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THERMAL STUDY OF STYRENE-BUTADIENE COMPOSITES WITH *ARTHROSPIRA PLATENSIS* BIOMASS

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Introduction

Spirulina (*Arthrospira platensis*) is a promising candidate for augmenting the biodegradability of polymer materials. This cyanobacteria often denoted as blue-green algae, has gained attention due to its diverse potential applications. Notably, it can serve as a biomass filler in the production of biodegradable polymers alongside natural rubber, ethylene propylene diene monomer rubber (EPDM), polylactic acid (PLA), poly(butylene succinate) (PBS), polyvinyl alcohol (PVA), and polypropylene (PP). The composition of *Arthrospira platensis* biomass primarily comprises mainly carbohydrates, lipids, proteins, and pigments. Considering these numbers, spirulina exhibits good promise as a high-protein content biomass filler for the development of biodegradable polymer materials. Thus, contributions to aligning with the objectives related to mitigation of the environmental impact of plastics and advancing to sustainable alternatives. Nevertheless, to successfully integrate Spirulina biomass into polymer materials, several factors must be carefully considered. These include the selection of appropriate processing methods that provide compatibility of the bio-filler with the polymer matrix, as well as optimizing the Spirulina content to achieve the desired properties without compromising the overall performance of the composite material. The aim of this study was to evaluate the thermal behavior of polymer composites incorporating Spirulina biomass in different mass ratios.

Materials and methods

For the present study, a styrene butadiene styrene (SBS) polymer composite made by mixing SBS and paraffin oil (3:1, w/w) was prepared and further used to incorporate *Arthrospira platensis* biomass in 5, 10, 20, and 30 % (w/w) ratios. The polymer composites subjected to the degradation test were characterized by thermal analysis, and differential scanning calorimetry (DSC) technique to evaluate the

effect of algal biomass added on the polymer material. Incorporation of the biomass powders up to a relatively high percentage was ensured by the relatively high percentage of paraffin oil in the base-polymer. The DSC measurements were performed with a thermal analysis system DSC3-StarE (Mettler Toledo, Switzerland) by heating the samples from 30 °C to 300 °C, in 40 μ L aluminum crucibles. The heating rate was set to 5 K \cdot min⁻¹ to reduce the thermal gradient effect and to distinguish clearly the transition peaks.

Results and conclusions

DSC curves of the tested composites showed significant changes in the thermal behavior of the polymer matrix when spirulina algal biomass was added as filler.

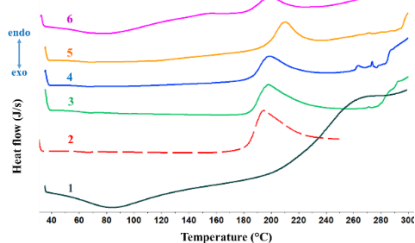


Fig.1. DSC comparative curves for

- 1 – *Arthrospira platensis* powder, and SBS composite with:
2 – 0 %, 3 – 5 %, 4 – 10 %, 5 – 20 %, and 6 – 20 % *Arthrospira platensis* biomass (w/w)

By analyzing the recorded DSC curves (Figure 1), one may observe that an endothermic thermal effect is recorded in the range of 170–200 °C associated with the melting of the polymer. This effect decreases with the increase of the biomass concentration in the composite polymer mass. The evolution of the melting temperature (onset values indicating the process debut) indicates that the addition of biomass influences the flow of the polymer upon heating. Also, it was observed that the glass transition temperature for the samples of SBS composites was in the range 69–70 °C, except for the composites containing spirulina powder in a proportion of 30%. The thermal behavior of tested composites suggests that there is a reduced interaction between the polymer matrix and the bio-filler, as similar glass transition temperatures T_g were recorded for samples with 5 %, 10 %, and 20 % *Arthrospira platensis* biomass incorporated. The studied bio-filler added to the polymer mass is a complex mixture of lipids, protein, and carbohydrates that may contribute differently to the global thermal effect recorded. This effect is best observed by the change of the curve shape for the composite containing 30% spirulina when compared with composites with a lower percentage of biomass. The addition of spirulina biomass to a polymer matrix can result in a complex mixture with various thermal effects: denaturation or decomposition of proteins, melting or crystallization of lipids, thermal decomposition, or phase transitions for carbohydrates.

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