Optimization of nano sized silicon-based graphene anodes for lithium ion batteries.

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Abstract

Silicon graphene-based composites are considered very promising next generation lithium ion battery (LIB) anodes because of silicon high capacity (4200 mA h g−1 and 2400 mA h cm−3)[1] and lower electrochemical potential with respect to Li (< 0.5 V *vs*. Li/Li+).[1] Unfortunately, Silicon anodes faces other problems of poor cycle stability and great volume expansion. However, silicon nanoparticles can overcome these issues by relieving larger stress/strain and facilitated by the short Li+/electron transfer length.

Extensive research has been performed with nano silicon-based anodes and major complexities rely with the optimization of silicon particle size, effect of oxidation, degree of crystallinity, dispersion of silicon particles in graphene matrices, nano silicon percentage in the composite etc.

This report is focused on optimization of oxidation and degree of crystallinity of silicon nanoparticles for the better battery performance. Initial results have suggested anodes with amorphous silicon particles suffer from lower first cycle efficiency while certain degree of crystallinity shows higher fading rate with improved first cycle efficiency. In coming months, a controlled study will be performed to understand more about the effect of oxidation and crystallinity.

References

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[2] Greco, E.; Nava, G.; Fathi, R.; Fumagalli, F.; Del Rio-Castillo, A. E.; Ansaldo, A.; Monaco, S.; Bonaccorso, F.; Pellegrini, V.; Di Fonzo, F. Few-Layer Graphene Improves Silicon Performance in Li-Ion Battery Anodes. *Journal of Materials Chemistry A* **2017**, *5* (36), 19306–19315.

Figures

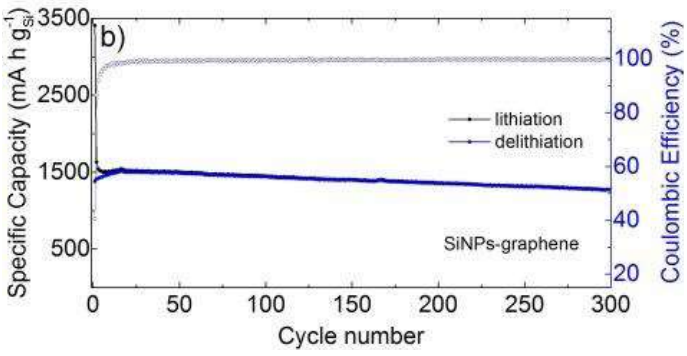

Figure 1: Charging, discharging and coulombic efficiency of batteries with amorphous silicon with fading rate of 0.04. [2]

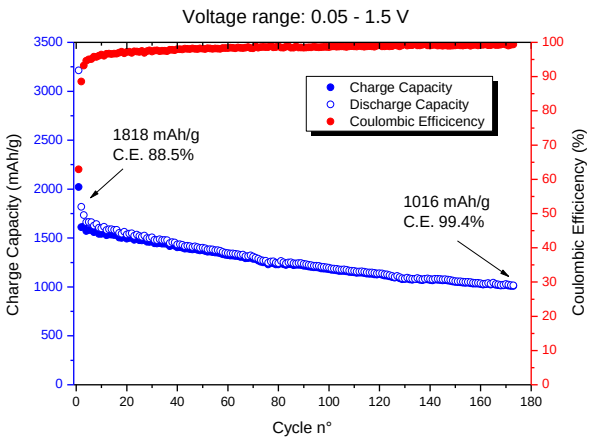

Figure 2: Charging, discharging and coulombic efficiency of batteries with crystalline silicon with fading rate of 0.3 but higher first cycle CE.

The research leading to these results has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 785219 - GrapheneCore2