MAPEX CALENDAR 2018

17 May	MAPEX Methods Workshop II – Computational Materials Science
1 June 12:30	Café Unique – MAPEX Lunch Meeting for Early Career Researchers
18 – 19 June	MAPEX Symposium 2018
3 September 12:30	Café Unique – MAPEX Lunch Meeting for Early Career Researchers
1 October 12:30	Café Unique – MAPEX Lunch Meeting for Early Career Researchers
25 October	7th MAPEX Early Career Researcher Workshop – science meets industry

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

Universität Bremen MAPEX Bremen Material. Process. Excellence. www.uni-bremen.de/mapex

IMPRINT/CONTACT DETAILS

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Link to the online version of the newsletter: *www.uni-bremen.de/mapex/whats-new/newsletter*

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06
05-2018

NEWSletter

HIGHLIGHTS

ERC Advanced Grant for Lutz Mädler

MAPEX member Lutz Mädler is one of the 269 top researchers in Europe awarded with this year's ERC Advanced Grant. With the budget of 2.5 Million Euro Lutz Mädler and his team will work on *"Inverted Reactive Spray Processes for Sulphide/Nitride High Surface Area Electrode Coatings (ReSuNiCo)"* within the next five years. Only established research leaders with a recognised track record of research achievements can apply for ERC Advanced Grants in order to realise their most creative ideas. After Ekkard Brinksmeier (2010), Lutz Mädler is the second holder of an ERC Advanced Grant in the MAPEX community. This confirms both the outstanding individual research performance as well as the excellent quality of materials science in Bremen in general.

Second funding phase for Research Training Group MIMENIMA

Great news just before Christmas: From 2018 to 2022 the teams around chairman Kurosch Rezwan and the 13 project leaders will continue their work within the DFG Research Training Group MIMENIMA. In their last meeting of 2017 the DFG grants committee has allocated 5 million Euro for the education and support of young researchers in Bremen. Within MIMENIMA two postdocs and 15 PhD candidates are working on novel porous ceramic structures and surfaces with tailored properties for applications in energy supply, environmental and chemical processing, as well as space technology.

Monthly Lunch Meeting for Early Career Researchers

A good opportunity to get in touch with peers from different faculties and institutes is during the monthly lunch meeting of the MAPEX Early Career Investigators.

* NEW jour fixe: every first working day of the month

* NEW location: Café Unique (MAPEX sign on the table)

* SAME time: 12:30

All interested scientists and students are invited to meet the MAPEX ECIs and stay up to date with the latest MAPEX developments.

You don't have to be a MAPEX member to join the meeting. There is no official programme; everyone pays his/her own food and drinks. For upcoming dates see the MAPEX calendar.

Master's programme 'Process-oriented Materials Research' (ProMat)

Excellent STEM students with the goal of pursuing an academic career and already having a clear vision of their future research field are the target group of the new research-oriented master's course 'Process-oriented Materials Research' (ProMat), that will start in October 2018. For more details see supplementary – Education 01 of this newsletter.

MAPEX funding and support

Currently the following funding opportunities are offered by MAPEX:

- Research stays abroad for PhD candidates (incoming and outgoing),
- scientific workshops,
- impulses for interdisciplinary project,
- support for child care during MAPEX events.

All details and collection dates for proposals are available online: www.uni-bremen.de/mapex > Research > Funding

MAPEX Methods Workshop II – Computational Materials Science

Get to know (how to use) the „simulation toolbox" at the University of Bremen. MAPEX will host its second Methods Workshop on 17 May 2018. The idea is to provide the audience, composed both of experimental and computational researchers in the field, with a showcase of the "simulation toolbox" available within the University of Bremen and the MAPEX community. We would like to show the different kinds of expertise in computationals materials science (from nano- to macroscale and from solid state to soft matter) that are present at our university, with the final aim of fostering new ideas and collaborations.

MAPEX Symposium – Process Monitoring

Process Monitoring will be in the focus of this year's MAPEX Symposium, taking place on 18 and 19 June in the *Haus der Wissenschaft*. The agenda will comprise keynote talks held by invited speakers from MAPEX as well as external experts. Furthermore, short presentations and posters by early-career researchers from the MAPEX community will round out the two-days programme.

