Nickel nanocrystal/nitrogen-doped carbon composites as efficient and carbon monoxide-resistant electrocatalysts for methanol oxidation reaction

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Electronic Supplementary Information

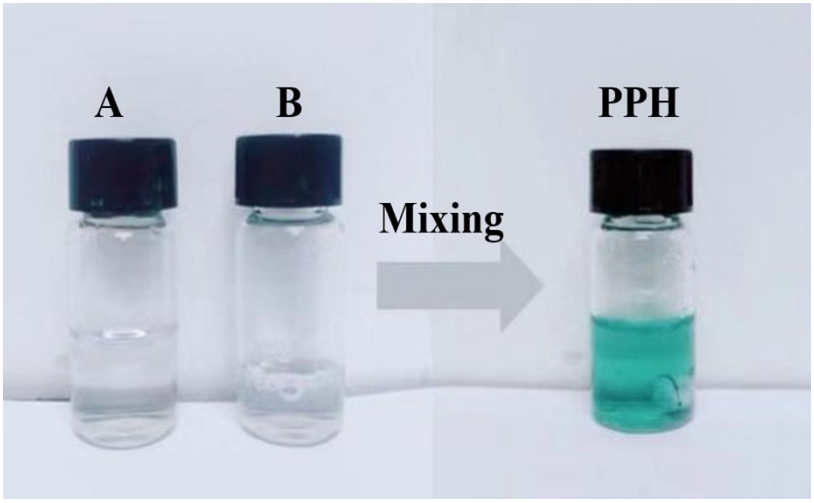


Fig. S1. The photographs of polyaniline-polyvinyl alcohol hydrogel synthesis. Immediately after mixing solution A and B, the mixture turns into blue color, indicating the formation of polyaniline.

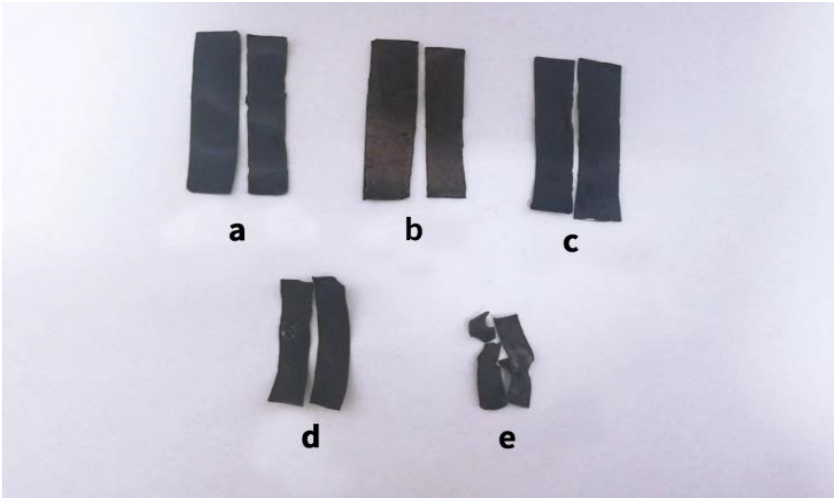


Fig. S2. The photographs of samples during the five synthesis steps. a) as-prepared PPH hydrogel; b) after ammonia solution treatment; c) after absorption of $NiCl_2$ salt; d) after freeze-drying; e) after calcination.

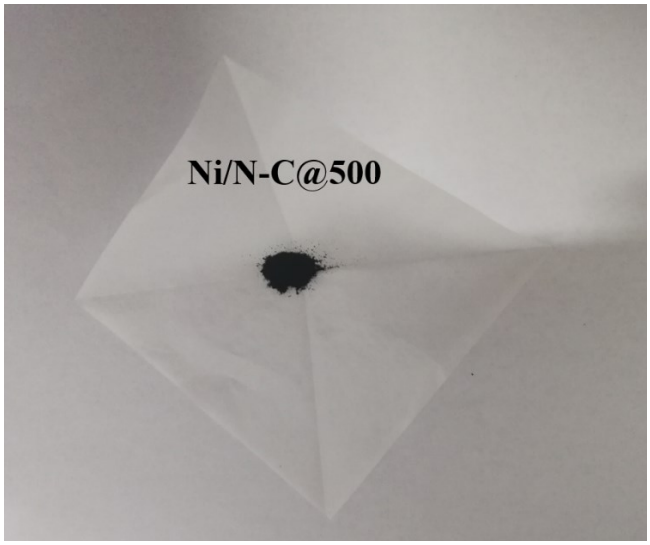


Fig. S3. The photograph of Ni/N-C@500 powders.

