Supporting Information

TiO$_2$-B Nanowire Arrays Coated with Layered MoS$_2$ Nanosheets for Lithium and Sodium Storage

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Experimental Section

*Preparation of TiO$_2$-B/MoS$_2$ core/shell nanowire arrays: First, a well-cleaned Ti foil was placed against the walls of a 100 mL Teflon-lined stainless steel autoclave filled with 60 mL of 1 M NaOH aqueous solution. Then, the sealed autoclave was put in an electric oven at 220 °C for 18 h. After the completion of the hydrothermal reaction, the titanium foil covered with Na$_2$Ti$_2$O$_5$·H$_2$O nanowires was subjected to an ion-exchange process in 0.5 M HCl solution for 2 h to replace Na$^+$ with H$^+$, rendering H$_2$Ti$_2$O$_5$·H$_2$O nanowire arrays on Ti foil. The Ti foil was removed from the HCl solution, rinsed with water and ethanol, and dried in air. The TiO$_2$-B nanowire arrays were then obtained after heat treatment of the H$_2$Ti$_2$O$_5$·H$_2$O nanowire arrays in a box furnace at 300 °C for 1 h in air with a ramping rate of 3 °C/min. Second, the as-prepared TiO$_2$-B nanowire arrays underwent another hydrothermal process with 1.5 mM MoO$_3$, 4 mM thioacetamide (TAA), and 0.01 M HCl solution at 220 °C for 20 h to produce the TiO$_2$-B/MoS$_2$ core/shell nanowire arrays. Subsequently, the MoS$_2$ nanofilm coated TiO$_2$-B/MoS$_2$ nanowire arrays were rinsed with deionized water and dried in air. The nanowires were then removed from one side of the Ti foil, and the resulting Ti foil with the nanowires on only one side was then used as the electrode for electrochemical cell assembly. The active electrode material loading...
was obtained from the difference in the weight of the Ti foil before and after removing the nanowires from one side of the foil. The loading of TiO$_2$-B/MoS$_2$ active materials is around 1.2 mg/cm$^2$, and the mass ratio of TiO$_2$-B and MoS$_2$ is around 1:6.

*Materials Characterization:* The phase purity and crystal structure of the obtained materials were studied with an X-ray diffraction (XRD, Rigaku Miniflex600) system with Cu K$\alpha$ radiation from 5 to 70$^\circ$. The Raman spectra were collected on a Bruker Senterra spectrometer equipped with a 20 mW diode laser, using an excitation wavelength of 532 nm, and the spectrum range was from 65 cm$^{-1}$ to 700 cm$^{-1}$. Field emission scanning electron microscopy (FE-SEM, Quanta 650), scanning transmission electron microscopy (STEM, Hitachi S5500), transmission electron microscopy (TEM, JEOL 2010F, equipped with energy dispersive X-ray spectroscopy (EDS)) and high-resolution transmission electron microscopy (HR-TEM) were used to examine the morphologies, crystalline structures, and elemental distributions of the samples.

*Evaluation of Electrochemical Behavior:* The electrochemical characterization was performed with 2032-type coin cells with two-electrodes, assembled in an Ar-filled dry glove box with TiO$_2$-based nanowire arrays (TiO$_2$-B/Ti foil or TiO$_2$-B/MoS$_2$/Ti-foil) and Li metal as the working electrode and counter electrode, respectively. 1M LiPF$_6$ in ethylene carbonate (EC)/dimethyl carbonate (DMC) (1/1 by volume) was used as an electrolyte and a thin polypropylene sheet was used as the separator in LIBs. 1M NaClO$_4$ in ethylene carbonate (EC)/propylene carbonate (PC) (1/1 by volume) with 3% fluorinated ethylene carbonate (FEC) was used as an electrolyte and aglass fiber was used as the separator in NIBs. The discharge-charge cycling was performed between 0.01 and 3 V at room temperature at different C-rates of C/10 to 20 C with an Arbin Instrument cycler (1C = 200 mA g$^{-1}$). Electrochemical impedance spectroscopy (EIS) was carried out in the frequency range of 1 MHz to 10mHz on an
electrochemical workstation with an impedance analyzer (SI 1260/SI 1287, Solartron), with an amplitude of the alternating voltage of 5 mV. Cyclic voltammetry (CV) testing was performed on an Arbin Instruments cycler with a scan rate of 0.1 mV s\(^{-1}\).

**Fig. S1** SEM and TEM images of the starting H\(_2\)Ti\(_2\)O\(_5\)·H\(_2\)O nanowire materials.

**Fig. S2** SEM and TEM images of the TiO\(_2\)-B nanowire array electrode.
**Fig. S3** (a, b) CV cycles and (c, d) discharge-charge curves of TiO$_2$-B and TiO$_2$-B/MoS$_2$ nanowire array electrodes.

**Fig. S4** Coulombic efficiencies of TiO$_2$-B and TiO$_2$-B/MoS$_2$ electrodes upon cycling in LIB and NIB.
**Fig. S5** Cycling performance of pure MoS$_2$ electrode in LIB.

**Fig. S6** Normalized capacity retention with regard to the electrode area of MoS$_2$, TiO$_2$-B, and TiO$_2$-B/MoS$_2$ electrodes in LIB (a) and NIB (b).
Fig. S7 (a) CV curves and (b) discharge-charge profiles of TiO$_2$-B nanowire array electrodes.

Fig. S8 Cycling performance of pure MoS$_2$ electrode in NIB.
**Fig. S9** Nyquist plots of MoS$_2$, TiO$_2$-B, and TiO$_2$-B/MoS$_2$ electrodes in Na-ion batteries.

**Fig. S10** SEM images of MoS$_2$ (a) before cycling and (b) after 100 cycles at 0.1C rate in Na-ion batteries.