Electronic Supplementary Material (ESI) for New Journal of Chemistry.

Supporting Information

Nickel foam supported mesoporous $NiCo_2O_4$ arrays with excellent methanol electro-oxidation performance

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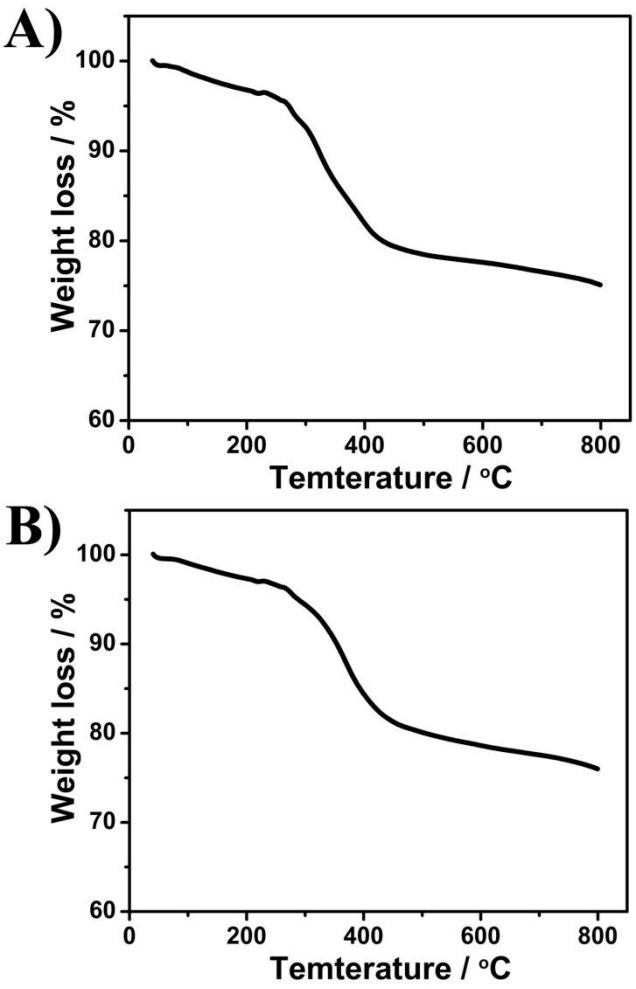

Fig. S1 TGA plots for the precursors of (A) NCO-NS and (B) NCO-NC

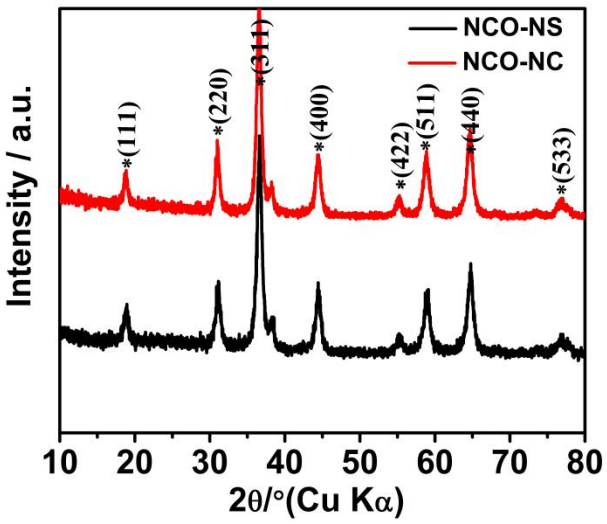

Fig. S2 XRD patterns of NCO-NS (black line) and NCO-NC (red line) scratched down from nickel foam

