Universität Bremen

MAPEX Center
for Materials and Processes

PROGRAMME

17th MAPEX Early Career Researcher Workshop

BUILDING BRIDGES
across the borders defined by the faculties and institutes

24th May 2024
AIB building (Hochschulring 40)

MAPEX Bremen

Programme overview

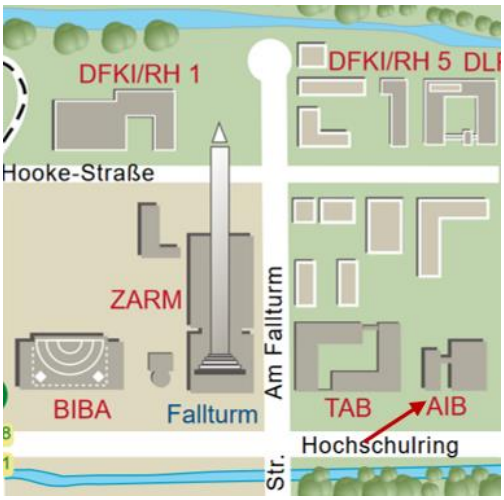
9:30	**Registration**
Session 1	
9:45	**Welcome note and introduction** Dr. Hanna Lührs, Dr. Enis Bicer *MAPEX Center for Materials and Processes*
10:00	**Pioneering Solutions in Material Science: Overcoming Degradation Challenges in High-Performance Steels** Dr. Cem Örnek *Leibniz-IWT*
10:30	**Coffee break**
Session 2	
10:45	**A factory in space? Synthesis of catalytic nanomaterials in conditions of microgravity** Dr. Camilla Tossi *ZARM – Center of Applied Space Technology and Microgravity, University of Bremen / IIT - Italian Institute of Technology*
11:15	**Science speed dating**
11:45	**Joint lunch / End of workshop**

Venue

AIB building

Hochschulring 40

First floor



Organizing committee

Enis Bicer, Hanna Lührs, Lena Ehlers

Support: Touhidul Islam, Bastian Dincher (photography)

Session 1

09:45	**Welcome note and introduction**

Dr. Hanna Lührs, Dr. Enis Bicer
MAPEX Center for Materials and Processes

10:00	**Pioneering Solutions in Material Science: Overcoming Degradation Challenges in High-Performance Steels**

Dr. Cem Örnek
Leibniz-IWT

Material degradation issues such as hydrogen embrittlement and corrosion often compromise the reliability and performance of corrosion-resistant steels in demanding industrial applications. These phenomena pose substantial threats to the structural integrity and functional lifespan of materials in rigorous industrial settings. This talk addresses the sophisticated challenges of material degradation through a dual approach of advanced characterisation techniques and simulation methods.

We will discuss the pivotal role of alloying and microstructural engineering in developing novel high-strength steel that mimics the corrosion resistance of traditional stainless steel. By smartly incorporating elements like chromium, molybdenum, aluminium, and nickel, a robust regenerating passive film can be forged, enhancing the material's overall resistance to corrosive environments. The synergistic effects of these alloying elements on the passivity and structural homogeneity of the steel will be explored in depth.

Additionally, the presentation will cover the contemporary understanding of hydrogen embrittlement in advanced stainless steels, mainly focusing on super duplex grades. We will demonstrate how operando advanced characterisation techniques, such as synchrotron in-situ X-ray diffraction, provide critical insights into the degradation mechanisms. These studies reveal how hydrogen absorption leads to lattice strain and metastable hydride formation, primarily in the austenite phase, illustrating the dynamic nature of the degradation processes under mechanical straining and hydrogen charging.

Furthermore, we will showcase how density functional theory (DFT) can be employed to design innovative hydrogen permeation barriers and microstructures to withstand hydrogen-induced mechanical degradation.

The session will conclude with a discussion on the potential of these advanced techniques to revolutionise the design and application of corrosion-resistant materials in challenging industrial environments.

Coffee Break
10: 30 – 10:45

Session 2

10.45 **A factory in space? Synthesis of catalytic nanomaterials in conditions of microgravity**

Dr. Camilla Tossi
ZARM – Center of Applied Space Technology and Microgravity, University of Bremen / IIT - Italian Institute of Technology

Two very important aspects of space travel are life support and in-situ resource utilization (ISRU) technologies. In Moon and Mars future habitats, on space stations, and in interplanetary spacecrafts, it is paramount to recycle waste-water and carbon dioxide into oxygen, hydrogen, and hydrocarbons, and to exploit the space environment and resources to enable such recycling: the ability to synthesize and fabricate all the necessary components in-situ, for example, would be an excellent advance in this direction. Also, developing fabrication techniques with low energy requirements will be a matter of great import. Finally, catalyst materials are involved in a large percentage of the industrial chemical processes on Earth, and they are of well-known importance for waste recycling, water reformation and CO_2 reduction, making them one of the earliest materials to develop for human space exploration.

Since reduced gravitational environments are known to affect nanomaterial synthesis by inducing higher crystallinity and increased surface area - attractive qualities in a catalyst - this research wants to investigate the effect of microgravity on catalyst structure, morphology and catalytic performance. For example, metal and metal oxide catalyst thin films and nanoparticles can be synthesized on semiconductor substrates, which are then used for photoelectrochemical processes that exploit solar irradiation for oxygen and hydrogen evolution from water, with a low energetic footprint and high sustainability.

This research is conducted thanks to the Drop Tower and the Gravi Tower Bremen Pro at ZARM, with precursor materials of known Moon- and Mars-abundance (Iron, Rhodium and Ruthenium), for a comprehensive model of off-Earth nanomaterial fabrication, with the goal to pave the way for nanomaterial synthesis in space and for increased sustainability in future space missions.

