University of Bremen

- 31. Technologiepark Frühstück -

Bremen, 06.11.2025

CENTER OF APPLIED SPACE TECHNOLOGY AND MICROGRAVITY ZARM

Neuartige (photo-)elektrochemische Sauerstoff- und Brennstoffproduktionstechnologien für die Raumfahrt und die grüne Energiewende

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Georgia Tech

DLR

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esa European Space Agency

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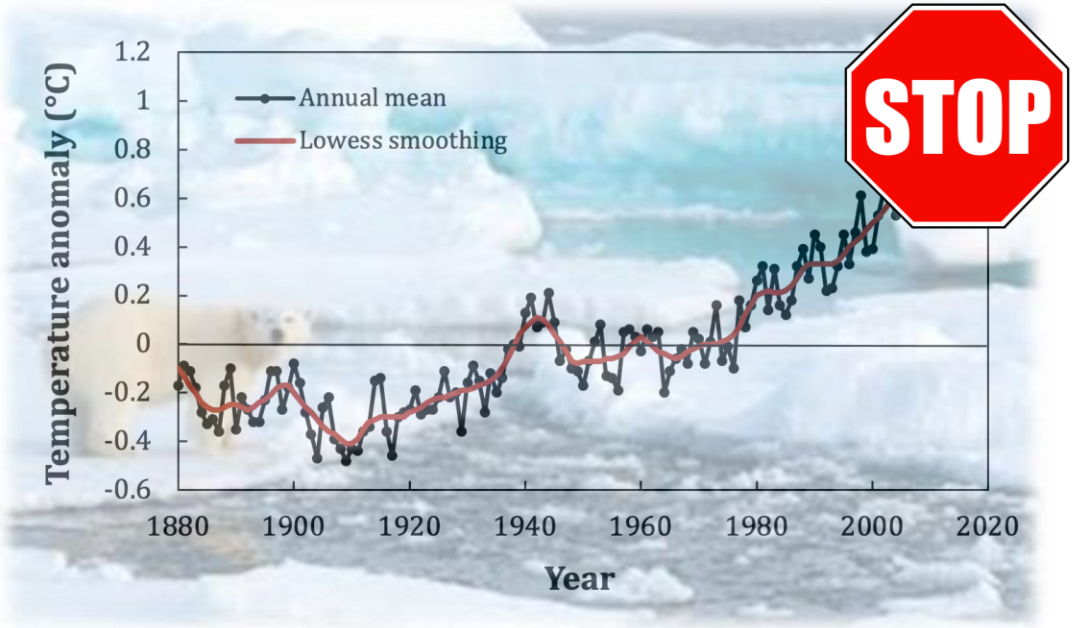
What do space exploration and our climate on Earth have in common?



Both need efficient, reliable and sustainable energy sources!

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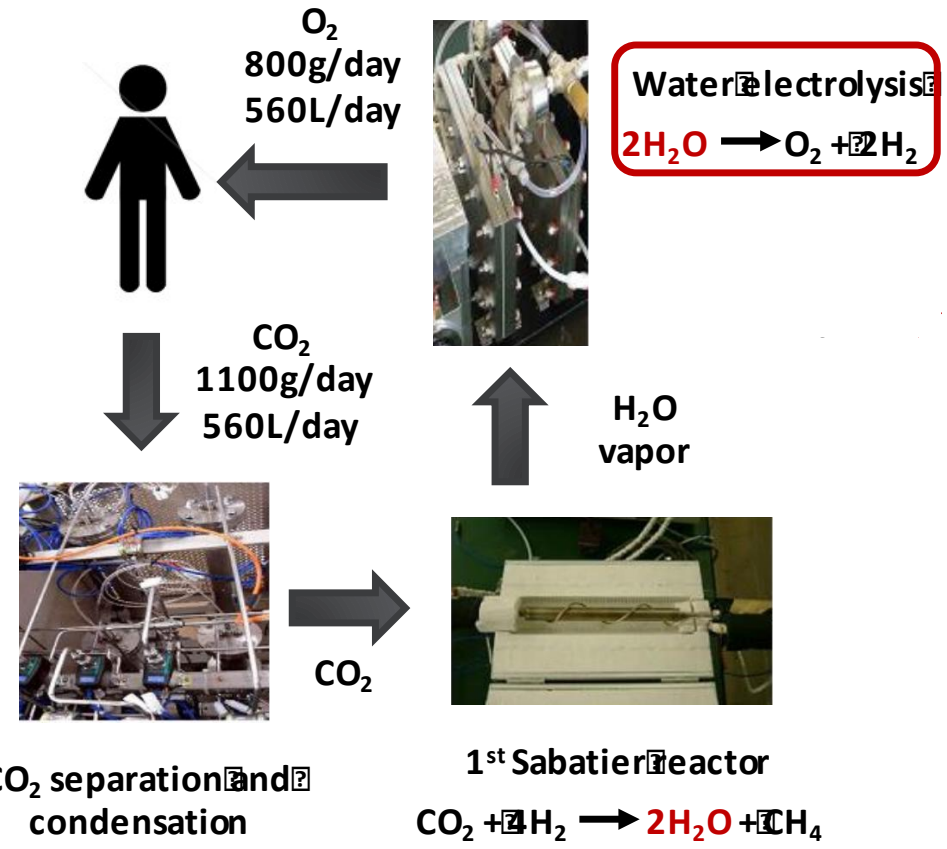
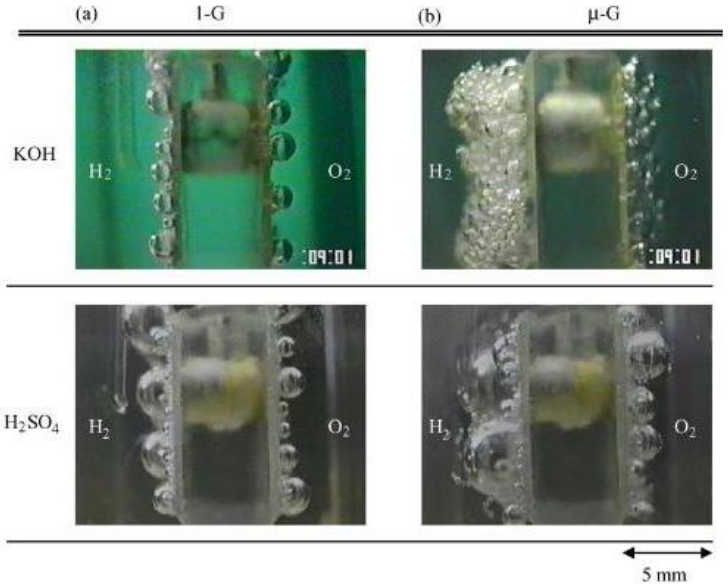
Creating an artificial atmosphere in space - the obstacles



