

# 3D-DRUCK AUF DEM MARS?

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# Hintergrund



## Persönlich:

- Seit 2016 in der Forschung bei der FOTEC Forschungs- und Technologietransfer GmbH tätig
- Fokus auf 3D-Druck von Metall und Entwicklungen für die Raumfahrt
- Inhalte sind aus dem Projekt „**Recycling enhanced additive manufacturing processes under Martian environmental conditions (RAMMEC)**“ gemeinsam mit der Universität Innsbruck
- Gefördert von der ESA im OSIP-Programm



Mehr Hintergrund

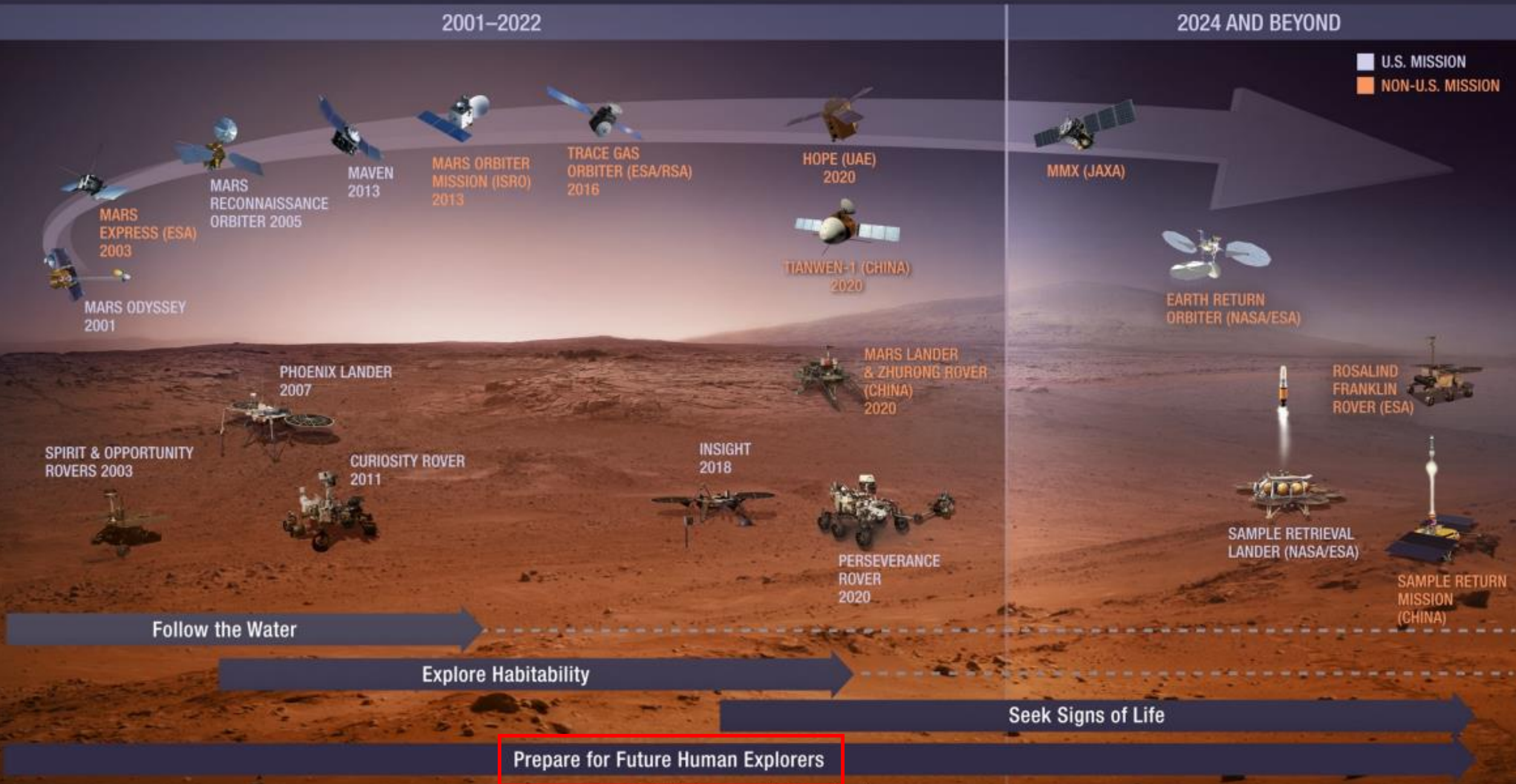


Projekt „ISRU“ bei FOTEC (2017)



# Warum beschäftigen wir uns damit?

Source: Ianson, E. „Exploring Mars together – DRAFT Plan for a Sustainable Future for Science at Mars

