Supplementary Information

Long life-span of Li-metal anode enabled by a protective layer based on the pyrolyzed N-doped binder network

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Supplementary Figures

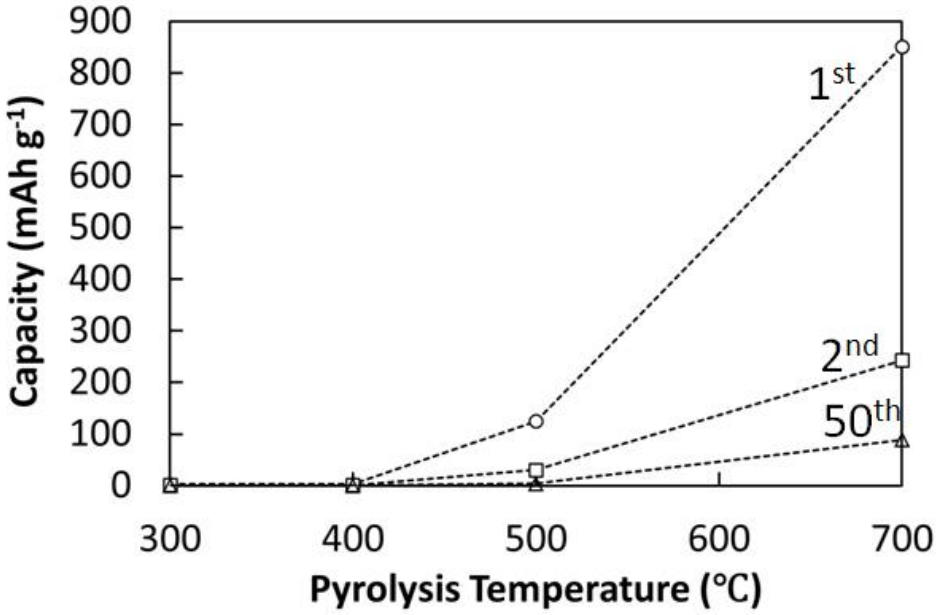

Fig. S1 Capacities of pyrolyzed PAN at various temperatures, for the 1st, 2nd and 50th cycles. The working electrodes are pyrolyzed PAN:SP:PVdF (8:1:1), the counter electrodes are Li foils, and the electrolyte is 1 M $LiPF_6$ in EC:DEC:EMC (1:1:1).

