A method to produce mesoporous silicon for Batteries

Technology invention

The University of Sheffield (TUoS) has discovered a reproducible, low-temperature and scalable process to manufacture mesoporous silicon via magnesiothermic reduction (MgTR) and without the requirement of hydrofluoric acid.

Overview Context

Porous silicon has a variety of applications including high performance anodes for lithium-ion batteries (LIBs). To date, routes to porous silicon has been surface based syntheses, which are unsuitable for bulk manufacture. Carbothermal methods operating at 2000^{o}C can produce silicon but these are non-porous and not suitable for LIBs. We disclose a reproducible and scalable method to control key material parameters including mesoporosity and purity.

Market Potential

As LIB material, porous silicon can expand into its on pore volume during cycling, overcoming the major hindrance of silicon technologies for next generation, higher capacity LIBs. Porous silicon has other wide number of applications from photocatalysis (producing fuels from solar energy), hosting chemical molecules (drug delivery), as a catalyst support material and photoluminescencent properties.

However, despite these many areas of potential applications, commercialisation of these materials is non-existent. This is due to a lack of scalable and reproducible synthetic approaches.

Technology Description

The invention uses our mechanistic understanding of the MgTR method to produce porous silicon with desired purities and porosities tailored for a desired application. We have found that the primary drivers for LIB capacity and stability are the purity and the porosity of a given silicon where targeted synthesis is required.

The GNRG-04 technology has been tested to produce a variety of porous properties and purities in a highly reproducible fashion from a variety of different feedstocks ranging from commercial precipitated silica to quartz.

Advantages

- Uses low cost abundant reactants magnesium and silica.
- Low reaction temperatures ≥550 ^{o}C
- Silicon easily incorporated in existing manufacturing routes for LIB electrodes
- No need for HF washing of product
- High capacity and stable cycle life in LIB applications compared with conventional graphite material (Figure 1).
- Customisable capacity for LIB applications.

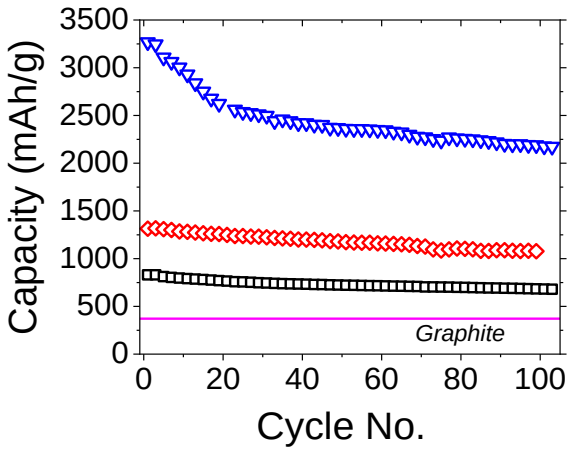

Figure 1 – Capacity of porous silicon produced compared with conventional graphite. The sample in red was produced at larger scales.

Technology Status

This technology currently operating at technology readiness level 2. We have also demonstrated scalability of this method with excellent performance (see red points in Fig 1). Know-how is available to support the exploitation and development of the invention in collaboration with the chosen industrial partner.

Contact

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The University Of Sheffield.