Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Cu-Fe-Ni Nano Alloy Particles Obtained by Exsolution from $Cu(Ni)Fe_2O_4$ for Active Anode of SOFCs

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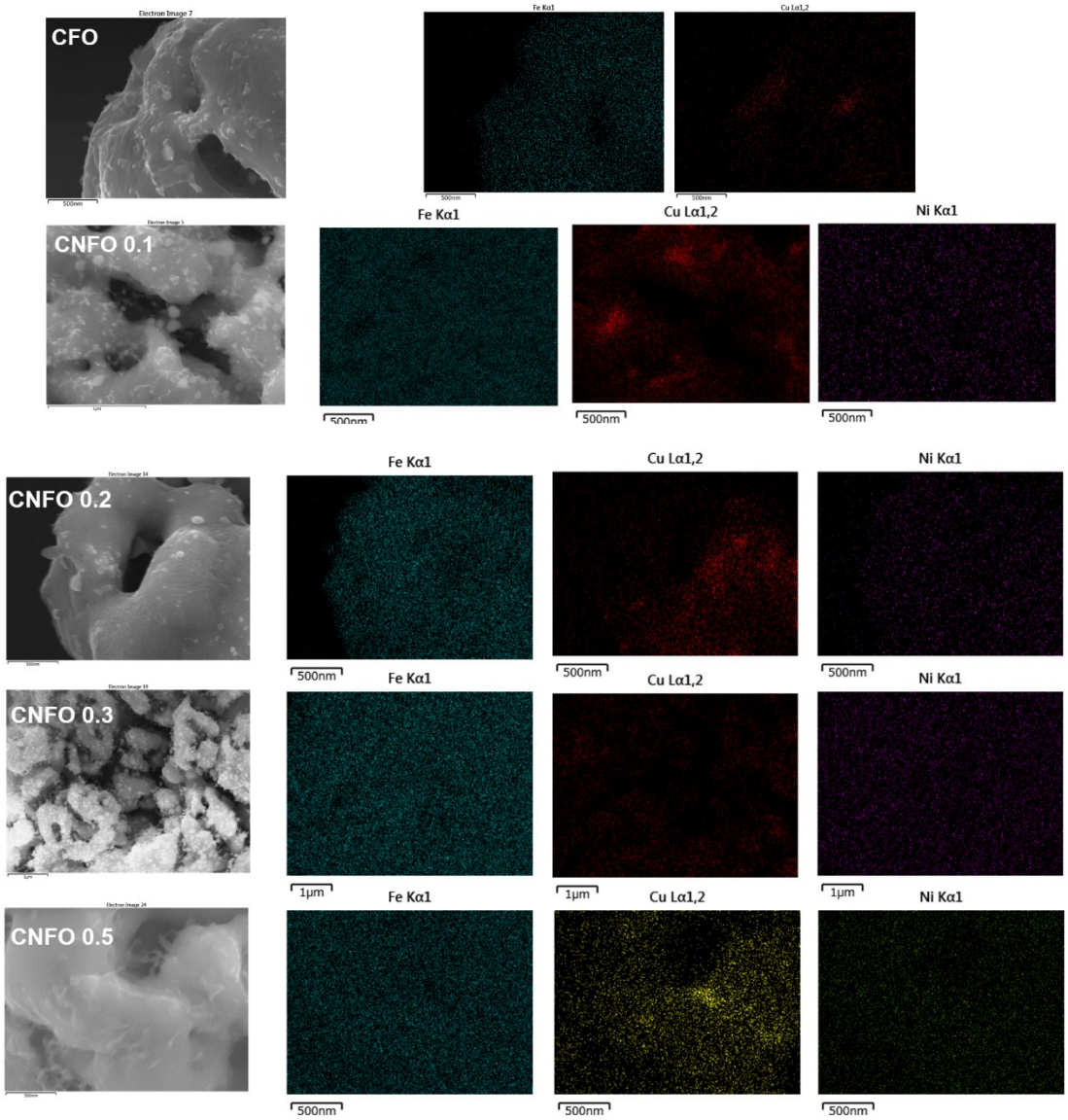
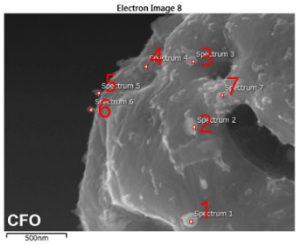


