Project A4: Nucleation and self-organized growth of nano-aggregates at interfaces

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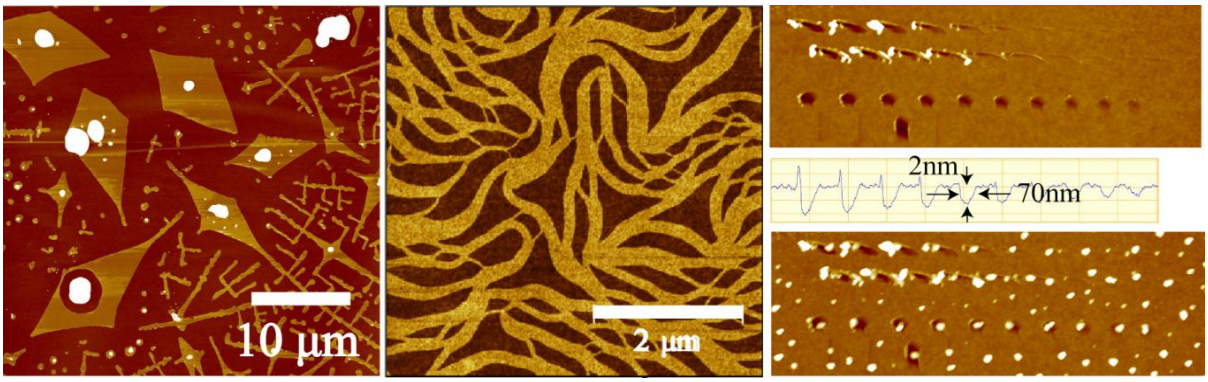
Co-supervisor: **Rabe (HUB), Stark (TUB)**
US partner: **Genzer (NCSU)**

Outline. We want to better understand fundamental processes of nucleation and self-organized growth of nano-aggregates at planar (structured) interfaces. The focus is on the formation of small (2-d) aggregates of organic molecules with different molecular shapes (spheres, rods, plates). The aggregation shall result from supersaturation in solution leading to 1.) nucleation and growth in solution followed by precipitation onto surfaces and/or 2.) nucleation and growth directly at the surface. We want to know in particular, which contributions (nucleation or growth after critical nucleus size?) dominate the final shape, size, location, etc. of nano-size (2-d) aggregates.

Research within the German group. We investigate how interfaces (confinement) affect the phase transition behavior and aggregation, such as the broadening of the melting transition of molecularly thin films, how line tension alters the shape of nano size sessile droplets and how new heterogeneous nucleation paths emerge at nano size terrace edges due to pre-critical morphological transitions. Currently we study why and how 1.) long chain alkanes form such a variety of 2-d domains plus 3-d aggregates (figure left), 2.) Phtalocyanines form 2-d ribbon-like domains structures (figure center), and 3.)nano size C60 aggregates preferentially are located (grow?) in the very shallow (depth only a few nm) but rather wide interfacial dents (figure right).



2d/3d interfacial aggregates (submonolayercoverages). Left: Domains of $C_{40}H_{82}$ on SiO_2 (height ≈1.5nm); center: Cu-Phtalocyanine on SiO_2, (height ≈1nm); right (top) SiO_2 with nano scratches/dents; right (center) height profile through scratches/dents (typical depth: 1-4nm, typical width: 50-100nm!); right (bottom): C60 aggregates in dents.

Longer-term perspective. We will continue to induce aggregate formation at interfaces by controlled spatio-temporal supersaturation, characterize the aggregates and analyze their nucleation and growth. In particular, we will investigate how structural and chemical nano size surface modifications (figure right) affect interfacial aggregate growth and how large the influence of the molecular shapes (spheres, rods, plates) is. Supersaturation/aggregation will be achieved by spin cast (AFM *a posteriori*) as well as in a wet cell (AFM *in vitro*).

Complementary work in US partner group. In collaboration with Genzer and Zauscher we will work on the chemical nano size surface modifications. The resulting aggregates will be studied by 3D high resolution electron microscopy in collaboration with Spontak.

Status of the project. Focusing on fundamental aspects of nucleation and growth, the project is relevant for most of the other IGRTG projects. There will be direct collaboration with the C1 (Rabe) who investigates similar systems (small aggregates at solid surfaces) with the same methods and with A2 (v. Klitzing) to prepare and investigate the nucleation and growth on differently structured surfaces (e.g. brushed surfaces). Patterned surfaces are studied in project A1 (Schoen). Nucleation is also the central issue in project A3 (Stark) and C3 (Dimova).