Supporting Information

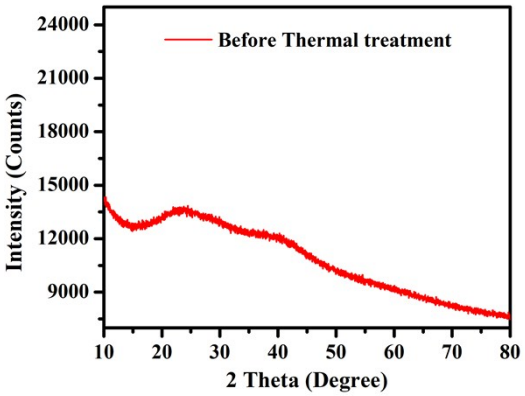

Figure S1 XRD profile of carbonaceous microspheres with uniformly embedded metal ions obtained after hydrothermal treatment (NMC-CS).

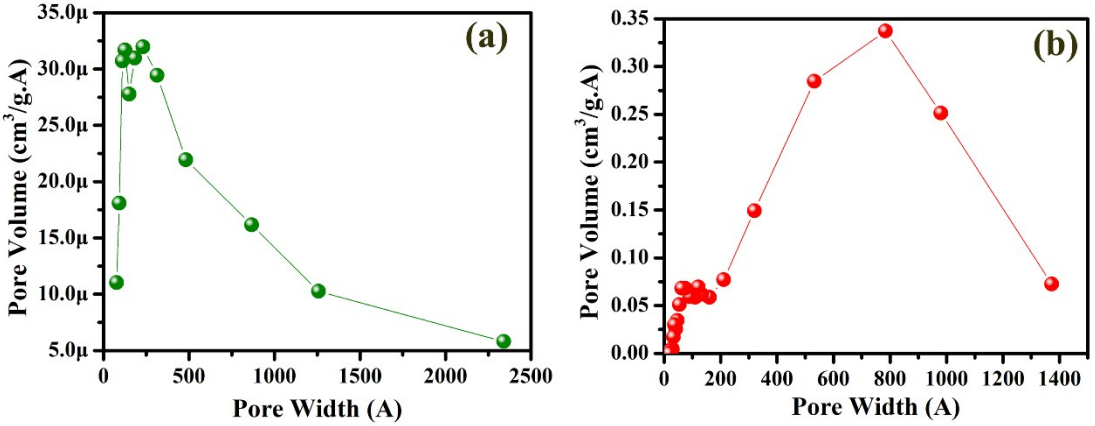

Figure S2 Pore-size distribution curve of (a) NMC-CS, and (b) NMCO-HS.