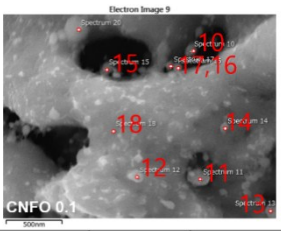
Fig. S1 EDX Mapping images for different composition of CNFO after cell test measured by SEM-EDX (a) CFO, (b) CNFO 0.1, (c) CNFO 0.2, (d) CNFO 0.3, and (e) CNFO 0.5.

(a)



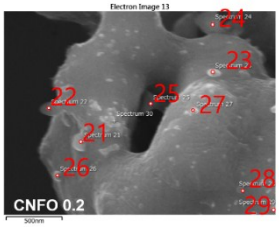
	O	Fe	Cu	Ni
Spectrum 1	8.4	86.2	5.4	-
Spectrum 2	8.6	85.5	5.9	-
Spectrum 3	12.4	79.8	7.7	-
Spectrum 4	13.3	56.4	31.3	-
Spectrum 5	28.1	61.0	10.9	-
Spectrum 6	12.6	80.6	6.8	-
Spectrum 7	7.5	79.9	12.5	-

(b)



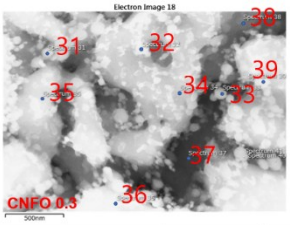
	O	Fe	Cu	Ni
Spectrum 10	10.4	75.3	10.6	3.7
Spectrum 11	6.4	75.9	12.8	4.9
Spectrum 12	7.1	68.5	20.9	3.4
Spectrum 13	3.6	72.0	19.1	5.3
Spectrum 14	4.6	65.9	26.4	3.1
Spectrum 15	0.6	85.7	8.6	5.0
Spectrum 16	8.6	74.0	11.6	5.8
Spectrum 17	3.6	79.3	13.0	4.1
Spectrum 18	2.1	67.7	26.7	3.4

(c)



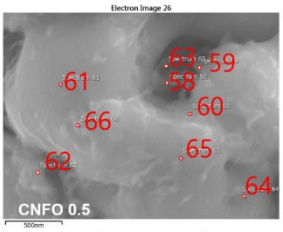
	O	Fe	Cu	Ni
Spectrum 21	11.0	76.3	5.4	7.3
Spectrum 22	21.4	65.0	8.9	4.7
Spectrum 23	5.1	68.6	19.9	5.1
Spectrum 24	4.4	72.1	18.6	4.9
Spectrum 25	7.3	68.0	16.9	7.8
Spectrum 26	26.0	57.3	10.7	6.0
Spectrum 27	8.5	53.4	32.7	5.4
Spectrum 28	5.9	76.4	11.9	5.9
Spectrum 29	6.3	76.3	10.6	6.8

(d)



	O	Fe	Cu	Ni
Spectrum 31	11.6	67.4	5.7	15.3
Spectrum 23	6.0	69.1	8.9	16.0
Spectrum 33	5.9	70.9	5.9	15.8
Spectrum 34	5.9	73.2	5.8	15.1
Spectrum 35	6.9	68.4	8.3	16.4
Spectrum 36	8.7	66.7	9.8	14.8
Spectrum 37	6.7	71.3	5.3	16.6
Spectrum 38	6.3	68.0	9.5	16.2
Spectrum 39	5.1	73.1	6.0	15.8

(e)



	O	Fe	Cu	Ni
Spectrum 58	16.9	61.4	6.0	15.7
Spectrum 59	5.5	63.5	10.8	20.3
Spectrum 60	6.8	52.4	25.0	15.9
Spectrum 61	4.9	66.9	7.0	21.2
Spectrum 62	9.2	66.0	4.9	19.9
Spectrum 63	23.0	58.6	4.0	14.4
Spectrum 64	3.9	70.3	2.0	23.8
Spectrum 65	6.3	61.5	12.3	19.9
Spectrum 66	10.4	61.5	8.3	19.7

Fig. S2 Point EDX images and the related composition for different composition of CNFO after cell test measured by SEM-EDX (a) CFO, (b) CNFO 0.1, (c) CNFO 0.2, (d) CNFO 0.3, and (e) CNFO 0.5.

