Supplementary Information for

Novel Mn-Bi-S hybrid mesoporous nanosheets as efficient electrocatalyst for nitrogen reduction reaction

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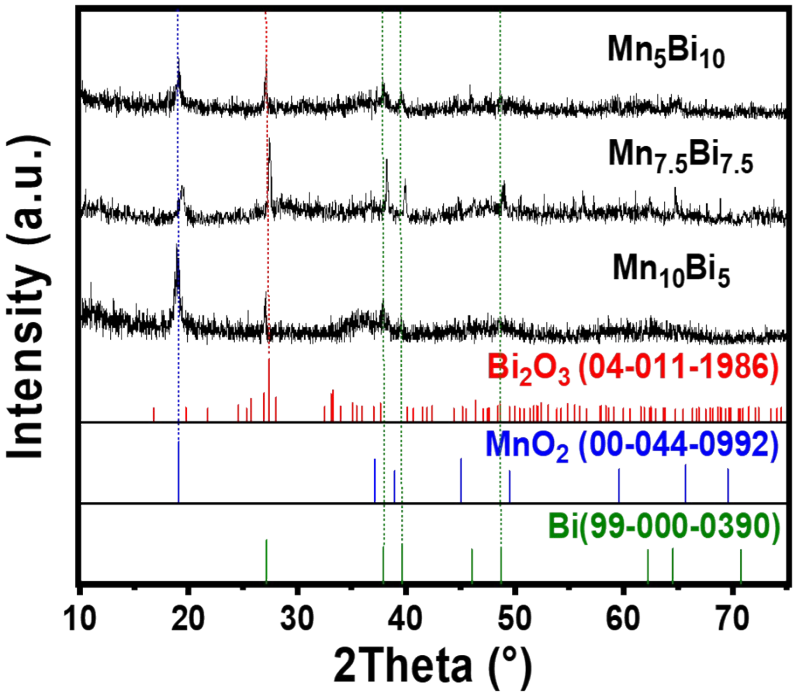

Fig. S1 XRD patterns of Mn_5Bi_{10}, $Mn_{7.5}Bi_{7.5}$ and $Mn_{10}Bi_5$.

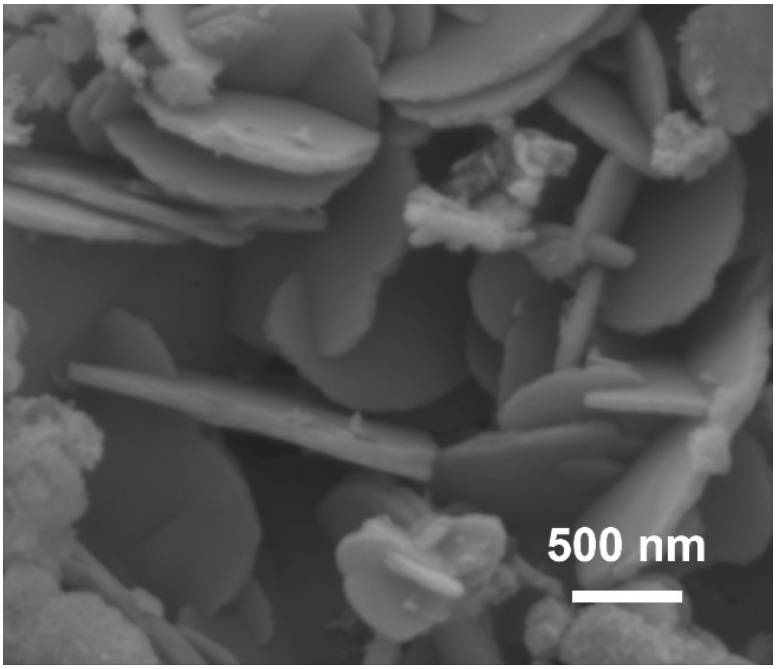

Fig. S2 SEM image of $Mn_{7.5}Bi_{7.5}$.

