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# Surface Physics Laboratory

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## Offer

- Materials morphological, crystallographic and chemical characterisation using in-air, vacuum and ultra-high vacuum techniques: Photoelectron spectroscopies including synchrotron radiation-based ones, electron diffraction methods, low-energy ion scattering, scanning tunnelling microscopy, infrared spectroscopy, scanning electron microscopy, atomic force microscopies, thermodesorption, microreactor mass spectrometry
- Materials synthesis using vacuum methods of molecular beam epitaxy and magnetron sputtering deposition of thin films and nanoparticles
- Development of catalysts for proton exchange membrane fuel cells (PEMFC) and electrolyzers by studying chemical activity of catalysts in a microreactor and testing performance and endurance of complete fuel cells in dedicated test stations
- Testing of gas sensors in a dedicated test station

## Expertise

- Multi-probe characterisation of materials and analysis of surface physico-chemical phenomena from sub-micron to atomic dimensions
- Synthesis of novel materials using vacuum technologies and electron and ion beam lithography
- Applied research and development of catalysts for energy conversion (e.g. maximizing the effectiveness of precious metal usage in PEMFC)
- Applied research of metal and semiconductor nanostructures for chemical sensors
- Providing open access and user support in photoelectron spectroscopies and electron microscopy

## Research Areas & Excellence

- Fundamental properties of surfaces and interfaces of solids, mainly metal, alloy, metal-oxide and semiconductor nanostructures
- Fundamental research of chemical reaction kinetics on gas-solid and liquid-solid interfaces
- Fundamental research of organic-inorganic interfaces
- Synthesis and characterization of novel nanostructured materials in planar geometry—nanoparticles, thin films, surface alloys, surface oxides, organic self-assembled layers
- Heterogeneous catalysis on nanostructured surfaces, dominant processes of interest are those related to proton exchange membrane fuel cells (PEMFC) anode and cathode: Hydrogen adsorption and oxidation, methanol oxidation, oxygen reduction reaction, catalyst poisoning
- Adsorption on nanostructured materials for gas sensing applications
- Research and development of PEMFC catalysts with low content of precious metals
- Development of hydrogen and methanol PEMFC compatible with silicon microfabrication technology

## Key Research Equipment

- XPS/XPD – UPS/ARPES Multi-probe, ultra-high vacuum instrument for integral and angle-resolved photoelectron spectroscopy (x-ray and ultra-violet), also including low-energy electron diffraction and thin film sample preparation methods
- STM – XPS – IV-LEED – TPD Multi-probe, ultra-high vacuum instrument for scanning tunnelling microscopy, x-ray , photoelectron spectroscopy, intensity-voltage low-energy electron diffraction and thermally programmed desorption mass spectrometry, also including thin film sample preparation methods
- Materials Science beamline Multi-probe, ultra-high vacuum instrument at synchrotron Elettra in Trieste, Italy, for synchrotron-radiation integral and angle-resolved soft x-ray photoelectron spectroscopy and near-edge x-ray absorption fine structure spectroscopy, also including low-energy electron diffraction and thin film sample preparation methods
- Tescan Mira 3 FESEM High-vacuum Tescan scanning electron microscope with field emission cathode, also allowing energy dispersion x-ray imaging.
- Tescan Lyra FIB-FESEM High-vacuum Tescan™ scanning electron microscope with field emission cathode, with focused ion beam and four-jet gas injection system for nanolithography

- Bruker MultiMode 8 EC-AFM Bruker atomic force microscope with nanomechanical properties imaging in air and (with an electrochemical cell) in electrolyte
- Fuel cell test stations with a bipotentiostat for automotive-standard protocol and customary testing of PEMFC
- Sensor test station for gas sensing materials
- Magnetron sputtering chambers for direct-current (DC) and radiofrequency (RF) sputtering, allowing reactive sputtering deposition
- NAP XPSSpecs™ multi-probe instrument for near ambient pressure x-ray photoelectron spectroscopy (up to 100 Pa)

## Achievements

### International Patents

- USA: US 8435921
- China: CN102186588B
- Euroasia: EA 019445
- Korea: KR 10-1331108
- Japan: JP 5214032
- Japan: JP 5158760
- India: IN 266215

### Czech Patents

- CZ 301 720

**"We deliver this through an increasing production of excellent scientific results with an essential involvement of undergraduate and graduate students, through active international networking and collaborative projects of high societal impact, such as clean energy."**

## Partnerships and Collaborations

### Academic Partners

Elettra - Sincrotrone Trieste, Italy | Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Germany | Université de Bourgogne, France | Universitat de Barcelona, Spain | Consiglio Nazionale delle Ricerche–Istituto Officina dei Materiali (CNR-IOM)-Democritos, Italy | Universität Bremen, Germany | Brookhaven National Laboratory, Upton NY, U.S.A. | Technische Universität Graz, Austria

### Industry Partners

- LEANCAT s.r.o. | Jablotron grup a.s. | HE3DA s.r.o.
- MAIN RECENT PROJECTS
- OP VVV, SPL-MSB, CZ02.1.01/0.0/0.0/16\_013/0001788
- OP VVV, Pac NG, CZ.02.1.01/0.0/0.0/16\_025/0007414

**"Our mission is the systematic development of science and scholarship based on highest quality scientific research in the field of physics and chemistry of solid surfaces and interfaces."**

## Are you interested in this expertise?

Please contact CPPT UK

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## Experts and their Department

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