Past and planned future space activities of the University of Miskolc

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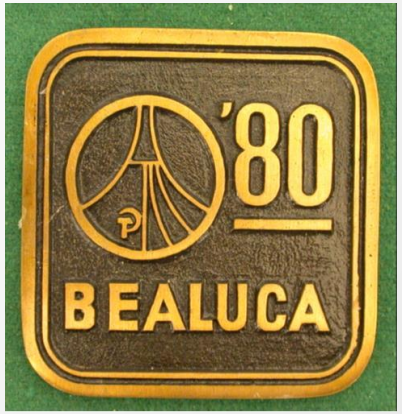
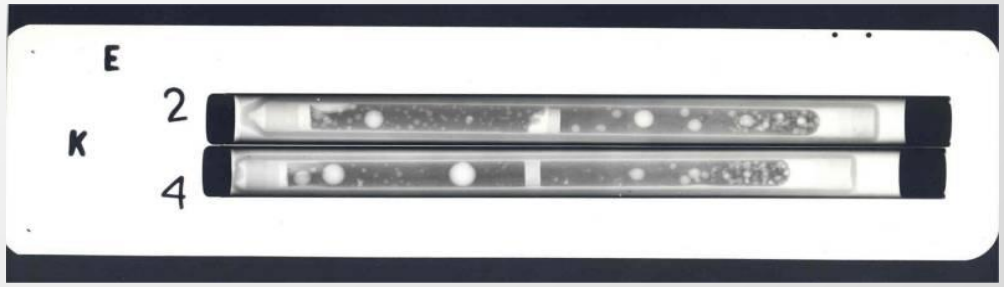
University of Miskolc

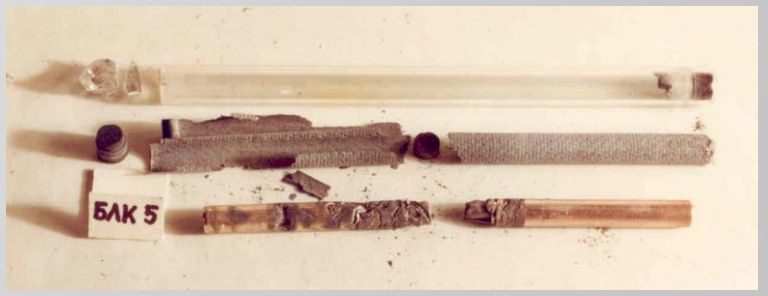
- Faculty of Earth and Environmental Sciences and Engineering
- Faculty of Materials and Chemical Engineering
- Faculty of Mechanical Engineering and Informatics
- Faculty of Law
- Faculty of Economics
- Faculty of Humanities and Social Sciences
- Faculty of Health Sciences
- Bartók Béla Faculty of music

Space activities in the past



- Interkozmos program, 1980
- SALJUT 6 space station in the SZPLAV and KRISZTAL furnaces
- Al-4%Cu alloy and pure aluminium rod covered by a copper mantle
- Diffusion was investigated



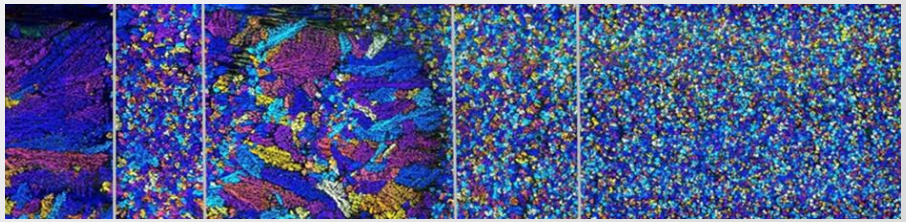


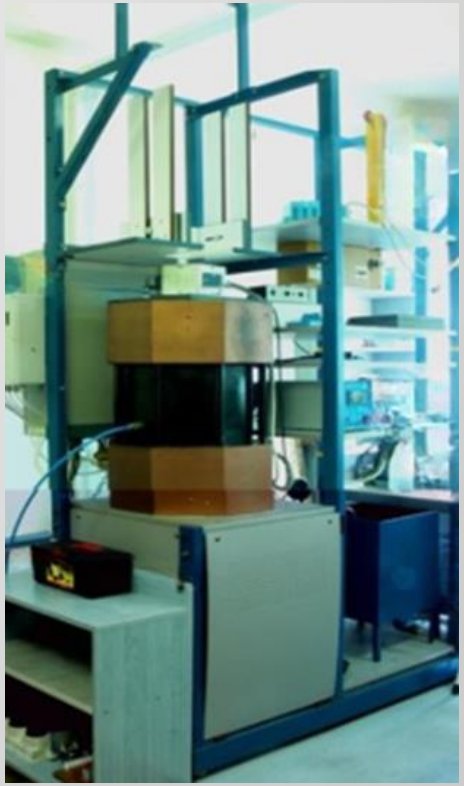
Space activities in the past

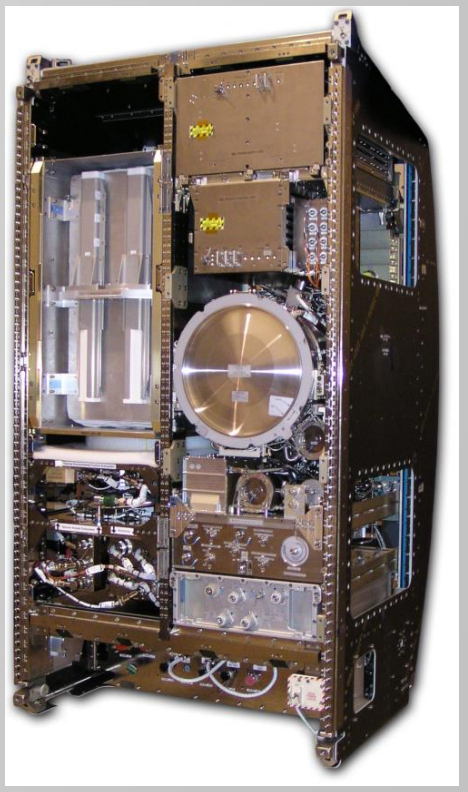
Current space activities, Materials science

The aim of the MICAST project is to investigate the effect of melt flow on the solidified microstructure of metals.

