'Molecular sponge' advancement in storing hydrogen

July 21 2015

Researchers at our University have discovered that hydrogen absorbed in specialised carbon nanomaterials can achieve extraordinary storage densities at moderate temperatures and pressures.

The research marks a major development in our understanding of efficient hydrogen storage. It was led by Dr Valeska Ting from our Department of Chemical Engineering in conjunction with researchers from Rutherford Appleton Laboratory and collaborators in the USA and Germany.

Sustainable, low-carbon fuel

Hydrogen presents a significant opportunity as a sustainable, low-carbon alternative to fossil-based transport fuels. However, hydrogen is typically stored as a compressed gas in bulky high pressure tanks and these costly storage problems are a barrier to its use as a transport fuel of the future.

The research, which has been published in the prestigious journal *ACS Nano*, found that when hydrogen is stored in materials with optimally-sized sub-nanometer pores, it is able to be simultaneously compressed and stored at much higher densities than in conventional tanks. These materials include activated carbons, zeolites, metal-organic framework materials and certain porous polymers which act as 'molecular sponges'.

Solid-like behaviour

Using inelastic neutron scattering, which is one of the few experimental techniques that can be used to obtain direct information on the state of the hydrogen inside a solid material, the team observed hydrogen gas with a solid-like behaviour, indicating hydrogen densities almost 1,000 times the density of gaseous hydrogen at ambient temperatures and pressures.

Dr Ting said: "Greater understanding of how the nanoscale structure of the storage material can influence gas storage capacities is expected to lead to more accurate evaluation methods for existing porous hydrogen storage materials. This, in turn, should have an impact on the design and evaluation of new hydrogen storage materials for future automotive applications."

Shift in focus

These findings open the door to a shift in focus towards pore design with future research looking to exploit storing high density hydrogen in solid materials, rather than as a liquid or a gas.

More information: "Direct Evidence for Solid-Like Hydrogen in a Nanoporous Carbon Hydrogen Storage Material at Supercritical Temperatures" *ACS Nano*, Just Accepted Manuscript DOI: 10.1021/acsnano.5b02623

Provided by University of Bath