MAPEX Bremen
Material. Process. Excellence.

02
05-2016

NEWSletter

FOUR SUCCESSFUL LARGE-SCALE RESEARCH PROJECTS

One Collaborative Research Center (SFB) and two Research Training Groups (GRK) coordinated by MAPEX members were funded by the DFG in the last quarter. Furthermore, a consortium of ten MAPEX members was successful within a DFG call for major equipment along with other five German Universities.

- **Collaborative Research Center (SFB) 1232** „Von farbigen Zuständen zu evolutionären Konstruktionswerkstoffen". Funded: positions for 17 scientists, 13 technicians, 17 student assistants. Speaker: Lutz Mädler, coordinator: Nils Ellendt.
- **Research Training Group (GRK) 2247** "Quantum Mechanical Materials Modelling - QM^3" Funded: 12 PhD and 2 postdoctoral positions. Speakers: Thomas Frauenheim and Tim Wehling.
- **Research Training Group (GRK) 2224** "π^3: Parameter Identification - Analysis, Algorithms, Implementations". Funded: 12 PhD and 1 postdoctoral positions. Speaker: Peter Maass.
- **Call for major equipment:** "In-situ studies of 3D microstructure evolution and spectroscopic imaging during processing and manufacturing of advanced materials". Funded: 2,4 Mio. Euro for an X-ray microscope and accessories. Coordinator: Lucio Colombi Ciacchi.

MAPEX Symposium 2016

The yearly MAPEX Symposium will take place on June 6th and 7th 2016. This year we will have the pleasure of hosting for the first time our five International Advisory Board members. We will present a selection of our latest scientific results and of our cooperation with the private sector in the MAPEX fields. A get-together dinner is open to all participants on the first evening. We look forward to seeing you there!

http://www.uni-bremen.de/mapex > events

Neighbor Visit in the IMSAS

On June 15th 2016 our colleagues from the Institute for Microsensors, -Actuators and –Systems (IMSAS) will host us for the next neighbor visit, where we will gain insights into their research based on microsystems, sensors, and microfluidic devices for applications ranging from medical analysis to industrial measurement systems.

http://www.uni-bremen.de/mapex > events

Research Grants

The MAPEX Center for Materials and Processes promotes the international exchange of PhD researchers, who can apply for short-term research grants to spend a limited period of time (one week to one month) either at the University of Bremen within the group of a MAPEX member (incoming grants) or at a research institution abroad (outgoing grants). Collection dates for outgoing proposals: 31 May 2016, 31 August 2016, 30 November 2016. Proposals from incoming PhD students can be submitted at any time. A list of funded projects is available online.

http://www.uni-bremen.de/mapex > MAPEX Funding > Research Grants

Workshop funding

MAPEX can fund scientific workshops organized by its members and taking place in Bremen with up to 3000 Euro. A strong connection to the MAPEX research landscape is a funding prerequisite.

http://www.uni-bremen.de/mapex > MAPEX Funding > Workshop Funding

Monthly Lunch Meeting

A monthly jour fixe of the MAPEX Early Career Investigators (ECI) is the informal lunch meeting, taking place every last Tuesday in the month. All interested scientists are invited to get in touch with peers from different faculties and institutes and build up their own network of experts. You do not have to be a MAPEX member to join the meeting and PhD students are warmly welcome. We reserve a table in the Mensa (close to the main entrance) and put up a MAPEX sign on the table. There is no official program; everyone pays for his/her own food and drinks.

Upcoming dates are: 31 May, 28 June, 26 July, 30 August, 27 September.

Child care during MAPEX events

To facilitate the participation of young parents to MAPEX events that last until late afternoon, we offer a child-care service, please contact Hanna Lührs for more information.

2ND MAPEX YOUNG SCIENTIST WORKSHOP – BUILDING BRIDGES

across the borders between the faculties and institutes.