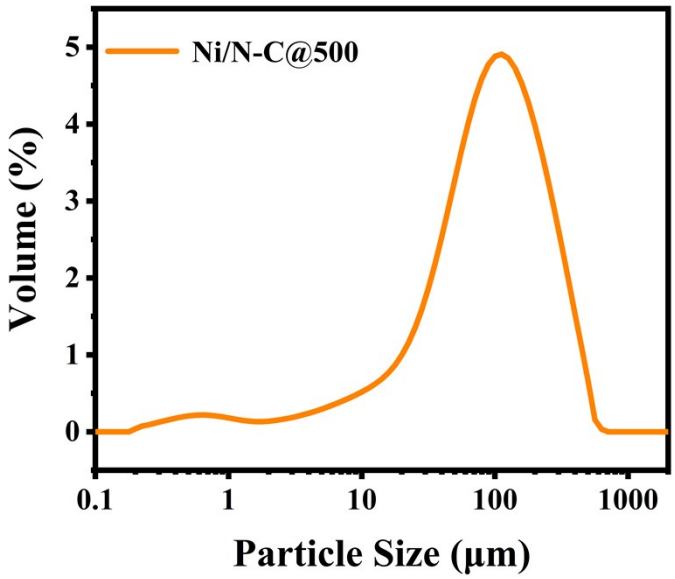


Fig. S4. The particle size distribution of Ni/N-C@500.

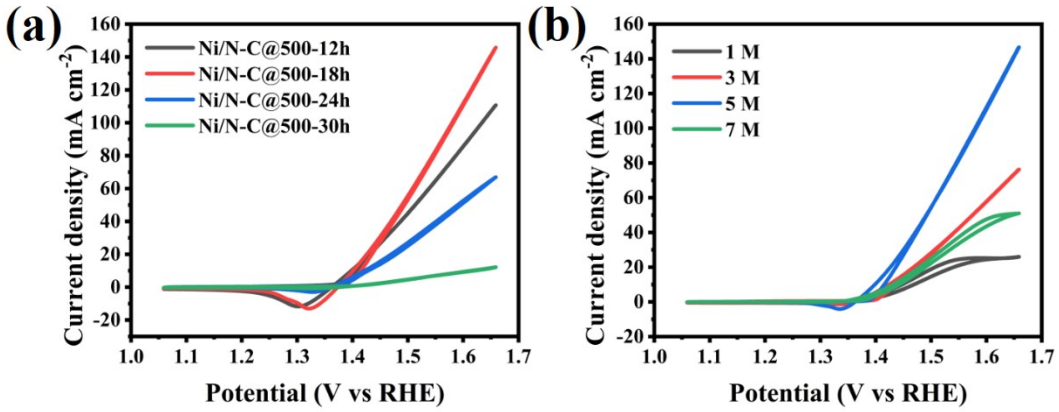


Fig. S5. CV curves of the electrocatalysts prepared (a) with different soaking time and (b) with different concentration of nickel chloride solution. The CV curves were measured at 10 mV s^{-1} in 1 mol L^{-1} KOH and 1.0 mol L^{-1} methanol.

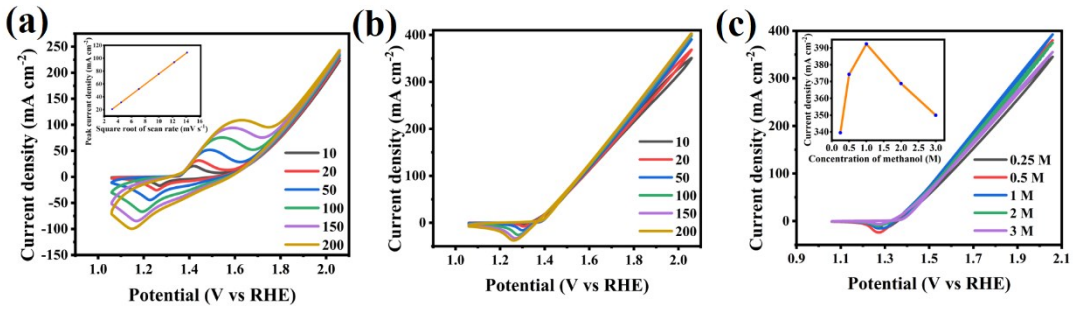


Fig. S6. Electrochemical characterization of Ni/N-C@500 in different electrolyte solutions. (a) CV curves of Ni/N-C@500 in 1 M KOH and (b) in 1 M KOH with 1 M methanol at different scan rate (10-200 mV s^{-1}). Inset of (a) shows the relation between the oxidation peak current and the square root of the scan rate. (c) CV curves of Ni/N-C@500 in 1 M KOH solution with different concentration of methanol (0.25-3 M, scan rate: 50 mV s^{-1}). Inset of (c) shows the relation between the oxidation peak current and the different concentration of methanol.

