

Organic Hydrogen Storage

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Fossil fuels are limited and polluting, hence the search for alternatives. One suitable and environmentally sound fuel would be hydrogen; unfortunately there are currently few technical possibilities for the construction of safe and efficient hydrogen storage tanks that are suitable for cars. One possible solution to the hydrogen storage problem is to use microporous materials such as zeolites or activated carbons, which have many molecular sized holes suitable for the containment of hydrogen and can also release it when needed.

Neil McKeown, of Cardiff University, UK, and his collaborators, Peter Budd (University of Manchester) and David Book (University of Birmingham) have chosen a new approach: they have developed a purely organic polymer that can adsorb appreciable quantities of hydrogen.

The molecular chains in most organic polymers are so flexible that they can form tightly packed structures. This means there are no cavities inside, and thus no appreciable internal surface onto which substances could be adsorbed. The chemists thus constructed polymers from interlinked five- and six-membered rings. At defined points in the molecule, two five-membered rings are connected in such a way as to provide a contorted shape to the stiff macromolecular structures. The contorted molecules cannot pack together efficiently and leave gaps and interstices. These “polymers of intrinsic microporosity” (PIMs) have large internal surface areas of over 800 m² per gram of material — equivalent to the surface area of three tennis courts.

In reproducible synthetic steps, the researchers have produced

chemically homogenous materials with a uniform distribution of pore sizes of 0.6–0.7 nm. These ultrasmall pores can absorb and then release between 1.4 and 1.7% hydrogen. Depending on the selection of building blocks the researchers can produce insoluble networks or polymers that are soluble in solvents and can thus be processed into useful shapes like common plastics.

In order for the PIMs to store enough hydrogen to be useful they must be optimized further. “However, there is great potential for tailoring the PIM structure by both chemistry and polymer processing techniques” says McKeown, who anticipates that by the year 2010 they will have succeeded in preparing a PIM capable of storing up to 6% hydrogen.

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