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Using nanoparticles to control the speed of capillary filling in microchannels YONGTING MA, OLGA KUKSENOK, University of Pittsburgh, Pittsburgh, PA 15261, AMITABH BHATTACHARYA, Indian Institute of Technology Bombay, Mumbai, 400076, DENNIS PERCHAK, Kodak Research Laboratories, Rochester, NY 14650, ANNA C. BALAZS, University of Pittsburgh, Pittsburgh, PA 15261 — Understanding the transport of multi-component fluids through porous medium is of great importance for a number of technological applications, ranging from ink jet printing, the production of textiles and enhanced oil recovery. Here, we examine the behavior of binary fluids containing nanoparticles that are driven by capillary forces to fill the microchannels. To carry out these studies, we use a hybrid computational approach that combines the lattice Boltzmann model for binary fluids and a Brownian dynamics model for the nanoparticles. We show that the nanoparticles dynamically alter both the interfacial tension between the two fluids and the contact angle in the microchannels; this, in turn, strongly affects the dynamics of the capillary filling. We demonstrate that by tailoring the properties of the nanoparticles, such as their affinity to the fluid components and their interaction with the microchannels, one can effectively control the filling velocities. Our findings provide fundamental insights into the dynamics of this complex multi-component system, as well as potential guidelines for a number of technological processes that focus on capillary filling with nanoparticles in porous media and microchannels.

Yongting Ma
University of Pittsburgh, Pittsburgh, PA 15261

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