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Institute of Energy Materials and Devices
Ionics in Energy Storage (IMD-4 / HI MS)

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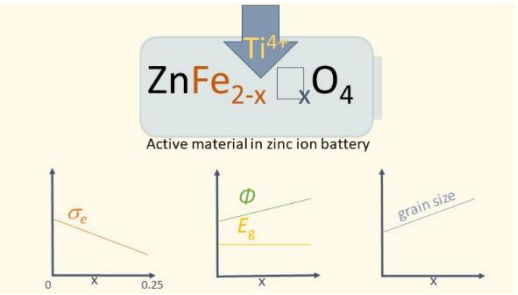
Doped Zinc Ferrite ($ZnFe_2O_4$) Cathode for Enhanced Battery Cycle Stability and Performance

Technology Description

Our invention suggests a cathode designed for rechargeable batteries, featuring a current collector coated with at least one active material suitable for the intercalation and deintercalation of electrochemically active species. This active material consists of zinc ferrite ($ZnFe_2O_4$) doped with tetravalent ions (Ti, Ge, Si). The innovative aspect of this approach lies in the ability to maintain a spinel structure while exhibiting enhanced electrical properties. The doping of zinc ferrite with said tetravalent ions has been surprisingly found to create a particularly effective active material for electrodes, facilitating the reversible storage of electrochemical substances. Notably, the introduction of these dopants minimally affects the electronic conductivity of the zinc ferrite, ensuring that its high conductivity is preserved even in the doped state. This technology aims to provide a rechargeable battery with improved cycle stability, making it a promising solution for novel energy storage applications.



Problem

Current approaches in the application of zinc ferrite as electrode material in zinc-metal and zinc-ion batteries present several challenges. While zinc ferrite is recognized for its low cost, availability, and chemical stability, its performance in energy storage is hindered by poor cycle stability. Thus, repeated charging and discharging leads to material degradation into ZnO and Fe_2O_3, resulting in the leaching of metal ions and a substantial loss of efficiency. Additionally, despite its high theoretical capacity of 1072 Ah/kg, the actual energy yield remains low, further contributing to inefficiency. Existing patents explore various configurations and additives to enhance battery performance, yet they still fall short in improving the electrical properties and cycle stability of the electrodes. Therefore, there is a need for solutions that address these limitations, particularly through the development of doped zinc ferrite electrodes that promise enhanced electrical characteristics and greater durability in rechargeable batteries.

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Contact
Scientific Contact
Dr. Hinrich-Wilhelm Meyer

Innovation Manager
Dr. Jörg Bohnemann

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More Information
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Solution

The incorporation of tetravalent ions into the zinc ferrite structure enhances its electrochemical performance, particularly in terms of cycle stability. Batteries utilizing this cathode can thus endure more charge and discharge cycles without significant degradation, leading to a longer lifespan and improved reliability. Additionally, the minimal impact of the dopants on the electronic properties of zinc ferrite ensures that the high conductivity is maintained, which is crucial for efficient energy transfer. Another notable benefit is the negligible effect of the dopants on the magnetic properties of zinc ferrite, allowing for easy separation of the cathode material during recycling processes. These advantages make our approach an attractive option for potential licensees.

Potential Use

The innovative cathode technology is suitable for a wide range of applications in the field of rechargeable batteries. Its design is particularly suitable for use in various energy storage systems, including electric vehicles, portable electronics, and renewable energy storage solutions. The enhanced cycle stability and electrical performance make it an ideal choice for applications where longevity and efficiency are key features. Furthermore, the ability to easily recycle the cathode material enables sustainable battery production and waste management. Potential licensees can leverage this technology to develop advanced battery systems that meet the growing demand for high-performance energy storage solutions. By integrating this cathode into their products, companies can not only improve the performance of their batteries but also align with environmental sustainability goals, making this technology a valuable asset in the competitive battery market.

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.

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