Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Flow stability of a liquid film partially wetting a substrate with rectangular trenches[1] DIONYSIS PETTAS, University of Patras, GEORGE KARAPETSAS, Aristotle University of Thessaloniki, YIANNIS DIMAKOPOULOS, JOHN TSAMOPOULOS, University of Patras — We investigate the hydrodynamic stability of a Newtonian liquid film flowing down an inclined, solid substrate featuring periodic rectangular trenches. We focus on cases where the film fails to thoroughly wet the topography forming air inclusions inside the structure of the substrate. We solve the two-dimensional NavierStokes equations and develop a finite element model to accurately describe the exact configuration of all liquid-gas interfaces at steady state. To determine the linear stability, we consider perturbations around this base state and employ Floquet-Bloch theory to account for disturbances of arbitrary wavelengths, i.e. not necessarily matching the periodicity of the substrate. Through numerical simulations, we highlight the effect of inertia, viscous, and capillary forces on the stability of the fluid flow and also examine in detail the effect of substrate wettability, orientation with respect to gravity and geometric characteristics of the substrate. Moreover, the existence of the freely moving contact lines inside the cavity gives rise to multiple steady states which are analyzed for their stability. The role of air inclusions in the stabilization of the liquid film and the related mechanism will be discussed.

[1]The authors acknowledge the financial support from the LIMMAT foundation under the grant MuSiComPS and from the Hellenic Foundation for Research and Innovation (HFRI) and the General Secretariat for Research and Technology (GSRT), under grant agreements No 1743 and No 792.

George Karapetsas
Aristotle University of Thessaloniki

Date submitted: 25 Jul 2019 Electronic form version 1.4