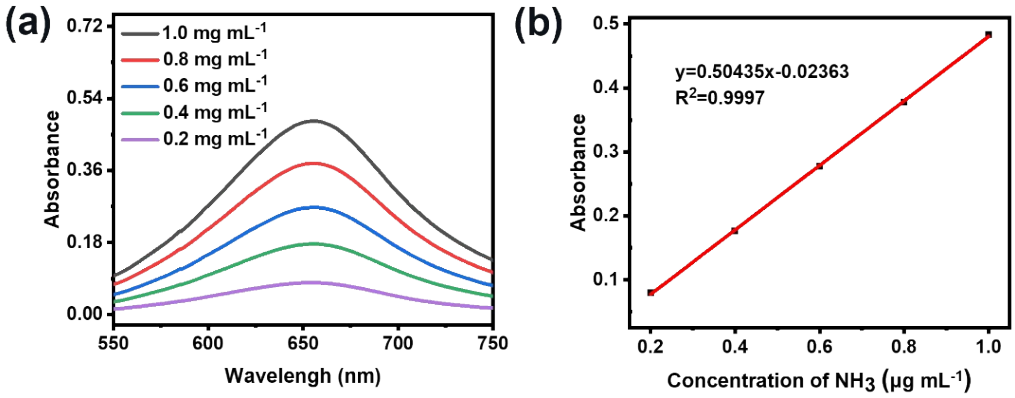

Fig. S3 (a) UV-vis spectra of indophenol assays with NH^{4+} after incubated for 2 h at room temperature. (b) Calibration curve used for estimation of concentration of NH_4Cl.

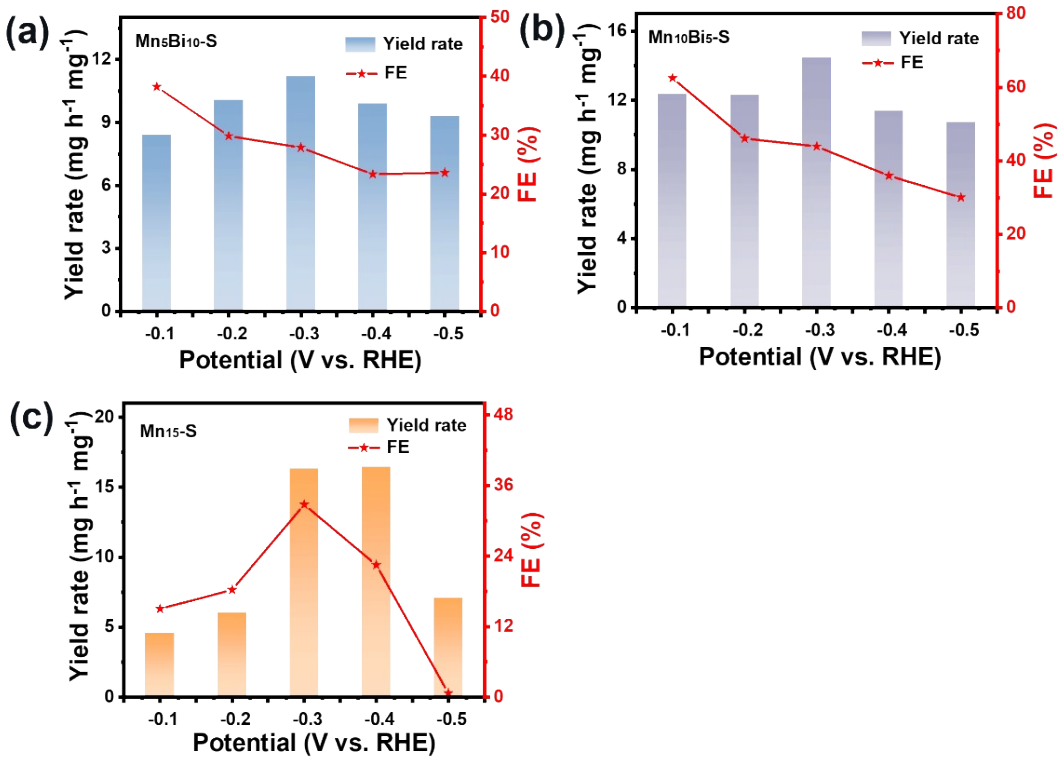

Fig. S4 Average ammonia production rate and FE at different potentials from -0.1 V to -0.5 V vs. RHE. (a) Mn_5Bi_{10}-S, (b) $Mn_{10}Bi_5$-S and (c) Mn_{15}-S.

