Buckled Silicon Nanostructures on Elastomeric Substrates for Rechargeable Lithium Ion Batteries
AzTE Case # M10-105

Background
As mobile electronics continue to evolve, the need for high-output, long-lasting rechargeable batteries has grown tremendously. Rechargeable lithium ion (Li-ion) batteries have high energy/weight ratios and high charge/discharge efficiencies relative to other rechargeable batteries which make them ideal for modern portable electronics, medical devices, satellites and electric vehicles. The development of high-energy storage devices has been a research area of top-most importance in recent years and rechargeable batteries are anticipated to be the primary sources of power for modern-day mobile energy requirements. Charge capacity has become the main limitation of today’s Li-ion batteries and the proposed method will overcome this by introducing silicon (Si) to the anode (negative electrode). Silicon anode (Si-anode) Li-ion batteries can have a theoretical charge capacity of ten times greater than currently used graphite anodes. Unfortunately Si-anodes pose their own problem; when the Li atoms come in contact with the Si-anode, stress is induced by a large volumetric change - about 400%. This volumetric change causes pulverization, early capacity fading and poor electrochemical performance. This volumetric change is the most challenging problem in the development of Si-anode Li-ion batteries.

Invention Description
Researchers at Arizona State University have proposed an innovative method using Si nanostructures (buckled wavy Si) on elastomeric substrates as anodes in Li-ion batteries. This formation releases the stress induced by Li ion movement during charge-discharge cycles. The proposed method is expected to realize theoretically determined maximum charge capacity of Si-anode Li-ion batteries with long cycle stability.

Potential Applications
- Portable Electronics
- Satellites
- Medical devices
- Electric Vehicles

Benefits and Advantages
- High charge capacity (close to theoretical maximum of 4,200 m Ah g⁻¹)
- Increased reliability and durability