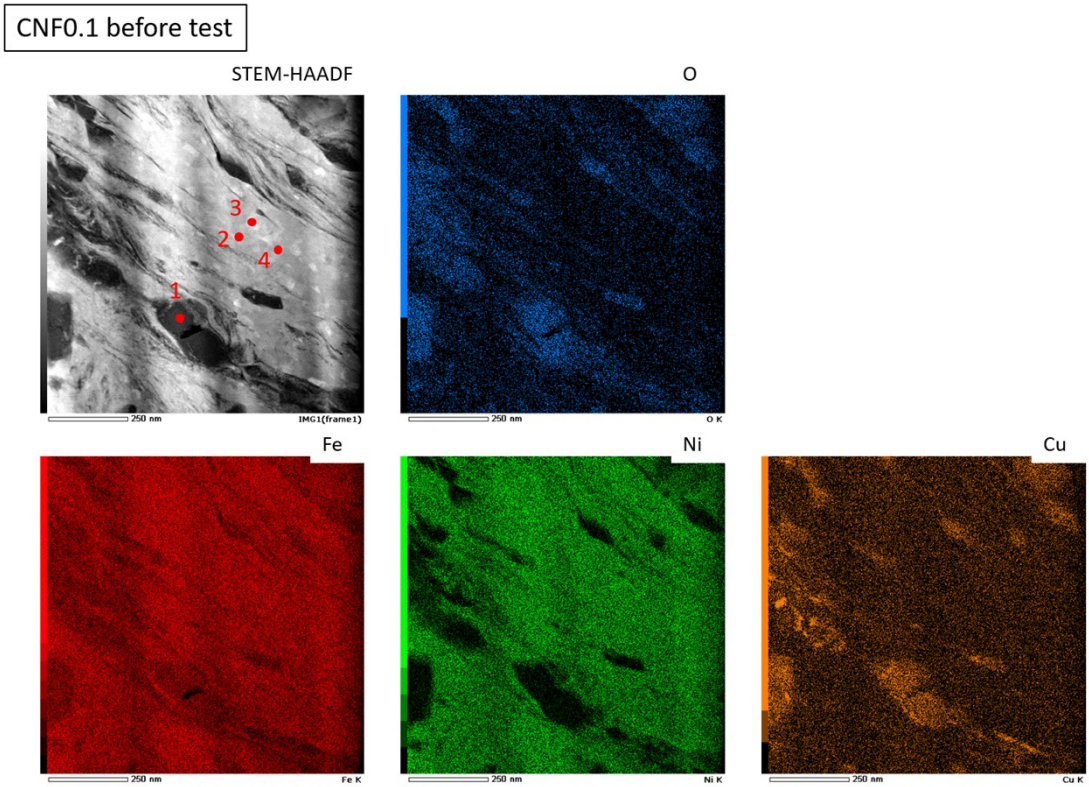


Fig. S3 STEM-EDX images of CNFO 0.1 before reduction.

