

## Supporting Information

### A nitrile solvent structure induced stable solid electrolyte interphase for wide-temperature lithium-ion batteries

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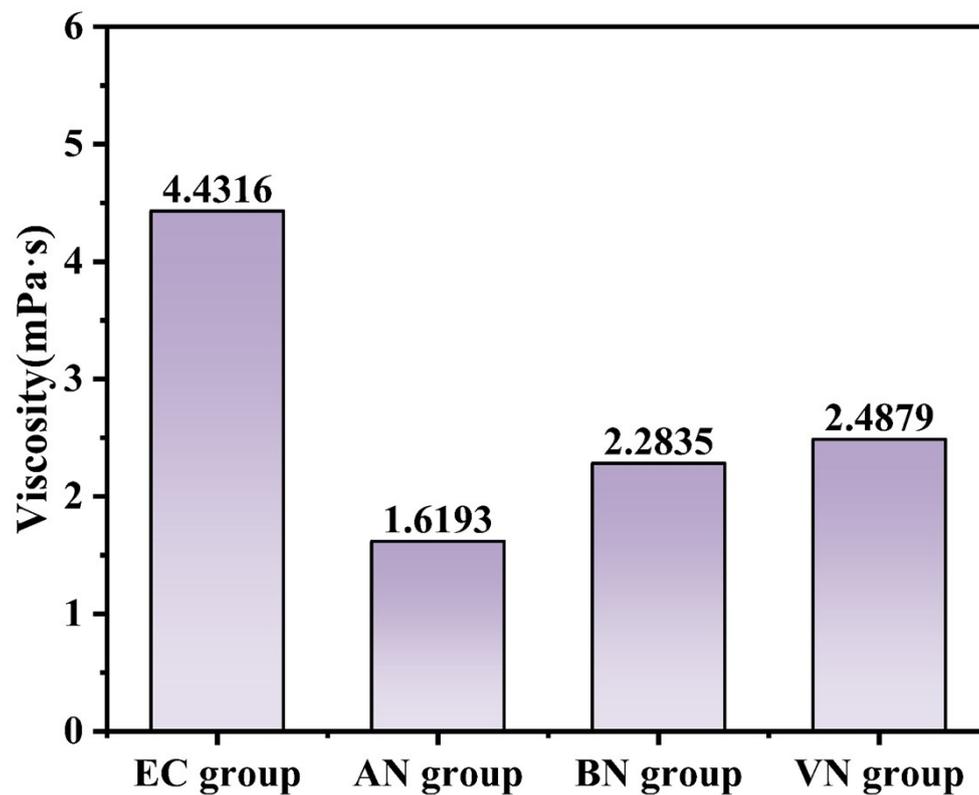
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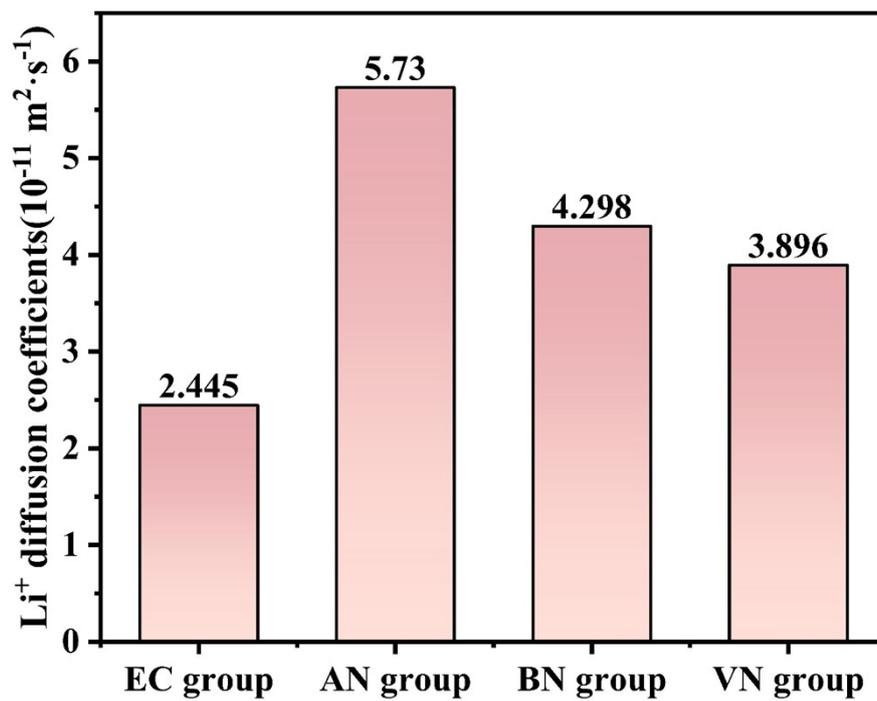
**Keywords:** lithium-ion battery; electrolyte; nitrile solvent; electrode interface; wide temperature

