Project A2.2: Patterning of thin films on laterally structured surfaces

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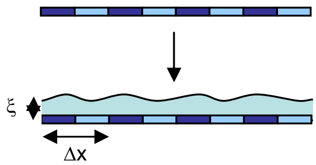
US partners: Velev, Gubbins (NCSU)

Outline. The project addresses the question, how “chemical” patterns, ranging from nano- to micrometer dimensions, can be imprinted onto adjacent soft-matter phases, like liquid films and polymer films. The surface is patterned with respect to the charge density and/or hydrophilic/hydrophilic balance of different periodicity Δx (10 – several 100’s of nm). Therefore solid substrates, e.g Silicon wafers are coated with domain patterns based on a lateral decomposition of binary self-assembled monolayers (SAMs), domains generated by ordered monolayers of long-chain alkanes or by aggregation of organic molecules, or the quasicrystalline tiling of the solid substrate with a binary mixture of organic molecules. Microcontact printing techniques and novel patterns developed by other groups within this IGRTG are used to produce patterns on substrates. The question is over which length ξ the periodic pattern is preserved. Therefore a control of the film thickness with nm or sub-nm precision is required.



Cartoon of imprinting of ‘chemical’ patterns (Δx = 10 nm – several 100’s of nm) onto adjacent soft matter phases, like liquid films and polymer films.

Research within the German group. The correlation length ξ over which periodic differences in surface energy of a patterned surface are causing periodic differences in thickness of a *liquid wetting film* will be studied with a Thin Film Pressure Balance (TFPB) [*J. Phys.: Cond. Mat.* **R15** 1197 (2003)]. In a TFPB disjoining pressure isotherms [disjoining (normal) pressure in dependence of the film thickness] are measured [*Langmuir* **21** 4790 (2005)]. The mean thickness of the film can be varied from 10 to 100 nm by applying a capillary pressure. Local variations in film thickness can be evaluated with nm-resolution from the optical interferogram. It will be studied over what distances ξ the surface pattern can be converted into a topological pattern via interactions between the opposing surfaces [see fig]. The successive change in topology of *adsorbed polymer films* on patterned surfaces will be followed by AFM and imaging ellipsometry after different numbers of deposition steps. In order to tune the film thickness with sub-nm precision for getting information about the correlation length ξ of the surface pattern, polyelectrolyte multilayers [*Phys. Chem. Chem. Phys.* **8** 5012 (2006)] will by studied which are formed from alternating adsorption of polycations and polyanions.

Complementary work in US partner group. Beside the interactions perpendicular to the surface also lateral interactions like capillary forces might affect the local variations in thickness. Velev is working on colloidal interactions, especially on capillary forces and might give scientific and technical input. Gubbins will do parallel simulations on this problem. The PhD student will do experiments on capillary forces on patterned surfaces in the group of Velev.

Status of the project. The surface patterns play an important role within the present project. Beside microcontact produce patterns on substrates. The patterns will be generated e.g. by aggregation of organic molecules [project A1.3 (Riegler/Möhwald)] and by self-assembly of rod-like molecules [project A1.2 (Rabe)]. In project A2.1 (Schoen) the structure and thermodynamic stability of a fluid in the vicinity of a chemically decorated solid surface will be investigated by Monte Carlo simulations. In project A1.1 (Stark) nanorods are simulated close to quasicrystalline surfaces. The coated nanopatternd surfaces can present a model system for membranes which is of interest with respect to the interaction with proteins [project C2.3 (Hildebrandt)].