MRC

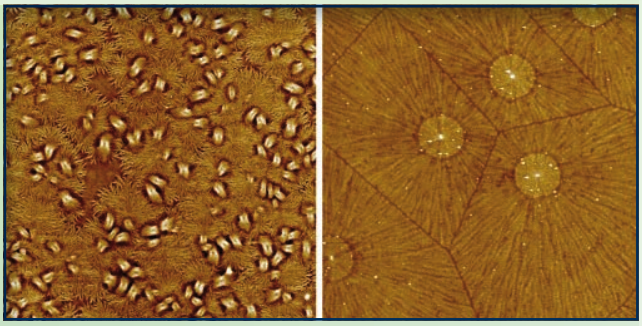
Materials Research Center

Laboratory for Surface Science and Technology (LSST)

Research Profile

The LSST is involved in research in numerous areas of surface science and technology, with a special focus on:

- surface modification and analysis (synthesis of functionalized coatings and characterization by analytical techniques, such as x-ray photoelectron spectroscopy (XPS), atomic force microscopy (AFM), infrared spectroscopy (IR) or spectroscopic ellipsometry.
- tribology (water-based and oil-based lubricants and lubricant additives, friction, lubrication and wear on the nanoscale)
- the development of platforms for studying surface interactions (chemical patterns, microwells, surface gradients, micro- and nanoparticles)
- biomedical and functional biointerfaces (cell-interactions, membranes and implants)
- the development of advanced surface-analytical and in situ sensing techniques (extended surface-forces apparatus, evanescent methods, such as optical waveguide lightmode spectroscopy (OWLS), surface plasmon resonance (SPR), dual polarization interferometry (DPI) and in-situ ATR-IR Tribometry)



Influence of solvent choice on film morphology for a polyesterurethane, spin-coated on silicon wafers from 5 wt% solutions in two different solvents (left: 1,4-dioxan (100x100 µm), right: chloroform (133x133 µm)).

X-ray photoelectron spectroscopy: a powerful tool for surface-chemical analysis.

Competences / Infrastructure

- surface modification and analysis
- lubricant surface chemistry (oil-based, water-based)
- biointerfaces: biosensors, implants, membranes, cell-surface interactions
- surface-chemical and –morphological gradients
- advanced analytical techniques

Surface Modification, Tribology, Biointerfaces, Thin organic films, Patterning and Gradients

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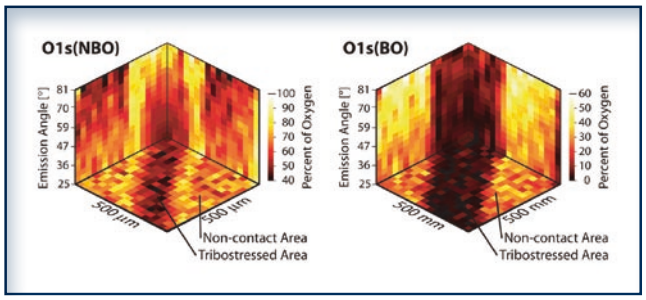
Tribochemistry / Lubricant additives: Glass in the motor

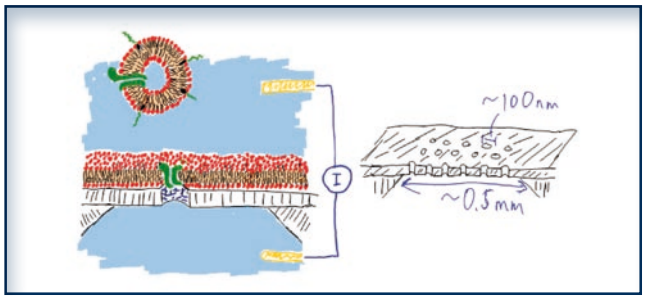
The development of new energy-conserving, environmentally compatible lubricants has a beneficial impact in reducing energy consumption and carbon dioxide emissions in the transportation, chemical, biomedical and aerospace industries. Research efforts at LSST focus on gaining a better understanding of the mechanism of interaction between lubricants and sliding surfaces under different environments (temperature and humidity) and sliding conditions (speed and applied loads) by the use of imaging and angle-resolved x-ray photoelectron spectroscopy (XPS).



3D distribution of the chemical composition (non-bridging and bridging oxygen signal) measured on a tribostressed area and the surrounding non-contact area.

Lipid Systems on Nanostructures

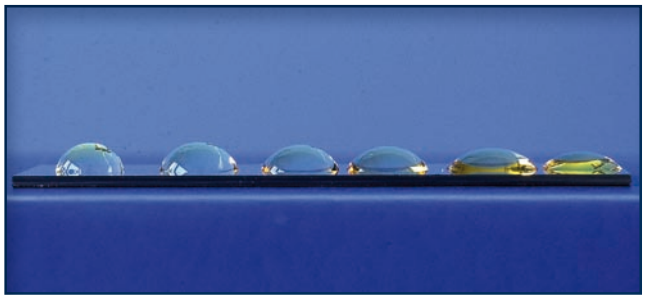
More than 50% of all drug targets are transmembrane proteins, which require a lipid membrane for their function. The complete lack of sensor platforms incorporating proteolipid membranes for analytical profiling and high-throughput screening of this class of drug targets severely increases cost and time to develop new drugs as well as their efficiency. LSST coordinates a EU FP7 project aiming to develop tools for such platforms within the next three years for functional screening, combining state-of-the-art self assembly of membranes with nanofabricated chips and novel sensor combinations.



Sketch of a sensor platform based on proteolipid membrane assembly and nanofabrication.

Gradient Surfaces

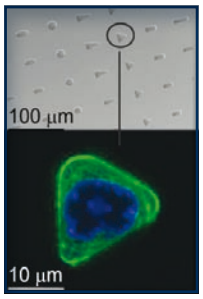
Surface gradients represent powerful tools for the high-throughput investigation of interfacial phenomena in the areas of physics, chemistry, materials science and biology. We have developed new techniques for the generation of chemical and morphological gradients, based on the gradual immersion of substrates into a dilute solution of one type of molecule (chemical gradients) or into a polishing solution (morphological gradients). Chemical and morphological gradients can be used further to study cell interactions, protein adhesion or surface crystallization.



Water droplets along a wettability gradient.

Microfabricated Surfaces for Single Cell Culture

Among others, substrate stiffness and dimensionality are important characteristics for the microenvironment of a cell, steering cell behavior and function, such as cell differentiation, proliferation and viability. This microwell platform represents an engineered three-dimensional environment for single cells with independently tunable parameters—the shape of the wells defines the cell shape, the stiffness of the substrate addresses the question of mechanosensation and the chemical coating inside the microwell is responsible for specific cell adhesion. This microwell platform helps to investigate the influence of microenvironmental cues and how cells can sense dimensionality.



Microwell platform and a single cell in a triangular shaped well (green = actin, blue = nucleus).