

Multiscale viscoelastic deformations of biological tissue

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We present a multiscale method for the simulation of large viscoelastic deformations of biological tissue. At the microscopic level, we consider cells with an elastic cell wall containing a viscous fluid, simulated via smoothed particle hydrodynamics. A hierarchical approach is used to couple this cellular model with a macroscale finite element method for the tissue. As in the equation-free framework, we construct operators to transfer information between the microscopic and macroscopic models. We discuss a lifting operator to initialize the microscopic model consistently in representative volume elements (RVEs), given the macroscopic deformation and velocity. Conversely, a restriction operator estimates macroscopic quantities (stress, elasticity and viscosity) from the RVE. We show how to use this hierarchical approach to construct implicit timesteppers at the macroscale.