In the CETSOL project, we investigate the circumstances of the columnar-equiaxed transition in the microstructure of metals

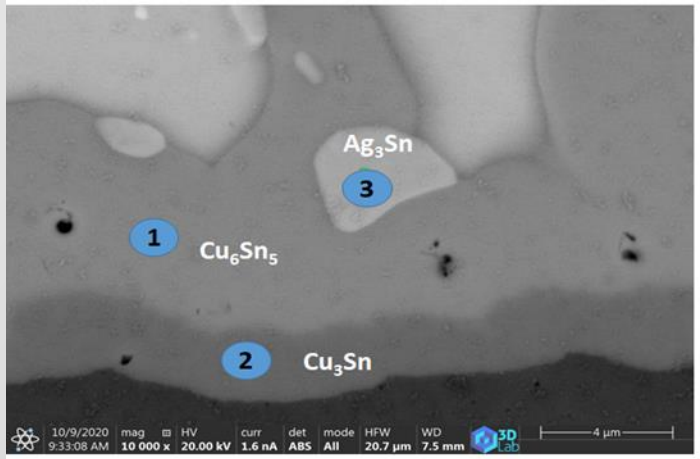






Future planned space activities

- Development of lead free solders and production technologies based on materials science:
  - Modification of the composition of solder alloys
  - Examination of solders
  - Study of soldering anomalies
  - Reliability characterization of solder joints
  - Optimizing the composition of solder alloys
  - Optimizing the soldering technologies



Point -1

Element	Weight (%)	Atomic (%)
Sn L	61.1	45.7
Cu K	38.9	54.3

Point -2

Element	Weight (%)	Atomic (%)
Sn L	37.7	24.5
Cu K	62.3	75.5

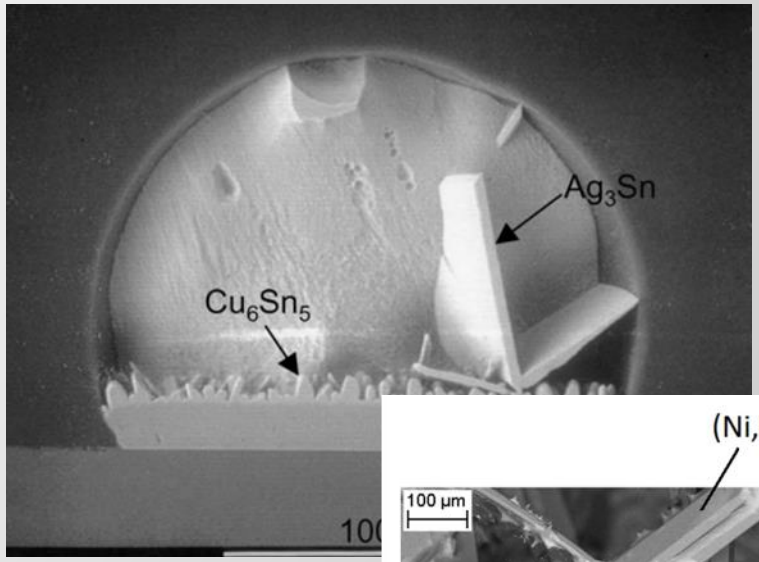
Point -3

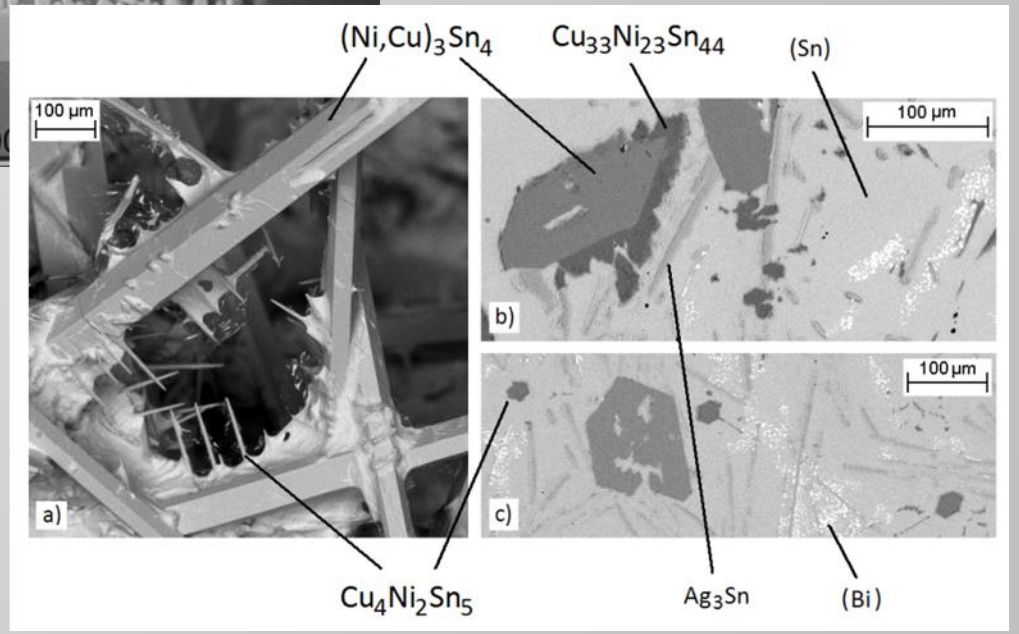
Element	Weight (%)	Atomic (%)
Ag L	68.4	70.4
Sn L	31.6	29.6

Formation of intermetallic compounds

- **Aims:**
- Explanation of the formation of harmful intermetallic compounds in the application of lead-free soldering technology.
- Modification of the composition of lead-free solders based on scientific knowledge.
- Examination of the effects of certain alloying elements and impurities on the microstructure.