II 6TH MAPEX EARLY CAREER RESEARCHER WORKSHOP

Building bridges across the borders defined by the faculties and institutes

More than 40 young scientists from four faculties of the university met during the sixth edition of the MAPEX Early Career Researcher Workshop on 25 April 2018. The flashlight and keynote presentations provided a good basis for a lively interdisciplinary exchange between postdocs, PhD candidates, and master students during the poster sessions. Colleagues from the research services unit and the Bremen Early Career Researcher Development (BYRD) answered numerous questions regarding funding schemes for postdocs as well as the support of early-career researchers at the University of Bremen. With his plenary lecture on "Semiconductor nanostructures – smart probes for biological systems" Martin Eickhoff closed the official programme of the workshop. After a day full of scientific insights, some participants enjoyed a visit of the „Hafenrummel", testing their luck and skill on a course of fairground attractions of the 1950ies.

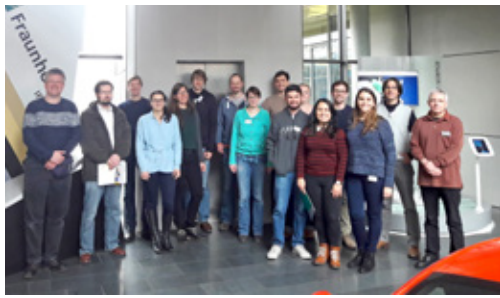
II MAPEX NEIGHBOUR VISIT

Get to know what the scientists next door are really doing...

The MAPEX Early Career Investigators regularly invite interested students and employees to join them for a short visit (60 minutes) to one of the MAPEX groups/ institutes. Past events at the three divisions of the IWT as well as at the IMSAS showed that there was great interest to discover the laboratories next door, gain insights into the daily work of other MAPEX scientists, and pave the way for new cooperation.

Beyond the limits of measurability ... is the daily work of Dirk Stöbener, team leader of the optical metrology group at the **Bremen Institute for Metrology, Automation and Quality Science (BIMAQ)**. In September 2017, he introduced us into the world of measurement system engineering. The BIMAQ scientists continuously strive to extend the limits of optical, geometrical, gearing and speckle-metrology in several research areas. The dimensions of the investigated objects/features range from the nanometre scale up to several meters.

In January 2018, we organized a visit to the **Fraunhofer Institute for Manufacturing Technology and Advanced Materials (IFAM)**. Guided by Dirk Lehmhus, we gained insights into the departments of **Powder Technology** and **Casting Technology**, learning about traditional and modern forming processes for metals. **Polymer Chemistry for Fiber Reinforced Plastics** is in the focus of the research group lead by Katharina Koschek, who presented a multitude of possibilities for the construction of strong yet flexible materials for lightweight structures.



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SCIENCE & PROJECTS
ERC Consolidator Grant

Universität Bremen

ll ELECTRON- AND ION TRANSFER AT THE INTERFACE – EllonT

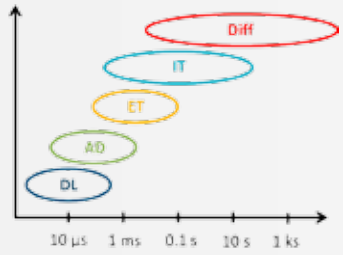
New tools and approaches for the analysis of electrochemical systems

Electrochemistry plays a fundamental role in modern everyday life: from the development of anticorrosion coatings for metallic components, up to personal health care and mobile power sources for electronic devices. However, its role will be even bigger in the future, as the energy sector is counting more and more on electrochemical devices in order to store electrical energy coming from renewable intermittent sources, such as solar and wind power. This is achieved by storing the electric energy in batteries or by using it to produce energy carriers and chemicals, such as hydrogen. Although the fundamental laws describing simple and ideal electrochemical systems have been well established since the 1980's, batteries, fuel cells and electrolysers, just to cite a few of the electrochemical systems for energy storage and conversion available in the market, are much more complex. Nowadays mostly empirical descriptions are used in order to predict and monitor their performance. It is therefore clear that, in order to achieve a better understanding of complex systems and of the materials used in these devices, it is necessary to develop new tools and a new approach to their analysis. The aim of the project "EllonT" is to develop a set of new analytical tools, which will allow unfolding the complexity of the reactions occurring in real electrochemical systems, and identify the deviation of the real world from the ideal one.

Fabio La Mantia holds a W3 bridge professorship for "Energy Storage and Energy Conversion Systems" at the University of Bremen in cooperation with the Fraunhofer IFAM since July 2015. He received his PhD from ETH Zurich and his master in chemical engineering from the University of Palermo. His research interests are centred on fundamentals and applications of electrochemistry for the storage of renewable energies and the development of alternative storage systems.

