Experimental thermomechanics and energetic behavior of elastomers: revisiting rubber elasticity, viscosity, stress-softening, strain-induced crystallization and energy stored

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Abstract:

Most of phenomena involved in deformation of rubber depend on temperature and have distinguishable thermal and calorimetric signatures. However, since the pioneer investigations being those conducted by Gough and Joule, studies were dedicated more to mechanical response, and the thermal aspects of the deformation of rubber were not really explored experimentally. Revisiting the rubber deformation using experimental thermomechanics should offer therefore new perspectives to better understand damage and deformation mechanisms. This conference discusses the use of the surface calorimetry approach to study rubber deformation. It introduces the theoretical framework for determining heat source (or heat power density) from full temperature field measurements and the heat diffusion equation. The determination of the mean intrinsic dissipation and the strain-induced crystallinity from the heat sources is presented and discussed. Typical results obtained under homogeneous tensile loadings are reviewed and analyzed according to four types of calorimetric responses. The types of responses depend on whether the rubber is filled or not, and whether it is crystallizing or not. The calorimetric signatures of thermo-elasticity, viscosity, strain-induced crystallization, stress softening and energy storage are analyzed and discussed.