Tertiary Mg/MgCl2/AlCl3 Inorganic Mg2+ Electrolytes with Unprecedented Electrochemical Performance in Ethereal Solvents

04/08/2026

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Biotech & Life Science

Abstract

This innovation introduces a new class of tertiary Mg/MgCl2/AlCl3 (MMAC) inorganic Mg2+ electrolytes in ethereal solvents that enable highly reversible Mg plating/stripping with dramatically reduced overpotentials and near#unity Coulombic efficiency after a simple Mg powder treatment. These one#pot electrolytes show significantly improved deposition onset potentials and kinetics compared with prior MACC systems, offering a practical route to high#performance Mg electrochemistry without complex purification.

Problem

Preparing reliable Mg2+ electrolytes is difficult because Mg salts form passivating films, MgCl2 has low solubility, and trace impurities cause poor, inconsistent reversibility, high overpotentials, and low anodic stability.

Solution

By adding elemental Mg powder to MgCl2/AlCl3 in ethereal solvents, this technology reduces excess Al and removes impurities, increasing dissolved Mg2+ and producing a cleaner composition that supports reversible Mg plating/stripping.

Value Proposition

This technology is a simple, conditioning#free approach yields reproducible, high#performance electrolytes with near#100% coulombic efficiency, low overpotentials, positive deposition onset, and up to 3.8 V stability.

Benefit

High-performance Mg2± carrying electrolytes for rechargeable magnesium batteries are difficult to prepare because Mg2+ salts in organic solvents tend to form passivating films on electrodes that block reversible Mg plating/stripping. Many electrolyte systems are highly reactive or nucleophilic and/or have limited anodic stability, MgCl2 has low solubility in common solvents, and trace impurities, moisture, or oxygen readily degrade performance, so as-prepared inorganic MgCl2/AlCl3 (MACC) electrolytes often show poor, inconsistent reversibility and stability and require lengthy, environment-sensitive electrochemical conditioning or the use of

problematic additives to approach acceptable coulombic efficiency, overpotential, and oxidative stability.

The invention uses a simple chemical conditioning step applied to MgCl2/AlCl3 electrolytes in common ethereal solvents to shift electrolyte composition and remove passivating impurities. This results in a cleaner electrolyte composition with a higher relative concentration of electroactive magnesium species and improved interfacial properties, enabling more reproducible reversible Mg plating/stripping without complex purification.

This approach provides a straightforward, conditioning#free route to produce reproducible, high#performance Mg2+ electrolytes suitable for grid and stationary energy storage applications. The technology delivers markedly improved plating/stripping behavior and enhanced oxidative stability compared with unconditioned inorganic electrolytes.

Market Application

This technology best fits into the grid and stationary energy storage market. It could be used as the electrolyte in rechargeable magnesium batteries for large-scale storage systems, offering a lower#cost, safer (reduced dendrite risk) alternative.

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USU Reference No. C17018

Publications

- Luo, J., He, S., & Liu, T. L. (2017). Tertiary Mg/MgCl#/AlCl# inorganic Mg²# electrolytes with unprecedented electrochemical performance for reversible Mg deposition. ACS Energy Letters, 2(5), 1197–1202. https://doi.org/10.1021/acsenergylett.7b00269

Intellectual Property

Date: Jul 11th, 2018
Number: 11,101,496

U.S. Patent No. 11,101,496 issued August 24, 2021, "Magnesium-Based Electrolyte Compositions and Uses Thereof"