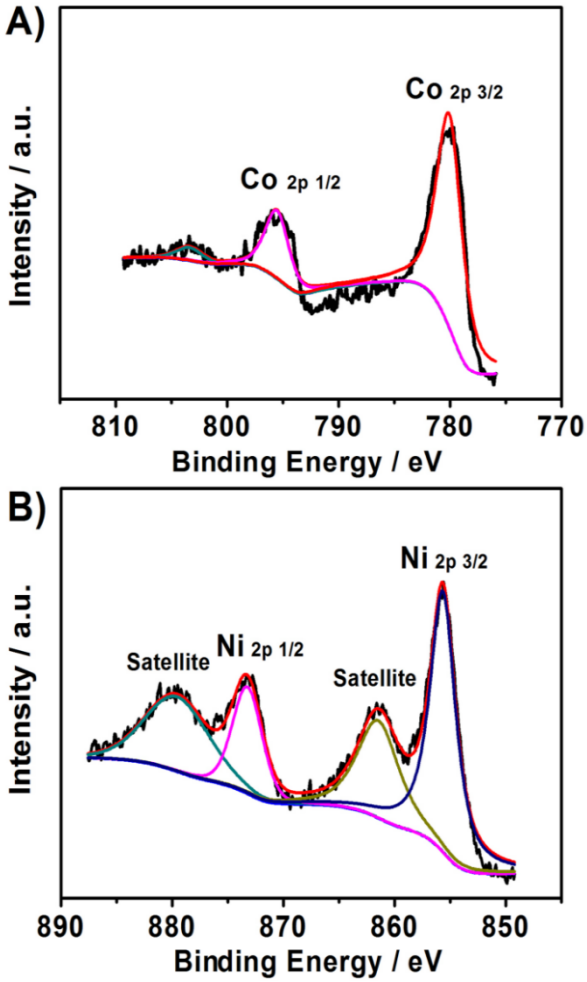

Fig. S3 High-resolution XPS spectra of (A) Co 2p and (B) Ni 2p of NCO-NS

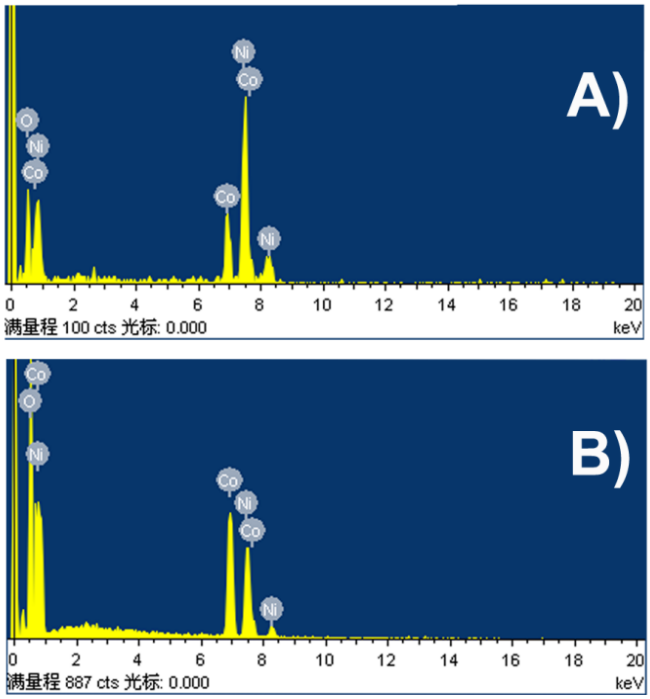

Fig. S4 EDS analysis of (A) NCO-NS and (B) NCO-NC

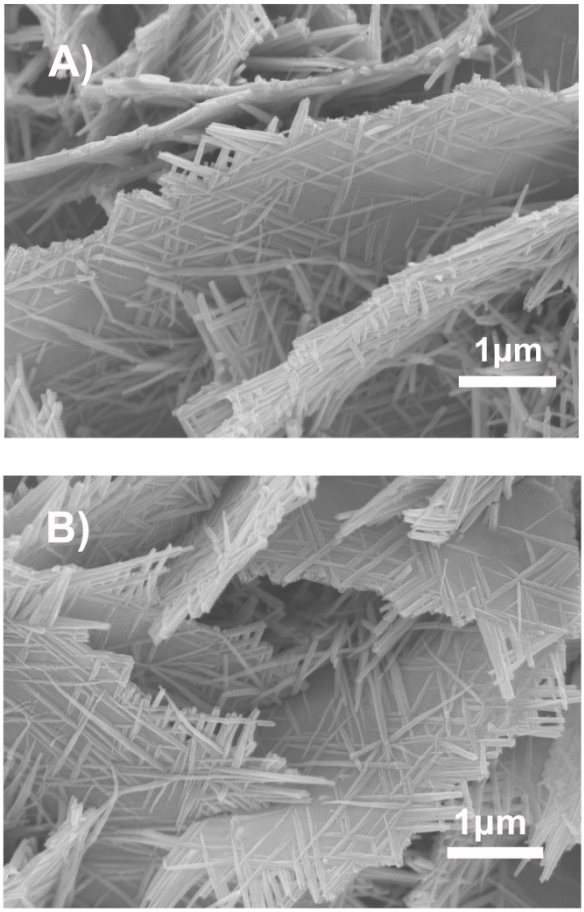

Fig. S5 The high-magnification images of NCO-NC grown on nickel foam.