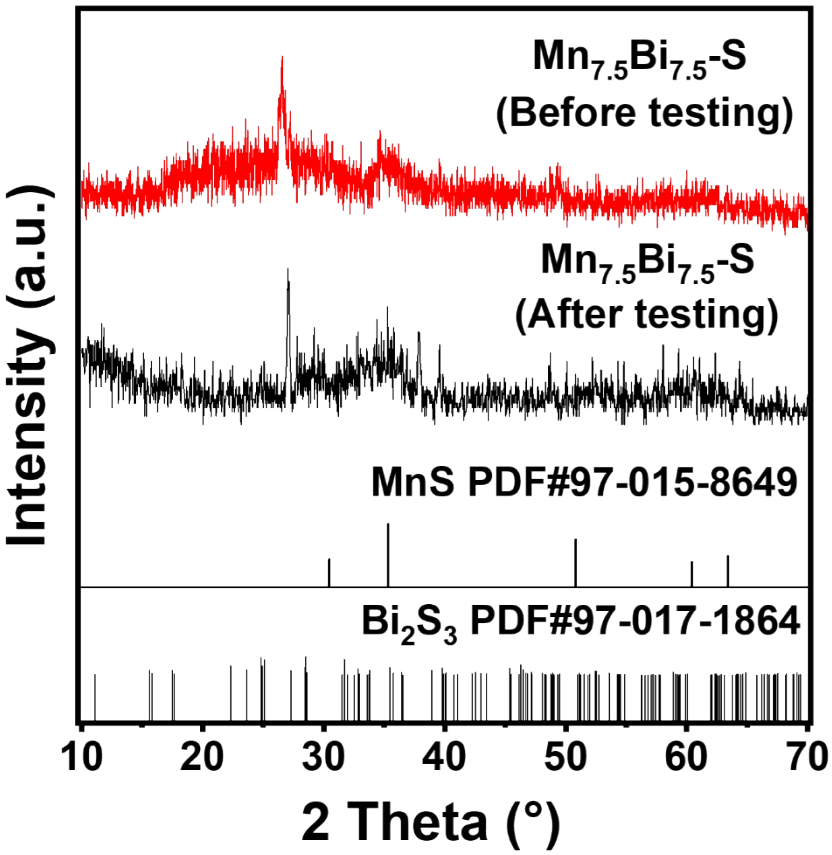

Fig. S5 XRD patterns of $Mn_{7.5}Bi_{7.5}$-S catalyst before and after stability test.

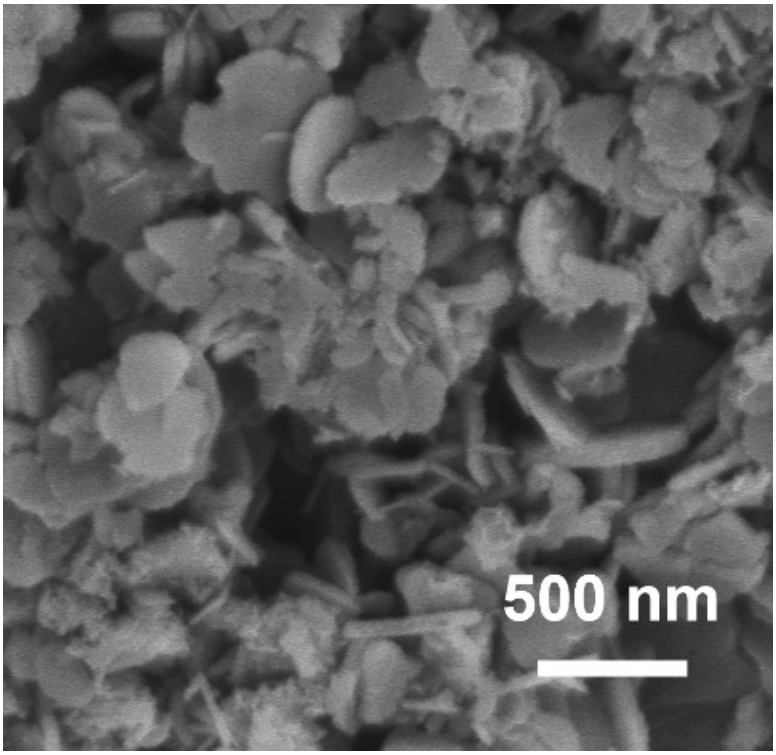

Fig. S6 SEM image of $Mn_{7.5}Bi_{7.5}$-S catalyst after stability test.

