Electronic Supplementary Material (ESI) for Catalysis Science & Technology.

MOFs-derived hierarchical hollow spheres composed of carbon-confined Ni nanoparticles for efficient CO_2 methanation

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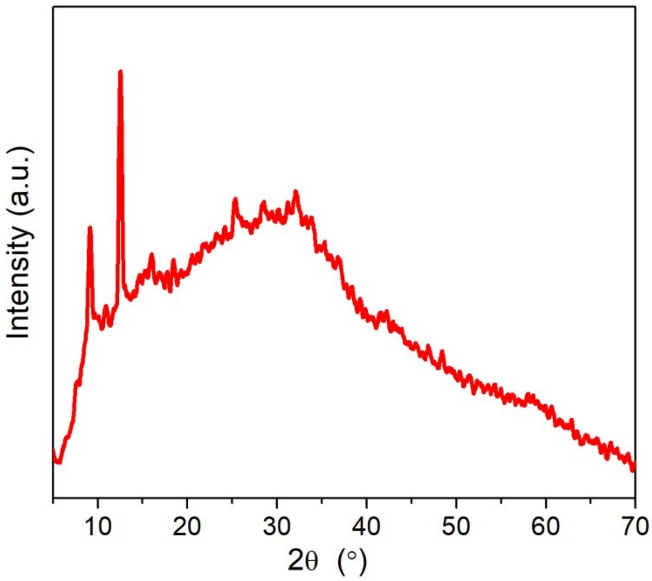

Fig. S1 XRD pattern of Ni-MOF.

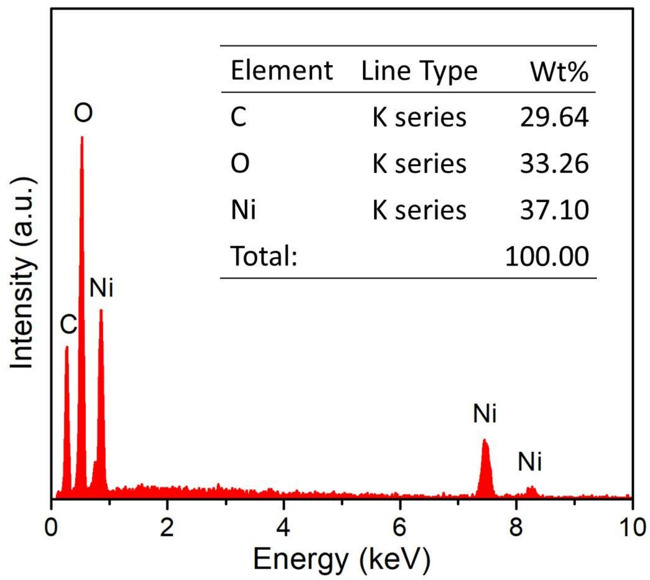

Fig. S2 EDX spectrum of Ni-MOF. Inset shows the corresponding weight contents of the elements.

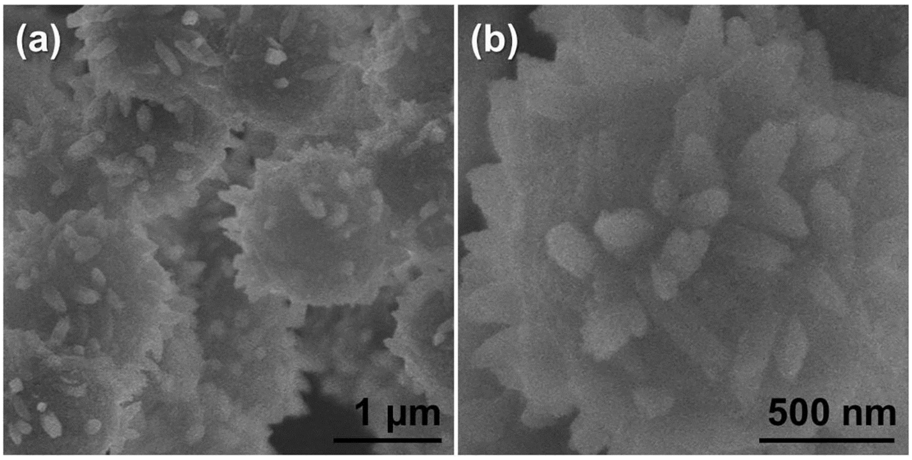

Fig. S3 FESEM images of hierarchical Ni-MOF microspheres.

