BAM
Bundesanstalt für Materialforschung und -prüfung

b-tu
Brandenburg University of Technology Cottbus - Senftenberg

BTU-BAM Graduate School “Trustworthy Hydrogen”

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https://www.b-tu.de/graduiertenkolleg-trustworthy-hydrogen/

Brandenburg
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BTU-BAM Graduate School
“Trustworthy Hydrogen”

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und -prüfung

- first graduate school in Germany focused on hydrogen trustworthiness
- combines the unique competences of BAM and BTU to train the **next generation** of **interdisciplinary hydrogen scientists**
- **hydrogen focused qualification programme** providing all PhD students with a holistic understanding of the hydrogen value chain
- starting date: January 2023

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- first graduate school in Germany focused on hydrogen trustworthiness
- combines the unique competences of BAM and BTU to train the next generation of interdisciplinary hydrogen scientists
- hydrogen focused qualification programme providing all PhD students with a holistic understanding of the hydrogen value chain and the regulatory framework conditions
- wide range of soft skill courses
- close interaction with industry (embedded in international networks of BTU and BAM)
- working language is English

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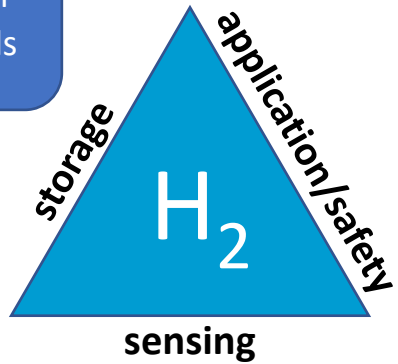
- initial launch with 7 PhD topics:

Influence of manufacturing-induced imperfections on the operational safety of composite H_2 pressure vessels

Influence of manufacturing process-related residual stresses in wound composite material on the operational safety of H_2 pressure vessels



Evaluation of the influence of lubricants on pre-ignition of hydrogen for engine-relevant conditions

Efficient polymer matrix composites qualification strategies for next generation H_2-pressure vessels

Influence of fires on tanks for cryogenic fluids

Digital sensor twins for hydrogen applications

Novel materials and coatings for the detection of hydrogen and hydrocarbons

PhD Research Topic 1: Hydrogen Storage

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- Overall Goal: Optimizing the material of light-weight pressure vessels → polymer matrix composites made from carbon-fibre reinforced plastics
- Present situation: in-service life strongly influenced by inter-fibre failure due to long-term and cyclic thermomechanical loading
- Problem: current planar test geometries and protocols not efficient
- Novel ansatz: tubular test geometry with in-situ investigation
- Deliverables:
  - ➡ Design, manufacturing and test of representative tubular specimens
  - ➡ Built-up of in-situ H_2-pressurized tubes in tensile testing
  - ➡ Multiaxial test protocols for standardization

PhD Research Topic 5: Hydrogen Storage

BAM Bundesanstalt für Materialforschung und -prüfung

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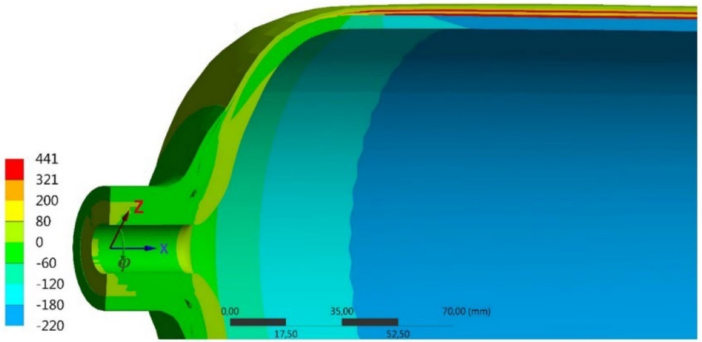
- Overall goal: Optimizing the material of light-weight pressure vessels → polymer matrix composites made from carbon-fibre reinforced plastics
- Present situation: creation of composite using winding technology, AFP process, or braiding
- Problem: reduced stresses in winding process lead to reduced strength and reliability
- Novel ansatz: study influence of stress by simulation and hydraulic testing of model tanks
- Deliverables:
  - ➡ finite-element model of pressure vessel
  - ➡ determination of vessel design and manufacturing process
  - ➡ implementation and application of test setup



finite-element model

PhD Research Topic 6: Hydrogen Storage

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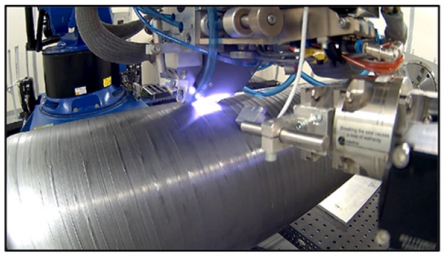
- Overall goal: Optimizing the material of light-weight pressure vessels ➞ polymer matrix composites made from carbon-fibre reinforced plastics
- Present situation: creation of composite using winding technology, AFP process, or braiding
- Problem: imperfections introduced in winding process lead to reduced reliability
- Novel ansatz: study influence of manufacturing-induced imperfections by simulation and testing
- Deliverables:
  - ➡ development and manufacturing of composite test specimen with targeted imperfections
  - ➡ FE model including manufacturing process derived imperfections
  - ➡ implementation of suitable test setup
  - ➡ design rules and new material concepts



automatic fiber placement (AFP) process

PhD Research Topic 7: Hydrogen Safety/Applications

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- Overall goal: safe transportation of cryogenic fluids (liquefied H_2)
- Present situation: most commercial products optimized for liquefied natural gas
- Problem: little knowledge about other gases, especially, hydrogen
- Novel ansatz: study influence of fires on tanks experimentally and theoretically
- Deliverables:
  - ➡ impact of fires on super insulation
  - ➡ how fires affect cryogenic hazardous materials
  - ➡ theoretical models describing such incidents

explosion of tank for liquefied gas

Prof. Seidlitz (BTU)/Prof. Otremba & Dr. Eberwein (BAM)