- **Examination methods:**
- Microstructure investigation (light microscope, SEM+EDS; TEM)
- Computer image analysis (IMC phases)
- Mechanical testing (tensile test, hardness measurement)
- X-ray diffraction (phase identification)
- DSC measurement (examination of solidification processes)





Formation of tin whiskers

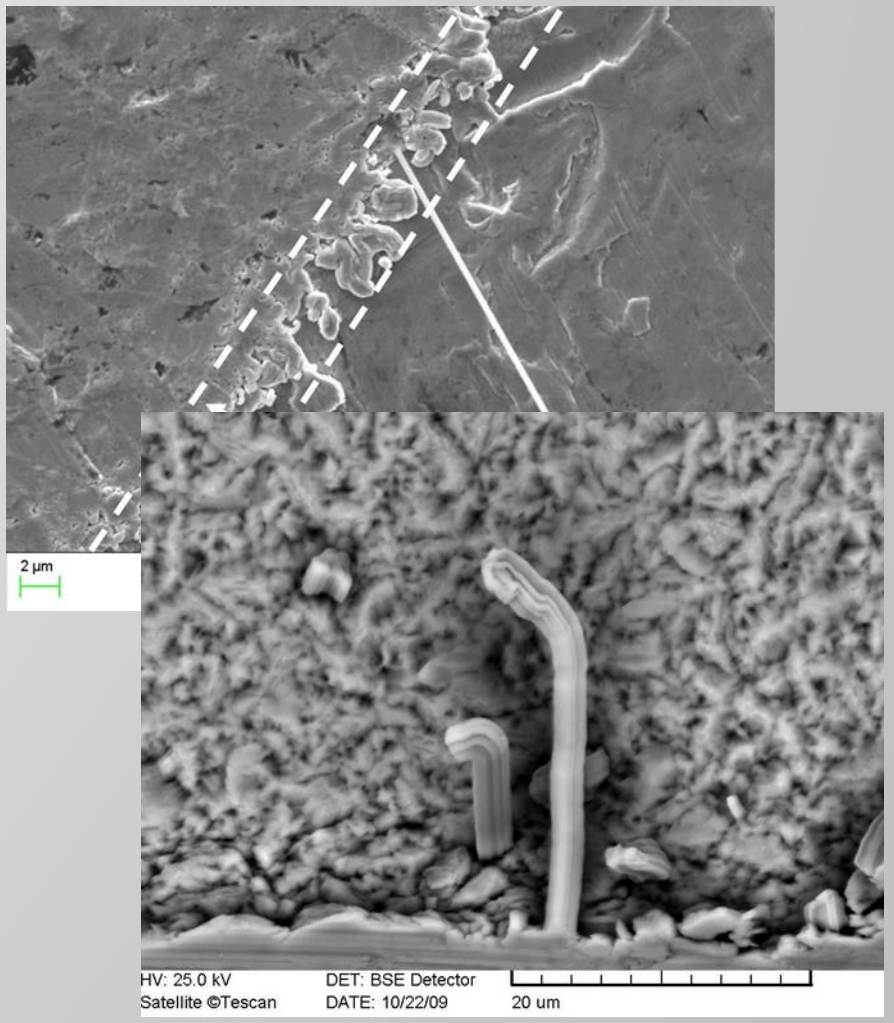
Aims:

Study of the parameters influencing the formation and growth of tin whiskers :

- Changes in the microstructure of solders
- Effects of mechanical and electrical stress
- Effect of temperature
- Effect of substrate’s composition
- Effects of coatings with different composition

Examination methods:

- Development of specific test equipment
- Microscopic examination (correlative microscopy, SEM+EDS, TEM)
- Computer image analysis



Lifetime of solder joint

Aims:

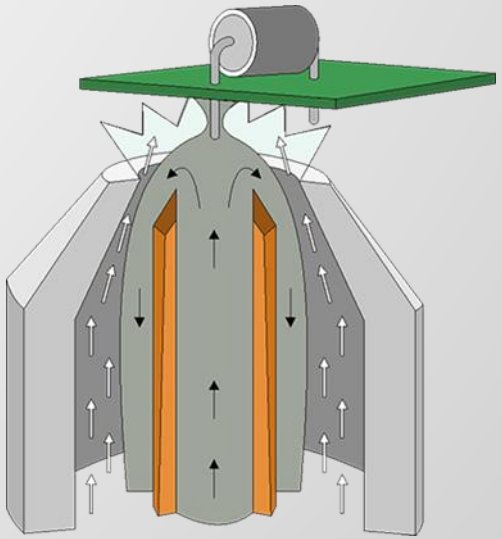
- Examination of mechanical properties of lead-free SAC alloys
- Thermo-mechanical examination of the soldered components (reliability)
- Effects of thermal shock on the microstructure (aging of solder joint)
- Examination of the evolution of the intermetallic layer
    - Effects of thermal shock's cycle number
    - Effects of certain alloying elements and impurities (Pb)
- Characterization of Ag_3Sn compound as a function of thermal shock

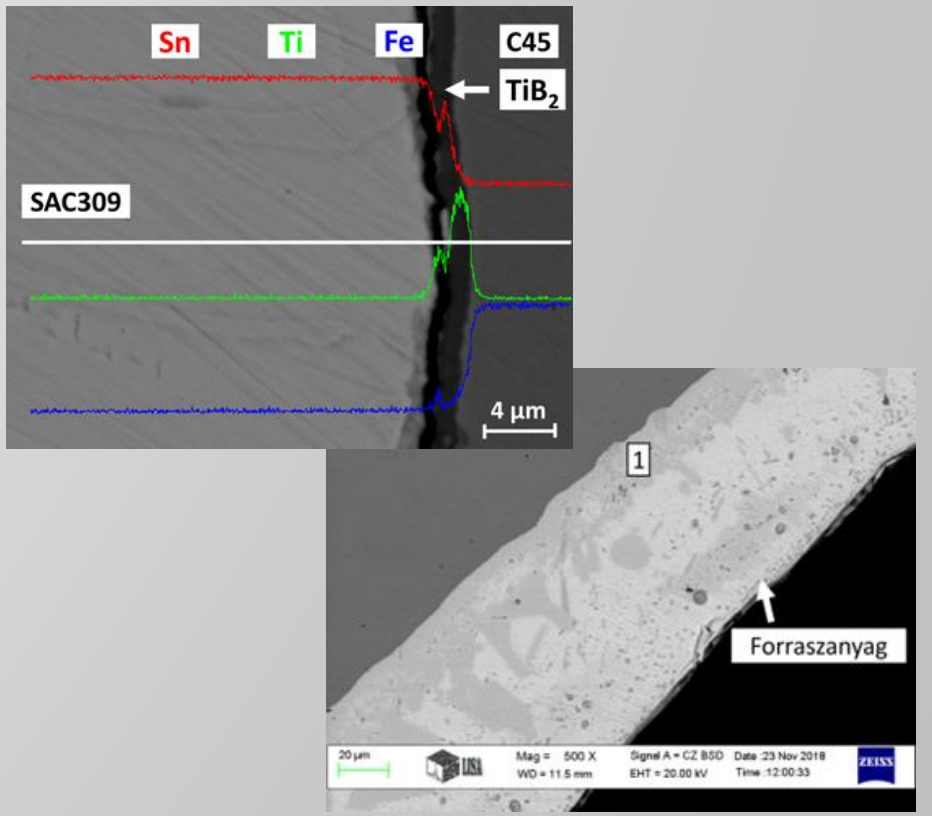
Examination methods:

