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Nanofluidic control by nanoporous materials using electrocapillary effects YAHUI XUE, HUILING DUAN, Department of Mechanics and Engineering science, College of Engineering, Peking University, Beijing, JUERGEN MARKMANN, PATRICK HUBER, JOERG WEISSMUELLER, Institute of Materials Physics and Technology, Hamburg University of Technology, Hamburg —
Electrocapillary techniques exhibit great advantages in nonmechanical electrofluidic manipulation, e.g., flow actuation in micro-/nano- channels. One issue of interest is the spontaneous imbibition of fluids in bodies with a nanoscale pores size. Contrary to previous studies we here use a metallic nanoporous body. This allows us to control the electrode potential at the solid-fluid interface. Nanoporous gold (NPG) with uniform pore- and ligament size of 45 nm was fabricated by dealloying an Ag75Au25 alloy. Spontaneous imbibition of aqueous electrolytes obeys the Lucas-Washburn law. Interestingly, the estimated tortuosity has the low value of 3.2 (3 is expected for an isotropic sponge). Electrocapillary effects were then used to manipulate the imbibition dynamics. As a result of the enhanced wetting by the electrocapillary effects, we observed an acceleration of the imbibition by 30%. When air as the pore fluid is replaced with cyclohexane, we show for aqueous electrolyte imbibition in nanoporous gold that the fluid flow can be reversibly switched on and off through electric potential control of the solid–liquid interfacial tension. Our findings demonstrate that the high electric conductivity along with the pathways for fluid/ionic transport render nanoporous gold a versatile, accurately controllable electrocapillary pump and flow sensor for minute amounts of liquids with exceptionally low operating voltages.

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