Supporting information:

Effect of Interaction among Magnesium Ions, Anion and Solvent on Kinetics of Magnesium Deposition Process

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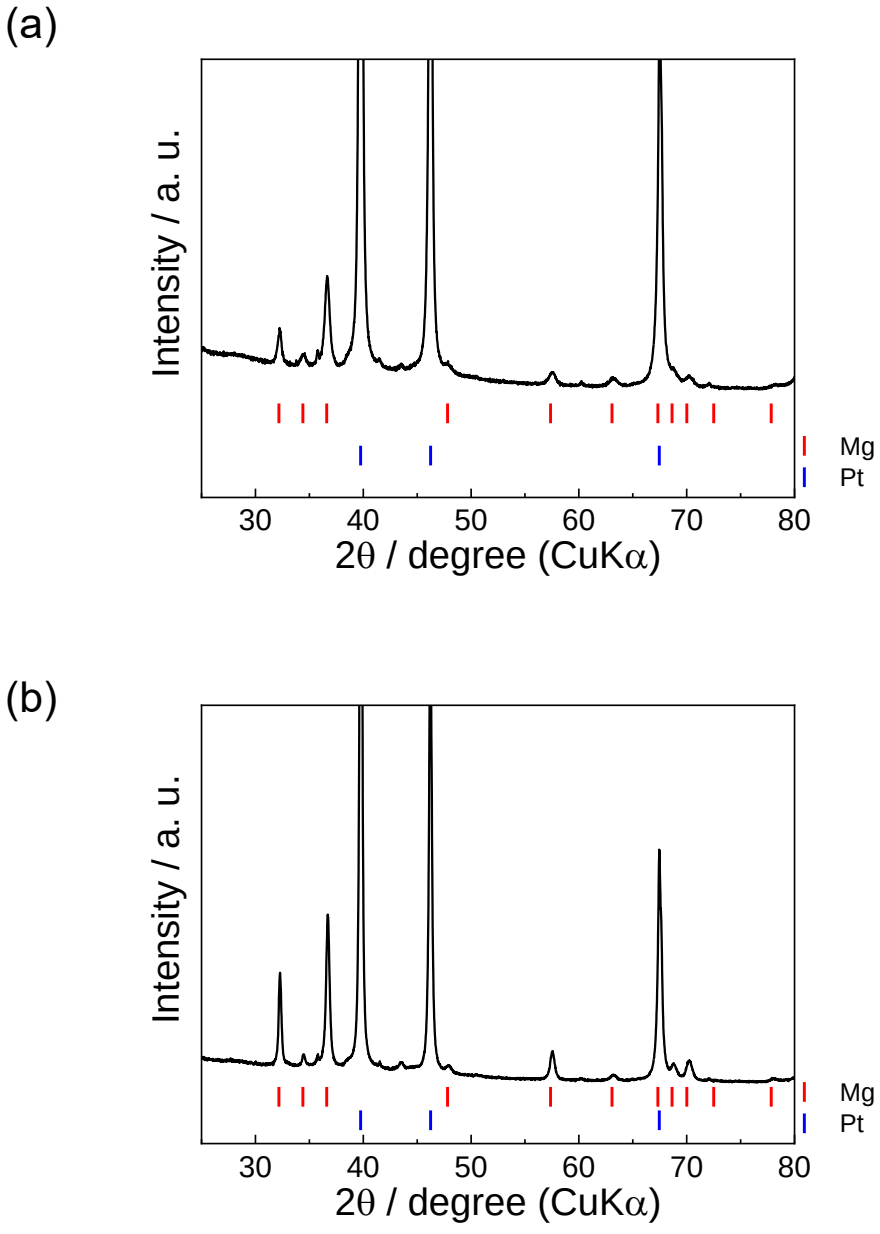
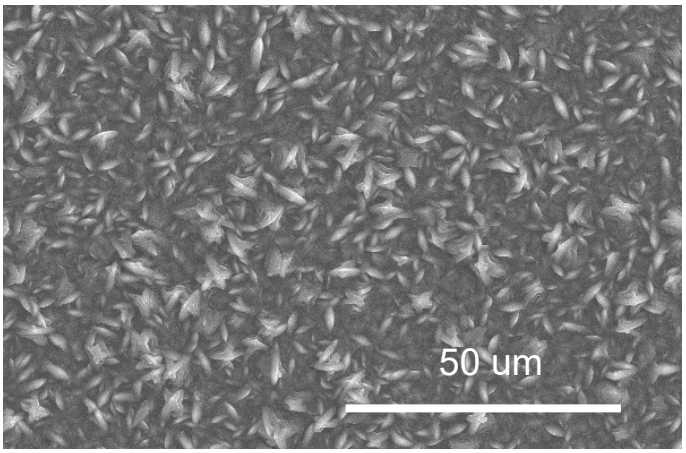


Figure S1. XRD patterns of electrodeposited of (a) 0.3 M $Mg[B(HFIP)_4]_2$/triglyme (b) 0.3 M $Mg[B(HFIP)_4]_2$/2-MeTHF on Pt substrate.

(a)



(b)