Water electrolysis under micro-gravity conditions faces obstacles:



CCD images of gas bubble formation in 25 wt.% KOH and in 0.1N H_2SO_4 under terrestrial gravity (1G) and microgravity (μG), 8s after starting the water electrolysis (E = -0.8 V *vs* RHE).

*From: Matsushima et al. (**2006**).*

Prof. Yasuhiro Fukunaka

Matsushima et al. (**2006**), *Electrochim. Acta* **51**, 4190.
Sakurai et al. (**2012**), *Electrochim. Acta* **100**, 350.

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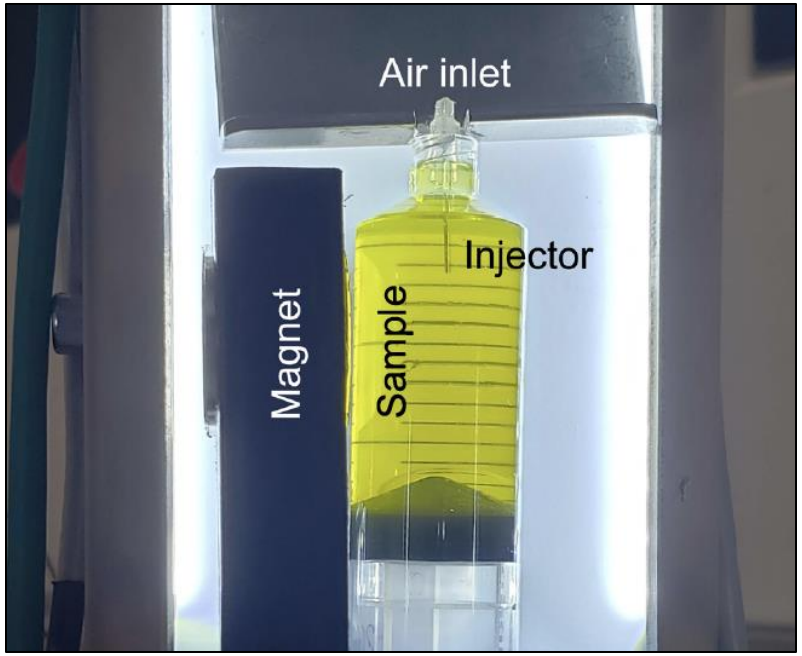
I Improving Electrolyser Device Performance in Microgravity

