Supporting Information

Long Cycle-Life and High Safety Na^+/Mg^{2+} Hybrid-Ion Battery Built by a TiS_2 Derived Titanium Sulfide Cathode

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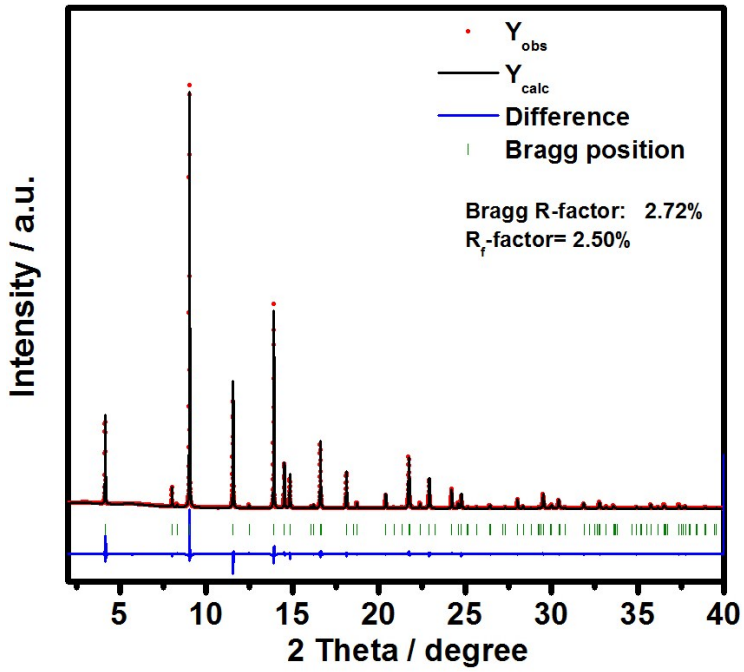

Figure S1. Rietveld refinement of the commercial TiS_2 powder based on synchrotron diffraction data.

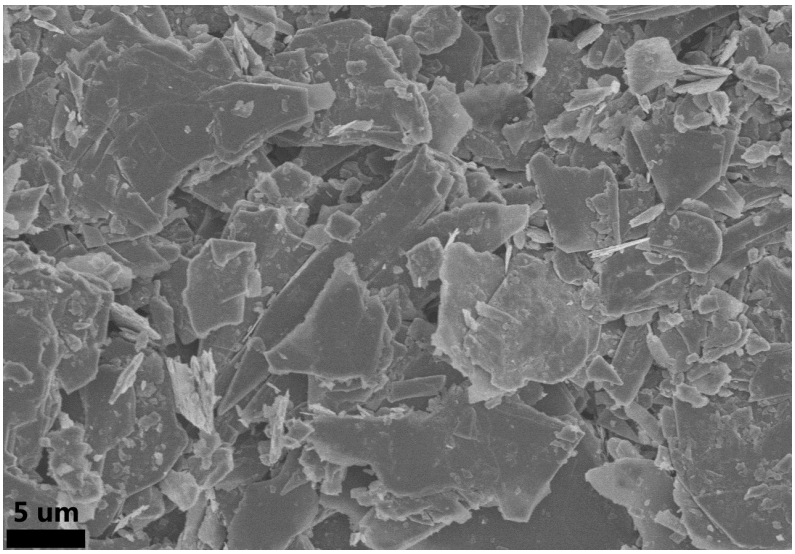

Figure S2. SEM image of the commercial TiS_2 powder.

