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Thermocapilary transport in thin films using traveling thermal waves[1] VALERI FRUMKIN, ALEX ORON, Technion - Israel Institute of Technology, WENBIN MAO, ALEXANDER ALEXEEV, Georgia Institute of Technology
— We use modeling and direct numerical simulations to investigate the nonlinear dynamics of a two-layer system consisting of a thin liquid film and an overlying gas layer sandwiched between two solid walls. Fluid flow in the system is driven by the Marangoni instability induced by thermal waves propagating along the bottom wall. We show that for relatively small Marangoni numbers interfacial capillary waves form in the thin film that transport liquid along the solid wall. In this case, the frequency of thermal waves leading to the most efficient net transport is defined by their wave length and weakly depends on other system parameters. For larger Marangoni numbers which are still sufficiently small to prevent film rupture, a periodic structure consisting of localized drops interconnected by thin liquid bridges emerges. This train of drops travels unidirectionally along the heated substrate following the thermal wave and effectively transport liquid enclosed in the drops. The results of our study are useful for developing new approaches for transporting and directing liquids in microfluidic systems with a free surface.

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