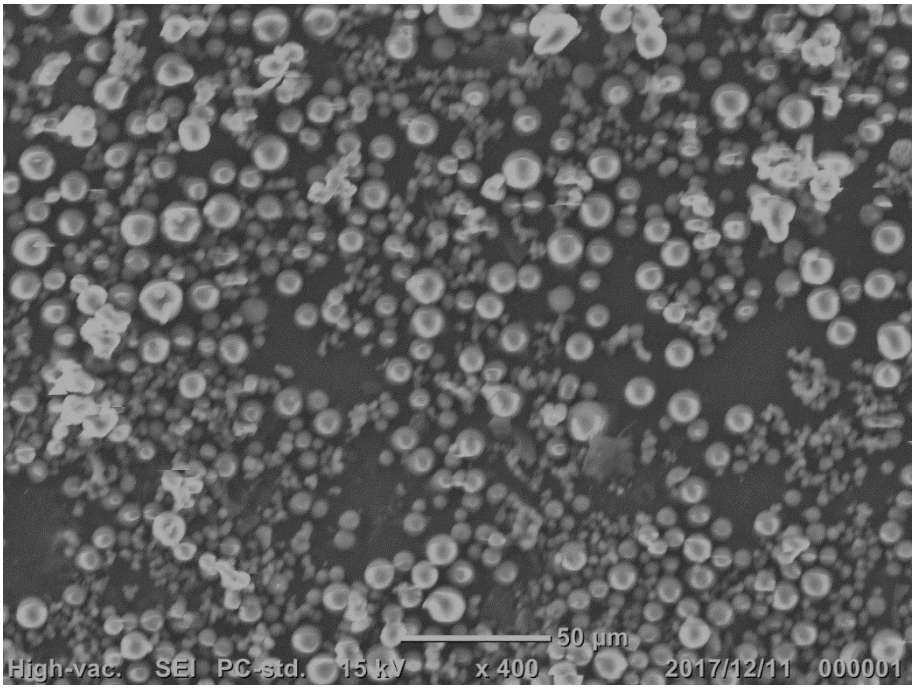

Figure S3 SEM image of carbonaceous microspheres with uniformly embedded metal ions obtained after hydrothermal treatment.

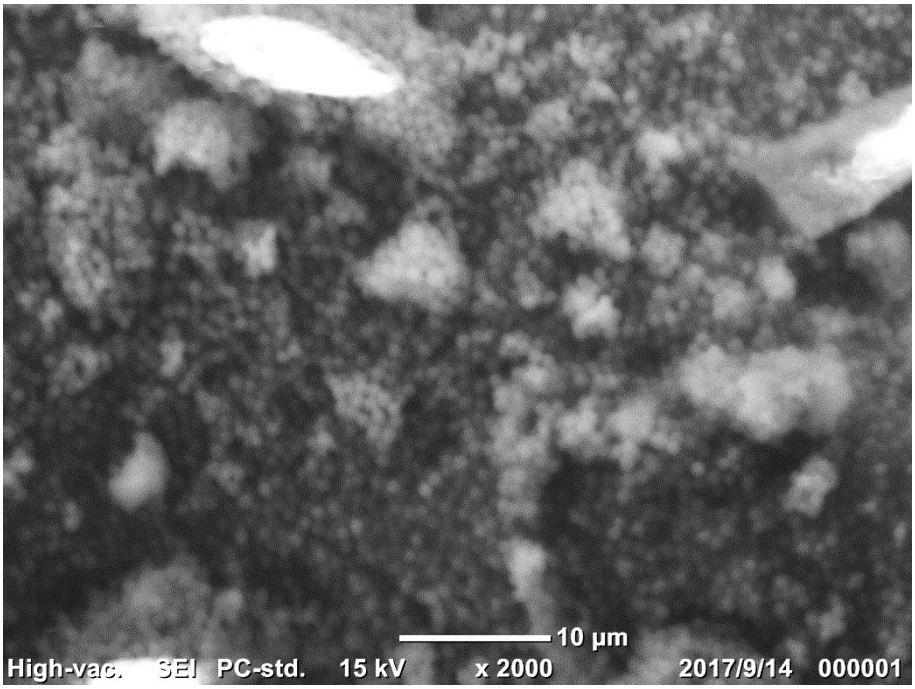

Figure S4 SEM image of pure carbon spheres.

