Supplementary materials

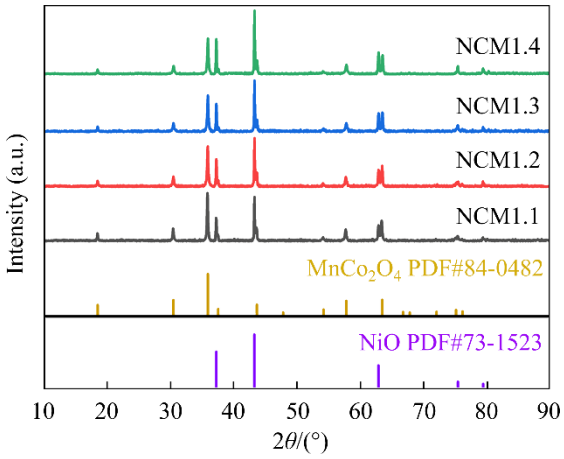

Figure S1 XRD patterns of delithiated materials with different $(NH_4)_2SO_4$ excess coefficients in sulfation roasting

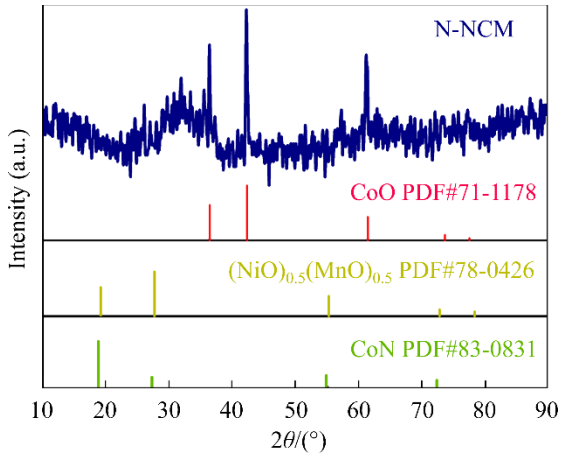

Figure S2 XRD patterns of N-NCM synthesized by N doping at 500 °C

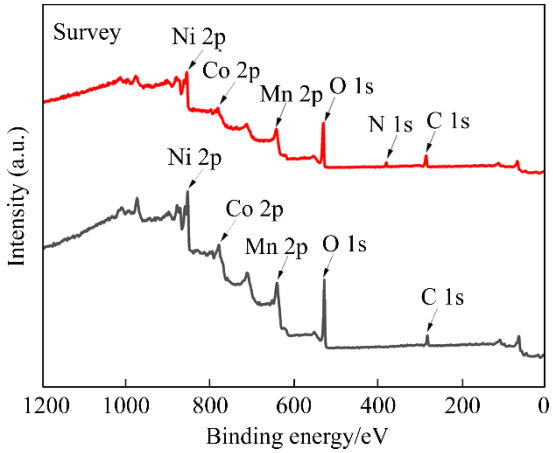

Figure S3 XPS full spectra of the N-NCM and NCM

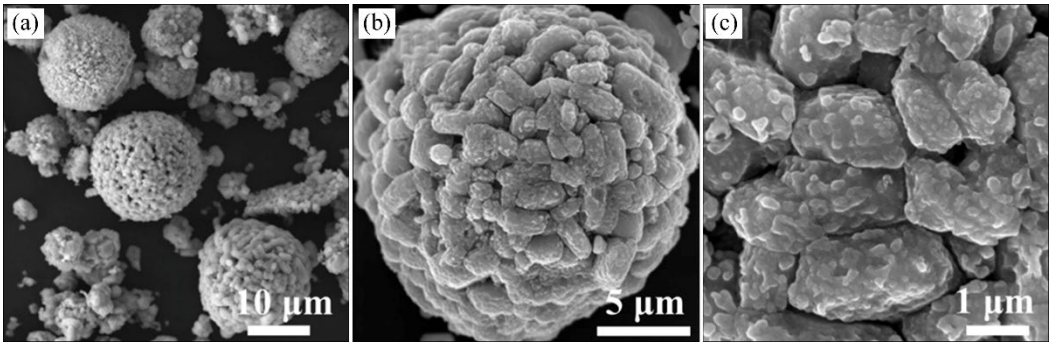

