Supporting information for

Reversible Magnesium Metal Anode Enabled by Cooperative Solvation/Surface Engineering in Carbonate Electrolytes

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Supplementary Figures

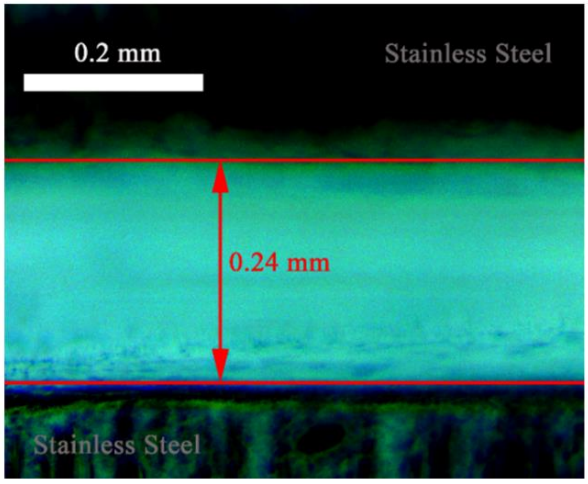

Fig. S1 Picture of the Mg^{2+}-conductive interphase under an optical microscope. The interphase sandwiched between two stainless-steel disks has a thickness of 0.24 mm.

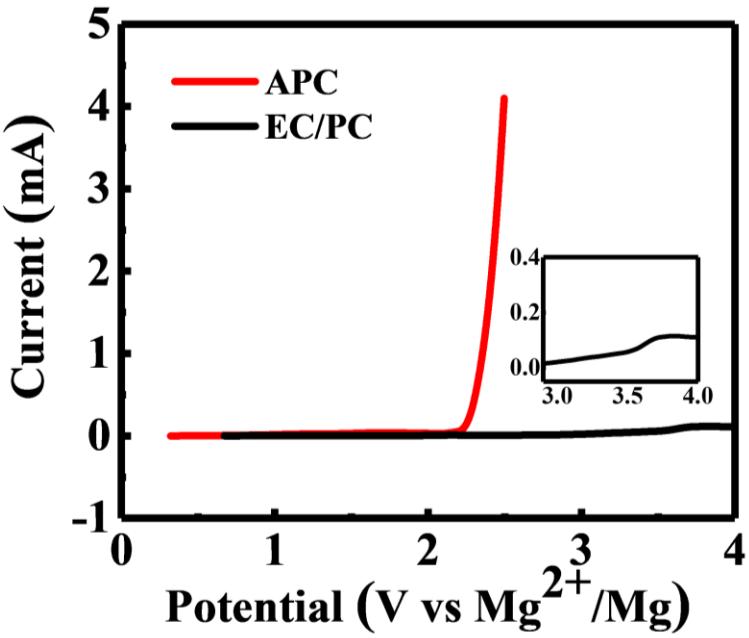

Fig. S2 LSV curve in APC and EC/PC electrolytes with Mg anode. APC electrolyte decomposes at 2.2 V, while EC/PC electrolyte can remain stable within 3.5 V.

