Mechanical properties of nanoporous carbons for hydrogen storage applications

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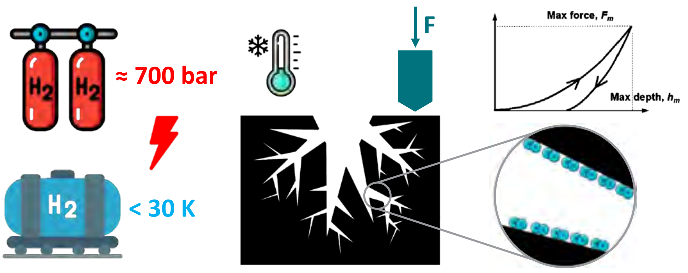
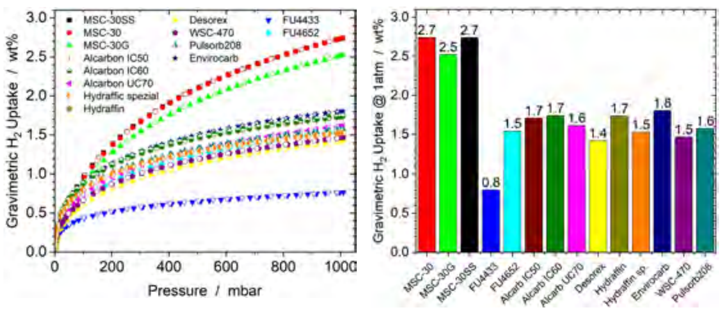
Introduction & Motivation



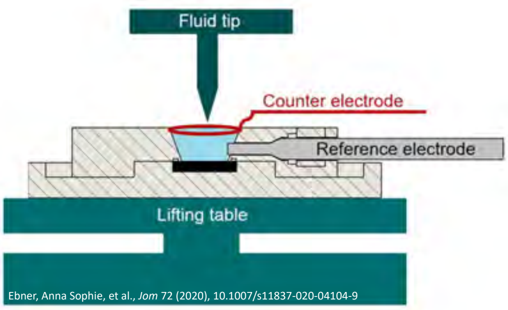
- Hydrogen → Crucial role in energy transition
- Challenging storage technologies
- Alternative: Storage in adsorbent materials → Mechanical behavior at cryogenic temperatures unknown
- **Aim: Utilize micromechanical testing at cryogenic temperatures to evaluate the mechanical stability of activated carbons after cyclic hydrogen exposure.**

Evaluation of H_2 uptake



- Highest gravimetric H_2 uptake at 77 K and 1 bar ≈ 2.7 wt%
- Further measurements at high pressures are necessary
  → Usable capacity between 1 bar and < 50 bar (tank pressure)
- Skeletal density and pore volume needs to be considered
  → Material based volumetric H_2 uptake

Other H_2 testing options



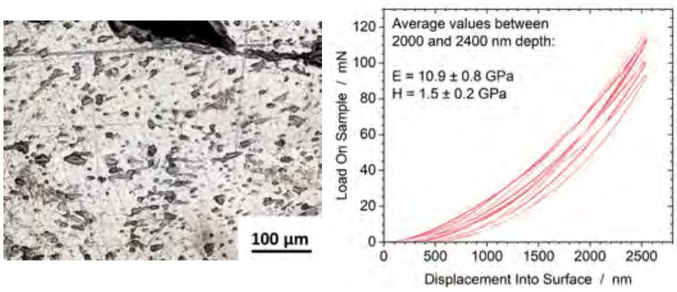
- In-situ hydrogen charging cell to evaluate hydrogen-metal interactions via
  - Hardness in-/decrease
  - Change of pop-in loads
- Principle: Cathodic hydrogen charging
- Used inside *KLA G200* nanoindenter

Materials

- Activated carbons with different macroscopic forms
  - Powders
  - Pellets
  - Granules
- Different pore structures/sizes and surface areas
- Coconut or petroleum derived
- Commercial availability due to upscaling

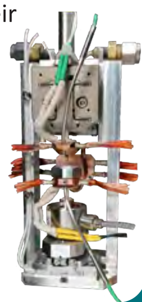
Experimental & Preliminary Results

- Micromechanical tests require a flat sample surface
- Comparison of traditional grinding & polishing and a preparation with femtosecond laser ablation system
- First indents at room temperature on surface prepared via traditional preparation → Further improvements necessary



Outlook

- Influence of preparation method of carbons on their
  - Mechanical properties
  - Structural properties
- Degradation of carbons at cryogenic temperatures due to
  - Cyclic hydrogen exposure
  - Humidity impurities in hydrogen
- Tests at down to - 150 °C → *Alemnis Indenter* to be installed in September 2023



Social Media

This research activity is carried out at Montanuniversität Leoben financed by TDE Group Limited and is part of the Strategic Core Research Area SCoRe A+ Hydrogen and Carbon

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