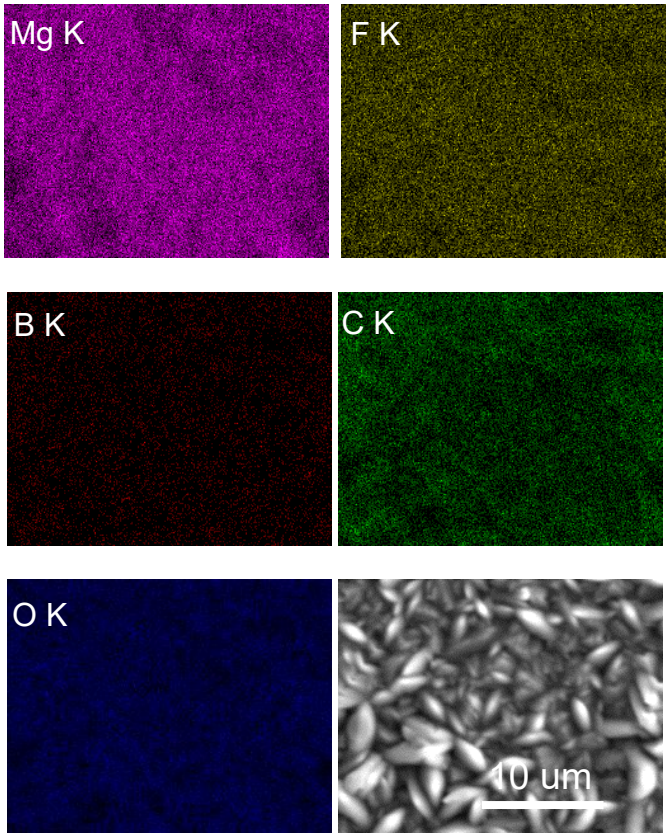


Figure S2. (a) SEM image, (b) EDX mapping and spectrum of Pt substrate after electrochemical measurements in 0.3 M $Mg[B(HFIP)_4]_2$/triglyme.

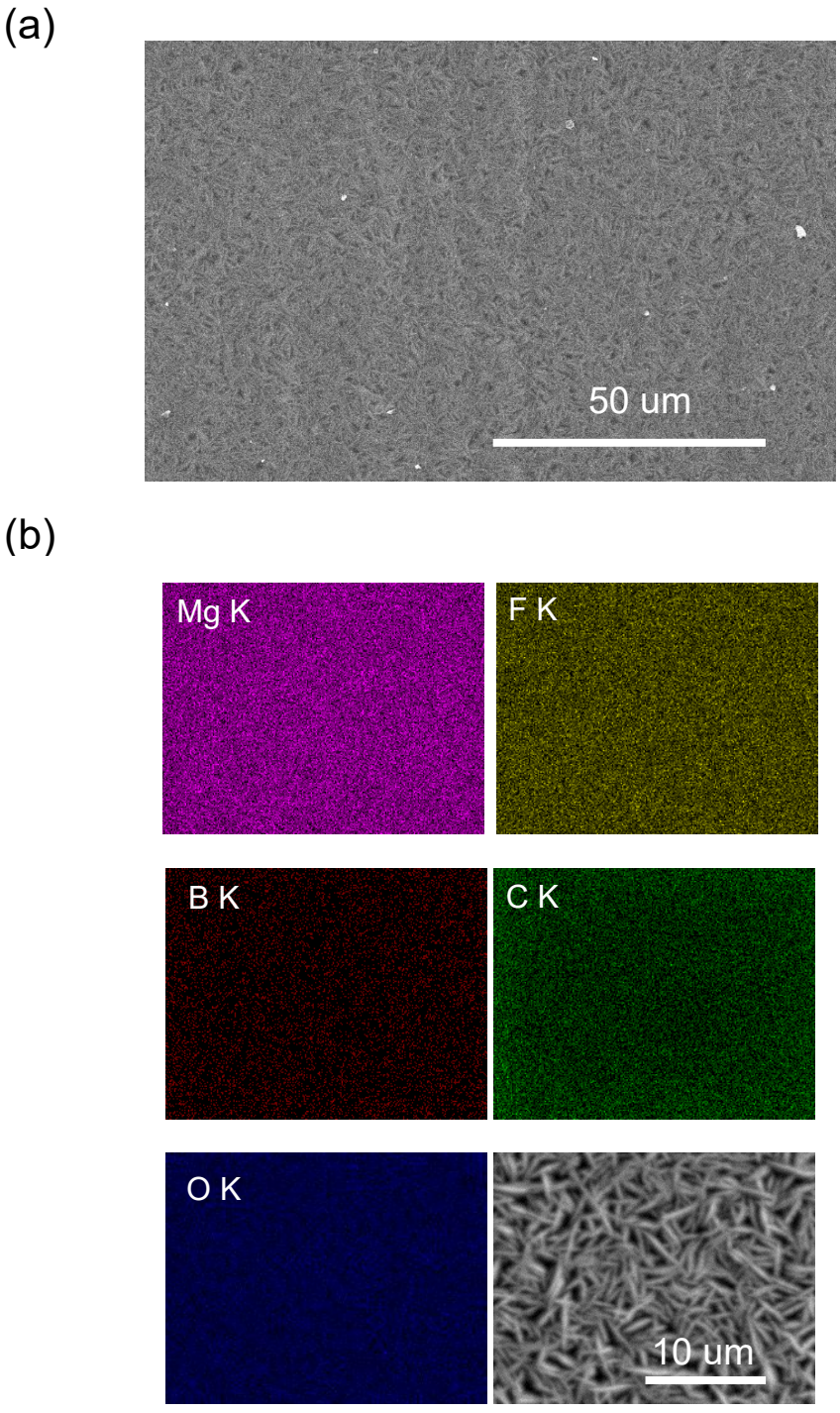


Figure S3. (a) SEM image, (b) EDX mapping and spectrum of Pt substrate after electrochemical measurements in 0.3 M $Mg[B(HFIP)_4]_2$/2-MeTHF.

