

The Magnesium Charge

Current Collectors for Magnesium Batteries: Why Material Compatibility Matters

Introduction – An essential component that is easy to overlook

When discussing rechargeable batteries, attention usually focuses on the active materials that store energy. Yet electrodes also depend on components that do not directly contribute to energy storage. One of these is the current collector: a conductive substrate that connects an electrode to the external circuit. In commercial lithium-ion cells, copper and aluminium foils are familiar examples. Their selection reflects a balance of electrical conductivity, electrochemical compatibility, cost and processability.

For emerging magnesium-based batteries, this choice cannot simply be transferred from established lithium-ion technology. Different electrode reactions, electrolyte chemistries and operating conditions create a distinct environment at the electrode interface. A current collector that performs well in one cell chemistry may behave very differently in another.

“A current collector is more than an electrical contact: in magnesium batteries, its interaction with the anode and electrolyte can influence the stability of the entire cell.”



Mario Marinaro 

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Mario Marinaro is a team leader at ZSW Baden-Württemberg, specialising in electrochemical energy storage and battery materials. His work covers electrode development, electrochemical characterisation and the evaluation of materials and interfaces for emerging battery technologies. In HighMag, he contributes to the assessment of current collectors for magnesium-based powder anodes.

The challenge – Conductivity alone is not enough

The basic task of a current collector is straightforward: it must carry electrons efficiently while supporting the electrode. However, conductivity is only one part of the picture. The collector also needs to remain sufficiently stable in contact with the electrolyte across the relevant electrode potential range. Unwanted surface reactions or corrosion can modify the contact, increase resistance and complicate interpretation of electrochemical measurements.

This is particularly relevant for magnesium metal and magnesium-based powder anodes. Their performance is strongly influenced by the interface between the active material and the surrounding electrolyte. Magnesium electro-plating and -stripping involve the deposition and dissolution of metal, while the formation of resistive surface layers can interfere with these processes. At the same time, the collector may influence local current distribution and the electrical connection to individual particles within a powder-based electrode.

Materials such as copper, aluminium, nickel and stainless steel therefore cannot be treated as interchangeable supports. Each forms different surface oxides and interacts differently with its chemical environment. Even a nominally identical collector may show different behaviour when the electrolyte formulation changes. Surface condition, manufacturing history and electrode preparation may also affect the outcome. This makes it important to evaluate the complete combination of current collector, magnesium electrode and electrolyte rather than ranking substrates solely by their bulk properties.

From material selection to reliable electrode testing

A systematic assessment begins with identifying candidate substrates that offer suitable conductivity, mechanical properties and practical availability. Their compatibility can then be examined under conditions relevant to the intended cell configuration. Electrochemical tests help reveal whether the collector contributes unwanted reactions and whether its behaviour remains stable over time.

For magnesium-based anodes, repeated plating and stripping experiments are especially informative. Changes in potential response, polarisation or cycling stability may signal evolving interfacial processes, although these observations must be interpreted carefully: they are not, by themselves, proof of a particular degradation mechanism. Comparison across current collectors, electrolytes and suitable reference configurations helps distinguish effects associated with the substrate from those arising elsewhere in the cell.

Surface and post-mortem characterisation can provide complementary information about electrode morphology, contact integrity and possible changes at the interface. Beyond conventional metal foils, coated substrates may offer additional routes to tailor surface behaviour. Any potential benefit must, however, be weighed against coating durability, electrical contact, manufacturing complexity and suitability for later scale-up.

The HighMag connection – ZSW’s contribution

Within the European HighMag project, the Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (ZSW) contributes its expertise in electrochemical testing and battery materials evaluation to the development of magnesium-based battery concepts. One area of investigation is the compatibility of different current collectors with magnesium powder anodes and the electrolytes used in the project.

This work addresses a practical question: which combinations of electrode support, active material and electrolyte can provide a sufficiently stable basis for reproducible cell operation? By comparing metallic substrates and exploring interface-related effects under controlled electrochemical conditions, ZSW aims to support the selection of suitable components for further electrode and cell development. The objective is not only to identify promising materials but also to understand the constraints that should guide their integration into more practical configurations.

The assessment of current collectors complements other HighMag activities involving electrode materials, protective strategies and advanced characterisation. These connected perspectives are important because improving one component in isolation does not guarantee improved behaviour of the full battery.



Conclusion – Looking beyond the active material

In magnesium battery research, the current collector deserves more attention than its modest role in a cell schematic might suggest. It must provide an effective electrical pathway while remaining compatible with the electrode and electrolyte throughout operation. Selection should therefore be based on the electrochemical system as a whole, not simply on familiar choices from other battery technologies.

Through its work in HighMag, ZSW is helping to clarify these material and interface requirements for magnesium-based powder anodes. Building this understanding is one step towards more reliable experiments, informed component selection and, ultimately, practical magnesium battery cells.



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