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Wettability effects on fluid-fluid displacement in a capillary tube BENZHONG ZHAO, AMIR PAHLAVAN, Massachusetts Institute of Technology, LUIS CUETO-FELGUEROSO, Universidad Politcnica de Madrid, RUBEN JUANES, Massachusetts Institute of Technology — Fluid-fluid displacement in a capillary tube is a classical problem in fluid mechanics, and it serves as a simple, but important analogue to multiphase flow in porous media. Despite many experimental and modeling studies of this problem, several key phenomena remain poorly understood. Here we experimentally study the constant-rate displacement of glycerol by air in a capillary tube. By treating the inside of the capillary, we obtain two distinct wetting conditions. We visualize the dynamics of the fluid-fluid interface in high-resolution for a wide range of capillary numbers (Ca). At small Ca, the air/glycerol interface remains spherical, whose curvature varies continuously as a function of Ca. At large Ca, the invading air forms a finger that advances along the center of the tube, leaving behind the contact-line and a macroscopic film of glycerol on the wall. We find that both the critical Ca at which film formation occurs and the speed of the contact-line is strongly controlled by the wettability of the tube. We demonstrate that these salient features of the experiment can be reproduced by a phase-field model of the system.

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