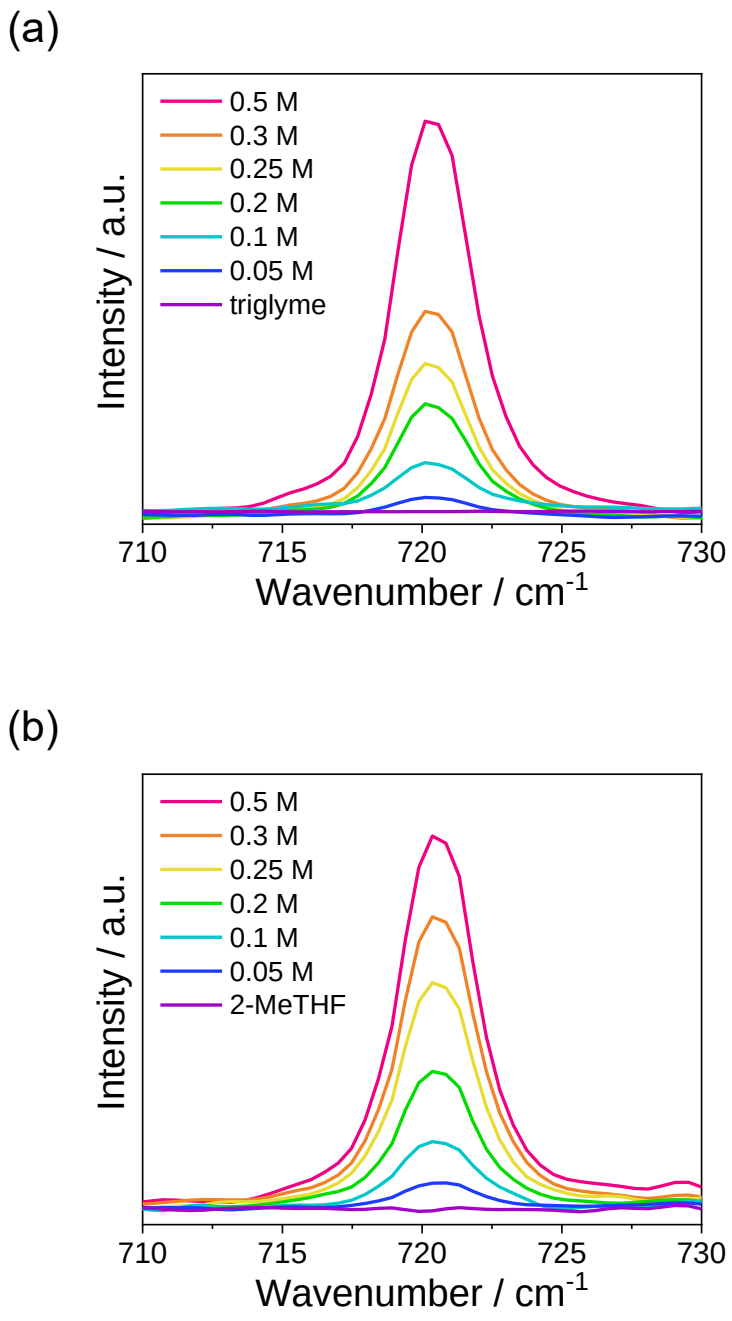


Figure S4. Raman spectra of (a) $Mg[B(HFIP)_4]_2$/triglyme and (b) $Mg[B(HFIP)_4]_2$/2-MeTHF with several concentrations in the region between 710 and 730 cm^{-1}

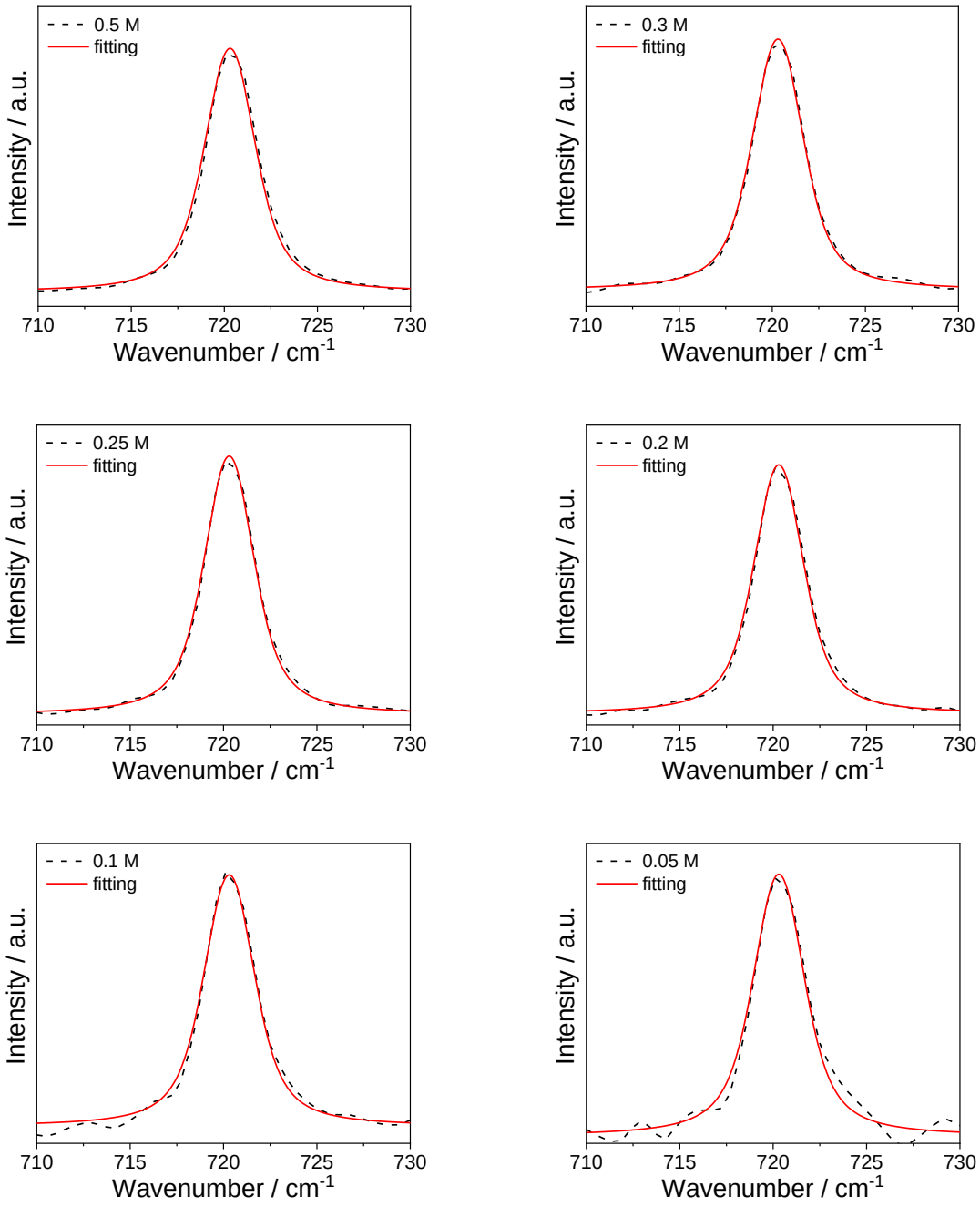


Figure S5. Raman spectra and voigt function fitting results of $Mg[B(HFIP)_4]_2$/triglyme in several concentrations in the wave number between 710 and 730 cm^{-1}.