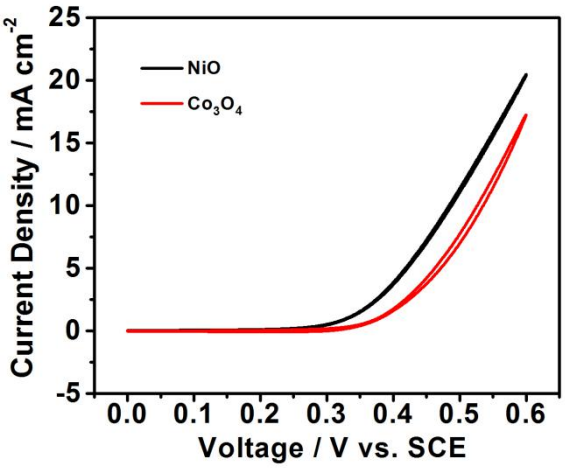

Fig. S6 CV plots of Co_3O_4 and NiO electrodes in 1 M KOH with 0.5 M methanol at a scan rate of 10 mV s^{-1}

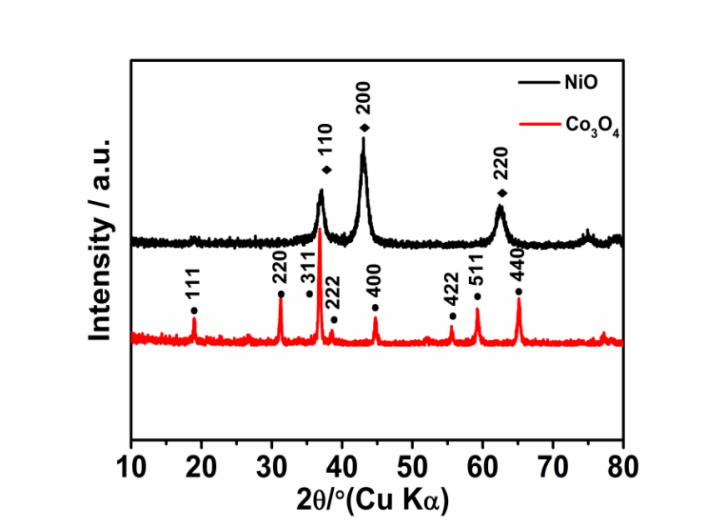

Fig. S7 XRD patterns of NiO (black line) and Co_3O_4 (red line) scratched down from nickel foam

