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Enhancing CO_2 gasification-reforming of municipal solid waste with Ni/CeO_2 and Ni/ZrO_2 catalysts

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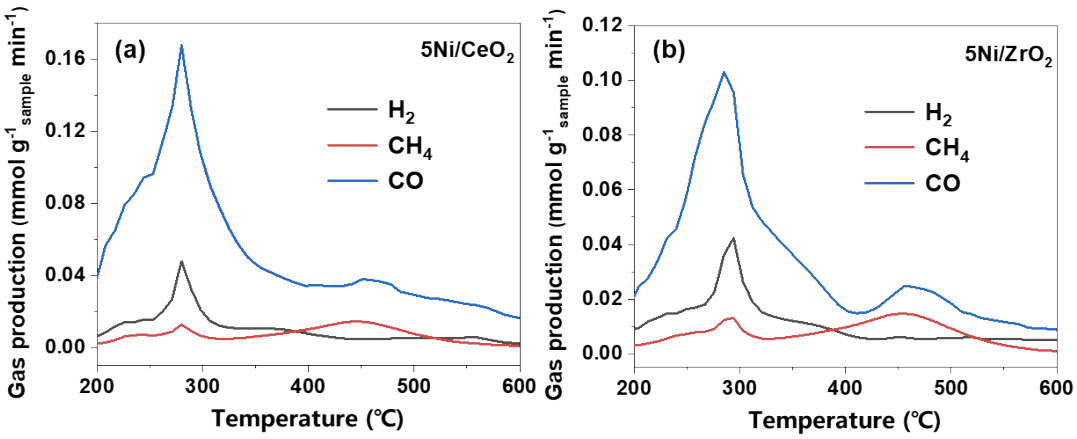

Fig. S1. The gas production rate of cabbage during CO_2 gasification-reforming with (a) 5%Ni/CeO_2 and (b) 5%Ni/ZrO_2 catalysts.

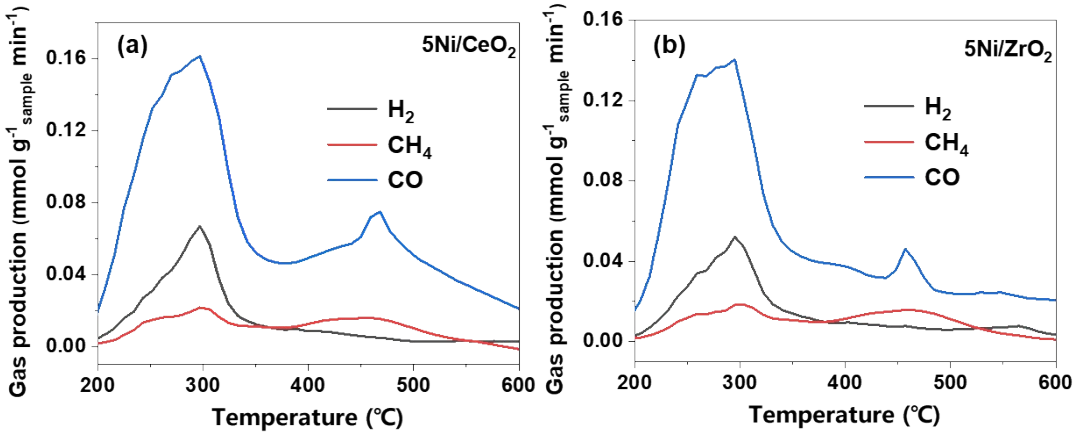

Fig. S2. The gas production rate of poplar leaves during CO_2 gasification-reforming with (a) 5%Ni/CeO_2 and (b) 5%Ni/ZrO_2 catalysts.

