Abstract Submitted
for the 4CF09 Meeting of
The American Physical Society

Thrombin flux and wall shear rate regulate fibrin fiber deposition state during polymerization under flow DAMIAN ILLING, KEITH NEEVES, Chemical Engineering, Colorado School of Mines — Thrombin is released as a soluble enzyme from the platelet surface to trigger fibrin polymerization during thrombosis under flow conditions. While isotropic fibrin polymerization under static conditions involves protofibril extension and lateral aggregation leading to a gel, factors regulating fiber diameter and orientation are poorly quantified under hemodynamic flow due to the difficulty of setting thrombin fluxes. A membrane microfluidic device allowed combined control of both thrombin wall flux (10^{-13} to 10^{-11} nmol/μ m^2 s) and the wall shear rate (10 to 100 s^{-1}) of a flowing fibrinogen solution. At the thrombin flux of 10^{-12} nmol/μ m^2 s, both fibrin deposition and fiber thickness decreased as the wall shear rate increased from 10 to 100 s^{-1}. Direct measurement and transport-reaction simulations at 12 different thrombin flux-wall shear rate conditions demonstrated that two dimensionless numbers, the Peclet number (Pe) and the Damkohler number (Da),defined a phase diagram to predict fibrin morphology. For Da<10,we only observed thin films at all Pe. For 10<Da<100, we observed either mats of surface fibers or gels depending on the Pe. For Da>900 and Pe<100, we observed three-dimensional gels. These results indicate that increase wall shear rate first quenches lateral aggregation and then protofibril extension.

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Date submitted: 23 Sep 2009 Electronic form version 1.4