

Supporting Information

Alkaline-Etched NiMgAl Trimetallic Oxides Supported KMoS-Based Catalysts for Boosting Higher Alcohols Selectivity in CO Hydrogenation

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Supporting figures and table **S2-S11**

Table S1. Elemental analysis by ICP-OES for MMO-*x* and K, Mo/MMO-*x*.

Materials	Ni (wt. %)	K (wt. %)	Mo (wt. %)	Mg (wt. %)	Al (wt. %)	Mg/Ni (mass ratio)	Al/Ni (mass ratio)
MMO-0	4.79	-	-	24.17	12.24	5.05	2.56
MMO-2	4.97	-	-	17.77	12.69	3.58	2.55
MMO-10	5.15	-	-	17.14	12.51	3.33	2.43
MMO-30	5.30	-	-	17.18	10.78	3.24	2.03
MMO-60	5.33	-	-	16.82	10.50	3.16	1.97
K, Ni/MMO-0	4.23	4.72	8.27	20.69	11.19	4.89	2.65
K, Ni/MMO-2	4.18	4.89	8.28	16.83	10.70	4.03	2.56
K, Ni/MMO-10	4.12	4.89	8.10	15.69	10.11	3.81	2.45
K, Ni/MMO-30	4.07	4.66	7.77	15.42	10.09	3.79	2.48
K, Ni/MMO-60	4.03	4.81	7.89	15.24	9.83	3.78	2.44

Table S2. Textural parameters of MMOs and K, Mo/MMOs from N₂ adsorption/desorption.

	Surface Area (m ² /g)		Pore Volume (cm ³ /g)		Average Pore Diameter (nm)	
	MMO- <i>x</i>	K, Mo/MMO- <i>x</i>	MMO- <i>x</i>	K, Mo/MMO- <i>x</i>	MMO- <i>x</i>	K, Mo/MMO- <i>x</i>
K, Mo/MMO-0	198.1	134.5	0.875	0.331	17.66	11.25
K, Mo/MMO-2	199.2	117.2	0.592	0.319	10.36	10.08
K, Mo/MMO-10	203.3	100.8	0.53	0.188	11.89	7.48
K, Mo/MMO-30	175.4	93.0	0.454	0.175	10.42	7.51
K, Mo/MMO-60	186.8	94.7	0.239	0.158	7.70	5.82

Table S3. H₂ consumption for K, Mo/MMO-*x* in TPR.

	Center Temperature (°C)	Peak area	H ₂ consumption (mmol/g·cat)		Center Temperature (°C)	Peak area	H ₂ consumption (mmol/g·cat)
K, Mo/MMO-0	578	123	0.289		712	672	1.57
K, Mo/MMO-2	576	292	0.684		702	568	1.33
K, Mo/MMO-10	579	332	0.777		701	521	1.22
K, Mo/MMO-30	577	299	0.700		719	581	1.36
K, Mo/MMO-60	595	179	0.419		735	665	1.55