Figure S4 SEM images of N-NCM synthesized by N doping at 500 °C

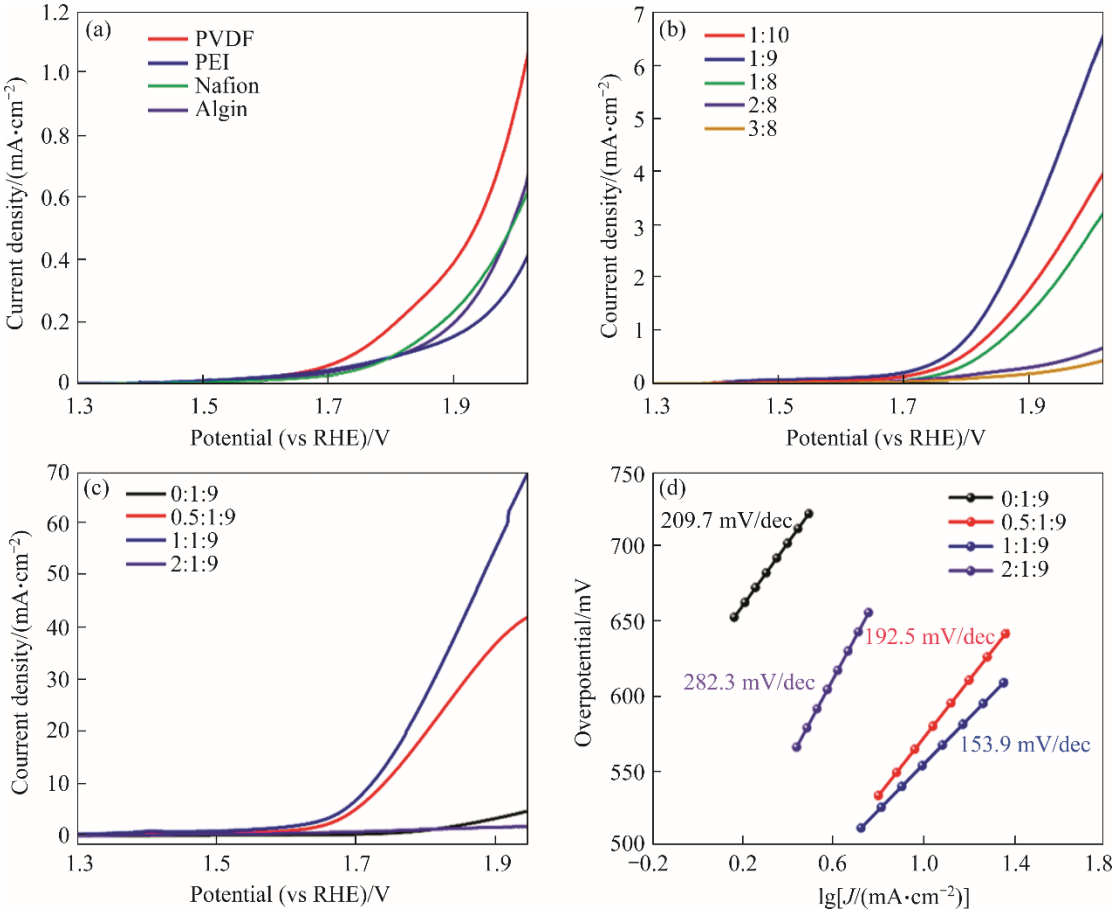

Figure S5 LSV curves of (a) different binders to the delithiated materials, and (b) different mass ratios of binder (PVDF) and delithiated materials; (c) LSV curves of different mass ratios of conductive agent (SP) and delithiated materials; (d) Tafel slope curves of different mass ratios of conductive agent (SP) and delithiated materials (All without IR compensation)

