Electronic Supplementary Information

Template-free hydrothermal synthesis of nickel sulfide nanocrystals on MWCNTs: Efficient and stable bifunctional electroactive material for oxygen electrocatalysis†

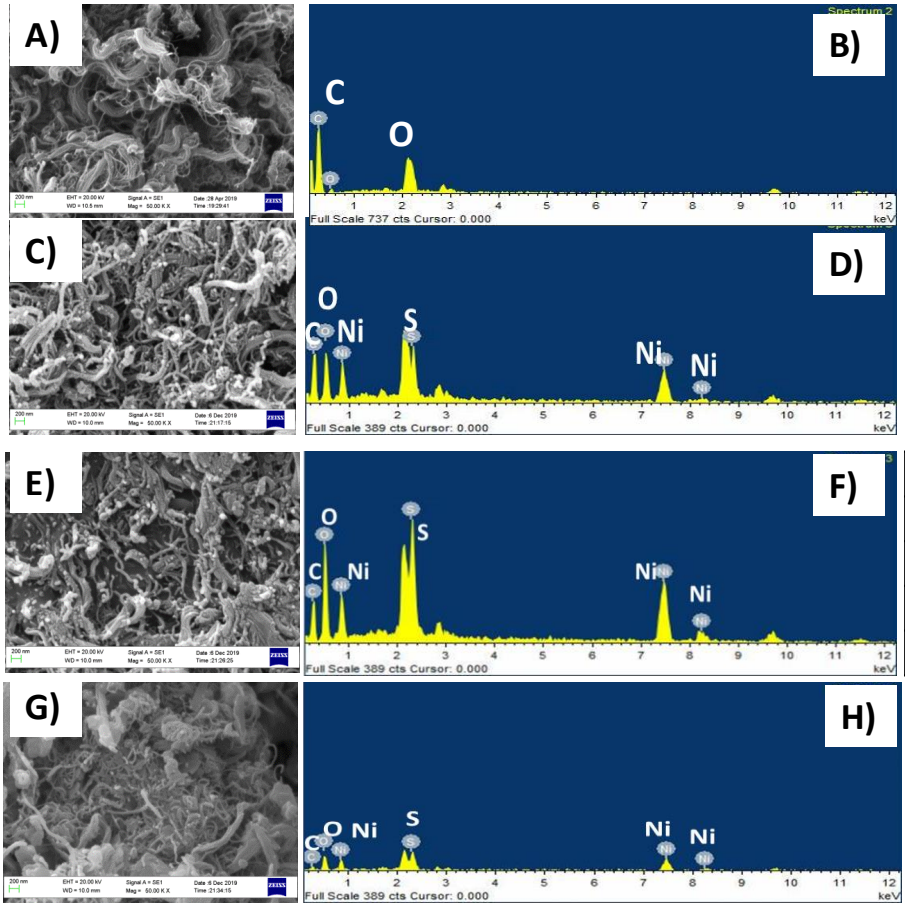
*Mamta Yadav[1], Devesh Kumar Singh[2], and Vellaichamy Ganesan[1]**

1 Department of Chemistry, Institute of Science, Banaras Hindu University, Varanasi-221005, UP, India

2 Kutir Post Graduate College, Chakkey, Jaunpur-222146, UP, India

* Corresponding author

E-mail: *velganesh@yahoo.com* and *velgan@bhu.ac.in*



Element	Weight %	Atomic %
C	79.57	83.84
O	20.43	16.16

Element	Weight %	Atomic %
C K	47.44	62.95
O K	30.70	30.58
S K	2.36	1.17
Ni K	19.50	5.29

Element	Weight %	Atomic %
C	35.49	52.04
O	33.72	37.13
S	6.39	3.51
Ni	24.40	7.32

Element	Weight %	Atomic %
C	28.92	46.64
O	31.95	38.67
S	6.52	3.94
Ni	32.61	10.76

Fig. S1 SEM (A, C, E, and G), EDAX (B, D, F, and H), and elemental composition of MWCNTs (A and B), NiS-(0.1)@MWCNTs (C and D), NiS-(0.5)@MWCNTs (E and F), and NiS (1.0)@MWCNTs (G and H).