**Table S1.** Physicochemical properties of different solvents

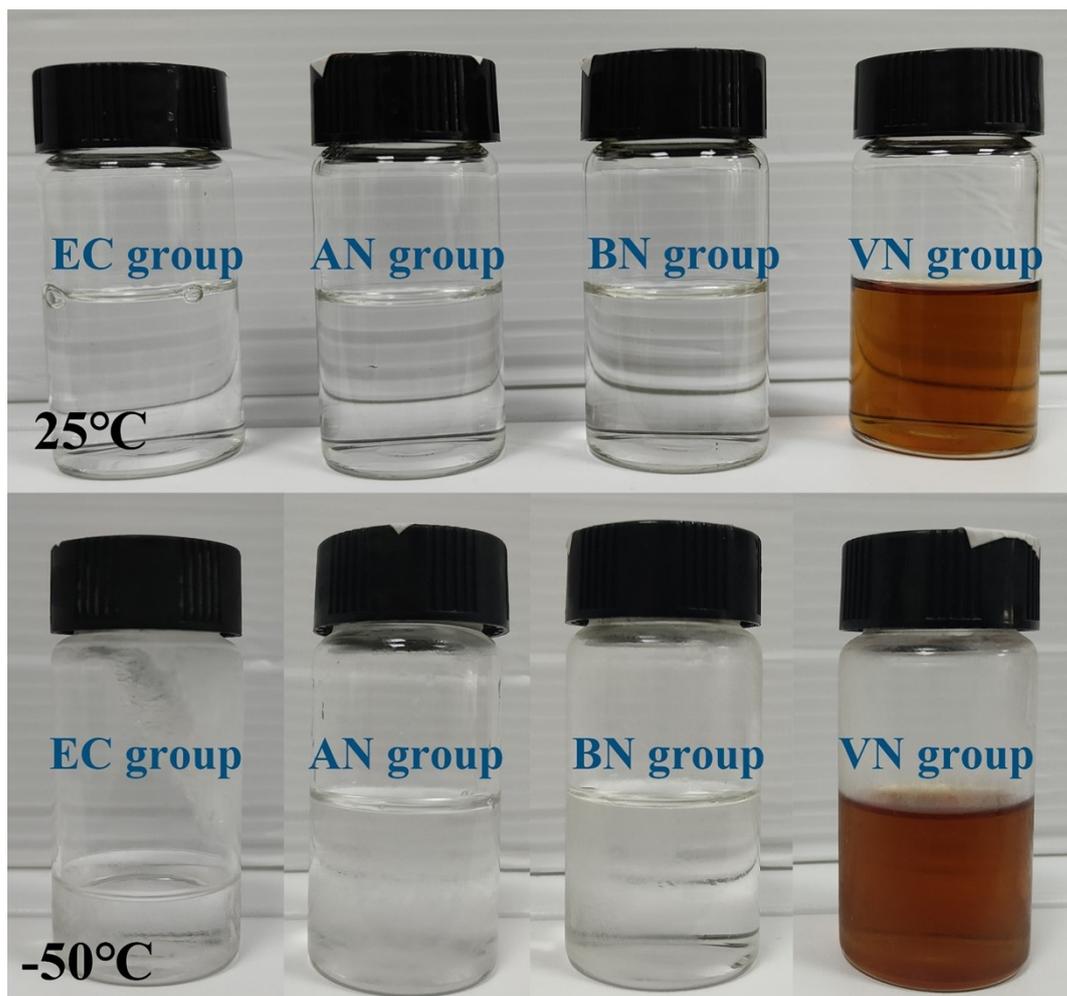
Solvent name /Physical property	Ethylene Carbonate (EC)	Acetonitrile (AN)	Butyronitrile ( BN)	Valeronitrile (VN)
melting point/°C	39	-45	-112	-96.2
boiling point/°C	248	82	117	141.3
density (20°C) g/cm <sup>3</sup>	1.41	0.786	0.794	0.795
Viscosity/mPa·S	1.9(40°C)	0.325 (30°C)	0.515 (30°C)	0.779 (25°C)
dielectric constant c/v·m	89	38.8	20.7	21



