
Si-based anode optimization and study of electrode / current collector interface.

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Résumé

The energy storage improvement is an important challenge for the future. Silicon is one of the most promising anode material to replace graphite in Li-ion batteries because of its high specific and volumetric capacity 10 times and 3 times higher than graphite (3579 vs. 372 mA.h/g ; 2194 vs. 719 A.h/L). Unfortunately, silicon good performance are associated with a huge particle swelling of +280% during the lithiation against only 10% for graphite. This expansion implies 3 main failure causes including electrode delamination from the current collector.

First, we worked on the electrode optimisation with an industrial approach in terms of active materials, areal capacity (mA.h/cm²) or process for example. We mixed graphite with a commercial silicon oxide named SiOx-C as active material with a mitigated specific capacity of \approx 1800 mA.h/g but a swelling divided by two (+140%) in order to limit silicon failures effects (1). We studied the SiOx-C amount impact and the calendaring effects on coin-cell cyclability.

After a lot of attempts, the first improvement come from the binder choice (PolyAcrylic Acid) and slurry pH during electrode fabrication (2). The second upgrade is based on Obrovac study which deals with the graphite type, shape and size (3). The specific capacity rise by +37% after 50 cycles thanks to these improvements.

The second part of my PhD is the study of the electrode / current collector interface. After the identification of efficient characterisation methods, we want to define the perfect characteristics for a coated current collector in order to limit the electrode delamination from the substrate caused by the silicon swelling.

References

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