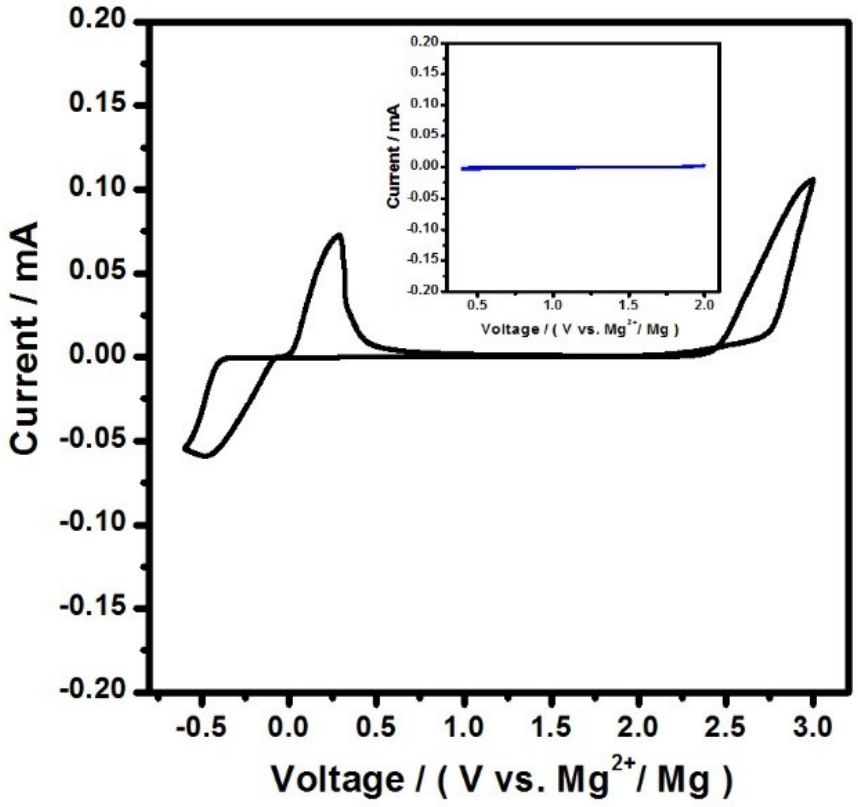

Figure S3. CV curves of the three-electrode cells with stainless steel as the working electrode, and (inset) graphite foil as the working electrode. Both cells were made of two Mg foils as the reference and counter electrodes, using the 1.0M $NaBH_4$+0.1M $Mg(BH_4)_2$/DGM electrolyte.

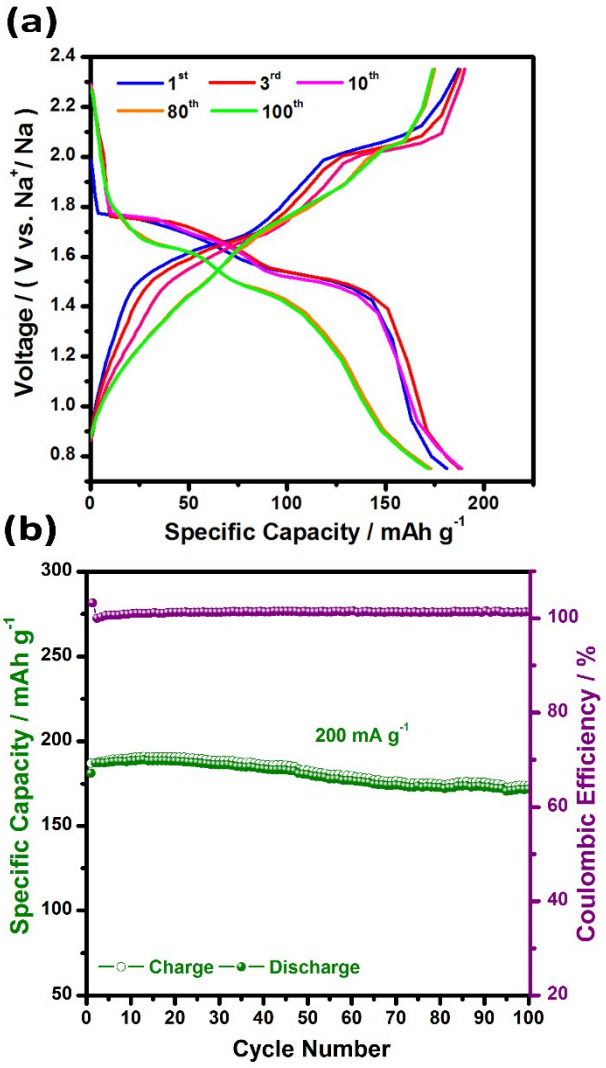

Figure S4. Charge-discharge profiles (a) and cycling performance (b) of the Na-ion half cell using TiS_2 cathode and 1.0M $NaBH_4$/DGM electrolyte at the current density of 200 mA g^{-1}.