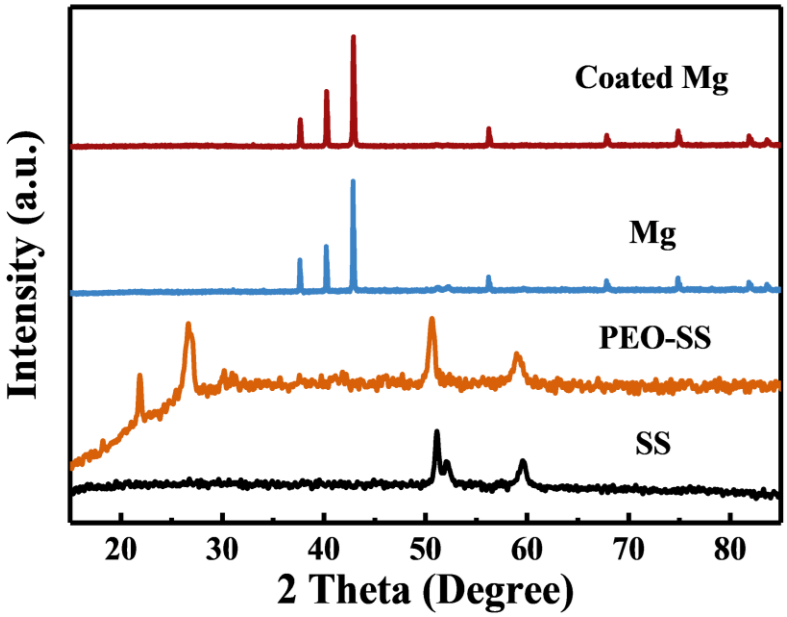

Fig. S3 XRD patterns of conducting film coated Mg, bare Mg, PEO coated stainless steel and stainless steel (SS). PEO peaks become undetectable for the conductive coating on Mg anode, which is caused by the destruction effect of crystallinity by $TFSI^-$ anions.

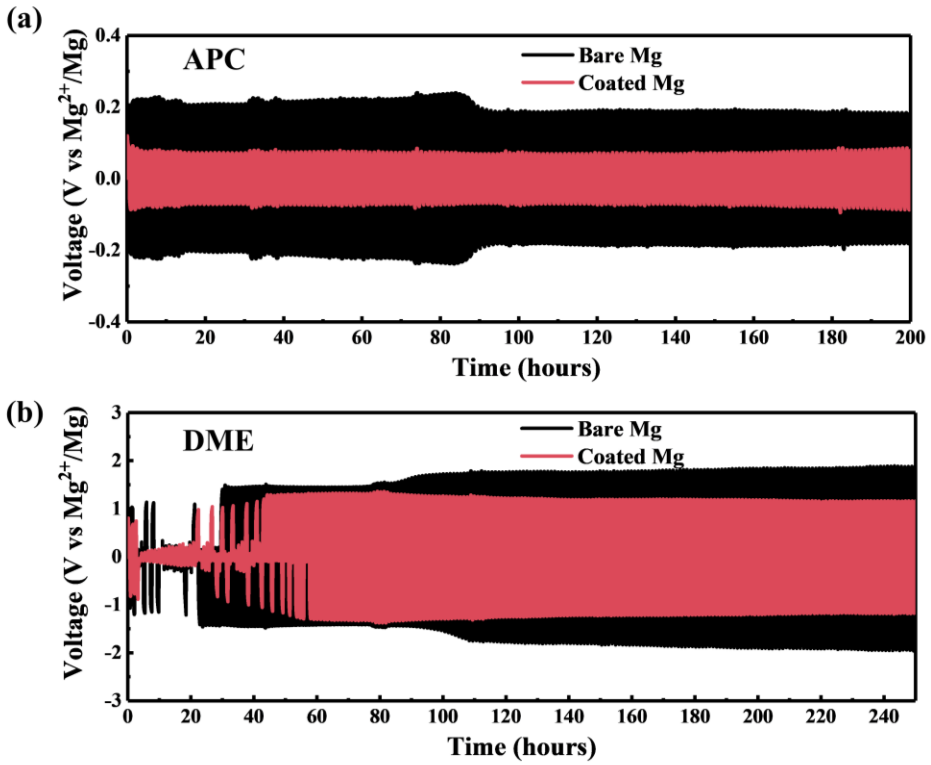

Fig. S4 Voltage responses of symmetric Mg batteries with and without the Mg^{2+}-conductive interphase in **a** APC electrolyte and **b** 0.5 M $Mg(TFSI)_2$ in DME at a current density of 0.01 mA cm^{-2} where each deposition/stripping cycle lasts for a half hour