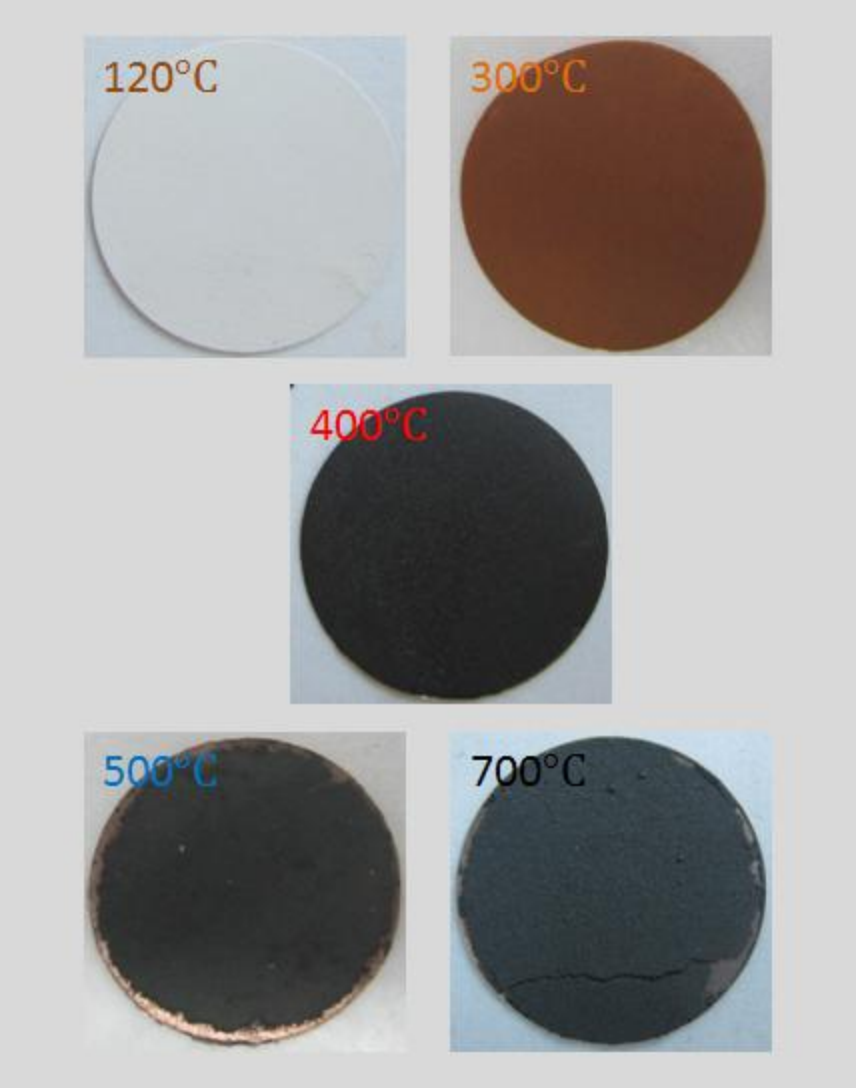

Fig. S2 Digital photos of the electrodes with porous layers prepared at various temperatures.