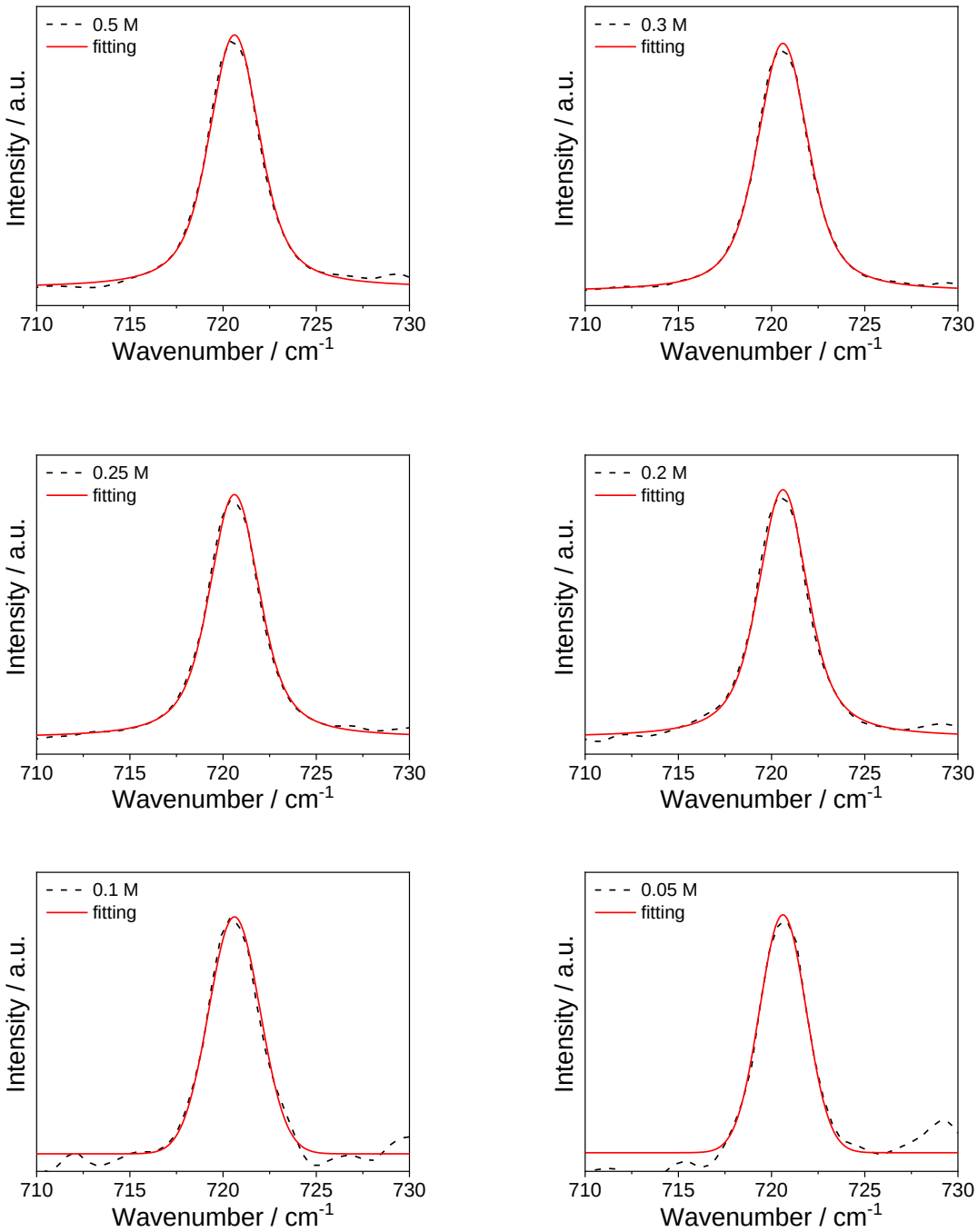


Figure S6. Raman spectra and Voigt function fitting results of $Mg[B(HFIP)_4]_2$/2-MeTHF in several concentrations in the wave number between 710 and 730 cm^{-1}.

