NTNU Energy Team Hydrogen 2022-06-24

Prof. Terese Løvås

NTNU

Research-based education is NTNU's mission!

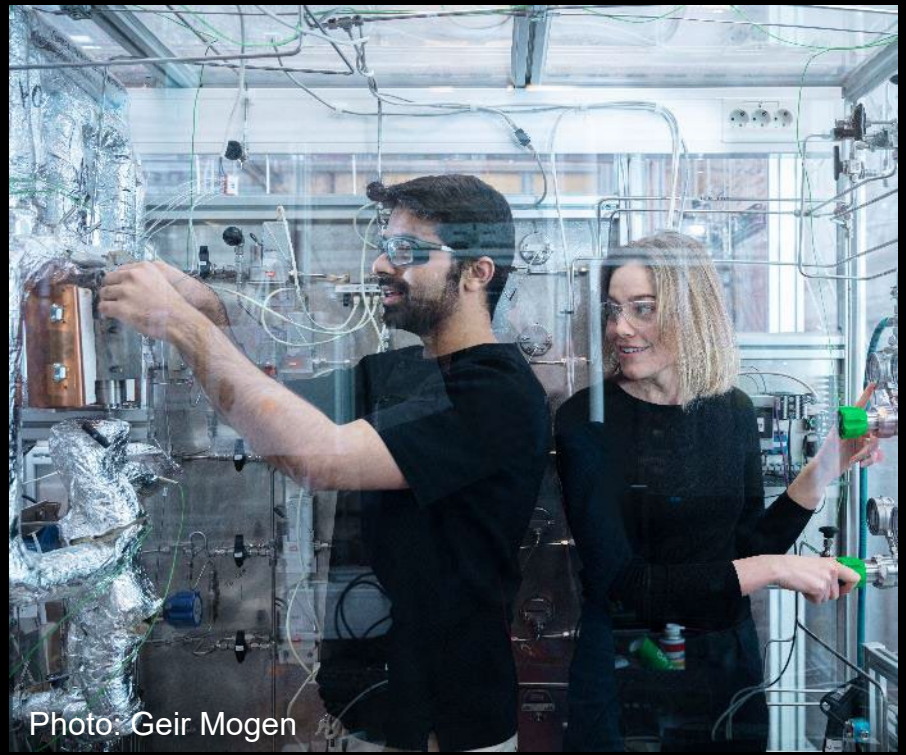


Photo: Geir Mogen

- UN Sustainable Development Goals, cross-disciplinarity and teamwork embedded at all levels (BSc/MSc/PhD)
- Hydrogen/energy topics integrated into courses in science, technology, economics, social sciences, humanities, …

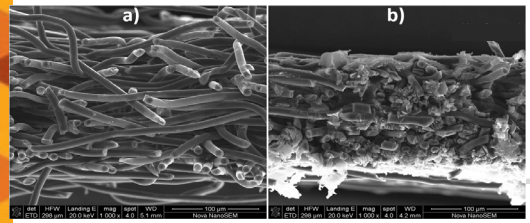
Our candidates will implement the green transition over the next generation!

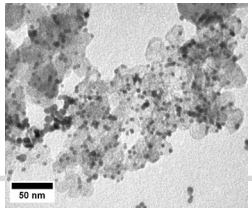
NTNU ENERGY
Team Hydrogen

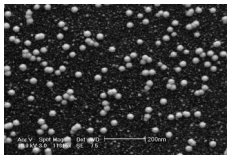
NTNU HYDROGEN

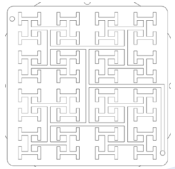
NTNU – Trondheim
Norwegian University of
Science and Technology

- ✓ >40 Professors & >60 researchers from different disciplines, departments and faculties across NTNU that works within the hydrogen area, from nanomaterials, hydrogen storage, system integration, hydrogen safety to life cycle assessment and environmental input-output analysis
- ✓ Internationally well-recognised academics with high *h*-indices
- ✓ Excellent facilities for fundamental and applied research
- ✓ International research collaborations and researchers' exchanges
- ✓ National and international research collaborations with Industry
- ✓ Offer undergraduate/postgraduate courses in Hydrogen Energy







