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Available Technologies

Aerogels: Chemical Functionalization of Nanostructured Materials Using Supercritical Reaction Media

SUMMARY

There exists a need for durable and thin functional coatings to utilize the afforded surface area of highly porous ceramic materials. Deposition of silane-based Self Assembled Monolayers (SAMs) has thus far been limited to maximum coverage of 4-5 molecules/nm2 and long processing times (up to 2 weeks) due to the restricted internal geometry of the substrates. Results are presented for SAMs deposited on high surface area silica from supercritical fluids (SCFs). The SAMs so produced display unprecedented coverage, high monolayer integrity, and extremely low surface defect density. Moreover, the depositions and subsequent removal of reaction byproducts are complete in a matter of minutes rather than days. Nuclear Magnetic Resonance (NMR) spectra of the surface modified silica demonstrate the SAM integrity and evolution over time. Sorption of aqueous metal ions is also demonstrated, and results are given demonstrating the broad pH stability of the deposited SAMs.

In the most basic aspect of the present invention, a monolayer coating is provided on the aerogel which improves the aerogel's physical properties, most notably its strength. In a more specialized aspect of the present invention, in addition to coating the aerogel, the molecules that make up the monolayer coating also include chemical species, or "functional group" that exhibits a desired chemical property. Thus, the monolayer is composed of molecules having at one end a chemical species that is bonded to the aerogel, and a "functional group" that exhibits a desired chemical property at the other end. Accordingly, in this more specialized form of the present invention, the aerogel is bonded to a material displaying a functional group at the outer surface, and the aerogel is referred to as "functionalized." The present invention is enabled by the surprising discovery that aerogels may be coated with monolayers, without destroying the high surface area and random structure that characterizes aerogels, by utilizing a supercritical fluid as a reaction medium. Accordingly, the monolayer coated aerogels of the present invention are formed by first providing a monolayer forming precursor and an aerogel in a supercritical fluid, allowing the monolayer forming precursor to form a monolayer on the surface of the aerogel, and removing the thus formed monolayer coated aerogel from the supercritical fluid.

ADVANTAGES

* Simple and direct method for chemically modifying the aerogel interface without destroying the porous nature of the structure
* Can be used to sequester heavy metals and radionuclides, and after toxic species

have been captures, is easily sintered to form an easily handled permanent waste form

RELATED LINKS

» **Self-Assembled Monolayers on Mesoporous Supports (SAMMS) Website**

http://samms.pnnl.gov

Patents & Intellectual Property

» Patent #: 7,019,037

Technology Portfolio(s)

» Materials Synthesis and Functionalization

Potential Industry Applications

» Agriculture & Mining

» Chemicals

» Energy & Utilities

» Oil & Gas

» Recycling & Waste Management

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