221g Dynamics of Micron-Scale Objects in Shear Flow over Nanotextured Sensor Surfaces

Jeffrey M. Davis, Ranojoy D. Duffadar, Maria M. Santore, and E. Bryan Coughlin

Selective modulation of nanometer-scale physicochemical heterogeneities on planar surfaces allows control over the adhesion of colloidal objects and suggests the development of artificial pattern recognition constructs for microfluidic sensor applications. Colloidal objects can be distinguished by their characteristic adhesion signatures and rates on these renewable surfaces. Motivated by theoretical studies of neutrophil rolling and receptor-mediated cell attachment, a probabilistic continuum model is developed to account for the interaction of hydrodynamic and physicochemical forces on micron-scale particles transported in a shear flow over planar surfaces with 10-nanometer scale features. This model is used to investigate the dynamics of particle deposition (skipping, rolling, and arrest) on these “patchy” surfaces and predicts particle forces and motion in solution near the surface, adhesion rates, the critical shear rate required to remove adhered particles, and characteristic adhesion signatures for different physical and process parameters. These theoretical predictions are coupled with fundamental experiments to quantify and enhance the capabilities of sensors based on artificial pattern recognition.