Supplementary material

Exceptional low-temperature activity of perovskite-type $AlCeO_3$ solid solution supported Ni-based nanocatalyst towards CO_2 methanation

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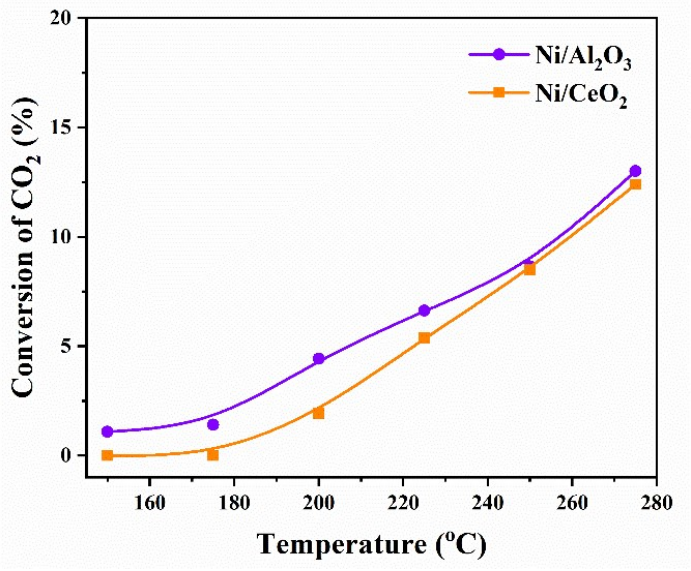

Fig.S1 The change in the CO2 conversion with the reaction temperature over Ni/Al_2O_3 and Ni/CeO_2 reference catalysts.

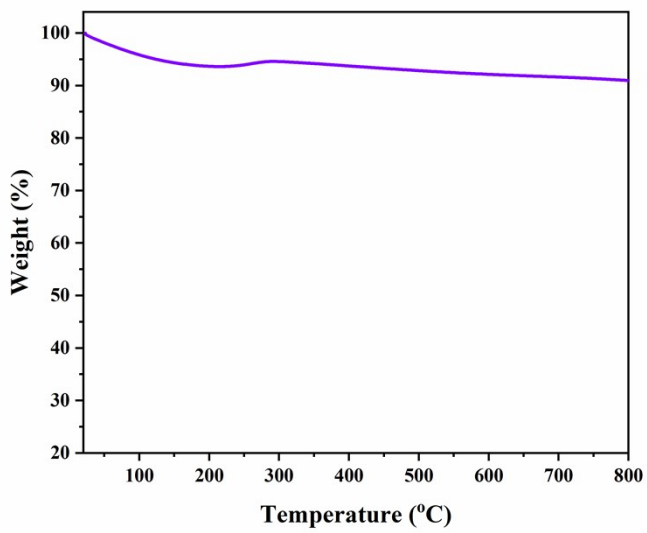

Fig.S2 TG curve of used Ni/AlCeO-0.2 catalyst after 55h test.

Table S1 Surface basicity of different Ni-based samples.

Samples	Specific basicity (CO_2 mmol/g）			
	Total basic sites	WB site	MSB site	SB site
Ni/AlCeO-0	1.0	0.049	0.732	0.219
Ni/AlCeO-0.1	1.165	0.073	0.898	0.194
Ni/AlCeO-0.2	1.211	0.117	0.900	0.193
Ni/AlCeO-0.4	1.221	0.102	0.900	0.219

Table S2 Data of H_2-TPD profiles for different Ni-based samples.

Samples	H_2 uptake (mmol/g)	H_{Ni}[a] (mmol/g)	H_{sp}[b] (mmol/g)
Ni/AlCeO-0	0.614	0.458	0.139
Ni/AlCeO-0.1	0.648	0.504	0.117
Ni/AlCeO-0.2	0.627	0.505	0.108
Ni/AlCeO-0.4	0.622	0.502	0.104
Ni/Al_2O_3	0.130	0.082	0.023
Ni/CeO_2	0.020	0.017	--

[a] Desorption in the range of 100–500 °C. [b] Desorption in the range of 500–900°C.

Table S3 Comparison of the results of CO_2 methanation over different metal catalysts.

Samples	CO_2/H_2 atomic ratio	GHSV ($mL \cdot g^{-1} \cdot h^{-1}$)	Temp。(^oC)	Conv. (%)	TOF (h^{-1})	Refs
Ni-Ce-Al_2O_3	1:3.5	9000	300	75	n.a	[13]
Ni/Al_2O_3-ZrO_2	1:4	6000	300	77	n.a	[23]
Ni/CeO_2-ZrO_2	1:4	21000	350	80	n.a	[30]
NiAl-MO/CeO_2	1:4	2400	250	91	n.a	[31]
Ni/ZSM-5	1:4	2400	400	70	27.3 [a]	[56]
Ni@UiO-66	1:5.2	1650	350	48	n.a	[57]
Ni@MOF-5	1:4	2000	280	47	n.a	[58]
NiAl-LDH	1:4	30000	250	50	n.a	[59]
Ni/CeO_2	1:4	10000	300	87	n.a	[60]
Ni/SiO_2-Al_2O_3-La_2O_3	1:5	55000	300	83	n.a	[61]
Ni-Cr_2O_3	1:3	18000	350	69	n.a	[62]
Ni/MIL-101	1:4	3000	300	n.a	5.9 [b]	[63]
Ni-MgO/MgH_2	1:4	9600	300	85.2	n.a.	[64]
Ru/Al_2O_3	1:4	1000	250	37	n.a	[65]
Ni/$AlCeO_3$-0.2	1:4	48000	200	83.2	18.2 [c]	This work

[a] calculated at 250 ^{o}C; [b] calculated at 300 ^{o}C; [c] calculated at 175 ^{o}C.