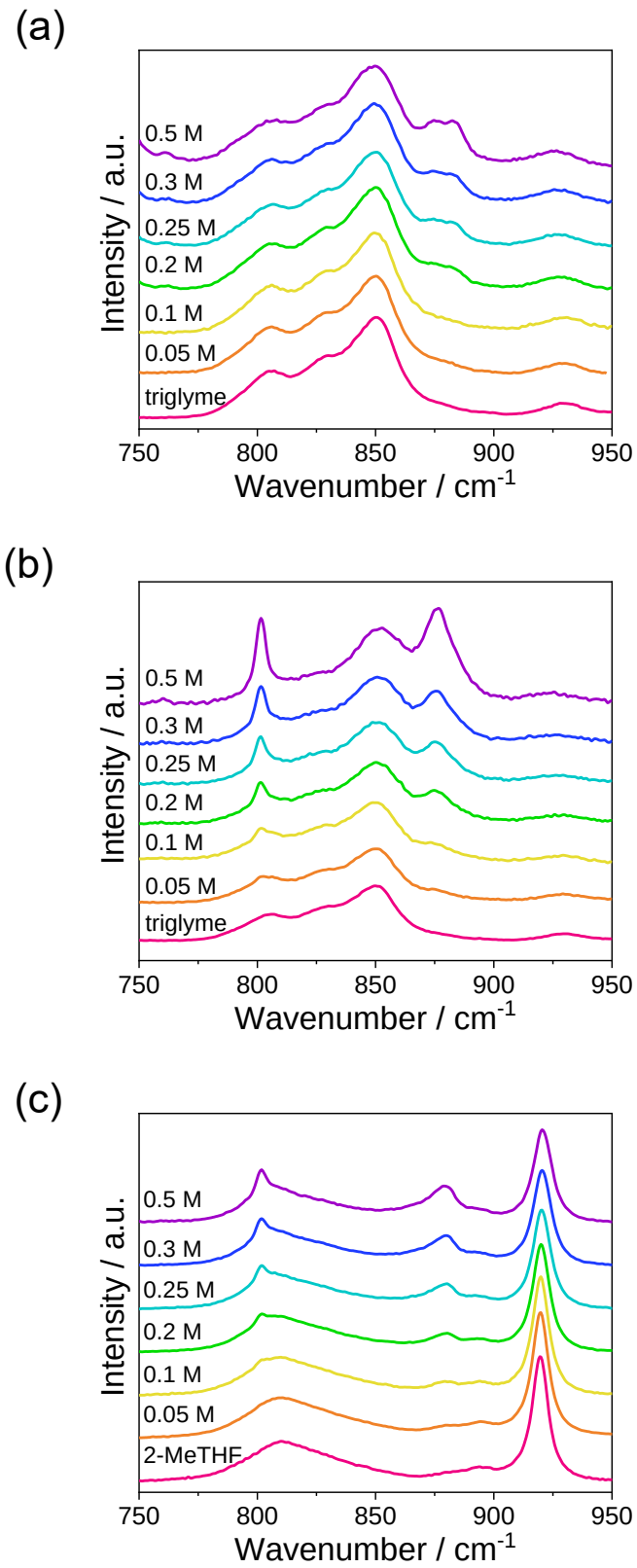


Figure S7. Raman spectra of (a) $Mg[TFSA]_2$/ triglyme (b) $Mg[B(HFIP)_4]_2$/triglyme and (c) $Mg[B(HFIP)_4]_2$/2-MeTHF in the wave number between 750 and 950 cm^{-1}.

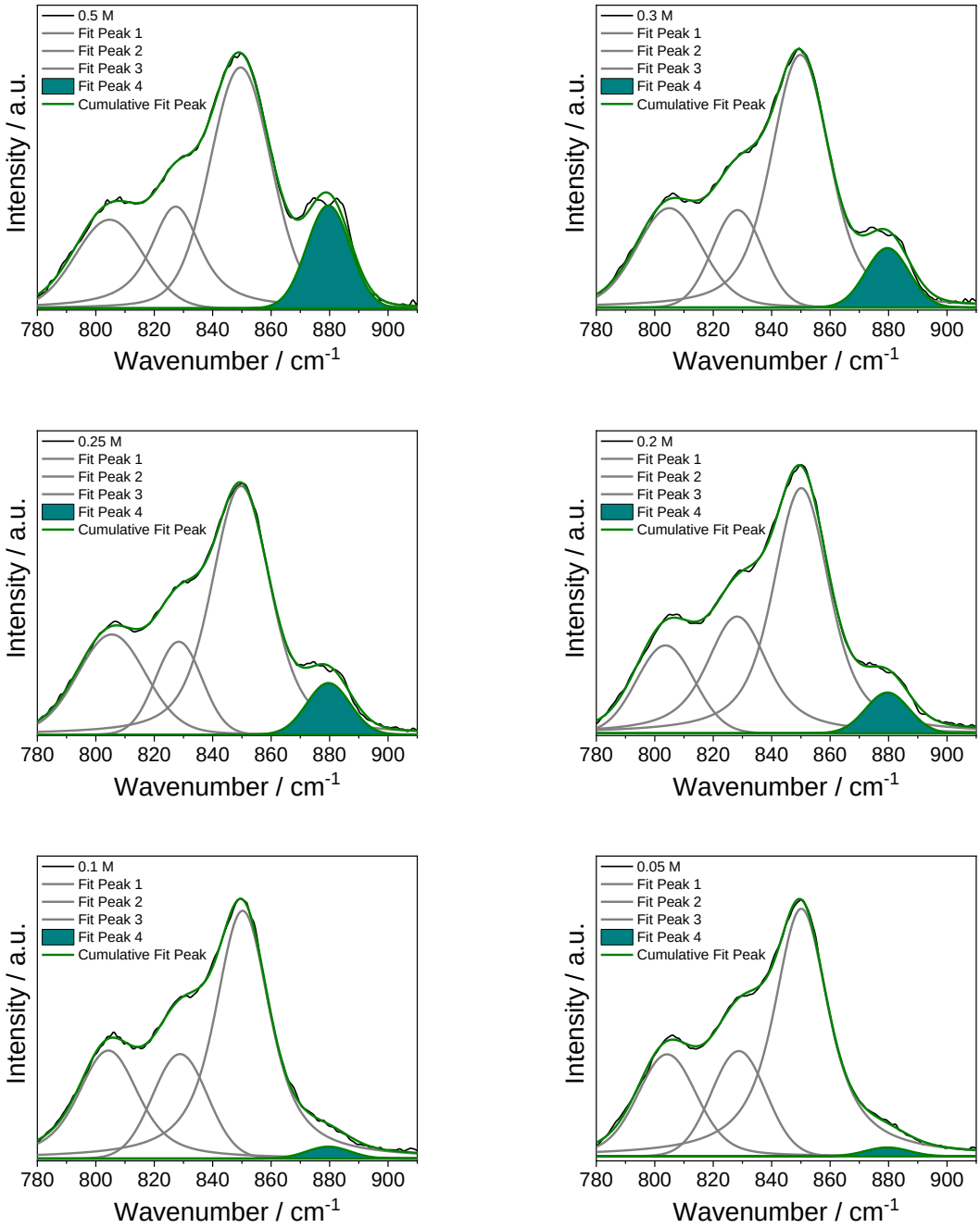


Figure S8. Raman spectra and Voigt function fitting results of $Mg(TFSA)_2$/triglyme in several concentrations in the wave number between 780 and 910 cm^{-1}.