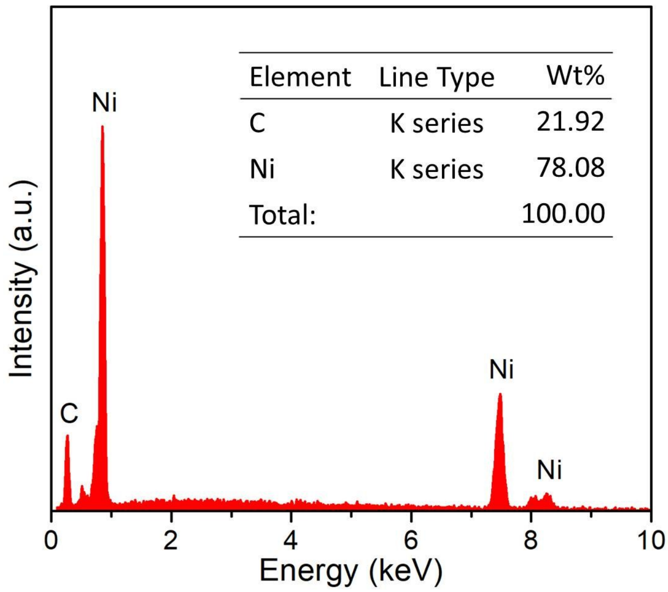

Fig. S4 EDX spectrum of Ni@C. Inset shows the corresponding weight contents of the elements.

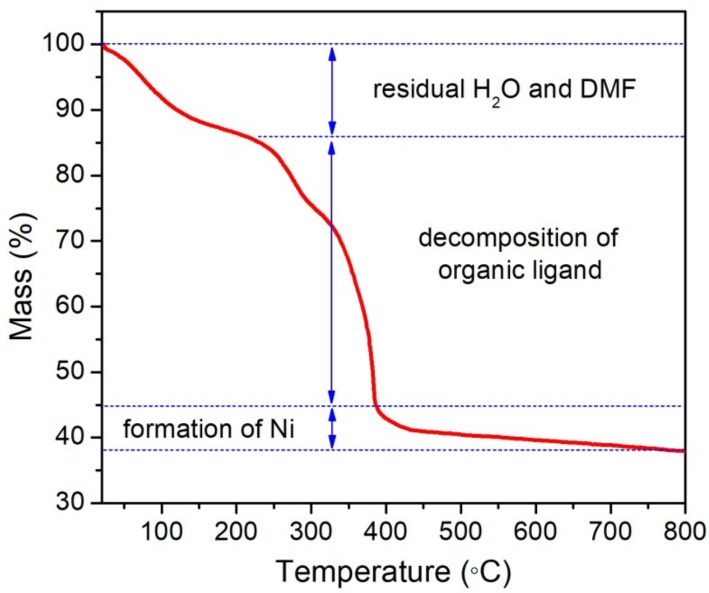

Fig. S5 TGA results of Ni-MOF in a N_2 atmosphere with a heating rate of 5 ºC min^{-1}.

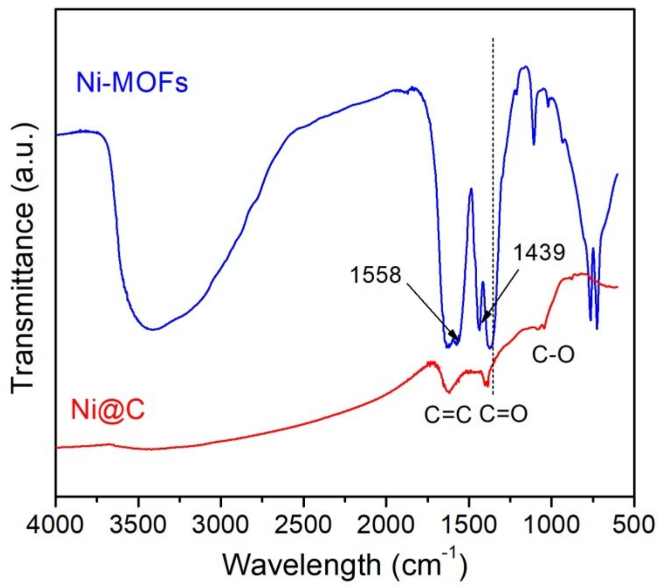

Fig. S6 FT-IR spectra of Ni-MOF and Ni@NC samples.

