Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Size determines the adhesive rolling of nanoparticle: smaller rolls faster HUILIN YE, ZHIQIANG SHEN, YING LI, University of Connecticut — The adhesive rolling of nano-sized particle (NP) plays an essential role in the delivery of therapeutic or imaging agents to diseased microvasculatures. we investigate the adhesive behaviors of NPs on a substrate under the shear flow. Based on the energy balance analysis, we theoretically derive the steady rolling equation for different sized NPs. Contrary to the fundamental Stokes prediction, it is found that smaller NPs move faster than their larger counterparts under the ligand-receptor binding (LRB) effect. Further, the hydrodynamic strength (quantified by shear rate γ) is demonstrated to be associated with the steady rolling velocity (v) of NPs as $R^{\sim 0.2}$ (R is radius of NP). This scaling is attributed to the size dependence of the adhesive kinetics that is described by energy based stochastic model. We also find the enlargement of flow strength will trigger the transition from adhesive rolling to free rolling of NPs, due to the saturation of stretching of biological bonds forming between ligands and receptors. The size dependence of the rolling behavior may provide a guidance for engineering efficient NPs in biomedical applications.

Huilin Ye
University of Connecticut

Date submitted: 22 Jul 2019 Electronic form version 1.4