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Effect of nanostructures and electrostatic interactions on disjoining pressure of ultra-thin liquid film HAN HU, CHRISTOPHER WEINBERGER, YING SUN, Drexel Univ — Disjoining pressure, the excess pressure that stems from the long-range intermolecular interactions, plays a key role in the stability of thin films in applications such as lubrication, wetting, boiling, condensation and evaporation. In recent years, nanostructures have been introduced as a means to control the stability of thin films. However, the classic theory of disjoining pressure assumes atomically smooth surface and neglects the electrostatic interactions. In the present study, the effect of nanostructures and electrostatic interactions on disjoining pressure is examined with combined modeling and molecular dynamics simulations. A model of meniscus shape and disjoining pressure for a thin liquid film on a nanostructured surface is derived based on minimization of system free energy and Derjaguin approximation. The scaled healing length ξ/D (D the nanostructure depth) is used to characterize the competition between the liquid surface tension and solid-liquid intermolecular forces. The result shows disjoining pressure increases with D. The model prediction agrees well with molecular dynamics simulations for a water-gold system. The electrostatic interactions enhance the disjoining pressure effect but the strength of the electrostatic interactions becomes weaker as the aspect ratio of the nanostructures increases.

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