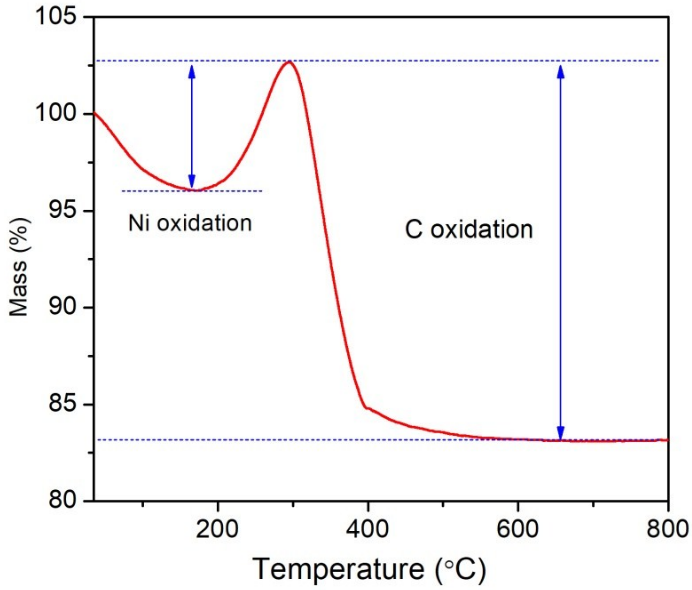

Fig. S7 TGA results of Ni@C in an air atmosphere with a heating rate of 5 °C min^{-1}.

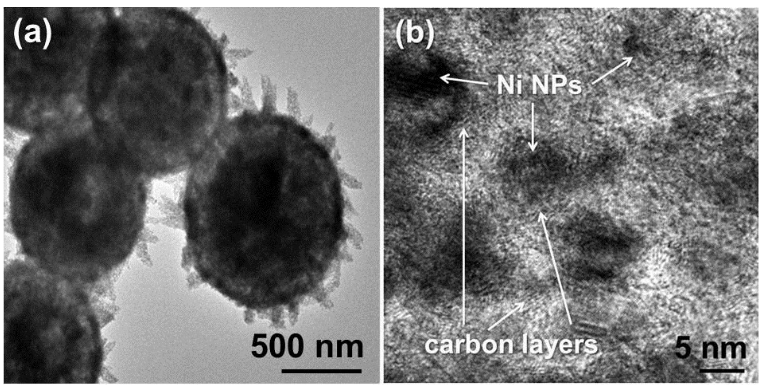

Fig. S8 (a,b) TEM images of hierarchical Ni@C microspheres.

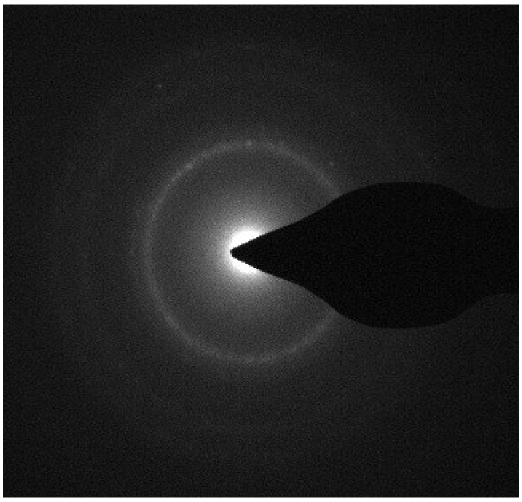

Fig. S9 SAED pattern of Ni@C sample.

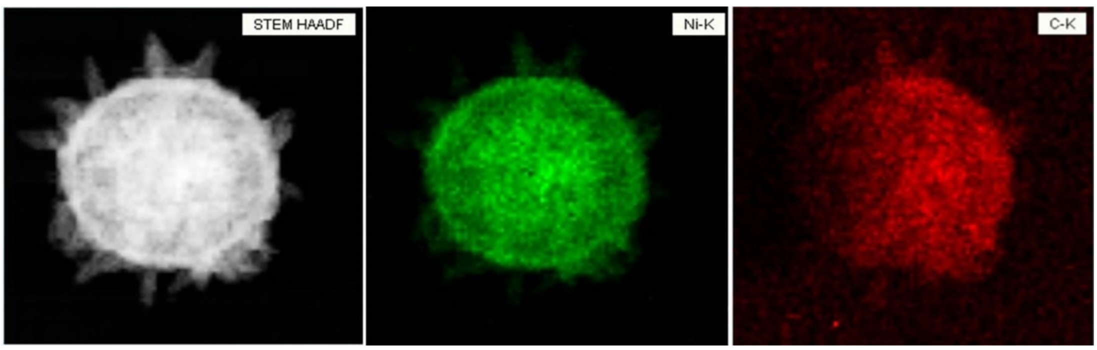

Fig. S10 Elemental mappings of an individual hierarchical Ni@C microsphere.

