Thermal Transport in Deforming Polymers

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The strong coupling of mechanical and thermal effects in polymer processing flows has a significant impact on both the processability and 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 addition, theoretical results suggest a linear relationship between the thermal conductivity and stress tensors, or a stress-thermal rule. In our laboratory we have developed a novel optical method based on Forced Rayleigh Scattering (FRS) to obtain quantitative measurements of components of the thermal diffusivity tensor in polymers subjected to deformations. We have found the stress-thermal rule to be valid for several polymer systems in both shear and elongational deformations. More recently, we have developed a novel technique based on Infrared Thermography (IRT) that complements FRS and allows for the study of a wider range of polymeric materials. The IRT technique also allows us to investigate the dependence of heat capacity on deformation. These experiments are used to develop an understanding of the molecular origins of anisotropic thermal transport in polymers.