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# Nanoscale Silicon Anodes for Next-Generation Li-ion Batteries

**Leon L. Shaw,* Bingyu Liu, Ziyong Wang**
Department of Mechanical, Materials and Aerospace Engineering,
Illinois Institute of Technology, Chicago, Illinois, USA
* Speaker: lshaw2@iit.edu

## Abstract

Silicon, with a theoretical capacity (~3579 mAh/g-$Li_{15}Si_4$) about 10 times that of graphite (372 mAh/g-$LiC_6$), is considered to be a good candidate as a next-generation anode for high energy Li-ion batteries (LIBs). However, the massive volume change (280%) of silicon particles during lithiation/delithiation cycling degrades the electrode integrity and durability. Moreover, it disrupts the stability of the solid-electrolyte-interphase (SEI) layer, introducing cracks and fresh active surfaces exposed to the electrolyte for repeated SEI formation and fracture, leading to increased impedance, loss of active $Li^+$ ions, and thus capacity decay. Various strategies have been devised to address these challenges. Designing nanoscale Si anodes is one of the effective solutions to achieve long-term cycle stability. However, many designs of nanoscale Si anodes require complex synthesis procedure with high processing costs which impede commercialization of nanoscale Si anodes. In contrast, we have introduced an innovative process to synthesize Si-C core/shell structures with engineered voids, leading to long cycle stability at low cost. Furthermore, the specific capacities of Si-C core/shell structures at the electrode level (i.e., including the weights of carbon black and binder) exhibit 66.8%, 38.2% and 22.7% higher than those of graphite anodes at the 1st, 300th and 500th cycles, respectively. These results demonstrate the enormous potential of nanoscale Si anodes to replace the state-of-the-art graphite anodes for next-generation Li-ion batteries in the near future.