About 60 young scientists from the University of Bremen and the Bremen University of Applied Sciences met on April 11th 2016 for the 2nd MAPEX Young Scientist Workshop in the science lounge of the TAB building. Master and PhD students presented their research in a series of 27 flash presentations and posters in front of the MAPEX Early Career Investigators and their colleagues. The contributions were embedded in a framework of keynote lectures given by the MAPEX members Michael Fischer (FB5), Dirk Lehmhus (FB4) and Dorothea Brüggemann (FB1). As a highlight, Prof. Fabio La Mantia, recently appointed at the faculty of Production Engineering (FB4), held a plenary lecture into novel battery systems for grid-energy storage.

Enthusiastic discussions started during the poster sessions and continued until late evening in the course of a blacklight minigolf match and a dinner. The young scientists considered the workshop to be an excellent platform to get an overview on the research topics and techniques available at the Bremen universities and to establish contacts with scientists from other faculties.

MOM MEETS MAPEX

How to build an airplane out of plastics? – International pupils get to know materials science at the University of Bremen.

60 pupils between 14 and 16 years from Ireland, Italy, Portugal, and Germany visited MAPEX on March 9th 2016. Their schools are taking part in the Erasmus-plus-program "Matters of Matter – Future Materials in Science Education", funded by the European Union. In small international groups and supported by their teachers, the pupils are working on projects regarding biosensors, "smart houses", or energy harvesting. The project foresees mutual visits to all partner schools. An excursion to Bremen was part of the one-week program hosted by the Gymnasium Papenburg. In small groups, the guests visited five different institutions of the MAPEX network and presented posters summarizing their visits during a final discussion round.

In the LFM they learned about ultrahigh-precision machines using diamond cutting tools in order to produce metals with mirror-like surfaces. "How to build an airplane out of plastics?" was the question they addressed in the FIBRE. The effect of laser radiation on the properties of different materials and their behavior was explained in the bias. Students of the Bremergy team demonstrated how they are building their own racing car. In the IMSAS the pupils visited the laboratories and workshops used for the fabrication of novel sensors.

MAPEX CALENDAR

31 May 2016 **12:30 Mensa**	MAPEX lunch meeting for young scientists
6 June 2016	MAPEX Symposium 2016 – science Haus der Wissenschaft
7 June 2016	MAPEX Symposium 2016 – technology transfer Labor für Mikrozerspanung, University of Bremen
15 June 2016 **14:00**	Neighbor Visit – IMSAS
28 June 2016 **12:30 Mensa**	MAPEX lunch meeting for young scientists
26 July 2016 **12:30 Mensa**	MAPEX lunch meeting for young scientists
Sept/Oct 2016	3rd MAPEX Young Scientist Workshop www.uni-bremen.de/en/mapex > events

More events, seminars, and talks related to MAPEX topics:
www.uni-bremen.de/mapex > events > calendar

Universität Bremen*

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IMPRINT/CONTACT DETAILS

* This project is funded by the German Excellence Initiative.

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Link to online version of newsletter: *www.uni-bremen.de/mapex > news > newsletter*

Design: Sabrina Goretzki (Druckerei Universität Bremen)

Druck: Druckerei Universität Bremen

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MAPEX COMMUNITY
People

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MAPEX EXECUTIVE BOARD

The Executive Board (EB) is the central decision making committee of MAPEX and is composed of ten Principal Investigators (PI) and two Early Career Investigators (ECI), all of them have a mandate for the duration of two years.

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Affiliations

- Faculty of Biology/Chemistry
- Chair: Physical Chemistry
- Center for Environmental Research and Sustainable Technology (UFT)
- Speaker FOR 2213

Research Landscape

Porous Materials, Nanomaterials, Materials Characterization, Materials Synthesis, Materials Modelling

Research Focus: We study innovative nanostructured materials and aim at exploring their potential at heterogeneous catalysts. For that purpose we often combine experiments on catalysts at typical reaction conditions with studies on carefully chosen, well-defined model surfaces, either experimental in ultrahigh vacuum or by calculations within density functional theory.

Prof. Dr. rer. nat. Ralf B. Bergmann

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Affiliations

- Faculty of Physics/Electrical Engineering
- Chair: Photonic Microsystems
- Bremen Institute for Applied Beam Technology (BIAS) , director of optical metrology and optoelectronic systems division

Research Landscape

Photonics, Materials Characterization

Research Focus: Optical and opto-electronic Systems: Optical metrology using geometrical and coherent optics, methods for optical non-destructive testing, micro- and nano optics, optic design, photonics for information processing.