Science Speed Dating
11:15 – 11:45

Science speed dating offers the opportunity to talk to fellow researchers and get to know what they are working on. The rules are simple and are taken from conventional speed dating: Two people sit opposite of each other at a table and share their scientific backgrounds. After a predetermined short time, the table is changed until everyone has had a chance to talk to each other. The aim of this format is to promote scientific networking by bringing together researchers from different fields in a relaxed atmosphere and encouraging them to mutually exchange ideas and get inspired.

Joint lunch / End of workshop

MAPEX
Doctoral Qualification Programme

In addition to their scientific education, MAPEX supports doctoral candidates in acquiring transversal skills and competencies needed for taking over leadership tasks inside or outside of academia after successful completion of the doctorate.

The MAPEX Doctoral Qualification Programme offers the following benefits to its members:

- a **milestone-based programme** covering five qualification areas,
- a **transcript of records** summarising achieved milestones,
- a comprehensive **summary of training courses** and **workshops** offered by various institutions at the University of Bremen,
- **individual consultation** and **advice** with regard to their doctoral qualification process and the development of their personal competencies,
- **workshops** and **networking events** specifically targeted at early career researchers from all MAPEX disciplines,
- the access to **MAPEX funding** for research stays abroad, materials analytics and organization of scientific workshops.

Contact and more information:

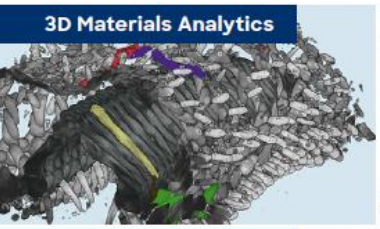
MAPEX-QP

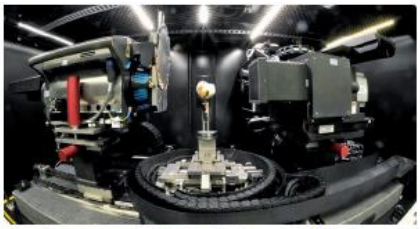
MAPEX
Core Facility for Materials Analytics

A unique combination of cutting-edge instruments for the structural and chemical characterization of materials is being established within the University of Bremen by MAPEX in the form of the **MAPEX Core Facility for Materials Analytics (MAPEX-CF)**.

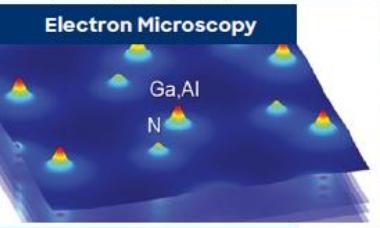
As a user facility, the MAPEX-CF allows scientists from several disciplines to share and access a wide range of high-performance scientific equipment in the investigation areas of **Electron Microscopy**, **3D Materials Analytics**, **Surface Analytics**, **X-ray Diffraction**, and **Spectroscopy**.

For an overview of instrumentation available in the research groups of MAPEX members, use the **Instrument Database** on the MAPEX-CF website.

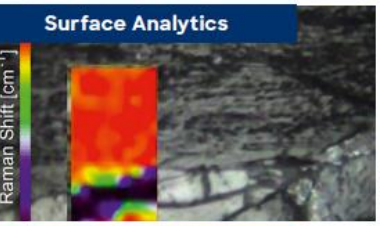




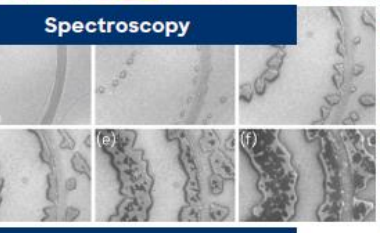
We use X-rays to non-destructively inspect the three-dimensional distribution of matter inside the object of investigation.



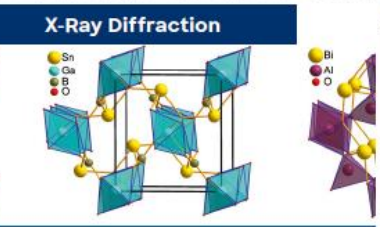
We investigate our samples using high-energy electron beams to obtain images with resolution down to the atom scale.

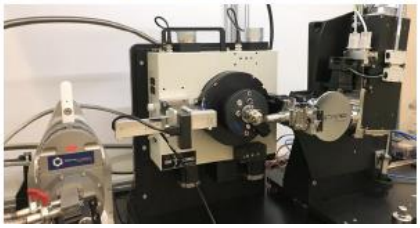


We combine microscopic and spectroscopic techniques to monitor processes at materials surfaces.



We perform in-situ and real-time chemical, electronic and optical characterization of materials under different conditions, e.g. to identify and map different phases.





We support structure investigations of materials from crystalline nano-materials to macroscopic single crystals at ambient and non-ambient conditions.

Funding

MAPEX and the MAPEX-CF also support Early Career Researchers by providing **funding** for short-term **research projects**, **materials analysis**, **workshops**, and **more**.

Research grants for Early Career Researchers:

Contact and more information:

MAPEX

MAPEX-CF

Universität Bremen

MAPEX Center
for Materials and Processes

17th MAPEX Early Career Researcher Workshop

With the aim of “building bridges” across faculties and institutes we encourage early-career researchers to boost their careers through interdisciplinary exchange.

The workshop is a good platform for you if you would like to …

- get in touch with peers, build up your own network of experts,
- learn from others, think outside the box,
- open doors to other experts – become aware of the huge potential for mutual support that you can access on the short way,
- develop ideas for cooperative research projects,
- get to know how MAPEX and the MAPEX Core Facility can support your research.

University of Bremen
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www.uni-bremen.de/mapex