Abstract Submitted
for the DFD05 Meeting of
The American Physical Society

Faraday Instability in a Surface-Frozen Liquid SATISH KUMAR, University of Minnesota, PATRICK HUBER, Universität des Saarlandes — Faraday surface instability measurements of the critical acceleration, a_c, and wavenumber, k_c, for standing surface waves on a tetracosanol ($C_{24}H_{50}$) melt exhibit abrupt changes at $T_s = 54$ C, ∼4 C above the bulk freezing temperature. The measured variations of a_c and k_c vs. temperature and driving frequency are accounted for quantitatively by a hydrodynamic model, revealing a change from a free-slip surface flow, generic for a free liquid surface ($T > T_s$), to a surface-pinned, no-slip flow, characteristic of a flow near a wetted solid wall ($T < T_s$). The foundation of the hydrodynamic model is a vertically vibrated liquid-air interface covered by an insoluble surfactant. When the Marangoni number (ratio of surface-tension-gradient forces to viscous forces) becomes large, the contractions and expansions of the free surface are suppressed and it behaves like a no-slip surface. The abrupt change in instability behavior at T_s is traced to the onset of surface freezing, where the steep velocity gradient in the surface-pinned flow significantly increases the viscous dissipation near the surface. These results shed light on the hydrodynamics associated with the surface freezing phenomenon, and may find use in other areas such as foam drainage, surface rheology, and microfluidic transport.

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Date submitted: 24 Jun 2005

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