Electronic Supplementary Information (ESI)

The effect of electrolyte with binary solvents to improve the cycling performance of rechargeable lithium-oxygen batteries

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The pre-treatment process of MCNTs

At first, 50 mg carbon nanotubes were prepared and dispersed in a mixed solution (60 mL) of nitric acid (60 *wt* %) and sulfuric acid (98 *wt* %) with a volume ratio of 1:3 at 80 °C for 8 h. Then, the acidified carbon nanotubes were cleaned with deionized water until the filtrate was neutral. After vacuum drying at 80 °C for overnight, it was subsequently calcined at 800 °C for 2 h in Ar protective atmospheres at a ramp rate of 5°C min^{-1} to obtain the MCNTs sample.

Table. S1 Physical properties of common solvents in LOBs

Solvents	DN/AN	Boiling point/ °C	Density/ (g cm^{-3})
G3	none	216	0.986
G4	16.6/11.7	276	1.009
DMSO	29.8/19.3	189	1.100
DMC	23.9/10.2	90	1.069

Notes: *DN, Donor number; AN, Acceptor number*

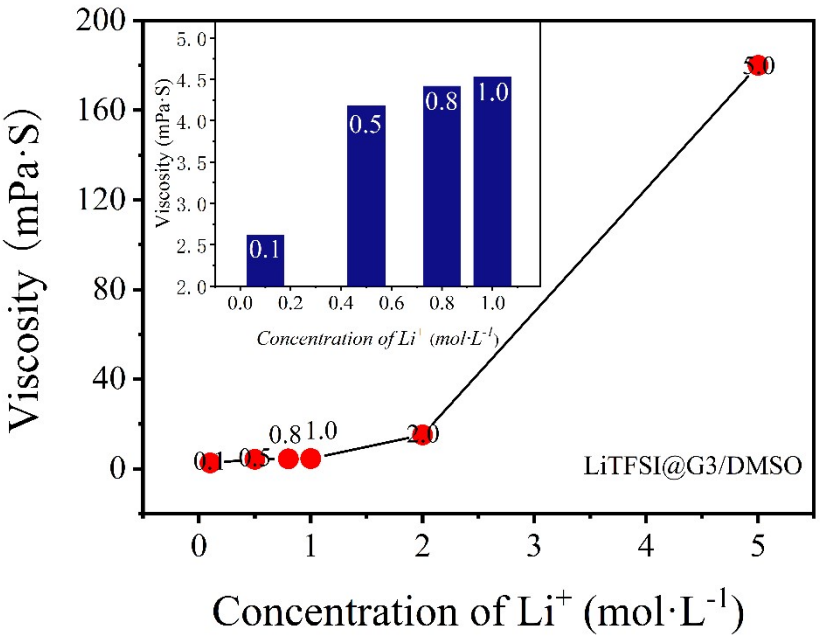

Fig. S1 The viscosity values of the G3/DMSO based electrolyte with different salt concentrations.

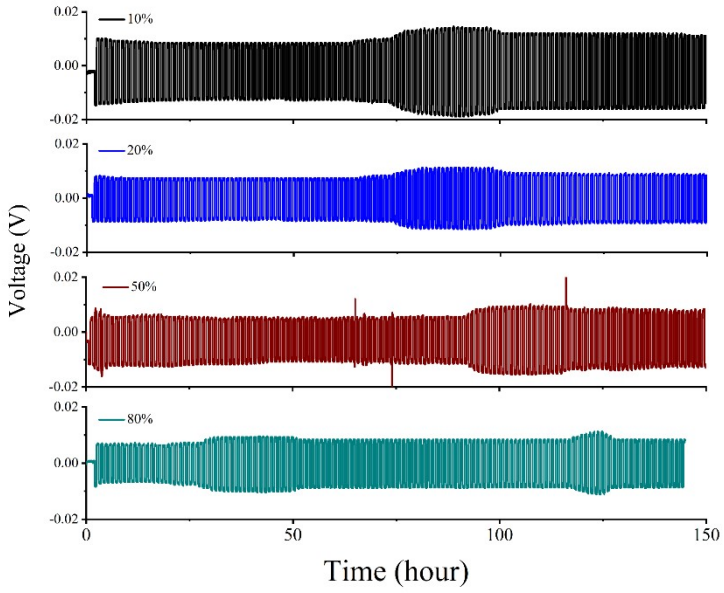

Fig. S2 The voltage profiles of Li plating/striping cycling using G3/DMSO based electrolytes with different volume ratio under 0.1 mA cm^{-2}.

