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Thermodynamic Model for Contact Angle Hysteresis on Rough Surfaces RISHI RAJ, Device Research Laboratory, Department of Mechanical Engineering, Massachusetts Institute of Technology, RYAN ENRIGHT[1], Stokes Institute, University of Limerick, SOLOMON ADERA, EVELYN WANG, Device Research Laboratory, Department of Mechanical Engineering, Massachusetts Institute of Technology — Wettability of solid surfaces can be tuned by introducing roughness. This effect has been explained by Wenzel, whereby texturing increases the degree of hydrophilicity (hydrophobicity) of an intrinsic hydrophilic (hydrophobic) flat surface. However, experimentally observed dynamic contact angles deviate significantly from those predicted by Wenzel equation. In this work, we demonstrate that local contact line distortion and pinning on structured surfaces is the key aspect that needs to be accounted for in the dynamic droplet models. Contact line distortions and pinning were visualized and analyzed to develop a thermodynamic model for contact angle hysteresis on rough surfaces. The developed model showed good agreement with the experimental advancing and receding contact angles, both at low and high solid fractions. The thermodynamic model was further extended to demonstrate its capability to capture droplet shape evolution during liquid addition and removal in our experiments and those in literature. The understanding developed in this study offers new insight extending the fundamental understanding of solid-liquid interactions required for the design of advanced functional coatings for microfluidics, biological, manufacturing, and heat transfer applications.

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