Electron- and Ion Transfer at the Interface – a Hyphenated Dynamic Multi-Frequency Approach

The first step in the direction of the goal of "EIIonT" will be to develop new electro-analytical tools capable of identifying and separating the different phenomena during an electrochemical reaction. These are occurring in a large range of time constants and they are often overlapping, thus making the identification and quantification of the single components very complex (see figures).



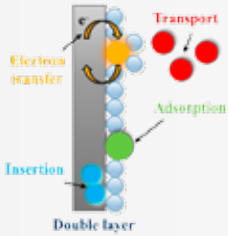


Figure: Time scale of different electrochemical phenomena.

DL: double layer charging;
AD: adsorption;
ET: electron transfer;
IT: ion-transfer;
Diff: diffusion and mass transfer.

A possible solution to this problem is the analysis of the frequency response of the system, which consists in stimulating the system with waves of different frequencies, and recording how the system responds to such stimuli. However, it is also important to identify the nature of the chemical species taking part in the reaction. This will be done by combining the frequency analysis with a quartz crystal microbalance, an apparatus able to measure extremely small changes in the weight of the materials, down to a few nanograms. These new tools will be at first tested with simple electrochemical systems, in order to validate their robustness, and later on more complex materials, in particular Prussian Blue derivatives. This family of compounds can easily capture and release ions from solution and can be used to store fast and efficiently energy from renewable sources. The large amount of data produced in the experimental part will be analysed by means of ad hoc developed software. The analysis of the data will give the opportunity to quantify the kinetic parameters influencing the reaction and to observe how such parameters are changing when the system passes from ideal conditions to real application. An attempt to generalize the approach will be done, in order to reach a phenomenological rigorous understanding of the effect of the real interactions between particles on the kinetic parameters. Collaboration with other groups from Chemical Physics, Biochemistry, Bioelectrochemistry, and Electrocatalysis is important, in order to use this approach also for other systems such as enzymatic fuel cells, bio-fuel cells, water and CO_2 reduction.

With the **ERC Consolidator Grant** the **European Research Council** funds individuals with 7 to 12 years research experience after their PhD with up to 2 million Euro, in order to consolidate their position in the scientific community.

EIIonT
ERC Consolidator Grant: Fabio La Mantia
Funding: 1.943.600 €
Funding period: 2018 – 2022
Staff (ERC funded):
3 (2) postdoctoral researchers,
5 (3) PhD students, 1 technician

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INSTRUMENT DATABASE
Advanced mechanical testing of materials

Universität Bremen

GLEEBLE 3500: THERMAL AND MECHANICAL TESTING SYSTEM

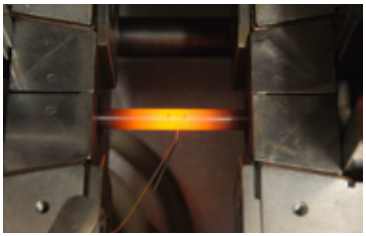

Fig.1: Thermal and mechanical testing of a 100Cr6 test specimen inside the Gleeble 3500.

The Gleeble 3500 simulates high temperature forming processes for metals like forging, welding or annealing. At its core, the device is a servohydraulic dilatometer for metallic materials with conductive heating at a maximum rate of 10.000 K/s up to 1.200 °C. Heat treatments with various quenching speeds up to 2.000 K/s can be realized while detecting phase transformations or determining mechanical properties at high temperatures. Tension and compression can be applied simultaneously to investigate stress/strain characteristics like the Bauschinger effect. The determination of such material properties are a core competence of the department of Metallic Materials and Structures since 15 years and are based on the expertise of the SFB 570 (Distortion Engineering).

As an example, the Young's modulus in dependence of the test temperature for 100Cr6 as a typical bearing steel and 20MnCr5 as a typical case hardening steel is shown in the diagram. Here, the Young's modulus has been determined in the temperature range between 250-800 °C for the metastable austenite, which will transform into ferrite, perlite or bainite with different mechanical properties shortly after the test temperature has been reached.

