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A multiscale numerical model for the multiphase flow in porous media ZHIPENG QIN, SOHEIL ESMAEILZADEH, Stanford University, AMIR RIAZ, University of Maryland, College Park, HAMDI TCHELEPI, Stanford University — Accurate prediction of multiphase flow dynamics in porous media is difficult due to the challenges associated with capturing the interfacial deformations, resolving the subgrid thin films, and accounting for the complex solid geometries. Here, we propose an accurate and efficient multiscale numerical framework for modeling the pore scale multiphase flow in the presence of complex solid geometries and thin films. Within this framework, we solve the Navier-Stokes equations using a projection method with approximate factorization and fractional time stepping on a staggered Cartesian grid, and employ a topologically preserved level set method to capture the evolution of immiscible fluid-fluid interfaces. In order to account for the effect of complex solid boundaries and capture the evolution of thin films, we couple an immersed boundary method based on a direct forcing approach with a sub-grid thin-film model. We evaluate the accuracy of our multiscale framework by studying the immiscible oil-water displacement in a converging-diverging capillary tube for both drainage and imbibition scenarios, and compare the results with a fully resolved solution on a much finer grid resolution.

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