

PHASE-FIELD SIMULATION OF RAYLEIGH INSTABILITY ON A FIBRE

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ABSTRACT

In this paper, we present a phase-field method for Rayleigh instability on a fibre. Unlike a liquid column, the evolutionary dynamics of a liquid layer on a fibre depends on the boundary condition at the solid-liquid interface. We use a Navier-Stokes-Cahn-Hilliard system to model axisymmetric immiscible and incompressible two-phase flow with surface tension on a fibre. We solve the Navier-Stokes equation using a projection method and the Cahn-Hilliard equation using a nonlinearly stable splitting method. We present computational experiments with various thicknesses of liquid thread and fibre. The numerical results indicate that the size of the satellite droplet decreases as the thicknesses of the thread and fibre increase.

REFERENCES

1. González, A.G., Diez, J.A., Gratton, R., Campana, D.M., Saita, F.A., “Instability of a viscous liquid coating a cylindrical fibre.” *J. Fluid Mech.*, 651, 2010, 117 – 143.
2. Joshi, C., Abinandanan, T., Choudhury, A., “Phase field modelling of Rayleigh instabilities in the solid-state.” *Acta Mater.*, 109, 2016, 286 – 291.
3. Vega, E.J., Montanero, J.M., Herrada, M.A., Ganan-Calvo, A.M., “Global and local instability of flow focusing: The influence of the geometry.” *Phys. Fluids*, 22(6), 2010, 064105.
4. Yan, N., Sheng, Y., Liu, H., Zhu, Y., Jiang, W., “Templated Self- Assembly of Block Copolymers and Morphology Transformation Driven by the Rayleigh Instability.” *Langmuir*, 31(5), 2015, 1660 – 1669.
5. Haefner, S., Benzaquen, M., Baumchen, O., Salez, T., Peters, R., McGraw, J.D., Jacobs, K., Raphael, E., Dalnoki-Veress, K., “Influence of slip on the Plateau-Rayleigh instability on a fibre.” *Nat. Commun.*, 6, 2015, 7409.
6. Mead-Hunter, R., King A.J.C., Mullins, B.J., “Plateau rayleigh instability simulation.” *Langmuir*, 28(17), 2012, 6731 – 6735.
7. Bai, F., He, X., Yang, X., Zhou, R., Wang, C., “Three dimensional phase-field investigation of droplet formation in microfluidic flow focusing devices with experimental validation.” *Int. J. Multiphase Flow.*, 93, 2017, 130 – 141.
8. Kim, J.S., “A diffuse-interface model for axisymmetric immiscible two-phase flow.” *Appl. Math. Comput.*, 160, 2005, 589 – 606.
9. Lee, H.G., Kim, J.S., “Accurate contact angle boundary conditions for the Cahn – Hilliard equations.” *Computers & Fluids*, 44, 2011, 178 – 186.