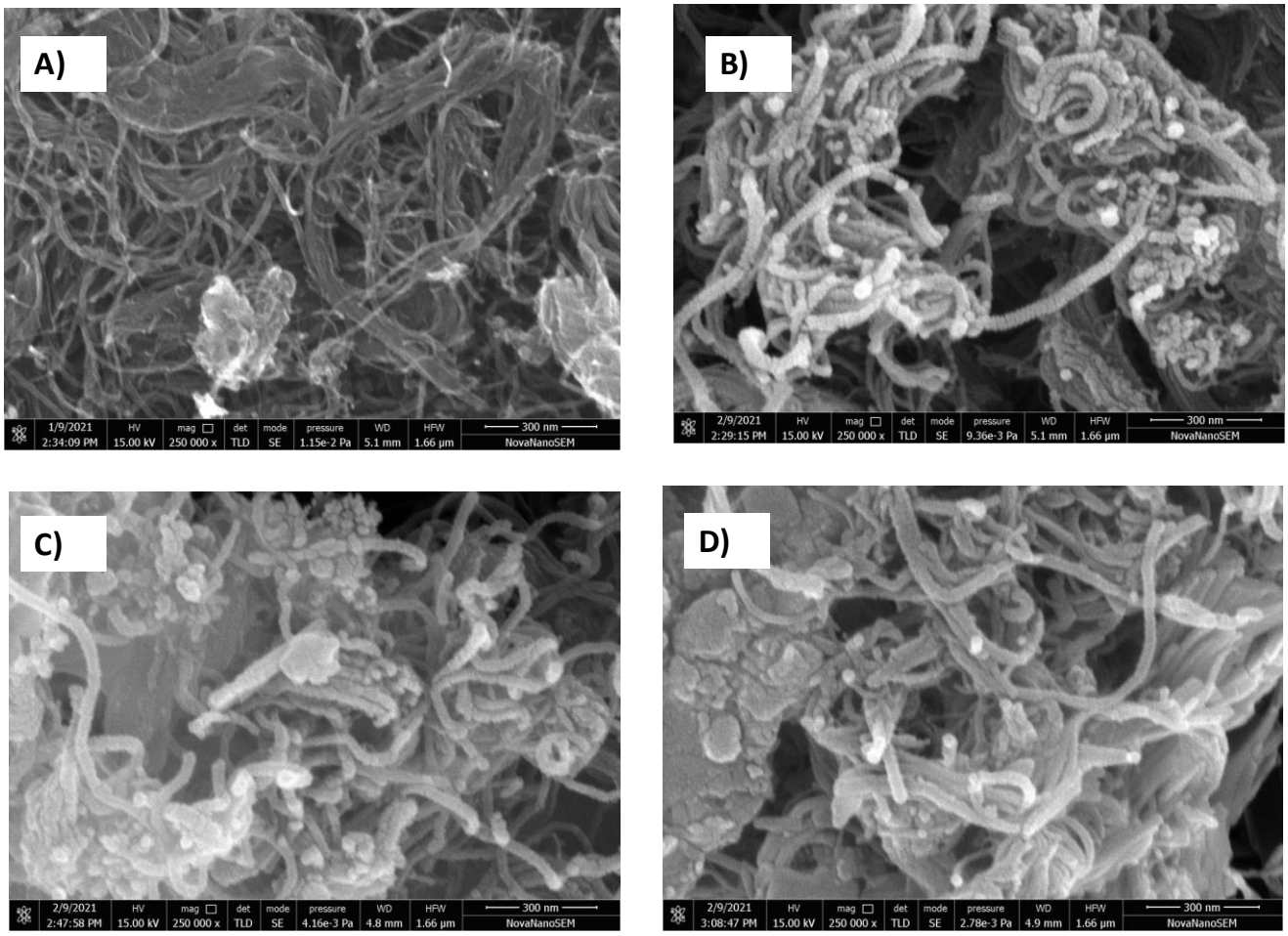


Fig. S2 FESEM images of A) MWCNTs, B) NiS-(0.1)@MWCNTs, C) NiS-(0.5)@MWCNTs, and D) NiS-(1.0)@MWCNTs