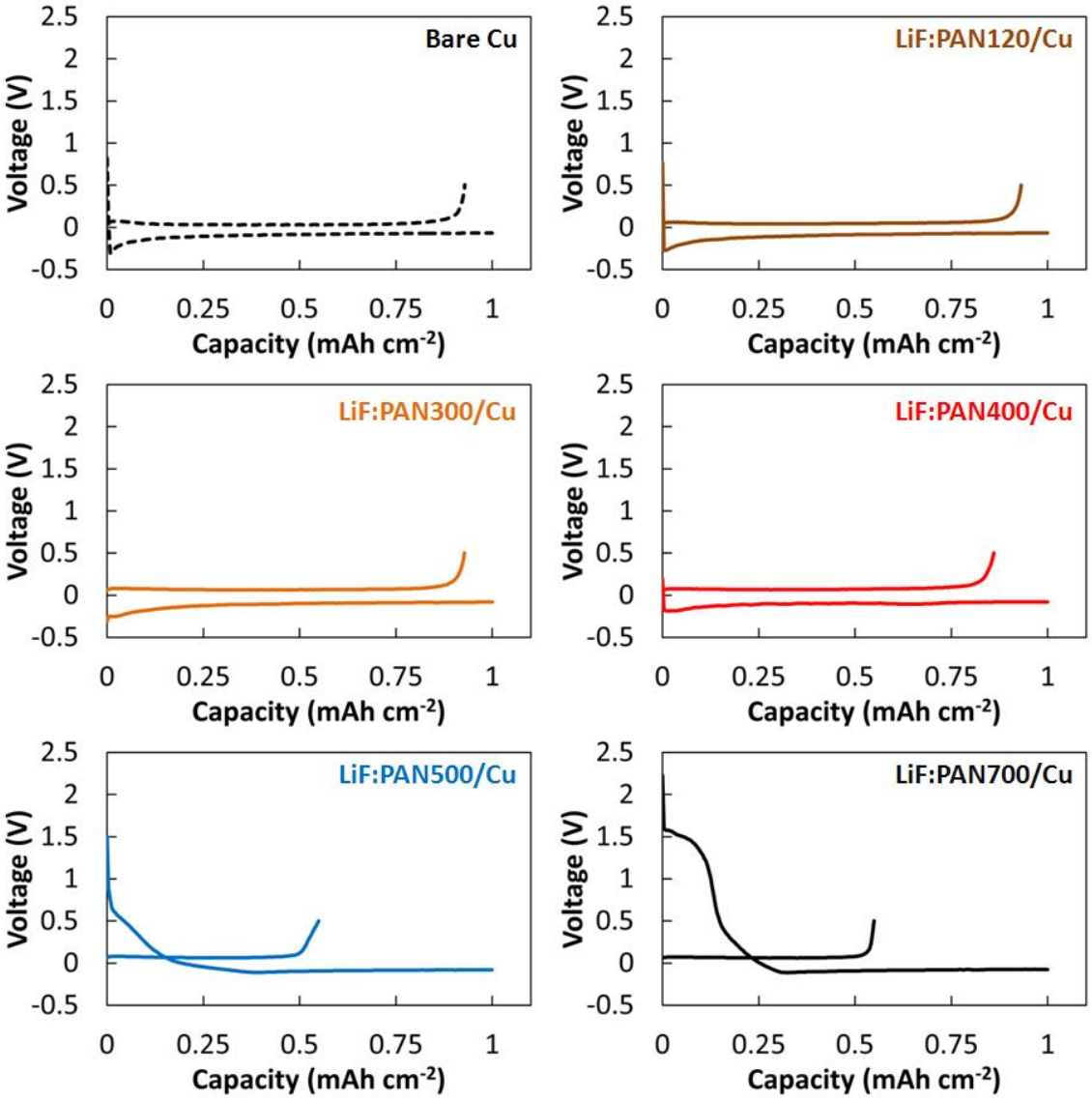

Fig. S3 Charge-discharge curvy of the 1st Li plating/striping cycle in the electrodes with porous layers prepared at various pyrolysis temperatures.

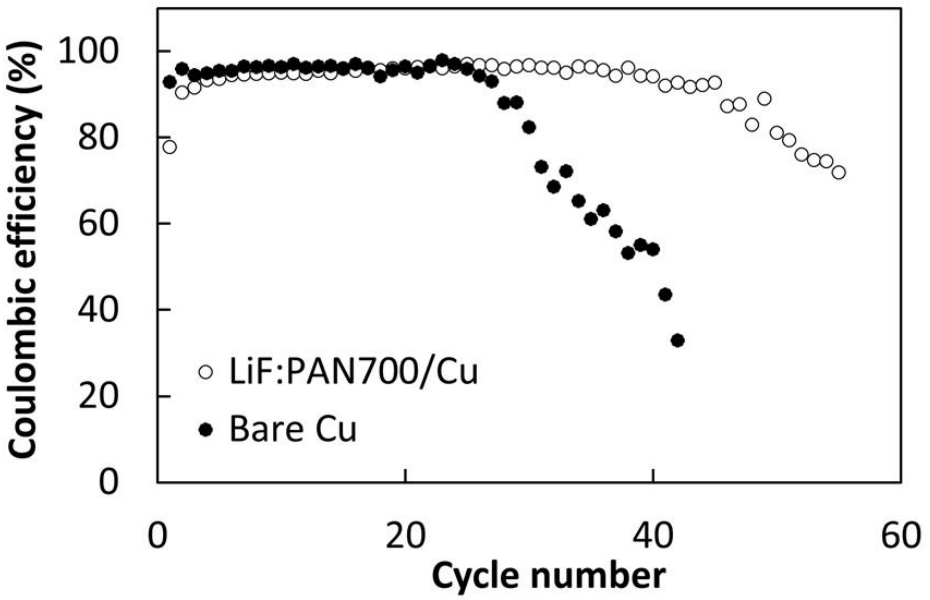

Fig. S4 Coulombic efficiency of Li plating/stripping in the electrode with porous layer prepared at 700 ℃.