Prof. Dr. Michael Böhm

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Affiliations

- Faculty of Mathematics/Computer Science
- Chair: Modelling and Partial Differential Equations
- Center for Industrial Mathematics (ZeTeM)

Research Landscape

Process Modelling, Metals

Research Focus: The group works on mathematical models of chemical and mechanical processes in materials with complex microstructures (e.g. steel) as well as in the field of mathematical analyses of systems resulting from partial and ordinary differential equations. Furthermore, the derivation of averaged models via homogenization methods is a key investigation area.

Prof. Dr.-Ing. Lucio Colombi Ciacchi

MAPEX speaker
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Affiliations

- Faculty of Production Engineering
- Chair: Hybrid Materials Interfaces (HMI)
- Bremen Center for Computational Materials Science (BCCMS)
- Center for Environmental Research and Sustainable Technology (UFT)

Research Landscape

Hybrid Materials, Nanomaterials, Materials Modelling

Research Focus: The focus of HMI group research lies on the atomic-level studies of interfaces between technological materials and biological macromolecules, with applications in the fields of biomedical implants, biosensors, pharmaceutical packaging, biocompatible adhesives, and many others. The activities of HMI comprise both experimental research into biomolecular adhesion and advanced theoretical modelling from the quantum to the classical level of precision.

Dr.-Ing. Nils Ellendt

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Affiliations

- Faculty of Production Engineering
- Foundation Institute of Materials Science (IWT)
- Coordinator SFB 1232

Research Landscape

Process Engineering, Process Modelling, Metals

Research Focus: Molten metal single droplet processes, synthesis of defined microstructural states, modelling of solidification processes, droplet based and conventional 3D printing, high-throughput materials discovery.

Prof. Dr. Reinhard X. Fischer

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Affiliations

- Faculty of Geosciences
- Chair: Crystallography

Research Landscape

Nanomaterials, Porous Materials, Materials Synthesis, Materials Characterization

Research Focus: Our research area covers the wide range from ocean sediment research to the systematics of crystal structures, crystal optics, crystal growth, and special aspects of the development of high performance materials with a focus on zeolites and mullite-type materials. This work is accompanied by comprehensive software development.

Prof. Dr. Thorsten M. Gesing

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Affiliations

- Faculty of Biology/Chemistry
- Institute of Inorganic Chemistry and Crystallography
- Chair: Solid State Chemical Crystallography

Research Landscape

Nanomaterials, Porous Materials, Materials Synthesis, Material Characterization

Research Focus: Our group is interested in temperature-dependent structure property relations of oxides, especially of compounds with activity lone electron pairs or small framework structures. Structural phase transitions, template-framework interaction, seperation of thermal displacment and structural distortion or thermochromic behavior are as well of interest as photonic and (photo-)catalytic effects. Additionally we are dealing with the modeling of thermal expansion behavior and the corresponding model development on one hand and structure refinements and spectroscopic characterization from nano- to single crystals on the othe hand.

Prof. Dr.-Ing. Carsten Heinzel

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Affiliations

- Faculty of Production Engineering
- Vice chair: Manufacturing Technology and LFM
- Foundation Institute of Materials Science (IWT)
- Laboratory for Precision Machining (LFM)

Research Landscape

Manufacturing Engineering, Metals

Research Focus: The key areas of investigation are hard and fine machining (cutting & grinding), modeling and simulation of manufacturing processes, prevention of material damage during metal-cutting, distortion engineering during cutting and forming, strain hardening by grinding and deep rolling, as well as sensor integration for grinding tools with a special focus on the complex interaction of manufacturing process and material.

Dr. Stephen Kroll

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Affiliations

- Faculty of Production Engineering
- Advanced Ceramics Group

Research Landscape

Porous Materials, Materials Engineering, Materials Characterization

Research Focus: Within the Advanced Ceramics Group the key areas are processing and characterization of functionalized porous ceramics for environmental, biotechnological and energy applications. Beside the controlled adjustment of pore sizes from nm to mm and the tailoring of porosites especially chemical functionalization approaches are used to alter the ceramic surface properties. Current research projects deal with functionalized ceramic membranes for bacteria and virus filtration, ceramic filters/adsorbents for gas separation and ceramic foams used as substrates for heterogeneous catalytic degradation of drug residues.

