

Thermal Transport and Flow in Polymeric Materials  
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Abstract:

The strong coupling of mechanical and thermal effects in polymer processing flows has profound implications on both the processability and final properties of polymeric materials. Simple molecular arguments suggest that Fourier's law must be generalized to allow for anisotropic thermal conductivity in flowing polymer melts. In addition, theoretical results suggest a linear relationship between the thermal conductivity tensor and stress tensor, or a stress-thermal rule. Using a novel optical method based on Forced Rayleigh Scattering (FRS) developed in our laboratory, we obtain quantitative measurements of all components of the thermal diffusivity tensor in polymers subjected to deformation. These data have been used to carry out the first (and only) tests of the stress-thermal rule, which we have found to be valid for several polymer chemistries 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. These experiments are used to develop an understanding of the molecular origins of thermal transport in deforming polymers.

Bio:

David C. Venerus is a Professor and Director of the Materials Engineering Program in the Otto H. York Department of Chemical and Materials Engineering at NJIT. Professor Venerus' research interests are in the areas of transport phenomena in soft matter, polymer science and the rheology of complex fluids. He is also interested in the theory of interfacial transport phenomena and its applications. In 2018, he co-authored the textbook "A Modern Course in Transport Phenomena" (Cambridge U. Press). He earned Ph.D. and M.S. degrees from Penn State University and B.S. degree from the University of Rhode Island (all in chemical engineering). Prior to coming to NJIT in the fall of 2018, he was on the faculty in the Department of Chemical and Biological Engineering at IIT in Chicago from 1989-2018. He has several times been a Visiting Professor in the Department of Materials at the Swiss Federal Institute of Technology (ETH) in Zürich, Switzerland, and in the Institute for Molecular Engineering at the University of Chicago.