On the use of infrared thermography to select more sustainable fillers for natural rubber components

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Abstract.

Elastomers are widely used in automotive industry due to their high deformability and good damping properties. For instance, natural rubber (NR) is typically used for antivibratory systems (AVS) due to its remarkable fatigue resistance, especially for non-relaxing loading conditions [1]. Today, the automotive constructors aim at integrating recycled raw materials (RRM) into parts made of elastomers to reduce their environmental impact. Up to now, some conventional reinforcing fillers, particularly carbon black (CB), were replaced by alternative reinforcing recycled or bio-based fillers [2-4]. The main challenge in their replacements lies in ensuring that the mechanical performance is not degraded.

NR mechanical properties are generally attributed to the reversible phenomenon of Strain-Induced Crystallization (SIC), i.e., ability to crystallize at a given stretch level [5]. This phenomenon is strongly influenced by both *(i)* the macromolecular network, and *(ii)* the nature and dispersion of fillers [5-7]. Thus, characterizing the effect of alternative fillers on SIC of NR is crucial to optimize their properties. However, the influence of alternative fillers on the SIC behavior of NR remains clearly unexplored, making this study a valuable contribution to the field.

In this study, SIC is investigated through surface calorimetry based on infrared thermography, a method recently validated on conventional formulations by comparison with X-ray diffraction (XRD) measurements [8-11]. NR-based elastomers filled with recovered carbon black from pyrolysis, rice husk ash, or lignin are subjected to uniaxial cyclic tensile loading. Power density is determined from temperature measurements and the heat diffusion equation, enabling quantification of the SIC contribution to energy dissipation. Special attention is paid to the influence of alternative fillers on the crystallization kinetics under strain and their role in mechanical reinforcement. The differences in crystallinity induced by alternative fillers in NR are highlighted and discussed, offering new insights for the design of more durable and high-performance elastomers.

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