

Supplementary Information

Design and Fabrication of Nickel (II) Thiourea-formaldehyde Polymer/Nanocarbon Bifunctional Molecular Catalyst with Superior ORR, OER Activities and its Application to Zn-air Battery

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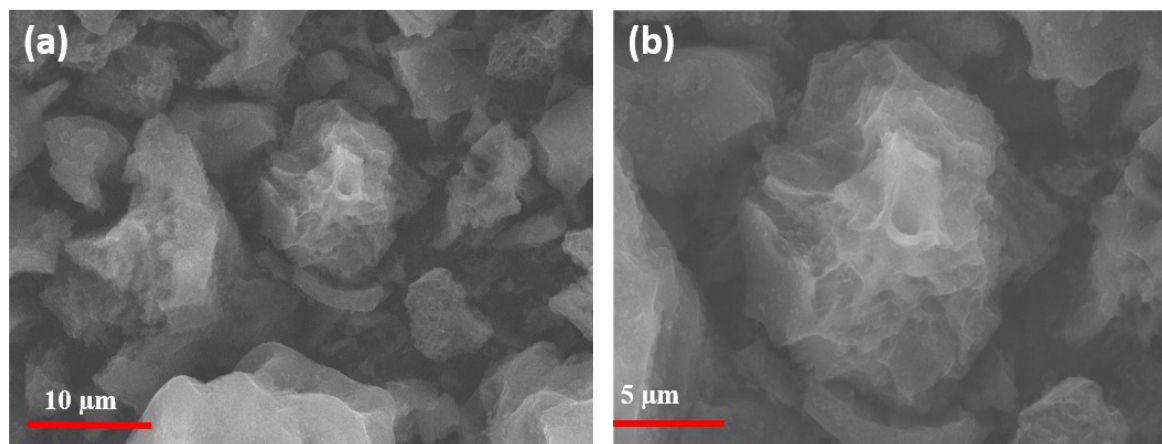


Figure S1. (a) Low and (b) high magnification SEM images of the CNovel carbon (MH-00).

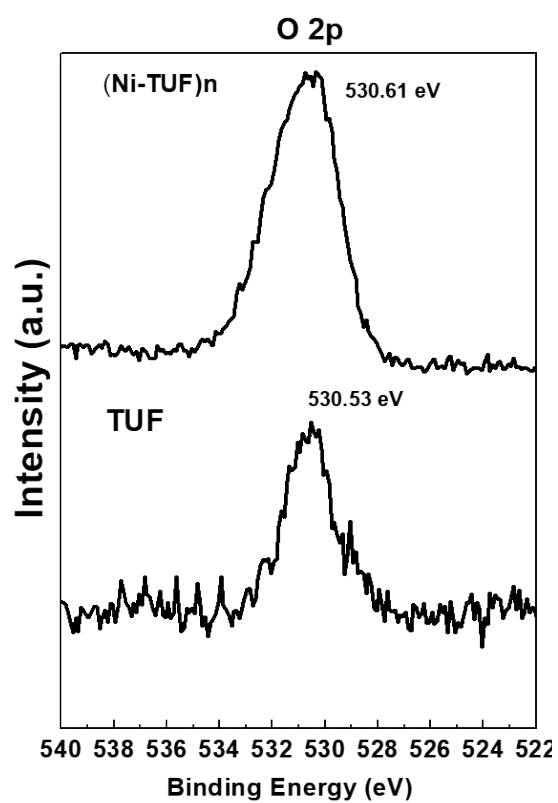


Figure S2. XPS of the (Ni-TUF)_n and TUF in the O₂p region.