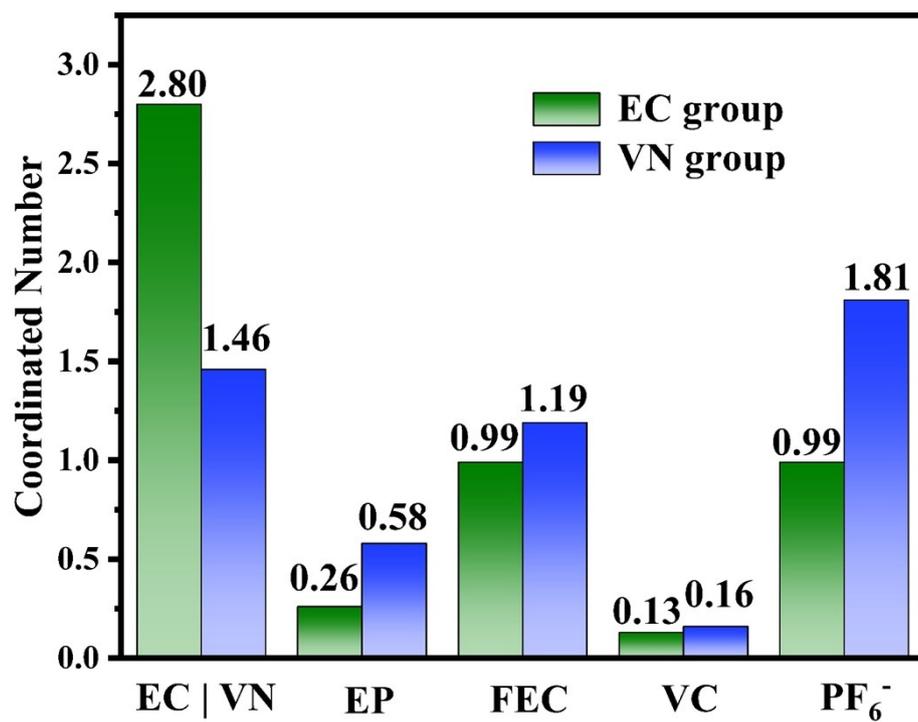
**Figure S1.** The viscosity of different electrolytes at room temperature.



