Supplementary Material

The influence of interfacial chemistry on magnesium electrodeposition in non-nucleophilic electrolytes using sulfone-ether mixtures

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Supplementary Figure 1: SEM images of magnesium metal (a) after polishing with the 3000 grit sandpaper and (b) after scraping the magnesium following the polishing step. Images shown were taken at 500x magnification.

Supplementary Figure 2: SEM images of magnesium deposited at 0.1 mA/cm² on copper in (a) the THF electrolyte and (b) the 50 BS/50 THF electrolyte. The images shown are at 1000x magnification.
Supplementary Figure 3: SEM image of magnesium deposited from the THF electrolyte at 0.5 mA/cm\(^2\) on copper at 10000x magnification.

Supplementary Figure 4: SEM image of magnesium deposited on copper from the 50 BS/50 THF electrolyte at 1 mA/cm\(^2\) at 1000x magnification. This is the same sample showed in Figure 2a.
Supplementary Figure 5: XRD of the copper substrate.

Supplementary Figure 6: Images of the deposit (a) from the THF electrolyte and (b) from the 50 BS/50 THF electrolyte

Supplementary Figure 7: Chronoamperometry of magnesium during electrodeposition onto a copper electrode for Mg(HMDS)$_2$ – 4 MgCl$_2$ in THF and in 50 BS/50 THF at -250, -375, and -500 mV vs. Mg.
**Supplementary Figure 8:** Dimensionless graph of $i^2/i_m^2$ vs $t/t_m$ for the electrolyte in THF at -250, -375, and -500 mV vs. Mg. The maximum current, $i_m$, and maximum time, $t_m$, were chosen from the local maxima present in Figure S5.

**Supplementary Figure 9:** Nyquist plots from every 10th cycle after a positive current. The electrolyte made with dried THF is shown with the solid lines and the electrolyte made with wet THF is shown by the dashed lines.
Supplementary Figure 10: Nyquist plot showing the impedance of the pristine Mg/Mg cells.

Supplementary Figure 11: Camera images of the cells post cycling in (a) the THF electrolyte, (b) the 50 BS/50 THF electrolyte, and (c) the 50 EMS/50 THF electrolyte. The green dashed circle identifies the glass fiber separator and the red solid circle identifies the cycled magnesium electrode after a final stripping step.
Supplementary Figure 12: Cyclic voltammogram of the 50 EMS/50 THF electrolyte. Copper was used as the working electrode and magnesium was used as the counter/reference electrode. Oxidative stability was approximately 1.9 V vs. Mg$^{2+}$/Mg$^0$. 

CE = 79 %