- Applying thermal shock chamber
- Microscopic examination (SEM+EDS, TEM)
- Computer image analysis

Soldering tool erosion

Lead-free soldering materials erode the tools made from steel very fast.
The tool must not be wetted by the solder.





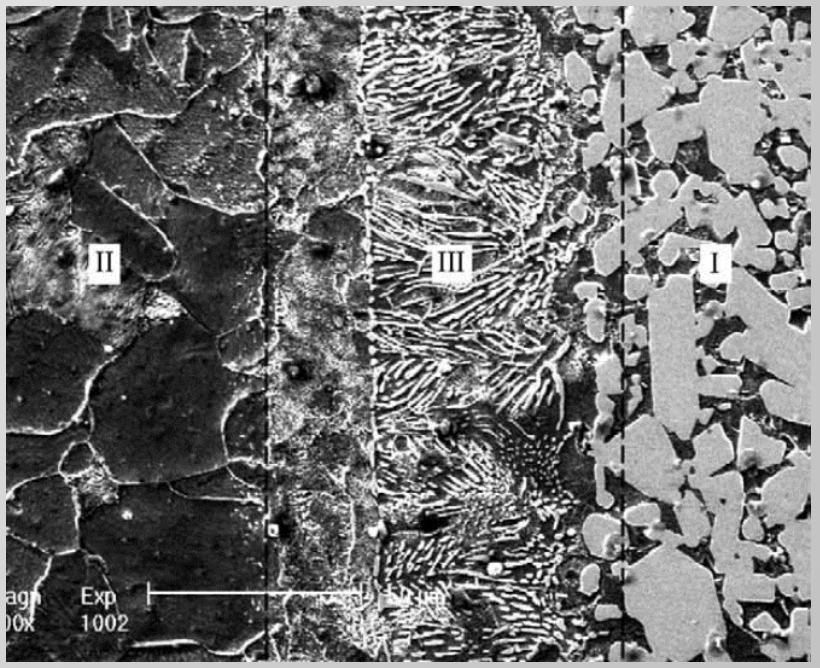
Composites in soldering materials

Aims:

- Preparation of composite solders
- Examination of the effects of technological parameters and chemical composition
- Characterization of the phases
- Examination of solder joints

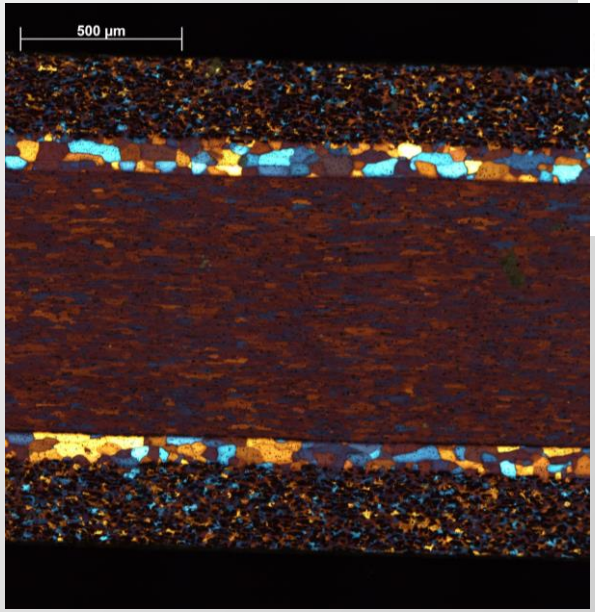
Experimental methods:

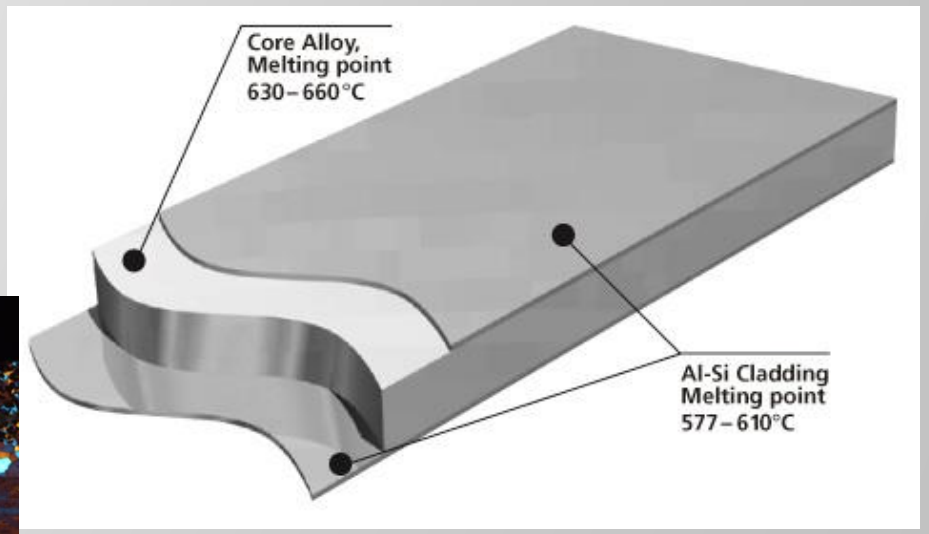
- Microscopic examination (light microscopy, SEM+EDS)
- Computer image analysis
- X-ray diffraction
- Mechanical testing