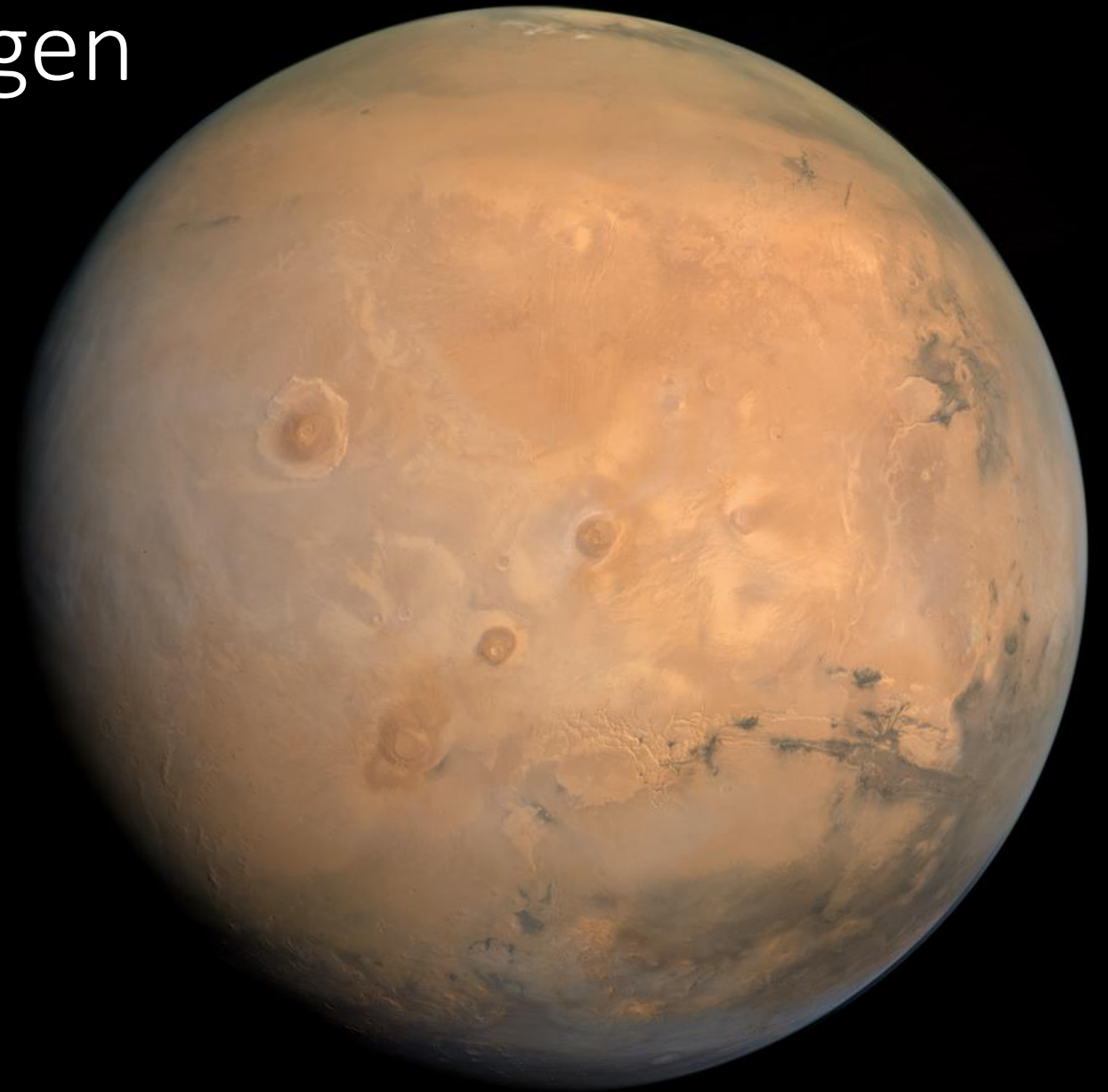


Prepare for Future Human Explorers

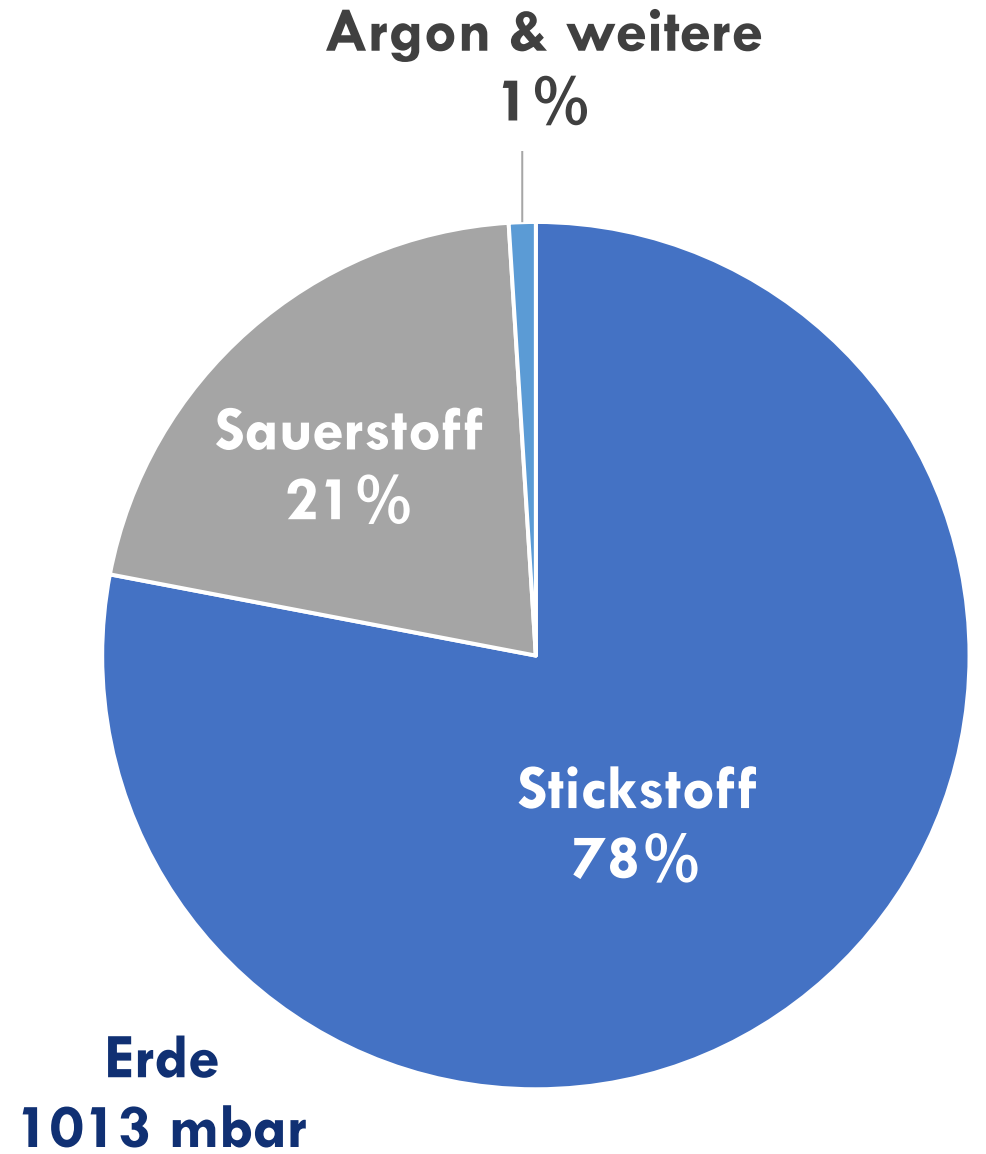
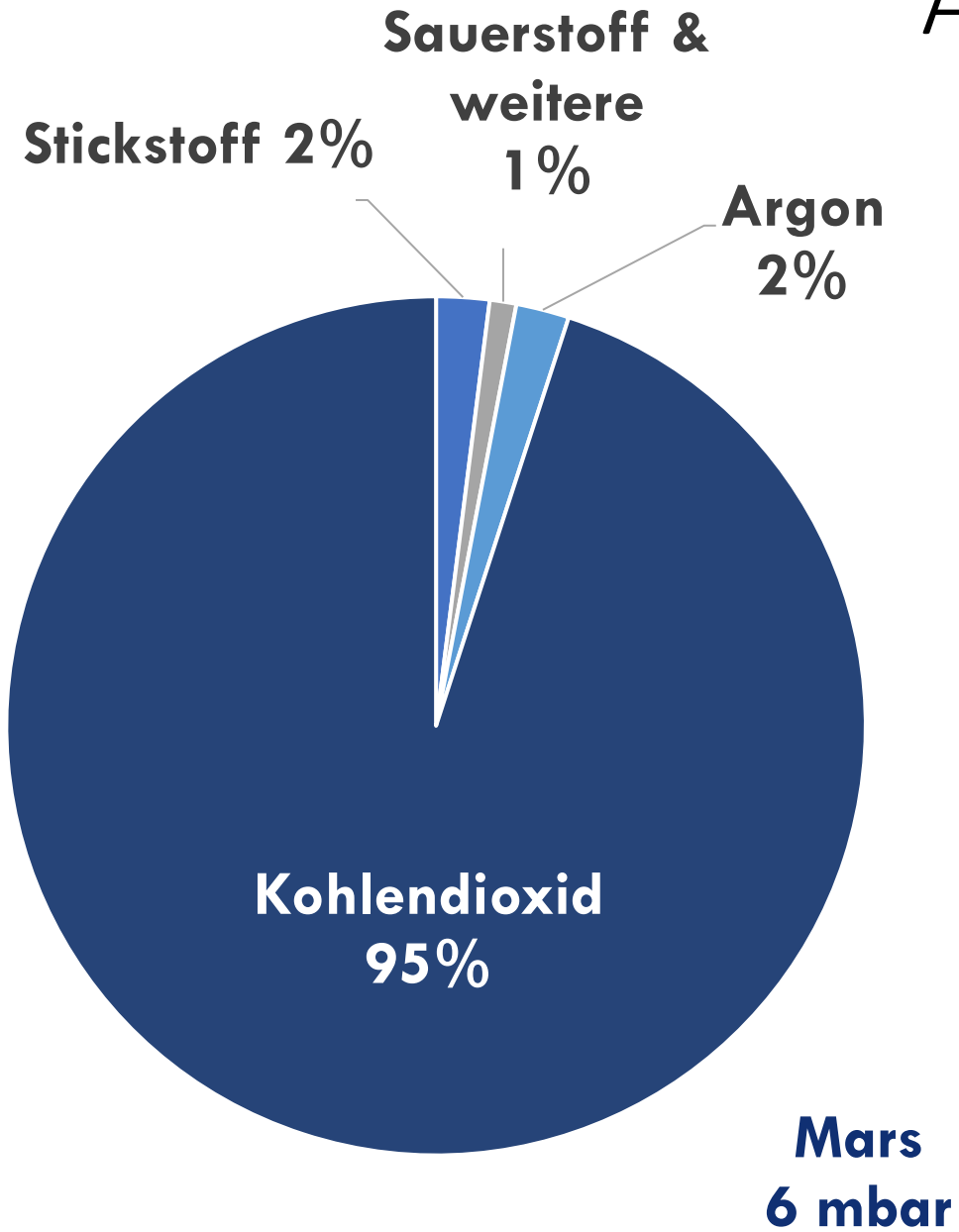
# Umgebungsbedingungen auf dem Mars