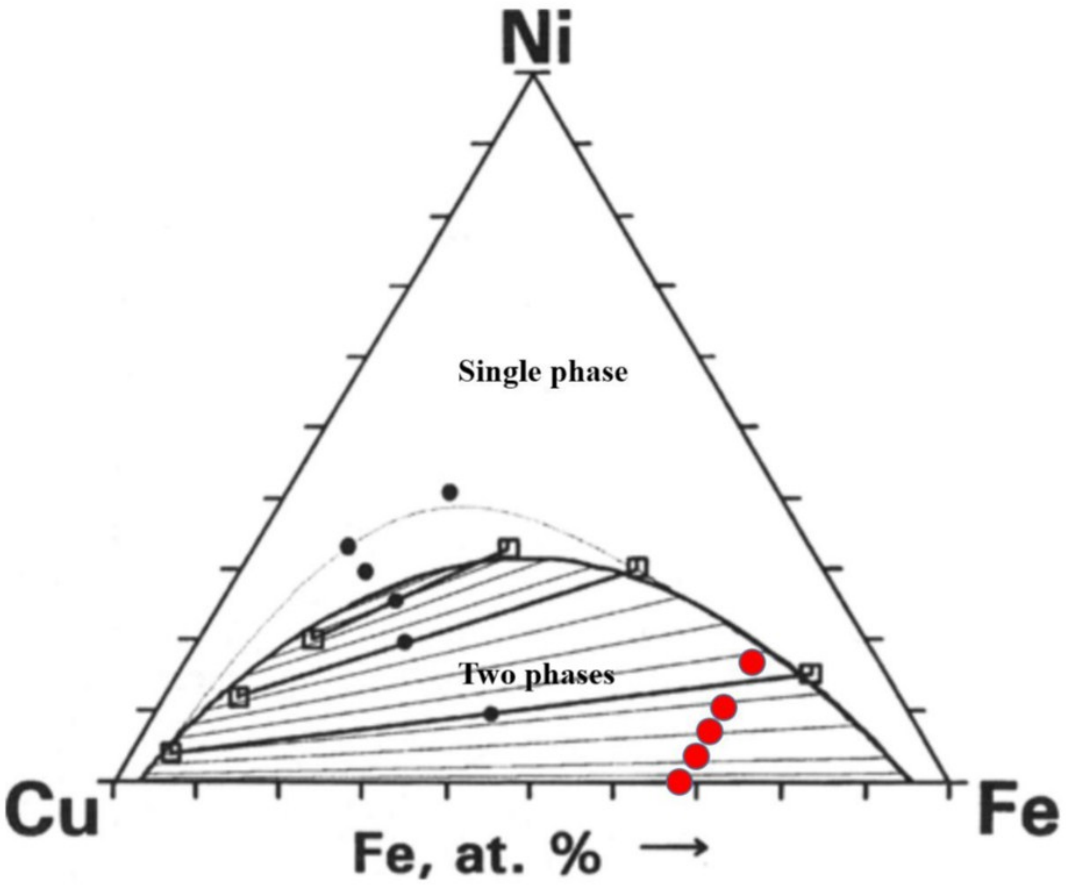


Fig. S4 Phase diagram of the Cu-Fe-Ni-system at 1273 K based on the experimental results and the thermodynamic reassessment [1] with CNFO composition, tested in this study (red circle).