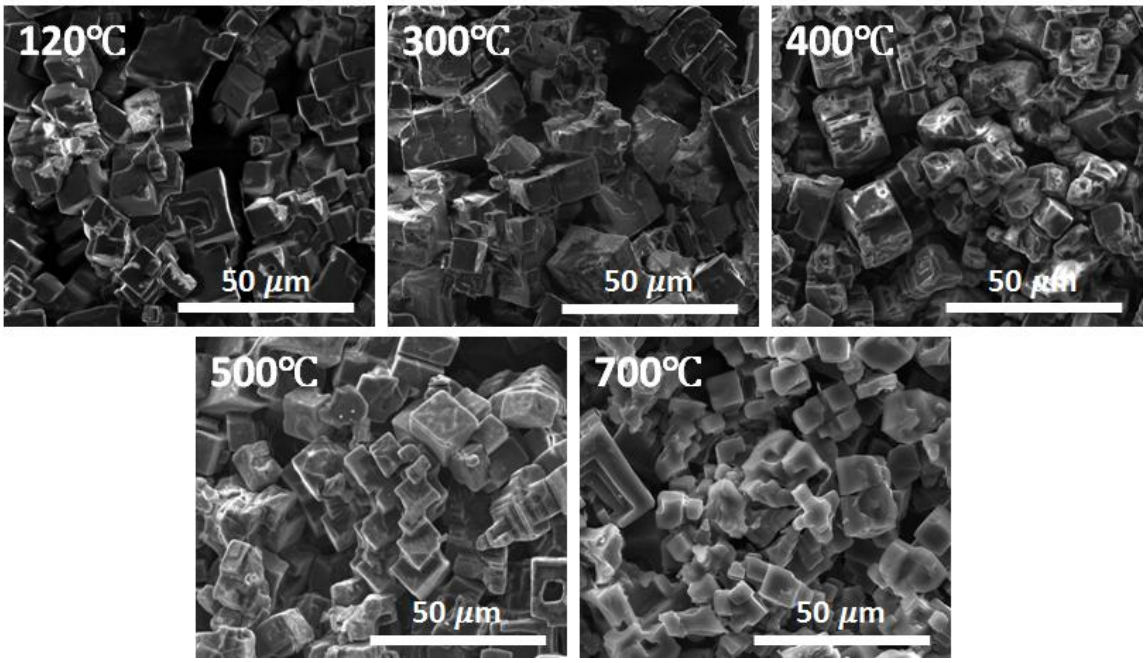

Fig. S5 SEM images of the electrodes with porous layers prepared at various temperatures.