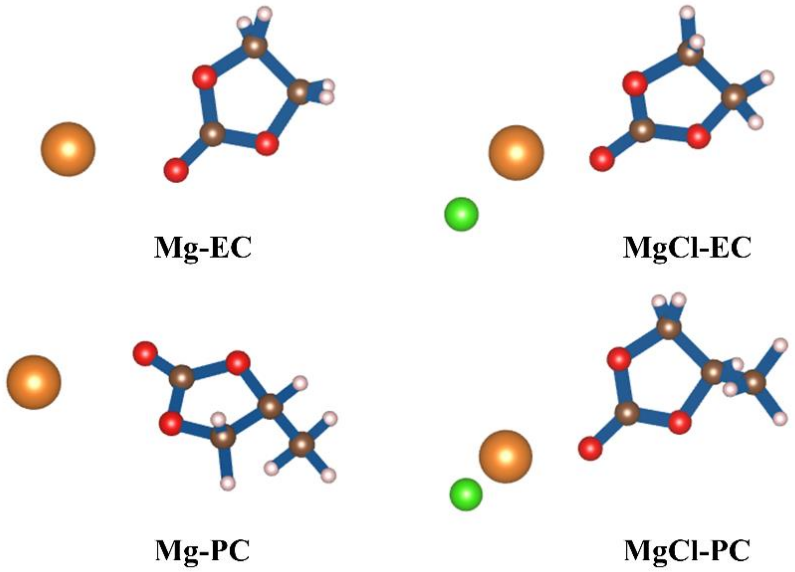

Fig. S5 Optimized solvation structures. The different colors represent different atoms (Orange-Mg, Green-Cl, Red-O, Brown-C, White-H).

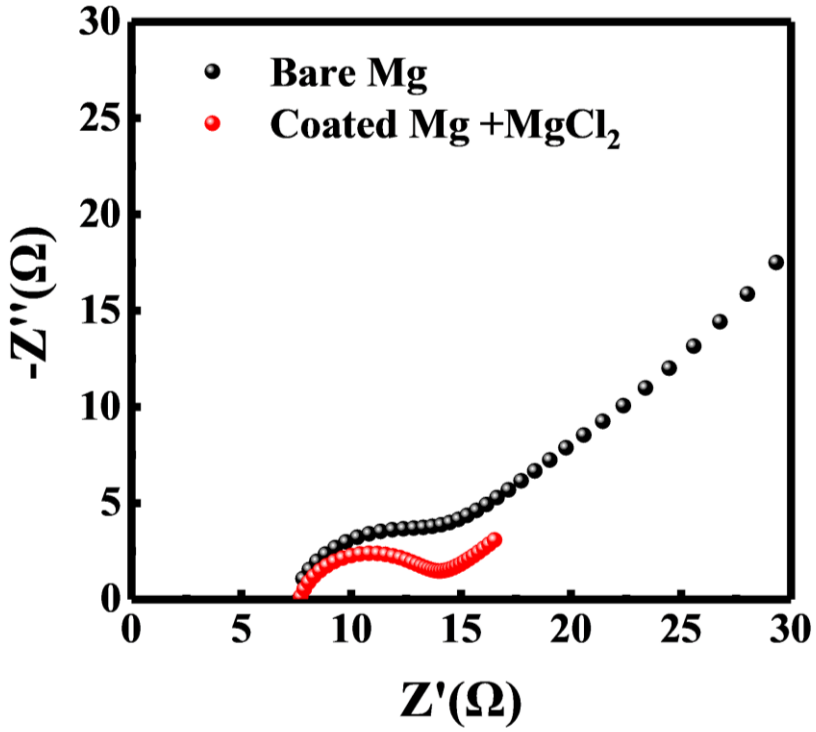

Fig. S6 Electrochemical impedance spectroscopies for cells before and after collaborative regulation

