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Bismuth oxide as high capacity anode materials for sodium ion batteries

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Experimental

1. *Characterization*

Field-emission scanning electron microscopy (FE-SEM) analysis was conducted with a SUPRA 55VP (Carl Zeiss). X-ray diffraction patterns were obtained using Bruker D-5005 with Cu kα radiation. Scan range between 20 and 80 degree at 40 kV and 200 mA. X-ray absorption near edge structure (XANES) data were obtained at the 8C beamline of Pohang accelerator laboratory (PAL, Korea).

2. ***Electrochemical characterization***

Bismuth oxide (No. 202827, 99.999%) and poly acrylic acid binder (PAA) was purchased from Aldrich. In order to prepare bismuth oxide and carbon composite, bismuth oxide and carbon (Super P) was mixed (7:3 in a weight ratio) and then ball-milled using PULVERISETTE 23. The rotation speed was 300 rpm and duration time was 12 hrs. The slurry for working electrode was composed of bismuth oxide, Super P and PAA binder in N-methyl-2-pyrrolidone (NMP). The prepared slurry was coated on the Al foil through doctor blade method. The electrode was dried at 120 ºC for 8 hrs in a vacuum. 2032 type coin cells were assembled with sodium metal in argon filled glove box. Electrolyte was a 1 M $NaClO_4$ in ethylene carbonate (EC) and diethyl carbonate (DEC) (1:1 vol%). Fluoroethylene carbonate (FEC) was added in the electrolyte with 5 wt.%.

All electrochemical tests were measured by using WBCS3000 cycler (WonA Tech, Korea). The galvanostatical charging and discharging of the bismuth oxide/carbon composite electrode was carried out in the voltage range from 0.01 to 2.5V.

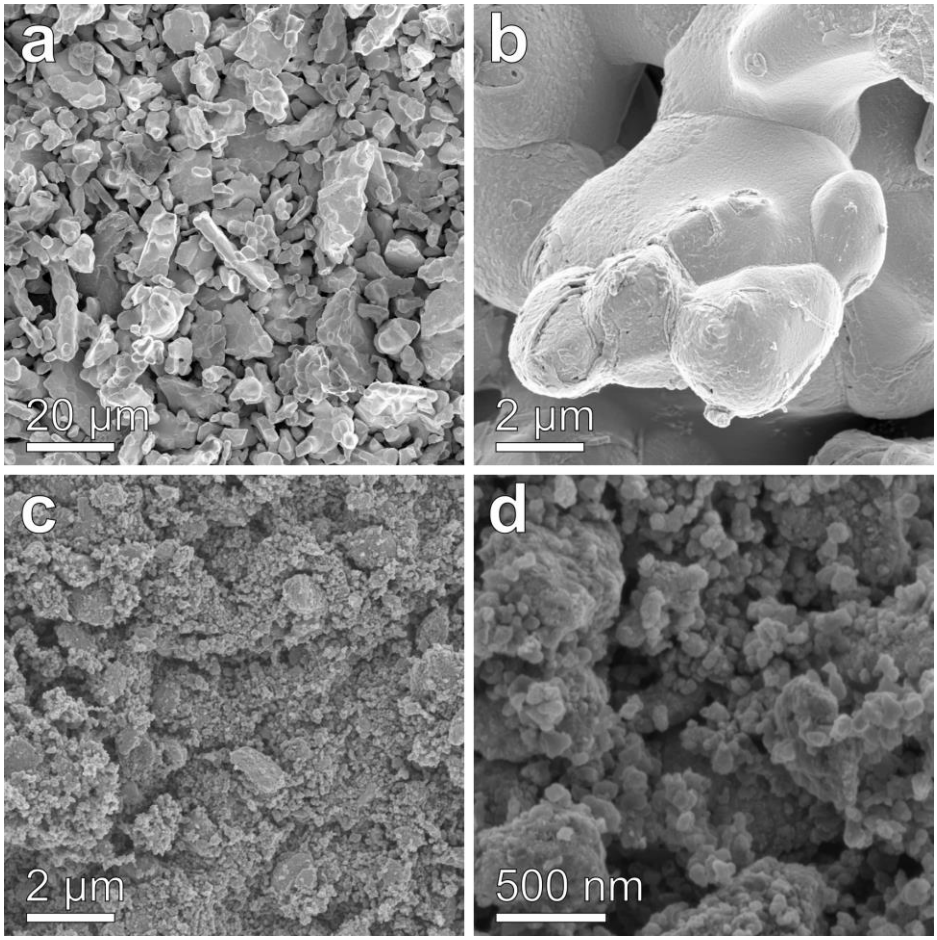

Fig. S1. SEM images of (a, b) pristine Bi_2O_3 and (c, d) Bi_2O_3/carbon composites.