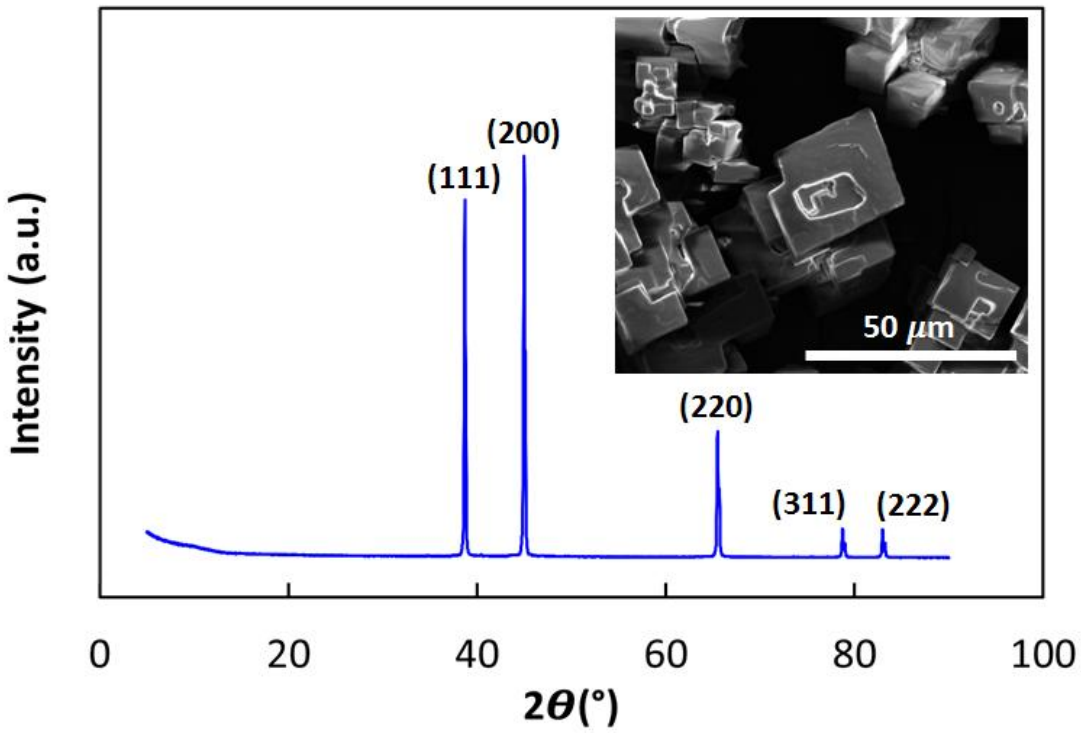

Fig. S6 XRD pattern and SEM image of the used LiF powders in this work, with a typical size of 20-30 μm. The well-defined XRD pattern justifies the high material purity.

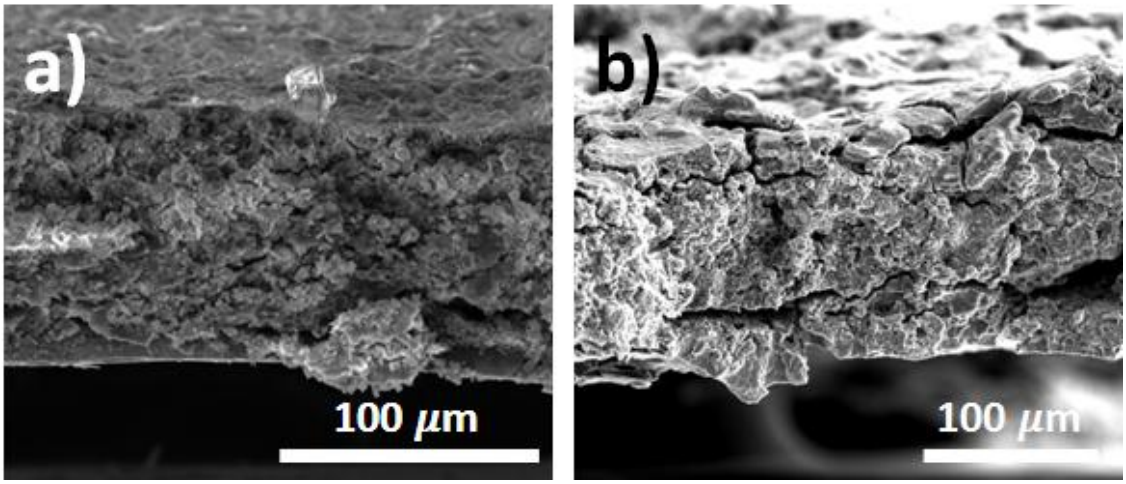

Fig. S7 Cross-sectional SEM images of the PAN-based porous layer formed at 400 ℃ with nano-sized Al_2O_3 powders, (a) before and (b) after cycling.

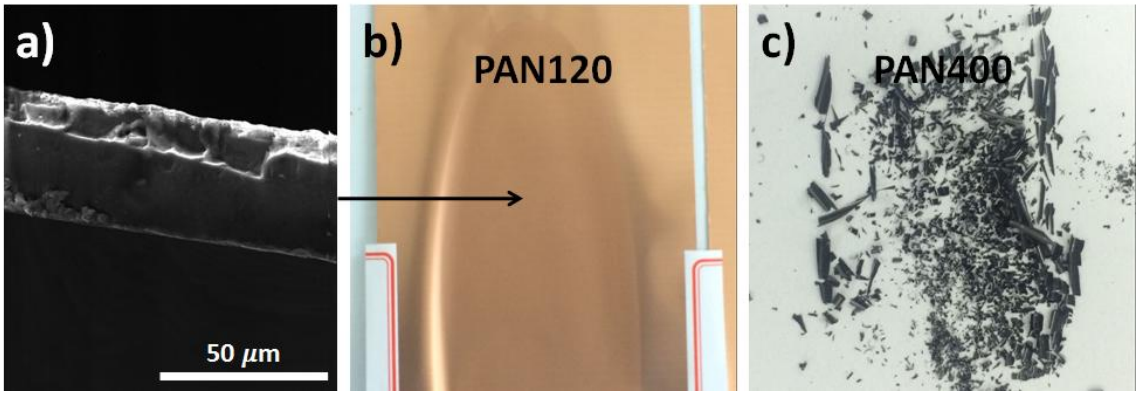

Fig. S8 (a) SEM image and (b) digital photo of the PAN layer prepared at 120 ℃; (c) digital photo of the PAN layer pyrolyzed at 400 ℃, with serious pulverizations.