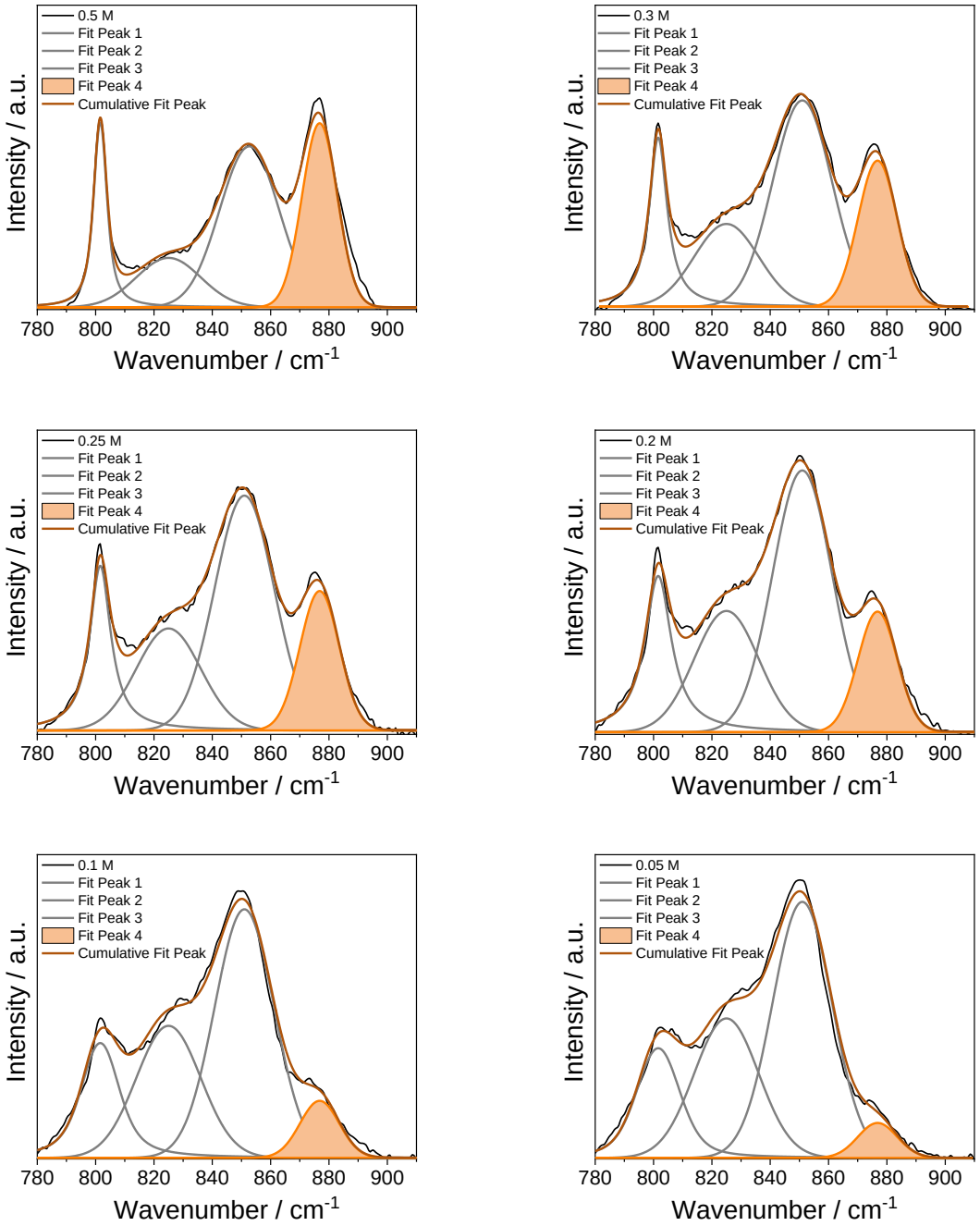


Figure S9. Raman spectra and Voigt function fitting results of $Mg[B(HFIP)_4]_2$/triglyme in several concentrations in the wave number between 780 and 910 cm^{-1}.