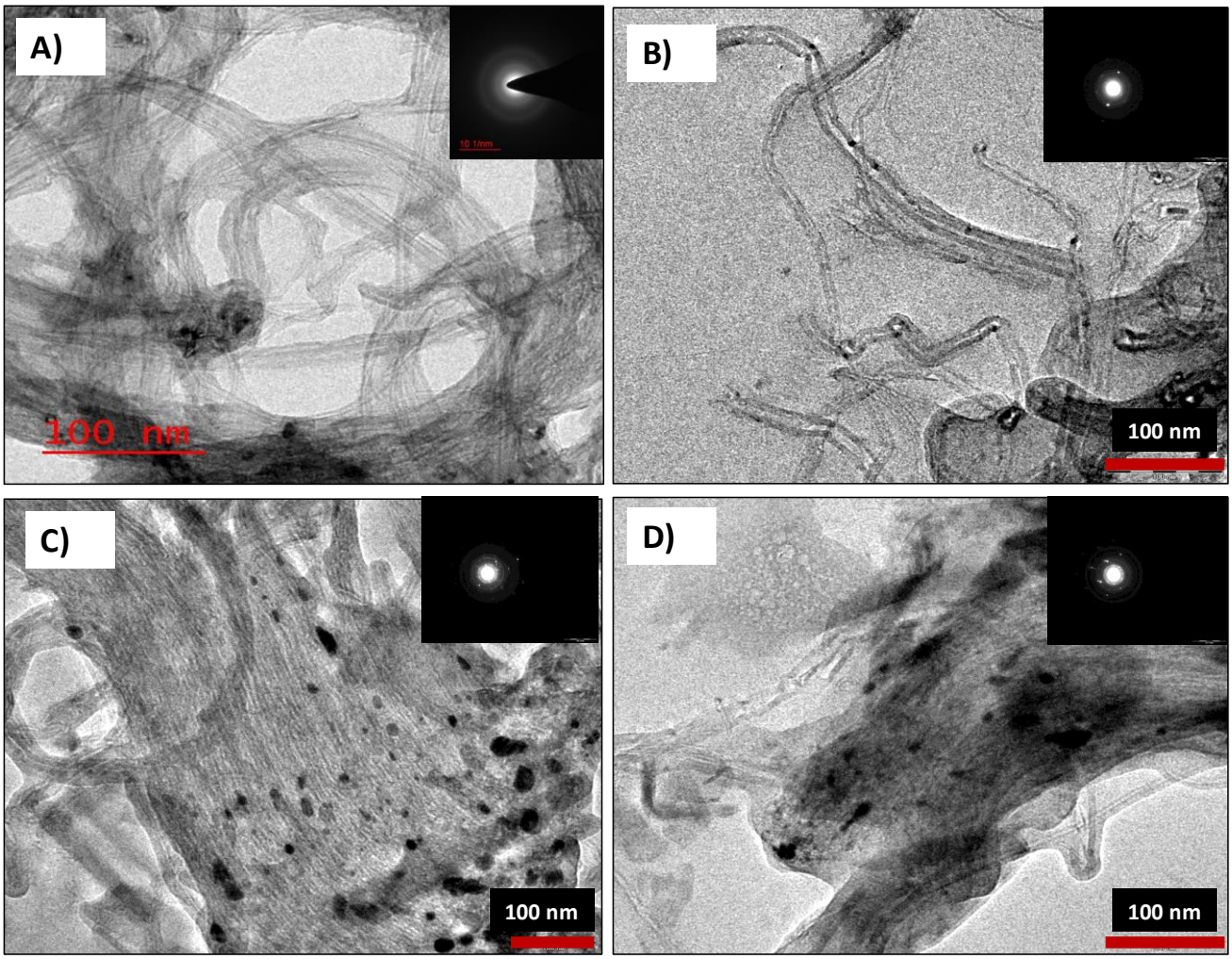


Fig. S3 HR-TEM images of A) MWCNTs, B) NiS-(0.1)@MWCNTs, C) NiS-(0.5)@MWCNTs, and D) NiS-(1.0)@MWCNTs. Inset shows the SAED pattern of the same.

