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Viscous fingering in thin volatile films

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Abstract

A thin water film on a cleaved mica substrate undergoes a first order phase transition between two values of the film thickness. By inducing a finite evaporation rate of the water, the interface between the two phases becomes unstable and develops fingers similar to those observed in diffusion limited solidification. It is shown that in the absence of surface tension the interface dynamics is integrable. Various solutions are constructed, however, experimentally, only a subset of them is observed. The selection of these solutions is associated with Rayleigh instability which develops along the interface.