The Excellence Initiative of the German Federal Ministry of Education and Research and the German Research Foundation aims to promote top-level research at German universities and research institutions and to make Germany a more attractive research location and more internationally competitive.

At the Cluster of Excellence of the TU Darmstadt, the Center of Smart Interfaces (CSI), the existing expertise of scientists of the TUD is complemented by new professors and young researcher groups as well as guest professors, post-docs and doctoral students from the departments Mechanical Engineering, Physics, Chemistry, Mathematics and Material Sciences from TUD and from external research institutions in Darmstadt and Mainz (Institut für Mikrotechnik Mainz, Max-Planck-Institute for Polymer Research, Fraunhofer-Institute for Structural Durability and System Reliability, Deutsches Kunststoff-Institut).

The Center of Smart Interfaces focuses on phase interfaces at which fluidic phases (gas and/or liquid) interact with a solid surface. Smart Interfaces are fluid-solid boundary interfaces that have been designed or built for achieving a specific purpose, such as enhancement or controllability of mass, momentum or heat transfer.

Potential for Cooperation

Our long-lasting experience in the area of molecular interactions between surfaces in air and in liquids, as well as the availability of complete state-of-the-art equipment, qualifies us for a reliable planning, measurement and modeling of these forces. We are able to characterize surface energies, adhesion and capillary forces, as well as the surface structure from the macroscopic to the nanoscopic scale. Further, we are able to characterize rheological properties of liquids depending on their composition. This is paramount for the development of, e.g. self-cleaning surfaces, glues with universal adhesion properties or inks and dispersions for optimal print and coating processes.

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Research Topics

– Surface forces in air and in liquids
– Static & dynamic wetting
– Forced & reactive wetting
– Drop evaporation processes
– Hydrodynamic boundary conditions
– Structure & dynamics polymers at interfaces
Innovative Environment

Workforce:
1 Research group leader, 3 PostDocs, 3 PhD students

Unique Features:
We cover the entire range from the detailed and quantitative analysis of surfaces at the nano- and microscopic scale. The focus is on properties like surface energy and wettability and on the influence of the surface topography and visco-elasticity.

Equipment:
- Atomic Force Microscopes
- High speed cameras with up to 500,000 frames/s
- Contact angle goniometers & tensiometer
- Automatised „Drop-on-Demand“ device

Research

The focus of the research group „Experimental Interface Physics“ is on experimental investigation of processes taking place at interfaces and surfaces, especially those between liquids and solid surfaces. Liquids can be simple one- or complex more-component liquids. Surfaces can be simple smooth and hard or complex microstructured and deformable solids.

Actually, one of the most often occurring processes is the wetting of solids by liquids. It plays a determining role in a multiplicity of natural phenomena and in a series of technological applications. Examples are the coating of metals or other materials; the controlling of surface and liquid properties for an efficient wetting of, e.g. plants with pesticides in agriculture, surfaces with coolants in heat exchange processes. Efficient and reliable methods for characterizing surface energies as well as a thorough understanding of the underlying mechanisms are indispensable. A special focus of our work is on dynamic wetting processes, i.e. when an additional external stimulus is acting on the wetting.

One innovative task will be the investigation of the wetting dynamics of complex liquids. Under this identifier we understand liquids that are structured at different length scales. Examples are polymer solutions or melts, dispersions, emulsions or generally liquids that show a non-Newtonian behavior. The dynamics of wetting of surfaces by such liquids is still largely unresolved and relies mostly on empirical evidences. By opportunistically designing experiments we want to aim at the goal of better understanding the wetting behaviour and thus of providing the basis for a mathematical description. This will allow us to make predictions and thus to design surfaces that show optimized wetting properties.

Selected Publications


