Docket #: S23-101

An ultra-high areal loading MnO2 electrode

Stanford researchers within the Cui Lab have discovered a promising practical application for grid-scale energy storage by solving poor electronic conductivity in Mn based aqueous batteries, resulting in cycling with an **ultrahigh areal loading of 20 mAh cm-2 for over 200 cycles with only 13% capacity loss.**

Poor electronic conductivity of electro-deposited MnO_2 is a key critical problem that limits the maximum specific areal loading, producing only a thin layer of MnO_2 with low areal loading (around 0.005~0.05 mAh cm-2) during the charge/discharge cycle. Stanford researchers discovered, by tuning the temperature, the deposited phase of MnO_2 can be manipulated from -?-MnO_2 with low conductivity to ?-MnO_2 with 2 orders of magnitude increase in conductivity.

Stage of Development

- Proof-of-Concept

Applications

- Potential use for manganese-hydrogen and manganese-zinc aqueous batteries in **grid-scale energy storage**

Advantages

- **More efficient:**
  - Can be cycled with 20 mAh cm-2 for over 200 cycles with only 13% capacity loss
  - Increase in electronic conductivity of electro-deposited MnO_2 **by 2-3 orders of magnitudes** compared to conventional Mn^{2+}/MnO_2 electrode (from 0.005~0.05 mAh cm-2 to 33 mAh cm-2)

    - Increase in electronic conductivity **by 100~1000 folds** compared to other doping methods to modify MnO_2 materials, and temperature dependent tuning technique maintains its polymorph during cycling
- **Scalable**
- **Lower overall cost** for manganese-based batteries
- **Safer** than fire-risk lithium-ion batteries

Publications

- Xiao, X., Zhang, Z., Wu, Y., Xu, J., Gao, X., Xu, R., ... & Cui, Y. (2023). Ultrahigh?loading Manganese?based Electrode for Aqueous Battery via Polymorph Tuning. *Advanced Materials,* 2211555.

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