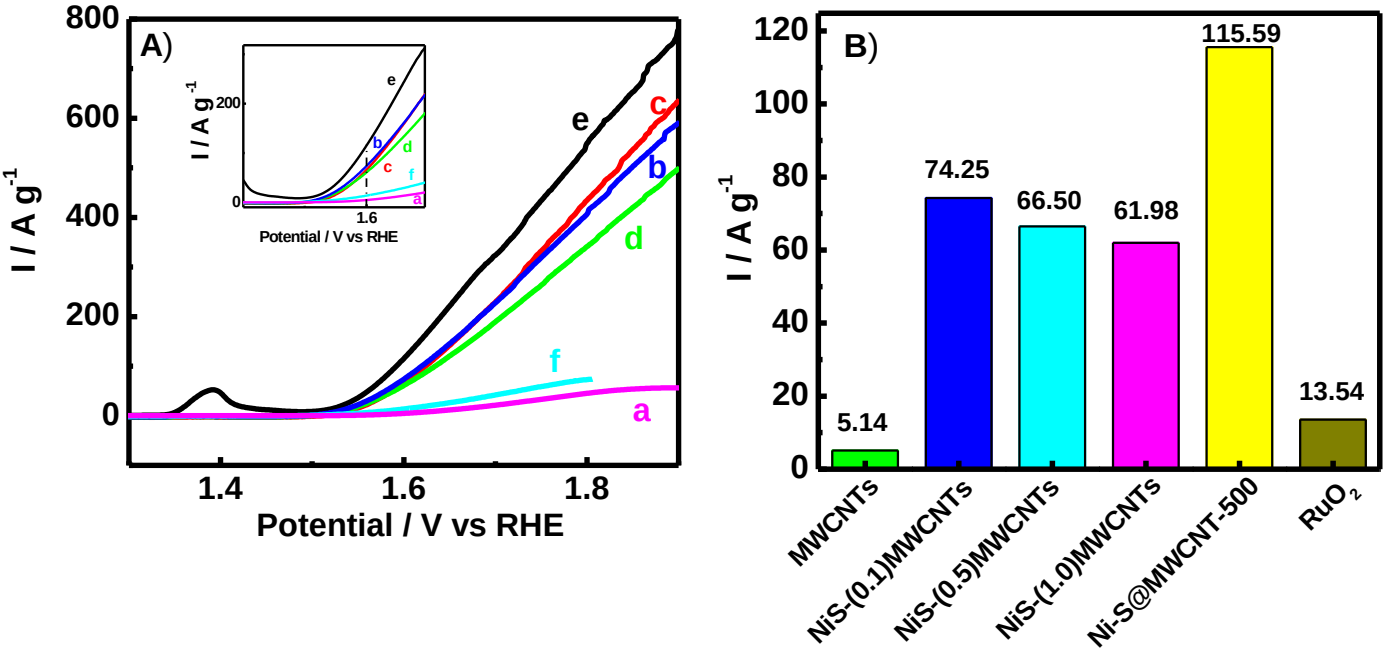


Fig. S4 A) LSV curves representing the mass activity of a) MWCNTs, b) NiS-(0.1)@MWCNTs, c) NiS-(0.5)@MWCNTs, d) NiS-(1.0)@MWCNTs, e) Ni-S@MWCNTs-500, and f) RuO_2.

B) Bar graph showing the mass activity at 1.6 V *vs.* RHE.

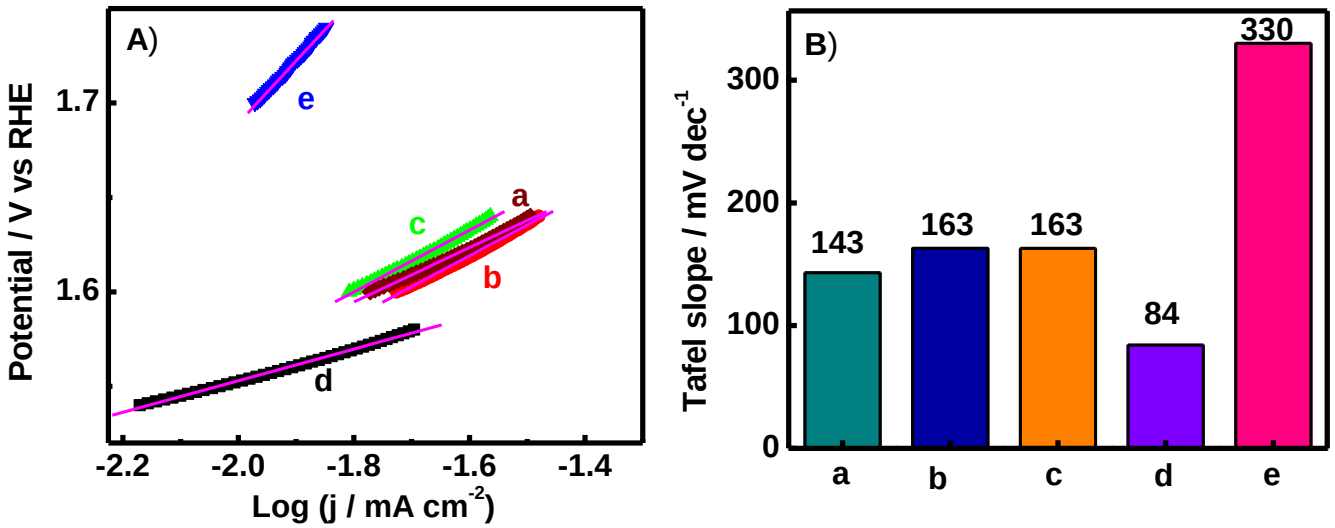


Fig. S5 A) Tafel slope for a) GC/NiS-(0.1)@MWCNTs, b) GC/NiS-(0.5)@MWCNTs, c) GC/NiS-(1.0)@MWCNTs, d) GC/ Ni-S@MWCNT-500, and e) RuO_2.

B) Bar diagram of the Tafel slope values for the respective electrodes.

