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Confinement effects in premelting dynamics

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We examine the effects of confinement on the dynamics of premelted films driven by thermomolecular pressure gradients. Our approach is to modify a well-studied setting in which the thermomolecular pressure gradient is driven by a temperature gradient parallel to an interfacially premelted elastic wall. The modification treats the increase in viscosity associated with the thinning of films, studied in a wide variety of materials, using a power law and we examine the consequent evolution of the confining elastic wall. We treat (1) a range of interactions that are known to underlie interfacial premelting and (2) a constant temperature gradient wherein the thermomolecular pressure gradient is a constant. The difference between the cases with and without the proximity effect arises in the volume flux of premelted liquid. The proximity effect increases the viscosity as the film thickness decreases thereby requiring the thermomolecular pressure driven flux to be accommodated at higher temperatures where the premelted film thickness is the largest. Implications for experiment and observations of frost heave are discussed.

Significance statement

The persistence of premelted liquid flow at low temperatures is a key aspect of frost heave as well as biological viability.

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