Electrochemical Energy Storage using Graphene Materials in Water-In-Salt Based Electrolyte (WiSE)

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Energy storage systems based on aqueous electrolytes offer higher safety and lower costs. Nevertheless, their biggest bottleneck is the narrow electrochemical window (1.23V) that is preventing from attaining higher energy and power densities in most of the aqueous electrochemical energy storage devices. For instance, aqueous rechargeable aluminum ion batteries promise high energy density due to multivalent redox chemistry of aluminum ion (Al^{3+}) but they exhibit much lower energy density in real experiments due to the limited electrochemical windows of the aqueous electrolytes. The water-in-salt based electrolytes (WiSE) can potentially eliminate this barrier by offering a larger electrochemical window by reducing the overall electrochemical activity of water on the electrodes. Here, we demonstrate a new concept using aluminum perchlorate based WiSE that is showing a stable and wide electrochemical window of nearly 3 V against Ag/AgCl. The electrochemistry tests of the electrolyte are performed using Kish graphite and hydrothermally reduced graphene electrodes. We employ the new electrochemical system in aqueous rechargeable aluminum ion batteries and supercapacitors, revealing superior performance to standard aqueous electrolytes. Our findings provide new possibilities for enhancing the electrochemical window and enhancing the energy and power density in aqueous electrochemical energy storage systems.

References

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