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What We Know and Don't Know About the Thermo-mechanical Behavior of Glassy Polymers

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The thermomechanical behavior of glassy polymers has been the subject of vigorous research for decades, but a fundamental understanding remains one of the outstanding challenges in condensed matter physics. First, the rich phenomenology of the thermo-mechanical behavior will be reviewed with emphasis on some of the more non-traditional experiments like multiple-step thermo-deformation histories and deformation induced changes in the enthalpic responses – experimental data that provides both insight and challenges to a more complete understanding of the glassy state. Second, we will show how a recently developed Stochastic Constitutive Model (SCM) that acknowledges dynamic heterogeneity is beginning to unify the rich experimental phenomenology of glassy thermo-mechanical behavior into a consistent description. Finally, key unanswered questions will be raised – questions that suggest directions for future experimental studies as well as outstanding theoretical challenges.