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ANISOTROPIC THERMAL CONDUCTION IN POLYMERIC MATERIALS

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The strong coupling of mechanical and thermal effects in polymer processing flows has a significant impact on the final properties of the material. Simple molecular arguments suggest that Fourier's law must be generalized to allow for anisotropic thermal conductivity in polymers subjected to deformation. In our laboratory we have developed a novel, optical method to obtain quantitative measurements of components of the thermal diffusivity (conductivity) tensor in polymers subjected to deformations. In this paper we report measurements of anisotropic thermal diffusivity, stress and birefringence in both molten and solid polymers subjected to uniaxial elongation. One set of data consists of time-dependent measurements the anisotropic thermal diffusivity in a polyisobutylene melt following the cessation of constant strain rate flow. A second set of data involves anisotropic thermal diffusivity measurements made on solid polymer samples that have either been quenched immediately after deformation in the molten state, or that are under stress in an unoriented state. We also report data on cross-linked and semi-crystalline polymers. These data are used to examine the validity of the stress-thermal rule, and to study the molecular origins of anisotropic thermal transport in polymers.