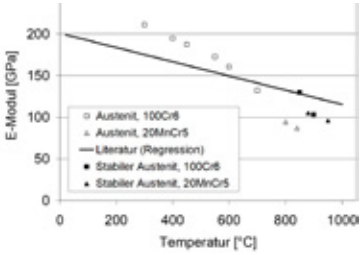

Fig.2: Young's modulus of different steels for metastable austenite as measured with the Gleeble 3500.

|| GLEEBLE 3500

01 || General Information

Keywords: Hot tensile test, phase transformation, heat treatment, dilatometer, quenching

Categories: Material properties of metallic materials

Main Application: Characterization of microstructural transformations, simulation of heat treatments

Measured Quantities: Temperature; longitudinal strain; lateral strain

Year of Fabrication: 2004

Manufacturer: Dynamic Systems Inc.

02 || Specifications

maximum force: 100 kN (tension & compression);

conductive heating 75kW;

heating rate: 10.000 K/s;

quenching rate: 2.000 K/s;

contact-free laser extensiometer;

possible materials: steel, aluminium, titanium

03 || Contact:

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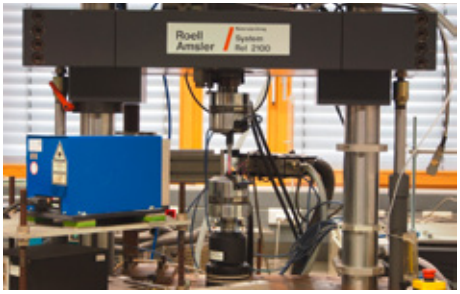
INSTRUMENT DATABASE
Advanced mechanical testing of materials

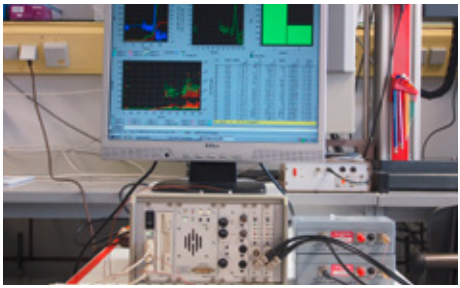
Universität Bremen

II HIGH-TEMPERATURE MECHANICAL TESTING OF MATERIALS



Servo-hydraulic testing machine for cyclic tests on materials up to 100Hz.

The Advanced Ceramics group has extensive experience in mechanical testing of engineering materials. Here, our main expertise lies in highly specialized mechanical tests at extreme temperature conditions along with standardized experiments. We are equipped with several universal testing machines with setups to perform most of the mechanical tests described by DIN standards such as tensile, compression, bending, shear, torsion, and multi-axial tests. Mechanical tests can be performed at temperatures ranging from 25°C to 1.700°C in different environmental conditions and under quasi-static, static and cyclic loading. To this end, we use tailor-made equipment such as laser extensometers for recording longitudinal deformation, induction and infrared ovens and vacuum chambers. Acoustic monitoring of damage during mechanical testing and non-destructive measurements of elastic characteristics of materials based on the Impulse Excitation Technique emission acquisition system are also possible.



Acoustic emission acquisition system for the monitoring of damage during mechanical testing.

II HIGH-TEMPERATURE MECHANICAL TESTING OF MATERIALS

01 II General Information

Keywords: Mechanical testing, mechanical properties, elastic constants, high temperature tests, fatigue, creep, micro-indenter tests, fiber tests

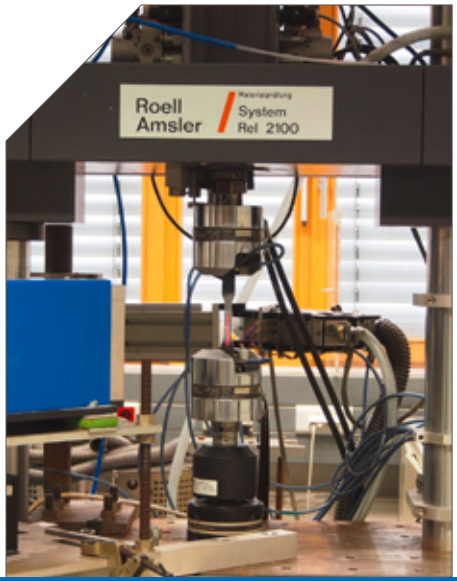
Categories: Material properties

Main Application: Mechanical characterisation of structural and functional materials

Measured Quantities: Strength, toughness, elastic constants, stress-strain behaviour, creep rate, durability

02 II Specifications

- **Universal testing machines** up to 50 kN for **quasi-static** and **creep tests** on materials, equipped with induction oven, vacuum chamber, laser extensometer and pyrometer. Testing temperatures: 25 – 1.600°C.
- **Servo-hydraulic testing machine** for cyclic tests on materials up to 100Hz. Strain measurement via strain gauge or laser extensometer.
- **Testing machines** for **quasi-static and creep tests on fiber filaments** at temperatures up to 1700°C in air or inert atmosphere.
- **Acoustic emission acquisition system** for the monitoring of damage during mechanical testing. The system is equipped with two VS 600-Z2 piezoelectric AE sensors. The system provides a possibility to quantify and localize failure events.
- Non-destructive measurements of materials characteristic **elastic properties** based on Impulse Excitation Technique. Extremely rapid and simple measurements of E- and G-modulus and Poisson's ratio.