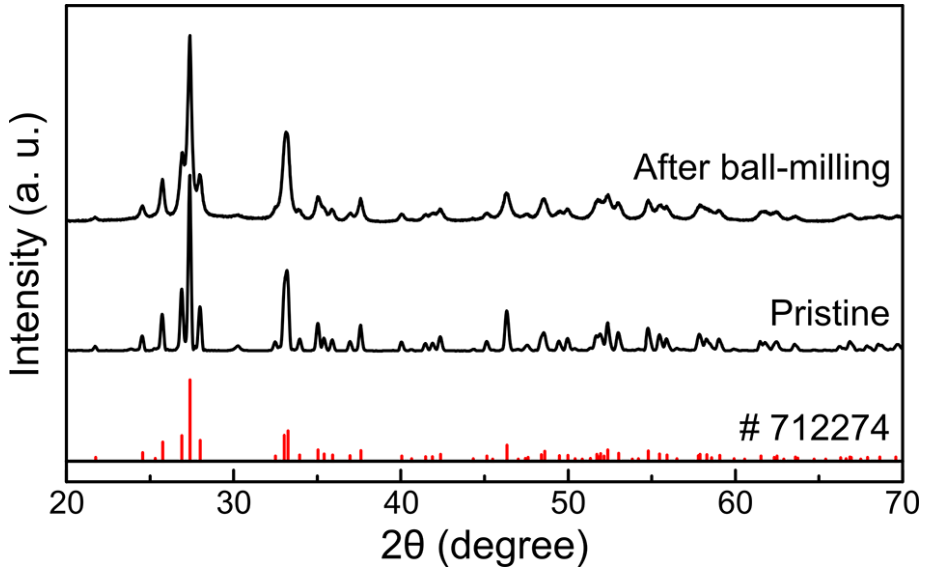

Fig. S2. XRD patterns of pristine Bi_2O_3 and Bi_2O_3/carbon composites.

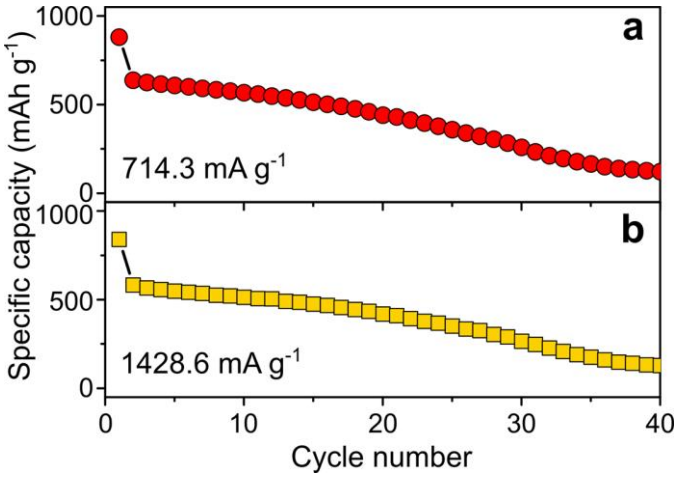

Fig. S3. Cycle performance of bismuth oxide/carbon composite at a current density of (a) 714.3 and (b) 1428.6 mA g^{-1} for 40 cycles.

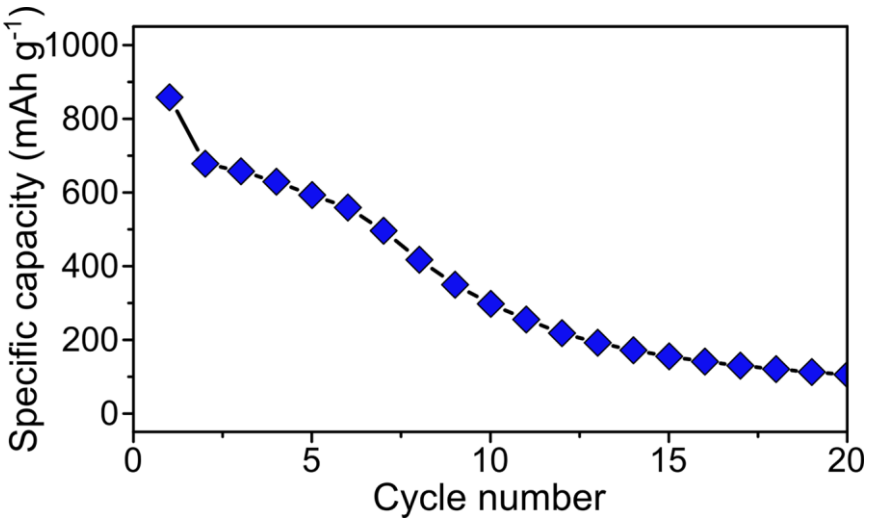

Fig. S4. Cycle performance of pristine Bi_2O_3 at a current density of 20 mA g^{-1}.