- Temperatur: 0 bis  $-100^{\circ}\text{C}$  (Mittelwert  $68^{\circ}\text{C}$ )
- Intensive UV-Strahlung
- Bis zu 700-fache Strahlung wie auf der Erde

→ Fazit: ned leiwand

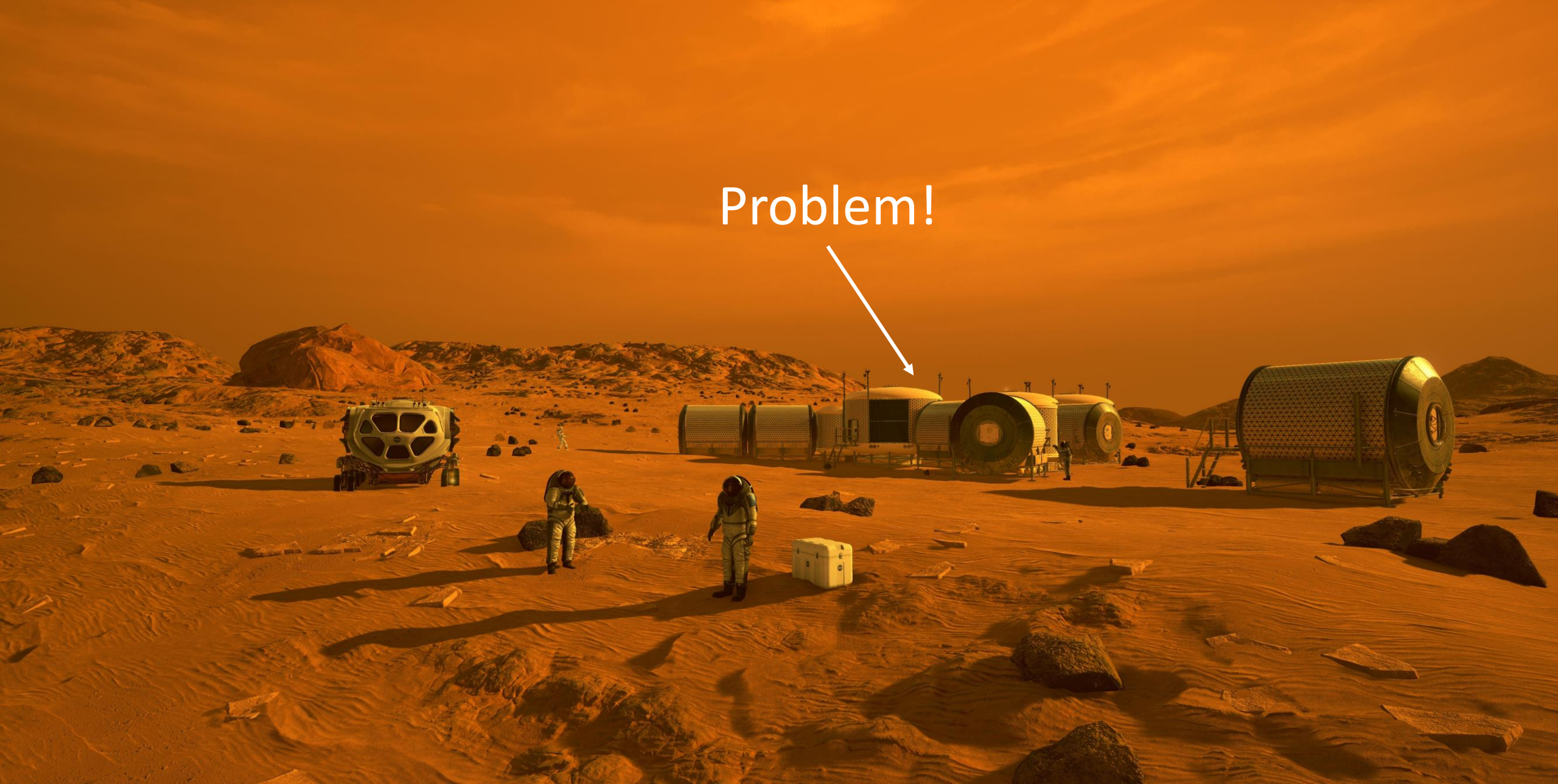


# Atmosphäre





Problem!