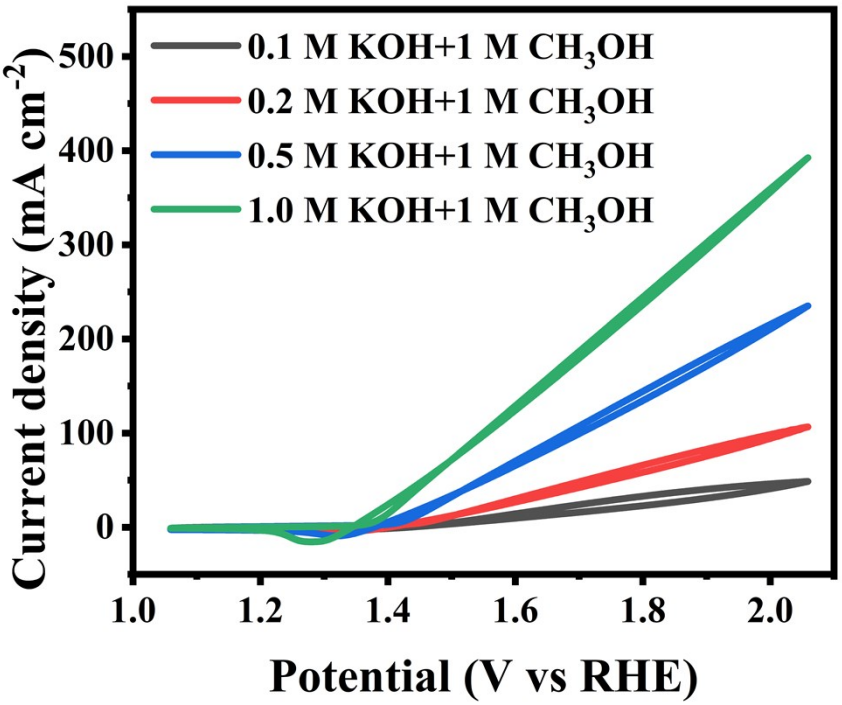


Fig. S7. CV curves of Ni/N-C@500 in 1 M methanol solution with different concentration of KOH (0.1-1 M, scan rate: 50 mV s^{-1}).

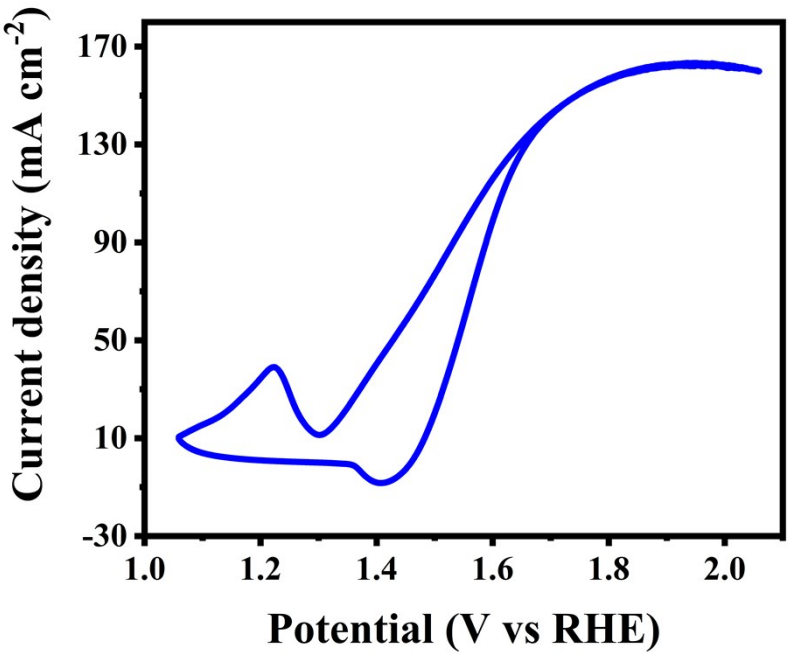


Fig. S8. CV curve of Ni/N-C@500 in 1M KOH and 1 M methanol solution subtracts the CV curve of Ni/N-C@500 in 1M KOH (scan rate: 50 mV s^{-1}).

