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FREE-BOUNDARY FLOWS OF COMPLEX FLUIDS BY MONOLITHIC METHODS

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ABSTRACT

Biofluids often display complex constitutive behavior due to intrinsic time scales stemming from the presence of large biomacromolecules or deformable particles such as cells. Problems in biomechanics are often coupled because of the presence of deformable interfaces. The coupling is often strong and domain and interface shapes must be resolved accurately because surface forces dominate over inertial ones. We are developing fully-coupled methods for flows of complex fluids with deformable interfaces. The fluid microstructure is described in terms of a continuum variable, the socalled conformation tensor. The conformation tensor obeys a hyperbolic convection relaxation equation which includes the effects of flow-induced microstructural deformation as well as relaxation by entropic or micro-elastic forces. Coupled interfaces are handled with monolithic methods, where all equations of the flow and of the mapping of (unknown) physical domain to a convenient computational domain [1] are solved simultaneously by Newton's method. We show initial results on the steady deformation of viscoelastic droplets in a Newtonian or viscoelastic matrix in confined shear flow. Results on two-dimensional (cylindrical) Newtonian droplets show that the method can handle large deformations accurately (as compared to earlier high-resolution results obtained with the boundary integral method). Results on viscoelastic droplets show considerable difference (5-10%) with earlier calculations by Yue et al. [2] based on diffuse interface methods.

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