Prof. Walter Lang

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Affiliations

- Faculty of Physics/Electrical Engineering
- Chair: Sensors, Sensorintegration, Neuroimplants and Sensornetworks
- Institute for Microsensors, -Actuators and –Systems (IMSAS)

Research Landscape

System Integration

Research Focus: Our group investigates sensors on solid and flexible substrates. One goal is to integrate the sensor into materials in such a way that macroscopic properties, like for example the material stability, are not influenced. To reach this aim, smaller sensor elements and new material embedding techniques are necessary. Current projects cover the following material systems: metals (aluminum, steel), elastomers (sensors in gaskets) and fiber compound materials.

Prof. Dr.-Ing. Lutz Mädler

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Affiliations

- Faculty of Production Engineering
- Chair: Particle and Process Technology
- Foundation Institute of Materials Science (IWT) director of Process & Chemical Engineering Division
- Speaker SFB 1232

Research Landscape

Nanomaterials, Process Engineering, Material Synthesis

Research Focus: Spray processing for particulate materials and functional surfaces, particle science and engineering, particulate systems, reactive and non-reactive spray systems, aerosol manufacturing of materials, nanoparticle technology, air pollution, environmental health (“nanotox”).

Prof. Dr.-Ing. Hans-Werner Zoch

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Affiliations

- Faculty of Production Engineering
- Chair: Materials Science
- Foundation Institute of Materials Science (IWT) Managing Director and Director of Materials Science Division

Research Landscape

Metals, Materials Engineering, Materials Characterization

Research Focus: Fundamental and application oriented research on heat treatment of metals, distortion engineering, surface technologies, characterization of microstructures and residual stresses, static and dynamic mechanical properties, optimization of material properties, lightweight materials, mechanical and corrosion testing, modelling & simulation, failure analysis.

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II INTERNATIONAL ADVISORY BOARD

The International Advisory Board (IAB) is composed of five internationally leading and highly distinguished scientists. Their role is to guide MAPEX with respect to the medium-term and long-term development of its research landscape, e.g. individuating key areas of investigation in which human and technical resources should be invested, or suggesting reduction of efforts in others. The IAB members are appointed by the Executive Board and hold a mandate of four years.

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Affiliations

- Stanford University
- Jagdeep and Roshni Singh Professor in the School of Engineering
- Chair: Chemical Engineering

Research Field

Surface and Interfacial Chemistry

Research Focus: Understanding surface and interfacial chemistry and materials synthesis, and applying this knowledge to a range of problems in sustainable energy, semiconductor processing, and nanotechnology.

Prof. Michael W. Finnis

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Affiliations

- Imperial College, London
- Faculty of Engineering
- Department of Materials
- Chair: Materials Theory and Simulation

Research Field

Materials Theory and Simulation

Research Focus: Current research themes include: (i) Properties of point defects and interfaces in alumina and strontium titanate; ii) Free-energy of crystal-melt interfaces; iii) Models of interatomic forces; iv) Thermodynamic properties of charged point defects; v) Thermodynamic properties of high-temperature ceramics; vi) Theory of hydrogen embrittlement of metals.

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Affiliations

- University of Alberta
- Faculty of Engineering
- Department of Chemical and Materials Engineering
- Head of Advanced Materials and Processing Laboratory

Research Field

Materials Processing

Research Focus: Processing of materials with special interest in particulate materials for powder metallurgy with emphasis on quantitative microstructural evolution of alloy system, metal-matrix composites, spraying and atomizing processing, rapid solidification, recycling of metals, alloys and composites also research on the manufacturing of micro-alloyed and low-alloyed steels for pipelines and SAGD (steam assisted gravity drainage) applications.