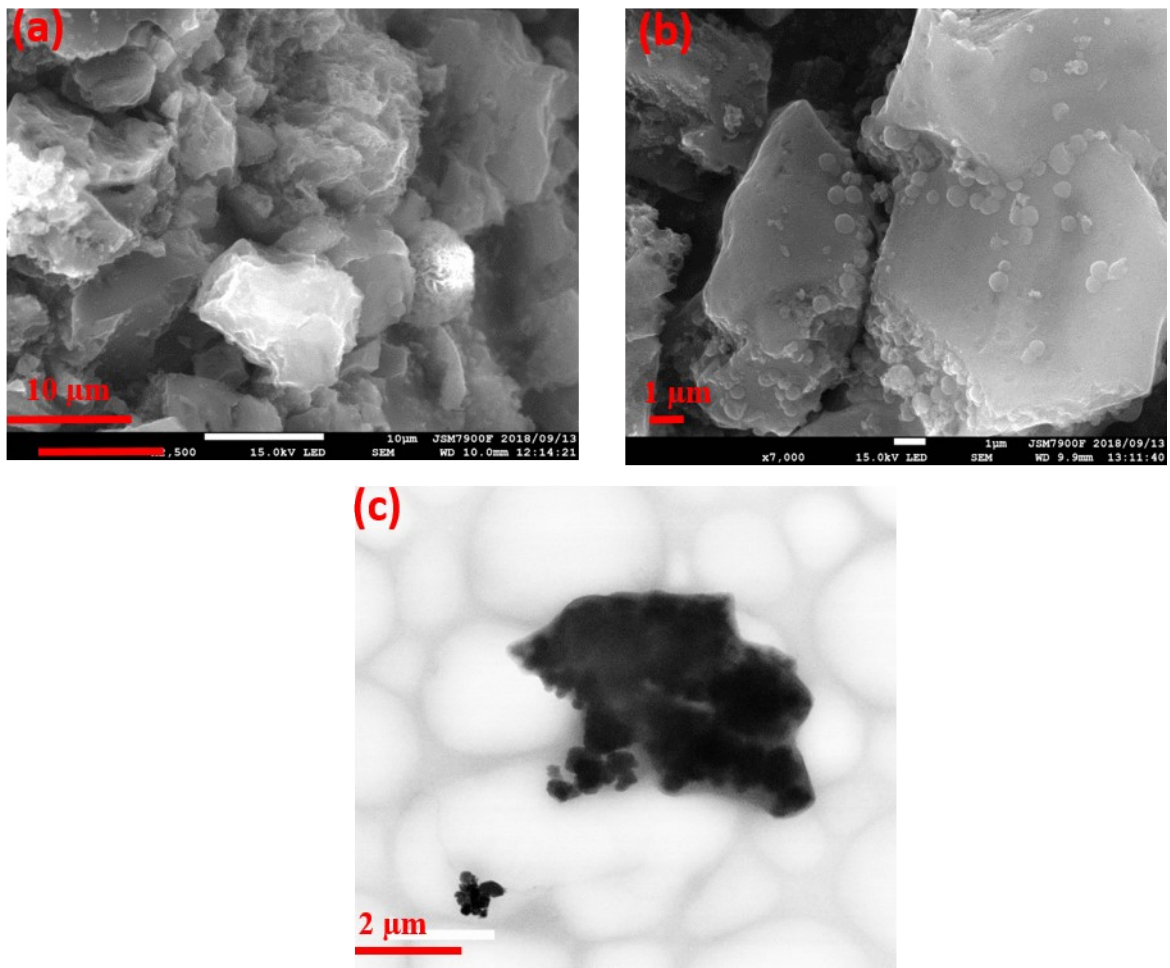


Figure S3. (a) Low and (b) high magnification SEM images of (Ni-TUF)_n/CN:w/w-1/5. (c) TEM image of (Ni-TUF)_n/CN:w/w-1/5.

