Thi Hoai Thuong Luu
YoungHee Lee

Center for Integrated Nanostructure Physics (CINAP), Institute for Basic Science (IBS), Suwon 16419, Korea

Department of Energy Science, Sungkyunkwan University, Suwon 16419, Korea

leeyoung@skku.edu

Enhanced capacity and high retention of binder-free anodic SnS nanodots@ in-situ S-doped CNT film for sodium ion storage

Sodium ion battery (SIB) has been considered a potential altervative for Lithium-ion battery (LIB), especially for the grid-scale energy storage applications, due to the abundance and low cost of the precusor[1]. However, the inadequacy of high capacity and long life-cycles anode materials hinders the development of SIB. Hitherto, Tin has attracted a great concern in SIB development as offering alloying process with high theoretical capacity of $Na_{15}Sn_4$ (851 mAh g^{-1})[2]. In addition, the volume extension (420%)[3] during the sodiation process and the low conductivity of Sn, unfotunately, still remain as big challenges in the long cycle-life tin-based SIB development. Hence, there have been tremendous researches focus on Sn-based materials to enhance the SIB anode performance. Here, we report a simple hydrothermal method to prepare free-standing SnS nanodots on in-situ S-doped CNT (SnS@S-CNT) film to augment the performance of SIB anode. With our approach, SnS not only expericences smaller volume expansion (242%), facilitates phase tranformation during sodiation/desodiation process as reported elsewhere[4], but also limits the negative effect of volume variation during battery operation as reducing the size of SnS nanodots (less than 10 nm). Furthermore, dissociated sulfur atoms, resulted from the annealling process to transform SnS_2 to SnS, could replace carbon atoms in aromatic rings which could boost the sodium ion storage capacity. The anode film is also binder-free which helps to limit the effect of binders during the battery operation. The hybrid exhibits an excellent cyclability; at the current density of 1 A g^{-1} with the capacity of 666 mAh g^{-1} after 100 cycles (100% retention), and 615 mAh g^{-1} after 500 cycles with the retention 92%; at current of density of 2 A g^{-1} the capacity was 550 mAh g^{-1} after 300 cycles with the retention 93%; demonstrates great capability to be applied for high-performance rechargeable batteries.

References

[1] B. Dunn, H. Kamath, and J. Tarascon, *Science* vol. 334 (2011), pp. 928–936.
[2] C. W. Yunhua Xu , Yujie Zhu , Yihang Liu, *Adv.Energy Mater.* vol. 3 (2013), pp. 128–133.
[3] J. W. Wang, X. H. Liu, S. X. Mao, and J. Y. Huang, *Nano Lett.(2012)*, vol. 12, pp. 5897–5902.
[4] T. Zhou, W. Pang, C. Zhang, J. Yang, Z. Chen, H. Liu, Z. Guo, *ACS Nano*. vol.8 (2014), pp. 8323–8333.

Figures

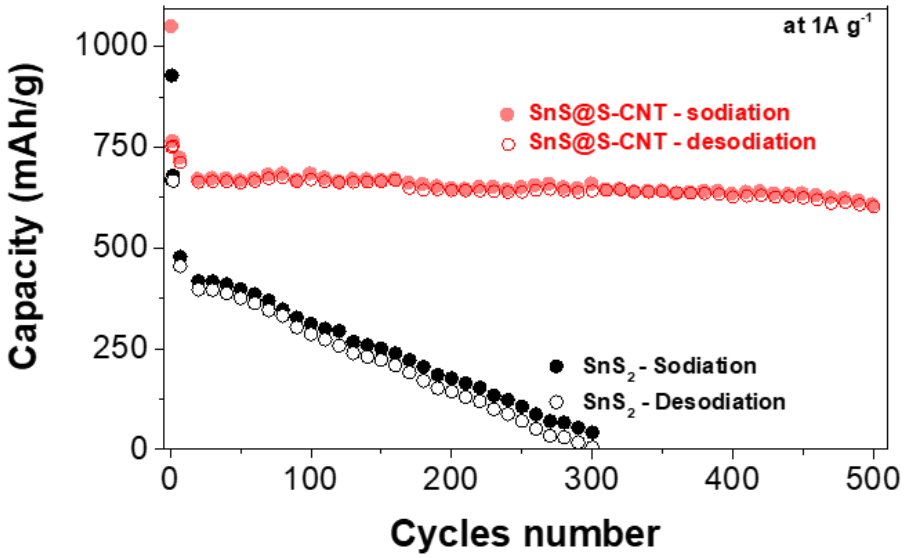

Figure 1: The long life cycles comparison between SnS_2 and SnS@S-CNT film.