Supporting Information

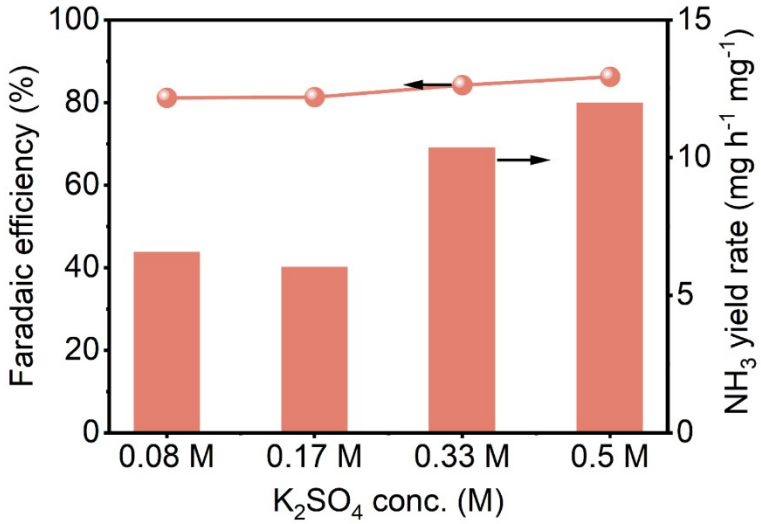

Fig. S1 Effect of K_2SO_4 concentration on the Faradaic efficiency of SNC catalyst under neutral pH conditions. The performance shows gradual improvement with increasing electrolyte concentration, reaching 86.2% FE at 0.5 M K_2SO_4, which demonstrates the catalyst's adaptability under different pH environments. Higher concentrations (0.08-0.5 M) show further enhancement, indicating that the catalyst maintains good activity even under high ionic strength conditions.

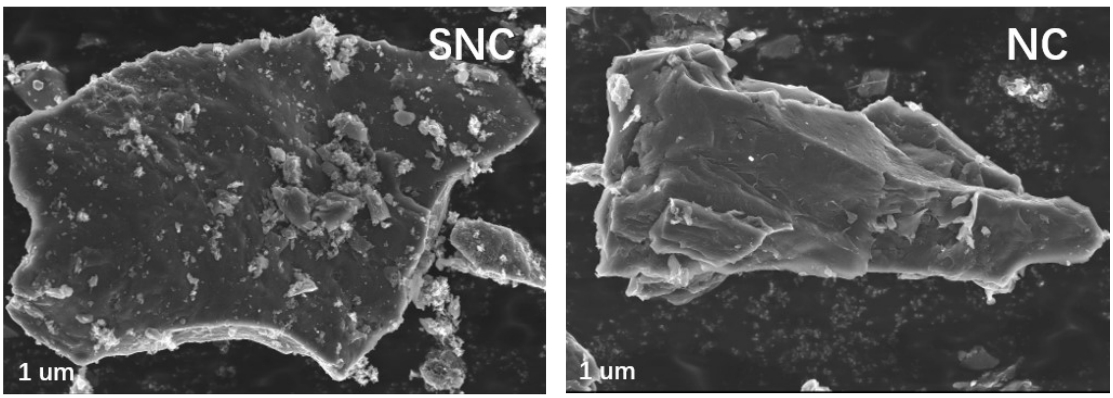

Fig. S2 SEM of SNC and NC catalysts.

