Intermetallic $CoSn_5$ phase: a new anode stable high-capacity as anodes for Li-ion batteries

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We prepared uniform nanospheres of the intermetallic $CoSn_5$ phase by a nanocrystal conversion-chemistry method. We resolved the crystal structure of $CoSn_5$, which was not established in the existing Co-Sn phase diagram. This tetragonal phase is an isostructural one of $FeSn_5$. As anodes in Li-ion batteries, $Co_{0.83}Sn_5$ has a theoretical capacity of 917 mAh g^{-1}; our nanospheres exhibit a relative stable capacity above 500 mAh g^{-1}. The change in the cycling profiles of the $Co_{0.83}Sn_5$ anode is much less pronounced than that of the $Fe_{0.74}Sn_5$ anode, so partially explaining why the cycling stability of $Co_{0.83}Sn_5$ is better.

Our work has two major implications: (1) Nanocrystal conversion-chemistry affords a powerful “bottom-up” approach to generate novel phases that are difficult to realize via other synthetic strategies; (2) the identical morphology and uniform size of $Co_{0.83}Sn_5$ and $Fe_{0.74}Sn_5$ nanospheres guarantee the validity of directly comparing their anode performance, so paving the way to identify which Sn-M alloy performs better.

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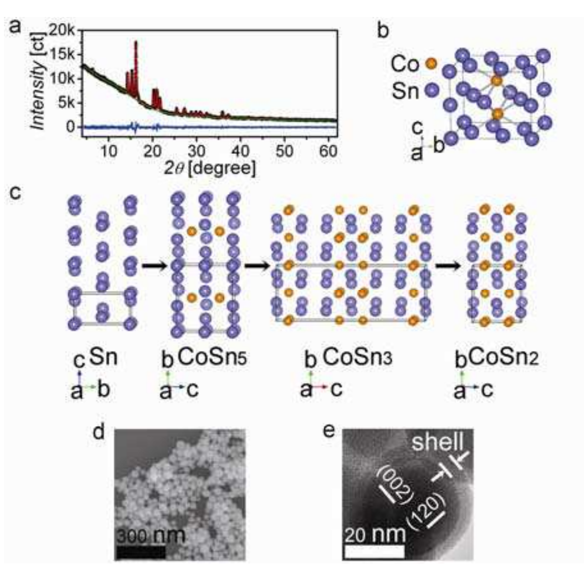

Figure 1. $Co_{0.83}Sn_5$ structure. a) Synchrotron XRD and Rietveld refinement. Black, measured profile; red, calculated profile; blue, difference profile; and olive, background. b) $CoSn_5$ crystal structure. c) Crystal structures of Sn and Co-Sn intermetallics. d) SEM image. e) TEM image.

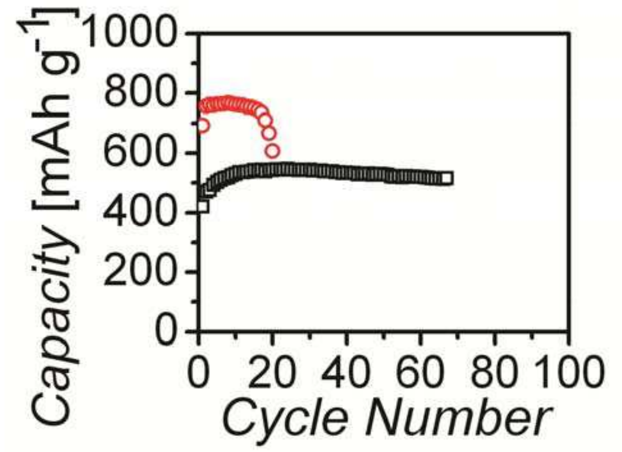

Figure 2. Reversible capacities of the $Co_{0.83}Sn_5$ nanospheres and the $Fe_{0.74}Sn_5$ nanospheres upon cycling.