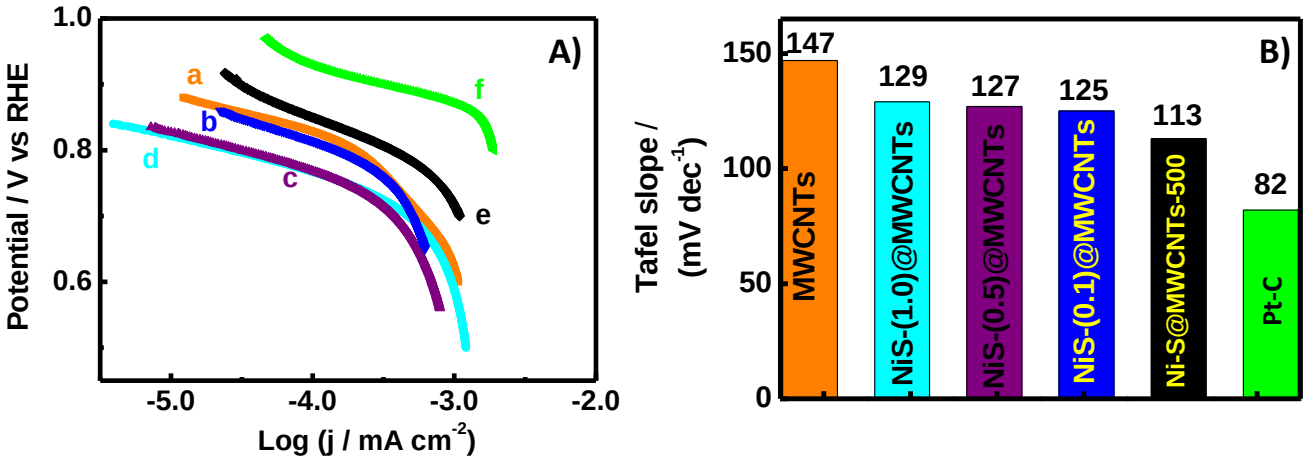


Fig. S6 A) Tafel slope of a) MWCNTs, b) NiS(0.1)@MWCNTs, c) NiS(0.5)@MWCNTs, d) NiS(1.0)@MWCNTs, e) Ni-S@MWCNTs-500, and f) Pt-C (20%), and B) bar diagram depicting the value of Tafel slopes of the corresponding material.