PhD Research Topic 3: Hydrogen Safety/Applications

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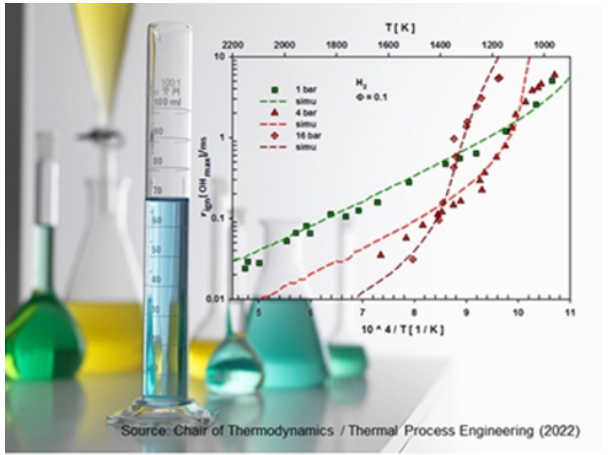
Brandenburg University of Technology Cottbus - Senftenberg

- Overall goal: safe and efficient operation of gas engines with green hydrogen
- Present situation: lubricants not optimized for hydrogen as fuel
- Problem: increased compression ratio and charging of intake air may cause self-ignition of engine oil
- Novel ansatz: theoretical and experimental study of influence of lubricants under engine-relevant conditions
- Deliverables:
  - ➡ fundamental understanding of influence of lubricant properties
  - ➡ validated detailed kinetic model for predicting pre-ignition in hydrogen/air mixtures with lubricants
  - ➡ identification of optimum lubricant properties



kinetic modeling of fundamental processes

PhD Research Topic 4: Hydrogen Sensors

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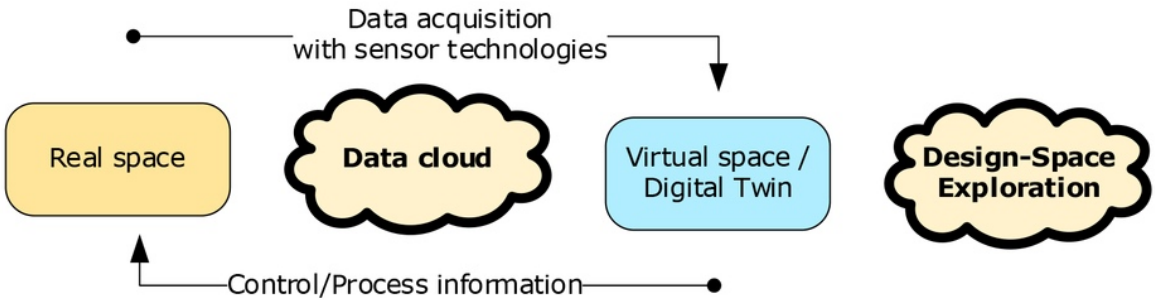
- Overall goal: optimized and validated process management in hydrogen plants using sensor technologies
- Novel ansatz: intelligent design of sensor networks based on digitally supported data mining
- Deliverables:
  - ➡ development of sensor network concept
  - ➡ establish sensor node system
  - ➡ digital twin for H_2 determination in air



PhD Research Topic 2:
Novel Hydrogen Sensor Materials

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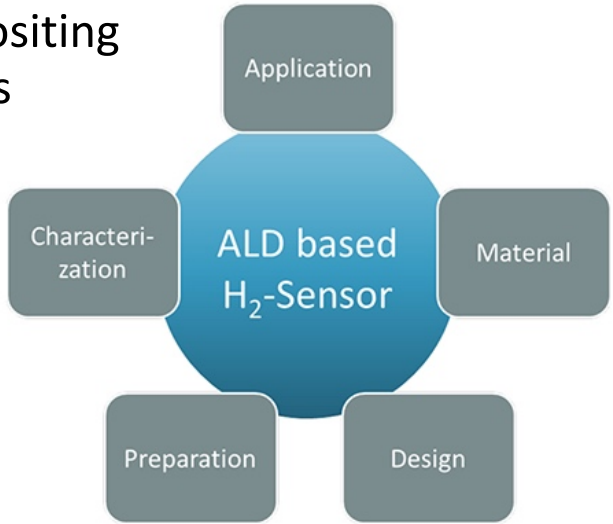
- Overall goal: miniaturized, efficient sensor materials for sensitive and selective H_2 detection
- Present situation: current sensors rather bulky, not CMOS-integrated
- Novel ansatz: use of atomic layer deposition (ALD) for depositing thin oxide films on nanostructured substrates
- Deliverables:
  - ➡ ALD preparation recipes for active sensor layers
  - ➡ characterization of gas-oxide interaction depending on temperature, pressure, gas composition
  - ➡ detailed sensor response depending on gas composition and exposure



Prof. Flege & Mauß (BTU)/Drs. Sobol & Tiebe (BAM)

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intimate connection to iCampus Cottbus and energy innovation center (EIC)