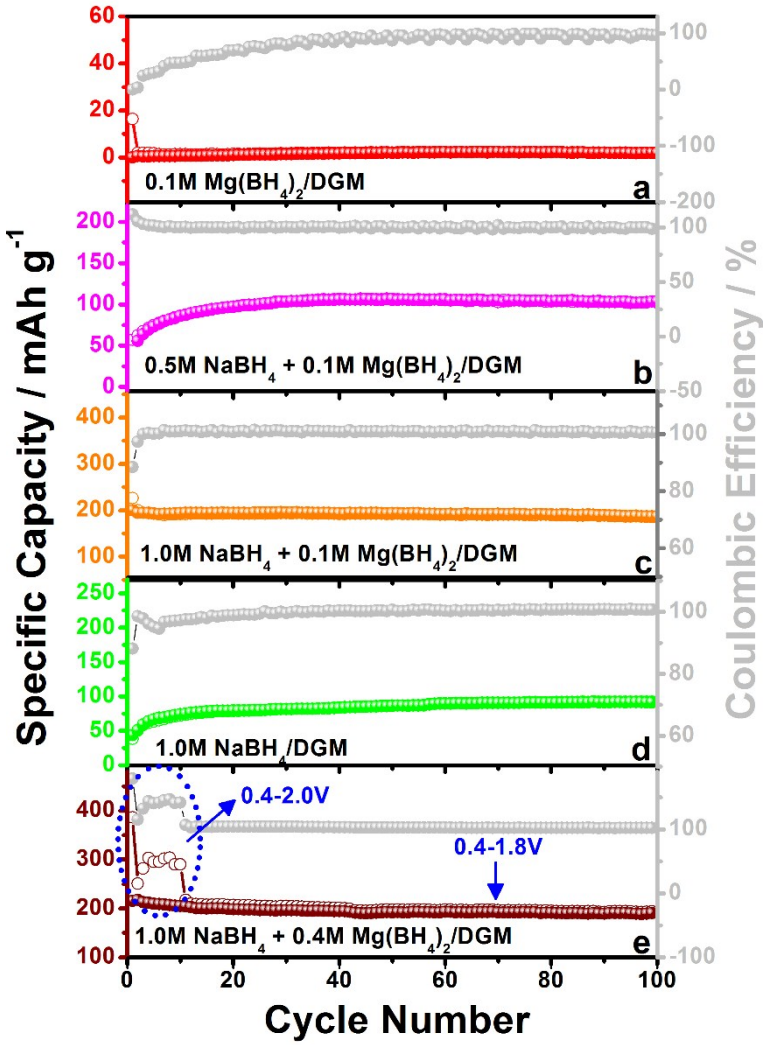

Figure S5. Cycling performance of the "TiS_2" NMIB cells using different electrolytes at 200 mA g^{-1} current density. (a): 0.1 M $Mg(BH_4)_2$/DGM, (b): 0.5 M $NaBH_4$+0.1 M $Mg(BH_4)_2$/DGM, (c): 1.0 M $NaBH_4$+0.1 M $Mg(BH_4)_2$/DGM; (d) 1.0 M $NaBH_4$/DGM and (e) 1.0 M $NaBH_4$+0.4 M $Mg(BH_4)_2$/DGM. When using the 1.0 M $NaBH_4$+0.4 M $Mg(BH_4)_2$/DGM electrolyte, the cell was initially cycled in the voltage window of 0.4-2.0 V for ten cycles, then the voltage window was limited to 0.4-1.8 V.