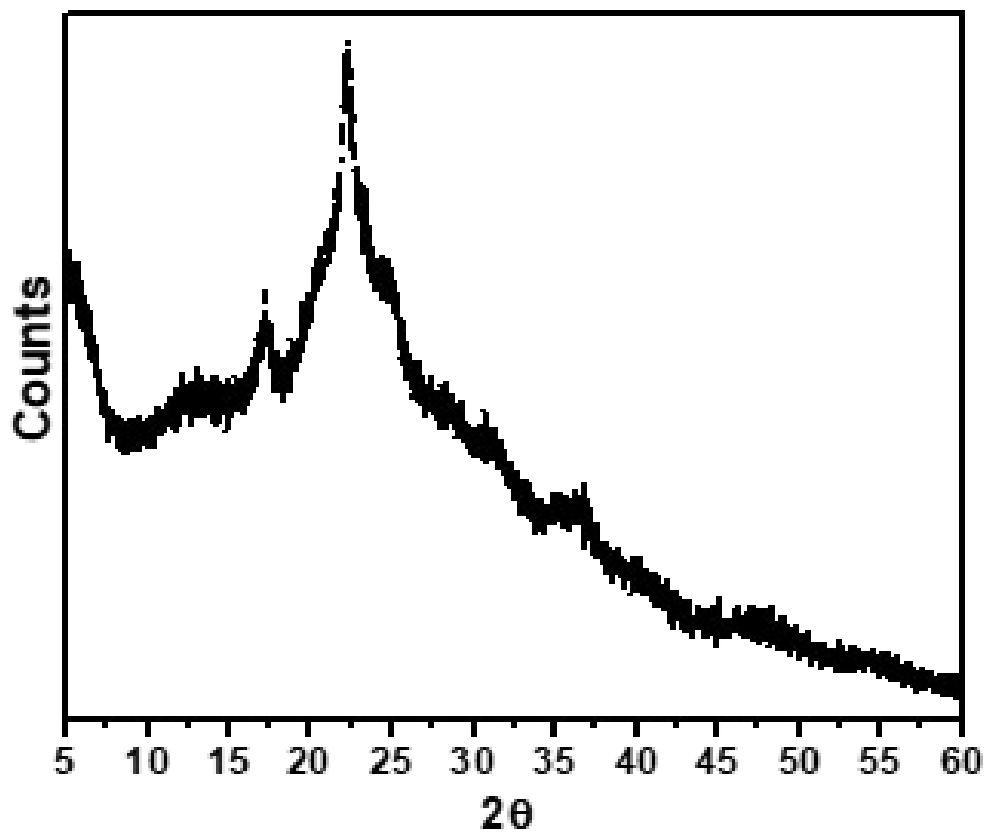


Figure S4. XRD diagram of the (Ni-TUF)_n.