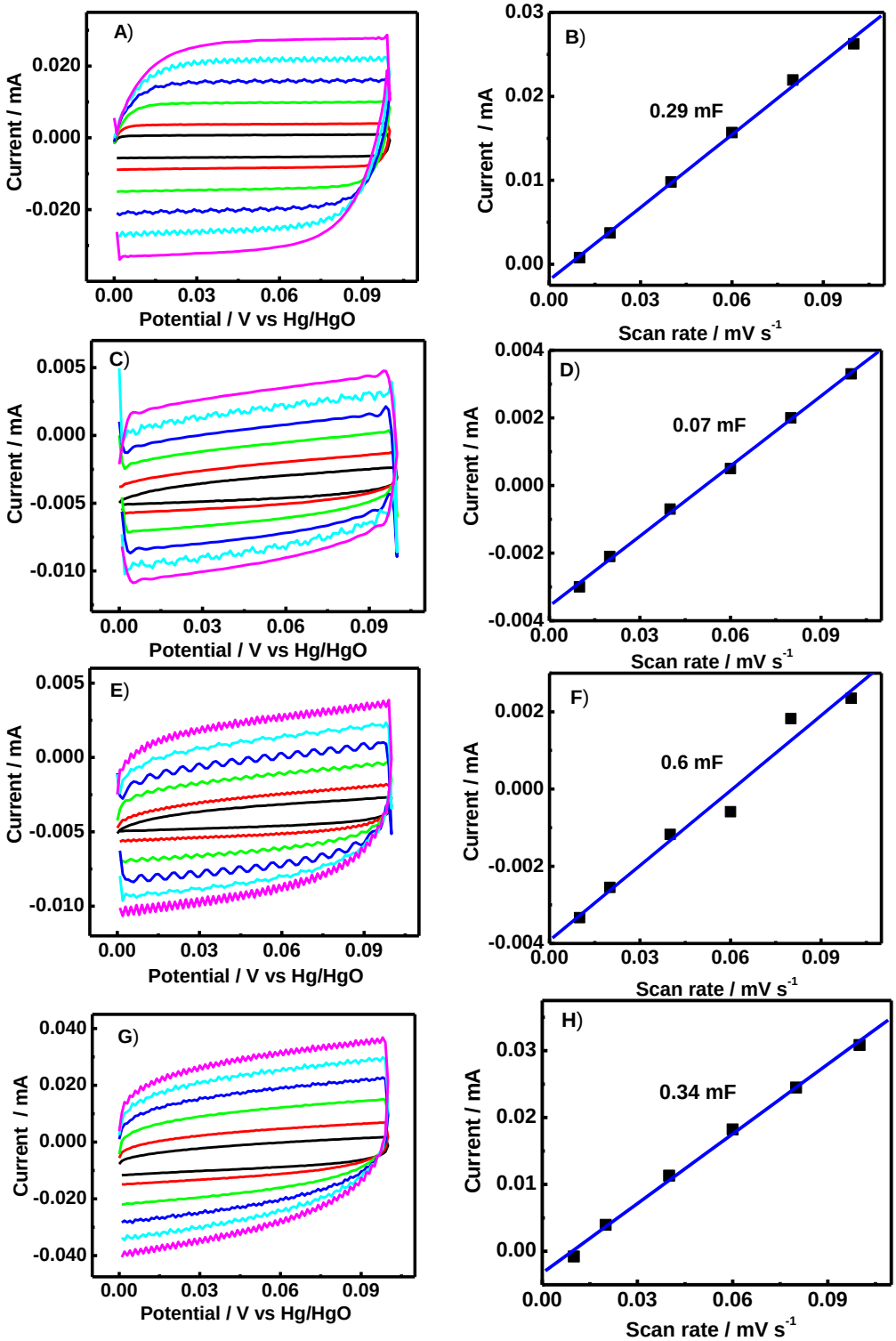


Fig. S7 CV responses (A, C, E, and G) at different scan rates in the non-faradaic region and the plot of scan rate *vs.* current density (B, D, F, and H) for NiS-(0.1)@MWCNTs (A and B), NiS-(0.5)@MWCNTs (C and D), NiS-(1.0)@MWCNTs (E and F), and Ni-S@MWCNTs-500 (G and H).

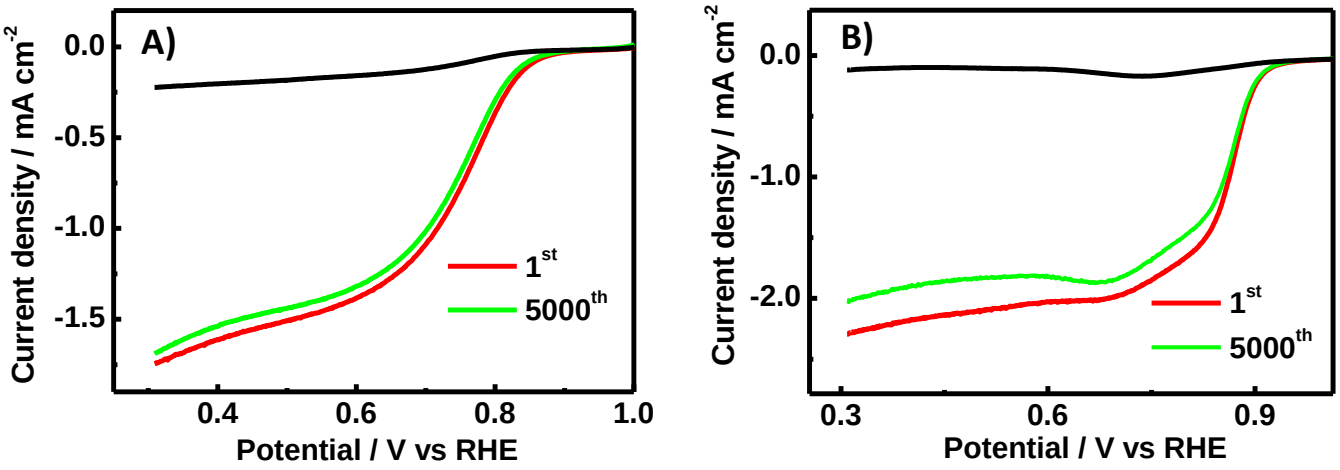


Fig. S8 The LSV responses before and after the 5000 continuous CV cycles at A) Ni-S@MWCNTs-500 and B) Pt-C (20%) in O_2 saturated environment.