Prof. Sybrand van der Zwaag

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Affiliations

- TU Delft
- Faculty of Aerospace Engineering
- Chair: Novel Aerospace Materials

Research Field

Novel Aerospace Materials

Research Focus: Microstructure-property relations for novel, not yet existing, materials. Research lines include the computational design of novel high-performance metals, the development of self-healing materials (polymers, metals and ceramics) as well as the development of novel functional composites. The work is generally of a fundamental nature, but with a clear link to industrial relevance.

Prof. Hans-Conrad zur Loye

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Affiliations

- University of South Carolina
- Department of Chemistry and Biochemistry
- Inorganic Chemistry Division
- Associate Dean for Research and Graduate Education
- David W Robinson Palmetto Professor

Research Field

Inorganic Materials Chemistry

Research Focus: Synthesis of novel solid-state materials and characterization of their physical properties; investigation of cooperative structure-property relationships; crystal growth of complex oxides and investigation of their electronic and magnetic properties.

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SCIENCE & PROJECTS
Recently funded large-scale projects

Universität Bremen

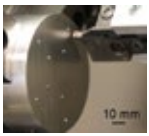
II COLLABORATIVE RESEARCH CENTER

Collaborative Research Center SFB 1232 "Von farbigen Zuständen zu evolutionären Konstruktionswerkstoffen"

The MAPEX Principal Investigator Prof. Lutz Mädler (IWT) initiated and successfully applied for the collaborative research center "Farbige Zustände" which will start on July 1st 2016. The consortium includes 10 MAPEX members from Institut für Werkstofftechnik (IWT), Bremer Institut für Strukturmechanik und Produktionsanlagen (bime), and Bremer Institut für Angewandte Strahltechnik (BIAS). Further members are from the Center for Industrial Mathematics (ZeTeM), the Center for Environmental Research and Sustainable Technology (UFT), the Group of Computer Architecture (AGRA) and the Max-Planck-Institut für Eisenforschung (Düsseldorf).

The initiative „Farbige Zustände" (engl.: "Colored States") aims at the exploration of a novel experimental method for the development of evolutionary metallic structural materials. The overall goal is the efficient and focused identification of compositions and process chains, which result in a specific performance profile of the structural material. Conventional materials developments are based on costly experimental investigations of chemical, mechanical, or technological material properties. Such expensive requirements reduce the number of possible experiments, so that mostly predictive (or intuitive) approaches are employed. As a result, potentials of non-intuitive parameter choices are not taken into account. Combining new processes for primary shaping, micro structure formation ("coloration") and characterization of microscopic material samples, sample logistics as well as mathematical and computer science based methods for the analyses of large amounts of data, this research initiative develops of a novel high throughput method.

Two of the novel processes developed in the collaborative research center SFB 1232: single droplet generation for micro-sample synthesis (left); micro-machining of single particles (right).



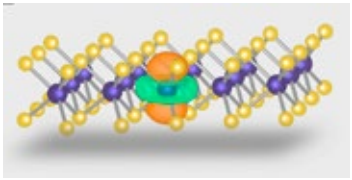
GRK 2247: QUANTUM MECHANICAL MATERIALS MODELLING - QM³

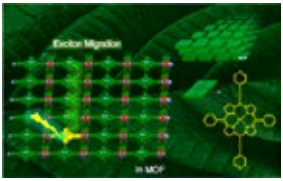
New DGF Research Training Group (RTG) in Computational Materials Science

Within the GRK 2247, coordinated by the two MAPEX members Thomas Frauenheim and Tim Wehling, interdisciplinary research projects for twelve PhD students and two postdoctoral researchers in the field of Computational Materials Science will be funded at the University of Bremen, the Jacob University Bremen, the Carl von Ossietzky University of Oldenburg and the Max-Planck Institute for the Structure and Dynamics of Matter in Hamburg.

In the last two decades, theoretical physicists and chemists have learned how to predict the outcome of chemical reactions with very high precision. They are able to numerically solve fundamental quantum mechanical problems with the help of large supercomputers. However, these solutions are based on approximations that are not valid for a wide range of important physical and chemical effects, such as photovoltaics or metal corrosion. Especially challenging is the description of materials with properties dictated by the strong correlation between their electrons (many-body effects). Also difficult to predict is the exchange of electrons across materials interfaces caused by interaction with light, which is for instance the basis of photocatalysis.

