

Abstract

Abiotic Surface Degradation Induced by Ozonation on Poly (Lactic Acid) (PLA)/Poly (Butylene Adipate-co-Terephthalate) (PBAT) Blends [†]

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1. Introduction

Biopolymers have emerged as sustainable alternatives to conventional plastics, showing advantages like biocompatibility, biodegradability, and non-toxicity [1]. Nevertheless, their aging processes under service life conditions still need a deeper evaluation [2,3]. This study examined films of three commercial compositions for rigid/flexible packaging based on poly (lactic acid) (PLA)/poly (butylene adipate-co-terephthalate) (PBAT) blends under oxidative degradation conditions.

2. Methods

Commercial PLA/PBAT films, of 100 µm thickness, were exposed to short- (0–2 h) and long-term ozone aging (24–96 h) in an Anseros SIM 6050 T chamber at 40 °C and 300 pphm of ozone concentration.

Analytical characterization included measurements for surface hydrophilicity analyzing water contact angle (WCA), microscopic morphology using a Hitachi S-4800 (Tokyo, Japan) scanning electron microscope (SEM), chemical structure by means of attenuated total reflectance Fourier transform infrared spectroscopy (FTIR-ATR) in an Agilent Technologies Cary 630 FTIR Spectrometer (Santa Clara, CA, USA), thermal properties through differential scanning calorimetry (DSC) in a Setaram Setline+ DSC (Caluire-et-Cuire, France), and mechanical performance through tensile tests in a PCE Instruments MTS500-FD 300 KIT setup (Albacete, Spain).

3. Results and Discussion

Ozonation caused significant variations in surface properties after long-term ozone treatment, demonstrated by a constant decrease in WCA. A 96-h treatment led to abiotic degradation revealed by chemical structure analysis, where carbonyl and carboxyl indices were reduced by 17% and 16%, indicating degradation of oxidized functional groups and products, along with mild chain scission. Surface morphology showed surface changes with initial oxidation, reinforcement and re-degradation tendencies. These changes were



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limited to surface modifications, as slight bulk changes were reported in thermal properties. Mechanical performance improved with the aging factor increasing from 0.5 to 0.9 to 1.14–1.30, suggesting that structural stability was maintained. Phase distribution within the polymer matrix influenced the extent of abiotic degradation. The progressive increase in additives such as plasticizers and inorganic fillers likely buffered the effects of ozone treatment.

4. Conclusions

Short- and long-term treatments promoted oxidative degradation of biodegradable film surfaces. Only long-term exposure led to macroscopic surface damage, altering morphology, chemical structure, and hydrophilicity, without affecting deeper layers, while maintaining thermal properties and slightly enhancing mechanical performance.

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