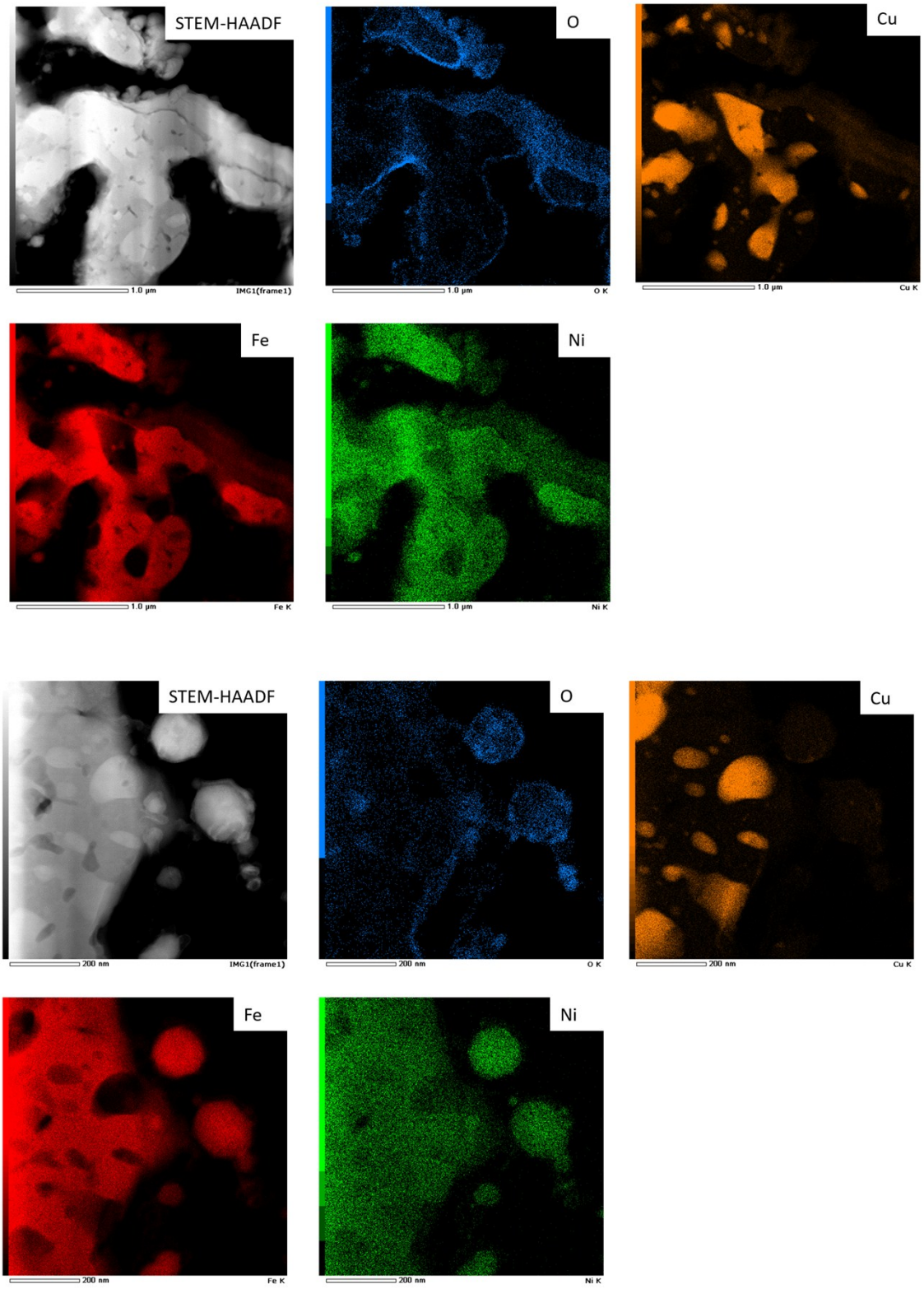


Fig. S5 STEM-EDX images of CNFO 0.1 after test.

