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EFFECTS OF GAMMA IRRADIATION ON THE STRUCTURAL AND THERMAL PROPERTIES OF STYRENE-BUTADIENE BIO-COMPOSITES FILLED WITH MICROALGAE

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Introduction

Radiation processing of polymers or elastomer/plastic blends is gaining increased attention as an alternative to traditional chemical methods for modifying the molecular structure of these materials. It is known that the primary effect of gamma radiation on polymers is the generation of free radicals, which can lead to chain scission, branching, and/or cross-linking. These processes typically occur simultaneously, with their prevalence influenced by various factors. Among the most significant are irradiation parameters, such as the total absorbed dose and dose rate, which impact the concentration of reactive species and, consequently, the reaction kinetics.

To address the issue of microplastic pollution, it is crucial to develop methods that can initiate material degradation or biodegradation through external stimuli not typically encountered during the polymer's lifecycle. One potential solution involves irradiating plastic waste, followed by its disposal in a landfill, where the polymer undergoes accelerated biodegradation. Additionally, the inclusion of fillers like microalgae can supply nutrients that support the growth of microorganisms capable of degrading polymers. This study aims to evaluate the behavior of biomass and microalgae filled styrene-butadiene-styrene (SBS) composites that were subjected to radiation doses of 25, 50, and 100 kGy.

Materials and methods

The combination of microalgae as a filler in styrene-butadiene composites, followed by gamma irradiation, is a novel approach for investigating material properties. The use of FTIR (Fourier-Transform Infrared Spectroscopy) and DSC (Differential Scanning Calorimetry) for characterization provided detailed insights into both the chemical structure and thermal properties of the composites.

In this study, a base polymer composite was prepared using 25% (w/w) SBS1 copolymer (with 30% styrene content), 50% (w/w) SBS2 copolymer (with 40% styrene content), and 25% (w/w) paraffin oil. A mass ratio of 1:2 for SBS1 to SBS2 was selected to allow the paraffin oil to be absorbed at 25% (w/w), which was found to be optimal for incorporating biomass. This formulation was determined through preliminary tests aimed at maximizing the amount of algal biomass that could be added. Reducing the paraffin oil content caused the extrusion machine to clog when higher percentages of algal biomass (up to 30%) were introduced.

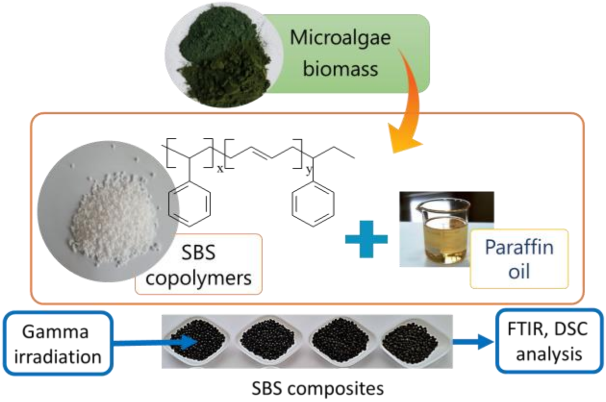

Figure 1. Irradiation procedure of microalagae-SBS composites

FTIR and DSC investigated the modifications induced by the irradiation procedure (Figure 1) of biomass and microalgae-filled styrene-butadiene-styrene (SBS) composites subjected to radiation doses of 25, 50, and 100 kGy.

Results and conclusions

Irradiation may cause bond breakages, cross-linking, or oxidation, which can alter the spectral peaks in the infrared region. By comparing the FTIR data of irradiated and non-irradiated samples was used to identify any new functional groups or changes in existing bonds. These changes are indicators of degradation, cross-linking, or oxidation in the material. DSC analysis showed that gamma irradiation altered the thermal properties due to changes in molecular weight or cross-link density. By comparing the DSC thermograms of irradiated and non-irradiated composites, it was assesed the radiation effect on the material's thermal stability.

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