

## RESUMO - CIÊNCIA DOS MATERIAIS

### **SUSTAINABLE COMPOSITE ENGINEERING WITH STYRENE-BUTADIENE RUBBER AND RECYCLED PET: EFFICIENT MECHANICAL REINFORCEMENT USING SECONDARY-ORIGIN CARBON BLACK**

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The growing environmental concern regarding the improper disposal of plastic waste, particularly polyethylene terephthalate (PET) bottles, has driven the development of sustainable solutions within the polymer materials industry. This study aimed to develop synthetic styrene-butadiene rubber (SBR 1502) composites by partially or fully replacing commercial carbon black (CB-N330) with recovered carbon black (rCB), obtained via pyrolysis of recycled PET bottles. Four formulations were prepared: F0 (no filler), F1 (50 per hundred

rubbers of CB-N330), F2 (25 phr of CB-N330 and 25 phr of rCB), and F3 (50 phr of rCB). All samples were processed through conventional mixing on a two-roll mill [1] and subjected to rheometry tests [2], filler dispersion assessment [3], crosslink density measurements [4], Shore A hardness [5], tensile strength [6], and scanning electron microscopy (SEM). The results showed that formulation F1 exhibited the highest performance in terms of torque, hardness (70 Shore A), tensile strength (11.33 MPa), and crosslink density ( $2.89 \times 10^{-4} \text{ mol}\cdot\text{cm}^{-3}$ ), confirming the superior reinforcing effect of CB-N330. Formulation F2 demonstrated intermediate performance, with a tensile strength of 5.92 MPa and good filler dispersion, indicating the feasibility of combining CB-N330 and rCB. Formulation F3 showed lower properties compared to F1 and F2 but outperformed F0, suggesting that rCB contributes partially to matrix reinforcement. It is concluded that the partial substitution of CB-N330 with rCB in SBR composites is technically viable, providing a more sustainable alternative without significantly compromising mechanical and structural properties.

The total replacement with recovered carbon black (F3) resulted in a reduction in properties, especially in tensile strength and homogeneity of dispersion, indicating limitations when used alone. Even so, the results surpassed those of the unfilled composite (F0), highlighting the structuring role of the recovered carbon black.

Therefore, it is concluded that the combined use of conventional and recovered carbon black (F2) represents the best relationship between performance and sustainability, enabling the development of composites with lower environmental impact and technically suitable properties for applications that demand mechanical resistance and good processability.

Palavras-chave: composites; mechanical reinforcement; partial replacement; recycled carbon black from pet; styrene-butadiene rubber.