Isomorphismcombined with intercalation methods to construct hybrid electrode material forhigh-energy storage capacitor

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1. Electrochemical characterization and test

Three-electrode equipment: the electrochemical studies of PM and PZM were first carried out in3.0 M KOH electrolyte solution. The electrochemical performances were measured with an electrochemical workstation (CHI 660E). Cyclic voltammetry (CV) tests were done between -0.2 and 0.6 V for electrodes at scan rates of 10, 20, 30, 40, and 50 $mV \cdot s^{-1}$. Following procedures is the preparing of working electrodes: the synthesized active material (PM and PZM), carbon black and PTFE were mixed homogeneously with ethanol by sonication (a mass ratio of 80:15:5). Then the mixture was coated on nickel foams ($1 \times 1 cm^2$). After dried at 55°C in vacuum for 12 h, the nickel foams were pressed under 15MPa for 20s. The loading mass of the active materials was measured. Galvanostatic charge-discharge (GCD) was employed to examine the specific capacitance of the electrode. According to the following equation, the single electrode capacitance was calculated from the GCD curves. And the Electrochemical Impedance Spectroscopy (EIS) measurements were carried out in

the different frequency.

$$C_s = \frac{I\Delta t}{m\Delta V} \quad \textbf{(1)}$$

The two-electrode asymmetric supercapacitor (ASC) of PZM//AC was built in 3.0 M KOH electrolyte. The mass of active sample: acetylene black: PTFE binder=80:15:5. In addition, Nickel foam (1×1 cm^2) served as the current collector. Specific capacitances derived from galvanostatic tests can be calculated from the equation:

$$SE = \frac{C\Delta V^2}{7.2} \quad \textbf{(2)}$$

$$SP = \frac{3600 * SE}{\Delta t} \quad \textbf{(3)}$$

The C_s, I, m, Δt and ΔV refer to the specific capacitance ($F \cdot g^{-1}$), current density (A), charge-discharge time(s), mass of active materials (g) and potential (V), respectively. The SE and SP refer to the specific energy density ($Wh \cdot kg^{-1}$) and specific power density ($W \cdot kg^{-1}$).

2. Figure

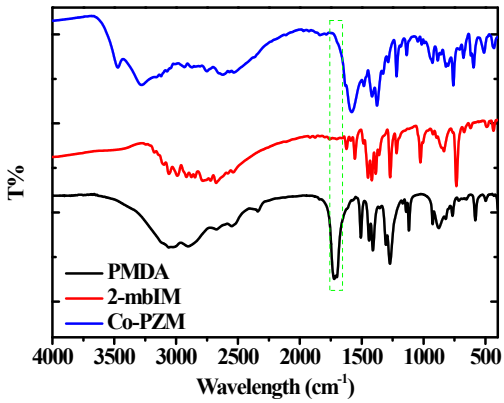

Figure S1 Infrared spectrum of PMDA, 2-mbIM and Co-PZM.

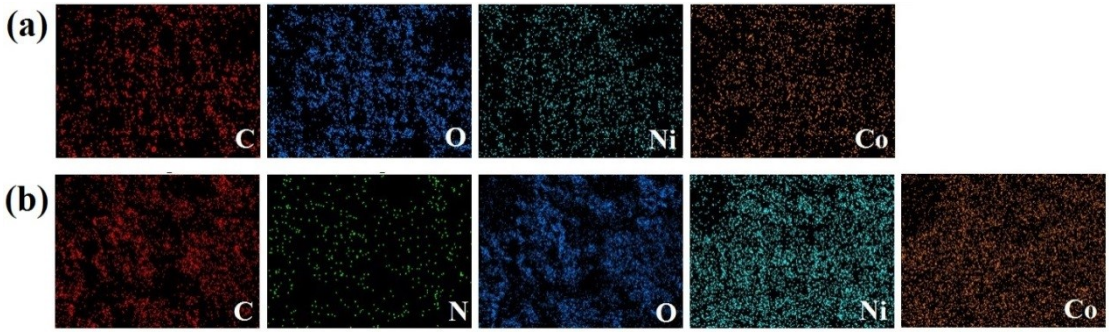

Figure S2 EDS mapping of (a) PM, (b) PZM.

