Electronic Supplementary Material (ESI) for RSC Advances.

Supplementary Information

Tungsten Diselenide (WSe_2) as a High Capacity, Low Overpotential Conversion Electrode for Sodium Ion Batteries

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Experimental Methods

Commercial TMD powders (WS_2, 99%, 2 μm, and WSe_2, 99.8%, 20 μm) were acquired from Sigma Aldrich and Alfa Aesar. Working electrodes were prepared by combining the TMD (60 wt%), super P carbon (20 wt%) and either PVDF (Alfa Aesar) or CMC (Sigma Aldrich, MW=90,000) binder (20 wt%) in NMP for PVDF or water for CMC, sonicating for 10 minutes, and then drying the slurry on a stainless steel disk for at least 12 hours at 55°C. Half cell batteries were assembled in an Ar filled glove box using a coin cell with a Na metal (Sigma Aldrich, 99.95%) electrode, 1M $NaPF_6$ (Strem, 99%) in anhydrous PC (Sigma Aldrich, >99.7%), anhydrous EC/DEC in a 4:6 ratio (Sigma Aldrich, 99%, >99%), or anhydrous diglyme (Sigma Aldrich, 99.5%) as the electrolyte, and a Whatman grade GF/F glass fiber microfiber filter separator (Sigma Aldrich). Cyclic voltammetry (CV) was performed on a Metrohm Autolab multichannel electrochemical workstation. Galvanostatic rate and cycling studies from 0.1 V to 2.5 V were performed on an MTI 8 channel battery analyzer. Immediately prior to all electrochemical tests, the batteries were allowed to reach open circuit voltage over 3 hours. All electrochemical measurements are normalized to the mass of the TMD. Raman measurements were performed using a Renishaw inVia Raman spectrometer with a 785 nm laser. XRD was performed using a Scintag XGEN 4000 system with a CuKα (λ=0.154 nm) radiation source. A FEI Tecnai Osiris TEM with EDX capability was used for elemental analysis. To prepare ex-situ samples, coin cells were disassembled in an Ar filled glovebox and the working electrode was removed and either washed in PC or untreated and then dried under vacuum for 24 hours. Raman measurements were carried out in a homemade air tight system.

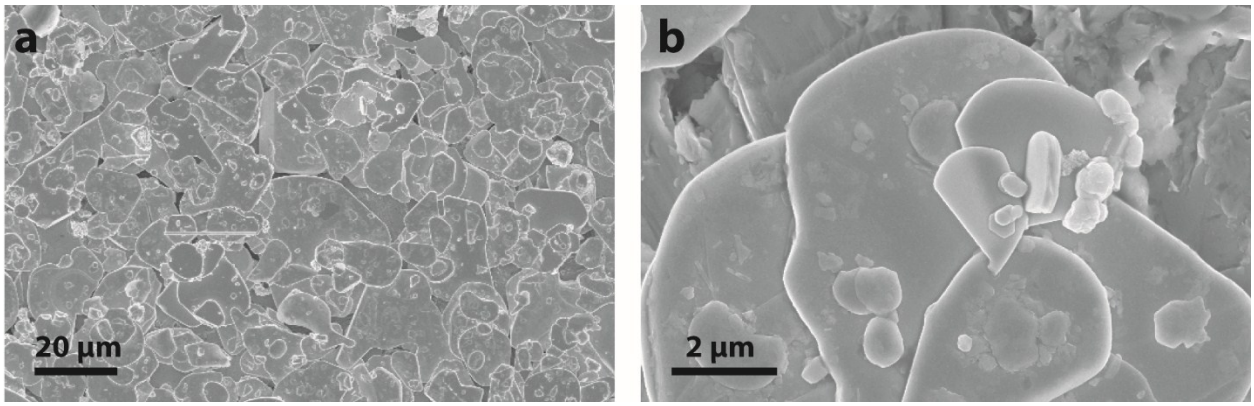

Figure S1. SEMs of WSe_2 particles utilized for this study.