# Ressourcen?



**Image Credit:** NASA/JPL-Caltech/ASU – Perseverance Right Mastcam on Nov. 20, 2024 (Sol 1334)



# Ressourcen?



**Image Credit:** NASA/JPL-Caltech/ASU – Perseverance Right Mastcam on Nov. 20, 2024 (Sol 1334)



# Ressourcen?

**Sand, viel Sand!**



**Image Credit:** NASA/JPL-Caltech/ASU – Perseverance  
Right Mastcam-Z on Nov. 20, 2024 (Sol 1334)

**Schwefel**



**Image Credit:** NASA/JPL-Caltech/ASU – Curiosity on July 18, 2024



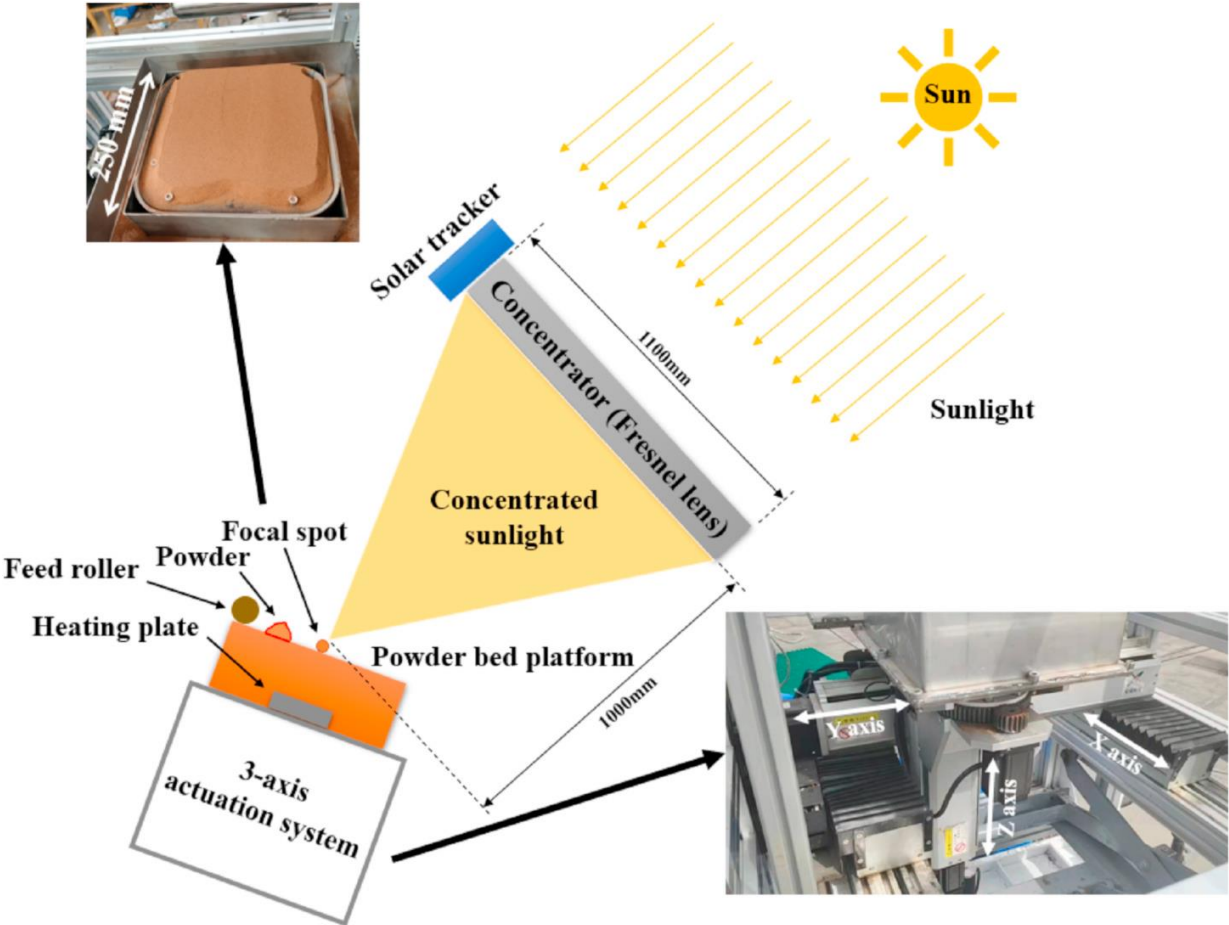
# Marsgestein-Simulant





# Methoden

## Verschmelzen mit Sonnenlicht



## Schmelzen mit Laser/Mikrowellen



A



B

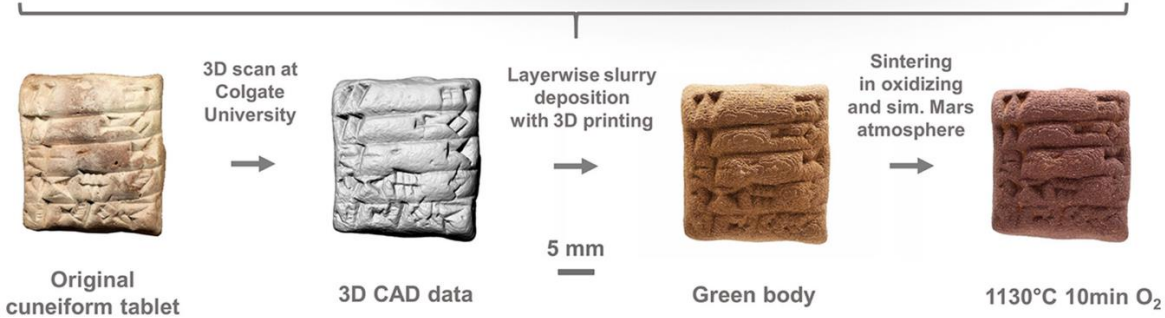
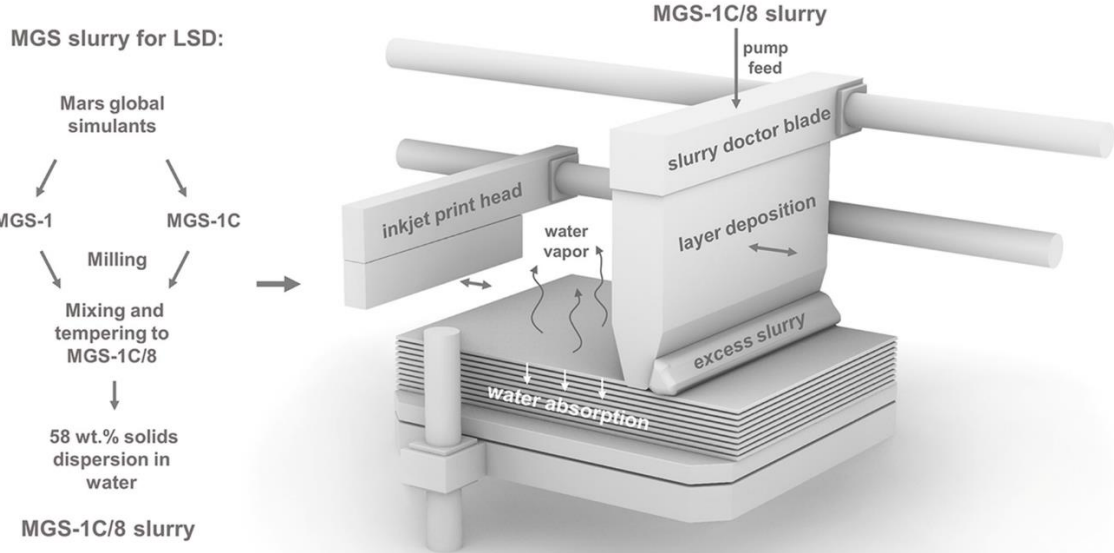
Chen, J. et al. (2022). *Turning desert sand into building material products: An ambitious attempt of solar 3D printing.*