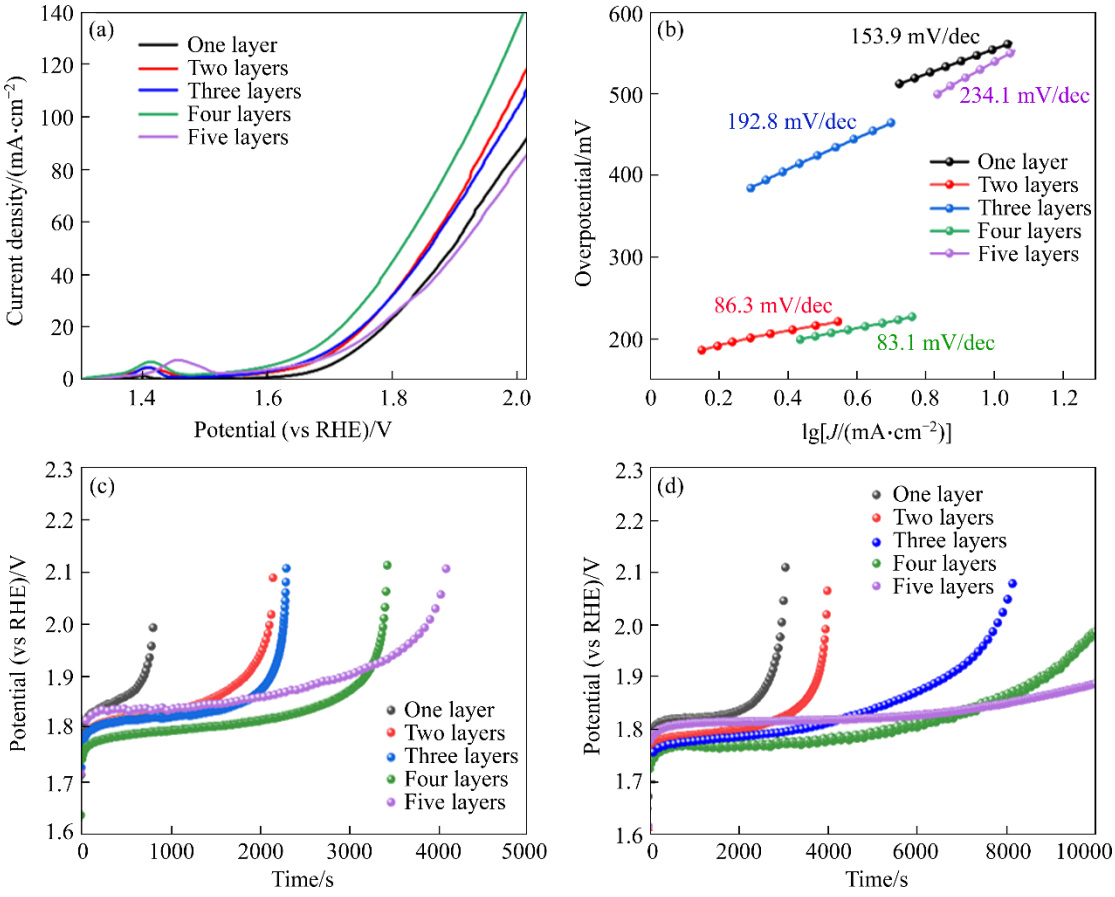

Figure S6 (a) CV curves with different coating number of delithiated materials; (b) LSV curves with different coating number of delithiated materials (without IR compensation); Constant current curves of current density of 25 mA/cm^2 by drying 1 d (c) and 3 d (d)