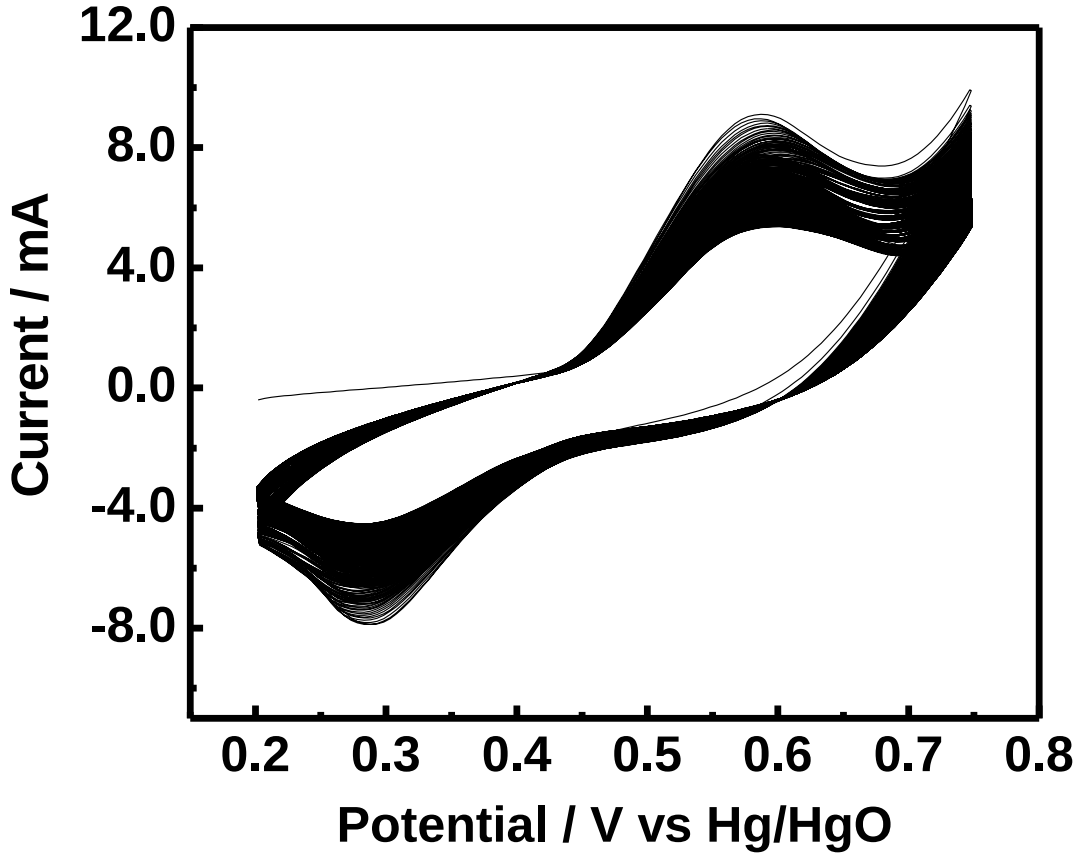


Fig. S9 The 1000 continuous CV cycles recorded at Ni-S@MWCNTs-500 in 1.0 M KOH at the scan rate of 300 mVs^{-1}.

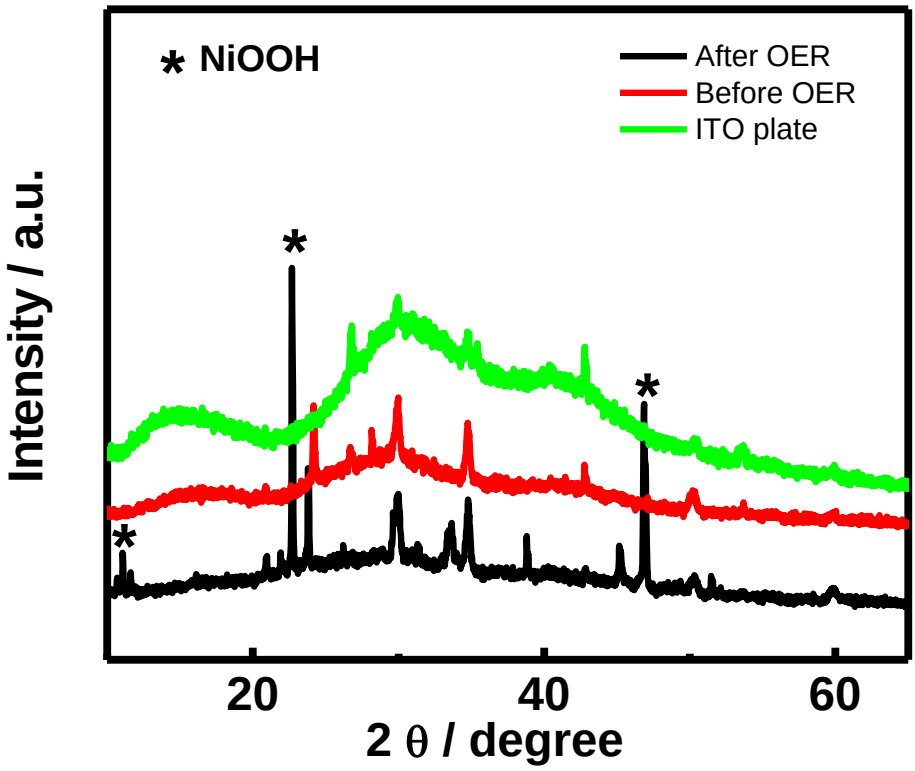


Fig. S10 XRD patterns of Ni-S@MWCNTs-500 coated on an ITO glass plate, before and after the OER catalysis.

