Big hopes for tiny, new hydrogen storage material

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Researchers at the Department of Energy's Pacific Northwest National Laboratory are taking a new approach to "filling up" a fuel cell car with a nanoscale solid, hydrogen storage material. Their discovery could hasten a day when our vehicles will run on hydrogen-powered, environmentally friendly fuel cells instead of gasoline engines.
The challenge, of course, is how to store and carry hydrogen. Whatever the method, it needs to be no heavier and take up no more space than a traditional gas tank but provide enough hydrogen to power the vehicle for 300 miles before refueling.

One approach is to find a solid chemical material that can hold and then release hydrogen as needed. Recently, PNNL researchers Tom Autrey and Anna Gutowska found a way to release hydrogen from a solid compound almost 100 times faster than was previously possible.

They will present their findings at the American Physical Society Meeting in Los Angeles on March 21, as part of The Grand Challenge of Hydrogen Storage symposium.

"The compound ammonia borane is known to release hydrogen at temperatures below 80 degrees Celsius, but the rate of release is extremely slow," said Autrey. "In the nanophase, the hydrogen comes off very fast – approximately 100 times faster compared to conventional bulk ammonia borane."

The PNNL team used a nanoscale mesoporous silica material as

scaffolding for ammonia borane to achieve a high rate of hydrogen release at a lower temperature than is found at the conventional scale. A lower temperature reaction, 80 degrees Celsius (170 degrees Fahrenheit), or below, is important because additional energy is not required to maintain the reaction.

To transform the ammonia borane to a nanomaterial, scientists dissolve the solid compound in a solvent and then add the solution to the mesoporous support material.

Capillary action of the porous material pulls the ammonia borane into the pores of the support. When the solvent is removed, nanosized pores filled with ammonia borane are left. Each pore is about 6.5 nanometers in diameter.

The nanoscience approach to using ammonia borane as a storage material exceeds DOE's weight and volume storage goals for 2010. As a bonus, it also avoids the volatile chemicals produced at the bulk scale.

"We found no detectable borazine, which is harmful to fuel cells, produced by the reaction in the mesoporous materials," said Autrey.

Based on computational thermodynamic analysis, researchers believe the process may eventually be designed to be reversible, which would allow the storage material to be regenerated and provide a sustainable hydrogen storage compound with a longer lifetime. A patent is pending on this process for hydrogen storage.

Source: PNNL