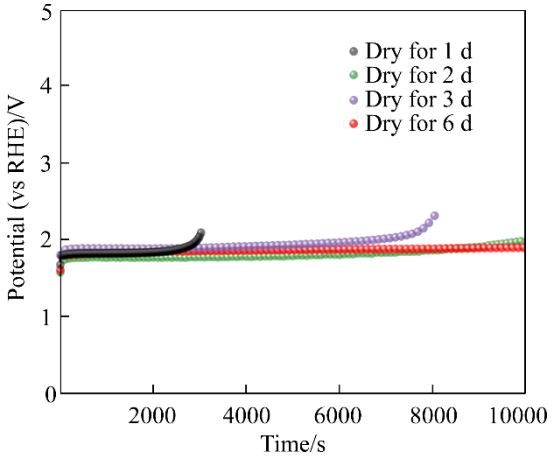

Figure S7 The constant current curves of glassy carbon electrode were dried at 60 °C for different time (current density of 25 mA/cm^2)

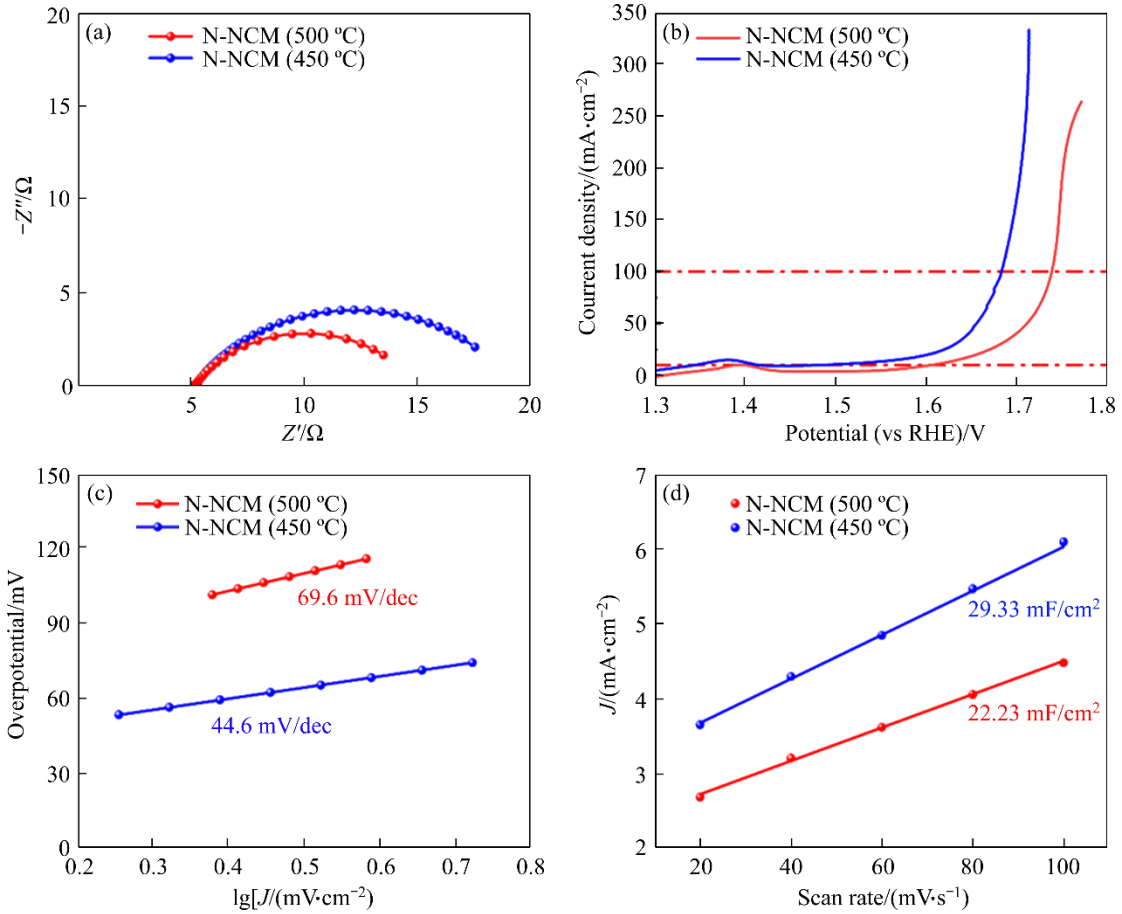

Figure S8 Delithiated materials prepared under different conditions: (a) The EIS curves (the inset is the equivalent circuit used for fitting); (b) The LSV curves of OER (after IR compensation); (c) The Tafel slope curves (after IR compensation); (d) The fitted ECSA curves