Although advanced approaches for the individual problems exist, the comprehensive understanding and the prediction of electronic properties for the rational design of advanced materials requires the development of modelling methods across the boundaries of traditionally separated subfields. The GRK 2247 has the mission of unifying different quantum mechanical materials modelling approaches and apply them to the two emerging topics of two-dimensional materials and metal-oxide interfaces. The unique interdisciplinary concept for the education of young scientists is embedded in a consortium in which the four research institutions mentioned above join their efforts in a brilliant example of Hanseatic cooperation.





Materials modeling methods at different levels of accuracy will be applied to two-dimensional materials (left) and functionalized oxide materials (right).

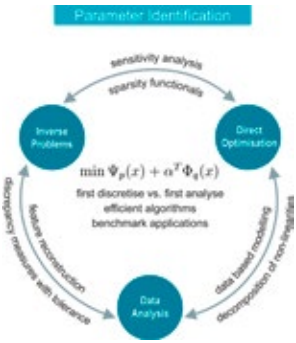
RTG 2224: π^3: PARAMETER IDENTIFICATION - ANALYSIS, ALGORITHMS, IMPLEMENTATIONS

New DGF Research Training Group (RTG) in Industrial Mathematics

Mathematics is a universal language, which allows to extract, model and analyze complex structures of different nature in a common abstract setting. Applied mathematicians go one step further and aim at relating the theoretical findings to real life applications. The newly funded RTG 2224, whose spokesperson is MAPEX member Peter Maass, combines mathematicians of the Center for industrial mathematics with mathematicians from computational topology, statistics and analysis.

The guiding principle of RTG 2224 is parameter identification, which relates to retrieving biological, physical, or technical parameters from measured data, or to determine system parameters for the optimization and controlling of complex processes. Accordingly, parameter identification is at the core of multiple applications in all fields of natural sciences, engineering, life sciences, and industrial applications. The demand for tackling even more complex models in terms of non-linearity, sensitivity, coupling of systems, or for including specific expert information as side constraints, provides numerous challenges in mathematical modelling as well as for designing, analyzing, and implementing appropriate algorithms.

Under the guidance of experienced scientists from the University of Bremen 24 PhD students (12 PhD positions funded by DFG) and several PostDocs will focus on the identification of deterministic high-dimensional and non-linear parameters for benchmark applications such as mass spectrometric imaging, optimization of automotive carburetor systems or optical analysis of fibre structures.

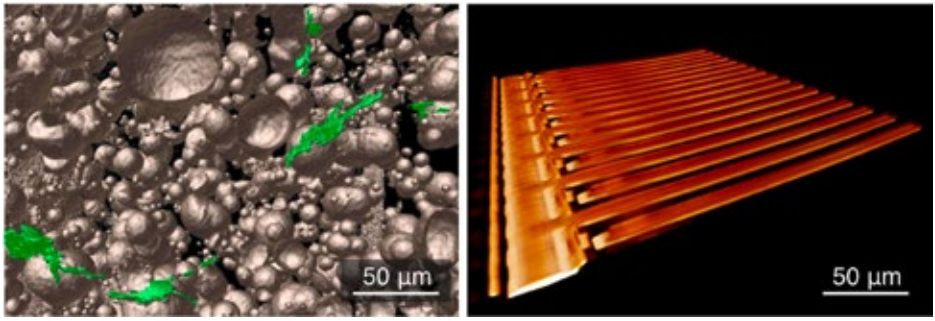


DFG major equipment funding: 2.4 Mio Euro for high-end X-ray Microscope

As one of six German institutions and less than one year after the official kick-off, MAPEX was successful within the major equipment call of the DFG for X-ray microscopes. Coordinated by the MAPEX speaker Lucio Colombi Ciacchi, eleven Professors of the University of Bremen were involved in the proposal *"In-situ studies of 3D microstructure evolution and spectroscopic imaging during processing and manufacturing of advanced materials"*. Thanks to recent advances of X-Ray Microscopy (XRM) and on-going efforts into fabricating spectroscopic detectors that allow a simultaneous detection of 3D microstructural maps and 3D chemical imaging, we will be able to open wholly new ways for a knowledge-based, concurrent development of materials and processes. Furthermore, a set of accessories will be developed to place samples under thermal, mechanical, or chemical load in the XRM sample chamber to enable in-situ studies of the effects of such loads on the materials microstructure and composition.

