



12th MAPEX Early Career Researcher Workshop

Programme

22th July 2021

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**BUILDING
BRIDGES**

across the borders defined
by the faculties and institutes

12

MAPEX

Materials Methods Technologies

Early Career Researcher
Workshop

PROGRAMME - overview

9:00 Session 1 – keynote room

10:00 Poster session – poster room

10:30 Session 2

11:00 Speed Dating and Networking – speed dating room

Session 1

09:00 Welcome

*Hanna Lührs, MAPEX
Wilke Dononelli, FB04, University of Bremen*

Cyprien Verseux

Center of Applied Space Technology and Microgravity (ZARM)

The leading space agencies have stated a common goal of sending humans to Mars in the coming decades. While the exact timeframe remains tentative, it is not far from the reach of today's technologies. However, as missions get longer, providing all life-support consumables from Earth becomes unrealistic given launch costs, travel times, and risks of resupply failure.

It has been argued that some species of diazotrophic, rock-weathering cyanobacteria could be used as a basis for life-support systems (LSS) on Mars that would rely on local resources, thereby greatly reducing the mass of consumables to be sent from Earth (Verseux et al., 2016). Fed with materials available there—atmospheric gases, water mined on site, and mineral nutrients from the regolith (Olsson-Francis and Cockell, 2010; Verseux et al., 2016)—, those cyanobacteria could be used for direct production (e.g., of oxygen and protein-rich dietary supplements), but also to support the growth of other organisms which, themselves, could perform LSS processes and bring further biotechnological capabilities (Rothschild 2016; Verseux et al. 2016).

Among the factors that will determine the efficiency of cyanobacterium-based LSS is the fitness of cyanobacteria under (i) hypobaria (low pressures), and as a result low partial pressures of dinitrogen (Verseux et al. 2021); and (ii) a dependence on regolith for all nutrients not provided as gases, which also leads to high concentrations of highly oxidizing compounds (chiefly, perchlorates). In this talk, I will outline the work performed at the ZARM's recently-founded Laboratory of Applied Space Microbiology to study those factors and thereby assess, and improve, the efficiency of cyanobacterium-based LSS.

Olsson-Francis, K., and Cockell, C.S. 2010. *Planet. Space Sci.* 58(10): 1279–85.

Rothschild, L.J. 2016. *Biochem. Soc. Trans.* 44(4): 1158–64.

Verseux, C. et al. 2016. *Int. J. of Astrobiol.* 15(1): 65–92.

Verseux, C. 2018. PhD thesis, University of Rome "Tor Vergata."

Verseux, C. et al. 2021. *Front. Microbiol.* 12: 67.



Cyprien Verseux is a Humboldt Postdoctoral Fellow at the ZARM, where he leads the recently-founded Laboratory of Applied Space Microbiology. After Master's degrees in biotechnologies and synthetic biology, and doctoral research in astrobiology (mainly pertaining to the search for life on Mars), he currently focuses on biological systems which could help improve the sustainability of future crewed outposts beyond Earth.

In molecular chemistry and materials science the knowledge of the exact chemical composition of a material is crucial to understand its properties and to allow design of new functional materials. Atomistic modelling can help to analyze the structure-property relation and to determine structures of new unknown materials. In this talk I will present a method that can be used to determine the structure of molecules and solids without any previous knowledge except the stoichiometry. These calculations are normally computationally extremely demanding, but by including some methods from the field of machine learning the computational demands can be drastically reduced. Using not only the thermodynamic stability calculated using density functional theory, but additionally, experimental values or calculated properties, we are able to determine even meta-stable configurations beyond the thermodynamic minimum.



Wilke Dononelli is Senior PostDoc at the HMI Group, BCCMS and MAPEX. After a master in chemistry, he received a PhD in theoretical chemistry (catalytic reactions at surfaces), worked as a Postdoctoral researcher in theoretical physics and now focuses on theoretical materials science. Wilke uses and develops methods for materials modelling including atomistic simulation based on density functional theory, high level wave function methods and machine learning.

9:50 Poster pitches

P1 Covalent adaptive network polymers: Plasticity under mechanical load and its temperature dependence

*Lea Pursche
Fraunhofer IFAM*

Covalent adaptive network (CAN-) polymers form a new polymer class, which combines the technical positive properties of thermosets and thermoplastics. The reversible covalent bonds enable multiple malleability and self-healing abilities while contain a good chemical resistance. Due to their relatively recent discovery, the creeping behavior of such systems is still unknown. Therefore, the aim of the research is to get a first insight into the creeping behavior of selected CAN-polymer systems.

P2 Mars regolith characterization from first principles

*Lorenzo Bastonero
Hybrid Materials Interfaces
Bremen Center for Computational Materials Science*

Future human space missions towards Mars will depend on a deep knowledge of its regolith, the unconsolidated cover layer of its surface. In fact, martian regolith will be also used as a resource. To date, only XRD and Mössbauer analyses have been performed in situ, while non-destructive methods would be more indicated for future applications. We use DFT to predict equilibrium structures, IR and Raman spectra of the olivine solid solution, one of the main mineral in martian soil.

P3 Simulation of the interaction of polymer/ceramic composite materials with ionizing space radiation

*Chieh-Min Hsieh
Institute for Physical and Theoretical Chemistry*

This project aims at designing a novel material that can generate electric power by utilizing ionizing radiation.

10:00 Poster session

Session 2

10:30 Aging of materials in space – a ground level perspective

Maciej Sznajder

DLR, Institute of Space Systems, Bremen

Space exploration demands reliable system components. They are built of materials which need to be extensively examined in context of their response to all kinds of aging factors. Those are: vacuum, rapid temperature changes, corpuscular and electromagnetic radiation, space debris and micro meteorites.

Materials are tested in terrestrial laboratories which try to recreate such environmental conditions. Unfortunately, each facility has its technical limitations making material aging studies challenging. I will give few examples where materials show (significant) change of their physical properties after being exposed to radiation. However, question rises, is the test outcome truly representative? And if not, which conclusions can be drawn? I will share my thought on this problematic.



Maciej Sznajder is a scientific co-worker at the Institute of Space Systems at the German Aerospace Center (DLR) in Bremen. He studied computational astrophysics at the University of Zielona Góra, Poland where he also obtained his first PhD in theoretical physics in 2013. And second, in the engineering field, was obtained at the Bremen University in 2016.

His research areas are:

- Radiation analysis and testing
- Aging mechanisms of materials used in space industry
- Theoretical aspects of radiation interaction with matter
- Computational physics and astrophysics

Speed dating & networking

11:00

Get to know as many other local researches as possible in a short time.



Location

Gather.town, Interactive meeting platform

link: <https://gather.town/invite?token=TqoUox4z>

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Organizing committee

Hanna Lührs, MAPEX

Wilke Dononelli, MAPEX

12th MAPEX Early Career Researcher Workshop

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

We’ve set up an interactive workshop environment on the platform gather.town where you will use your personal avatar to ...

- listen to the invited talks and poster pitches in the keynote room;
- visit the poster exhibition for in depth discussions with the authors;
- join the speed dating event to get to know other local researchers;
- meet colleagues in private spaces for small group discussions, e.g. at the bar or at the beach.



MAPEX Bremen

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