

Self-patterning induced by evaporation and solutal Marangoni effect

Mohar Dey¹, Frédéric Doumenc^{1,2} and Béatrice Guerrier¹

¹Lab FAST, University Paris-Sud, CNRS, Bat 502, Campus Universitaire, Orsay F-91405, France

²UFR919, Sorbonne Universités, UPMC Univ Paris 06, Paris F-75005, France

Corresponding author: doumenc@fast.u-psud.fr

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This study explores through numerical simulations the impact of solutal Marangoni effect on the deposit obtained by drying a polymer solution. A hydrodynamic model with lubrication approximation is used to describe the liquid phase in a dip-coating-like configuration. We consider the regime of small capillary numbers where evaporation occurs at the meniscus, and the coupling between evaporation and fluid motion may result in self patterning of the deposit. The present study is a contribution to the analysis of possible mechanisms that may induce the periodic regime [1,2].

The studied case considers evaporation in stagnant air (diffusion-limited evaporation), which results in a coupling between liquid and gas phases. Viscosity, surface tension, and saturated vapor pressure depend on solute concentration. When surface tension increases with polymer concentration, numerical simulations show that a periodic regime appears for some values of the control parameters (substrate velocity and initial concentration). A morphological phase diagram as well as meniscus and dry-deposit shapes are provided as a function of the substrate velocity and bulk solute concentration.

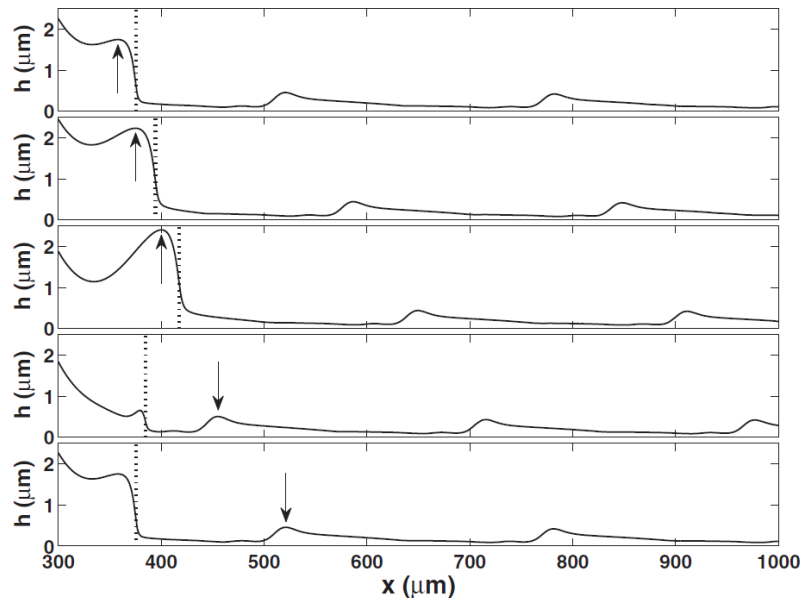


Fig.1 Periodic time evolution of the meniscus, substrate velocity = $30\mu\text{m/s}$, solute bulk volume fraction = 0.01. The dotted vertical line is the position of the drying front.

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References

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