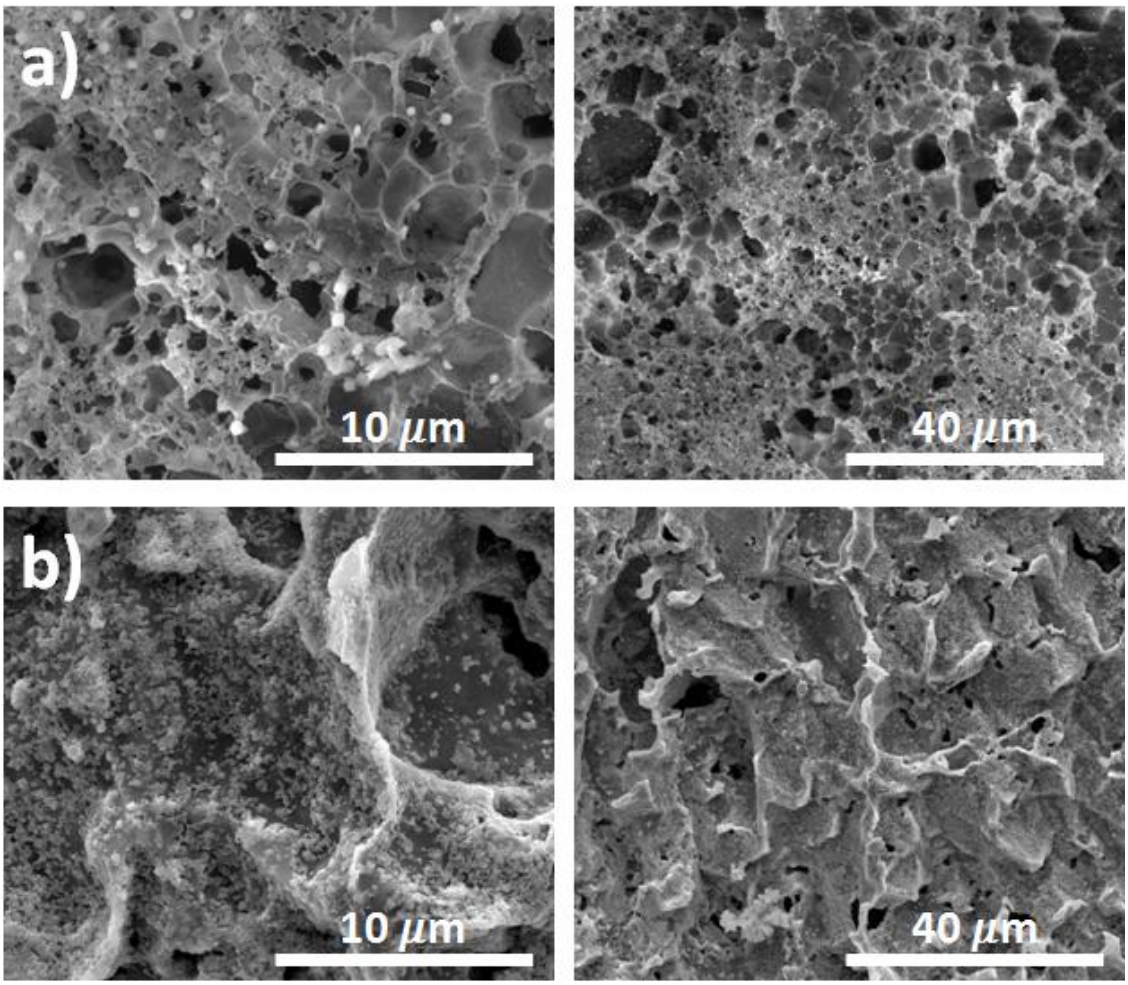

Fig. S9 SEM images of the PAN binder networks prepared at (a) 120 ℃ and (b) 400 ℃, using LiCl to replace LiF in the porous layers followed by the removal in water.