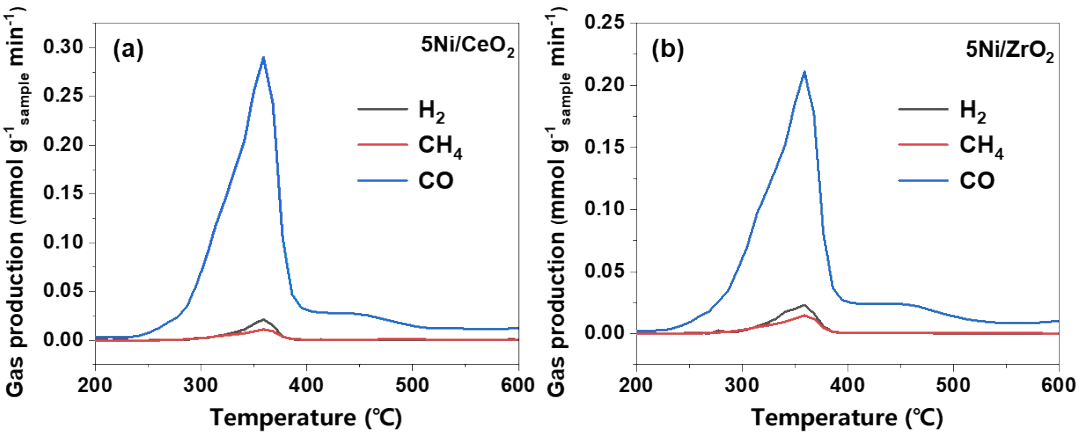

Fig. S3. The gas production rate of printed paper during CO_2 gasification-reforming with (a) 5%Ni/CeO_2 and (b) 5%Ni/ZrO_2 catalysts.

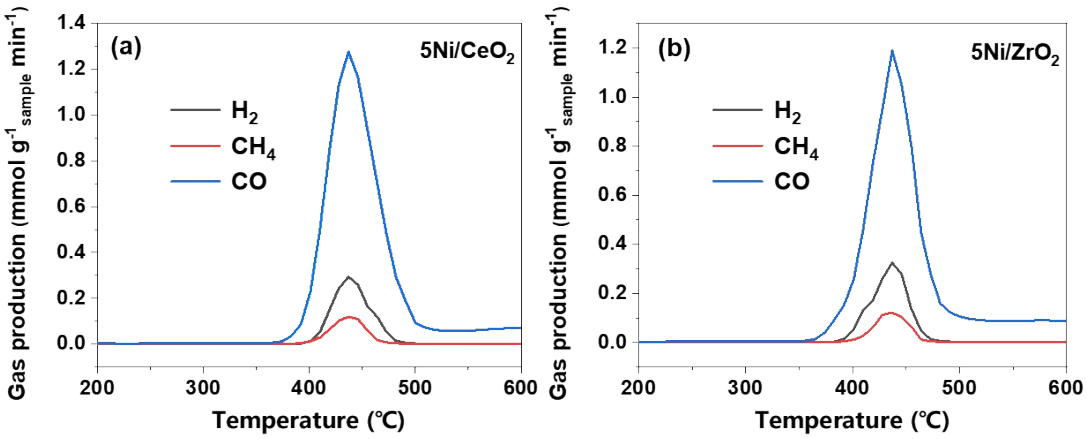

Fig. S4. The gas production rate of PET during CO_2 gasification-reforming with (a) 5%Ni/CeO_2 and (b) 5%Ni/ZrO_2 catalysts.

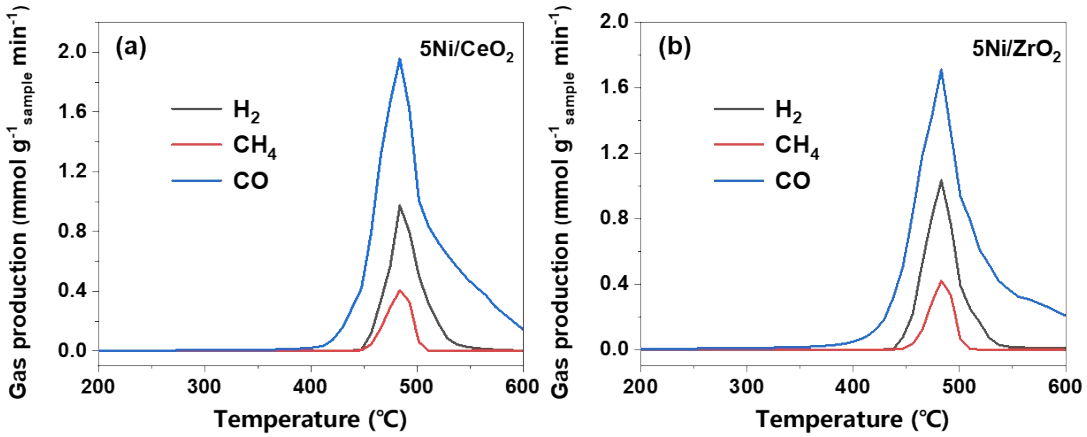

Fig. S5. The gas production rate of HDPE during CO_2 gasification-reforming with (a) 5%Ni/CeO_2 and (b) 5%Ni/ZrO_2 catalysts.

