Physik der Molekularen und Biologischen Materie
Arbeitsgruppe Prof. Dr. Frank Schreiber

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Crystalline thin film growth in anisotropic mixtures: A combined approach by experiment, theory and simulation

The research group *Physics of Molecular and Biological Materials* at the Institute for Applied Physics at the University of Tübingen is offering a PhD position in experimental physics. Candidates with a diploma/master degree in physics, chemistry or a related field and experience in the fields described below are encouraged to send their applications.

Project description

This project is a collaboration of three different groups working on experiments, simulations, and theory of thin film growth in anisotropic mixtures. It focuses on relatively simple model compounds such as rod-like PEN and DIP as well as essentially spherical C60 on simple model substrates such as oxidized silicon wafers and mica. By varying the growth conditions, particularly the substrate temperature T, the deposition rate R, and the mixing ratio X the film structure can be influenced.

With the chosen materials we have collected ample experience in their pure phases [1], which will make the study of the mixtures, some of which we have already started to test, more efficient. The mixtures will be studied by a combination of atomic force microscopy (AFM) to characterize the real-space structures and interface-sensitive scattering techniques (X-ray reflectivity, grazing incidence X-ray diffraction, grazing incidence small-angle X-ray scattering) [2]. A detailed analysis of the data will give access, e.g., to the average density profile perpendicular to the substrate and to the three-dimensional shape of the islands on the substrate. Overall, this will lead to a comprehensive picture in terms of *i*) the out-of-plane structure/density, *ii*) the in-plane structure including lattice parameters and *iii*) the formation of new and/or mixed phases and structures. The distinction between lying-down and standing-up molecules will be obtained in parallel.

A particular strength of our group is the *in situ* application of these scattering techniques using synchrotron radiation [3,4], which allows monitoring of the growth in real-time in order to find possible transient structures, follow the nucleation of different phases and to trace the mixing/demixing processes on a molecular level. For all these, the experimental conditions will be determined for the three

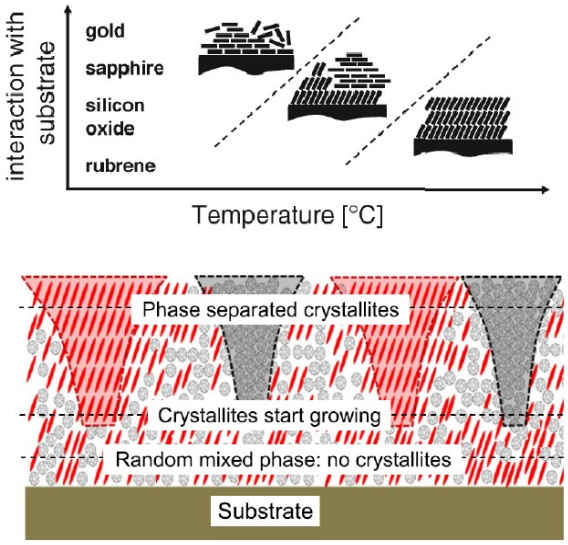

Figure : (top) Schematic drawing showing the influence of substrate temperature and strength of interaction with the substrate on the orientational transition from upright to flat structures. (bottom) Schematic representation of the model proposed for the kinetically driven phase separation during the growth of a co-evaporated DIP and C60 thin film [4].

compounds and their three bicomponent mixtures. In addition to the PEN, DIP, and C60, we have the opportunity to study perfluorinated PEN (PFP), which is structurally very similar to PEN, but electronically different, so that for sterically similar conditions the impact of a different interaction potential can be studied (stronger component of the donor-acceptor nature). We also have the technical infrastructure to study intentionally interrupted growth with different timing patterns / waiting times. This project is part of a larger research program in the field of organic thin film growth which is being pursued by our group.

University of Tübingen

Being a classical university town in southern Germany, Tübingen hosts 27.000 students. The picturesque historical town and its attractive position on the Neckar River offer a high quality of life. The University of Tübingen is consistently ranked among the best research universities in Germany. It provides an stimulating environment and many additional services to students, such as the Language Learning Centre.

Candidate Profile

Candidates are expected to participate in research and teaching activities of the chair. We offer a team-oriented, motivating work atmosphere, which allows to concentrate on challenging research questions. The applicant is expected to have good communication skills in English and importantly the enthusiasm for the topic.

Contact

Applications including CV and at least one letter of recommendation should be sent to Prof. Dr. Frank Schreiber (frank.schreiber@uni-tuebingen.de).

Further Informationen

http://www.soft-matter.uni-tuebingen.de

1. A. Hinderhofer and F. Schreiber, *Organic-organic heterostructures: Concepts and applications,* ChemPhysChem **13** (2012) 628.
2. C. Frank, R. Banerjee, M. Oettel, A. Gerlach, J. Novak, G. Santoro, and F. Schreiber. *Analysis of island shape evolution from diffuse x-ray scattering of organic thin films and implications for growth,* Phys. Rev. B **90** (2014) 205401.
3. A. Aufderheide, K. Broch, J. Novak, A. Hinderhofer, R. Nervo, A. Gerlach, R. Banerjee, and F. Schreiber, *Mixing-Induced Anisotropic Correlations in Molecular Crystalline Systems,* Phys. Rev. Lett. **109** (2012) 156102.
4. R. Banerjee, J. Novak, C. Frank, C. Lorch, A. Hinderhofer, A. Gerlach, and F. Schreiber, *Evidence for Kinetically Limited Thickness Dependent Phase Separation in Organic Thin Film Blends*, Phys. Rev. Lett. **110** (2013) 185506.