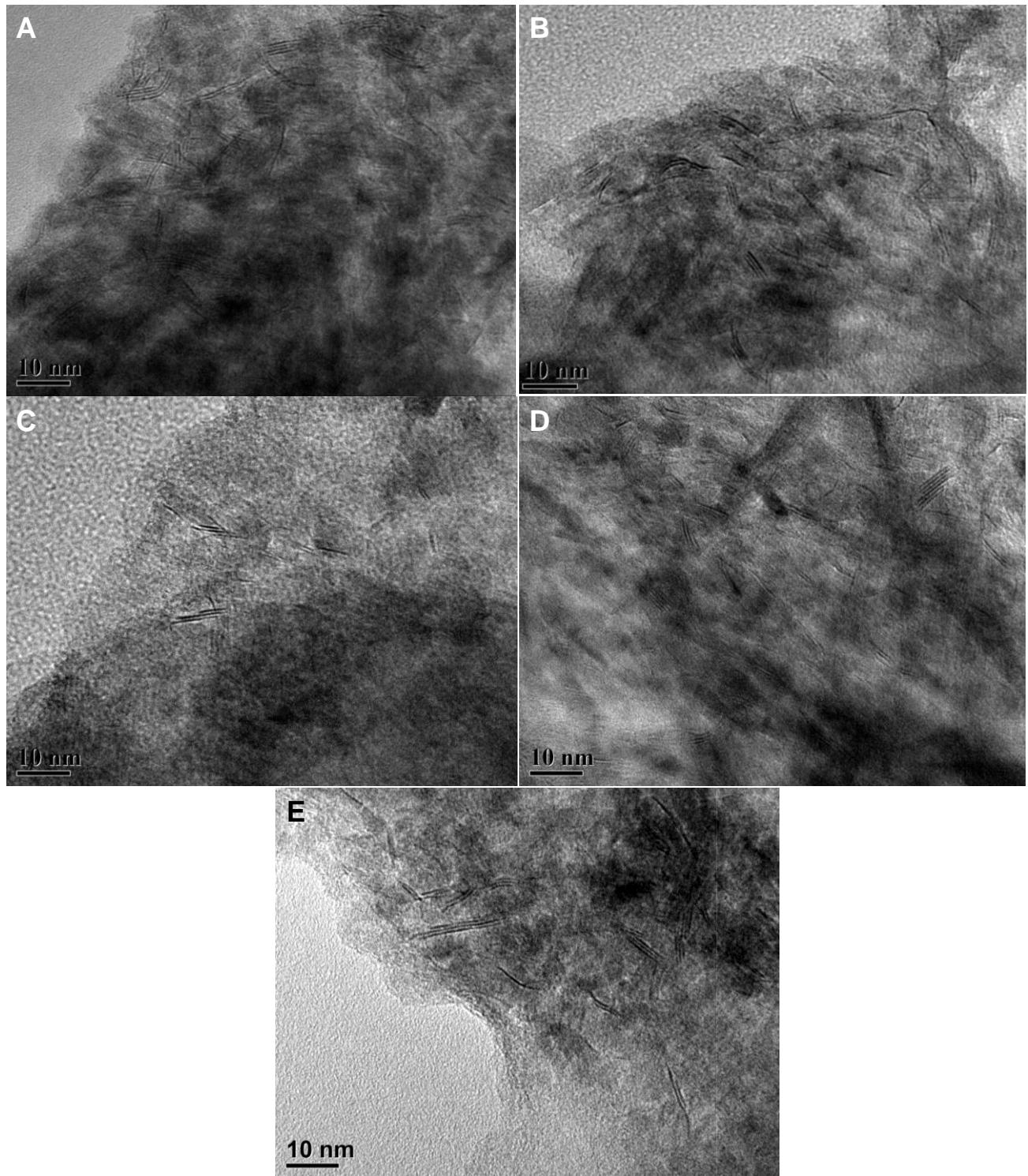


Figure S1. Representative TEM images of after sulfurization (A) K, Mo/MO-0, (B) K, Mo/MMO-2, (C) K, Mo/MMO-10, (D) K, Mo/MMO-30 and (E) K, Mo/MMO-60.

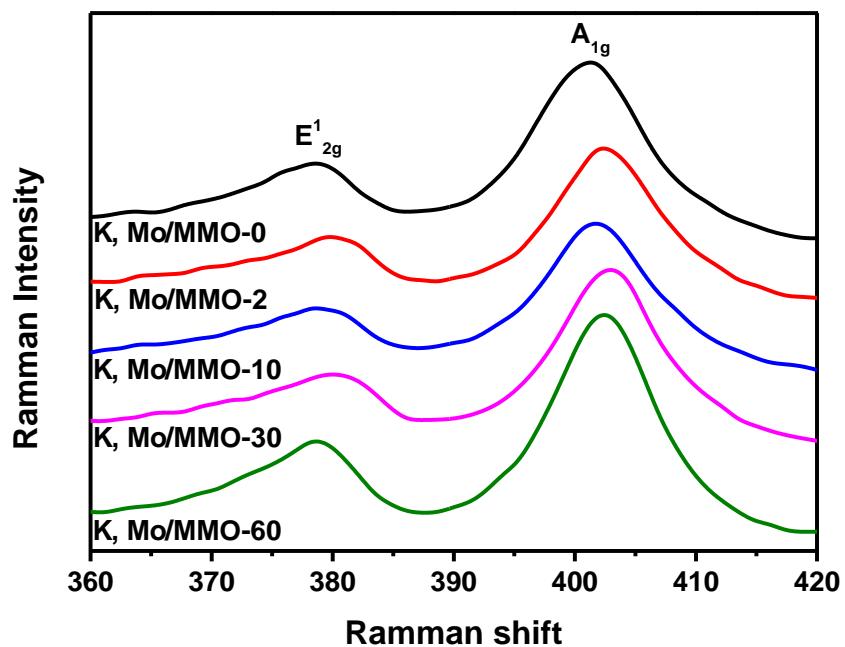


Figure S2. Raman spectra of pre-sulfided K, Mo/MMO-*x*.