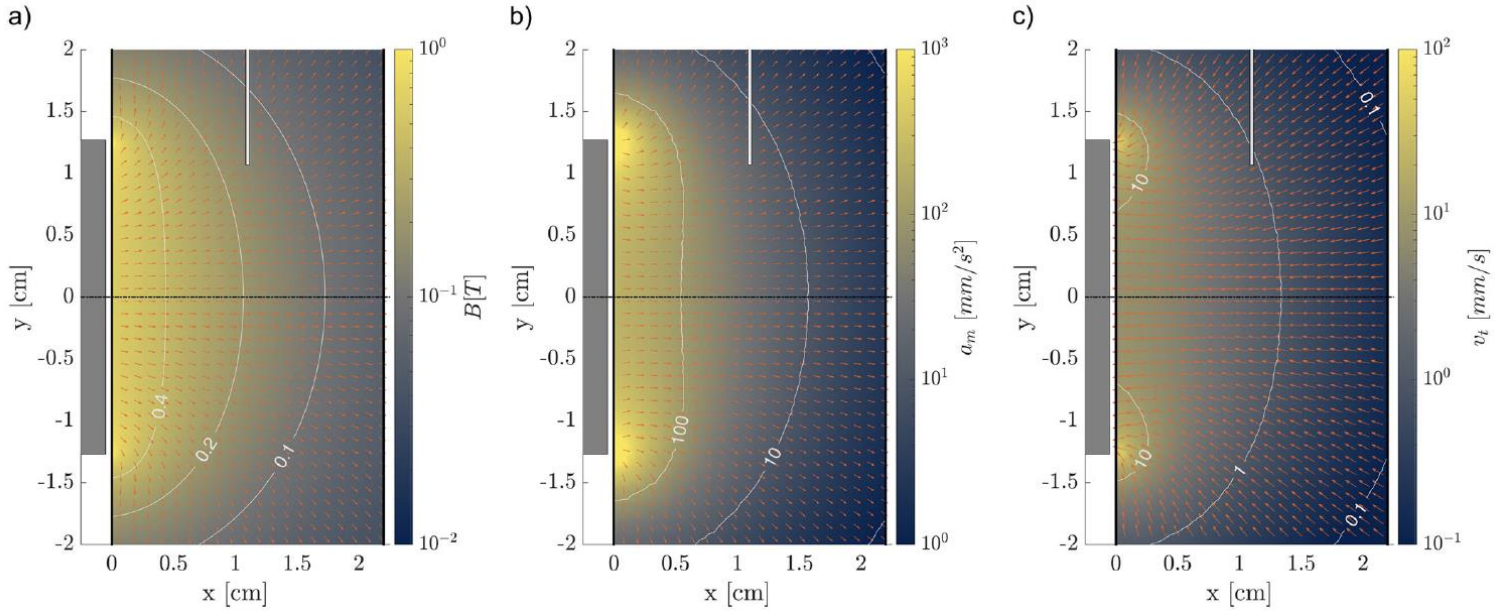
How can we remove gas bubbles in microgravity and improve phase sepration?

Prof. Álvaro Romero-Calvo



Details of the syringe sample container with the magnet on the left.

Magnetic environment inside the syringe filled with MilliQ water



White bar: gas injector; grey box: magnet. The panels represent **a** the magnetic field, **b** the diamagnetic acceleration exerted on the liquid, and **c** the terminal velocity of a 1 mm diameter air bubble.

Romero-Calvo et al. (**2022**), *npj Microgravity* **8** (32).

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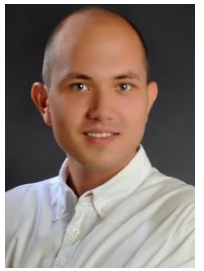
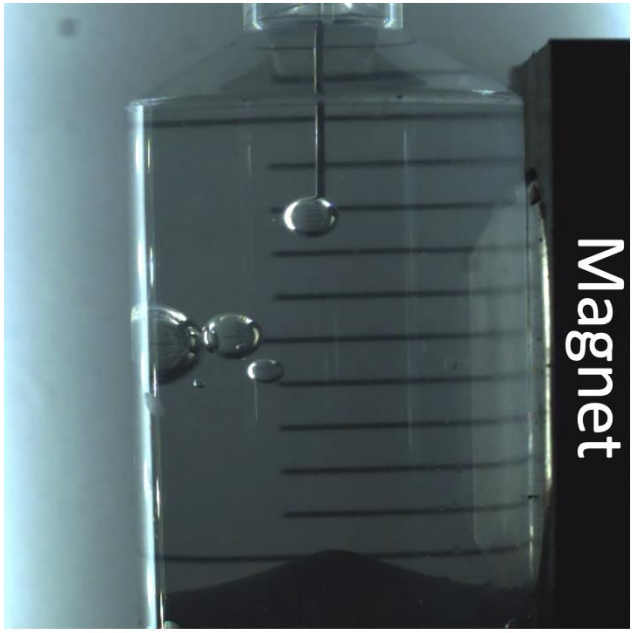
Results for dia- and paramagnetic solutions in microgravity



Ömer Akay

Prof. Álvaro Romero-Calvo

0.5 M $MnSO_4$ (aq)



Milli Q water no magnet

Milli Q water

Romero-Calvo et al. (**2022**), *npj Microgravity* **8** (32).

