# Highly Cyclable Mg Batteries using a Composite Polymer Electrolyte

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Significant challenges have been hindering the development of high-energy-density magnesium (Mg) batteries, among which electrolyte development is deemed as an important one. Most electrolytes that are compatible with Mg metal possess low anodic stabilities, and often use flammable organometallic reagents, thereby rendering the overall battery unsafe. On the other hand, electrolytes that have been shown to possess high anodic stabilities tend to passivate the surface of Mg metal. Research progress on Mg cathode materials have also been affected by the limited availability of electrolytes that simultaneously possess Mg-anode compatibility and high anodic stability.[1] Polymers like PEO, PVdF have been known for a long time to be safe, robust, and highly-conductive media for rechargeable battery electrolytes. Following their successful integration into Li-battery systems, there have been several reports on Mg-ion conducting polymer electrolytes having high ionic conductivities. However, studies to determine their cycling performance and Mg-deposition overpotential have been scarce. Here, we report our development of a safe, composite polymer electrolyte (Figure 1a) that supports high cyclability with Mg-metal anode. Its Mg-ion transport was quantitatively analyzed by performing DC polarization tests, and by measuring the cationic transference number. Raman spectra of the polymer composites were obtained at different stages of the synthesis to understand the chemical environment of the polymer. Its compatibility with Mg-metal anode and the reversibility of the Mg deposition/stripping were tested through galvanostatic cycling of symmetric Mg | Mg two-electrode cells. Even at room temperature, the solid-state Mg-cells exhibit excellent cycling performance with low overpotentials (0.1 – 0.2 V) for different values of applied current densities (0.05 – 0.20 mA/cm$^2$), as shown in Figure 1b. We believe that the performance of this composite polymer electrolyte would be a significant step forward towards the development of safe rechargeable Mg-metal batteries.

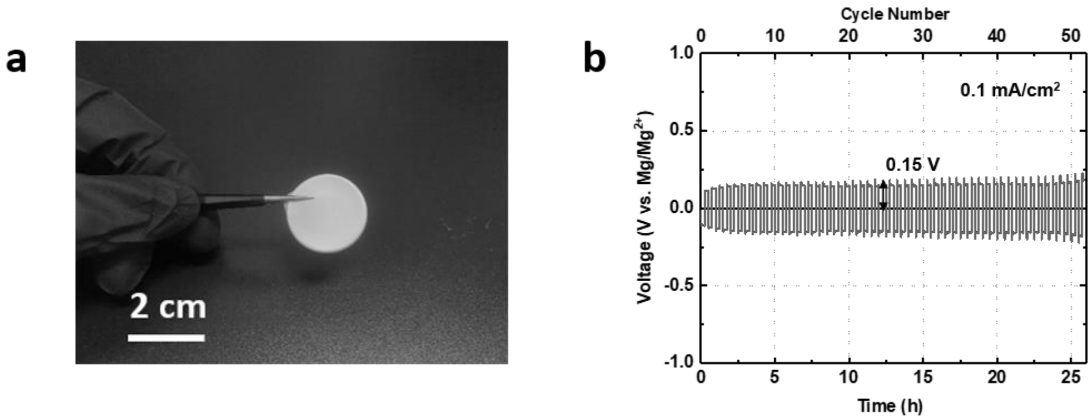


**Figure 1:** (a) Digital image of the dried composite polymer electrolyte, (b) Galvanostatic cycling of symmetric Mg-Mg cells at 0.1 mA/cm$^2$.

**References:**

[1] Muldoon, J.; Bucur, C. B.; Gregory, T. Quest for Nonaqueous Multivalent Secondary Batteries: Magnesium and Beyond. *Chem. Rev.* **2014**, 114, 11683–11720.