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INFLUENCE OF *CHLORELLA VULGARIS* BIOMASS CONTENT ON THE THERMAL BEHAVIOUR OF STYRENE BUTADIENE STYRENE COMPOSITES

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Introduction

Using bio-based components in thermoplastic composites can offer advantages, such as reduced cost and different properties of the polymer material. Bio-based resources can be cost-effective compared to certain synthetic alternatives, as they are readily available, and accessible for a wide range of applications. An important feature of the obtained polymer composites is the recyclability and biodegradability. Microalgae are a diverse group of microorganisms that come in various shapes and sizes, including rods and spheres with sizes in the 2-200 µm range. The microalgae biomass is of significant interest due to its potential applications in biotechnology, biofuel production, and materials science (*i.e.* polymer composites with biogenic fillers). Microalgae are primarily composed of various biopolymers, such as proteins, lipids (fats and oils), and carbohydrates (cellulose, starch, other polysaccharides). As these compounds are biodegradable and renewable, microalgae qualify as suitable candidates for development of eco-friendly polymer composites, in contrast with traditional fillers as glass fibers or carbon nanotubes, which may not be environmentally friendly. When incorporated into polymer composites, microalgae-based fillers may enhance mechanical properties of resulting materials. However, many challenges are associated with the use of microalgae-based fillers. Some refer to efficient blending methods, compatibility of the biomass with different polymer matrices, while others may refer to ensuring a consistent quality and purity of the bio-fillers, especially when they are used as secondary raw materials.

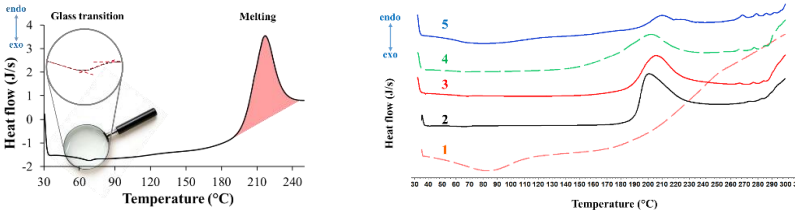
Materials and methods

The base polymer matrix was prepared by extrusion of a three components mixture (mass %): 25 % of a linear SBS1 copolymer (30 % styrene, 70 % butadiene), 50%

SBS2 copolymer (40% styrene, 60% butadiene), and 25% (w/w) paraffin oil. The microalgal biomass of *Chlorella vulgaris* (powder with 5 ± 0.5% moisture) was incorporated in the base-polymer-matrix so that the biogenic content in the final bio-composite polymer was of 5, 10, 20 % (w/w). The incorporation of the biomass powders was facilitated by the relatively high percentage of paraffin oil in the base-polymer. Characterization of the new composites with different bio-fillers content has been performed by thermal analysis, the technique differential scanning calorimetry (DSC3-StarE, Mettler Toledo, Switzerland). The DSC measurements were performed by heating the samples in the temperature range of 30 - 300 °C. A heating rate of 5 $K \cdot min^{-1}$ was applied, so that a reduced thermal gradient effect and clear transition peaks may be recorded.

Results and conclusions

DSC curves of the tested composites indicated significant changes of the thermal behaviour of the polymer matrix (Figure 1), in relation with the masic concentration of the bio-filler in the base polymer matrix.



a **b**

Fig. 1. – a) Glass transitions and melting thermal effect for the SBS composites tested, b) DSC comparative curves for 1 - *Chlorella vulgaris* powder, and SBS composite with 2 – 0 %, 3 – 5 %, 4 –10 %, 5 – 20 % *Chlorella vulgaris* biomass (w/w)

It was observed that the glass transition temperature (Tg) for SBS polymer composites samples was in the range of 69-70 °C, except for the composites containing *Chlorella* powder in a proportion of 20 %. On the other hand, there is a decrease in the thermal effect that accompanies the melting of the polymer composite with the increase in the content of algal biomass filler that was added, as may be observed in Figure 1 b). When a polymer is mixed with a filler material, various types of interactions can occur between the polymer chains and the filler particles. When some covalent or non-covalent bonds form between the polymer and the filler, they restrict the movement of the polymer chains in the vicinity of the filler particles. As the filler restricts the molecular mobility of the polymer chains, the polymer's transition from the glassy to the rubbery state is more difficult. As a result, the Tg of the composite material increases, the practical meaning is that the material remains more rigid at higher temperatures. The experimental findings on thermal behavior of the studied composites could show that there is a reduced interaction between polymer matrix and the studied bio-fillers resulting in the same Tg for samples with 5 %, and 10 % *Chlorella vulgaris*.

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