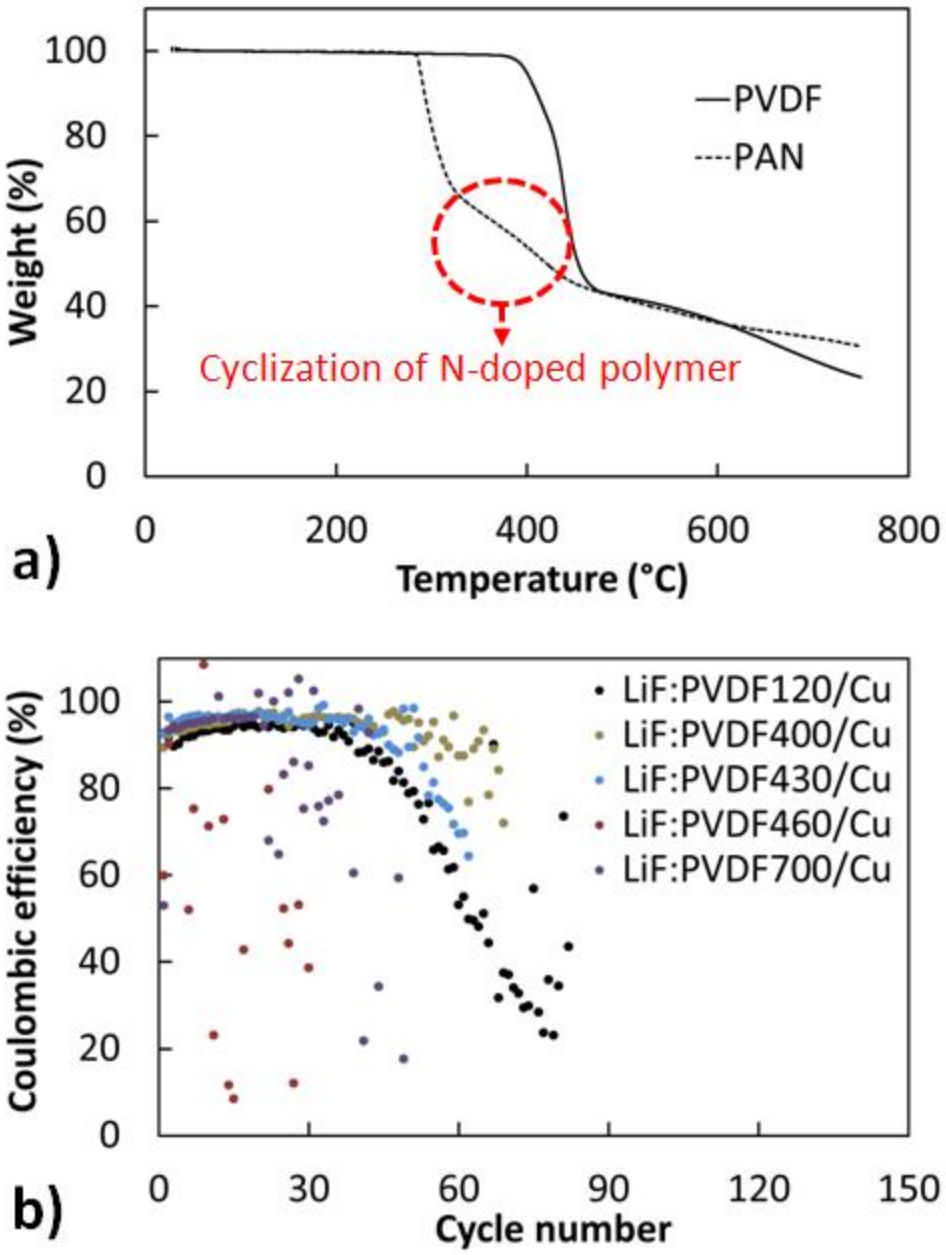

Fig. S10 (a) TG curves of PVDF and PAN; (b) Coulombic efficiencies of Li plating/stripping in the electrodes with porous layers based on PVDF binders prepared at various pyrolysis temperatures.