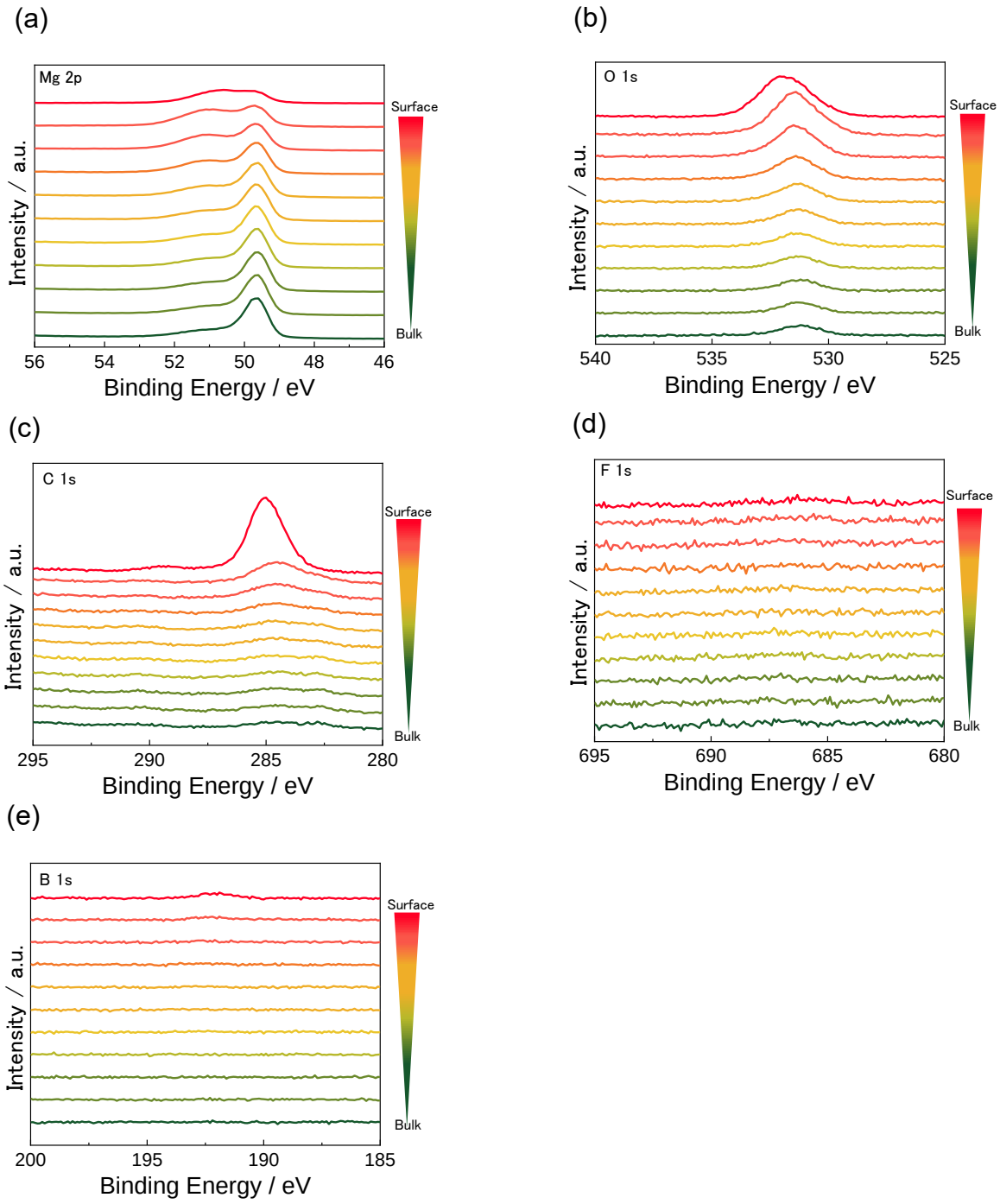


Figure S10. XPS spectra for the deposited magnesium metal on platinum substrate by using immersed in the 0.3 M $Mg[B(HFIP)_4]_2$/triglyme; (a) Mg 2p, (b) O 1s, (c) C 1s, (d) F 1s and (e) B 1s. The Ar ion beam sputtering times are marked at the right side of the graph.

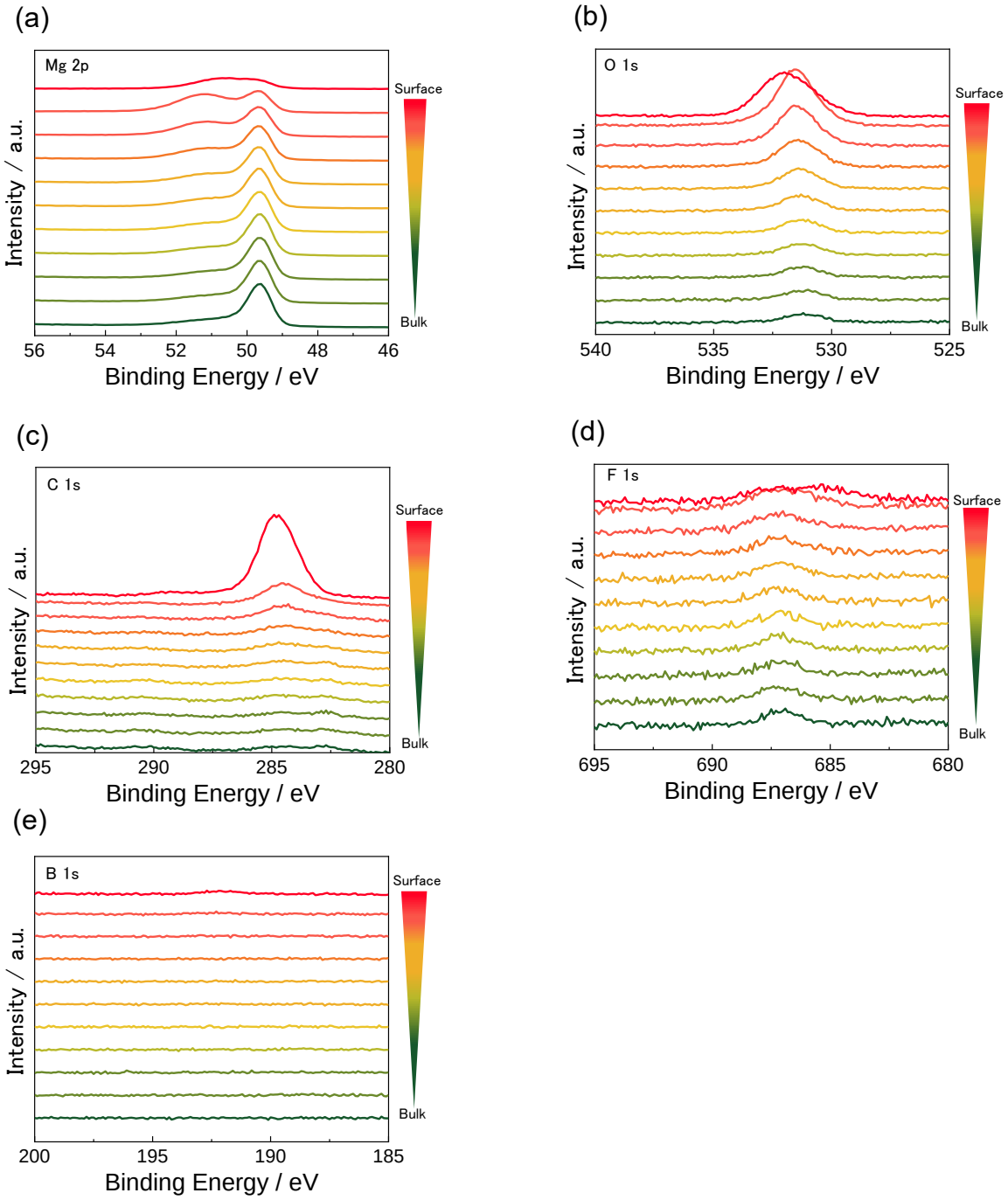


Figure S11. XPS spectra for the deposited magnesium metal on platinum substrate by using immersed in the 0.3 M $Mg[B(HFIP)_4]_2$/2-MeTHF; (a) Mg 2p, (b) O 1s, (c) C 1s, (d) F 1s and (e) B 1s. The Ar ion beam sputtering times are marked at the right side of the graph.