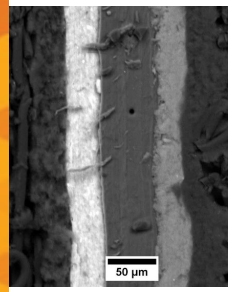


Membrane

Prototyping

Techno-Economics & Life Cycle Analyses

Bipolar Plates & Flow Fields



Safety

Gas Diffusion Layer

Transport & Micro-Porous Layer

Component & Systems

System Integration

H_2 Embrittlement

Conversion, Storage & Combustion

Component & System Modeling

Maritim

Non-PGM Catalyst & Catalyst Layer

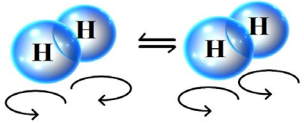
Ammonia

Liquid Hydrogen

Materials

Natural Gas, Biogas & Alcohol Reforming

Hydrogen Comb



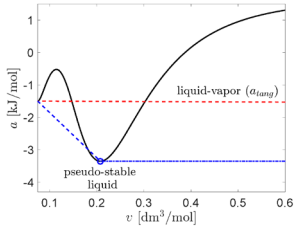
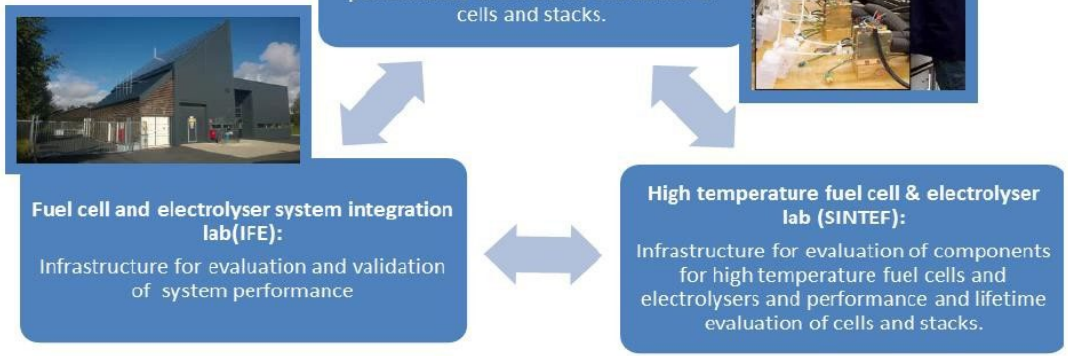


Illustration: https://www.skipsrevyen.no/batomtaler/m-s-

Largest R&D Hydrogen & Fuel Cell Infrastructure in Norway!

NORWEGIAN FUEL CELL AND HYDROGEN CENTRE



NTNU
Norwegian University of Science and Technology

SINTEF

IFE Institute for Energy Technology

The Research Council of Norway

30m NOK

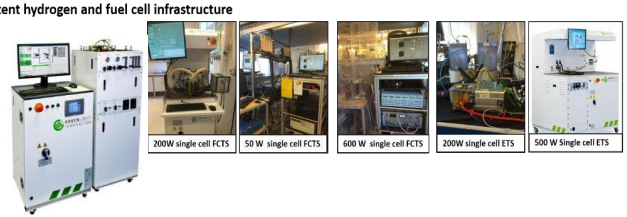
NORWEGIAN FUEL CELL AND HYDROGEN CENTRE

LOW TEMPERATURE FUEL CELLS & ELECTROLYSERS

In order to strengthen and increase fuel cell and electrolyser research activities at SINTEFs/NTNUs new equipment have been installed & commissioned

New hydrogen and fuel cell infrastructure

Existent hydrogen and fuel cell infrastructure



TRONDHEIM

- ***PEM/AEM fuel cell and electrolyser test stations*** *400-500 W*
- ***DMFC fuel cell test station*** *40W*
- ***PEM fuel cell and electrolyser stack test stations*** *10-12 kW*

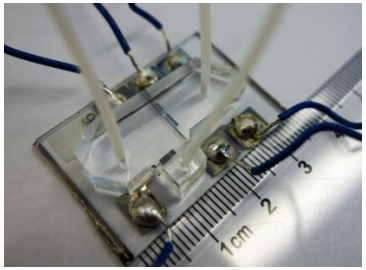
OSLO

- **SOFC/SOEC** 650 W & 6 kW

Hydrogen and Fuel Cell infrastructure @ NTNU

NTNU has excellent state-of-the-art hydrogen and fuel cell laboratories and equipment

- Potentiostats/galvanostats
- Photoelectrochemistry
- Sonoelectrochemistry
- Test-station facility
- Electrochemical FTIR and Raman
- Electrochemical AFM/STM
- ICP/GC/HPLC etc
- DEMS
- UV-vis PMRS
- Microfluidic flow cells
- Scanning Probe Microscope (AFM/STM)
- FTIR spectrometer, UV-vis etc
- Advanced electrochemical equipment (RDE, DEIS, DEMS, EQCM)
- Battery/fuel cell/water electrolyzer test stations
- Ultrasonic devices (baths, probes & US-spray)



NTNU

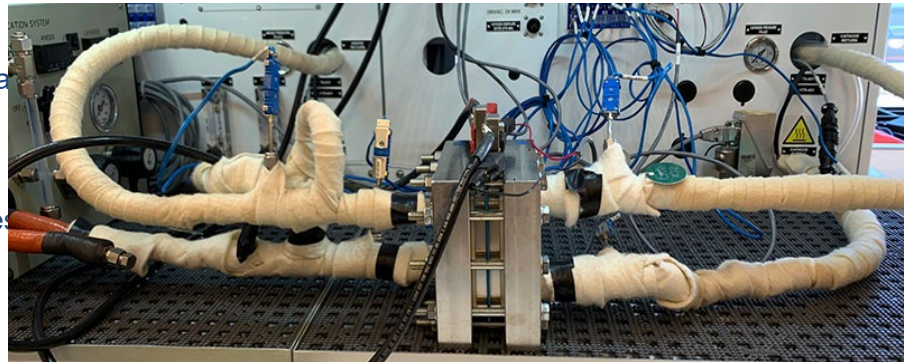
Norwegian University of Science and Technology