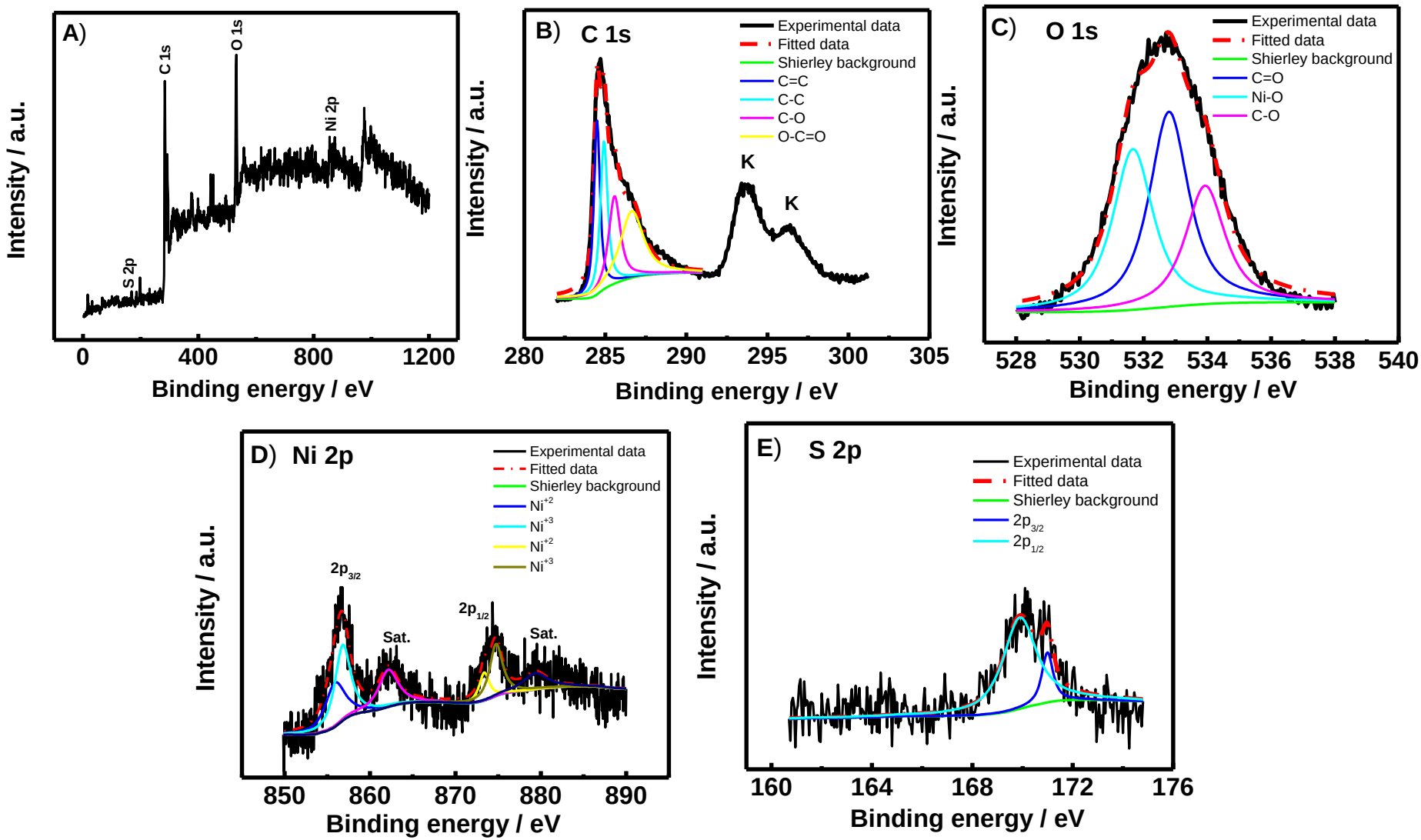


Fig. S11 A) XPS survey spectra of Ni-S@MWCNTs-500 after the OER catalysis, with high-resolution scan for B) C 1s, C) O 1s, D) Ni 2p, and E) S 2p together with the respective de-convoluted spectra.