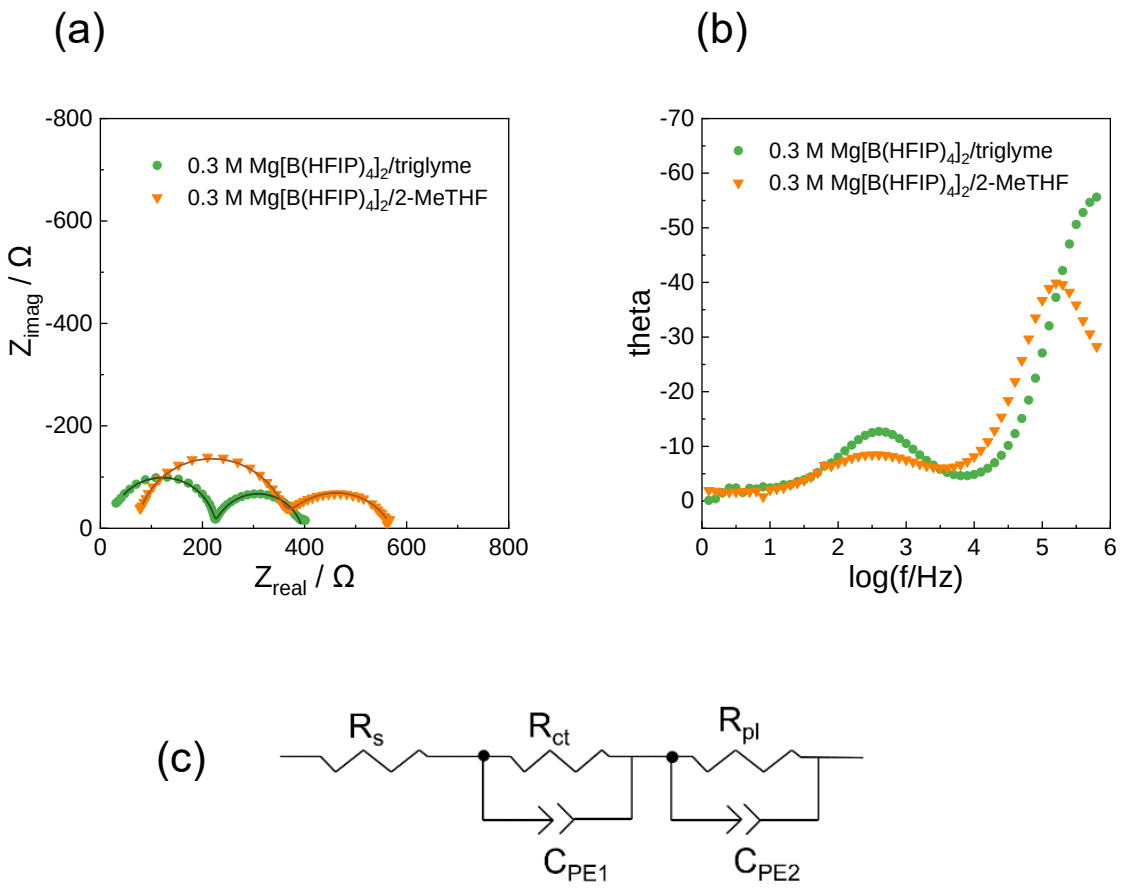


Figure S12. (a) Nyquist plots of deposited magnesium metal on Pt substrate in 0.3 M $Mg[B(HFIP)_4]_2$/triglyme, and 0.3 M $Mg[B(HFIP)_4]_2$/2-MeTHF electrolytes. Fitted impedance spectra shown in solid line. (b) Bode phase shift plot that donates the capacitive responses. (c) Equivalent circuit model, in which electrolyte solution resistance is R_s, charge transfer resistance is R_{ct}, constant phase element is C_{PE1}, passivation layer resistance is R_{pl} and constant phase element is C_{PE2}.

Table S1. The fitted parameter results of Figure 5.

Electrolyte	0.3 M $Mg[B(HFIP)_4]_2$/triglyme	0.3 M $Mg[B(HFIP)_4]_2$/2-MeTHF
R_s / Ω	22.3	45.3
R_{ct} / Ω	115.6	151.4
CPE	1.1×10^{-8}	5.3×10^{-9}
p	0.96	1.05
C / F	6.2×10^{-9}	1.0×10^{-8}
Time constant / s	7.9×10^{-7}	1.0×10^{-6}

Table S2. The fitted parameter results of Figure S12.

Electrolyte	0.3 M $Mg[B(HFIP)_4]_2$/triglyme	0.3 M $Mg[B(HFIP)_4]_2$/2-MeTHF
R_s / Ω	18.25	71.4
R_{ct} / Ω	205.8	287
CPE1	6.4×10^{-9}	1.3×10^{-8}
p1	0.97	0.95
C / F	4.2×10^{-9}	6.7×10^{-9}
Time constant / s	1.0×10^{-6}	2.0×10^{-6}
R_{pl} / Ω	171.2	213.2
CPE2	1.1×10^{-5}	2.4×10^{-5}
p2	0.84	0.72
C / F	3.3×10^{-6}	3.1×10^{-6}
Time constant / s	6.3×10^{-4}	7.9×10^{-4}