Development of brazing materials

- Preparation and examination of solder alloys
  - Sn-based solders
  - Application area
  - Process technology
- Complex development of aluminium brazing technology
  - Vehicle cooling system
  - Process technology
  - Applied alloys
  - Increasing corrosion resistance





Results

- We increased different properties of different lead free solders
- We developed nem factoring methods for solders
- We increased soldering tools’s life time

21 Scientific student dissertation

17 University thesys

4 Ph.D dissertation

44 Scientific paper

Partners

International:

- ❑ CGL, Erlangen (D)
- ❑ DLR, Cologne (D)
- ❑ ACCESS e.V. Aachen (D)
- ❑ TU Freiberg (D)
- ❑ TU Berlin (D)
- ❑ WW University of Münster (D)
- ❑ Grenoble Polytechnics, MADYLAM, Grenoble (F)
- ❑ SIMAP, CEA, Grenoble (F)
- ❑ ENSIACET, Toulouse (F)
- ❑ TU Madrid (E)
- ❑ DEM, Sheffield (GB)
- ❑ University of Leeds (GB)
- ❑ Romanian Academy of Sciences (RO)
- ❑ TU Kosice (SK)
- ❑ AGH Krakow (PL)
- ❑ METU Ankara (TR)
- ❑ University of Victoria, Victoria (CDN)
- ❑ University of Arizona, Tucson (USA)
- ❑ MSFC, Huntsville (USA)
- ❑ Tohoku University (J)

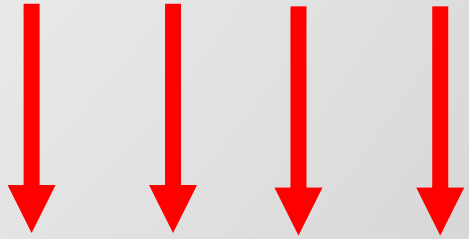
Industrial:

- ❑ Robert Bosch GmbH
- ❑ Knorr-Bremse GmbH
- ❑ Metalloglobus Fémöntöde és Kereskedelmi Ltd.
- ❑ Glob-Metal Ltd.
- ❑ ALCOA-Köfém Ltd.
- ❑ Güntner Tata Hűtötechnika Ltd.

MISKOLCI EGYETEM

UNIVERSITY OF MISKOLC

Versatile and integrated knowledge, team work

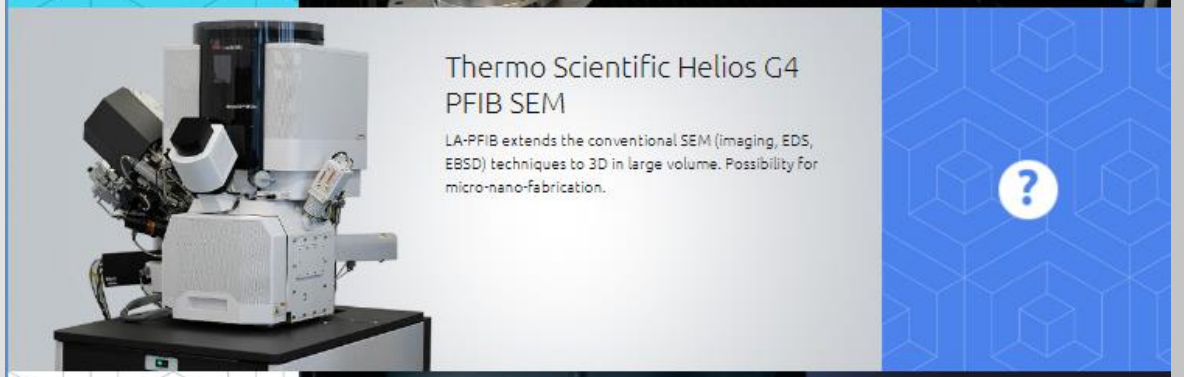


Novel ideas, excellent engineering execution

3DLab
Infrastructure for Fine Structure Analysis

MISKOLCI EGYETEM
UNIVERSITY OF MISKOLC

Also Astromony and planetology course with Béla Somosvári (ADMATIS Kft)



https://www.unexmin.eu/

https://unexup.eu/

https://robominers.eu/

UNEXUP UNEXMIN, and ROBOMINERS: innovative ways for raw materials exploration and resource extraction

Some past projects with the coordination of Uni. Miskolc

UNEXMIN (2016-2019)

- **Focus on research and development of a robotic platform to survey flooded underground mines and other flooded environments. Prove the concept.**
- **Core objective: Develop a prototype for underwater exploration; raise scientific interest.**
- **EU funded H2020cresearch project** (RIA)
- Agreement number: **690008, 12 organizations** (8 EU countries), Budget: **4.87 million Euro**
- **TRL 6**

UNEXUP (2020-2022)

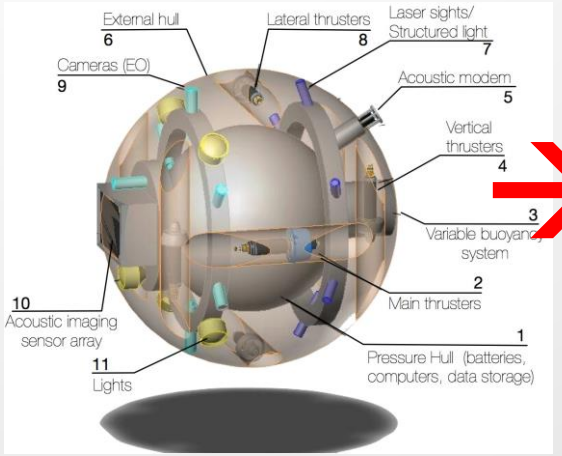
- **Focus on the commercial deployment of the technology developed in UNEXMIN, while further improving the robotic system's hardware, software capabilities.**
- **Core objective: Upgrade the prototype; sell an exploration service.**
- **EIT RawMaterials funded Acceleration, Upscaling project** (D2.2)
- Agreement number: **19160, 8 organizations** (6 EU countries), Budget: **3 million Euro** (80% from EIT RM)
- **TRL 8**

