Slip and flow in pastes of soft particles: Direct observation and rheology

Steven P. Meeker

Laboratoire Matière Molle et Chimie (UMR 167, ESPCI-CNRS), ESPCI, 10 rue Vauquelin, 75321 Paris Cedex, France

Roger T. Bonnecaze

Department of Chemical Engineering and Texas Materials Institute, The University of Texas at Austin, Austin, Texas 78712

Michel Cloitre[a)]

Laboratoire Matière Molle et Chimie (UMR 167, ESPCI-CNRS), ESPCI, 10 rue Vauquelin, 75321 Paris Cedex, France

(Received 2 March 2004; final revision received 9 July 2004)

Synopsis

Microgel pastes and concentrated emulsions are shown to exhibit a generic slip behavior at low stresses when sheared near smooth surfaces. The magnitude of slip depends on the applied stress. Well above the yield stress, slip is negligible compared to the bulk flow. Just above the yield stress, slip becomes significant and the total deformation results from a combination of bulk flow and slip. At and below the yield stress, the bulk flow is negligible and the apparent motion is entirely due to wall slip. By directly imaging the deformation of pastes and from rheological measurements, we show that slip is characterized by universal scaling properties, which depend on solvent viscosity, bulk shear modulus, and particle size. A model based on elastohydrodynamic lubrication between the squeezed particles and the shearing surface explains these properties quantitatively. [DOI: 10.1122/1.1795171]