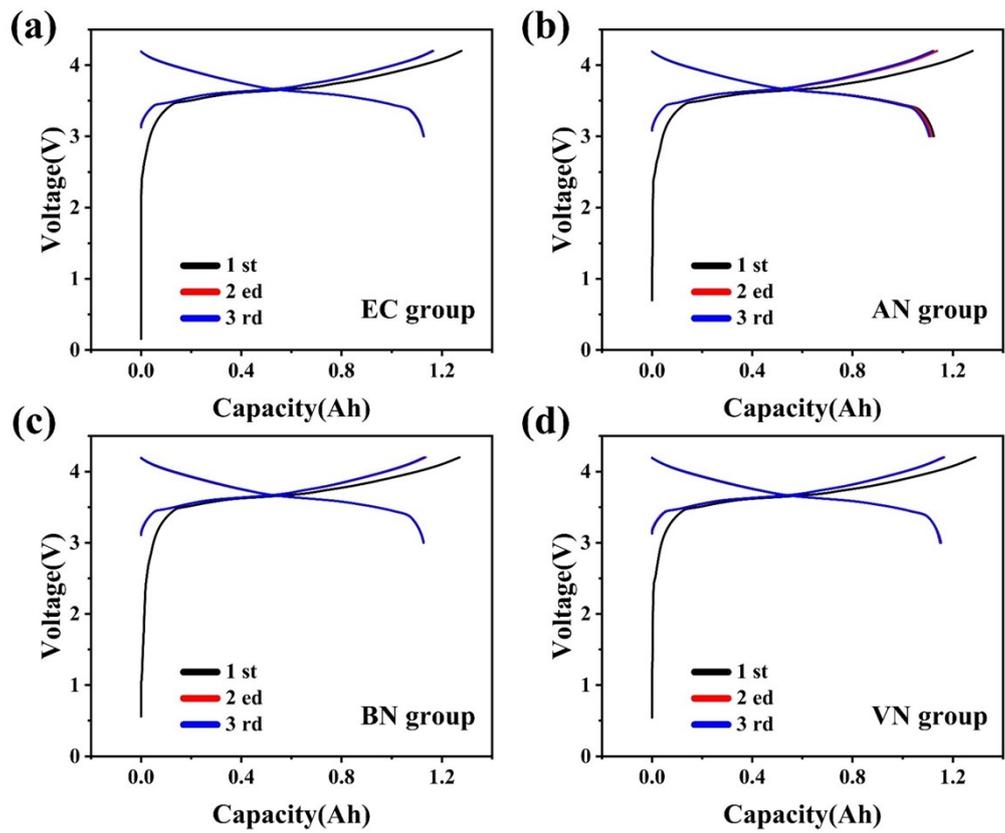
**Figure S2.** The Li<sup>+</sup> diffusion coefficients of different electrolytes at room temperature.



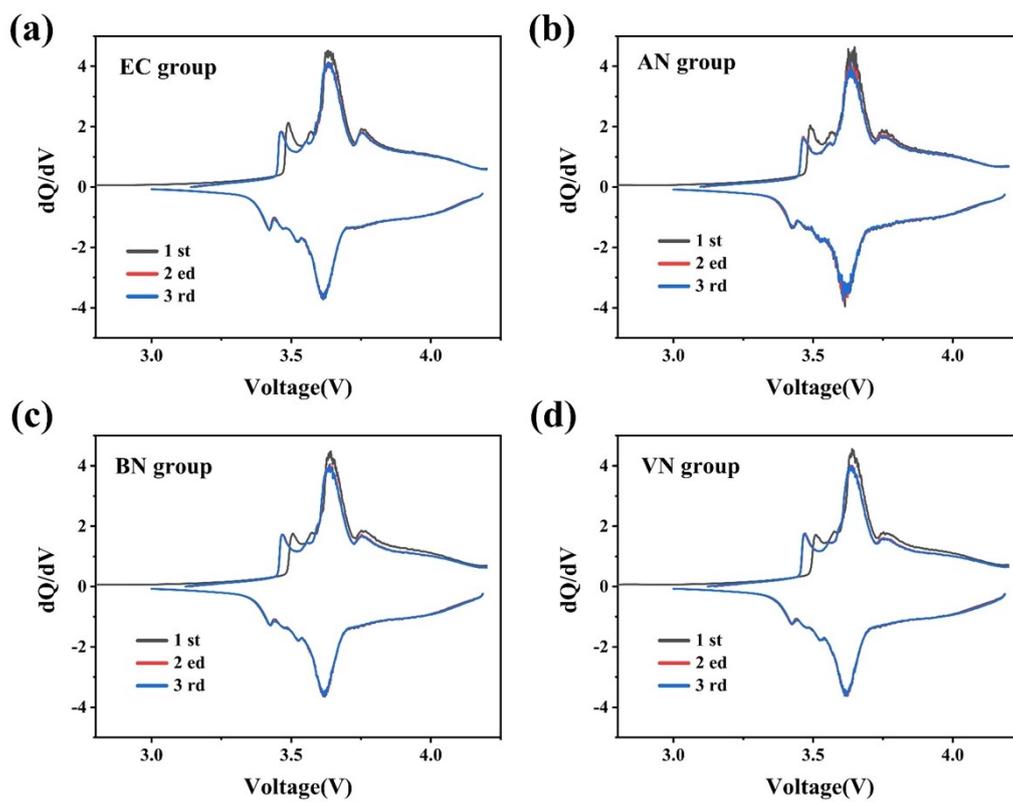
**Figure S3.** The image records of various electrolytes after being statically placed for over 10 hours under the conditions of 25°C and -50°C, respectively



