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Impact of thermal oxidation of polymers on features of fluorescent probes

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Abstract

The aim of this work was to evaluate the potential of 2-dimethylamino-6-propionylnaphthalene (denoted Prodan®) as a sensitive fluorophore for monitoring the oxidation of polymers at low extent of oxidation within the "induction period" and for characterizing the chemical modification of polymers induced by thermal oxidation. The fluorophore was introduced into polyethylene films (85 microns thick) by soaking in a methanolic solution before and after thermal oxidation carried out for various durations. The emission features of this fluorescent probe are known to be strongly dependent on the polarity of the medium. Changes in polarity due to the formation of oxidized products provoked a notable shift of the wavelength at the maximum of fluorescence, which was correlated to the extent of the oxidation measured by infrared spectroscopy. Moreover, the emission intensity of the probe was observed to dramatically increase with the amount of oxidation products. It was observed that there was a good correlation between the wavelength at the emission maximum, the amount of fluorophore absorbed, and the oxidation extent. Interestingly, the modification of the fluorophore features was detected within the induction period when no oxidation product could be detected by infrared spectroscopy. The probe fluorescence was then used as a sensitive and easy method to monitor the chemical modification of the polymer at the early stages of oxidation.

Keywords: polyethylene, thermooxidation, Prodan®, fluorescence, emission properties, polarity

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