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Local thermodynamic equilibrium for globally disequilibrium open systems under stress

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Predictive modeling of far and near equilibrium processes is essential for understanding of patterns formation and for quantifying of natural processes that are never in global equilibrium. Methods of both equilibrium and non-equilibrium thermodynamics are needed and have to be combined. For example, predicting temperature evolution due to heat conduction requires simultaneous use of equilibrium relationship between internal energy and temperature via heat capacity (the caloric equation of state) and disequilibrium relationship between heat flux and temperature gradient. Similarly, modeling of rocks deforming under stress, reactions in system open for the porous fluid flow, or kinetic overstepping of the equilibrium reaction boundary necessarily needs both equilibrium and disequilibrium material properties measured under fundamentally different laboratory conditions. Classical irreversible thermodynamics (CIT) is the well-developed discipline providing the working recipes for the combined application of mutually exclusive experimental data such as density and chemical potential at rest under constant pressure and temperature and viscosity of the flow under stress. Several examples will be presented.