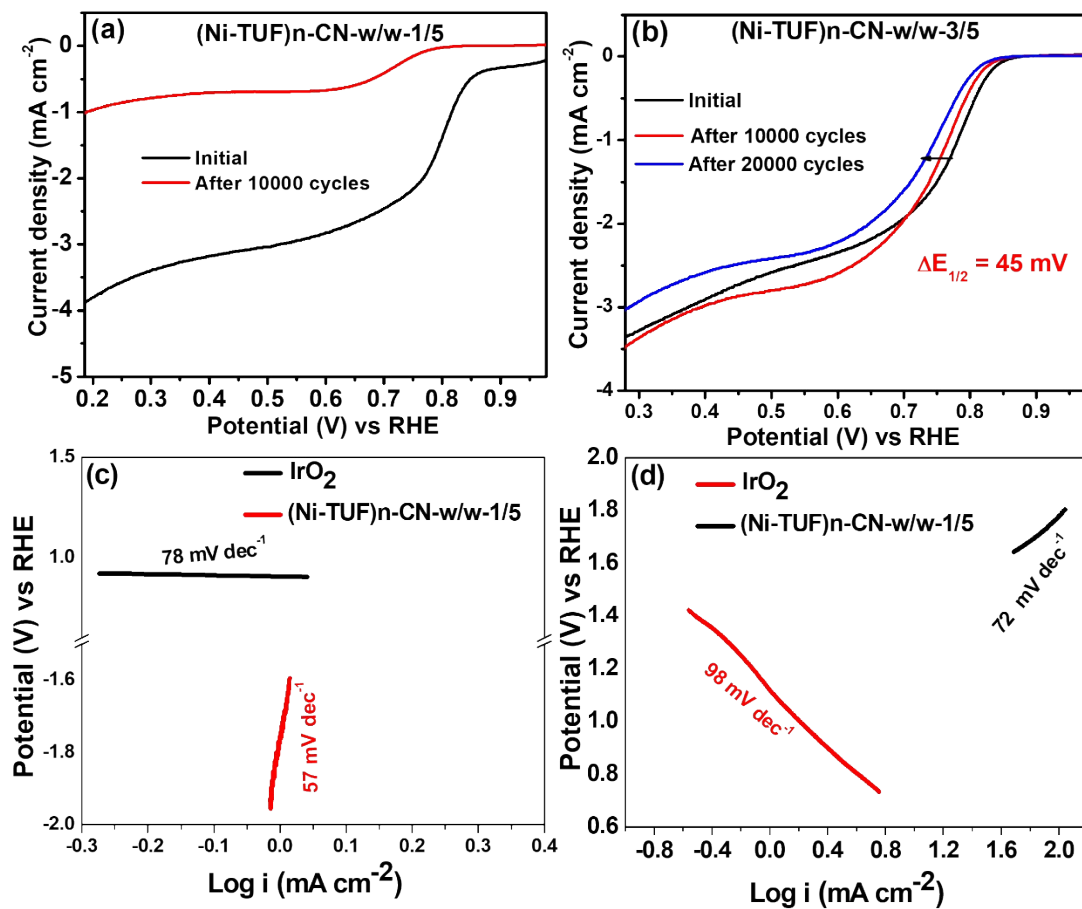


Figure S5. ORR accelerated durability tests for (Ni-TUF)n/CN:w/w-1/10 (a) and (Ni-TUF)n/CN:w/w-3/5 (b). (c) the ORR Tafel slope of (Ni-TUF)n/CN:w/w-3/5 and (d) the OER Tafel slope of (Ni-TUF)n/CN:w/w-3/5.

