TO-177 • PT 1.3092
Institute of Energy Materials and Devices
Ionics in Energy Storage (IMD-4 / HI MS)

ENDEAVOURS
science creating solutions

Organic Ketazine Derivatives as a superior Electrolyte Alternative for Redox-Flow Batteries with enhanced Performance

Technology Description

We introduce a novel electrolyte for Redox-Flow Batteries (RFBs) based on specific organic ketazine derivatives as redox-active species. Our technology also includes a method for operating an electrically rechargeable RFB based on this redox system. Ketazines prove to be an advantageous redox system for storing and releasing electrical energy. The electrolyte solution is designed for RFBs, which store electrical energy in the form of chemical compounds dissolved in a solvent. The RFB allows for the circulation of two energy-storing electrolytes in separate loops, with a separator facilitating charge exchange.

Problem

The transition to renewable energy sources like solar, wind, and hydro power is crucial for combating global climate change. While generating renewable electricity is scalable, the challenge lies in storing this energy efficiently. Redox-Flow Batteries (RFBs) offer a promising solution by decoupling energy storage and release, allowing for easy scalability. However, current obstacles in commercializing RFBs, particularly with Vanadium-based systems, include issues like V_2O_5 precipitation at elevated temperatures, limited membrane compatibility, irreversible redox species crossover reactions between anolyte and catholyte, low concentrations and cell voltages, and the fluctuating price of Vanadium. Many non-aqueous Redox-Flow systems based on alternative metals as redox-active species (e.g. cobaltocenes) show similar disadvantages and even higher toxicity than Vanadium. So, organic Redox-Flow Batteries (ORFBs) present a potential alternative with lower costs, improved sustainability, and reduced toxicity even if challenges still include low conductivity, stable multi-oxidation state compounds, voltage limits and the low solubility of the redox-active species. There is the need to address these and other drawbacks and explore alternative battery concepts, especially for RFBs.

Solution

Our patented ketazine (general formula: $R_2C{=}N{-}N{=}CR_2$) based redox system offer a sustainable and cost-effective solution for Redox-Flow Batteries. These heavy metal-free organic compounds enable the transfer of two electrons per molecule during oxidation or reduction, bypassing

IP
DE102024108919.9

PCT filing is being pursued

TRL
4

Contact
Scientific Contact
Dr. Hinrich-Wilhelm Meyer

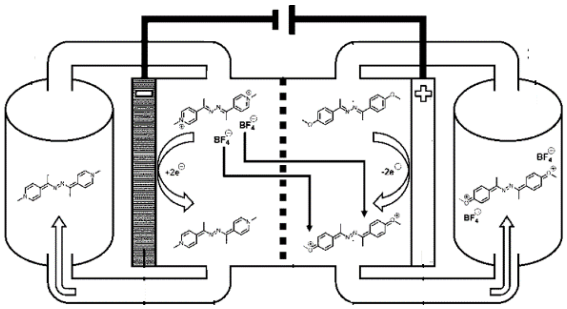
Innovation Manager
Dr. Jörg Bohnemann

Keywords
Redox-Flow Battery, RFB, Electrolyte, Ketazine Derivatives, Redox System, Cycle Stability, Energy Storage and Release

More Information
go.fzj.de/to-177

As of 07/2024

reactive radical intermediates and extending the electrolyte's lifespan. The reversible nature of the organic compounds ensures full regeneration and high cycle stability, leading to increased energy storage capacity per unit volume. The material efficiency of ketazine systems also results from lower mass sums compared to conventional systems, optimising material consumption. Additionally, the thermal stability of our ketazines exceeds 250°C (482°F), ensuring safe operation. Overall, the non-toxic and easily handled nature of the ketazine components makes them a superior alternative to metal-based redox systems.



Potential Use

Our advanced ketazine-based electrolytes for rechargeable Redox-Flow batteries offer high energy storage capacity and cycle stability, making them a reliable choice for potential licensees. The flexibility of the mobile organic redox system builds on a basic structure that is also suitable for solid-booster based ORFBs or stationary energy storage when used in the form of oligomers or polymers. Such mobile and/or stationary use cases for organic compounds increase the system's adaptability and longevity. With a wider voltage window than previous Redox-Flow systems (e.g. vanadium-based approaches), our ketazine-based electrolytes are an attractive option for various industries seeking efficient and sustainable energy storage and release solutions for various applications.

Development Status and Next Steps

Our technology is continuously being enhanced. Our Institute of Energy Materials and Devices – Ionics in Energy Storage (IMD-4 / HI MS) already cooperates with numerous national and international companies and scientific partners. Forschungszentrum Jülich focuses on energy and cost-efficient devices suitable for application in various emerging technologies. We are thus constantly seeking cooperation partners and/or licensees in this field and adjacent areas of research and applications.

IP
DE102024108919.9

PCT filing is being pursued

TRL
4

Contact
Scientific Contact
Dr. Hinrich-Wilhelm Meyer

Innovation Manager
Dr. Jörg Bohnemann

Keywords
Redox-Flow Battery, RFB, Electrolyte, Ketazine Derivatives, Redox System, Cycle Stability, Energy Storage and Release

More Information
go.fzj.de/to-177

As of 07/2024