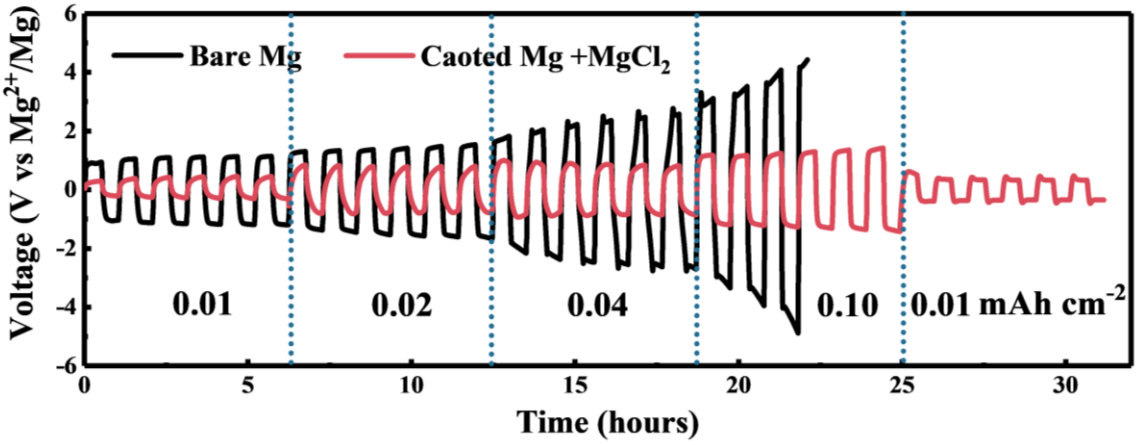

Fig. S7 Galvanostatic cycling test of symmetric cells at various current density before and after cooperative solvation/interface engineering in the carbonate electrolyte

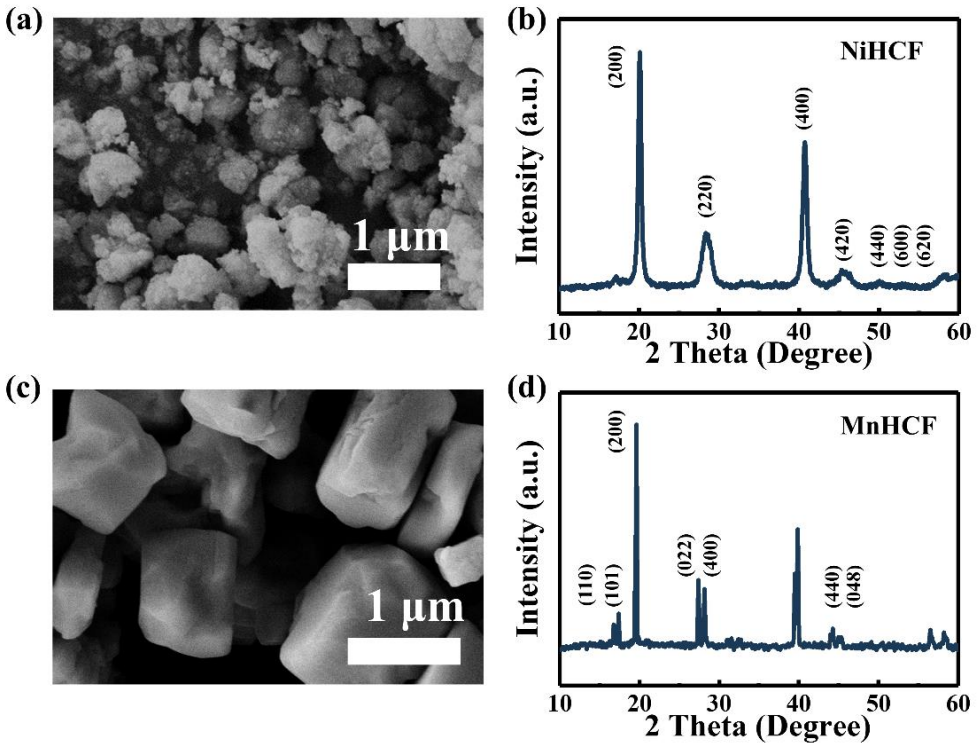

Fig. S8 (**a**) SEM image and (**b**)XRD pattern of NiHCF. (**c**) SEM image and (**d**)XRD pattern of MnHCF