**Figure S4.** The solvent coordination number of EC and VN electrolyte group



**Figure S5.** The capacity and voltage curves of various electrolytes during 3 cycles with 0.1C, (a) EC group, (b) AN group, (C) BN group, (d) VN group



**Figure S6.** The  $dQ/dV$  curves of various electrolytes during 3 cycles with 0.1C, (a) EC group, (b) AN group, (c) BN group, (d) VN group

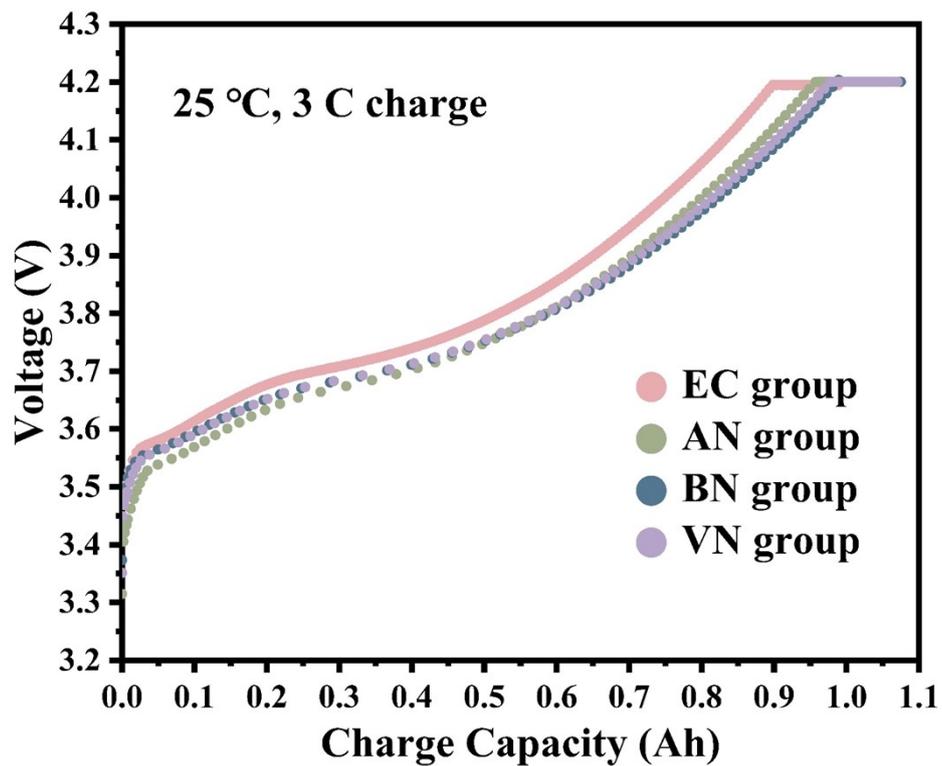
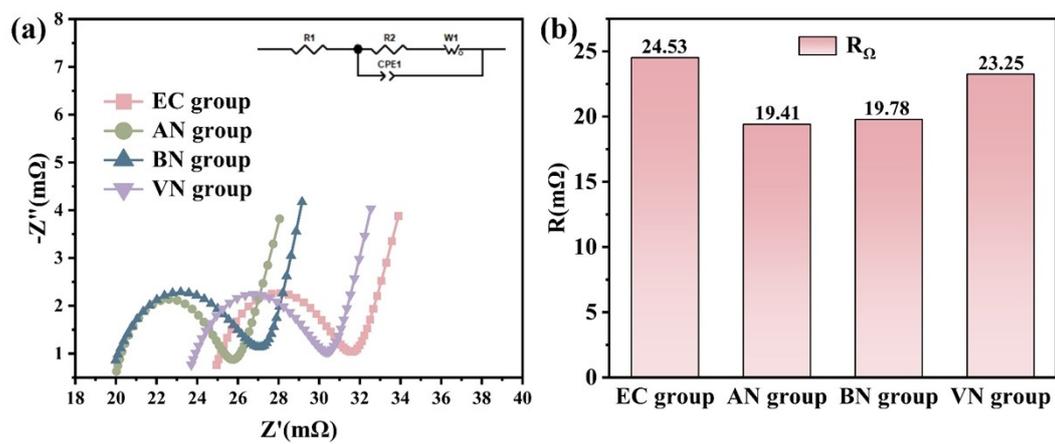
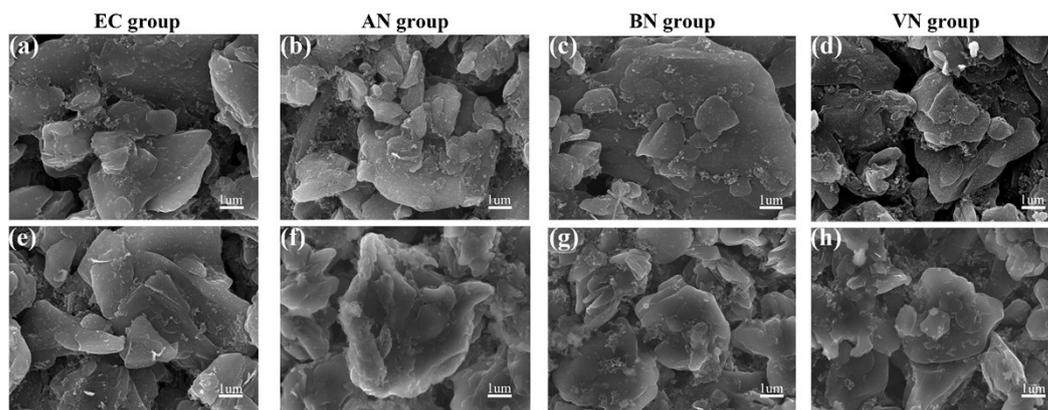


