Mesoscale Modelling of Thrombus Formation using smoothed Dissipative Particle Dynamics

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Abstract:
Mathematical modeling and numerical analysis are fundamental allies in medical applications, such as understanding thrombus formation dynamics and exploring therapeutic interventions for clotting disorders. We propose a computational scheme for modeling blood coagulation using Advection-Diffusion-Reaction (ADR) equations.

Our computational scheme employs a particle-based representation, adapting the smoothed Dissipative Particle Dynamics (sDPD) method to capture fluid momentum transport at mesoscales. Additionally, we account for diffusion and reaction phenomena among multiple coagulation species through compositional-field variables associated with each particle. Notably, our model faithfully reproduces concentration profiles observed in blood experiments reported previously [1, 2], validating its accuracy.

Our approach facilitates the exploration of diverse scenarios, spanning from homogeneous to heterogeneous conditions, both static and dynamic. Particularly in dynamic scenarios, we explore the impact of the Peclet number on species concentration distribution across the domain. This analysis offers promising prospects for applications in in-vivo and in-vitro systems, as well as in multiscale models involving medical devices.

References:

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