Evolution of the UX robots

UNEXMIN

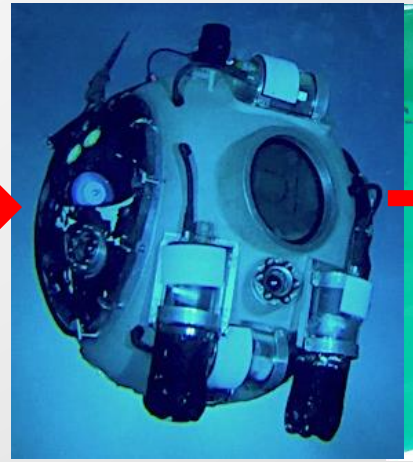
UNEXUP

Concept idea (2015)



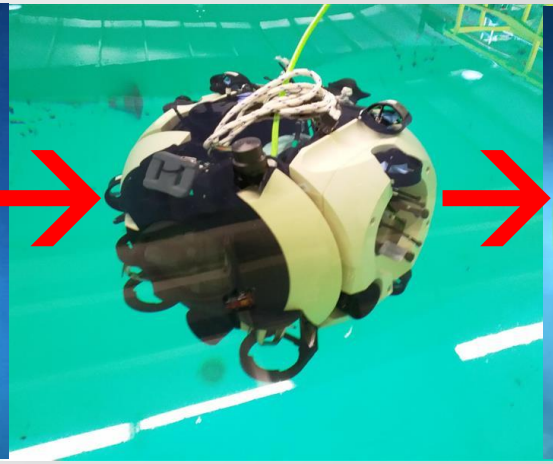
UX-1 Nata (2018)

closed hull version



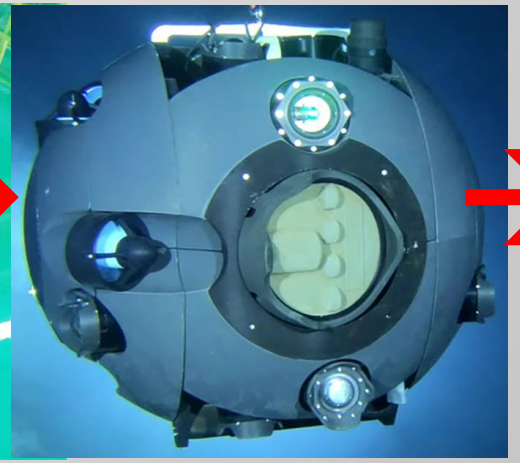
MARA (2020)

open frame concept



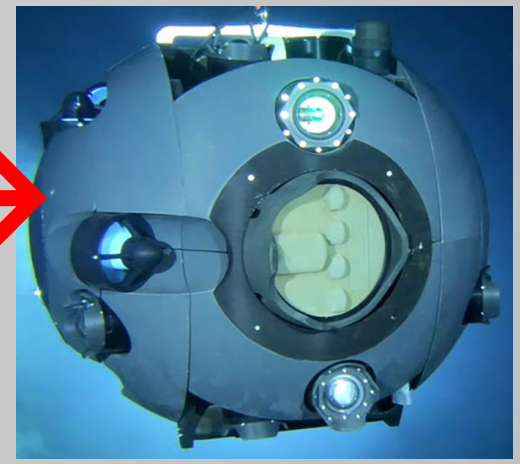
UX-1Neo (2020)

500 m



UX-2Deep (2022)

1.500 m



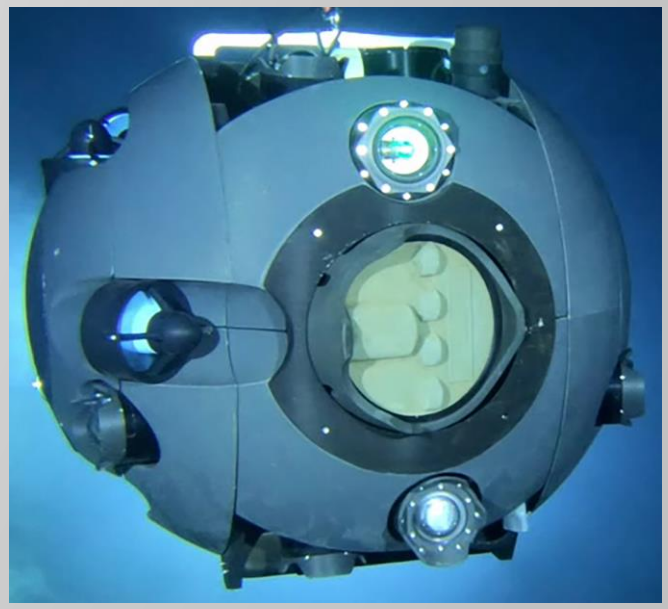
eit RawMaterials
Connecting matters

UNEXUP

Co-funded by the
European Union

UX-2 technical parameters

- **Size: 60x60x70 cm**
- **Weight: 100 kg**
- **Neutral buoyancy with adjustable ballast system**
- **Energy: swappable batteries with 6–8 h operation time**
- **Autocalibration for navigation**
- **6 degree of freedom movements by 8 thrusters**
- **6 cameras covering every direction simultaneously**
- **Environment: sweet water, sea water, fully saturated brine (1.25 g/cm^3)**
- **Dynamically adjusted sonars for different density waters (different sound speed)**
- **Automatic collision avoidance**



- **Reduced crew → more productive and cost-effective operations**

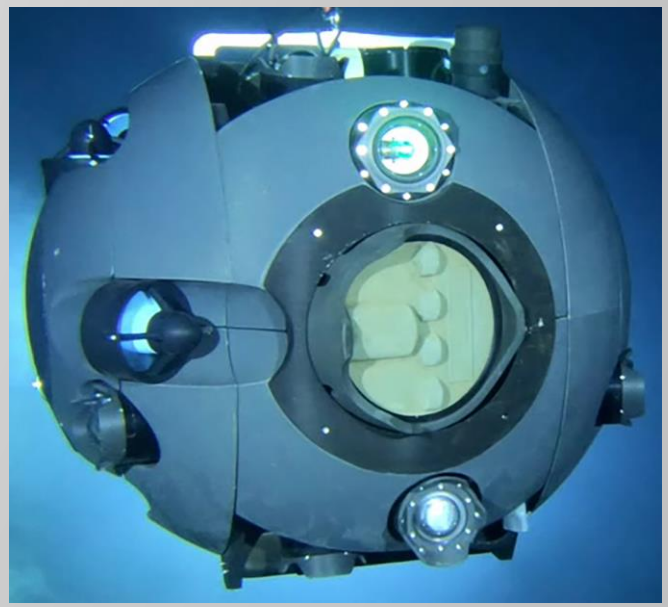
eit RawMaterials Connecting matters

UNEXUP

This activity has received funding from European Institute of Innovation and Technology (EIT) , a body of the European Union, under the Horizon 2020, the EU Framework Programme for Research and Innovation.