Mueller, R. et al. (2014). *Additive Construction using Basalt Regolith Fines*



# Methoden

## Paste mischen und Brennen



## Material extrudieren

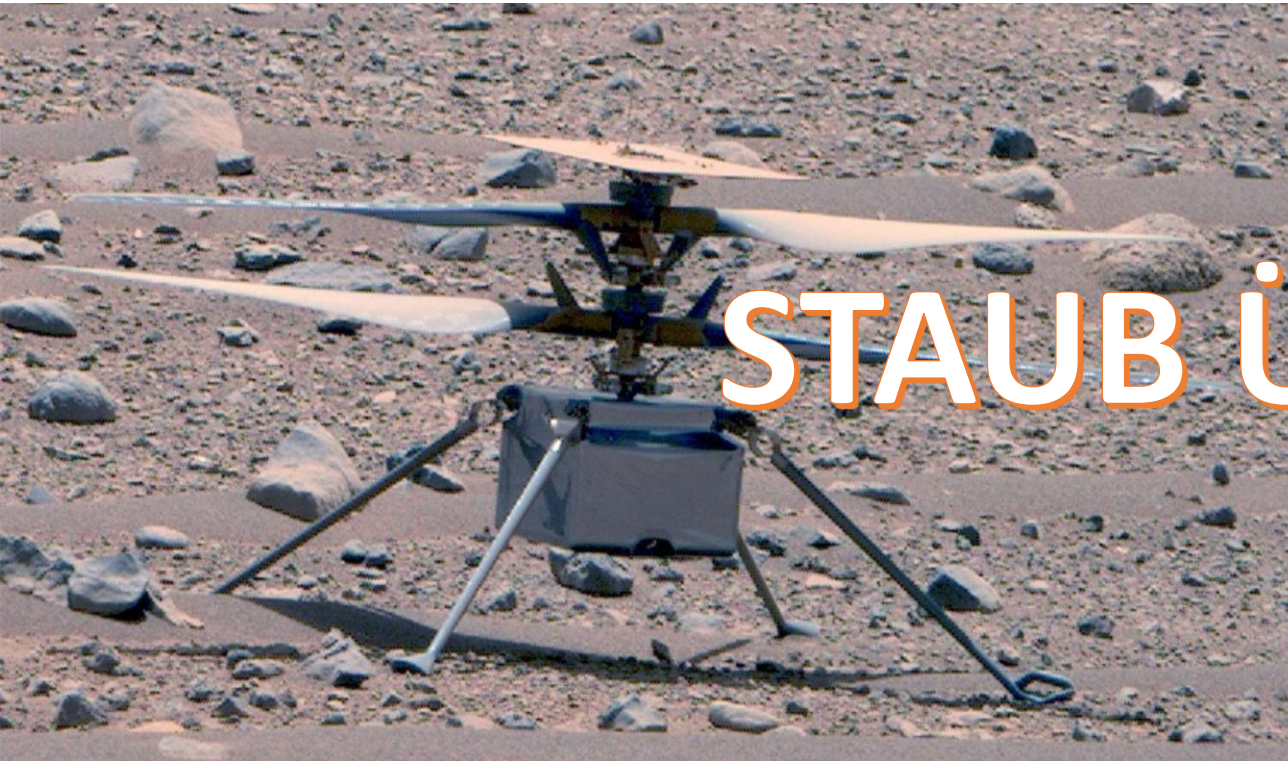


Bild CC BY-SA 4.0 COBOD

Karl D. et al. (2022). Sintering of ceramics for clay in situ resource utilization on Mars.



# Methodenauswahl



**STAUB ÜBERALL**

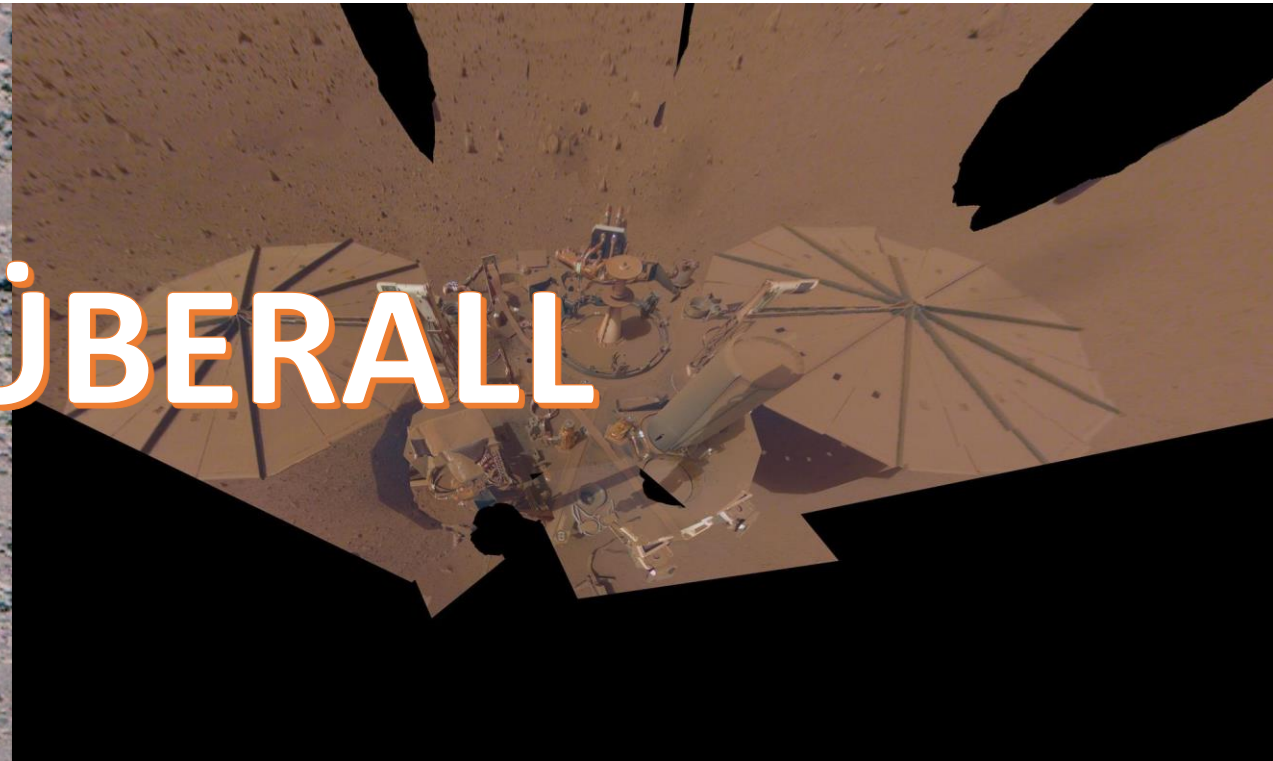


Image Credit: NASA/JPL-Caltech/ASU/MSSS – Perseverance  
Right Mastcam-Z on April 16, 2023 (Sol 766)

