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DESIGN OF MECHANICAL PROPERTIES OF POLY(BUTYLENE-ADIPATE-TEREPHTHALATE) REINFORCED WITH ZEIN-TiO₂ COMPLEX

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Introduction

The realization of composite materials aims to modify the properties of the matrices, besides lowering their costs [1].

Poly (butylene-adipate-terephthalate) (PBAT) is a flexible thermoplastic biodegradable polymer that has gained increasing attention in the last years.

Zein is a protein derived from corn, with film-forming ability but characterized by poor mechanical properties [2].

TiO₂ is an amphoteric, inert, non-toxic, and biocompatible metal oxide, widely used as a white pigment in the food industry and recently employed as a reinforcement for zein films [3].

The study of the interactions between matrix and filler is crucial to define the properties of the composites. Several theoretical models allow correlating the tensile properties to the effectiveness of the reinforcement.

In this study, PBAT-based composites are reinforced with a zein-TiO₂ complex (ZTC) at different concentrations. The mechanical characterization is carried out through a uniaxial tensile test (UTT) and the obtained properties are modeled through the application of Kerner's and Pukánszky's models.

The composites were realized by solvent casting at 4 different filler concentrations: 0, 5, 10, and 20 wt%, named PBAT, PBAT+5% ZTC, PBAT+10% ZTC and PBAT+20% ZTC, respectively.

Specimens 1BA (standard ISO 527) were obtained by injection molding of the pelletized casted films and subjected to UTT at a constant speed of 100 mm/min up to failure. Averaged values of Young's Modulus (E), yield stress (σ_y), stress at break (σ_B), elongation at break (ϵ_B), and toughness (T) were calculated.

Generalized Kerner's equation [4, 5] was applied to compare experimental values of E obtained from the mechanical analysis with predicted calculated values.

Pukanszky's model was applied to σ_y and σ_B , respectively [6, 7], to analyze the trend of experimental tensile and to investigate the extension of the interphase interaction through the calculation of the empirical parameters B and B_b , respectively. The composite microstructure was investigated with scanning electron microscopy (SEM).

Result and discussion

The stress-strain curves obtained by the UTT are reported in Figure 1.

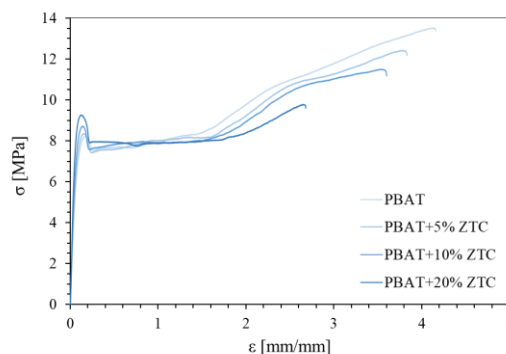


Figure 1: Stress-strain curves of PBAT and PBAT composites obtained by UTT

The composites showed increments of E and σ_y up to 44 and 10%, respectively, besides, the overall reduction of 27, 33, and 42% of respectively σ_B , ϵ_B , and T , confirming a stiffening effect at expenses of the flexibility of the pristine matrix.

The application of generalized Kerner's model was expressed on the reduced modulus (the ratio between the composite (E') and the neat polymer (E'_0)) as a function of the volumetric filler fraction ϕ_f . Remarkable agreement was found between the experimental and the theoretically predicted values, even at the highest filler concentration (Figure 2).