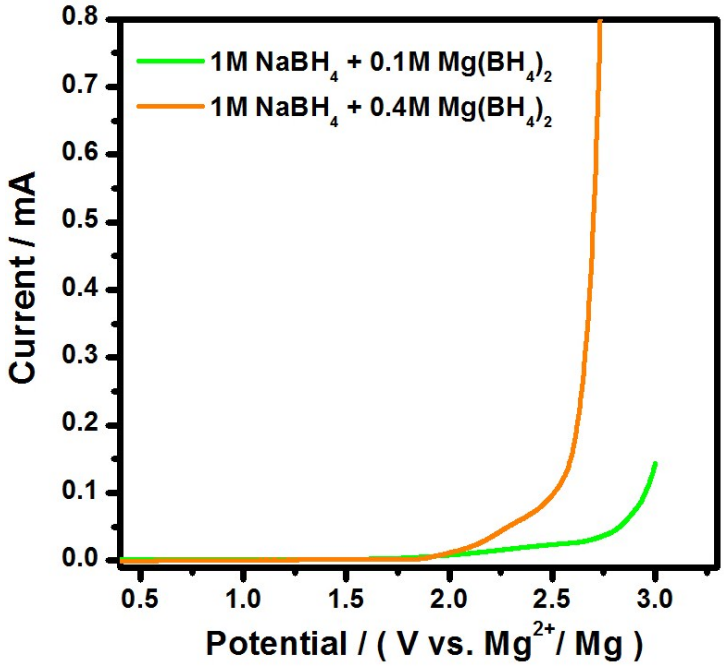

Figure S6. Cyclic voltammograms of the two-electrode cells with stainless steel as the cathode and Mg foil as the anode, using 1.0 M $NaBH_4$+0.1 M $Mg(BH_4)_2$/DGM and 1.0 M $NaBH_4$+0.4 M $Mg(BH_4)_2$/DGM electrolytes.

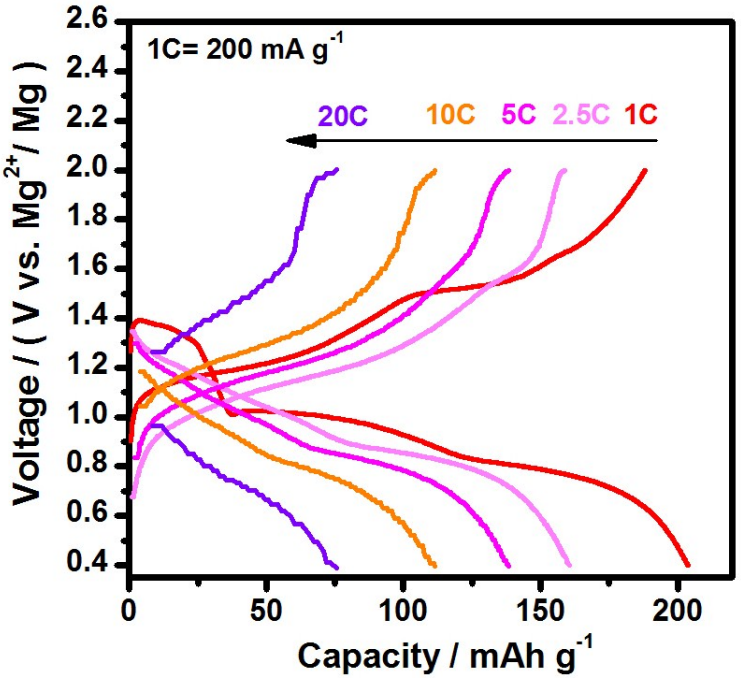

Figure S7. Charge-discharge curves of the "TiS_2" NMIB cell using the 1.0M $NaBH_4$+0.1M $Mg(BH_4)_2$/DGM electrolyte at different current rates.

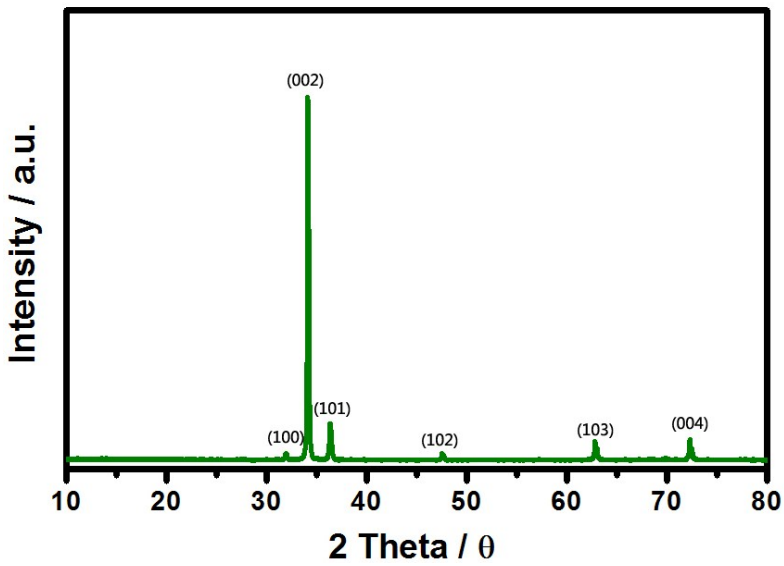

Figure S8. X-ray diffraction pattern the Mg electrode after 100 cycles. All the diffraction peaks can be indexed to metallic Mg.