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Study of PBAT/PLA bio-based blends reinforced with chicken eggshell nano powder compatibilized with ionizing radiation

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Abstract

Eggshell is a solid waste, with production of several tons per day and it is mostly sent to landfills at a high management cost. A few used of eggshell include: fertilizing the garden, cleaning pots and pans, seed starter, feeding birds, making bone broth, etc… Nevertheless, chicken eggshell biowaste has recently been used to substitute calcium carbonate (CaCO3), due to its reinforcing property and low price. It is economically viable to transform eggshell waste to acquire new values, transforming it into a bioplastic: a biodegradable polymer made from bio-mass. The surprising strength of eggshells endorses their application for reinforcement of biodegradable polymers herein studied: PLA (poly-lactic acid) and PBAT (butylene adipate co-terephthalate). PLA is derived from renewable sourced: polylactic acid plastics are sturdier and capable to be blend with conventional petroleum polymers; nevertheless, they exhibit a narrow process window and low thermal stability, besides an inherent high cost. PBAT, as PLA, is a biodegradable aliphatic polyester, although a synthetic polymer based on fossil resources. By incorporating PBAT in PLA it is expected to improve flexibility of PBAT/PLA blend. Previous studies using PBAT/PLA, 50/50 blends containing 15% of chicken eggshell 125 µm improved mechanical behavior of net blends: values for both force and strain practically doubled, proving the effective reinforcement action of calcium carbonate extracted from eggshells. Conventional polymer processing methods can be used in both PLA and PBAT compositions. Due to common incompatibility between PLA and PBAT, considering their extreme glass transition temperatures: 62 ° C and – 30 ° C, respectively, it is required a compatibilizer to accomplish or increase their interaction. Herein it was used PLA previously e-beam radiated at 150 kGy, as compatibilizing agent: ionizing radiation induces compatibilization by free radicals, improving the dispersion and adhesion of blend phases, without the use of chemical additives and at room temperature. Herein there were prepared bio-composite PBAT/PLA 82/18 blends with 2.5, 5.0 and 10.0 % of eggshell nano-powder, 161 nm, in average, and 5.0 % of PLA 150 kGy e-beam radiated were homogeneized in a co-rotating twin-screw extruder. Subsequent investigations included: Differential Scanning Calorimeter (DSC), Thermal Gravimetric Analysis (TGA), Fourier Transmittance Infrared (FTIR), X-Ray Diffraction (XRD), Tensile Strength and Elongation at Break

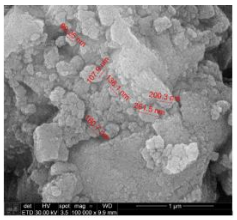

Figure 1. chicken eggshell nano powder

Table 2: Material designation and composition for PBAT/PLA/CaCO3/PLA 150 kGy e-beam radiated

Designation	PBAT (wt%)	PLA (wt%)	Bio CaCO3 nanopwder (wt%)	PLA 150 kGy, e-beam (wt%)
PBAT	100	--	--	--
PBAT82	82	18	--	--
Sample 1	82	18	2.5	5
Sample 2	82	18	5.0	5
Sample 3	82	18	10.0	5
PLA	--	100	--	--

Keywords—eggshell, e-beam radiation, PBAT, PLA.

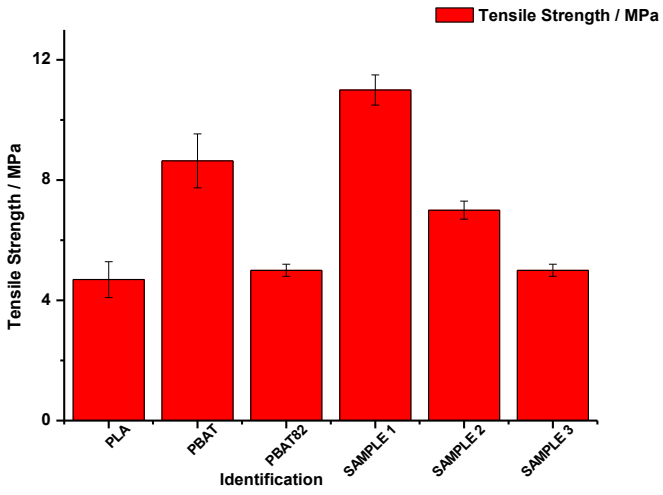

Figure 10. Tensile Strength for samples and their constituents

Biography:

E. C. L. Cardoso is a chemical engineer who completed his PhD in 2014, in Ipen: Instituto de PesquisasEnergéticas e Nucleares / USP – Universidade de São Paulo and completed postdoctoral studies in Ipen: 2015 – 2016: Development of partially biodegradable foams from PP/HMSPP blends with apliphaticpoliesters, intercalated with nanoclaysand 2017 – 2019: Development of foams based in biodegradable composites reinforced with bio micro and nano paricles e-beam compatibilized. Actually, as volunteer researcher in Ipen, develops project based in structural foams from PE/EPDM ionizing irradiated.

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