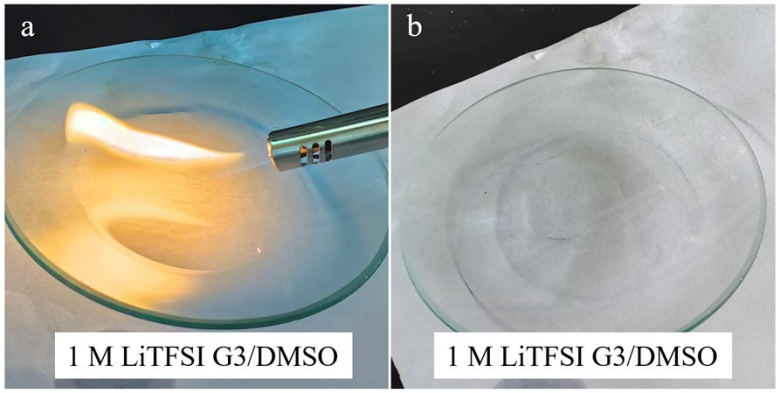

Fig. S3 Flammability test of the 1 M LiTFSI G3/DMSO electrolyte using a butane flame: (a) ignition for 20 s and (b) after ignition.

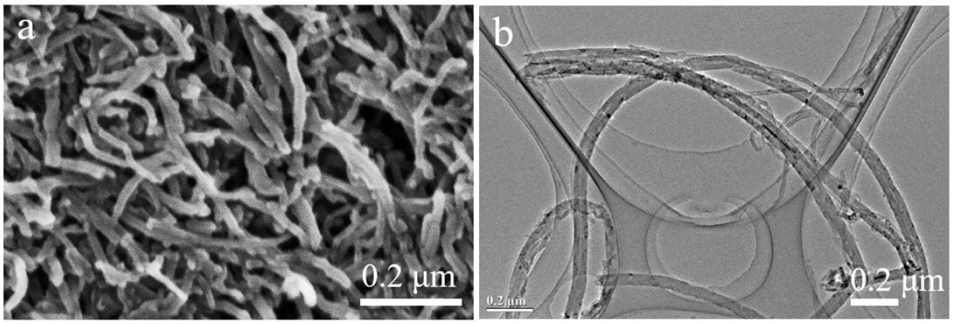

Fig. S4 (a) SEM image and (b) low TEM image of post-treatment MCNT, respectively.

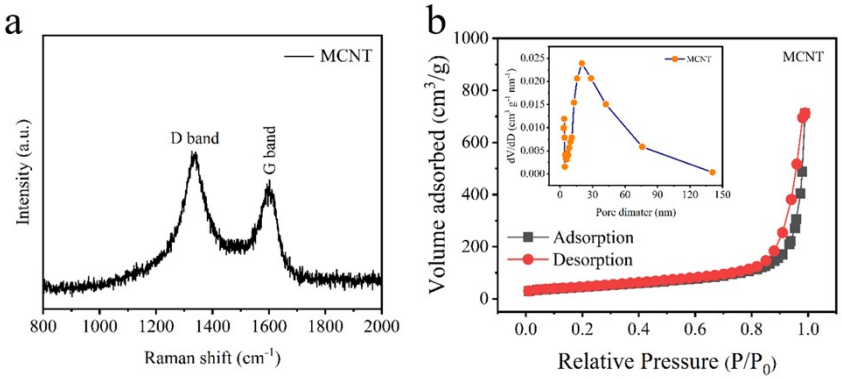

Fig. S5 (a) Raman spectrum and (b) N_2 adsorption–desorption isotherms and pore-size distribution of post-treatment MCNT, respectively.

