Workshop »Coatings for Energy Technologies«

Enabling Layer-Structured Si-Anodes for usage in Li-ion Batteries

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Silicon is one of the most promising anode materials replacing graphite due to its maximum specific capacity of 3579 mAh/g to fabricate high-capacity anodes for lithium-ion batteries (LIB). However, the insertion of lithium in silicon is accompanied by a volume expansion of more than 300%, which so far hindered the use of layered Si structures due to pulverization of the electrode. Nanoscale structures such as nanowires and nanoparticles attracted lots of attention to reduce stress and compensate the intense volume expansion during lithium incorporation. In layer structures, top-down approaches like the patterning of Si anodes by photolithography or etching techniques are a compromise to overcome the structural disintegration using state-of-the-art deposition techniques. On the material side, the use of Si-metal compositions or alloys are proposed to enable the usage of Si layers in LIB by adjusting the amount of incorporated Li. However, there was no breakthrough towards cost-efficient industrial production and sufficient anode capacity so far. In our work, we present a unique and novel approach to create self-aligned nanostructures inside a Si layer stack by using purely industry-proven processes. By using ultra-fast annealing on silicon layers, a rigid network of conductive nanostructures inside an amorphous silicon matrix is formed, which effectively helps to stabilize thick Si layers and result in an excellent cycling performance.