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Biopolymers 2019: Nanocomposites foams of polypropilene modified by ionizing radiation containing CaCo3/ag° nanoparticles of bio-calcium carbonate-study of bactericidal effect-DucleF rc Parra-Instituto de Pesquisas Energeticas e Nucleares IPEN

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Foamed polymers are future materials, considered "green materials" due to their properties with very low consumption of raw materials; they can be used to ameliorate appearance of structures besides contributing for thermal and acoustic insulation. Nevertheless, waste disposal has generated about 20–30% of total of solid volume in landfills besides prejudicing flora and fauna by uncontrolled disposal. The development of biodegradable polymers aims to solve this problem, considering that in 2012, bio-plastics market was evaluated in 1.4 million tons produced and in 2017 attained 6.2 million tons. Biodegradable polymers as poly(lactic acid) and poly(butylene adipate-co-terephthalate) are thermoplastics which can be processed using the most conventional polymer processing methods. PLA is high in strength and modulus but brittle, while PBAT is flexible and tough. In order to reduce interfacial tension exhibited by PLA/PBAT blends, it was used as compatibilizing agent 5phr of PLA previously gamma-radiated at 150kGy. Ionizing radiation induces compatibilization by free radicals, improving the dispersion and adhesion of blend phases, without using chemical additives and at room temperature. As a reinforcement agent, calcium carbonate from avian eggshell waste was used, at 10ph of micro particles, 125µm. Admixtures were further processed in a single-screw extruder, using CO2 as physical blowing agent (PBA). Property investigations were performed by DSC, TGA, XRD, SEM, FTIR, and mechanical essays.

Introduction:

Natural polymers, biopolymers, and synthetic polymers based on annually renewable resources are the basis for the twenty-first-century portfolio of sustain-able, eco-efficient plastics. The interest on these polymers is considerable, due to a decrease of world resources in oil; in addition, there is a concern to limit the plastics' contribution to waste disposal. The degree of concern has been raised

Use of Gamma Radiation Techniques in Peaceful Applications along with the development in urbanization. The development of biodegradable polymers generally catches the attention of researchers due to environmental problems associated with the disposal of petroleum based polymers. The depletion of petroleum resource led to considerable research efforts on the development of biodegradable polymeric materials. In addition, natural polymer-based materials offer a feasible alternative to the traditional polymeric materials when recycling of synthetic polymer is not cost-effective or technically impossible.

Materials:

Both PLA and PBAT were dried at 70°C for 12h before processing. PLA irradiated in a Cobalt-60 source, 150kGy, 10.5kGYh−1 dose ratio, at multipurpose reactor, in CTR/IPEN, Instituto de Pesquisas Energéticas e Nucleares, São Paulo. Carbon dioxide (CO2): physical blowing agent, selected according to good diffusion in PLA foaming. Calcium carbonate (CaCO3) from avian eggshells: white chicken eggshells were subjected to a thorough cleaning using tap water for removing of internal membranes. Afterward, clean eggshells were kept for 4h in a 100°C water bath.

Preparation and processing

Composite materials were prepared they were first homogenized by melting extrusion process, using a corotating twin-screw extruder (HAAKE Rheomex 332p, 3.1L/D, 19/33 compression ratio), by using a 120–145°C temperature profile and 50rpm.Homogenized samples (pellets) were further subjected to extrusion under pressure, by expansion physical method using carbon dioxide (CO2) as blowing agent, at 10bar. A mono-screw specific for foaming was used, maintaining the same temperature profile: 130–145°C. Characterization-Differential scanning calorimetric analyses (DSC) Thermal behaviour was examined in a DSC Mettler Toledo apparatus, according to ASTM D3418-08. A set of heating/cooling ramps was carried out following a three-step process the samples were firstly heated to 200°C and kept in the molten state for 10min to erase the thermal history of the material.

Main characteristics of used polymers:

Study of Bio-Based Foams Prepared from PBAT/PLA Reinforced with Bio-Calcium Carbonate to 30°C at 10°Cmin−1 to evaluate the ability of PLA, PBAT. After cooling treatment, the samples were heated back to 200°C at 10°Cmin−1. The percent crystallinity of each one was calculated separately, upon the second heating by using x c (%Crystallinity) = ΔH m ΔH mo × 100 w where ΔHm is the measured heat of fusion, w is the weight fraction of PLA or PBAT in the blend, and ΔHom is the enthalpy of fusion for a crystal having infinite crystal thickness (93Jg−1 for PLA and 114Jg−1 for PBAT). Thermogravimetric analyses (TG) Thermogravimetric analyses provide complimentary and supplementary characterization

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information to DSC, by measuring the amount and rate (velocity) of change in the mass of a sample as a function of temperature or time in a controlled atmosphere. Measurements are used primarily to determine the thermal and/or oxidative stabilities of materials as well as their compositional properties. Spectra were obtained from a PerkinElmer, universal ATR sampling accessory spectrum 100 FTIR spectrometer. Setup collection sample was adjusted for 64 scans, within a 4000–650 ⌄cm−1 range. Tensile and elongation at break Tensile and elongation at break essay are relevant instruments for evaluating loss of properties and evolution of degradative process of the polymer.

Conclusion:

Interaction between PLA and PBAT, registered from thermal analyses, proved to be fundamental for accomplishment of investigations. Addition of calcium carbon-ate from avian eggshells proved to be effective for reinforcement of PBAT/PLA blends, according to mechanical tests. PLA gamma-radiated at 150kGy, used as compatibilizing agent, provided a higher crystallinity in assessed samples, as it can be seen from DRX analyses, exhaustively shown in separate graphs: in summary, it contributed for the effective interaction between components and further good performance in mechanical essays. Spectra obtained from infrared determinations were typical for PLA, PBAT, and their blends; nevertheless, insertion of bio-CaCO3 and PLA gamma-radiated at 150kGy contributed for more defined peaks, within 2750 and 3200cm−1. SEM analyses pointed toward the acquisition of structural closed-cell foams, with no interference of naturally immiscible PLA and PBAT; this efficacy can be attributed to PLA gamma-radiated at 150kGy, capable to provide a complete and expected interaction between bio-CaCO3 and PBAT/PLA blends.