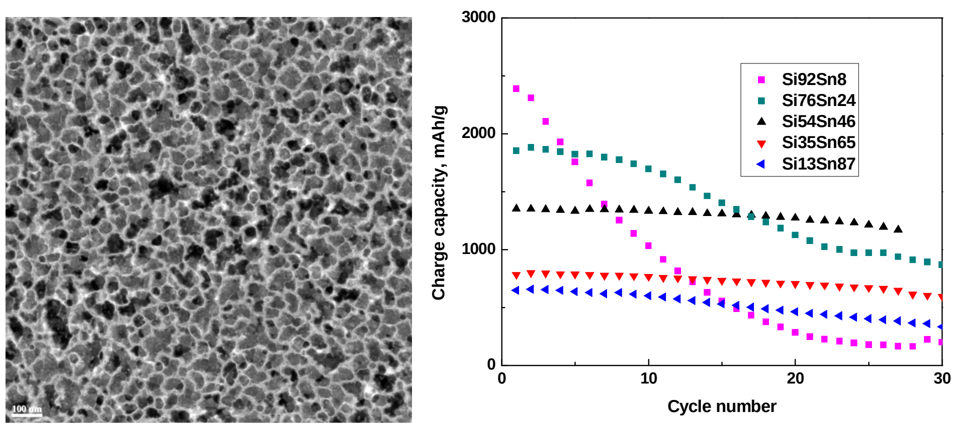
Abstract #213, 223rd ECS Meeting, © 2013 The Electrochemical Society

Phase Separated Silicon-tin Nanocomposites for High Capacity Negative Electrodes in Lithium ion Batteries

Xingcheng Xiao[1], John S. Wang[2], Ping Liu[2], Mark W. Verbrugge[1],

[1]General Motors Global R&D Center, 30500 Mound Road, Warren, MI, 48090
[2]HRL Labs, Malibu, CA 90265-4797

Both silicon and tin have a high specific capacity (3600 mAh/g for $Li_{15}Si_4$ and 992 mAh/g for $Li_{22}Sn_5$ respectively) and are among the most attractive materials for potential negative electrodes in lithium ion batteries. However, mechanical degradation induced by the large volume expansion during the cycling has limited their practical application. In this work, we developed a new class of Si-Sn nanocomposites with unique phase-separated nanostructure wherein amorphous Si nanoparticles are thermodynamically precipitated out from SiSn alloy and embedded within the Sn matrix. The phase separation induced nanostructure provides the capability to mitigate the mechanical degradation by preventing the nucleation and propagation of microcracks during lithiation. An in-situ electrochemical stress senor is applied to understand the stress evolution with different nanostructure and the correlation between them will be discussed. The nanocomposite electrode exhibits relative high capacity (1400 mAh/g) and promising cycling stability (in a half cell, i.e., against a Li counterelectrode) with the optimum composition and nanostructure.



(a) (b)

Figure 1 (a) HAADF STEM images showing the phase separation between Si and Sn. (Si is the darker phase and Sn is the brighter phase). (b) The charge capacities of Si-Sn film electrodes at different Sn/Si composition ratios were plotted as a function of the cycle number.