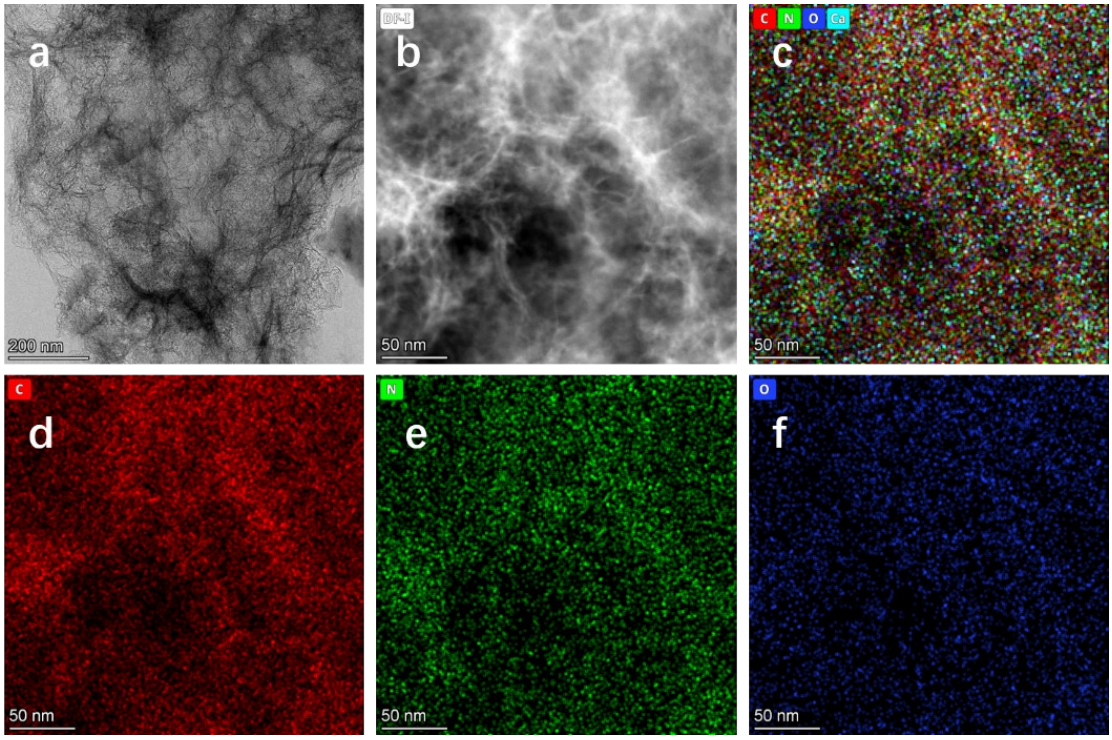

Fig. S3 HRTEM and EDS mapping of NC.

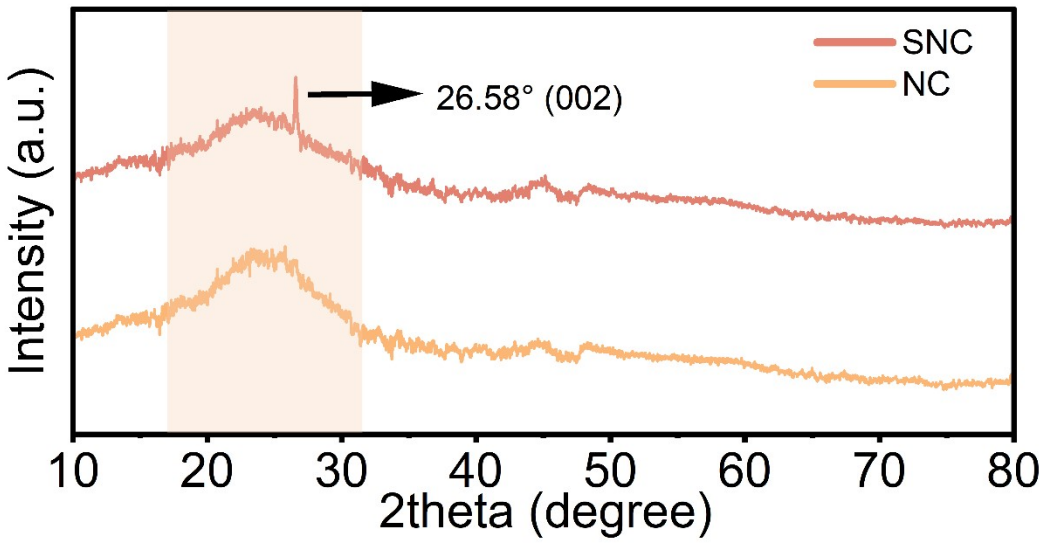

Fig. S4 XRD of SNC and NC.

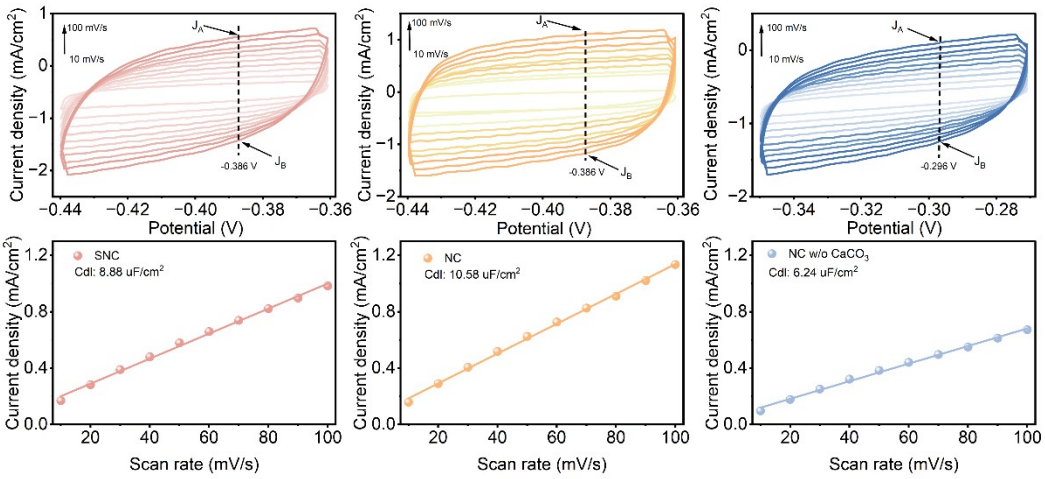

Fig. S5 CV for the determination of ECSA. (a–c) CV in the non-Faradaic region, and (d–f) capacitive current differences, $(J_A - J_B)/2$, as a function of the CV scan rates in (a, d) SNC (b, e) NC, and (c, f) NC w/o $CaCO_3$

