

Multiscale Rheological Modeling

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The objective of rheological modeling of fluids and solids is to establish a passage between their microscopic physics and macroscopic flow and morphological properties observed in macroscopic experimental observations. Such passage provides a setting for efficiently organizing and recording results collected in the macroscopic experimental observations and for understanding the micro-macro relation. The passage also serves as a tool for making predictions, optimization and control. The multiscale modeling (GENERIC modeling) begins with an abstract mathematical structure (GENERIC structure) of the governing equations that by itself guarantees agreement of their solutions with certain basic experimental observations (namely with the experimentally observed approach of externally unforced systems to equilibrium states at which the classical equilibrium thermodynamics is found to provide a good description of the observed behavior). The insight into the microscopic physics of the fluids and solids under consideration enters the GENERIC modeling in the process of constructing a particular realizations of the GENERIC structure. After solving the governing equations, the validation of the model continues with the comparison of solutions with results of more specific experimental observations. The GENERIC structure thus provides both a scaffold for the modeling and a partial validation of the resulting models. The GENERIC modeling is illustrated on the investigation of the rheology versus morphology investigation of fiber (both rigid and soft) suspensions and rigid sphere suspensions.