catalysts

MDPI

Supplementary Materials

RuNi/MMO Catalysts Derived from a NiAl-NO_3-LDH Precursor for CO Selective Methanation in H_2-Rich Gases

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Table S1. Structural characteristics of the prepared LDHs.

Samples	LDHs-C	LDHs-N (0.03M)	LDHs-N (0.06M)	LDHs-N (0.09M)	LDHs-N (0.12M)
d_{003}, nm	0.781	0.795	0.831	0.834	0.827
D_{LDHs}, nm	5.89	4.48	4.84	4.65	5.05

Table S2. C and N chemical compositions of LDHs.

Samples	N (mol/g)	C (mol/g)
LDH-C	0.09	1.86
LDH-N (0.09 M)	1.89	0.72

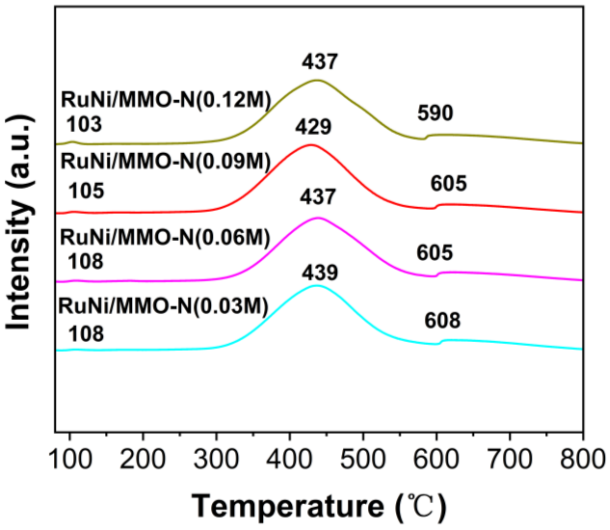

Figure S1. H_2-TPR profiles of different HNO_3–ethanol solutions concentrations (0.03 M, 0.06 M, 0.09 M, and 0.12 M) of the RuNi/MMO catalysts.

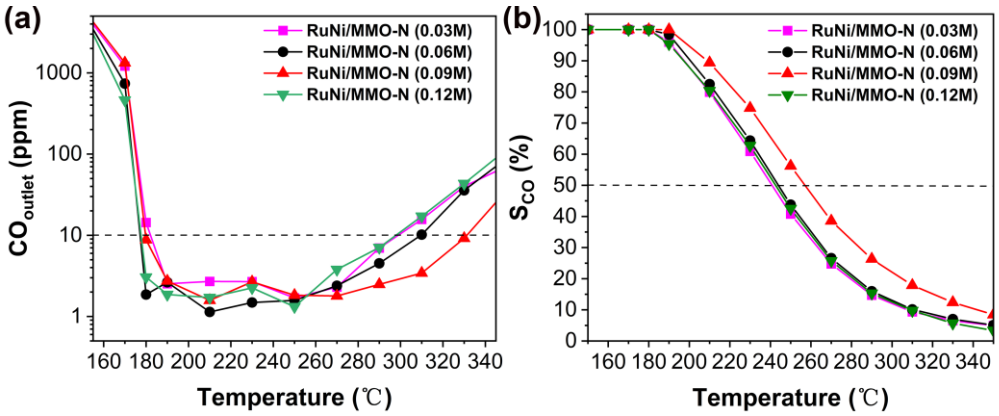

Figure S2. (a) The CO outlet concentration and (b) the selectivity of CO methanation over the different RuNi/MMO-N catalysts.

Table S3. The physicochemical properties of the RuNi/MMO-C and RuNi/MMO-N catalysts.

Catalysts	S_{BET} [1] (m^2/g)	Pore size [2] (nm)	V_{BJH} [3] (cm^3/g)	Metal load [4] (wt%)	
				Ni	Ru
RuNi/MMO-C	75.479	9.095	0.230	45.556	0.256
RuNi/MMO-N	128.873	6.839	0.234	47.177	0.336

[1] Obtained from the BET equation.
[2] Barrett–Joyner–Halenda (BJH) desorption average pore diameter.
[3] BJH desorption pore volume.
[4] Elemental loading amounts for Ni and/or Ru of the RuNi/MMO-C and RuNi/MMO-N catalysts from ICP-OES.