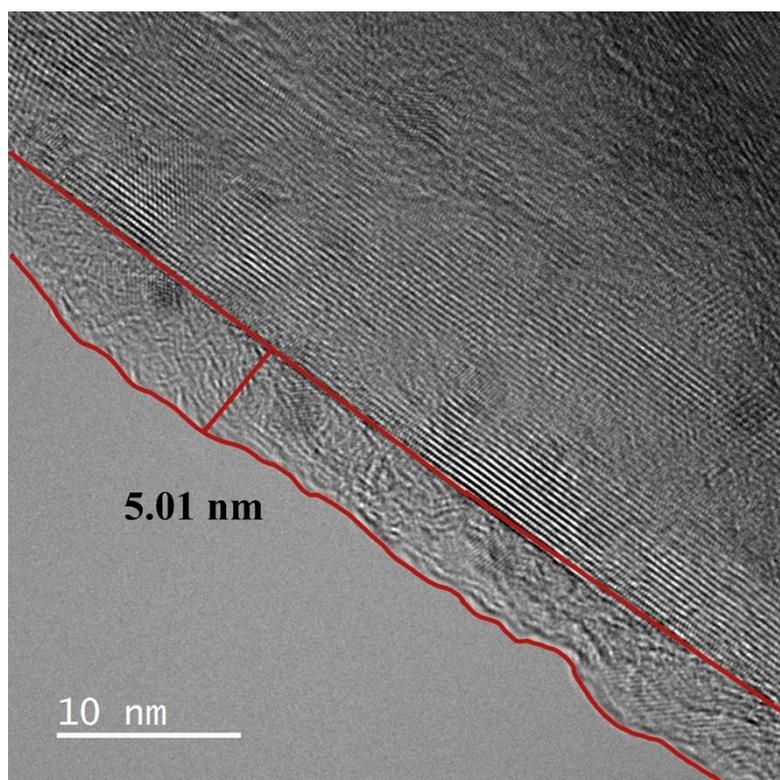
Figure S7. Charging curves of different electrolytes with 3 C at room temperature.



