Porous Silicon

Porous silicon is a mixture of solid silicon and void. The pore size and shape depend on the fabrication method and can range from the nanoscale to the microscale. The shape of the pores can vary from tortuous and randomly directed to crystallographically defined. Porous silicon can be formed as a thin film on single crystal wafers, as usually made by anodization.

Alternatively, electroless etching can be used to produce porous silicon on any sort of substrate including powders. When combined with an array of metal nanoparticles or holes in a metal film, electroless etching creates etch track pores that produce a forest of ridges or nanowires. The etched structures can themselves either be solid or porous.

A significant advance in the processing of porous silicon powders is embodied in the ReEtching process. ReEtching is an abbreviation for regenerative electroless etching. It greatly expands the functionality of electroless etching such that the extent of etching of silicon of arbitrary shape and size can be controlled. Therefore, any type of silicon-comprising powder can be used as a feedstock including wafers, high-purity granules, metallurgical grade powders, as well as porous silicon powder produced by any other method, e.g. magnesio-thermal reduction, metal-assisted catalytic etching (MACE) or pulverization of anodized wafers.

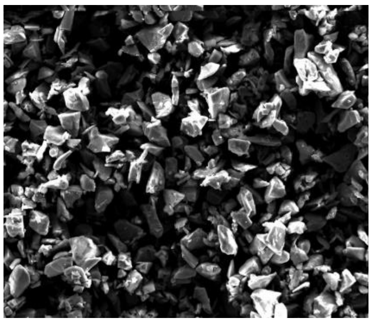
Drug Delivery

It has been shown that when silicon is porosified with nanometer-scale pores and pore walls, it becomes resorbable. This means that nanostructured porous silicon, when placed in the body, is transformed into bio-available and naturally occurring silicic acid, a molecule for which the body actually has a dietary need. The ability of nanostructured porous silicon particles to combine targeted therapeutic as well as diagnostic functionalities in the same package means that they are optimal vectors for the burgeoning field of theranostics (therapeutics/diagnostics). Porous silicon particles are amenable to simple drug-loading processes that can incorporate both small molecule and large molecule payloads such as peptides, siRNA and DNA. It can also host different types of drugs simultaneously, for example, a hydrophilic small molecule drug and a hydrophobic peptide. Because of their easily controlled dissolution chemistry, porous silicon particles are capable of sustained release of drugs.

Crystalline silicon does not luminesce visible light under UV irradiation. However, because of the effects of quantum confinement, nanostructured porous silicon is a bright emitter of visible light when excited with UV light. The color of the emitted light depends on the thickness of the pore walls as well as the surface termination of the pore walls. Significantly, porous silicon can be passivated with either hydrophobic or hydrophilic layers that retain its visible photoluminescence (PL) for days in a simulated biological fluid. The long lifetime of the PL means that these particles are particularly well-suited for time-gated PL measurements using either one-photon UV/visible nanosecond-pulsed excitation or two-photon infrared femtosecond-pulsed excitation.

Ram Nanotech

Custom porous silicon materials, for research and manufacturing.



1. Variable pore size
2. Variable pore size distribution
3. Hierarchical pore distributions
4. Nano-ridges

We offer a variety of porous silicon products. Etching can be performed either to leave a solid core or such that the particles are completely porosified. Powder particles can have a mean size between 1 and 75 µm and still be etched completely through the core. Larger particles can also be etched but will generally have a solid core. The mean pore size can be varied over the range of roughly 3 nm to 20 nm. Hierarchical pore size distributions can also be produced, for example, combinations of 3–5 nm pores with larger mesopores in the 10–20 nm range or with macropores larger than 50 nm. Porosity can be varied up to approximately 50% and specific surface areas of 50–450 cm^3/g are available.

Most varieties of por-Si that we offer are photoluminescent. The initial PL peak wavelength can be varied from roughly 550 nm to 700 nm. PL stabilized by native oxide formation peaks at roughly 610 nm, while that stabilized by a passivating layer formed by hydrosilylation with undecylenic acid emits in a broad peak centered at 650 nm. These powders can be excited with one UV or visible photon. They also exhibit large cross-sections for excitation with two infrared (IR) photons.

Custom Specifications

If companies/researchers have a particular type of raw silicon-comprising powder that they would like to etch, we can work with them to develop custom batches. For example, we have produced hierarchical por-Si in which non-luminescent mesoporous Si is transformed into a luminescent nanomaterial with specific surface area in excess of 1000 cm^3/g. This material is characterized by a bimodal pore size distribution because ~4 nm pores are etched into the walls of the ~15 nm mesopores.

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