UX-2 technical parameters

- Ca. 1 TB data generation / hour (mostly navigational)
- Processed, stored, filtered and calculated real time for navigation
- Hyperspectral imaging, UV-fluorescent imaging, water parameter measurements, water sampling, total γ-ray measurement, magnetic field measurement with directions
- Control: on-site / remote (anywhere thru 4G net) / full autonomous
- Web browser access of every instrument simultaneously from multiple locations
- Navigation: SLAM (simultaneous localization and mapping)
- Mapping: fused data from multiple sonars, Doppler Velocity Log, Inertial Motion Unit, Optical triangulation (no GPS)



- https://www.youtube.com/watch?v=2w6Vkdu2S4s

eit RawMaterials Connecting matters

UNEXUP

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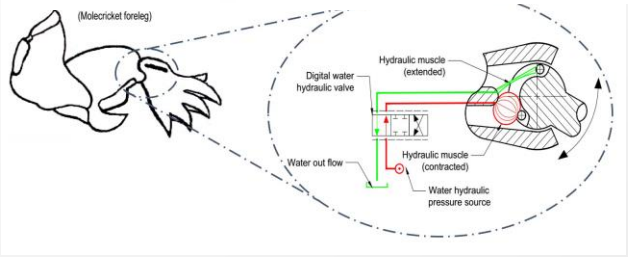
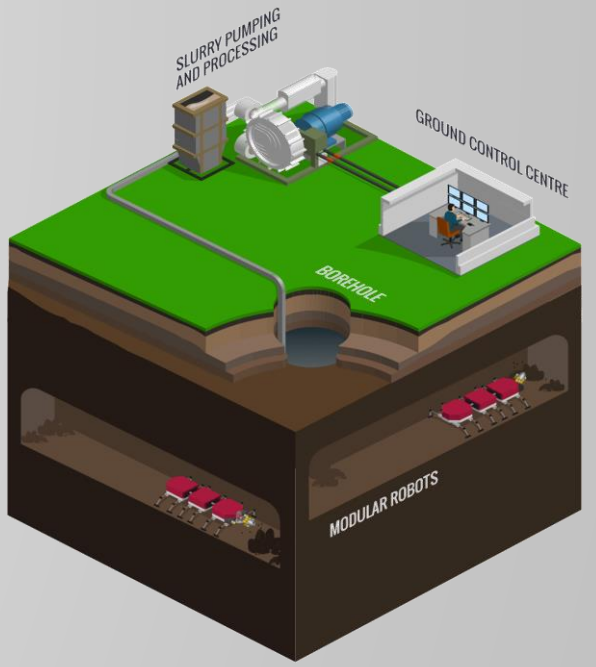
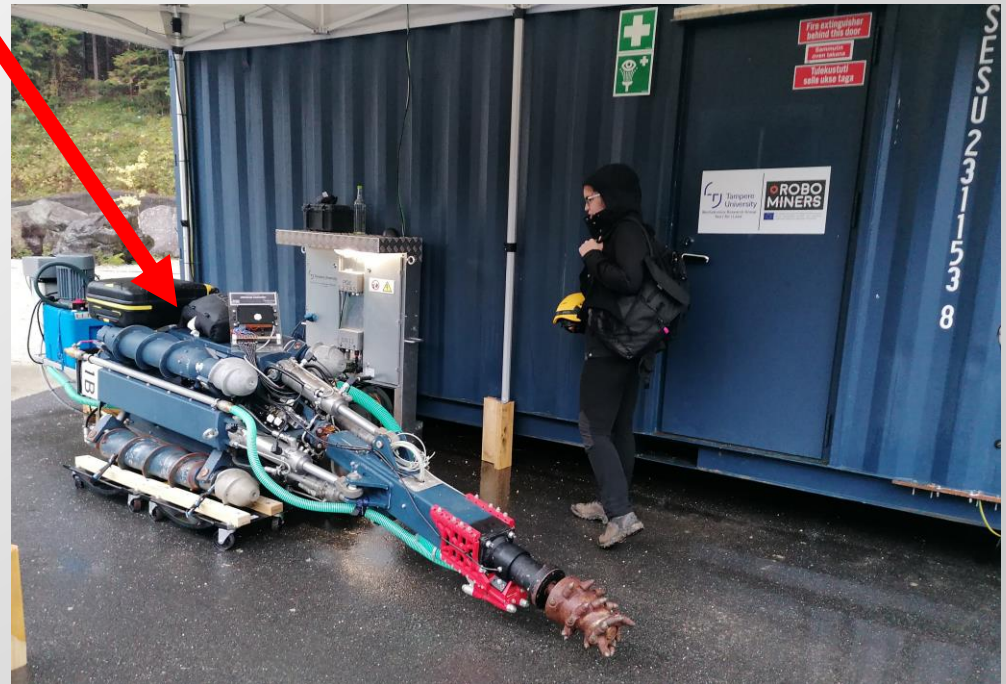
ROBOMINERS