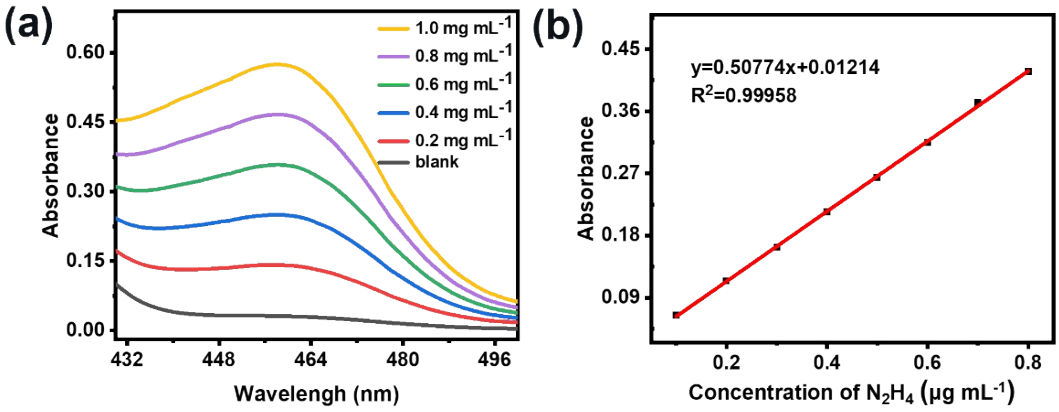

Fig. S7 (a) UV-vis spectra of various N_2H_4 concentrations after incubated for 15 min at room temperature. (b) Calibration curve used for calculation of N_2H_4 concentrations.

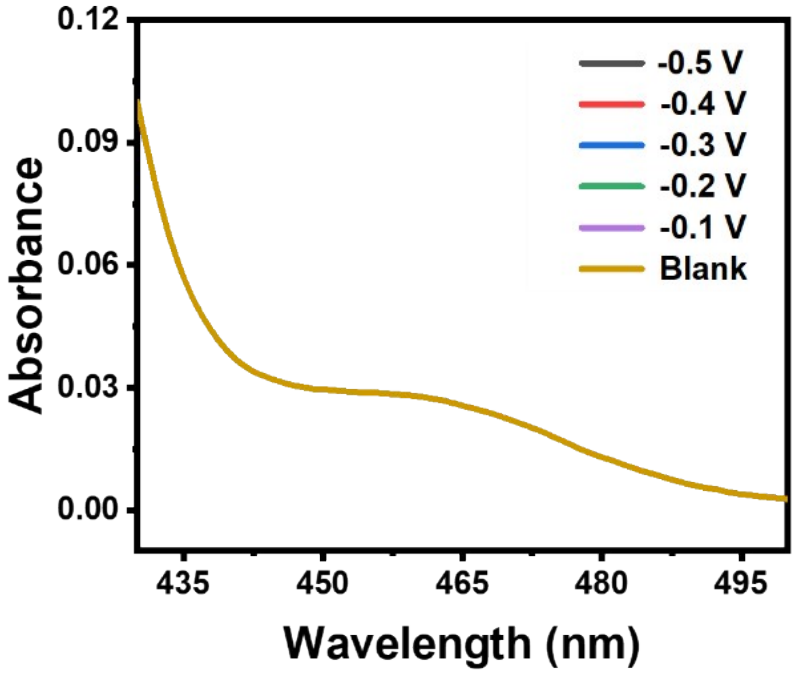

Fig. S8 UV-vis spectra of the electrolytes stained with Watt and Chrisp indicator at various potentials for 2 h.

