Supplementary Information

Vertically Ordered Si/Ni_3Si_2 Nanorod Arrays as Anode Materials for High-performance Li-ion Batteries

Xing Fan, Hui Zhang,* Ning Du, Ping Wu, Xiaoyan Xu, Yunpeng Li, Deren Yang

State Key Lab of Silicon Materials and Department of Materials Science and Engineering, Zhejiang University, Hangzhou 310027, People's Republic of China

*Author to whom correspondence should be addressed, electronic mail: msezhanghui@zju.edu.cn, tel: 86-571-87953190, fax: 86-571-87952322

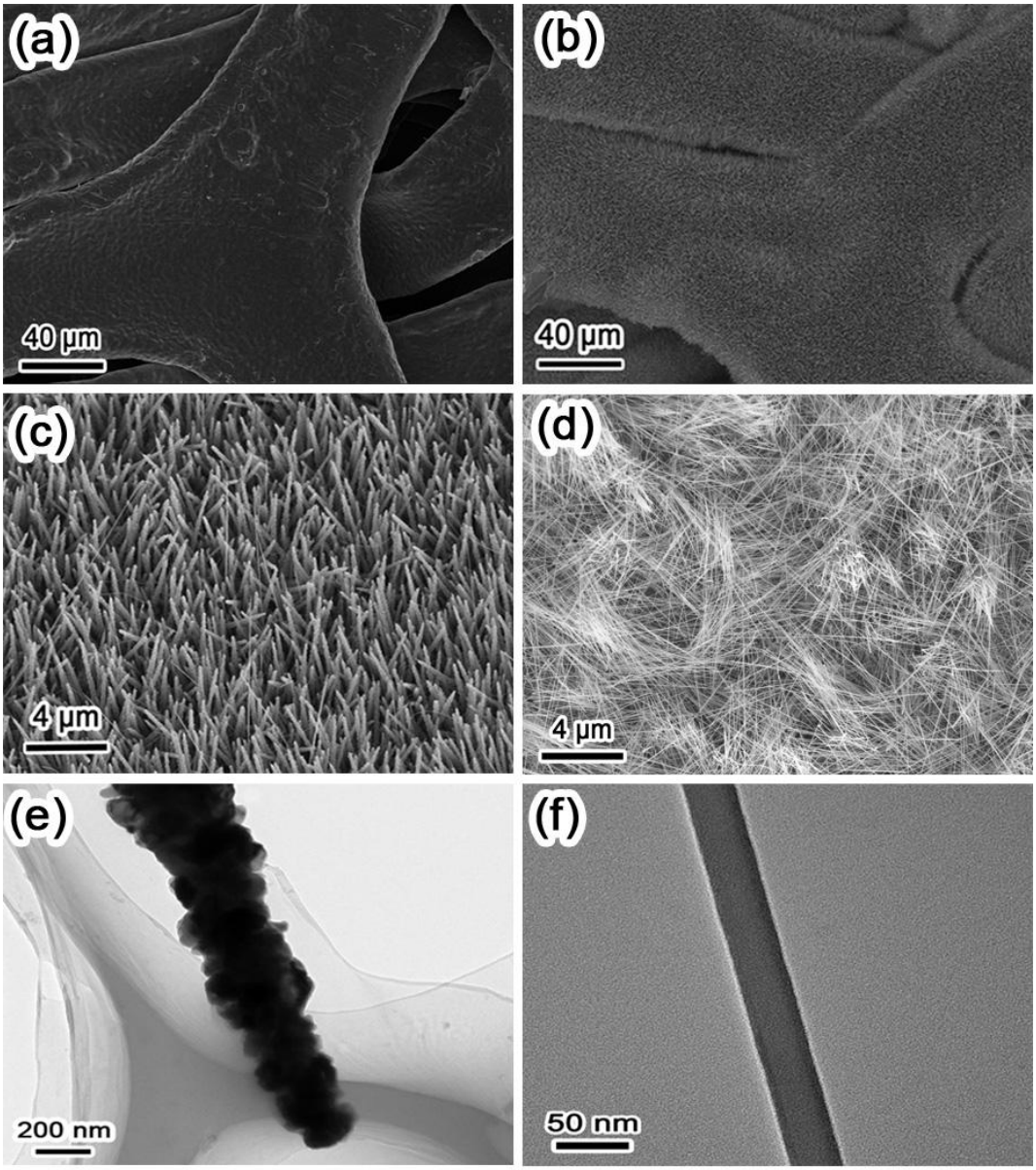

Fig. S1 (a) SEM image of bare Ni foam. (b, c) SEM images of Ni_3Si_2 NRs arrays grown in-situ on Ni foam with 120 sccm SiH_4 and 80 sccm H_2 at 500 ^oC. (d) SEM image of Ni_3Si_2 NWs grown in-situ on Ni foam with 80 sccm SiH_4 and 80 sccm H_2 at 500 ^oC. (e) TEM image of Ni_3Si_2 NR. (f) TEM image of Ni_3Si_2 NW.