Image Credit: NASA/JPL-Caltech



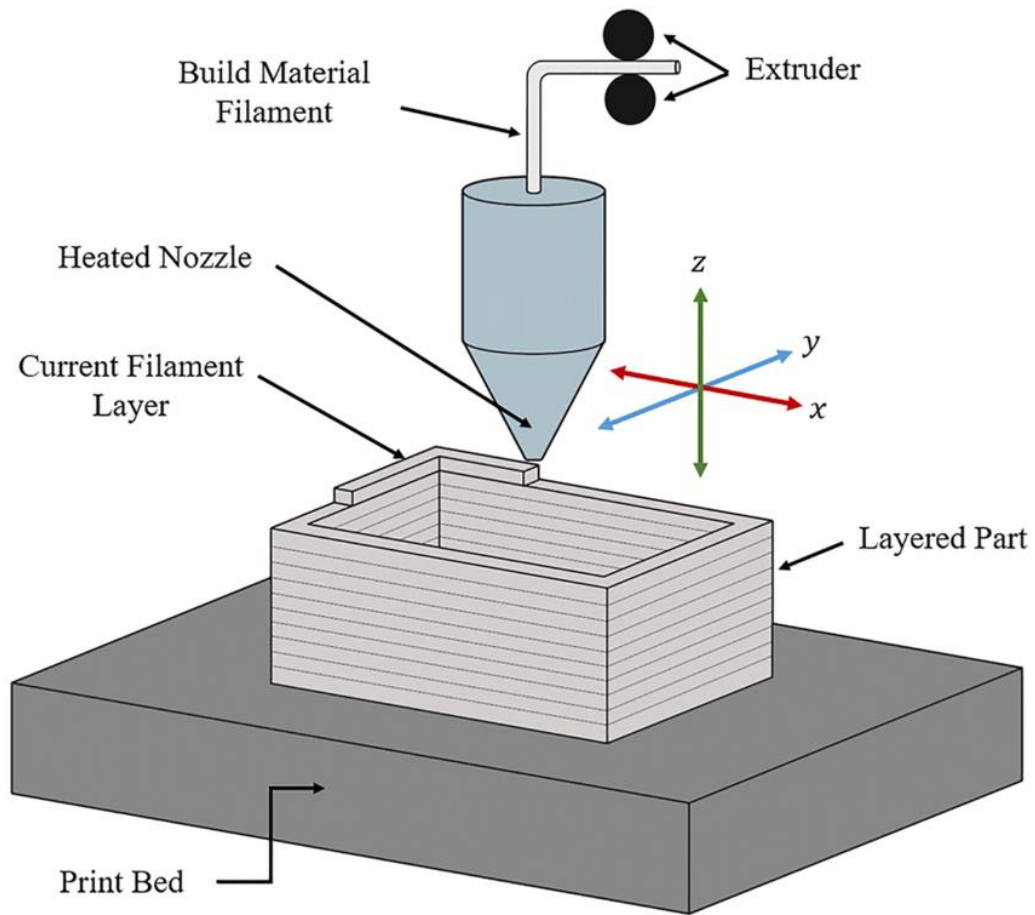
Schlecht für die Optik



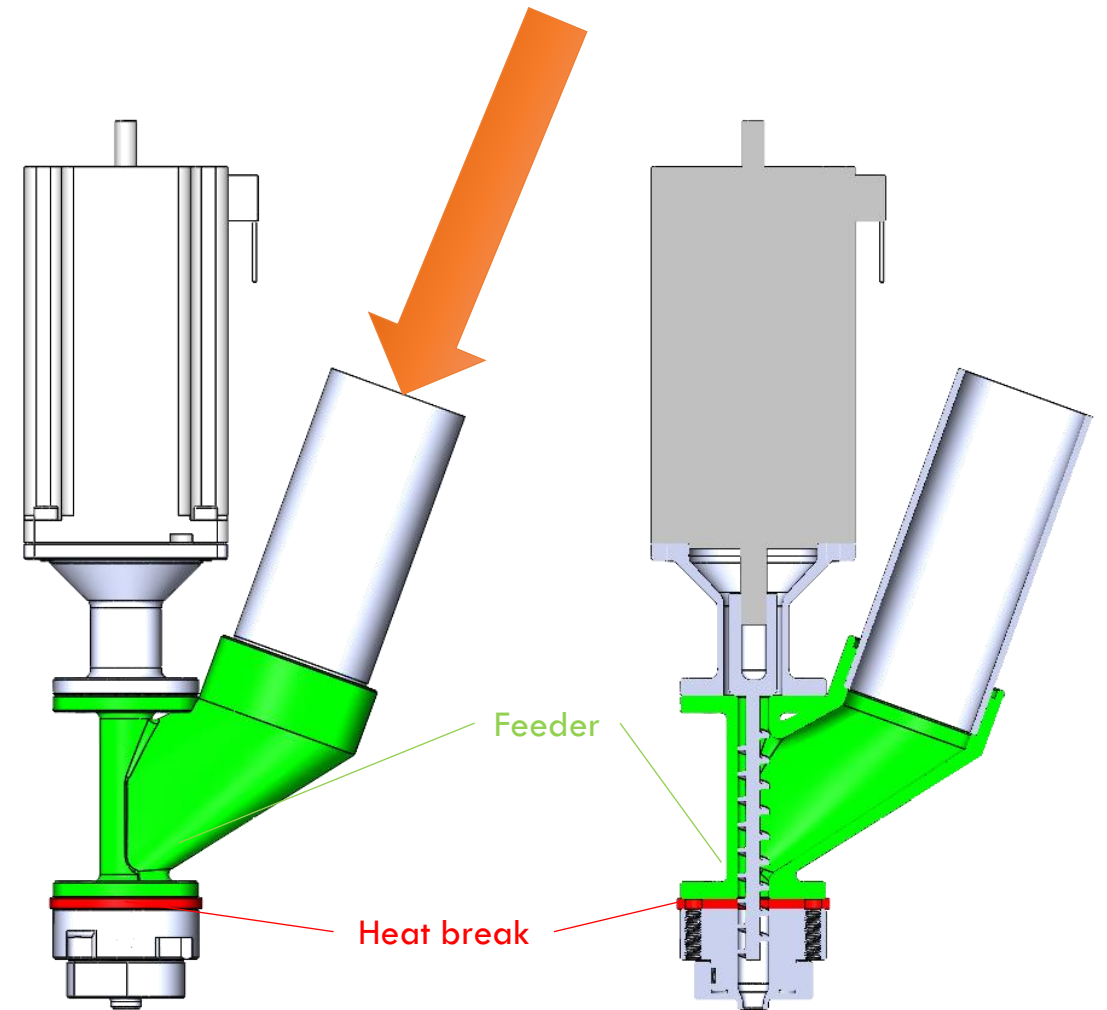
Materialextrusion mit  
Sand + Schwefel



