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Aqueous Electrolyte for High Voltage, High Energy-Density Aqueous Rechargeable Batteries and Supercapacitors

A new, novel electrolyte that enhances the stability, increases the energy density and lowers the cost of aqueous rechargeable batteries.

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IP Status

Patent application submitted

Seeking

Licensing, Commercial partner

About **University of Warwick**

We are committed to ensuring that our research makes a distinctive, competitive impact on the world. We believe in a collaborative approach to research and education in addressing global challenges and opportunities.

Background

Despite facing issues relating to safety, cost and environmental concern, Li-ion batteries continue to be the most popular type for portable and stationary applications. In addition, they also suffer from other challenges including: (a) low energy density; (b) safety and toxicity issues associated with the electrolyte; (c) high cost of the electrolyte and electrode materials; (d) difficulty associated with fast-charging; and (f) limited life-time / cyclability. For larger-scale applications, especially stationary grid electricity storage, aqueous rechargeable batteries are becoming more common due to their low-cost and safe, water-based electrolytes. However, aqueous electrolytes have a narrow electrochemical window that limits the stability and energy density of conventional aqueous rechargeable batteries. Researchers at the University of Warwick have developed a novel “oversaturated gel” electrolyte using cost-effective inorganic salts. This new, novel electrolyte enhances the cyclic stability, increases the energy density and lowers the cost of aqueous rechargeable batteries.

Tech Overview

The new, novel “oversaturated gel” electrolyte (OSGE) enhances the cyclic stability and increases the energy density of aqueous rechargeable batteries (ARBs). It has been made using cost-effective inorganic salts and is prepared by dissolving salts with hydrophilic polymers above room temperature until it is saturated at that temperature. The electrolyte is then cooled to room temperature with some crystallized salts dispersed by the ionic-conductive continuous phase. The electrochemical stability window of OSGE can extend beyond 3.0 V; this being much wider than than that saturated gel electrolyte at room temperature.

Fig. 1 , shows that the electrochemical stability window of 10 m (mol-salt in kg-solvent) $LiClO_4$-PVA OSGE is 3.3 V. This is 0.6 V higher than that of 6 m $LiClO_4$-PVA (room temperature saturated). As a consequence of the wider stability window, the maximum energy density of an aqueous rechargeable battery based on the new OSGE can reach 183.3 $Wh{\cdot}kg^{-1}$.

The new OSGE also permits wider operational range operation as the stability window only varies from 3.3 to 2.5 V between room temperature and 80 °C.

Further Details: Shigang Chen, Rong Lan, John Humphreys and Shanwen Tao, Perchlorate Based “Oversaturated Gel Electrolyte” for an Aqueous Rechargeable Hybrid Zn–Li Battery, ACS Applied Energy Materials, 2020, published on-line, doi.org/10.1021/acsaem.9b02249

Benefits

The new, novel OSGE can be integrated to existing plants with minimum modification. The new OSGE saves on operating costs by increasing both the energy density and operating temperature range.

• **Improved safety and environmental impact** due to the use water, instead of flammable organic chemicals, as the solvent;

• **Lower cost** as inexpensive inorganic salts are used as electrolytes;

• **Higher energy density** (in aqueous rechargeable batteries) due to the wider electrochemical stability window of the electrolytes.

• **Improved cyclic stability** due to high stability of OSGE in aqueous rechargeable batteries;

• **Wider operating range** as OSGE have higher boiling point and lower freezing point, leading to wide operating temperature.

Applications

- Batteries
- Electricity Storage Batteries
- Supercapitors
- Grid electricity storage

Opportunity

The filed patent and the associated intellectual property are available for licence through Warwick Ventures.

Patents

- PCT/GB2019/051482 - Aqueous electrolytes

Appendix 1

Fig. 1

Electrochemical window; OSGE and lower concentration electrolytes