

Microstructure and Rheology of Patchy Particle Suspensions via Brownian Dynamics Simulations

Recent experimental and theoretical studies on patchy particles have examined collective structures, phase diagrams, and self-assembly at different particle concentrations, and patch sizes. However, only a few efforts have focused on understanding their potential rheological advantages in comparison to their isotropic counterparts. In order to make some progress in this field, we propose a simple suspension model consisting of spherical colloidal patchy particles interacting via a combination of square-well (SW) and hard-sphere (HS) surface potentials subject to a simple shear flow. Using Brownian dynamics simulation, relevant rheological properties are obtained, such as the osmotic pressure, relative viscosity, and normal stress differences at steady state as a function of Péclet number Pe (the ratio between shear and Brownian forces), particle volume fraction, and patch size. The microstructures show the departure from equilibrium as Pe increases for all patch sizes and volume fractions. Patch size dependence of the rheological properties is predicted and their values interpolate between HS and SW suspensions. Moreover, at volume fractions near the glass transition, the rheology is less affected by the interparticle potential distribution. The present work demonstrates that we can control the microstructure and therefore the rheological properties by changing the patch size, which is not possible with their isotropic counterparts.