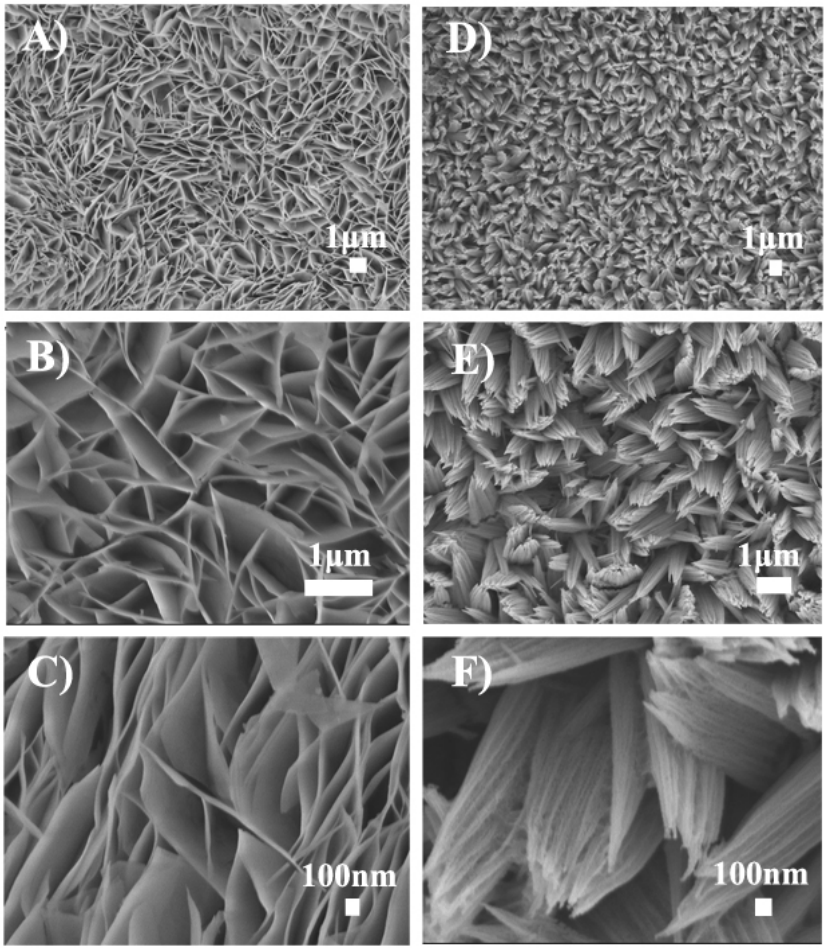

Fig. S8 SEM images of (A-C) NiO and (D-E) Co_3O_4 grown on nickel foam

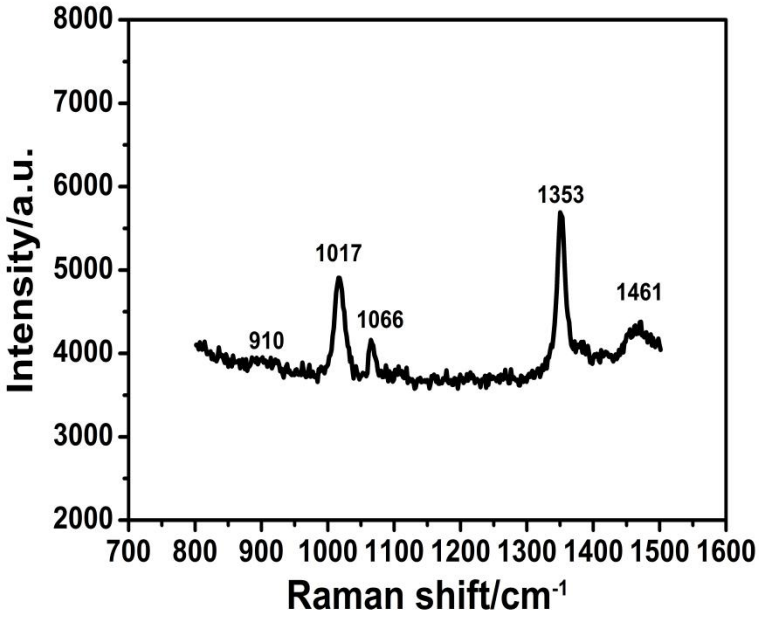

Fig. S9 Raman spectra of 1 M KOH electrolytes with 0.5 M methanol after 500 cycles. The peaks around 1017 cm^{-1} and 1461 cm^{-1} are C-O stretching mode and CH_3 bending mode of CH_3OH (J. Phys. Chem., 1980, 84, 3130). In addition, it can be clearly see that the additional peaks around 910, 1066, 1353 and 1461 cm^{-1}(overlapping peaks), which maybe belong to the symmetric C-O stretching mode, antisymmetric C-O stretching mode, C-H wagging motion and C=O in plane of HCOH (J. Phys. Chem. B, 2005, 109, 432). The involvement of OH and CHO species as intermediates in the electro-oxidation of methanol has been proposed in elsewhere (Electrochim. Acta, 1998, 44, 1135. Journal of Power Sources, 2008, 185, 776). Therefore, Raman spectra of electrolytes can prove that CH_3OH has been oxidized to other intermediate products.

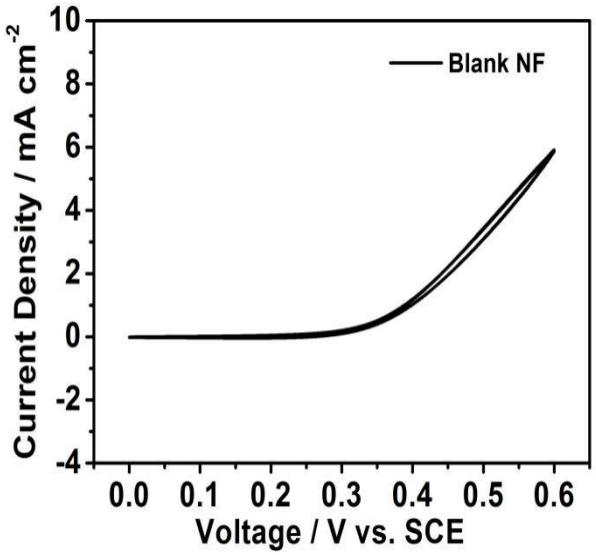

Fig. S10 CV plot of blank nickel foam in 1 M KOH with 0.5 M methanol at a scan rate of 10 mV s^{-1}

Table 1

The fitting values of impedimetric parameters for both $NiCo_2O_4$ electrodes in 1 M KOH electrolytes with and without 0.5 M methanol.

Electrode	Impedimetric parameters									
	L	R_e (Ω cm^2)	Q_1, Y_0 (Ω^{-1} S^n cm^{-2})	R_{ct} (Ω cm^2)	W, Y_0 (Ω^{-1} $S^{0.5}$ cm^{-2})	Q_2,Y_0 (Ω^{-1} S^n cm^{-2})	n1	n2	f_{knee} (Hz)	C (F cm^{-2})
WO-NCO-NS	$7.4E^{-7}$	1.59	$2.6E^{-3}$	4.27	0.67	0.18	0.6	0.96	6.8	-
WO-NCO-NC	$9.5E^{-7}$	0.87	$3.7E^{-3}$	0.89	0.55	-	0.7	-	31.6	0.3
W-NCO-NS	$6.4E^{-7}$	1.75	$7.5E^{-3}$	5.02	0.24	0.34	0.6	0.98	2.2	-
W-NCO-NC	$7.4E^{-7}$	1.33	$7.1E^{-3}$	0.86	0.97	-	0.6	-	26.1	0.3

Note: The symbols “W” and “WO” represent the 1 M KOH electrolytes with and without 0.5 M methanol respectively.