# Umsetzung

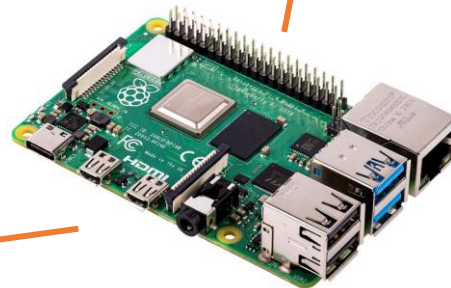


## Marsgestein + Schwefel





# Umsetzung

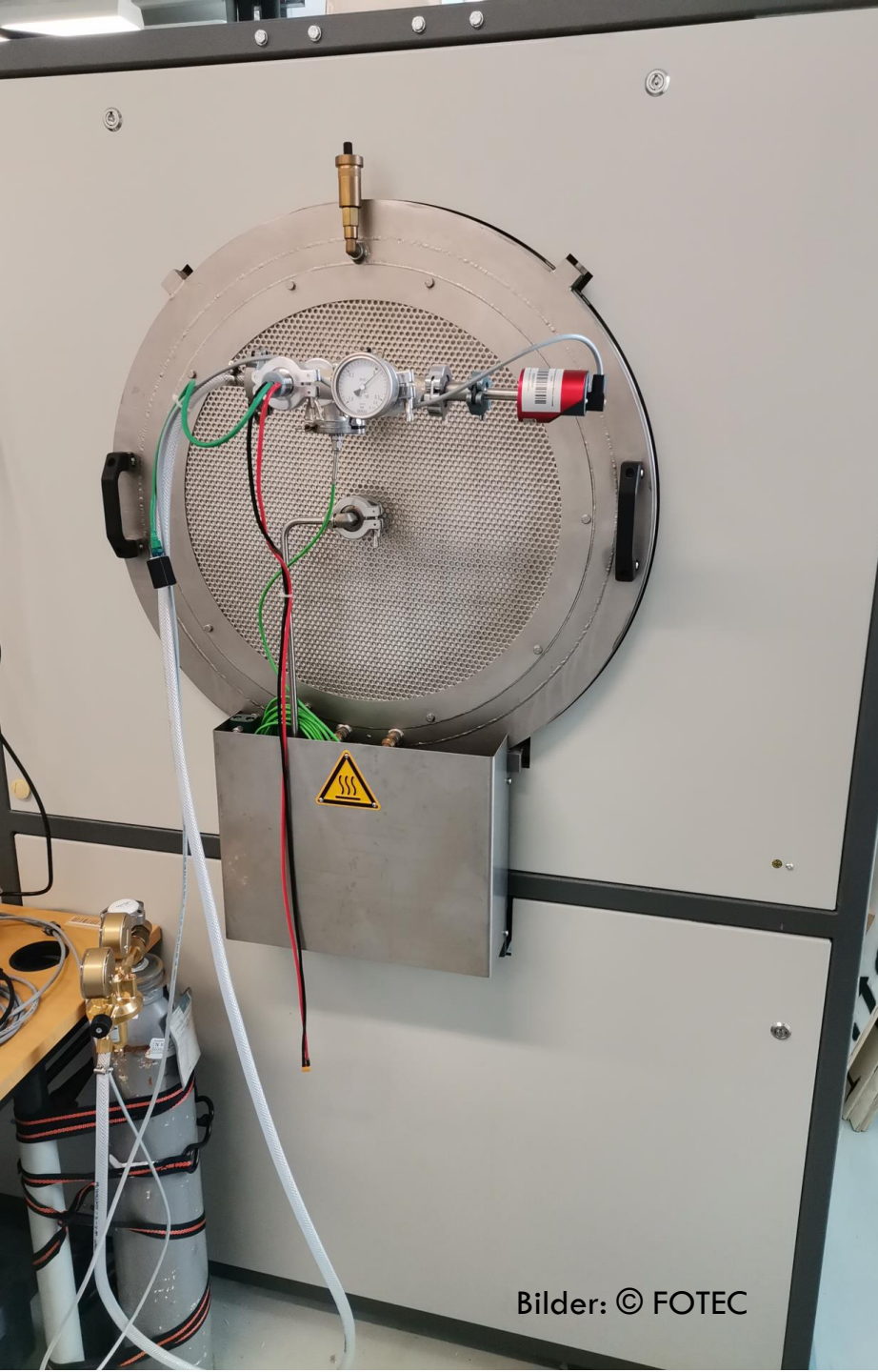


OctoPrint

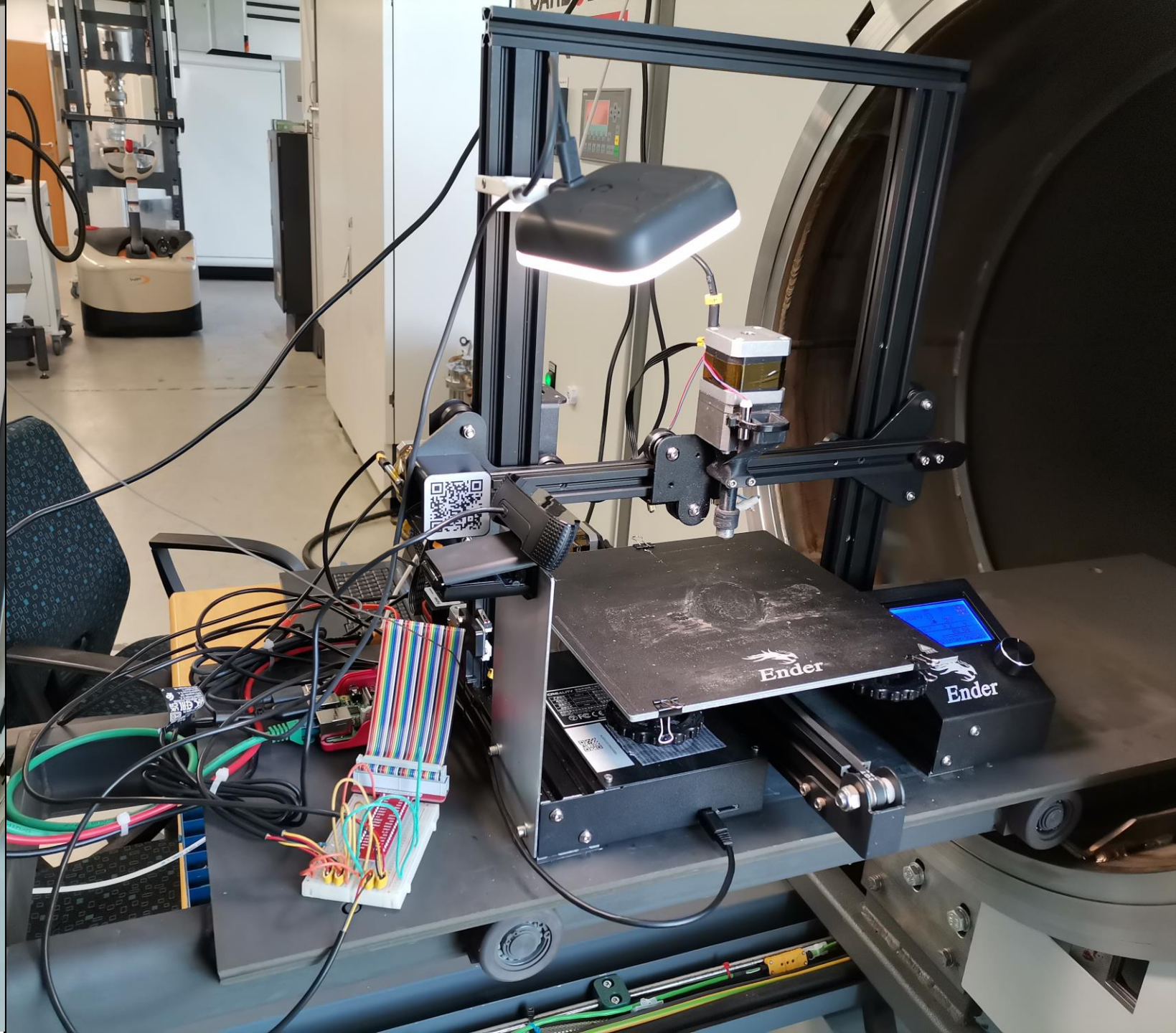


COTS (Commercial Off The Shelf)