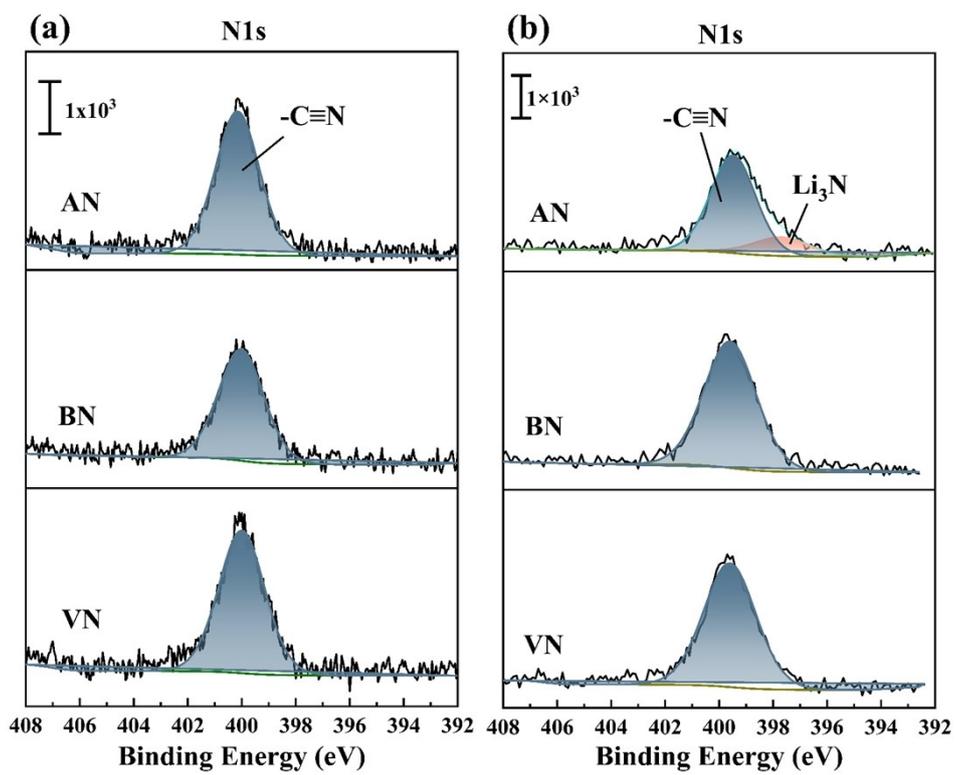
**Figure S8.** (a) The electrochemical impedance spectroscopy (EIS) of each electrolyte, (b) Ohmic internal resistance values of different groups



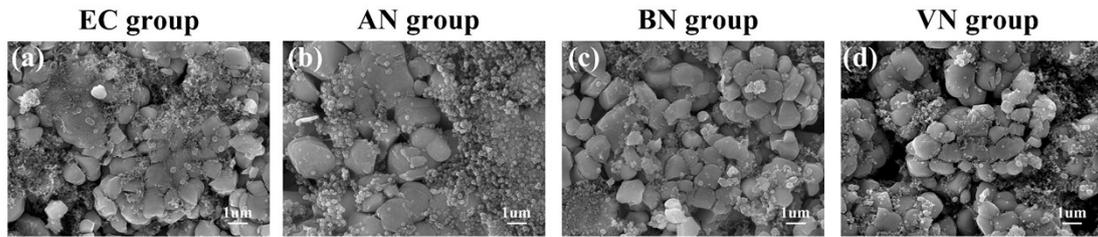
**Figure S9.** Scanning Electron Microscopy (SEM) images of graphite electrode after 1 cycle(a-d) and 10 cycles(e-h) of cycling



**Figure S10.** TEM image of the anode of AN electrolyte after 1 cycle



**Figure S11.** N1s spectrum of anode XPS: (a) after capacity grading and (b) after 10 cycles



**Figure S12.** Scanning Electron Microscopy (SEM) images of NCM523 electrode after 1 cycle