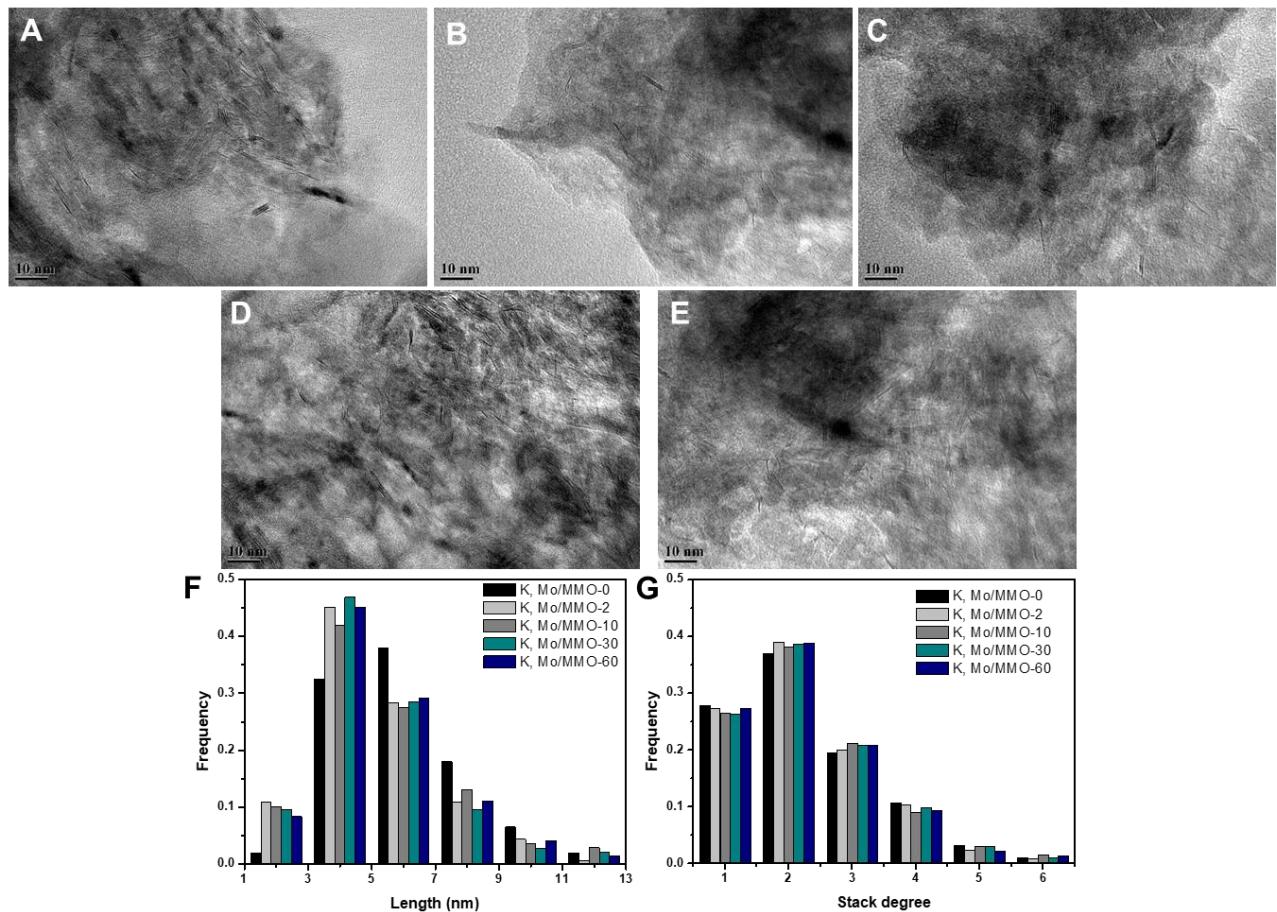


Figure S3. Representative TEM images after CO hydrogenation reaction (A) K, Mo/MMO-0, (B) K, Mo/MMO-2, (C) K, Mo/MMO-10, (D) K, Mo/MMO-30 and (E) K, Mo/MMO-60, and statistic results of MoS₂ slab (F) length distribution and (G) stacking degree distribution.