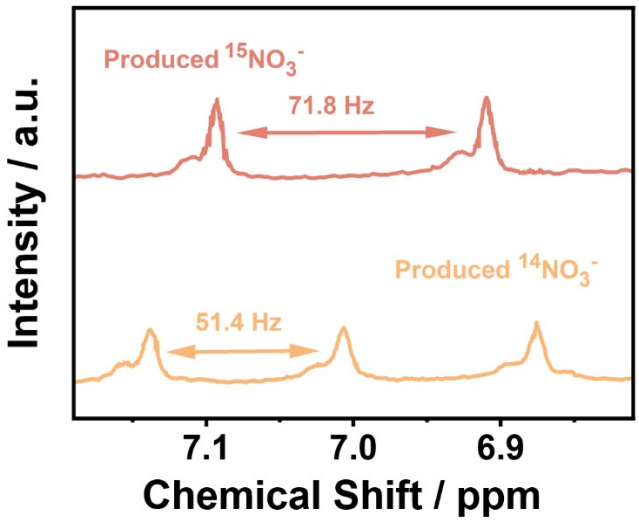

Fig. S6 1H NMR test of produced ammonia using $K^{14}NO_3$ and $K^{15}NO_3$ as nitrogen sources.

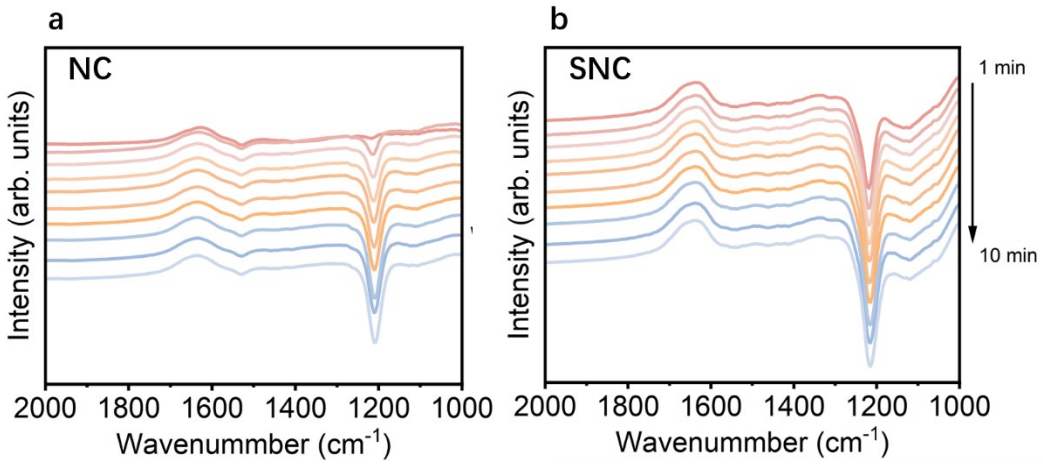

Fig. S7 Time-dependent in situ ATR-FTIR spectra of SNC and NC.

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Table S1. Chemical compositions of samples characterised via XPS

Samples	Elements	States	Percentages (%)
SNC	C1s	C-C / C=C	66.0
		C-N	22.3
		C=O	6.8
		O-C=O	4.9
	N1s	Pyridinic N	38.6
		Pyrrolic N	34.2
		Graphitic N	20.3
		Oxidized N	6.9
	O1s	C=O	24.3
		C-OH	45.7
		C-COOH	30.0
	S2p	C-S-C 2p3/2	24.8
		C-S-C 2p1/2	12.5
		C-SO_X 2p3/2	41.7
		C-SO_X 2p1/2	21
NC	C1s	C-C / C=C	66.5
		C-N	21.4
		C=O	6.6
		O-C=O	5.5
	N1s	Pyridinic N	35.7

		Pyrrolic N	40.4
		Graphitic N	17.4
		Oxidized N	6.5
	O1s	C=O	24.5
		C-OH	47.6
		C-COOH	27.9

Table S2. Physicochemical Properties of SNC, NC, and C-ref

Samples	BET Surface Area ($m^2\ g^{-1}$)	BJH cumulative pore volume (1.7-300 nm) ($cm^3\ g^{-1}$)	BJH average pore diameter (4V/A) (nm)
SNC	9.9715	0.058921	25.5056
NC	15.6871	0.041844	10.5208
NC w/o $CaCO_3$	4.0267	0.015620	15.2111

Table S3

Experimental condition	FE (%)
Without Nitrate (Only N_2-saturated 1 M KOH)	5.4
Open Circuit Potential (OCP)	0
Without Catalyst (Bare Carbon Paper)	6.1