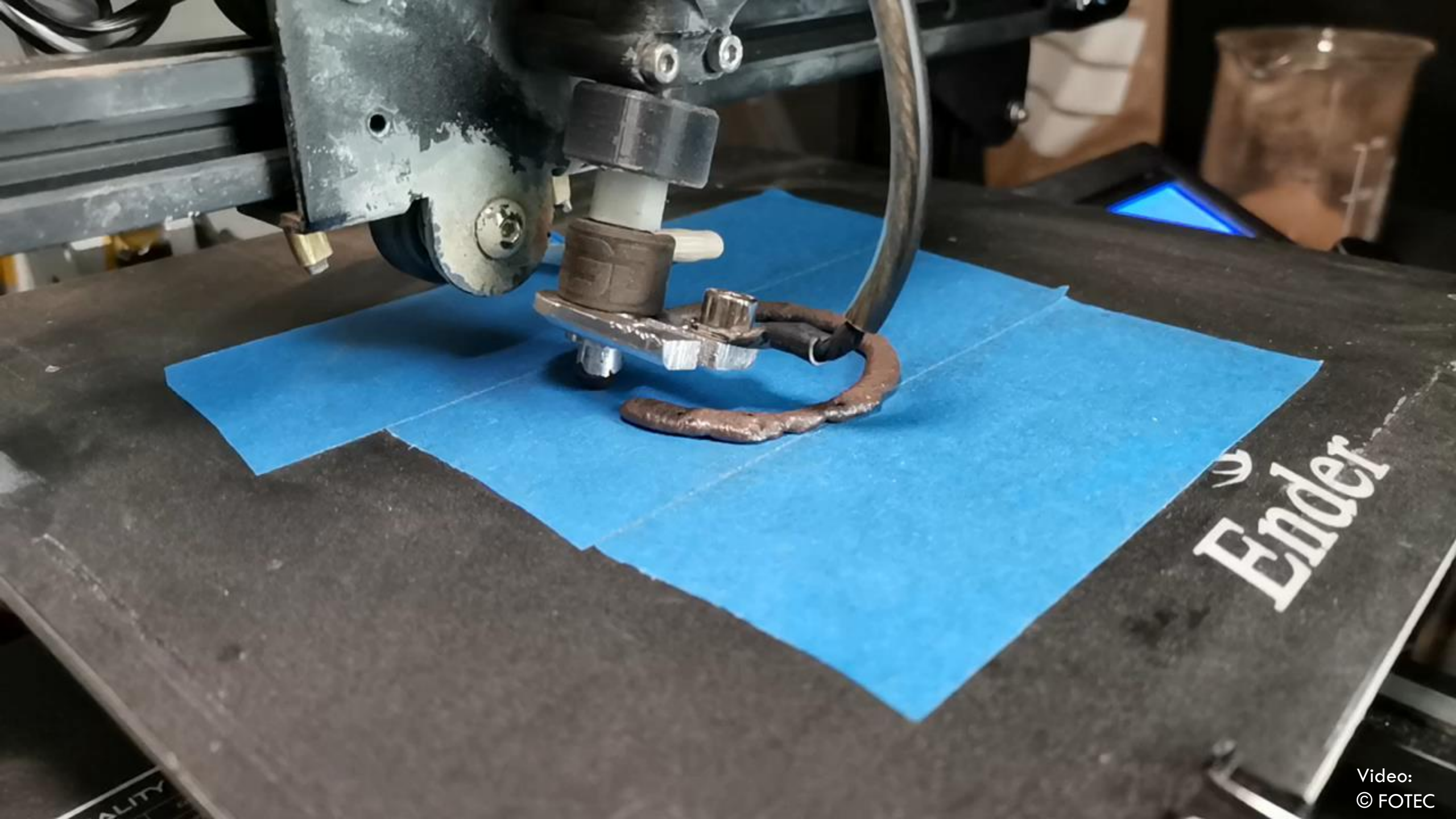




Bilder: © FOTEC



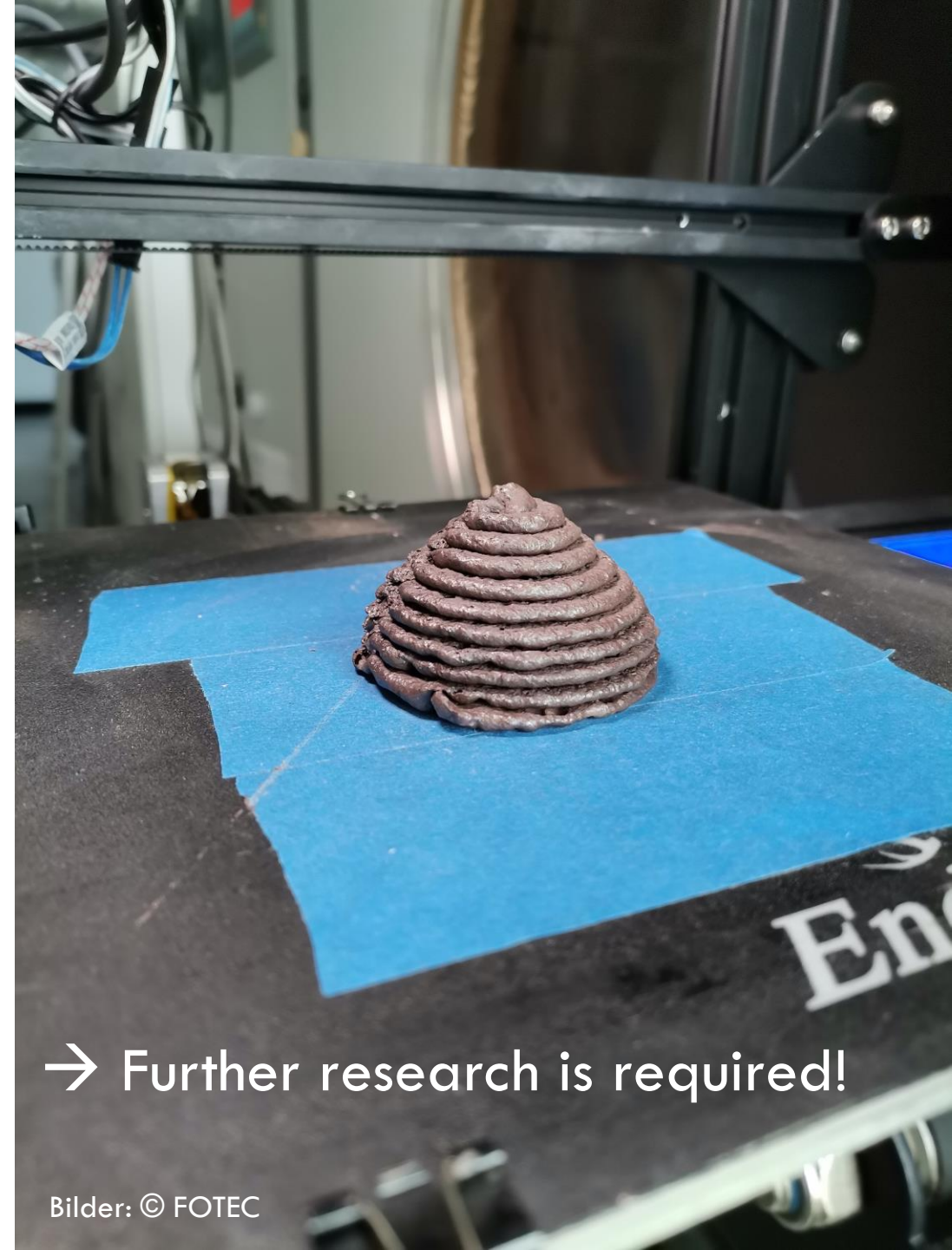




Ender



# Ergebnisse



→ Further research is required!