Multiscale Modeling of Thrombus Formation and Growth in Vascular Systems

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Vascular and cardiovascular pathologies, such as aneurysms and arteriosclerosis, are affected by the global blood circulation as well as by the local microrheology covering a wide range of spatial and temporal scales, and hence, making the numerical simulations extremely challenging. We present a multi-scale computational framework to bridge disparate spatio-temporal scales involved in this problem. More specifically, the macro-scale hemodynamics and the interaction of blood with thrombus are modeled via the spectral/hp element spatial discretization, with an ad hoc "smooth profile method" (SPM) to model the macroscopic clot growth within the fixed computational grid. To understand the thrombus bio-mechanics at the microscopic level, we present a coarse-grained molecular dynamics approach named Dissipative Particle Dynamics (DPD) in which the platelets are modeled by DPD particles interacting with each other via the Morse potential. Further, these heterogeneous continuum/particle based solvers are linked together by a computational multiscale interface that facilitates modularity and high parallel efficiency.