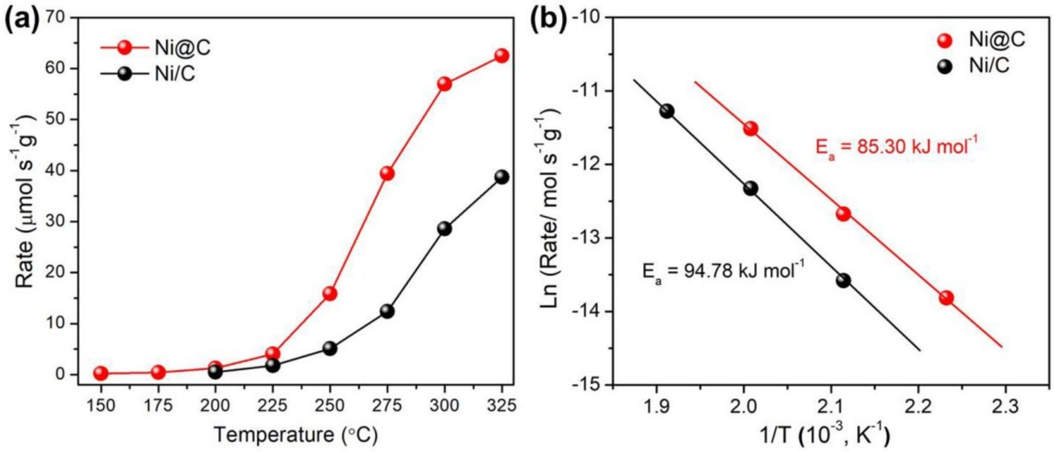

Fig. S11 (a) CO_2 methanation performance of Ni@C and Ni/C catalysts under different temperatures. (b) Arrhenius plots for CO_2 methanation over Ni@C and Ni/C catalysts.

Table S1. Comparison of CO_2 methanation performance of Ni@C with that of other Ni-based catalysts at atmospheric pressure.

Catalyst	Temp. (°C)	GHSV (mL g^{-1} h^{-1})	Con.$_{CO2}$ (%)	Sel.$_{CH4}$ (%)	TOF (10^{-3} s^{-1})	Ref.
Ni@C	300	33000	91.16	99.9	4.28	This work
12Ni4.5Ce/CNT[a]	350	30000	83.8	100	/	1
Ni/MSN[b]	300	50000	64.1	99.9	1.61	2
OMA-2Co8Ni[c]	400	15000	79.9	98.3	/	3
15%Ni/ZSM-5	250	2400	27.1	99	7.56	4
15%Ni/TiO_2	260	2400	96	99	1.22	5
$Ni_{0.8}Mg_{0.2}$@SiO_2	300	60000	87	99	/	6
Ni(21.7)@S16C[d]	500	36000	33	30	12	7
Ni/CeO_2	350	10000	100	100	/	8
Ni-Al_2O_3-HT[e]	350	75000	82.5	99.5	5.7	9
7.5Ni2.5Fe/Al_2O_3	250	32000	22.1	99	5.9	10

[a] CNT: multi-walled carbon nanotubes.

[b] MSN: mesostructured silica nanoparticles.

[c] OMA: ordered mesoporous Al_2O_3.

[d] S16C: the cage-type mesopores of −COOH-functionalized mesoporous silica SBA-16.

[e] HT: hydrotalcite.

Table S2. The weight contents of the elements of four Ni@C samples (denoted as Ni@C-1#, Ni@C-2#, Ni@C-3# and Ni@C-4#) prepared in different batches.

Element	Line Type	Wt%			
		Ni@C-1#	Ni@C-2#	Ni@C-3#	Ni@C-4#
C	K series	20.40	20.92	23.10	22.97
Ni	K series	79.60	79.08	76.90	77.03
Total:		100.00	100.00	100.00	100.00

Supplementary references

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