Universal testing machine for quasi-static and creep tests.

03 II Contact:

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Principal Investigator:
Prof. Dr.-Ing. Kurosch Rezwan

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05-2018

EDUCATION
Master of Science

Universität Bremen

PROCESS ORIENTED MATERIALS RESEARCH / PROZESSORIENTIERTE MATERIALFORSCHUNG – PROMAT

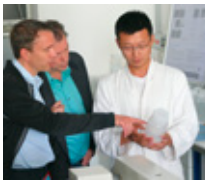
professional aim: academic researcher

The goal of the master programme ProMat is to prepare students for a future scientific career within the scope of the MAPEX research landscape. The novel concept of this interdisciplinary programme, starting in October 2018, emerges from MAPEX and is carried out by the five STEM faculties of the University of Bremen.

Individual curriculum tailored to the personal research interests

Although all modules in ProMat are compulsory, the courses and lectures available in the modules of foundations and the modules of specialization are elective. The students can choose from more than 350 different courses offered by the five STEM faculties of the University of Bremen. This provides them with the opportunity of designing an individual curriculum around their research interests within the MAPEX research landscape and according to their educational background.

<table>
<tr><th></th><th></th><th>Foundation Modules (45 CP)</th><th colspan="2">Specialization Modules (24 CP)</th><th>Research experience (21 CP)</th><th>Master thesis (30 CP)</th></tr>
<tr><td rowspan="5">Semester</td><td>I</td><td rowspan="4">Mathematics, 9 CP
Physics, 9 CP
Chemistry, 9 CP
Engineering, 9 CP
Computer science tools, 9 CP</td><td colspan="2"></td><td rowspan="2">Research processes, 12 CP</td><td rowspan="3"></td></tr>
<tr><td>II</td><td rowspan="2">Theory-oriented specialization, 12 CP</td><td rowspan="2">Application-oriented specialization, 12 CP</td></tr>
<tr><td>III</td><td>Research stay abroad, 12 CP</td></tr>
<tr><td>IV</td><td colspan="3">In the foundation and specialization modules you can choose out of more than 350 courses.</td><td></td><td>Master thesis including the colloquium, 30 CP</td></tr>
</table>



1:1 supervision by personal mentor

Within ProMat, a personal mentor is guiding every student and advising him/her while creating the individual curriculum keeping in focus the student´s research topic. The students are integrated into their mentor´s working group and they actively participate in ongoing research projects. All MAPEX members and scientists teaching at the University of Bremen are eligible to be a mentor.

Create a first scientific network

The mentor is the student´s first link to a professional network, introducing him/her into the broad field of materials science at the Bremen location, and encouraging and supporting the students to present their own research results in the national and international scientific community.

The module research processes represents a central platform for exchange of ideas and experiences among the ProMat students of all years and is a direct link to the MAPEX community. Participation in MAPEX activities such as workshops and symposia is organized within the course. Furthermore, the students will get familiar with the tools, methods, and (soft) skills they will need as researchers and get to know the science system and its rules.

Early research experience – in the mentor's group and abroad

Integrated into their mentors' research groups, ProMat students are encouraged to develop their own research questions, to methodically carry out their research, and to interpret their acquired results in an interdisciplinary scientific context. The curriculum-based compulsory research stay abroad emphasises the importance of networking and international experience. This, in addition, builds up the students' competencies in a foreign language and intercultural interaction inside and outside of science. Supported by the research processes module, research experience is actively growing from the first semester until graduation.

Study profile:

- Title: Master of Science (M.Sc.)
- Length of study: 4 semesters (120 CP)
- Programme language: German and English

Application requirements (extract)

- above average first degree in the STEM-field,
- proficient use of English and German language,
- clear motivation to study research-oriented within the scope of the MAPEX research landscape,
- a clear vision of the personal research goals, expressed in a letter of motivation and a 2-pages essay.

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