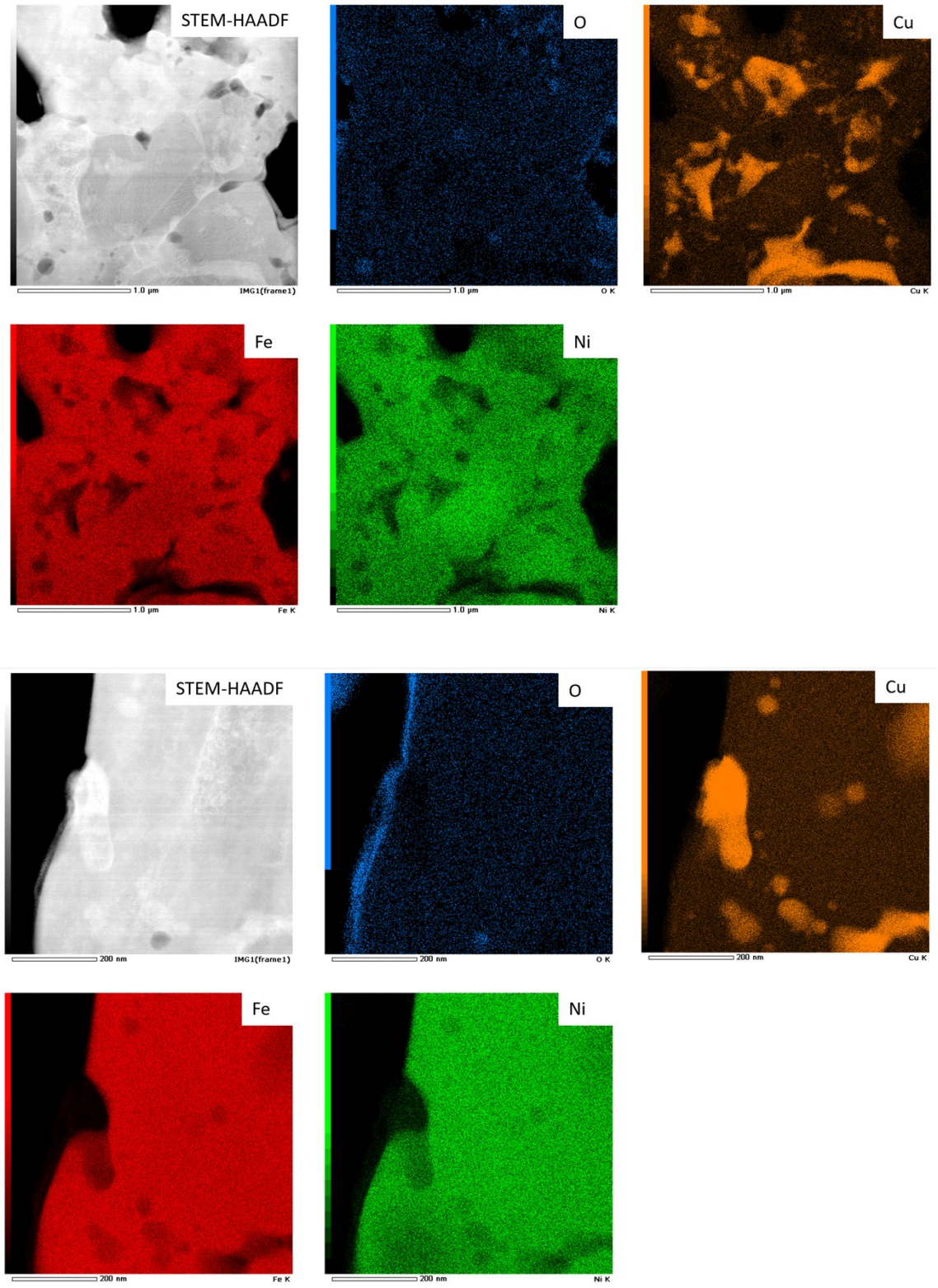


Fig. S6 STEM-EDX images of CNFO 0.5 after reduction.

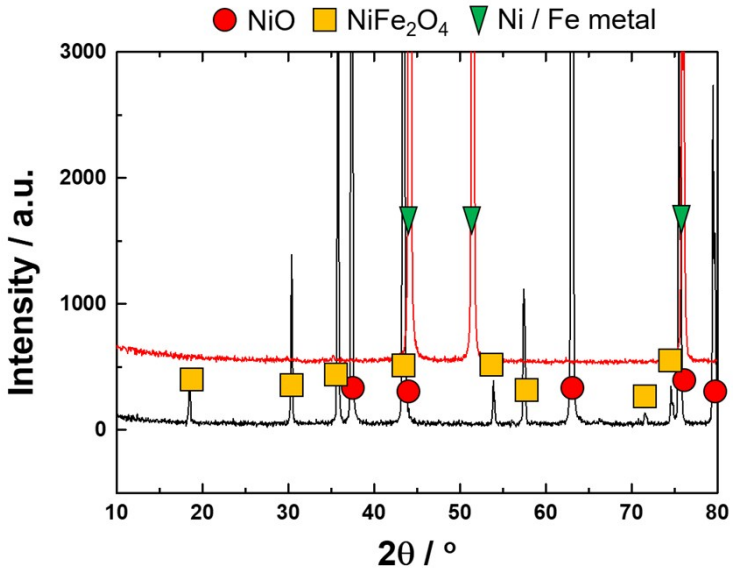


Fig. S7 XRD patterns of NiFe oxide before and after reduction at 1073 K.