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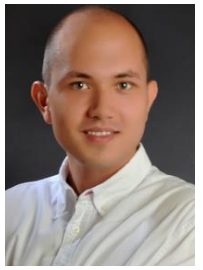
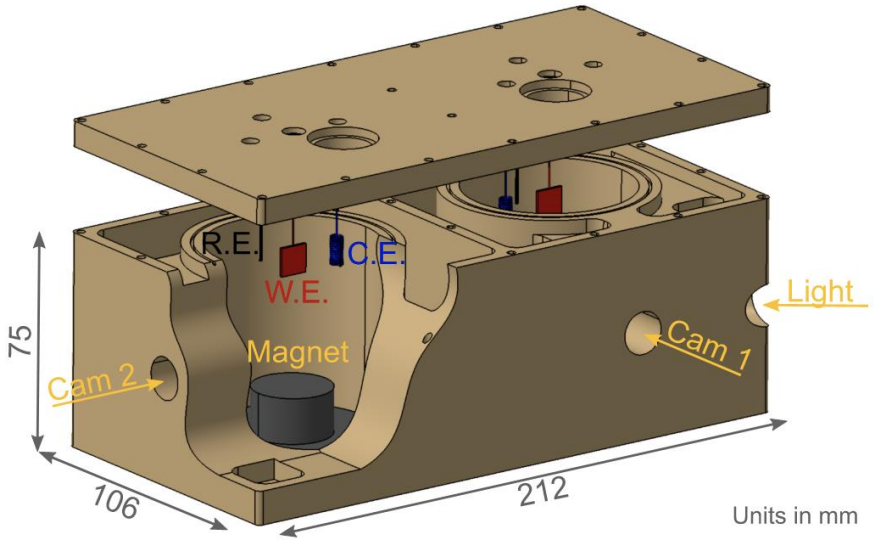
Utilization of Magnetically-Induced Phase Separation for Water (Photo-)Electrolysis in Microgravity

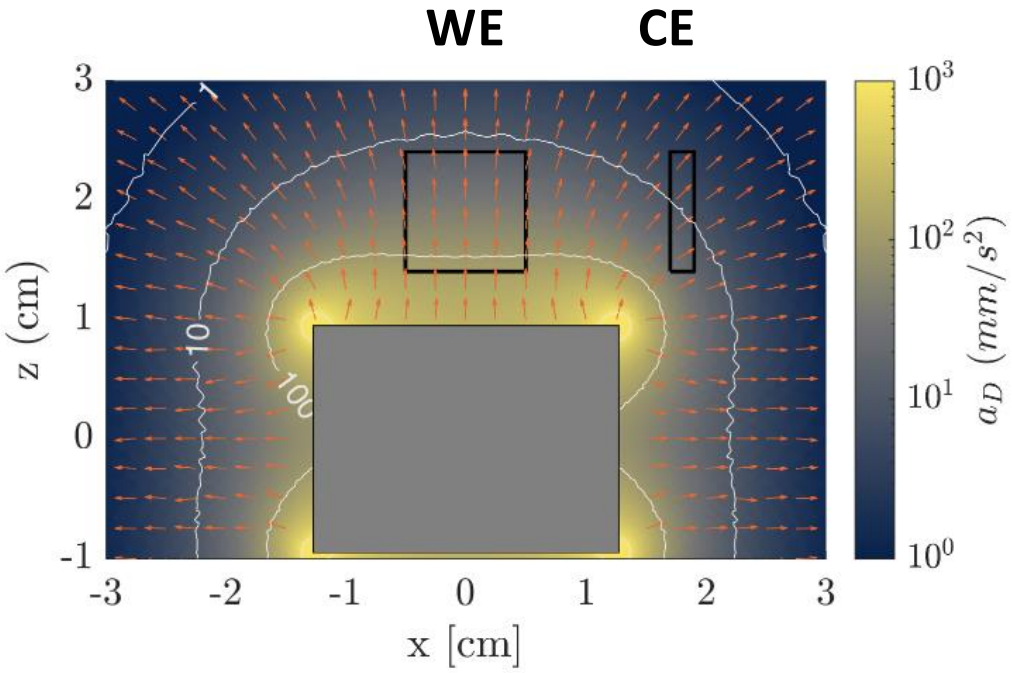

Ömer Akay


Theo St Francis


Prof. Álvaro Romero-Calvo



Photoelectrochemical cell set-up in the drop capsule



Diamagnetic acceleration

Ö. Akay et al. (**2025**), *Nat. Chem.*

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The experimental set-up in the drop capsule

