Experimental Investigation of Transient Marangoni Convection in a Drying Polymeric Film Subject to Lateral Inhomogeneities

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Thin films are an essential component of novel organic electronic devices and low-cost sensors. Inhomogeneous drying conditions may result in undesired Marangoni convection and free-surface deformation deteriorating device performance. Since surface tension of multi-component solutions depend on both temperature and composition, control of local heat and mass transfer by means of tuning the material system or the boundary conditions while drying should lead to a homogenous solute deposition.

In order to investigate the flow field within drying thin films, a new measurement technique (µPTV) has been developed in preliminary studies. It is based on tracking fluorescent particles in drying polymer solutions with an inverse microscope.

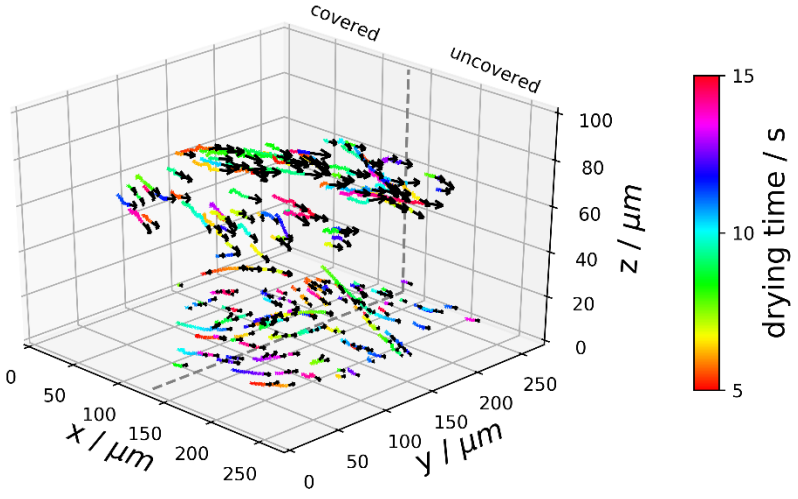

Figure 1. 3D flow field in poly(vinyl acetate)-methanol film subject to lateral inhomogeneous drying conditions. (Tönsmann, 2019)

A technique called “off-focus imaging” allows the tracking along the line-of-sight direction, enabling us to measure three-dimensional flow fields while drying. Our measurement technique gives unique insights, which will allow us to identify process parameters crucial to the surface homogeneity of thin films and printed structures. (Tönsmann, 2019)

New results will be presented with data from a drying poly(vinyl acetate)-methanol film at different drying times. A partial cover above the film results in lateral inhomogeneous gas-sided drying conditions and therefore imposes a lateral concentration- and surface-tension gradient. The reconstructed 3D transient flow field within the film is depicted in Figure 1. The dynamics of long-wave perturbations induced by partially covering the film as well as Bénard-like convection cells and their respective transient behavior will be presented.

References

Tönsmann, M.; Kröhl, F.; Cavadini, P. et al. Calibration Routine for Quantitative Three-Dimensional Flow Field Measurements in Drying Polymer Solutions Subject to Marangoni Convection. *Colloids and Interfaces* 2019, 3, 39.