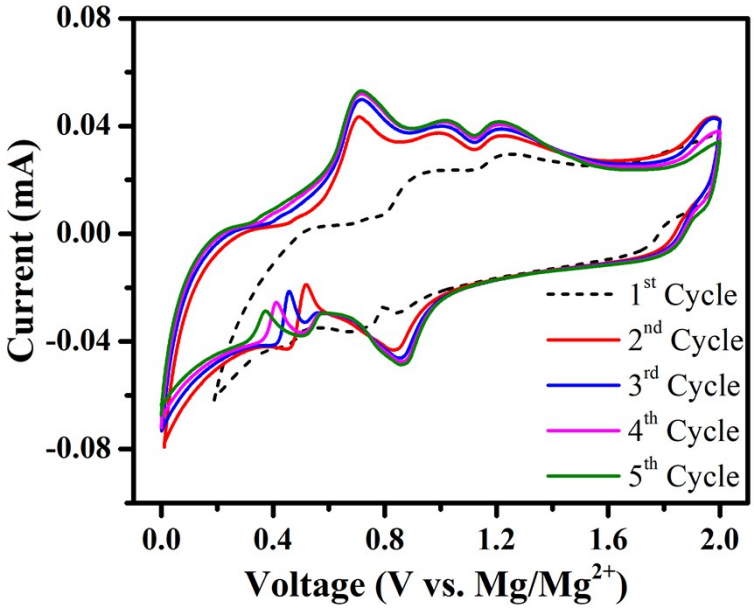

Figure S5 Cyclic voltammetry of MNC-O HS500 based MIBs at the scan rate of 0.5 mVs^{-1}.

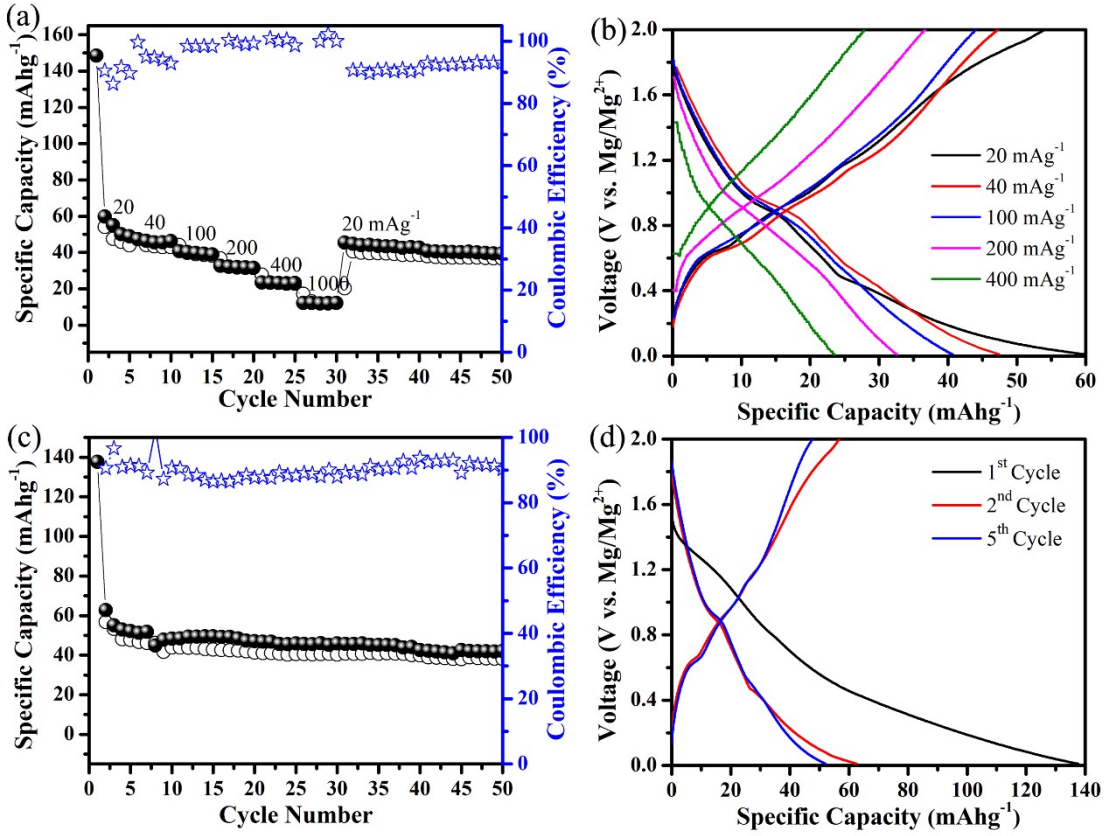

Figure S6 Electrochemical characterizations of MNC-O HS500 based MIBs: (a) Rate performance, (b) Charging-discharging profiles at different current rates (20-

1000mAg^{-1}), (c) Cycle stability, and (d) 1st, 2nd, and 5th charge-discharge profiles at 20mAg^{-1}.