Table. S2 Theoretical electromotive force and theoretical energy density of post-treatment MCNT

Sample	Surface Area/ (m^2 g^{-1})	Total pore volume/ (cm^3 g^{-1})	Average pore Diameter/ (nm)
MWCNT	160.504	1.102	27.47

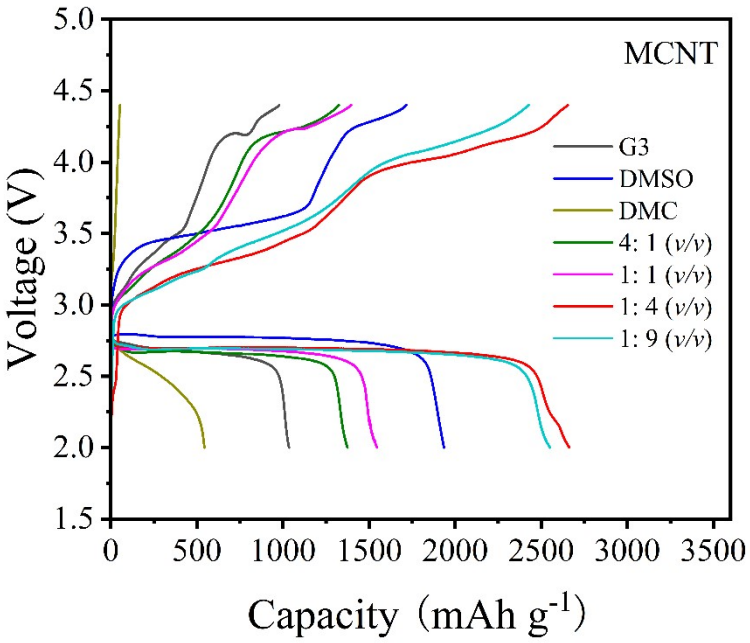

Fig. S6 The initial 1st full discharge-charge profiles of MCNT cathode using various electrolytes at 0.05 mA cm^{-2}.

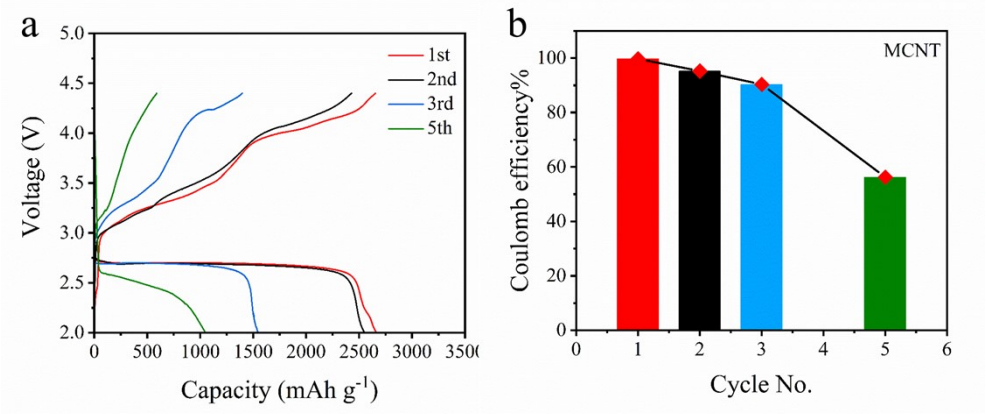

Fig. S7 (a)The full discharge-charge profiles at 0.05 mA cm^{-2} and (b) the corresponding coulomb efficiency of MCNT cathode using G3/DMSO based electrolyte with a volume ratio of 1:4.

