



Non-Confidential Description

Unique Electrospinning Process and Compositions for High-Volume Silicon Nanowire Production

Technology Case: RFT-311

Invention Summary

Scientists at North Dakota State University (NDSU) have developed a unique process for high-volume production of silicon nanowires based on electrospinning. The technology can be used for the development of lithium ion batteries with significantly improved energy densities and long life, consistent with performance targets established by the US Department of Energy for plug-in hybrid electric vehicles.

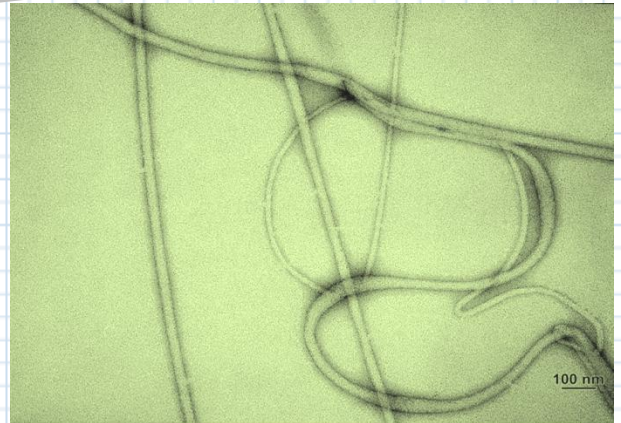


Figure 1: TEM micrographs of electrospun nanowires formed from a PMMA/Si₆H₁₂-based ink

Benefits

- **GREEN TECHNOLOGY!** Enables the creation of lithium ion batteries with significantly improved energy densities and capacities.
- Provides a high-volume route to the production of silicon nanowires.
- Allows the production of silicon nanowires as a high-volume, continuous, roll-to-roll manufacturing process, which other methods of silicon nanowire fabrication have failed to achieve.

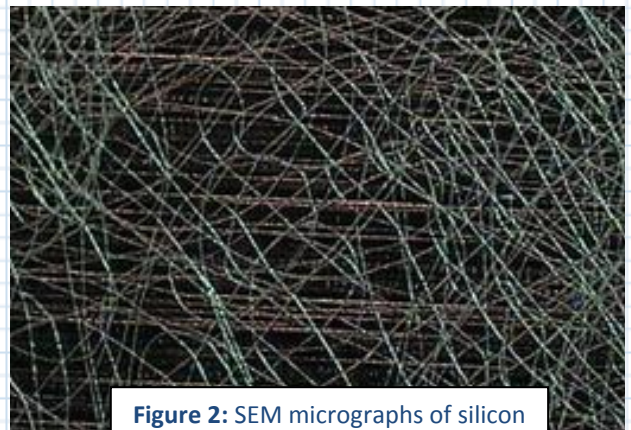


Figure 2: SEM micrographs of silicon wires formed by electrospinning a PMMA/Si₆H₁₂-derived ink

Invention Premise

North Dakota State University (NDSU) has developed unique synthetic routes to a novel liquid silicon precursor, cyclohexasilane (Si₆H₁₂), which is converted to silicon nanowires by electrospinning. Readily purified by distillation, the liquid nature of Si₆H₁₂ allows the development of a high-volume electrospinning route for silicon nanowire production. Because the spun wires convert to amorphous silicon at relatively low temperatures, formation of excessive surface oxide and carbide phases can be avoided which would otherwise negatively affect capacity and rate capabilities. The technology can be used in the development of anodes for use in next-generation lithium ion batteries, in which the traditional carbon-based anode is replaced with a silicon-based anode for a dramatic increase in capacity (theoretically over 1100% increase in capacity). Silicon nanowires can expand radially during cycling without fracturing, enabling the use of silicon as an anode material for lithium ion batteries.



Patents

This technology is patent pending and is immediately available for licensing/partnering opportunities.

The Inventors

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Center for Nanoscale Science and Engineering (CNSE)



The disclosed silicon nanowire technology was developed by the team at NDSU's Center for Nanoscale Science and Engineering (CNSE). CNSE, established in 2002, conducts large-scale, multidisciplinary research for government and industry. Located in a state-of-the-art research facility in the NDSU Research & Technology Park, CNSE employs approximately 65 full-time staff, and 80 part-time students and faculty researchers. CNSE's Research 2 facility includes 77,000 square feet of cleanroom, laboratory and engineering spaces that house its design, synthesis, fabrication, and characterization capabilities. Core competencies include wireless miniaturized electronics design and prototype fabrication, research on polymeric and hard protective coatings, and materials for electronics and energy conversion. CNSE's electronics-oriented facilities occupy 25,000 square feet of Research 2, including 6,500 square feet of Class 10,000 and Class 100 cleanrooms, design and device testing laboratories, and an antenna design and test facility in the nearby NDSU Business & Technology Incubator. Equipment and prototyping tools are valued at nearly \$10M. Technologies transferred from Alien Technology (Morgan Hill, Calif.) and Tessera Incorporated (San Jose, Calif.) are utilized in electronics packaging R&D. The Center also has an extensive research program in which students and faculty participate with staff researchers on studies of materials, design, and manufacturing process innovations in the electronics area.

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