After the installation of the new equipment (Zeiss Xradia 520 Versa) in late 2016, routine measurements and service orders will be possible from early 2017. A detailed description of the new instrument will be published in one of the next newsletters.

"This success once more demonstrates the strength and relevance of the intense cooperation of the University with the external research institutions that makes Bremen an excellent science location", remarks Andreas Breiter, vice rector for research and young academics, University of Bremen.



Examples of XRM imaging of a steel sample (left) produced by selective laser melting after bending test including micro-fractures (colored in green) and of portion of a microsensor element (right) showing work-hardened zones at the electrode base.

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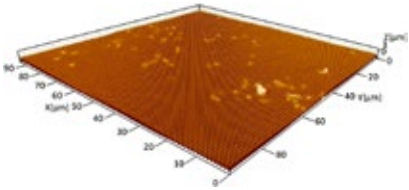
INSTRUMENT DATABASE
Chemical imaging of rough surfaces

Universität Bremen

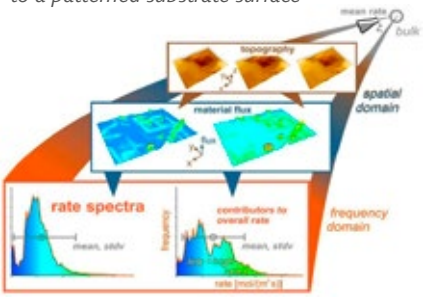
VSI-R: VERTICAL SCANNING INTERFEROMETRY - RAMAN COMBINATION

Surface reactions of materials result in heterogeneous alteration of their topography. Thus, repeated high precision measurements of reacting surfaces during experiments provide quantitative data about reaction kinetics and spatial heterogeneity of surface reactivity. Vertical scanning interferometry (VSI) is a surface-sensitive method that provides high spatial resolution and a large field of view. VSI is the method of choice to analyze the surface evolution of materials during corrosion or adsorption reactions. Now, with the novel combination of a Raman spectrometer (R) and VSI, we generate combined datasets of both the reaction kinetics and the chemical properties of reacting surfaces.

An exciting example is the unprecedented insight into the impact of microbial films on surface reactivity that the new VSI-R system provides. While VSI alone quantified already the alteration of surface topography, the new instrument provides spatially-resolved information about the surface chemistry and its changes.



left: Shewanella oneidensis bacteria attach to a patterned substrate surface



right: Mean reaction rates lack critical information about spatial distribution and intensity of contributors to the overall rate. In contrast, temporal sequences of topographic measurements map material flux directly via surface difference calculations. Analysis of these data in the frequency domain identifies critical modes of the resulting rate spectra

|| VSI-R: VERTICAL SCANNING INTERFEROMETRY - RAMAN COMBINATION

Custom build prototype VSI-R combination

01 || General Information

Keywords: surface topography, surface chemistry, surface reaction kinetics, surface films, roughness

Categories:

- Surface/Interface Characterization
- Materials Properties
- Surface Analytics
- Spectroscopy
- Microscopy

Main Application: Analysis of chemical kinetics during dissolution/corrosion, growth, and adsorption of materials.

Measured quantities: surface heights, Raman shift spectra

Year of Fabrication: 2016

Manufacturer: Bruker, Renishaw

02 || Specifications:

- The Interferometer is equipped for white light scanning and monochromatic phase shift mode.
- Interferometer objectives include TTM, 5x Michelson, 20x, 50x, 115x Mirau, 0.55x and 2.0x FOV multiplier tubes.
- The Raman spectroscope is equipped with two lasers (532 nm and 785 nm).
- Maximum sample size is about 100 mm x 100 mm x 20 mm.
- Data reduction with SPIP software (Image Metrology).

03 || Contact:

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