Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Electrohydrodynamic Patterning of non-Newtonian Thin Films

ADHAM RIAD, HADI NAZARIPOOR, ALI MOHAMMADTABAR, MOHTADA SADRZADEH, Department of Mechanical Engineering, University of Alberta —
Electrically driven instabilities of thin liquid films or electrohydrodynamic (EHD) induced patterning has gained popularity for its ability to create nano-sized features for various applications. An initially quiescent thin film of uniform thickness is sandwiched between two electrodes. A voltage is then applied across the electrodes, creating a destabilizing electrostatic pressure on the interface, causing surface deformation and patterns to evolve. A mathematical model is proposed to study the effect of power-law rheology on the EHD patterning process. Simplifying the governing equations using the long-wave approximation leads to a novel thin-film equation that describes the interface's dynamics for both pseudo-plastic and dilatant fluids. The spatiotemporal evolution of the patterning process is then numerically simulated by solving the nonlinear thin-film equation using a finite-difference based discretization scheme and an adaptive time step solver. The results show that the patterning time is strongly influenced by the power-law index and is significantly shorter for shear thickening than shear thinning fluids. Moreover, morphological changes between patterns of shear thinning and shear thickening fluids are correlated to local viscosity variations.

Adham Riad
Department of Mechanical Engineering, University of Alberta

Date submitted: 01 Aug 2019 Electronic form version 1.4