Abstract Submitted
for the DFD13 Meeting of
The American Physical Society

Quantifying the transition of blood flow to the non-continuum regime HUAN LEI, Pacific northwest national lab, DMITRY FEDOSOV, Institute of Complex Systems (ICS-2), Research Center Juelich, BRUCE CASWELL, GEORGE KARNIADAKIS, Brown University — Blood flow is usually treated as a Newtonian fluid down to diameters of about 200 μm. We employ the dissipative particle dynamics to simulate the flow of red blood cell suspensions driven through small tubes (diameters $10-150$ μm) in the range marking the transition from venules to the large capillaries. Simulation results show that for diameters less than about 100 μm the suspension's stress cannot be described as a continuum, even a heterogeneous one. In tube flow the cross-stream stress gradient induces an inhomogeneous distribution of RBCs featuring a centerline cell density peak, and a cell-free layer next to the wall. The local viscosity across the section as a function of the strain rate is found to be essentially independent of tube size for the larger diameters and is determined by the local hematocrit (H) and shear rate. As the tube diameter decreases below about 100 μm, the viscosity in the central region departs from the large-tube similarity function of the shear rate, since H increases significantly towards the centerline. The dependence of shear stress on tube size, in addition to the expected local shear rate and local hematocrit, implies that blood flow in small tubes cannot be described as a heterogeneous continuum.

Huan Lei
Pacific northwest national lab

Date submitted: 03 Aug 2013 Electronic form version 1.4