Table S4. Statistical results of morphology parameters and fraction of Mo atoms on the edge sites of K, Mo/MMO-*x* after CO hydrogenation reaction.

	L _{average} (nm)	σ _{length}	N _{average}	Fraction of Mo _{edge}
K, Mo/MMO-0	5.83	4.79	2.32	0.184
K, Mo/MMO-2	5.06	4.08	2.24	0.211
K, Mo/MMO-10	5.23	3.83	2.30	0.200
K, Mo/MMO-30	5.02	4.02	2.26	0.210
K, Mo/MMO-60	5.38	3.94	2.27	0.205

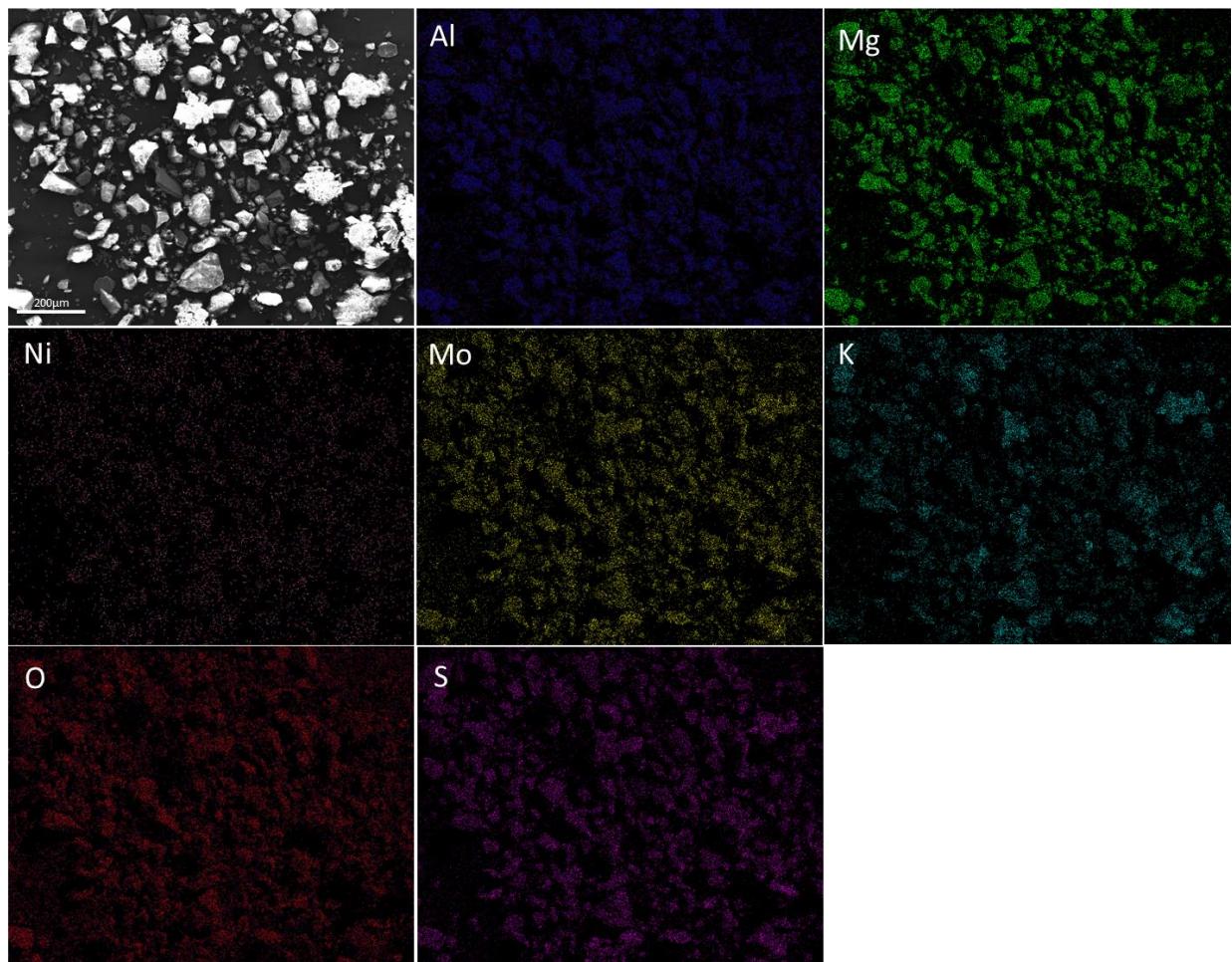


Figure S4. SEM-EDS element mapping of sulfide K, Mo/MMO-10.

Table S5. Summary of HAS results of K, Mo/MMO-*x*

Samples	Hydrocarbons selectivity (%)	Alcohols selectivity (%)	CO ₂ selectivity (%)	Other oxygenates selectivity (%)	C ₂₊ alcohols selectivity (%)	STY for C ₂₊ alcohols (g/g·Mo/h)
