

Acid-Prepared Mesoporous Silica Spheres

Inventor: Christopher Landry

The University of Vermont, Office of Technology Commercialization

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Overview

The large surface area and high stability of porous silica nano- and microparticles has made them useful in a variety of applications, from separation of organic compounds (chromatography) to immobilization and protection of enzymes from denaturation. Amorphous silica is classified as a non-toxic substance, making these particles useful in drug delivery.

Christopher Landry, Ph.D., has invented a new method to produce highly porous, surface-activated silica particles with a spherical morphology. The internal pore structure allows the particles to be loaded with large amounts of a wide range of biological molecules, with demonstrated applications in molecular separations, enzyme catalysis, and molecular delivery. Professor Landry's academic publications have already demonstrated the utility of these particles in the targeted delivery of chemotherapeutic drugs to tumors *in vivo*; the particles were shown to be non-toxic and non-immunogenic. Other publications describe the *in vivo* use of particle-based contrast agents for MRI, the immobilization and protection of enzymes with high activity and stability that degrade pesticides, and the separation of chiral organic compounds.

Patent Status

US Patent Application Filed
Worldwide Rights Available

Invention

Professor Landry's technology is a process to manufacture highly porous silica particles with a spherical morphology, and the particles themselves. The particles are > 95% monodisperse and have a narrow distribution of sizes. The reactions conditions can be manipulated to produce an average particle diameter anywhere from 0.5 to 10 μm . Pore diameters also have a narrow distribution that is synthetically controllable, from 2 to 200 nm. Other important physical properties include very large internal surface areas and pore volumes, in excess of 700 m^2/g and 1.0 cm^3/g , respectively. Importantly, the synthesis process is complete in less than 2 hours, and scale-up is easily accomplished using pilot-plant equipment. By combining multiple batches, the largest production run to date was approximately 3 kg.

As with all amorphous silica, the particle surfaces are readily modified with a variety of organic and biological compounds, including catalysts, polymers, enzymes, antibodies, and others. For example, the external surface can be modified with poly(ethylene glycol), to enhance uptake by cells, and an antibody to target a cell type; separately, the internal pore surface can be modified with a drug, contrast agent, fluorophore, or other molecular cargo. In other applications, the pores could contain enzymes; the confined pore environment prevents denaturation of the enzyme, and therefore retention of its activity, even after exposure to temperatures as high as 65 $^{\circ}\text{C}$ for extended times.

Advantages

- Improved efficiency in delivering therapeutic agents
- More reproducible manufacturing, longer shelf-life, and easier sterilization, as compared to the more traditional delivery agent liposomes
- Large surface area for trapping molecules or providing a site for chemical reactions to occur
- Surface modification allows binding of a vast array of biological compounds, including proteins, drugs, nucleic acids, and gene therapy vectors

Applications

- Targeted delivery of therapeutic agents, including pharmaceutical, proteins, and gene therapy vectors
- Delivery of imaging agents or markers to tissues, such as in particle-based MRI contrast agents
- Separation of compounds during manufacturing of biological compounds, including pharmaceuticals or fuels
- Neutralization of harmful species in the environment (toxins or pollutants)
- Substrate catalysts to speed chemical reactions

Learn more about Dr. Landry's research at:
<http://bit.ly/1dPwM00>

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innovate@uvm.edu

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