

**BUSINESS UNIT CHEMICAL SURFACE AND
REACTION TECHNOLOGY**

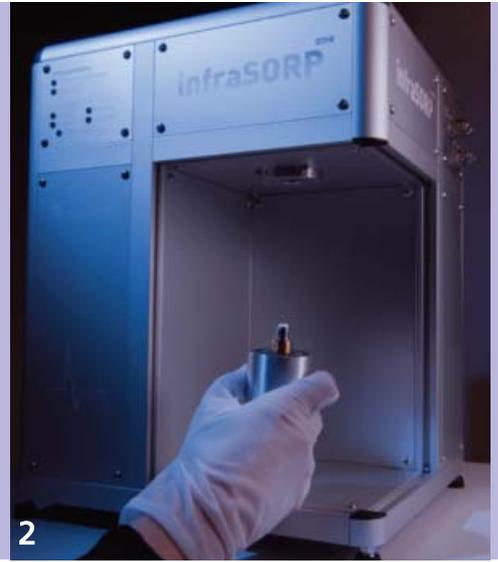


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NEW TECHNOLOGIES IMPROVE SURFACE FUNCTIONALITIES

Fraunhofer IWS has long-term experience in the application of plasma-assisted processes and procedures of chemical gas plasma deposition at atmospheric pressure. These technologies are used to create functional surface layers with scratch-resistant, conductive and self-cleaning properties. Another research focus is the development of nano-structured materials with a defined surface chemistry. These materials are a decisive prerequisite for the efficiency enhancement of double-layer capacitors and next-generation batteries. Furthermore, IWS scientists use their expertise for the research into the application of optical-spectroscopic measuring systems to analyze production processes and their products in a non-contact way.

Scientific basis

- development of nano-structured materials with defined surface chemistry
- fabrication and preparation of nano particles and nano tubes
- development of coatings with tailored properties
- thermo-fluid dynamic simulation of gas flows in complex reactors as well as of gas concentrations, temperature fields, deposition and particle formation rates
- spatially resolved chemical analyses of coatings and defects by means of Hyperspectral Imaging (HSI)

Trends

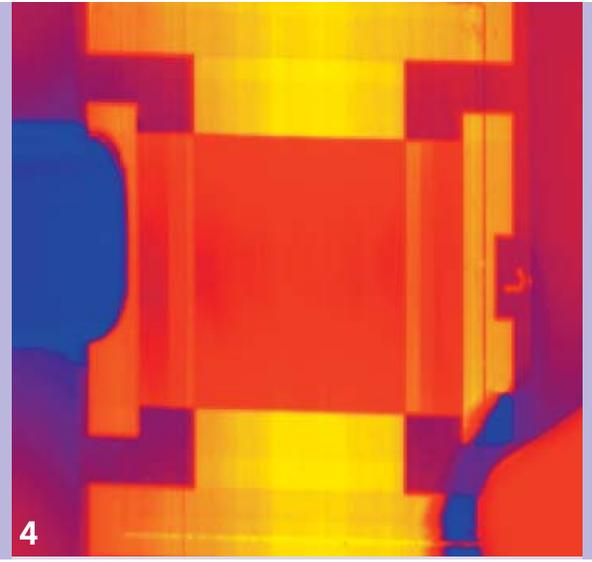
The business unit "Chemical Surface and Reaction Technology" focuses on the development of processes and materials as well as on the fabrication of prototypes for industrial applications.

Main research topics are:

- material and process development for the line production of next-generation energy storage devices and super capacitors
- process development for chemical surface functionalization
- gas phase reactors and processes for atmospheric pressure plasma applications (coating, etching, cleaning, surface modification)
- process development for sensor and trace analysis



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OUR COMPETENCES

Battery research

Research into electromobility and stationary energy storage technology is a key issue for our IWS scientists. They specifically concentrate their efforts on the development of a technology, which makes a cost-efficient large-scale production of lithium-ion cells possible. Their aim is the development of a continuous demonstrator unit, which comprises all steps from the rewinding of electrode foils and the packing of electrodes and separators to the construction, joining and welding of the staple into a pouch foil. A further IWS research key area focuses on novel material concepts for mobile energy storage systems. Here, research concentrates on the materials as a most primary alternative to traditional lithium-ion batteries. IWS scientists develop materials for low temperature sodium sulfur batteries and the corresponding manufacturing methods for the stationary application in highly-capacitive battery storage units.

Process monitoring

The optical spectroscopy technology is an important IWS core competence. In recent years IWS researchers have expanded their activities from solid state and coating characterization tasks to the monitoring of complex gas phase processes. Comprehensive measurement solutions have been developed based on optical and fluid-dynamical simulations. These solutions are highly sensitive measuring sensors integrated into industrial systems. They have been customized as stand-alone systems and meet long-term operational requirements. Within this field the institute cooperates with well-known manufacturers of ultra-pure gas equipment.

Plasma-CVD-procedures

IWS researchers develop chemical gas phase (CVD) and liquid phase processes to generate various functions on different material surfaces. Special emphasis is put on the application of single-walled CNTs. Here the IWS offers specified expertise in their fabrication and preparation. Embedded in corresponding materials, these CNTs enable large-area coatings and thus, open up new markets. Transparent, functional thin-film coatings, anti-adhesive coatings, flexible, conductive polymers and energy storage systems are our main foci.

- 1 *Hydrophilic/hydrophobic-structured surface at a sheet steel*
- 2 *Measuring device for the quick characterization of porous materials*
- 3 *Lithium-sulfur pouch cell*
- 4 *Imaging spectroscopy (Hyperspectral Imaging) for surface analysis*



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HIGHLIGHTS

IWS scientists of the business unit “Chemical Surface and Reaction Technology” concentrate on research into mobile and stationary energy storage systems. Fraunhofer IWS, as a publicly funded battery center, offers best conditions for working on various public and industrial projects and for transferring the results into application-oriented innovations.

By means of atmospheric pressure processes the IWS is able to generate transparent, conductive surfaces, which are, e.g., used in display or photovoltaic industries. Process monitoring foci are sensor applications in the electronics industry and trace analysis in the field of ultra-pure special gases.

Examples of IWS innovations are:

- process chain optimization for the fabrication of lithium-sulfur batteries: electrode coating in a roll-to-roll process, dry electrode processing, electrode packing from “on-the-fly” material by rotating punching processes or remote laser cutting technology
- the development of plasma sources and reactors for atmospheric plasma processes up to 350 mm processing width
- synthesis and preparation of SWCNTs in kg-scale for application developments
- the development of a device for water vapor transmission measurements of ultra-barrier materials in the range of $10^{-6} \text{ g m}^{-2} \text{ d}^{-1}$
- the development of a measuring unit for throughput screening of porous materials