The difference between Ni_3Si_2 NRs and NWs lies in following points.

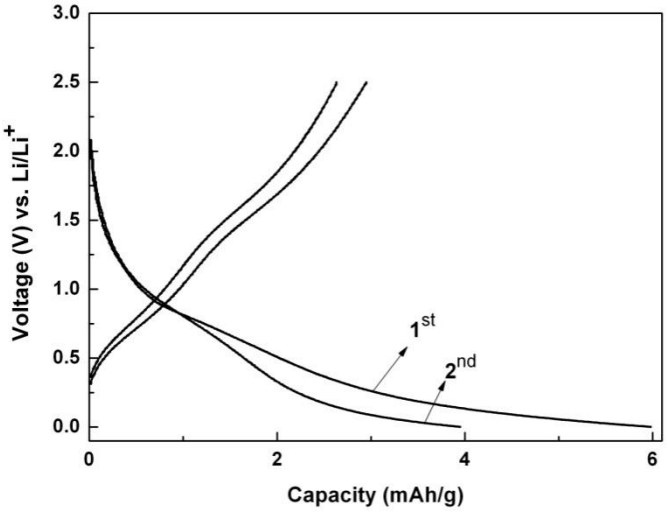

Fig. S2 Voltage profile of pure Ni_3Si_2 NR arrays grown on Ni foam for the 1st, 2nd cycle.

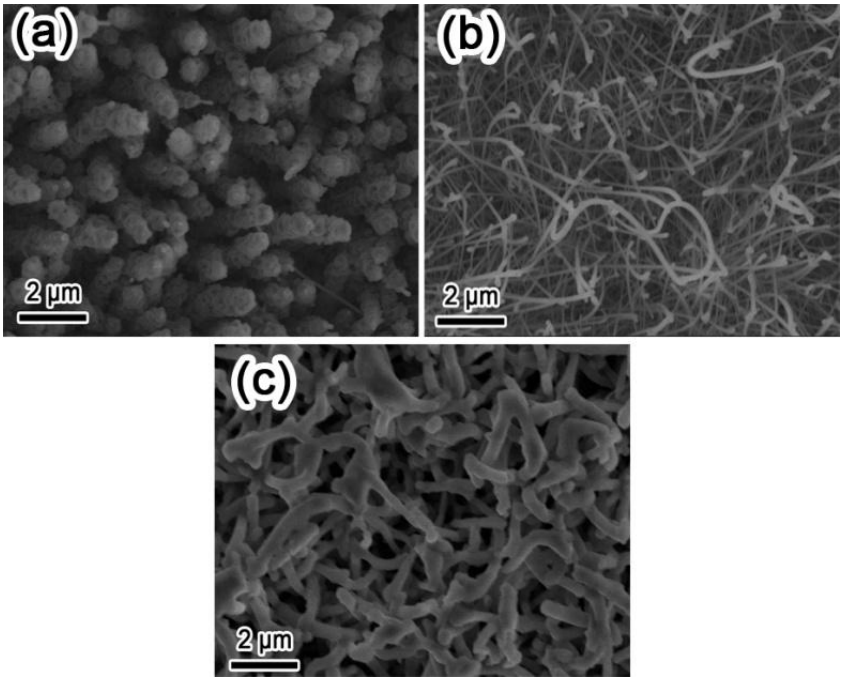

Fig. S3 (a) SEM image of Ni_3Si_2/Si NR arrays. (b) SEM image of Ni_3Si_2-Si NWs. (c) SEM image of Ni_3Si_2-Si NWs after 100 cycles

First, the two structures Ni_3Si_2 NRs and NWs were synthesized in different experimental condition. We controlled the flow rate of SiH_4 and acquired different morphologies of Ni_3Si_2 nanostructures. The Ni_3Si_2 nanowires and nanorods were produced with the flow rate of 80 and 120 sccm SiH_4, respectively. It has been studied by us that when temperature was fixed, low flow rate of SiH_4 favored the growth of nanowires, while high flow rate favored the growth of nanorods. The variation lies in the prevailing role of supersaturation on the morphological determination influenced by the gas flow rate.

Second, the morphological difference between nanowires and nanorods is shown apparently from the TEM images in Fig. S1. The dense nanorods are grown in the form of very orderly arrays, among which are filled with full space that plays a significant role in buffering the volume expansion/contraction during the lithiation/delithiation. However, the nanowires show disorder of growth and are inferior to nanorods in the uniformity of nanostructures which can tolerate large stress change to a certain extent during electrochemical cycling.

Third, it can be seen from Fig. S3 that the differences between NRs and NWs after Si coating for the same time are similar to those before Si coating. The disorder Ni_3Si_2 NWs have their limitation in application due to the overlap among them, which influences the full sputtering of Si. But the Ni_3Si_2 NRs can avoid this problem because of the vertically ordered geometry. The morphological changes of Ni_3Si_2-Si NWs after cycling in Fig S3 (c) also correspond these reasons above.