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Abstract

We propose viscoelastic smoothed particle hydrodynamics (SPH) with extended boundary conditions as a new method to model the extracellular matrix (ECM) in contact with a migrating cell. The contact mechanics between a cell and ECM is modeled based on an existing boundary method in SPH that corrects for the well-known missing kernel support problem in Fluid Structure Interactions (FSI). This boundary method is here extended to allow the modeling of moving boundaries in contact with a viscoelastic solid. To validate the method, simulations are performed of tractions applied to a viscoelastic solid, Stokes flow around an array of square pillars, and indentation of a viscoelastic material with a circular indenter. By drop out of the inertial terms in the SPH equations of motion, the new SPH formulation allows to solve problems in a low Reynolds environment with a timestep independent of the particle spacing, permitting to model processes at the cellular scale (i.e. μm -scale). The potential of the method to capture cell-ECM interactions is demonstrated by simulation of a self propelling object that locally degrades the ECM by fluidizing it to permit

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