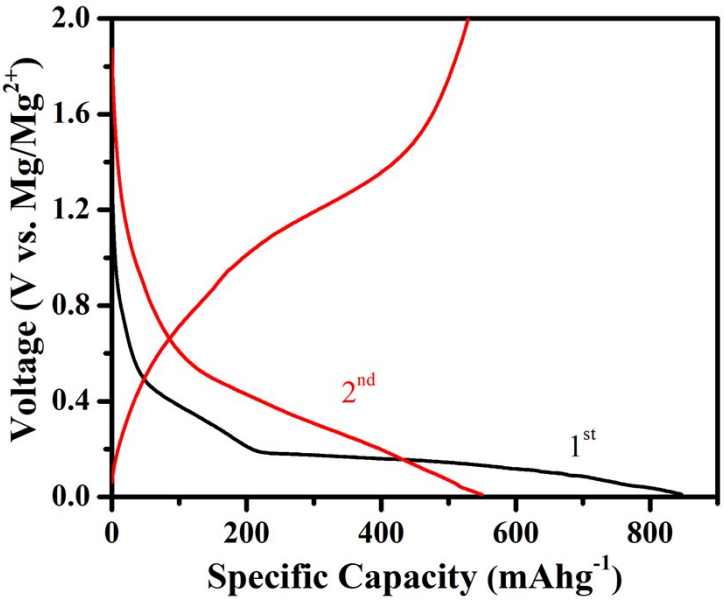

Figure S7 1st and 2nd charge-discharge profiles of MNC-O HS500 based MLIBs at the current density of 50mAg^{-1}.