Examples of activities

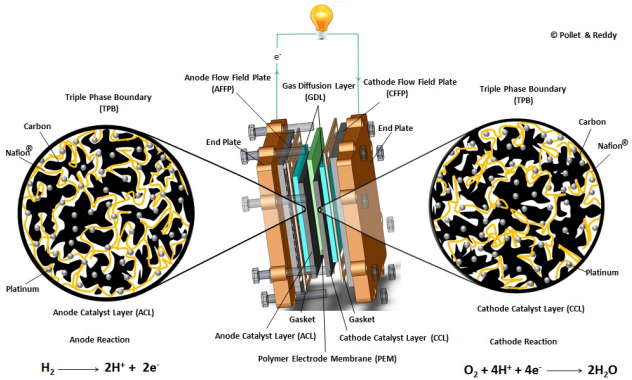
Hydrogen and Fuel Cell activities @ NTNU

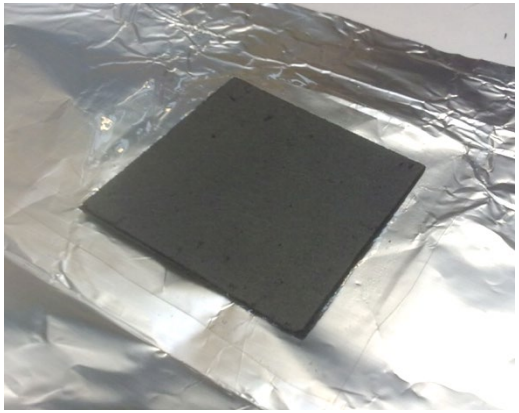
"From Nanomaterials, Heat Management, Ageing, Sensors to System Integration, Demonstrators, Feasibility Studies & LCA Analyses"

- ✓ Material and electrode (CCM, GDE & MEA) development, testing & durability for PEM Fuel Cell (PEMFC), PEM Water Electrolyser (PEMWE) & Alkaline Water Electrolyser (AWE)
- ✓ PEMFC/PEMWE/AWE sub-components material development, testing & durability
- ✓ PEMFC/PEMWE/AWE stack development, testing & durability
- ✓ PEMFC/PEMWE/AWE electrocatalysis development, testing & durability
- ✓ Reforming catalysis development, testing & durability
- ✓ Hydrogen embrittlement
- ✓ Renewable H2 (from H_2O, bioma
- ✓ Hydrogen from natural gas
- ✓ Hydrogen separation membrane
- ✓ Material and system modelling
- ✓ System integration
- ✓ Hydrogen in maritime, automotive and stationary applications
- ✓ Feasilibity studies, cost analyses, life cycle assessment & environmental input-output analyses

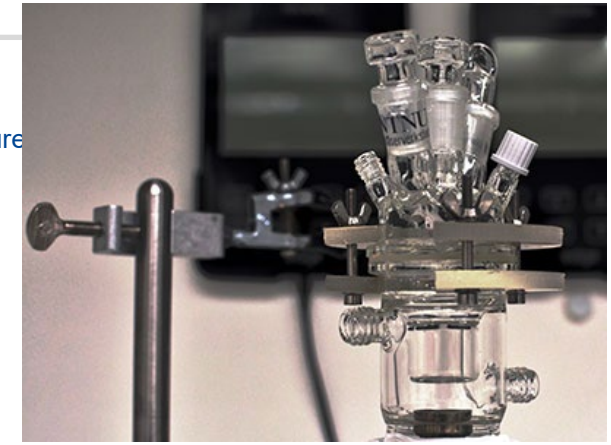


Other examples of Hydrogen and Fuel Cell activities @ NTNU





- ✓ **Electrocatalysis**
  - Oxygen evolution
  - Hydrogen evolution
  - Hydrogen oxidation
  - Core@shell catalysts/nano-architecture
  - Electrooxidation of methanol and CO
  - Electrochemical CO_2 reduction
- ✓ **Water Electrolysis**
  - Polymer exchange membrane
  - Alkaline
  - Super-gravity
  - Sonoelectrolysis
- ✓ **Fuel Cells**
  - Membrane electrode assemblies for PEM
  - Bipolar plates for PEM
  - Performance/diagnostics/analysis
  - Alkaline fuel cells
- ✓ **NG Reforming**
  - Reforming catalysis, POX, WGS
  - Membrane separation
- ✓ **Hydrogen Combustion**



Others

- GDL
- PEM
- MPL
- Bipolar plates
- Stacks
- Reformers

NTNU Energy Team Hydrogen looking forward!

Find more information at https://www.ntnu.edu/energy/hydrogen

NTNU ENERGY
Team Hydrogen