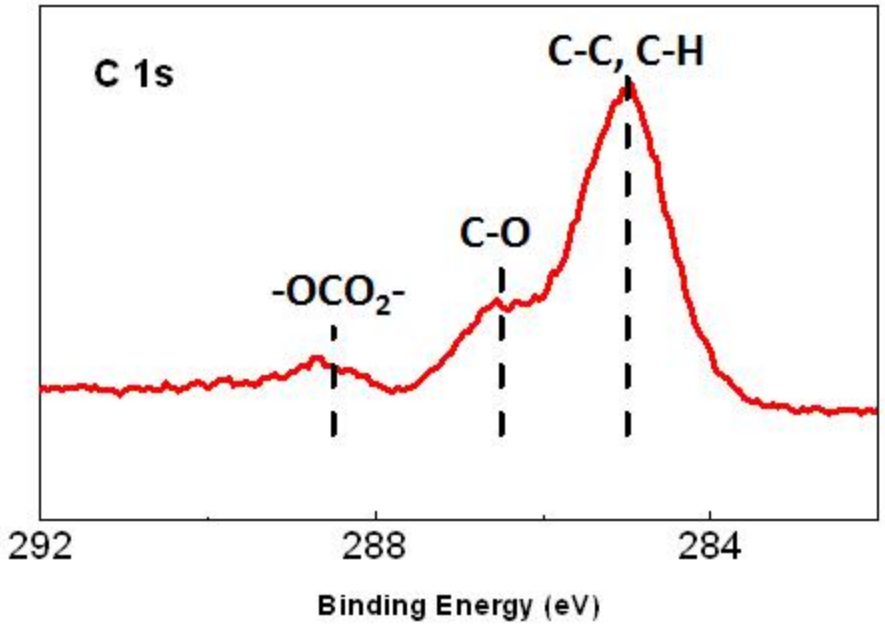

Fig. S11 C 1s XPS spectrum of a typical SEI layer formed on Li metal in carbonate-based electrolyte ($LiPF_6$ in EC:DEC).

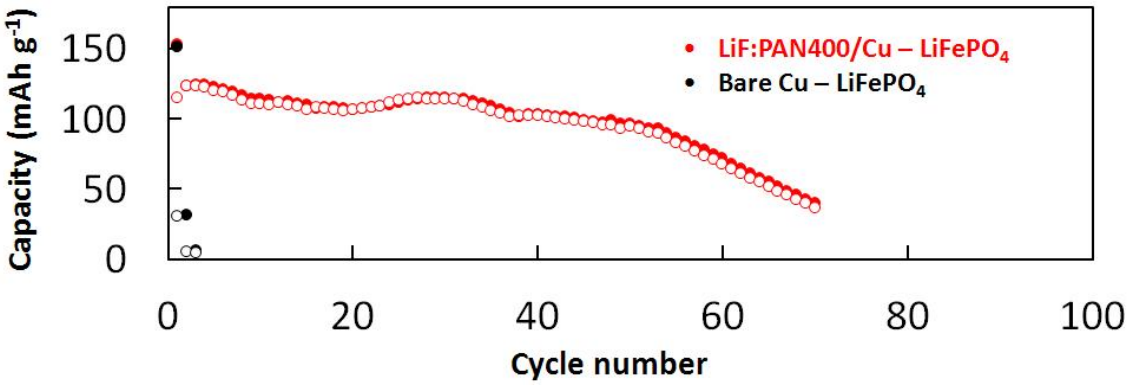

Fig. S12 Charge-discharge capacities of the Cu-$LiFePO_4$ cells with/without the porous layer prepared at 400 ℃, the investigated Cu electrodes are directly paired with $LiFePO_4$ cathodes to construct the "anode-free" batteries. The mass loading of (LiF+PAN400) is ~ 0.35 mg cm^{-2}, on the Cu foil.