# Nano-structures to realise hydrogen's energy potential

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(Phys.org) -- For the first time, engineers at the University of New South Wales have demonstrated that hydrogen can be released and reabsorbed from a promising storage material, overcoming a major hurdle to its use as an alternative fuel source.

Researchers from the Materials Energy Research Laboratory in nanoscale (MERLin) at UNSW have synthesised nanoparticles of a commonly overlooked chemical compound called sodium borohydride and encased these inside nickel shells.

Their unique "core-shell" nanostructure has demonstrated remarkable hydrogen storage properties, including the release of energy at much lower temperatures than previously observed.

“No one has ever tried to synthesise these particles at the nanoscale because they thought it was too difficult, and couldn’t be done. We’re the first to do so, and demonstrate that energy in the form of hydrogen can be stored with sodium borohydride at practical temperatures and pressures,” says Dr Kondo-Francois Aguey-Zinsou from the School of Chemical Engineering at UNSW.

Considered a major a fuel of the future, hydrogen could be used to power buildings, portable electronics and vehicles – but this application hinges on practical storage technology.

Lightweight compounds known as borohydrides (including lithium and sodium compounds) are known to be effective storage materials but it was believed that once the energy was released it could not be reabsorbed – a critical limitation. This perceived "irreversibility" means there has been little focus on sodium borohydride.

However, the result, published last week in the journal *ACS Nano*, demonstrates for the first time that reversibility is indeed possible using a borohydride material by itself and could herald significant advances in the design of novel hydrogen storage materials.

"By controlling the size and architecture of these structures we can tune theirproperties and make them reversible – this means they can release and reabsorb hydrogen," says Aguey-Zinsou, lead author on the paper. "We now have a way to tap into all these borohydride materials, which are particularly exciting for application on vehicles because of their highhydrogen storage capacity."

The researchers observed remarkable improvements in the thermodynamic and kinetic properties of their material. This means the chemical reactions needed to absorb and release hydrogen occurred faster than previously studied materials, and at significantly reduced temperatures – making possible application far more practical.

In its bulk form, sodium borohydride requires temperatures above 550 degrees Celsius just to release hydrogen. Even on the nano-scale the improvements were minimal. However, with their core-shell nanostructure, the researchers saw initial energy release happening at just 50 °C, and significant release at 350 °C.

"The new materials that could be generated by this exciting strategy could provide practical solutions to meet many of the energy targets set by the US Department of Energy," says Aguey-Zinsou. "The key thing here is that we've opened the doorway."

**More information:** dx.doi.org/10.1021/nn3030018

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