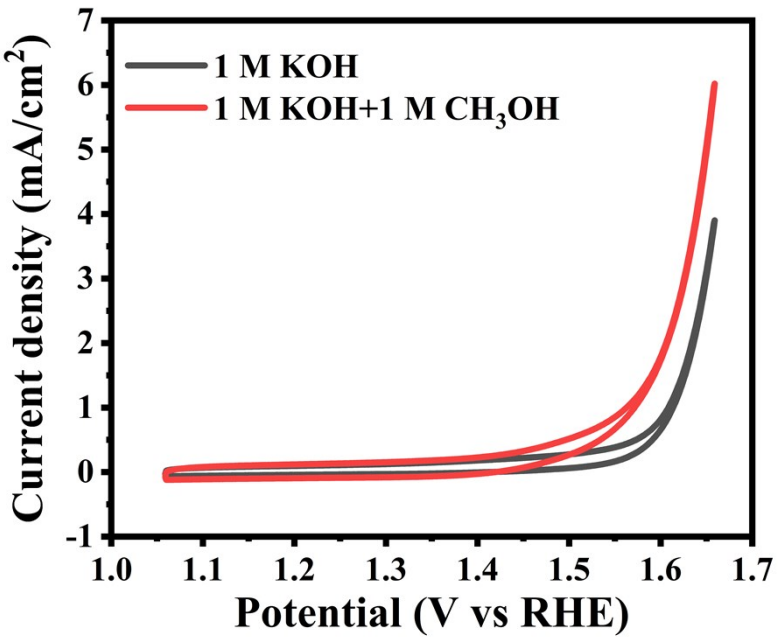
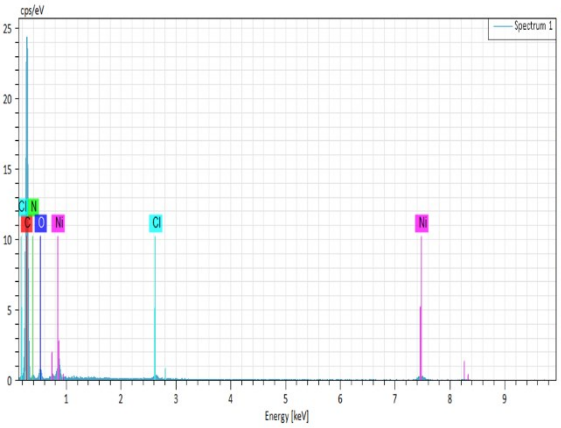


Fig. S9. CV curves of the N-C@500 in 1 M KOH and 1 M methanol solution.



Spectrum 1

ELEMENT	ATOMIC NUMBER	NET WORTH	QUALITY[%]	NORMALIZED MASS[%]	ATOM
C	6	22697	78.31	78.31	85.93
O	8	859	7.78	7.78	6.41
Ni	28	815	7.06	7.06	1.59
N	7	246	6.21	6.21	5.85
Cl	17	525	0.63	0.63	0.24
		TOTAL:	100.00	100.00	100.00

Fig. S10. EDS spectra of Ni/N-C@500.

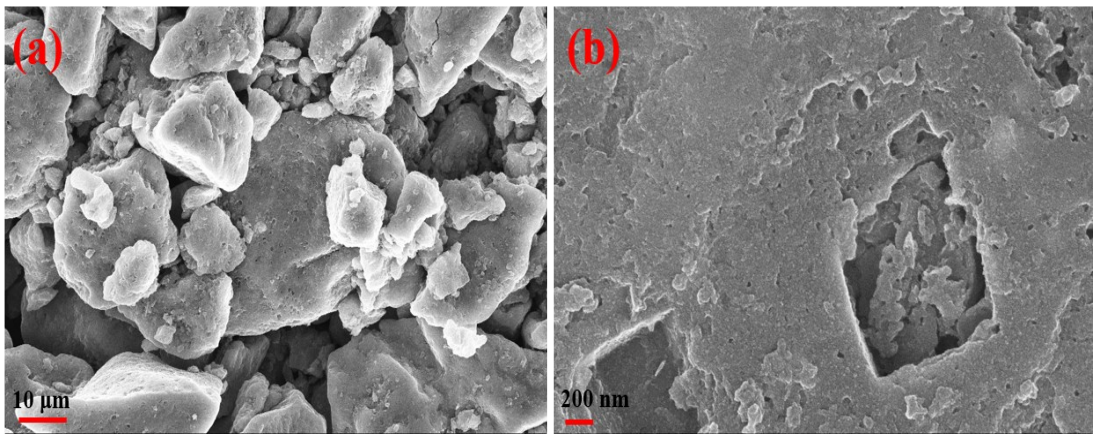


Fig. S11. SEM images of Ni/N-C@500 electrocatalyst after 12-h MOR test.

Table S1. Comparison of the Ni/N-C composites prepared at different pyrolysis temperatures.

pyrolysis temperature (°C)	current density for MOR (mA cm^{-2})	C_{dl} (mF cm^{-2})	ECSA
400	73.5	3.2	80
500	147	4.29	107
600	97.6	3.62	90.5

The current densities were taken at a fixed potential of 0.6 V vs SCE.