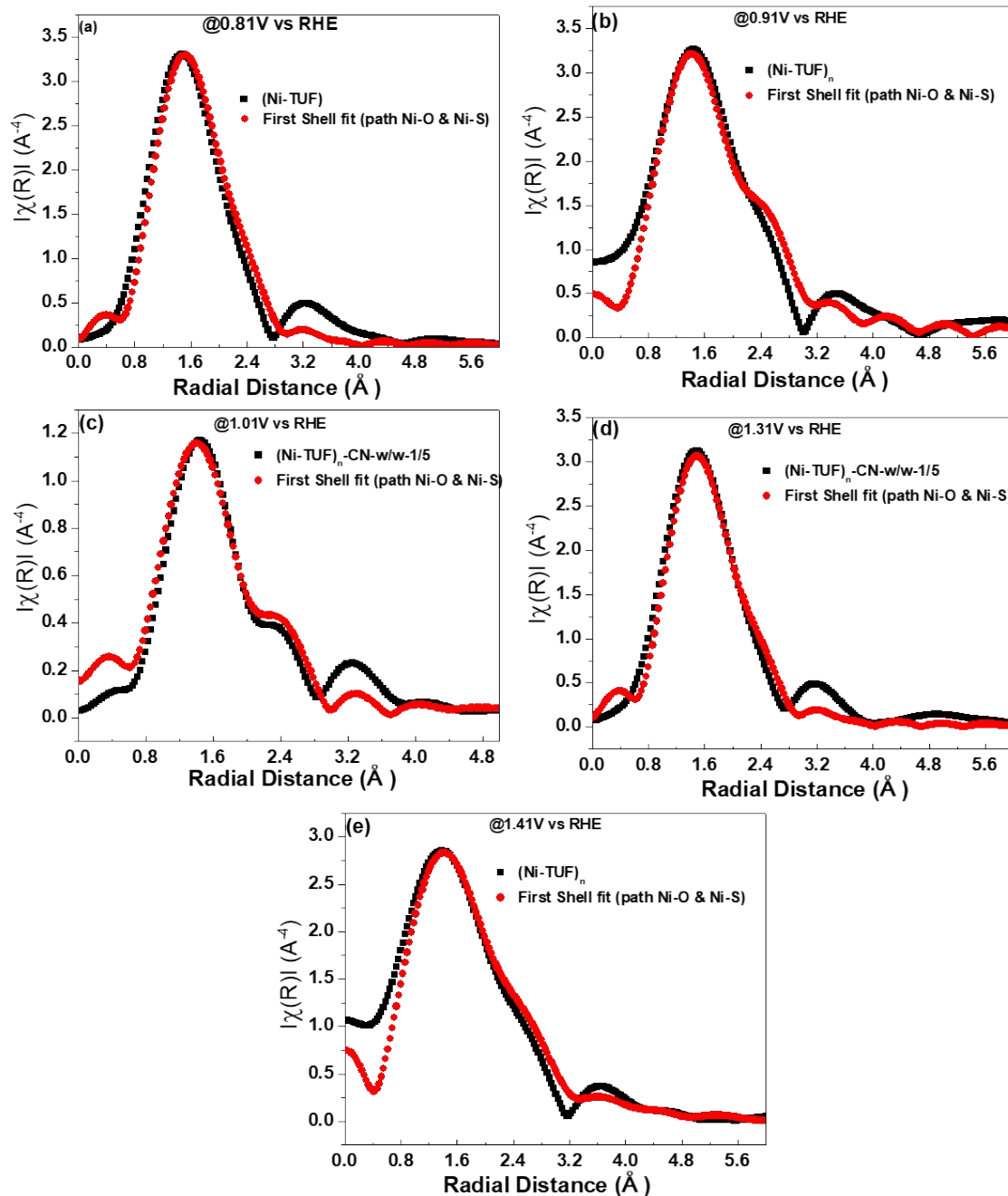


Figure S6. Electrochemical EXAFS diagrams (black) of the provided catalyst at potentials of (a) 0.81V, (b) 0.91V, (c) 1.01V, (d) 1.31V and (e) 1.41V vs. RHE and their first shell fitting curves (red) for path Ni-O and Ni-S.

Table S1. List of parameters used for the first shell fitting in the EXAFS of (Ni-TUF)_n/CN-

Voltages V vs. RHE	R-window	S_0^2	Debye Waller factor σ_j^2	E_0	Coordination number		
					Ni-O	Ni-S	Total
<i>ex situ</i>	Kaiser-Bessel	9.95	0.072	2.88	2.0	2.0	4
1.01	Kaiser-Bessel	6.00	0.040	5.00	2.0	2.0	4
0.81	Kaiser-Bessel	4.55	0.321	4.80	2.0	2.0	4
0.91	Kaiser-Bessel	3.60	0.017	5.20	2.0	2.0	4
1.31	Parzen	4.30	0.020	4.20	2.0	2.0	4
1.41	Parzen	3.80	0.014	4.50	2.0	2.0	4

w/w:1/5.

Table S2. List of parameters used for the first shell fitting in the EXAFS of (Ni-TUF)_n.

Voltages V vs RHE	R-window	S_0^2	Debye Waller factor σ_j^2	E_0	Co-ordination number		
					Ni-O	Ni-S	Total
<i>ex situ</i>	Sine	3.66	0.025	0.00	2.0	2.0	4
1.01	Parzen	3.00	0.018	4.17	2.0	2.0	4
0.81	Welch	3.00	0.045	4.23	2.0	2.0	4
0.91	Welch	3.00	0.005	4.23	2.0	2.0	4
1.31	Sine	4.00	0.030	3.80	2.0	2.0	4
1.41	Hanning	3.00	0.024	4.20	2.0	2.0	4