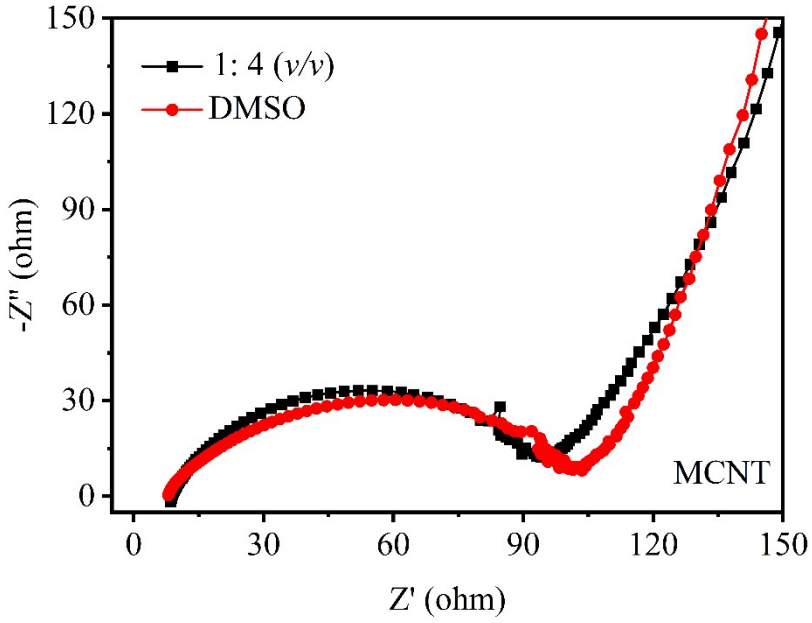

Fig. S8 The EIS spectra of MCNT LOBs using marked electrolytes.

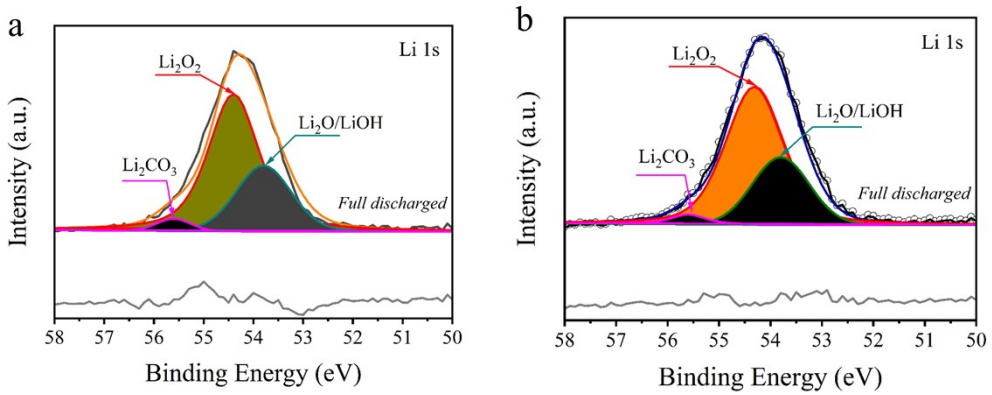

Fig. S9 The XPS spectra of Li 1s for MCNT cathodes after full discharged process in: (a) DMSO based battery and (b) G3/DMSO based battery

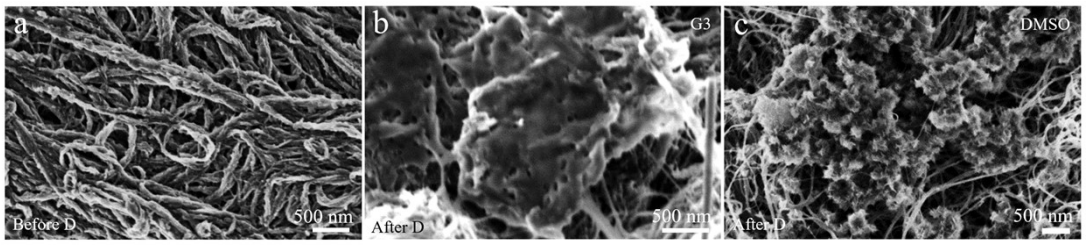

Fig. S10 SEM images of (a) the pristine MCNT cathode without discharge, 1st discharged products from (b) the G3 and (c) DMSO based battery