K, Mo/MMO-0	13.0	55.2	26.2	5.7	46.0	0.58
K, Mo/MMO-2	9.3	64.9	21.6	4.2	52.6	0.71
K, Mo/MMO-10	8.9	66.1	21.4	3.6	49.6	0.68
K, Mo/MMO-30	10.2	61.8	24.1	3.9	48.2	0.63
K, Mo/MMO-60	11.5	61.1	22.9	4.5	48.9	0.59
K, Mo/MMO-0-g5*	13.4	52.8	28.2	5.6	39.7	-
K, Mo/MMO-0-g10*	12.6	55.4	26.5	5.5	43.5	-

Note: * K, Mo/MMO-0-g5 and K, Mo/MMO-0-g10 were prepared with the same materials with K, Mo/MMO-0, except for they were ground with K₂CO₃ for 5 and 10 minutes, respectively.

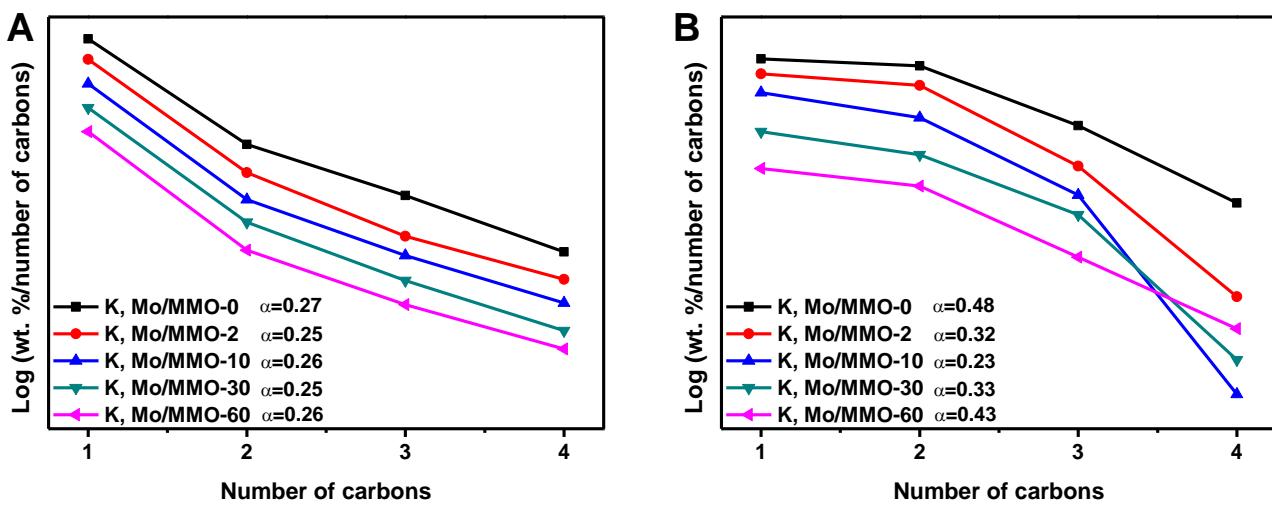


Figure S5. ASF distributions and chain growth probability of (A) hydrocarbons and (B) alcohols.