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Capillary adhesion of a circular plate to solid: large deformation and movable boundary condition

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Abstract

Capillary adhesion of the thin plate induced by liquid film or liquid bridge has attracted more and more attention in the broad spectrum of engineering applications. In this study, we carry out a comprehensive exploration directed towards getting more appropriate laws of a circular plate adhered to solid with large deformation, which may provide some inspirations on the design of MEMS and some other micro/nano-devices. Firstly, the energy functional of the plate-liquid-substrate system is established, which includes the stretching energy, bending energy and interfacial energy. By means of the principle of least potential energy and functional variation with movable boundary condition, the governing equations of the plate and the corresponding transversality condition are derived. The radial displacement and deflection, and the critical adhesion radius of the plate are calculated, and these parameters have also been compared with several experimental results. It manifests that our theoretical prediction is in excellent agreement with the experiments, demonstrating the necessity to adopt the finite

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