Contribution ID: **92** Type: **Poster**

Morphology tuning of polymer templated Si/Ge/C anodes in Li-ion batteries

Friday, 9 December 2022 15:30 (1h 30m)

With high energy density, long lifespan, and environmental friendliness, lithium-ion batteries (LIBs) represent one of the most attractive energy storage devices and are playing increasing roles in modern society. This technology is already present in the portable electronics markets, electric vehicles, and small-scale energy storage systems. For higher performances, changing the anode material from graphite to silicon (Si) or germanium (Ge) could enhance the capacity multiple times. In particular, Si is a potential anode material due to environmentally friendly production, resource abundance, low cost and its outstanding high theoretical capacity of 4200 mAh/g (roughly ten times larger than state-of-the-art graphite). Although Ge has non-negligible drawbacks such as commodity price and abundance, it benchmarks Si and graphite in conductivity and Li+ diffusivity.

Our concept is to synthesize porous SiGe thin-films in a sol-gel approach via an amphiphilic diblock copolymer. In this process, polystyrene-b-polyethylene oxide (PS-b-PEO) acts as the structure-directing agent. As a Si/Ge source, soluble ZIntl-phases are used, where the amount of Si and Ge can be adjusted at your own discretion. These phases are polyanionic cages formed in intermetallic compounds between alkali or alkaline earth metals and p-block semimetals.

This work investigates the morphology-dependent battery performance of these Si/Ge/C thin films.

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Session Classification: Poster Session

Track Classification: Material Science