MATERIALS

# Characterisation of fuel cells and hydrogen storage materials and devices

## Neutron characterisation techniques can:

- Show **where $H_2$ is flowing** within a storage tank or a fuel cell.
- Show where and how **$H_2$ is fixed and released** by storage materials.
- Investigate **membrane** materials and **fuel cells** in operation.

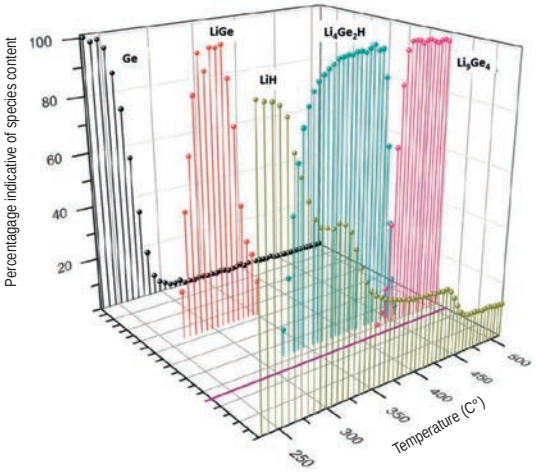
## Typical areas of study:

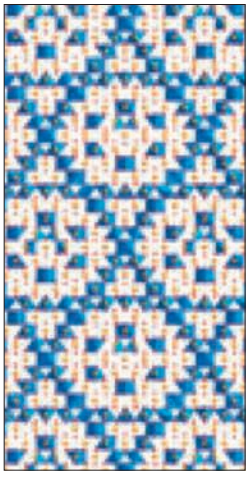
- $H_2$ storage materials: $H_2$ uptake and release under various operating conditions.
- $H_2$ storage devices: in operando $H_2$ imaging.
- Materials for fuel cell membranes.
- Fuel cells in operation: tracking water distribution within the cell at the μm level.

## Examples

**A neutron tomography image**. It reveals the development of defects in a **light metal hydride storage material:** channels developing inside a hydrogen tank after two cycles of loading and unloading with hydrogen.

Dehydrogenation pathways in an **$H_2$ storage material**. Powder neutron diffraction experiments on a lithium-hydride / germanium composite (LiH / Ge) can reveals the species that form as the composite decomposes when slowly heated to 500°C.

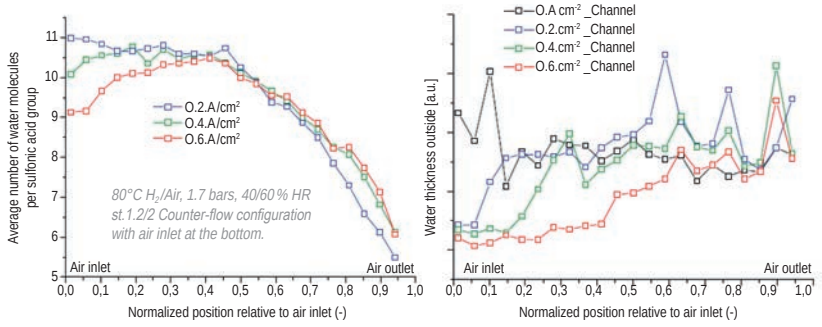


**A fuel cell membrane material.**
Beside as an example: the refined crystal structure of bismuth niobium oxide obtained from neutron diffraction data.

- *Bismuth atoms*
- *Oxygen atoms*
- *Polyhedra-centred niobium atom*

Small-angle neutron scattering techniques make it possible to **measure the variation in water content** in both the vertical and horizontal planes throughout the **fuel cell** simultaneously. (*Left*) Water content in the menbrane and (*right*) water outside the membrane, along the flow field in the channel, for different current densities.





**REFERENCES**

Pranzas et. al., Adv Eng Mat, (2011); Abbas M. A. et al., Phys. Chem. Chem. Phys. (2013); Ling C. et. al., J. am. Chem. Soc. (2013 ); Morin A. et. al., Fuel Cells (2012); $H_2$FC newsletter (2015); Neutrons and energy ILL (2015).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NEUTRONS FOR SOCIETY

HZB Helmholtz Zentrum Berlin

MLZ Heinz Maier-Leibnitz Zentrum

GEMS German Engineering Materials Science Centre Helmholtz-Zentrum Geesthacht

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