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Modulating the Electrolyte Inner Solvation Structure via Low Polarity Cosolvent for Low-Temperature Aqueous Zinc-Ion Batteries

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Abstract

Aqueous zinc-ion batteries (AZIBs) are regarded as the promising candidates for large-scale energy storage systems owing to low cost and high safety; however, their applications are restricted by their poor low-temperature performance. Herein, a low-temperature electrolyte for low-temperature AZIBs is designed by introducing low-polarity diglyme (DGM) into an aqueous solution of Zn(ClO4)2. The DGM disrupts the hydrogen-bonding network of water and lowers the freezing point of the electrolyte to -105 °C. The designed electrolyte achieves ionic conductivity up to 16.18 mS cm-1 at -45 °C. The DGM and ClO4- reconfigure the solvated structure of Zn2+, which is more favorable for the desolvation of Zn2+ at low temperatures. In addition, the DGM effectively suppresses the dendrites, hydrogen evolution reaction, and by-products of the zinc anode, improving the cycle stability of the battery. At -20 °C, a Zn||Zn symmetrical cell is cycled for 4,500 h at 1 mA cm-2 and 1 mA h cm-2, and a Zn|| polyaniline (PANI) battery achieves an ultra-long cycle life of 10,000 times. This study sheds light on the future design of electrolytes with high ionic conductivity and easy desolvation at low temperatures for rechargeable batteries.

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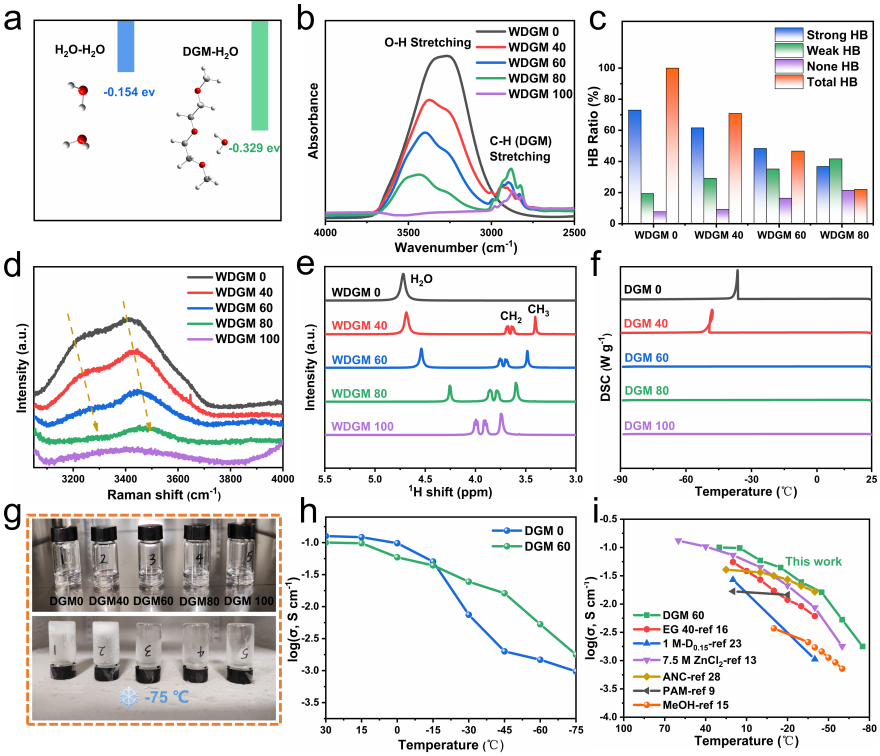

