Abstract Submitted for the DFD19 Meeting of The American Physical Society

Stability of evaporating sessile drops comprising binary mixtures¹ ADAM WILLIAMS, School of Engineering, The University of Edinburgh, GEORGE KARAPETSAS, Department of Chemical Engineering, Aristotle University of Thessaloniki, PEDRO SAENZ, Department of Mathematics, Massachusetts Institute of Technology, OMAR MATAR, Department of Chemical Engineering, Imperial College London, KHELLIL SEFIANE, PRASHANT VALLURI, School of Engineering, The University of Edinburgh — Spreading and evaporation of a binary mixture sessile drop is a highly dynamic and complex process governed by the interplay between capillary stress, evaporation, hydrodynamic flow, mass diffusion and surface tension, with both thermal and solutal Marangoni stresses also present. We examine the behaviour and stability of volatile wetting ethanol-water drops deposited onto heated substrates using both experiments and modelling. We take a one-sided approach, utilising lubrication theory to obtain a base state before assessing stability by performing a linear stability analysis evoking the quasi-steady-state approximation. Evolution equations are derived for the interface height, temperature and concentration fields, assuming that the mixture comprises two ideally mixed volatile components with a surface tension linearly dependent on both temperature and concentration. Singularity at the contact line is avoided by releasing the drop over a precursor film. Results from both simulations and experiments indicate that concentration gradients in binary drops give rise to super-spreading, and, at high ethanol concentrations, contact line instability. Our initial stability analysis also confirms that the process is highly unstable.

¹EPSRC and EC-RISE-ThermaSMART

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Date submitted: 31 Jul 2019

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