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.

We employ electroless etching 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 are themselves either solid or porous.

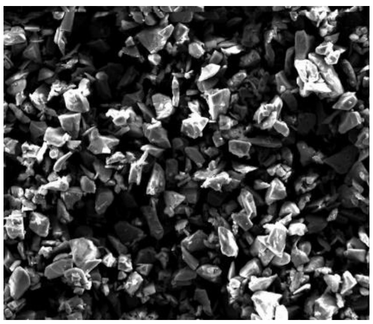
Significant advances in the processing of porous silicon powders are embodied in the regenerative electroless etching (ReEtching) and injection metal-assisted catalytic etching (iMACE) processes. These advances greatly expand the functionality of electroless etching such that the etching of silicon of arbitrary shape and size is controlled with respect to its porosity and pore size distribution. Therefore, any type of silicon-comprising powder can be used as a feedstock including wafers, high-purity granules, metallurgical grade powders, as well as silicon alloys and porous silicon powder produced by any other method, e.g. magnesio-thermal reduction, or pulverization of anodized wafers.

Energy Storage

Silicon has the highest theoretical capacity for the storage of lithium of any element or compound. Its theoretical capacity is roughly 10 times greater than that of graphite, which is currently used. Therefore, silicon could potentially be used to dramatically increase the capacity of rechargeable lithium ion batteries. Our processes work with metallurgical grade silicon, a bulk material that costs over 1000 times less than electronics grade silicon. Furthermore, our advanced iMACE process does not require expensive metals such as silver, gold or platinum; hence, it significantly reduces the cost of porous silicon powders.

Previously the promise of silicon as an anode material in lithium ion batteries has been hampered by its tendency to pulverize upon cycling. Pulverization can be overcome by nanostructuring of silicon. However, traditional etching methods are costly and cumbersome to scale to high volume production. Our process allows us to produce nanostructured silicon in a range of form factors – from irregular to high aspect ratio elongated elements and as either nanoparticles or microparticles. We can customize the scale of nanostructuring as well as specific surface area and pore size distribution to optimize the introduction of silicon into the construction of your anodes.

Custom porous silicon materials, for research and manufacturing.



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

Ram Nanotech

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.

Tortuous pores with mean size in the range of roughly 3 nm to 20 nm are available. Microparticles of this type produce porous nanoparticles with irregular shapes when ground or subjected to sonication.

Alternatively, straight or meandering pores in the range of 20–100 nm range can be formed. Microparticles of this type produce high-aspect-ratio elongated particles when ground or subjected to sonication. These particles have widths on the order of 100 nm to several hundred nanometers and lengths of several micrometers.

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.

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.

Contact

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