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Use of Nano-patterning to Manipulate Particle-Wall Interactions for Micron Scale Objects in Shear flow RANOJOY DUFFADAR, JEFFREY DAVIS, MARIA SANTORE, University of Massachusetts Amherst — Computational models have been developed to understand the adhesion dynamics of micron- and submicron-scale objects in low Reynolds number flows over planar surfaces with randomly distributed electrostatic heterogeneity at $O(10\text{nm})$ length scales. These surfaces are net-repulsive but present spatially varying colloidal potentials. In addition to hydrodynamics and the heterogeneous colloidal field, the model includes surface roughness and contact and frictional forces between the particles and the nano-textured surface to investigate particle motion both in flowing solution and upon wall contact. The predicted particle trajectories, velocities, adhesion thresholds, and deposition rates agree quantitatively with experimental results. Adhesion regime diagrams are constructed to quantify the regions in parameter space in which no contact, skipping, rolling, and arrest are observed. These diagrams and characteristic adhesion signatures are reminiscent of pattern recognition and adhesion in biological systems, such as leukocyte rolling. This dynamic adhesion behavior relies on local fluctuations in the electrostatic heterogeneity and is not observed for systems with ordered heterogeneity at the same length scales.

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