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Nonequilibrium Thermodynamics of Driven Disordered Materials

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We present a nonequilibrium thermodynamic framework for describing the dynamics of driven disordered solids (noncrystalline solids near and below their glass temperature, soft glassy materials such as colloidal suspensions and heavily dislocated polycrystalline solids). A central idea in our approach is that the set of mechanically stable configurations, i.e. the part of the system that is described by inherent structures, evolves slowly as compared to thermal vibrations and is characterized by an effective disorder temperature. Our thermodynamics-motivated equations of motion for the flow of energy and entropy are supplemented by coarse-grained internal variables that carry information about the relevant microscopic physics. Applications of this framework to amorphous visco-plasticity (Shear-Transformation-Zone theory), glassy memory effects (the Kovacs effect) and dislocation-mediated polycrystalline plasticity will be briefly discussed.