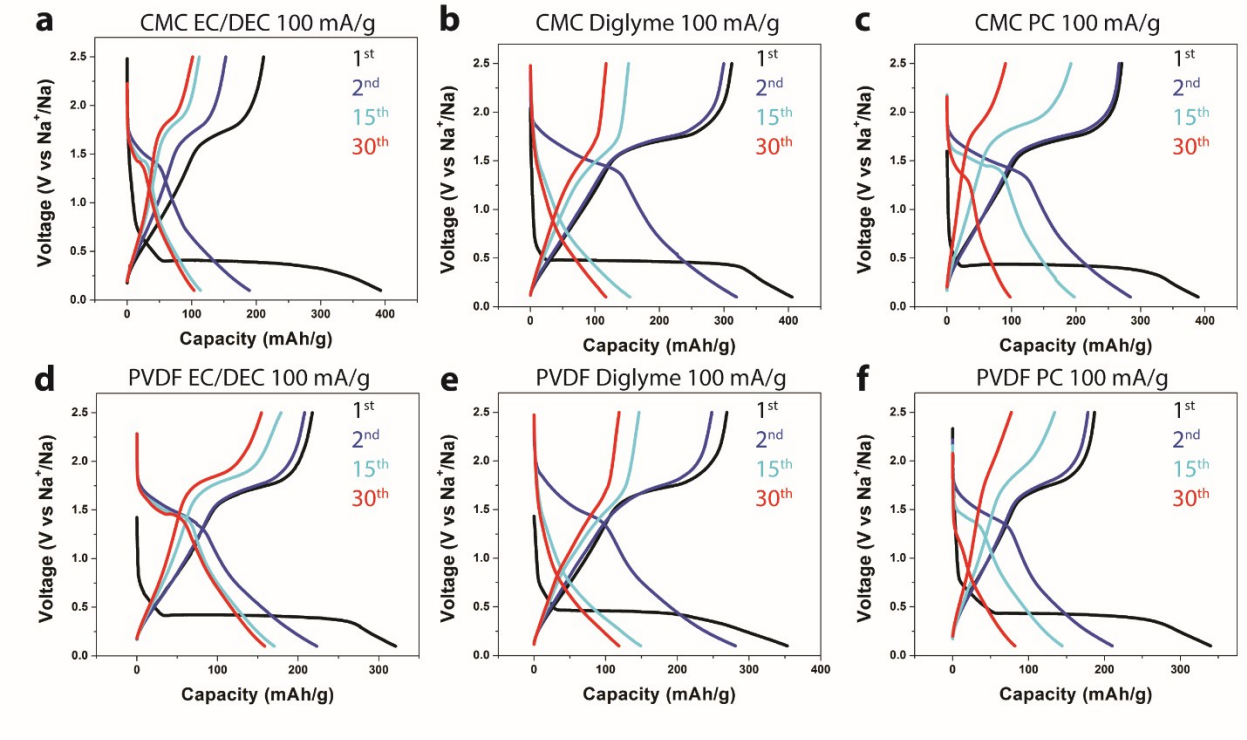

Figure S2. Charge-discharge curves for the 1st, 2nd, 15th, and 30th cycle for each electrolyte/binder combination. The electrolyte/binder combinations have no effect on the energetics of the reaction, only the performance. CMC with a) EC/DEC b) diglyme c) PC. PVDF with d) EC/DEC, e) diglyme, f) PC