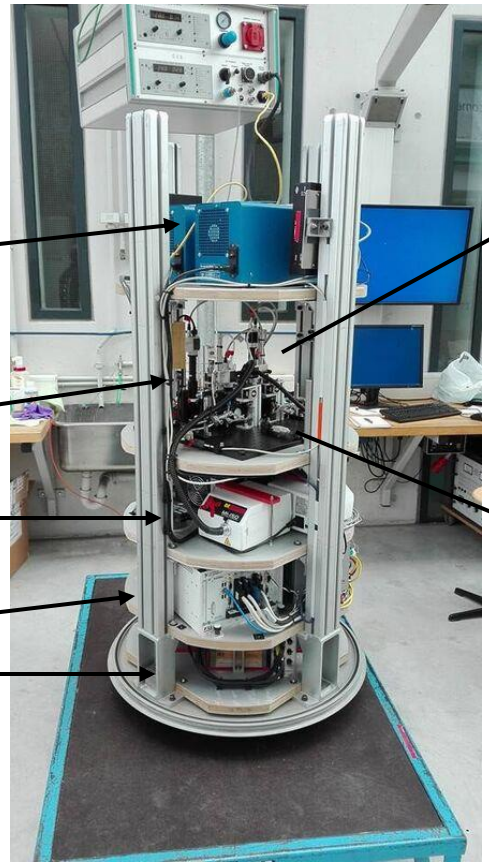
Potentiostats, shutter control

Photoelectro-chemical set-up, cameras

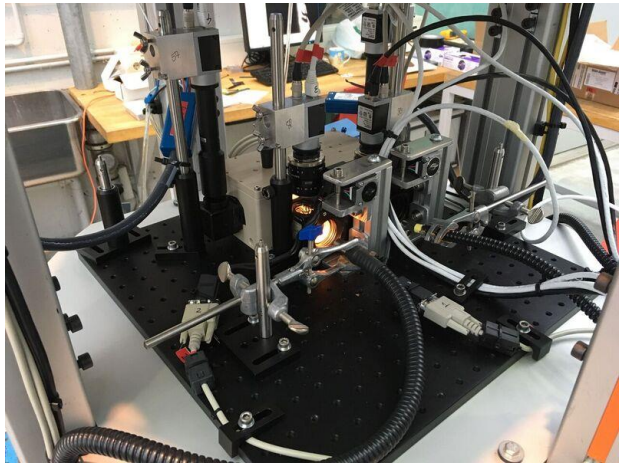
Light sources, computer

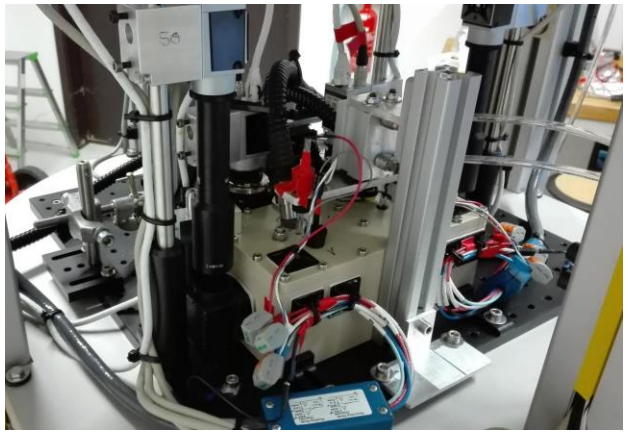
DC/AC converter

Battery

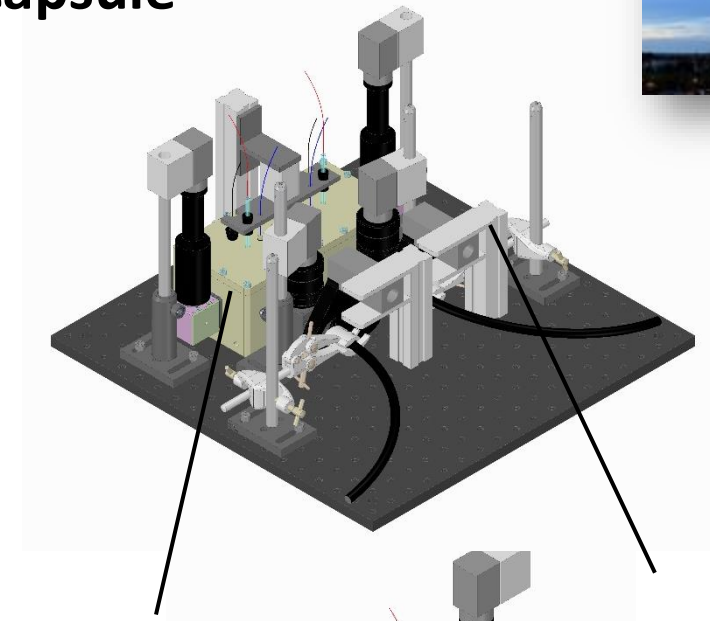


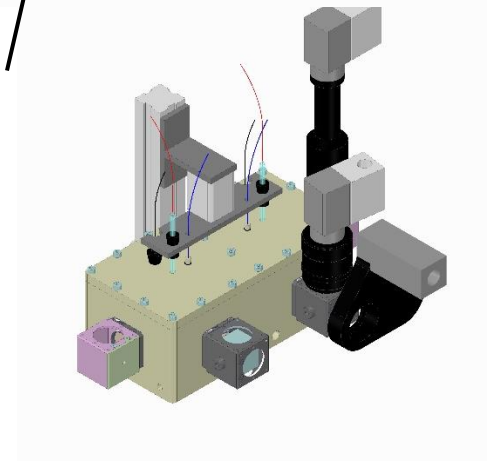
Capsule





Optical board with photoelectrochemical cell, cameras, light shutters and light guides





