Abstract Submitted
for the MAR10 Meeting of
The American Physical Society

*In vitro* **microfluidic model of sickle cell disease** D.K. WOOD, Massachusetts Institute of Technology, J.M. HIGGINS, Massachusetts General Hospital, L. MAHADEVAN, Harvard University, S.N. BHATIA, Massachusetts Institute of Technology — The pathophysiology of sickle cell disease is complicated by the multiscale processes that link the molecular genotype to the organismal phenotype: hemoglobin polymerization occurring in milliseconds, microscopic cellular sickling in a few seconds or less, and macroscopic vessel occlusion over a time scale of minutes. The rheology of sickle blood, which captures many of these processes, can be studied *in vitro* using physical tools and insights. We present a minimal microfluidic device in which blood flow dynamics can be directly manipulated by modulating physical factors such as oxygen concentration, capillary size, and fluid shear. We have used this system to map out the phase space of blood flow with respect to a combination of geometric, physical, chemical, and biological parameters. We show that morphological changes in erythrocytes due to sickle hemoglobin polymerization and melting are alone sufficient to change blood rheology. We characterize whole blood from many patients in this device and correlate *in vitro* performance to clinical outcomes, suggesting the potential utility of such a device for patient monitoring. Our experimental study integrates the dynamics of many of the processes associated with vasoocclusion and provides a potential tool for optimizing and individualizing treatment, and identifying new therapies.

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Date submitted: 17 Nov 2009 Electronic form version 1.4