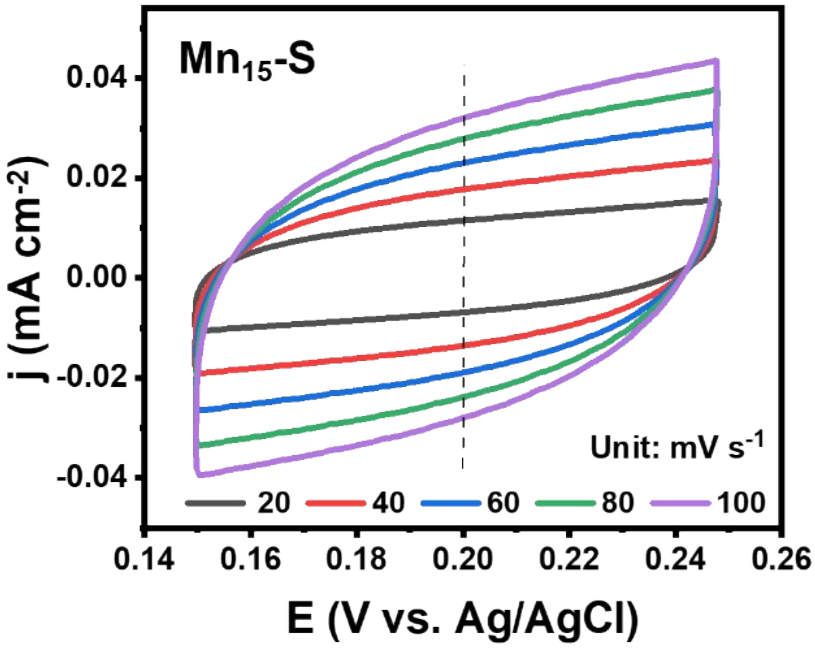

Fig. S9 CV scans measured at a potential range from 0.15 to 0.25 V vs. Ag/AgCl with different scan rates (20, 40, 60, 80 and 100 mV s^{-1}) for Mn_{15}-S.

Table S1 Optimal yield rate and Faraday efficiency of Mn_xBi_{15-x}-S (x = 5, 7.5, 10, 15 at. %).

Catalyst	Yield rate (μg h^{-1} mg^{-1})	FE (%)
$Mn_{7.5}Bi_{7.5}$-S	21.56	73.36
$Mn_{7.5}Bi_{7.5}$	15.94	40.06
$Mn_{10}Bi_5$-S	14.48	43.91
Mn_5Bi_{10}-S	11.18	27.87
Mn_{15}-S	16.31	32.77

Table S2 Comparison for the NRR electrocatalytic activity of $Mn_{7.5}Bi_{7.5}$-S catalyst with other reported catalysts.

Catalyst	Electrolytes	Yield rate	FE	Ref.
Mn−Bi_2O_3	0.1 M Na_2SO_4	23.54 μg h^{-1} mg^{-1}	21.63%	[1]
CuMn	0.1 M Na_2SO_4	28.9 μg h^{-1} mg^{-1}	9.83%	[2]
BQD/15MS	0.1 M Na_2SO_4	18.5 μg h^{-1} mg^{-1}	33.2%	[3]
Bi_2S_3-x/$Ti_3C_2T_x$	0.1 M Na_2SO_4	68.3 μg h^{-1} mg^{-1}	22.5%	[4]
Bi NS	0.1 M Na_2SO_4	13.23 μg h^{-1} mg^{-1}	10.46%	[5]
Bi@C	0.1 M Na_2SO_4	4.22 μg h^{-1} mg^{-1}	15.10%	[6]
S-Bi NB	0.1 M Na_2SO_4	10.28 μg h^{-1} mg^{-1}	10.48%	[7]
Au/PCN	0.05 M H_2SO_4	13.8 μg h^{-1} cm^{-2}	61.8%	[8]
AuNPs	0.1 M Li_2SO_4	9.22 μg h^{-1} cm^{-2}	73.32%	[9]
Bi-NPs	0.1 M Na_2SO_4	16.25 μg h^{-1} mg^{-1}	12.11 %	[10]
$Mn_{7.5}Bi_{7.5}$-S	0.1 M Na_2SO_4	21.56 μg h^{-1} mg^{-1}	73.36%	This work

Notes and references

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