Two compartment photoelectrochemical cell

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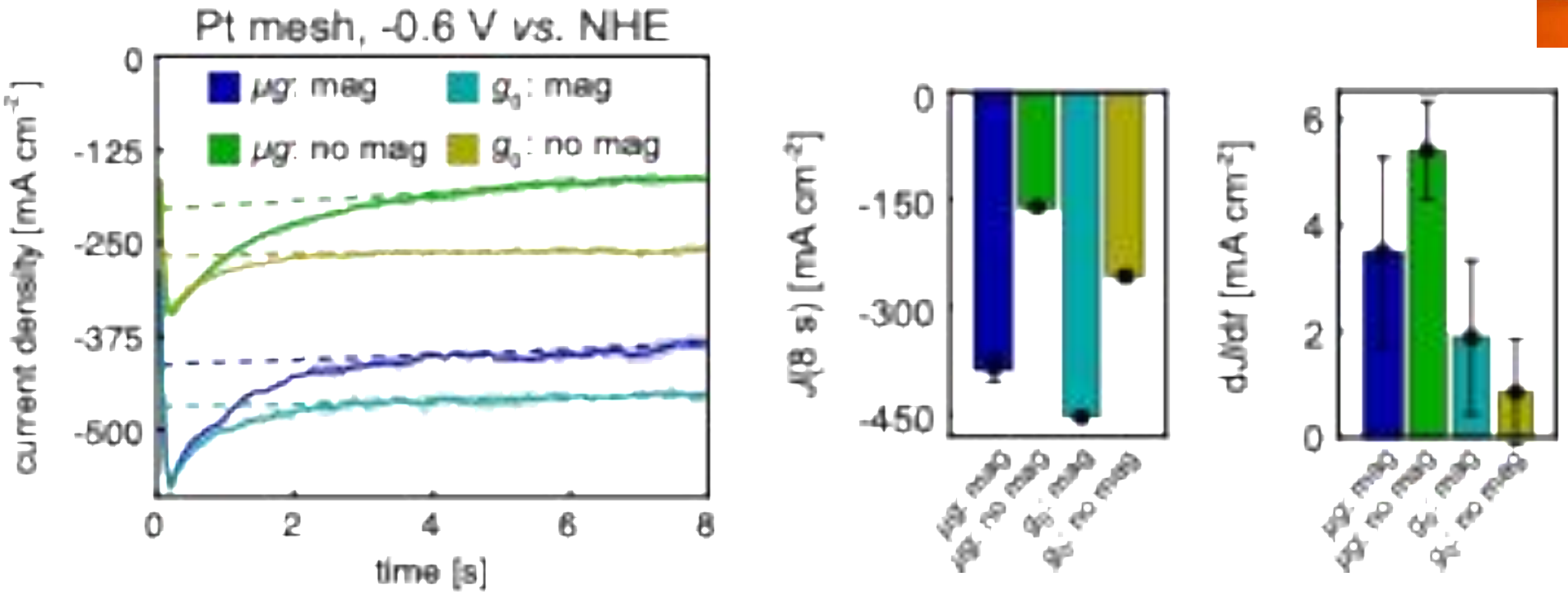
Efficient H_2 production with Pt mesh electrodes



