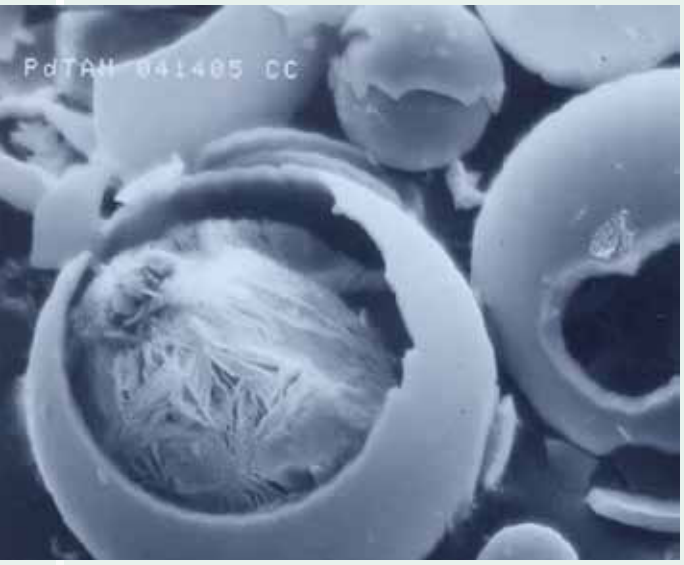


Scanning electron micrograph of hollow glass microsphere, with its top removed to show its contents

Porous Wall Hollow Glass Microspheres

Tiny Glass Spheres for Energy Storage, Medical Applications and Other Uses

Researchers at Savannah River National Laboratory (SRNL) have developed a new class of materials, dubbed porous wall hollow glass microspheres (PWHGMs). These miniature balloon-like structures are capable of containing and releasing a variety of materials, with exciting potential for use in areas that range from energy to biomedicine. PWHGMs have a diameter of about half the width of an average human hair (about 50 micrometers). Their walls are only about 1 to 2 microns thick, and contain interconnected pore-channels. These channels can be used to fill the microballoons with special absorbents and other materials of interest—gases, liquids and solids. For example, initial work centered on using the microspheres to store and release hydrogen gas in controlled fashion, with applications in hydrogen fuel cell automotive technology.

"a protective . . . cocoon for their contents"

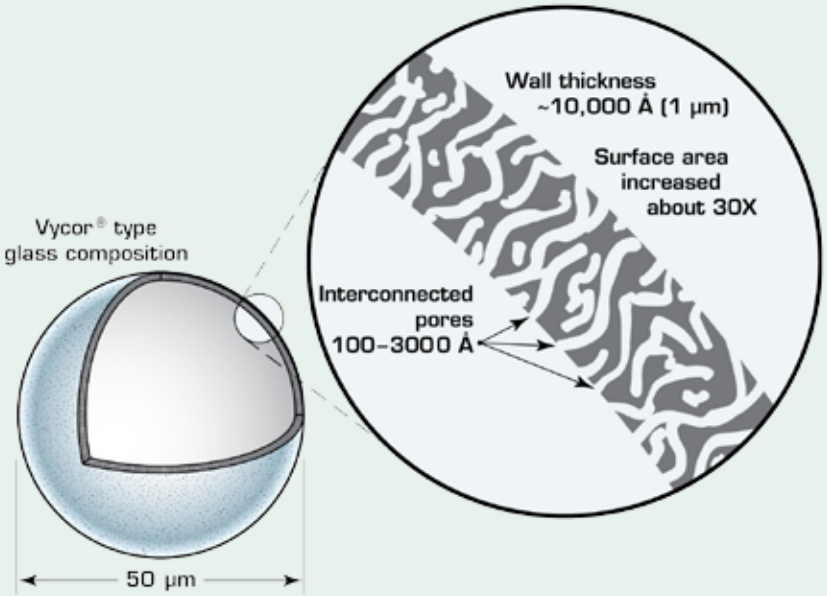
Why It Matters

What makes SRNL's microspheres unique, and gives them the capability to be useful in so many fields, is the network of interconnected pores in the thin outer shells that allow the tiny "microballoons" to be filled with a diversity of materials for a broad range of applications. The capability to control pore size in the walls of these unique microspheres gives them exciting potential for use in areas including energy, environmental remediation, drug delivery, hydrogen storage and many other uses. For example, patients who required controlled release of a drug over time might readily benefit from this technology. Because the glass spheres provide a protective environment, or cocoon, for their contents, they can also be used to hold reactive or flammable absorbents or stored materials. This endows them with the potential to provide a safe method of handling, storing or transporting a variety of difficult materials.

Methods

A glass composition that is chemically disposed to undergo amorphous phase separation is used to produce a hollow glass microsphere. The microsphere is heat-treated to develop the interconnected microstructure, then subjected to a leaching

process, which results in a sponge-like network structure consisting mainly of silica. Two LDRD projects have had an impact in development and understanding of this unique material. One focused on the impact of composition and temperature on pore size, showing, among other results, that heat treatment temperature, rather than composition was most effective in changing porosity. Heat treatment at 600 °C for 8 hours increased the pore diameter ten-fold, from approximately 100 Å to approximately 1000 Å. A second LDRD project in collaboration with Virginia Polytechnic Institute and Boston University examined chemical and mechanical means of releasing "payloads" contained within the microballoons.



Schematic of PWHGM, showing porosity of walls

What's Next

One patent has been issued with four more pending. Specialty glass manufacturer Mo-Sci Corporation of Rolla, Missouri, has licensed the technology from SRNL and is developing capabilities for large-scale production. Technology transfer initiatives related to the PWHGMs earned an Honorable Mention in the 2010 Federal Laboratory Consortium Excellence in Technology Transfer Awards.

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SRNL has been involved in almost a dozen different programs involving the PWHGMs, many in collaboration with academic institutions, as well as industrial partners, such as Toyota and Exide. These include on-board storage of hydrogen for vehicles (with Toyota), drug delivery and other medical applications (with Georgia Health Sciences University), and lead acid battery improvements (with Exide, University of Idaho). A proposed project with Toyota for use in lithium batteries was a finalist for ARPA-E consideration.