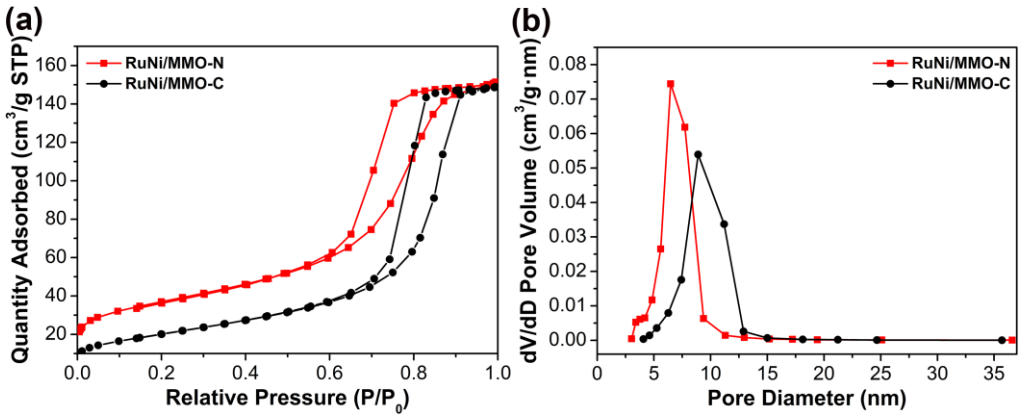

Figure S3. (**a**) N_2 adsorption–desorption isotherms and (**b**) BJH pore size distributions of the RuNi/MMO-C and RuNi/MMO-N catalysts.

Table S4. The peak areas of CO_2-TPD for the RuNi/MMO-C and RuNi/MMO-N catalysts.

Samples	RuNi/MMO-C	RuNi/MMO-N
weak basic sites	4.19	1.84
moderate basic sites	2.27	1.76
strong basic sites	3.12	2.63

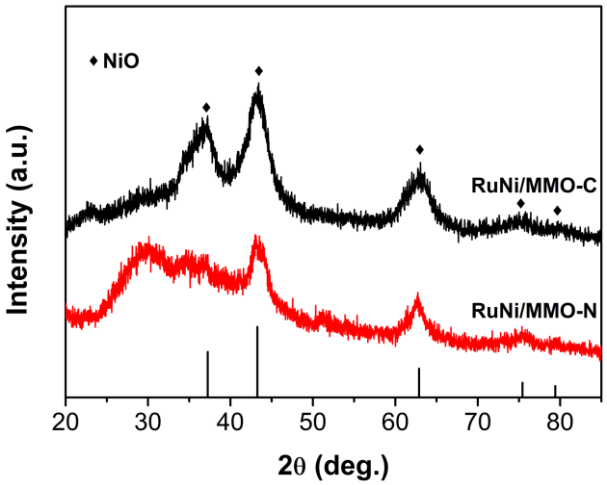

Figure S4. XRD patterns of the RuNi/MMO-C and RuNi/MMO-N catalysts.

Table S5. Summary of the CO-SMET performances for the Ru- and Ni-based catalysts developed in recent years.

Catalysts	Optimal temperature (°C)	$[CO]_{min}$ (ppm)	SWTW [1]	Stability (h)	Reference
RuNi/MMO	190	<10	180~260	120	In this work
RuNi/Al_2O_3-CNTs/NF	200	<10	190~250	120	[15]
Ru-Ni/Al_2O_3	150	<100	-	-	[20]
Ru-Ni/TiO_2	200	11	-	-	[57]
Ru-Ni/Al_2O_3	210	11	-	80	[60]
Ru-Ni/TiO_2-Al_2O_3	210	<10	210~220	200	[61]
Ru/Ni-Al-oxide/NF	200	<10	200~260	120	[62]
Ni/TiO_2	225	1000	-	-	[63]
SiO_2/Ni-ZrO_2	200	<10	200~240	100	[64]
Ni/ZrSBA-15	180	<10	170~220	-	[65]
Ni/CeO_2	250	<10	250~320	-	[66]
Ru/Ni-TNTs	220	<10	210~285	-	[67]

[1] A suitable working temperature window, with a CO concentration in the effluent of less than 10 ppm and a CO selectivity greater than 50%.