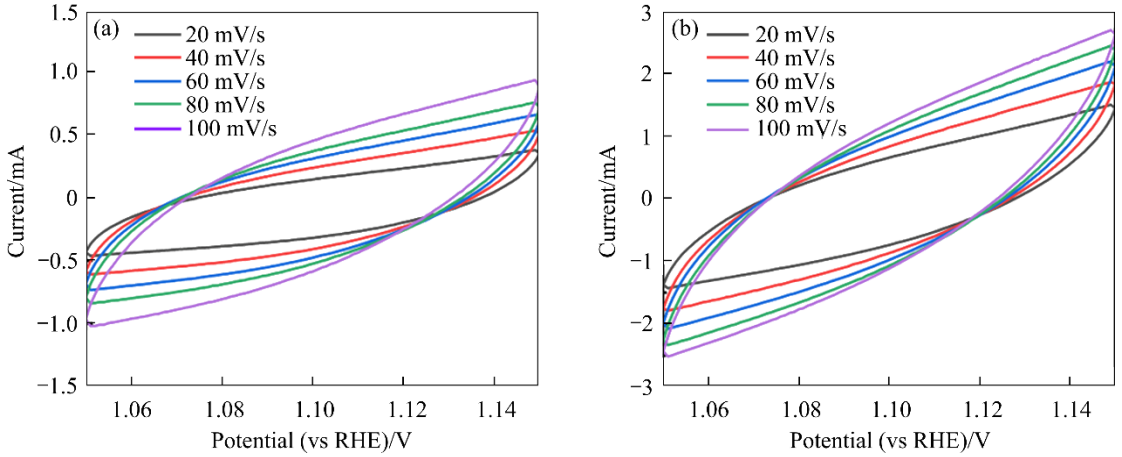

Figure S9 The CV curves obtained at different scanning speeds (the voltage range of 1.05−1.15 V vs SCE): (a) NCM; (b) N-NCM

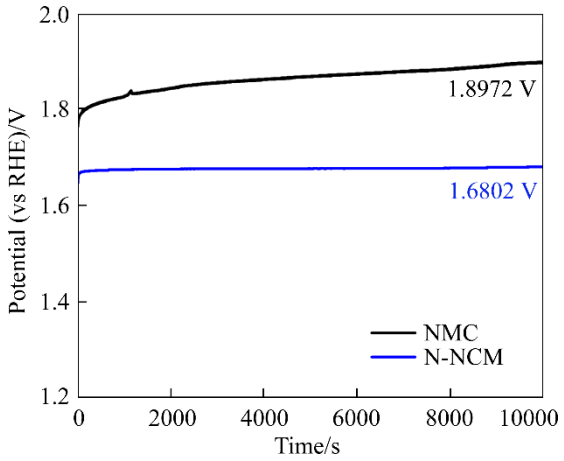

Figure S10 The constant current curves of current density of delithiated materials at 50 mA/cm^2

Table S1 Recovery rate of major elements (Co, Mn, Ni) from solids and Li from solution after sulfation roasting with different $(NH_4)_2SO_4$ excess coefficients wt.%

Element	NCM1.1	NCM1.2	NCM1.3	NCM1.4
Li	97.6536	97.8756	98.001	98.6203
Co	90.0393	90.2325	88.6573	90.0572
Mn	78.7262	69.1670	64.3049	58.2338
Ni	99.1324	99.8306	99.9685	99.9859

Table S2 Specific values of R_s and R_{ct} for each sample in the Nyquist plots

Sample	R_s/Ω	R_{ct}/Ω
GCE	8.6402	5911.54
NCM	5.1882	23.5533
N-NCM	5.1905	18.4571