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Thermocapillary-assisted pulling of free liquid films BENOIT SCHEID, Universite Libre de Bruxelles, ERNST VAN NIEROP, Harvard University, HOWARD STONE, Princeton University — We study the formation of a free liquid film that is pulled out of a bath at constant speed and stabilized by the action of thermocapillary stresses prescribed at the free surfaces. We show that only large shear induced by thermocapillary stresses allows for the stable pulling of the liquid film and that both extensional viscous stresses and gravity play no role. For small speeds and negligible inertia, the resulting thickness of the free film in independent on the pulling speed and proportional to the capillary length lc as well as to a parameter Γ that measures the relative amplitude of the surface tension change at the interface. If this change is imposed (through a temperature gradient) along a distance d larger than the characteristic length $\ell = lc\sqrt{2\Gamma}$ of the system, the film thickness decreases with increasing d; otherwise it is independent of d. For large speeds and non-negligible inertia, the film thickness decreases with an increase of the Weber number. We also show how the results depend on heat transfer properties. The present theory suggests that very thin ribbons or foils of molten material can be drawn out of a melt over a wide range of thicknesses at speeds relevant to manufacturing.

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