- Resilient Bio-inspired Modular Robotic Miners





A new approach to mining strategy and mine design



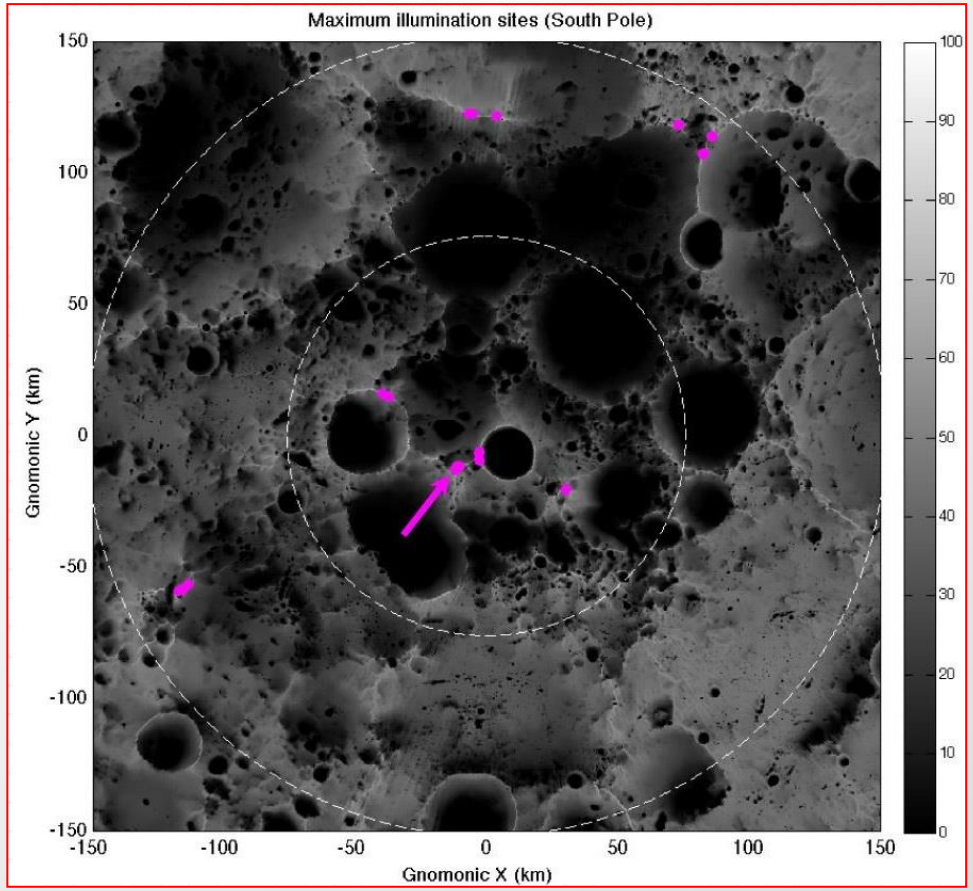
1. Robot parts (modules) are sent underground via a d=30cm borehole
2. They self-assemble to form a fully functional modular robot
3. Using specialised sensing devices, they detect ore
4. Using ad-hoc production devices, they produce slurry that is pumped out
5. They can re-configure on-the-job

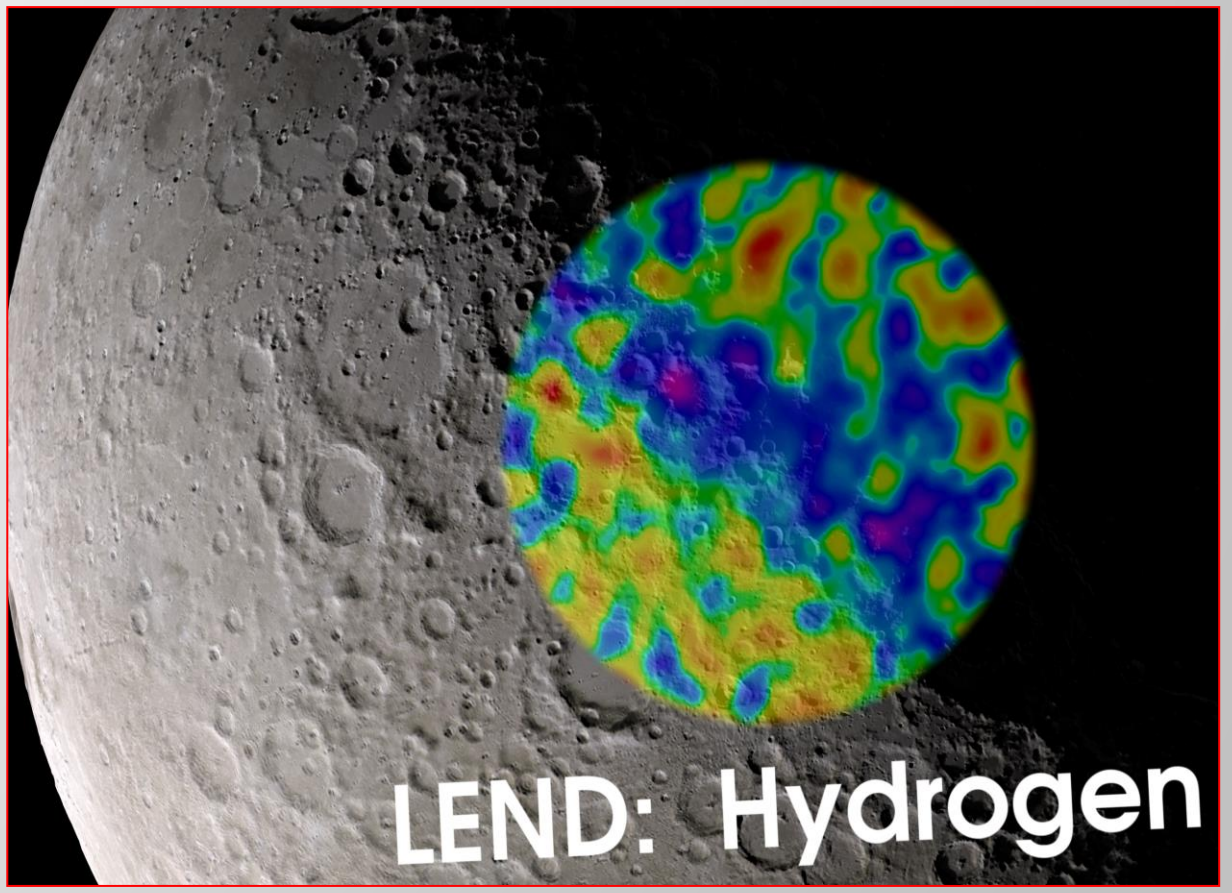
Funded by the European Union

Crazy ideas?? → Or out of the box thinking...

Steam-engines for the Moon!!

Let’s build a powerplant on the Southern pole of the Moon!!





Thank you for your attention!