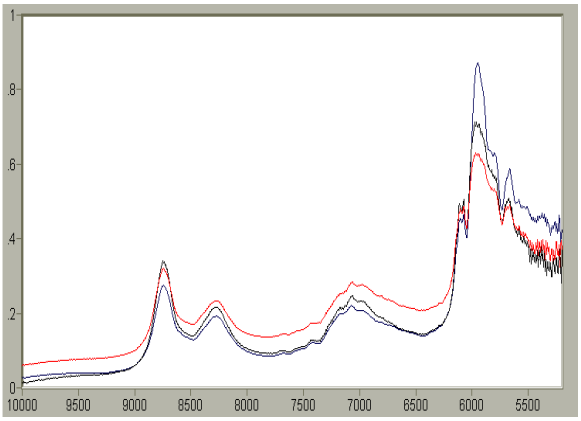

Figure 2. The normalized HIPS NIR spectra. (cm^{-1}). Blue 0 d, Black 180 d and Red 90 d.

The spectral variability observed in the NIR spectrum of the HIPS exposed to natural and artificial weathering can be used to establish a correlation between natural and artificial weathering though the use of chemometrics.

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