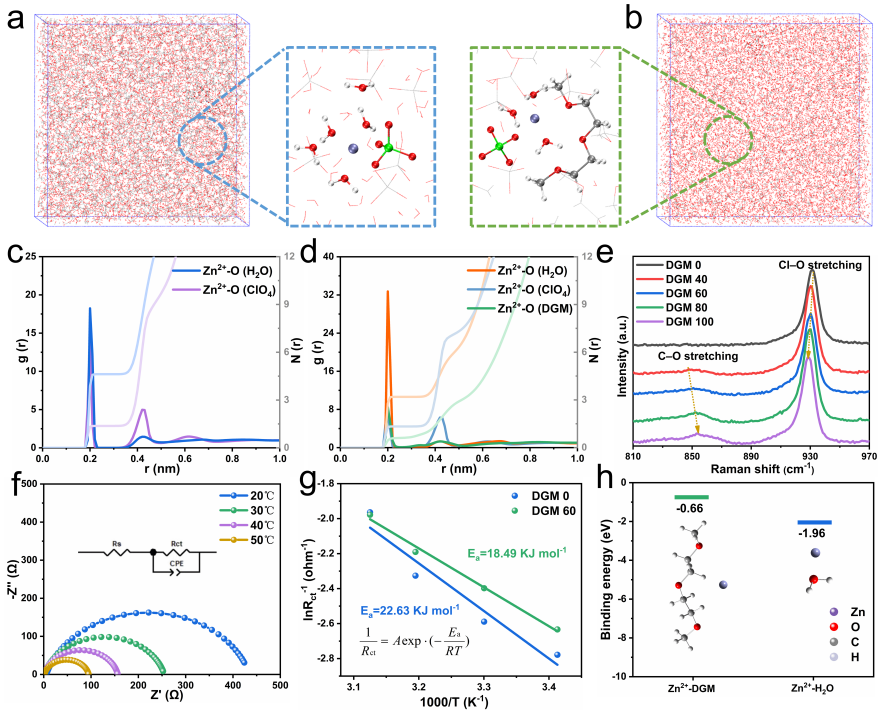

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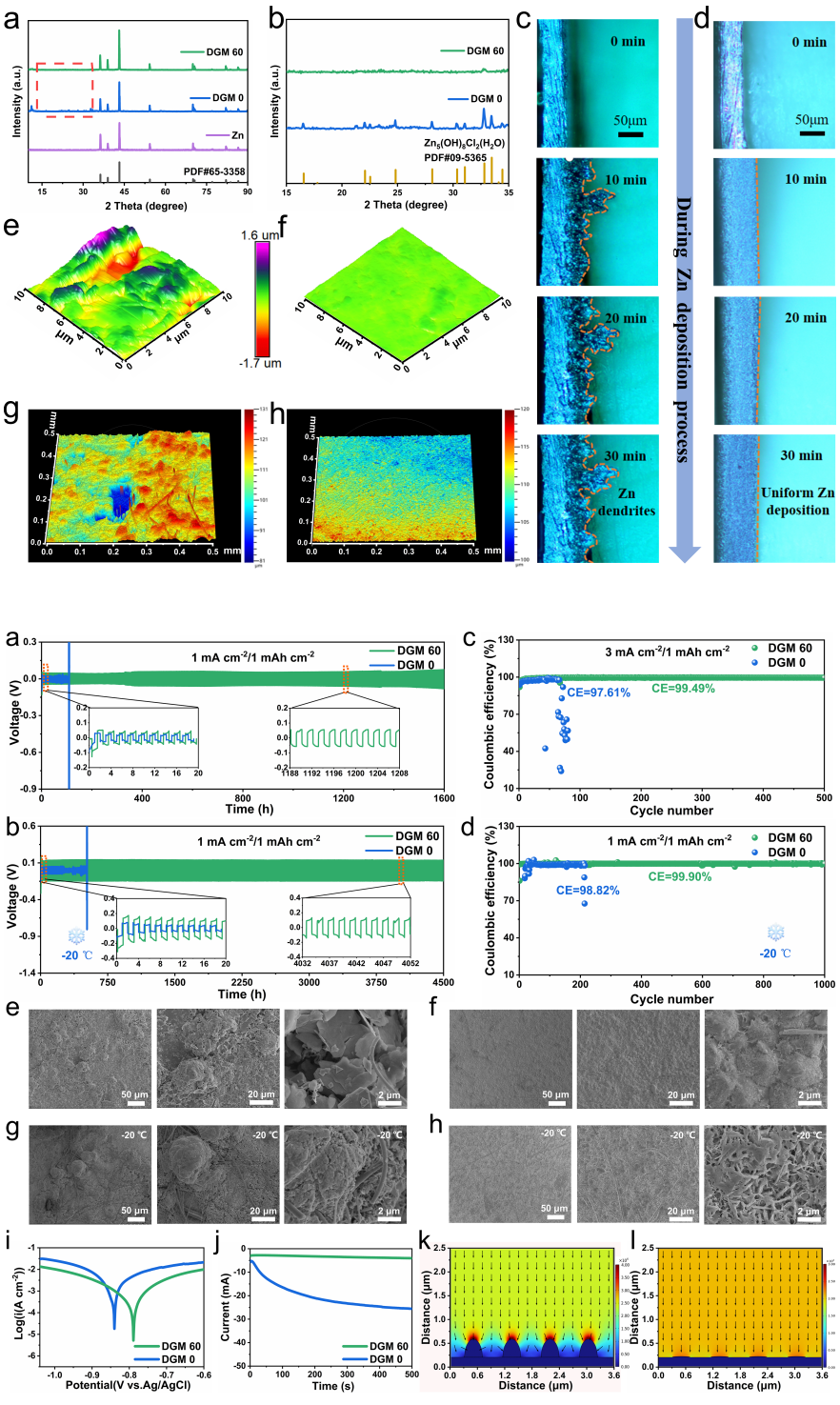

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