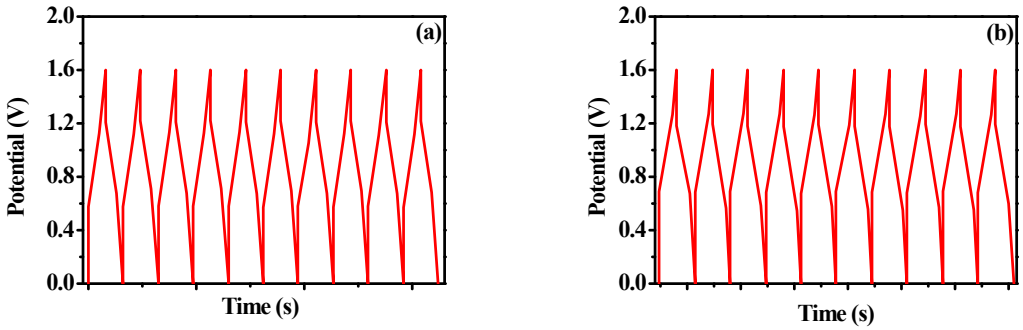

Figure S3 GCD curves of PZM//AC ASC at a current density of 10 $A \cdot g^{-1}$: **(a)** the first ten cycles, **(b)** the last ten cycles.

3. Table

Table S1 Phase Data and Atomic Parameters for Co-PZM;

Phase data	
Space-group	P-1 (2) - triclinic
Cell	a=7.0903(8) Å; b=9.6953(11) Å; c=10.7313(12) Å; α=93.062(3)°; β=104.142(3)°; γ=107.964(3)°; V=673.80(13) Å^3; Z=1

Atomic parameters						
Atom	**Wyck.**	**Site**	**x/a**	**y/b**	**z/c**	**U [Å^2]**
C1	*2i*	1	0.3630(2)	1.03048(14)	0.71223(12)	
C3	*2i*	1	0.1730(2)	1.01379(14)	0.60321(12)	
C4	*2i*	1	0.1894(2)	1.02188(15)	0.47635(13)	
H4	*2i*	1	0.32049	1.0361	0.46268	0.022
C5	*2i*	1	-0.0191(2)	0.99142(14)	0.62608(12)	
C9	*2i*	1	-0.0486(2)	0.98837(16)	0.76105(12)	
C10	*2i*	1	0.2705(3)	0.5135(3)	0.1511(2)	
H10D	*2i*	1	0.13223	0.49181	0.09745	0.075
H10E	*2i*	1	0.32448	0.43903	0.12868	0.075
H10F	*2i*	1	0.35524	0.60683	0.13772	0.075
C11	*2i*	1	0.2700(3)	0.51764(19)	0.28915(18)	
C12	*2i*	1	0.2216(2)	0.44658(17)	0.47468(16)	
C13	*2i*	1	0.1696(3)	0.37110(18)	0.57387(17)	
H13	*2i*	1	0.11375	0.26948	0.56176	0.04
C14	*2i*	1	0.2041(3)	0.4528(2)	0.69156(18)	
H14	*2i*	1	0.17053	0.40521	0.76012	0.045
C15	*2i*	1	0.2887(3)	0.6059(2)	0.70991(19)	
H15	*2i*	1	0.31117	0.65782	0.7906	0.048
C16	*2i*	1	0.3390(3)	0.68081(19)	0.61115(19)	
H16	*2i*	1	0.39544	0.7824	0.62337	0.046
C17	*2i*	1	0.3021(2)	0.59883(17)	0.49232(17)	
Co1	*1d*	-1	1/2	1	1	
N1	*2i*	1	0.3289(2)	0.63806(16)	0.37426(16)	
H1	*2i*	1	0.37606	0.72628	0.35833	0.043
N2	*2i*	1	0.2061(2)	0.40079(15)	0.34697(14)	
H2	*2i*	1	0.16215	0.31122	0.31086	0.038
O1	*2i*	1	0.33012(15)	0.97073(12)	0.80956(9)	
O2	*2i*	1	0.53569(16)	1.09672(13)	0.69844(11)	
O3	*2i*	1	-0.13591(18)	0.86448(12)	0.78957(10)	

O4	*2i*	1	0.00775(16)	1.10772(12)	0.83141(9)	
O9	*2i*	1	0.63803(16)	0.84112(11)	0.96793(9)	
H9	*2i*	1	0.73444	0.84854	1.03132	0.037
H12	*2i*	1	0.68846	0.85765	0.90604	0.037
O10	*2i*	1	0.22512(17)	0.83497(12)	1.01171(11)	
H10B	*2i*	1	0.11259	0.83192	0.93928	0.045
H10C	*2i*	1	0.19447	0.85783	1.09107	0.045

Table S2 Summary report: the surface area, pore volume and median pore width of PZM and PM;

	Summary Report	PZM	PM
Surface Area	BET Surface Area	145	39
	Langmuir Surface Area	209	56
Horvath-Kawazoe	Median pore width	12Å	13 Å