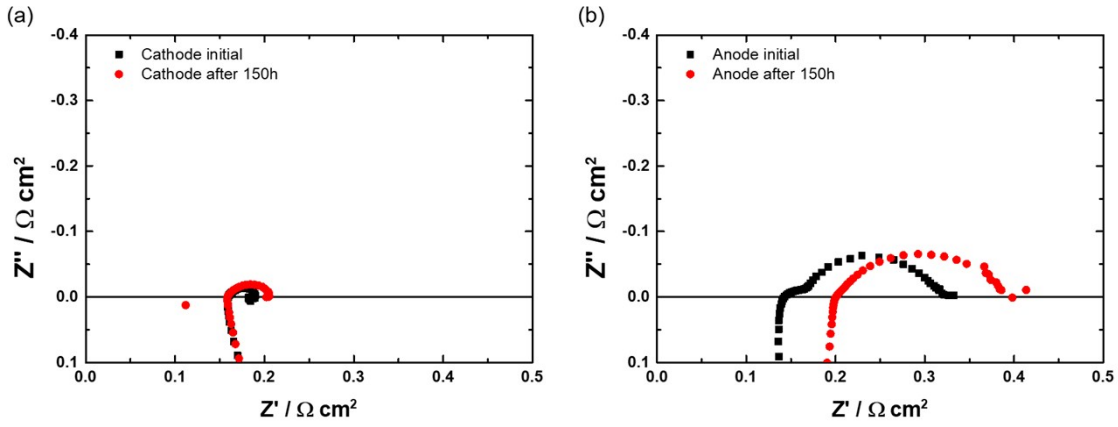


Fig. S8 Impedance plot of CNFO 0.1 initial and after operation under 0.8V for150 h at 1073K, (a) cathode and (b) anode.

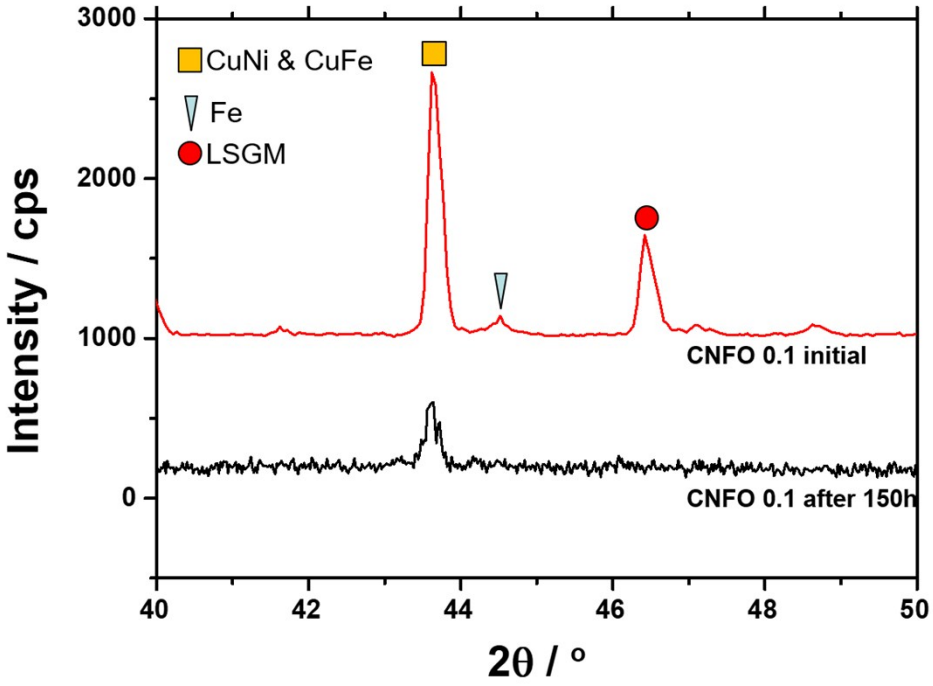


Fig. S9 XRD patterns of CNFO 0.1 initial and after operation under 0.8V for150 h at 1073K.

[1] K. J. Rönkä, et. al., Matall. And Materials Transactions A, 27, (1996), 2229-2238.