Abstract Submitted
for the MAR12 Meeting of
The American Physical Society

Quantifying the deformation of the red blood cell skeleton in shear flow[1] ZHANGLI PENG, Massachusetts Institute of Technology, QIANG ZHU, University of California San Diego — To quantitatively predict the response of red blood cell (RBC) membrane in shear flow, we carried out multiphysics simulations by coupling a three-level multiscale approach of RBC membranes with a Boundary Element Method (BEM) for surrounding flows. Our multiscale approach includes a model of spectrins with the domain unfolding feature, a molecular-based model of the junctional complex with detailed protein connectivity and a whole cell Finite Element Method (FEM) model with the bilayer-skeleton friction derived from measured transmembrane protein diffusivity based on the Einstein-Stokes relation. Applying this approach, we investigated the bilayer-skeleton slip and skeleton deformation of healthy RBCs and RBCs with hereditary spherocytosis anemia during tank-treading motion. Compared with healthy cells, cells with hereditary spherocytosis anemia sustain much larger skeleton-bilayer slip and area deformation of the skeleton due to deficiency of transmembrane proteins. This leads to extremely low skeleton density and large bilayer-skeleton interaction force, both of which may cause bilayer loss. This finding suggests a possible mechanism of the development of hereditary spherocytosis anemia.

[1]This work was supported by the National Heart, Lung and Blood Institute under award number R01HL092793.

Zhangli Peng
Massachusetts Institute of Technology

Date submitted: 10 Nov 2011 Electronic form version 1.4