Electrolyte: 1 M $HClO_4$, 1% isopropanol

Ö. Akay et al. (**2025**), *Nat. Chem.*

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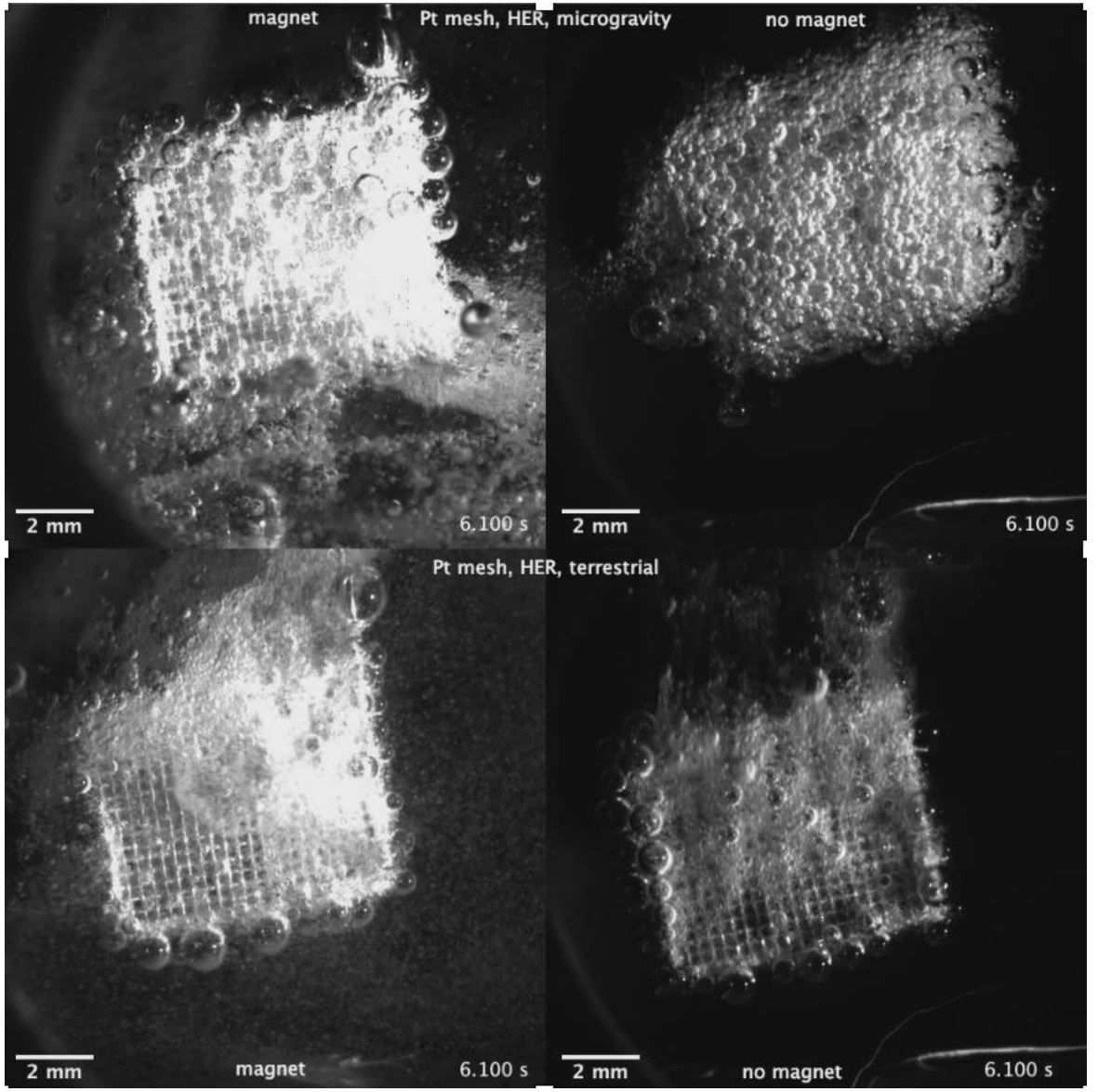
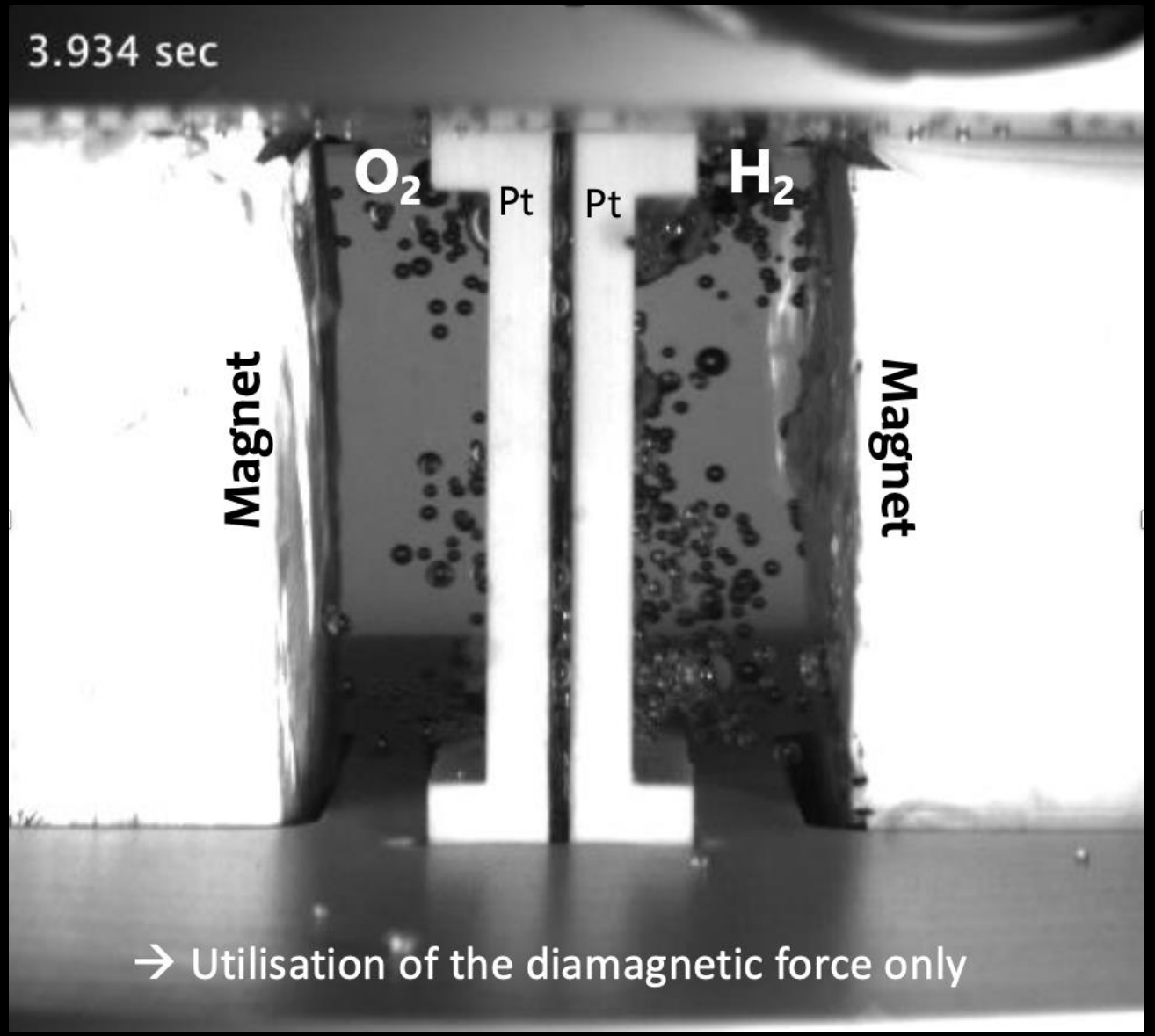
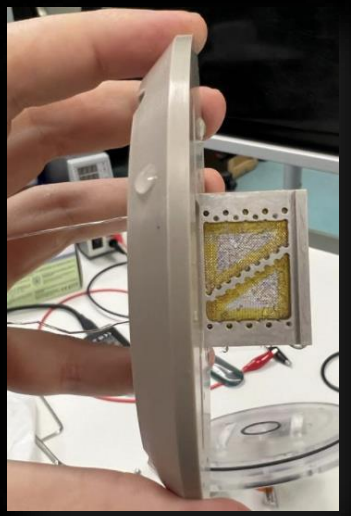
Combining Lorentz and diamagnetic forces at high current densities



