Facile synthesis of manganese-based complex as cathode materials for conductive-carbon-assisted aqueous rechargeable batteries

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**Figure S1.** The photographs of the cathode film.
Figure S2. SEM images of cathode electrode in the charged/discharged state. a) 1.85V, charged state, b) 1V discharged state.
Figure S3. Electrochemical performance of manganese-based complex in 1M ZnSO$_4$. a) Cycling performance at various current densities (0.1-4.0 A g$^{-1}$). b) Charge and discharge voltage profiles using 1M ZnSO$_4$ as electrolyte at various current densities between 1.0-1.85 V vs. Zn/Zn$^{2+}$.
Table S1. Specific capacity and energy density of manganese-based complex.

| Current density (A g\(^{-1}\)) | 0.1 | 0.2 | 0.5 | 1.0 | 1.5 | 2.0 | 4.0 |
|---------------------------------|-----|-----|-----|-----|-----|-----|-----|
| Discharge capacity (mAh g\(^{-1}\)) | 248 | 231 | 196 | 175 | 160 | 149 | 131 |
| Energy density (Wh kg\(^{-1}\)) | 335.0 | 317.3 | 261.5 | 231.0 | 211.8 | 197.5 | 175.0 |

Table S2. Summary of electrochemical performance of different cathode materials for aqueous rechargeable batteries

| Samples | Electrolyte | Energy density base on the active mass of electrode materials | Cycling performance | Reference number |
|---------|-------------|---------------------------------------------------------------|---------------------|-----------------|
| LiMn\(_2\)O\(_4\) | 21M LiTFSI | ~200 Wh/kg at 24 mA/g | ~40 mAh/g, 68% with 1000 cycles at 540 mA/g and 78% with 100 cycles at 18 mA/g | 3 |
| LiMn\(_2\)O\(_4\) | 0.5 M Li\(_2\)SO\(_4\) | ~75 Wh/kg at 500 mA/g | ~120 mAh/g, 100% capacity after 1200 cycles at 500 mA/g | 4 |
| LiMn\(_2\)O\(_4\) | 0.5 M Li\(_2\)SO\(_4\) | ~100 Wh/kg at 500 mA/g | 37 mAh/g, 93% capacity retained after 10000 cycles at 1000 mA/g | 5 |
| NaMnO\(_2\) | 2 M CH\(_3\)COONa | ~30 Wh/kg at 60 mA/g | 37 mAh/g, 75% capacity retained after 500 cycles at 300 | 6 |
| Na\(_{0.95}\)MnO\(_2\) | 0.5M Zn(CH\(_3\)COO)\(_2\) | ~84 Wh/kg at 1C | 40 mAh/g, 92% capacity retained after 1000 cycles at 4C | 7 |
| Amorphous FePO\(_4\) | 1M ZnSO\(_4\) | -- | 96 mAh/g at 10 mA/g | 8 |
| ZnMn\(_2\)O\(_4\) | 3M Zn(CF\(_3\)SO\(_3\))\(_2\) | ~202 Wh/kg at 50 mA/g | ~90 mAh/g, 94% capacity retained after 500 cycles at 500 mA/g | 2 |
| CuHCF | 20mM ZnSO\(_4\) | ~95 Wh/kg at 60 mA/g | ~55 mAh/g, 96.3% capacity retained after 100 cycles at 60 mA/g | 9 |
| Zn\(_2\)[Fe(CN)\(_6\)] | 1M ZnSO\(_4\) | 100 Wh/kg at 60 mA/g | ~65 mAh/g, 76% capacity retained after 100 cycles at 60 mA/g | 10 |
| Material                  | Electrolyte     | Capacity (mAh/g) | Rate Capacity (%) | Cycle Life (mA/g) |
|--------------------------|-----------------|------------------|-------------------|-------------------|
| α-MnO₂                   | 1M ZnSO₄        | 195              | 70%               | 30 cycles at 10 mA/g |
| δ-MnO₂                   | 1M ZnSO₄        | 100              | 100%              | 100 cycles at 380 mA/g |
| α-MnO₂                   | 1M ZnSO₄        | 252              | 44%               | 100 cycles at 83 mA/g |
| VS₂                      | 1M ZnSO₄        | 123              | 98%               | 200 cycles at 50 mA/g |
| Na₃MnTi(PO₄)₃            | 1M Na₂SO₄       | 58.4             | 98%               | 100 cycles at 58.7 mA/g |
| γ'-MnO₂ with TiB₂        | 1M ZnSO₄ saturated LiOH | 220             | 55%               | 40 cycles at 0.5 mA/cm² |
| γ'-MnO₂ with TiS₂        | 1M ZnSO₄ saturated LiOH | 148             | 50%               | 40 cycles at 0.5 mA/cm² |
| Manganese-based complex  | 1M ZnSO₄ 0.1M MnSO₄ | 335              | 100%              | 500 cycles at 2000 mA/g |

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