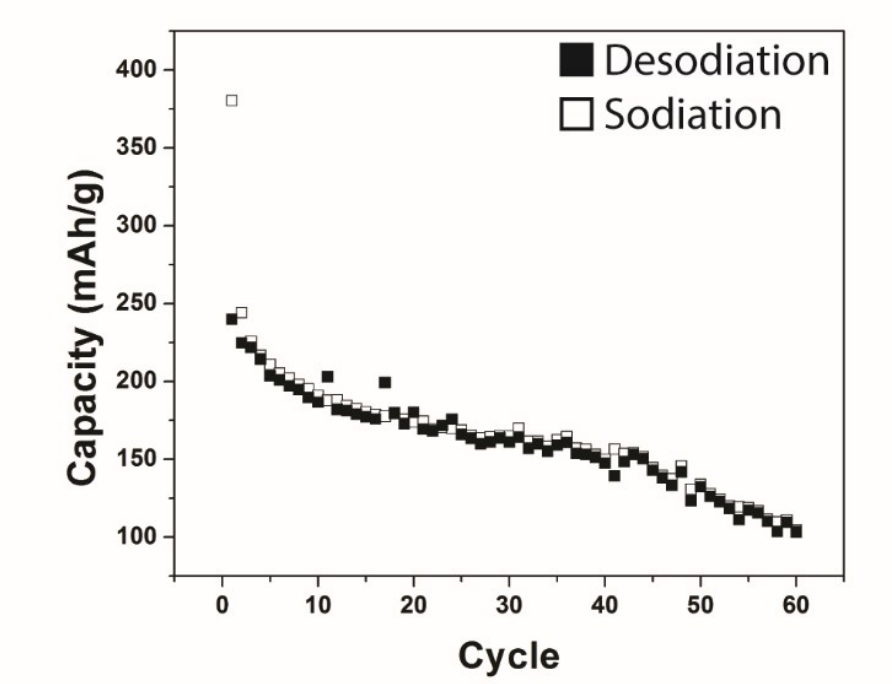

Figure S3. Capacity for 60 cycles at 100 mA/g of WSe_2 with CMC in EC/DEC. The capacity after 60 cycles is near 100 mAh/g.

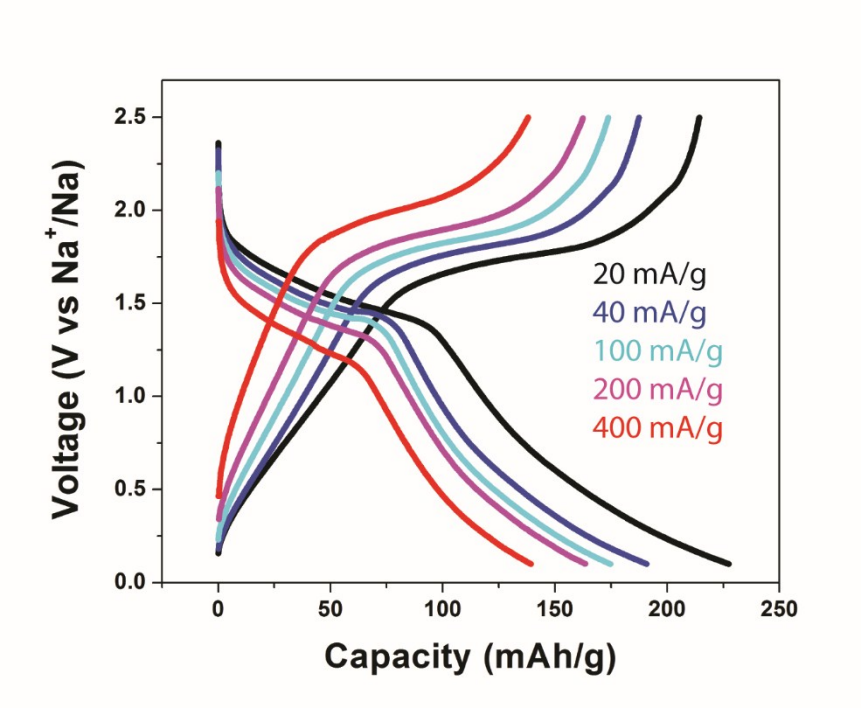

Figure S4. Charge-discharge curves of WSe_2 with CMC in EC/DEC at different charging rates. The overpotential increases at faster charging rates due to resistive effects.