Ö. Akay et al. (**2025**), *Nat. Chem.*

Model of a PEM electrolyser system





Ö. Akay et al. (**2025**), *Nat. Chem.*

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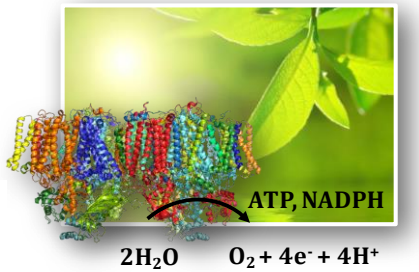
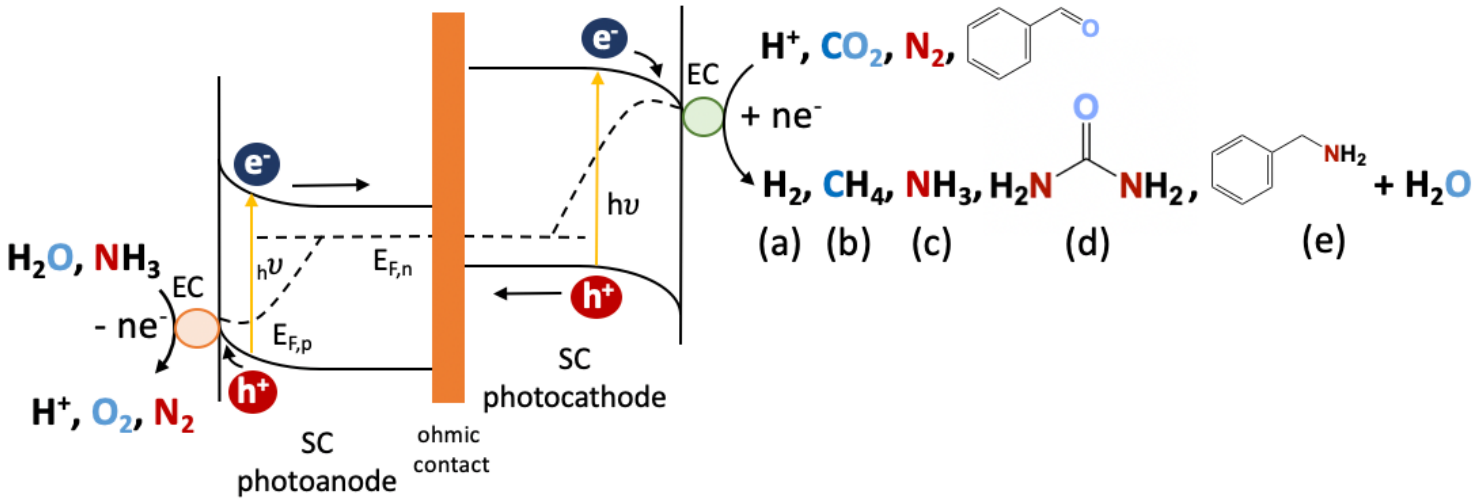
How about using the effect for photoelectrochemical devices and directly utilize sunlight on Earth and in space?





Semiconductors generate electron-hole pair upon light absorption which are used for catalysis via deposited electrocatalysts.

Acknowledgments

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esa European Space Agency

ZARM team and Brinkert Group @ University of Bremen and University of Warwick

- Dr. Byron Ross, Ömer Akay, Dr. Julian Becker, Shaumica Saravanabavan, Dr. Camilla Tossi; Theo St Francis and Prof. Álvaro Romero-Calvo (Georgia Tech, USA) and their team, Prof. Sophia Haussener

„A solar power plant would be a symbol of peace.“
Gerd Eisenbeiß