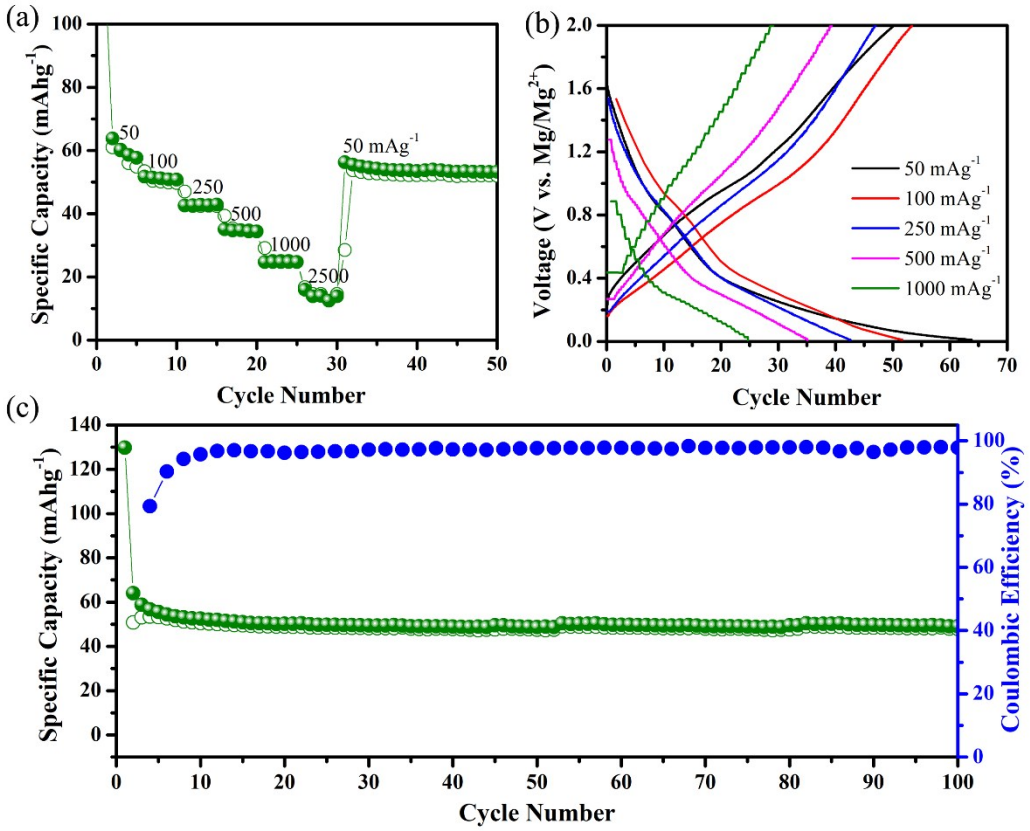

Figure S8 Electrochemical characterizations of MNC-O HS000 based MLIBs: (a) Rate performance, (b) Charging-discharging profiles at different current rates (50-1000mAg^{-1}), (c) Cycle stability at 50mAg^{-1}.

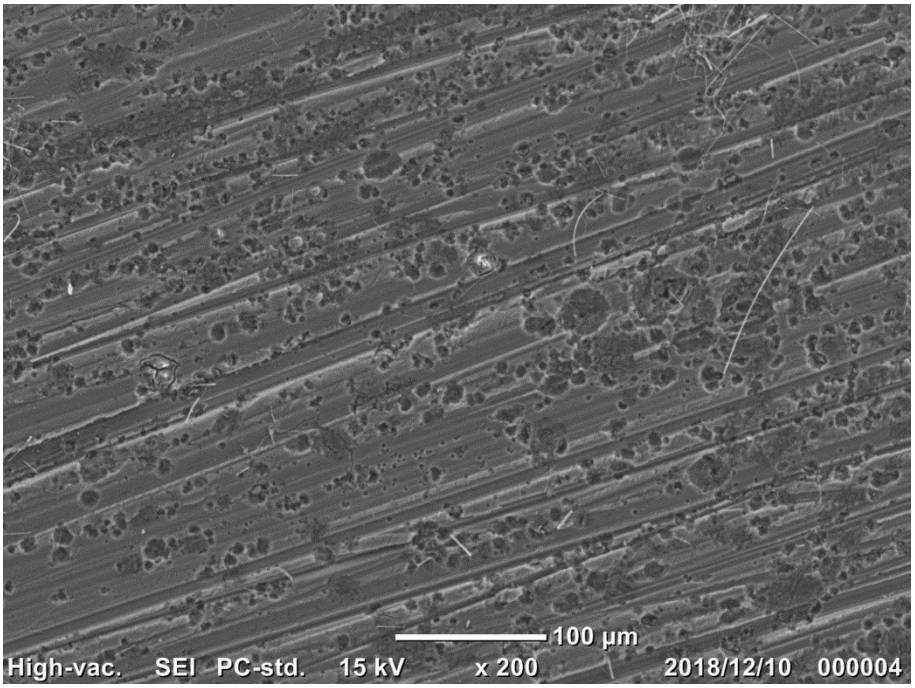

Figure S9 Surface morphology of magnesium anode after 100 cycles in 0.4APC-1.0LiCl hybrid electrolytes.

Table S1 Inductively Coupled Plasma (ICP) mass spectrometry results

Electrodes	Lithium (µg/L)	Magnesium (µg/L)
Pristine	008.675	2745.057
Discharged (0.05V)	912.561	6734.681
Charged (2.0V)	203.173	4245.116

Calculation of Energy and Power Densities:

The power density (***P***) was calculated using Equation 1 given below.

$$P = U * I \qquad (1)$$

Where ***U*** is average working voltage of battery and ***I*** is applied current. Whereas, energy density ***E*** was calculated using average working voltage (***U***), specific capacity (***C***) based on the total mass of the active materials (***m***) using Equation 2 given below.

$$E = {}^{U * C}\!/_{m} \qquad (2)$$