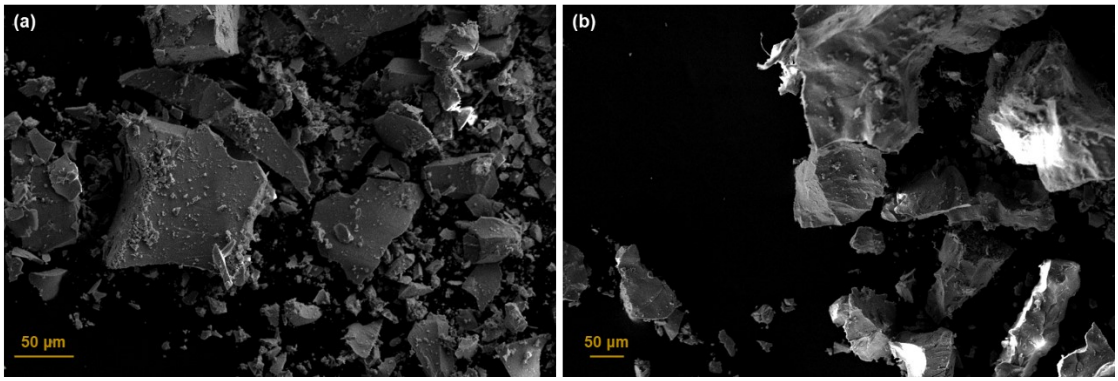

Fig. S6. SEM images of (a) CeO_2 and (b) ZrO_2 supports.

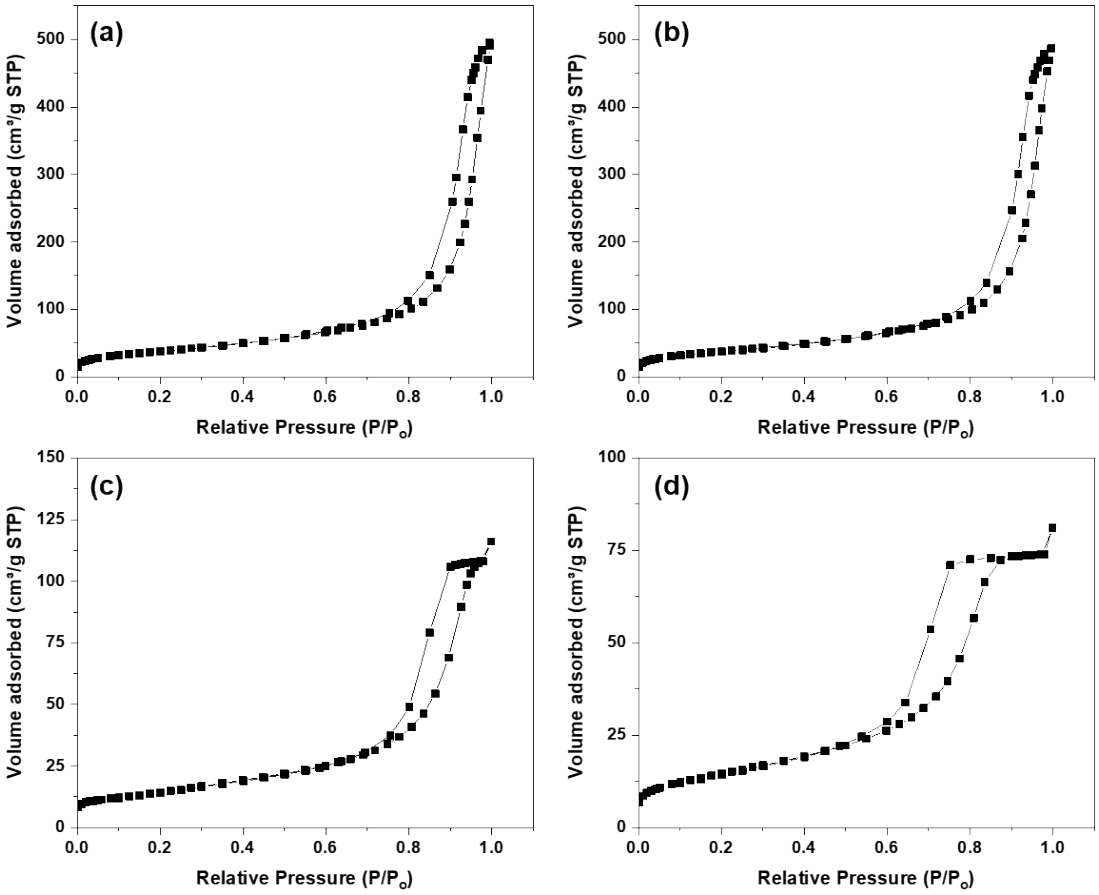

Fig. S7. N_2 adsorption–desorption isotherms of catalysts: (a) CeO_2, (b) ZrO_2, (c) 5%Ni/CeO_2, and (d) 5%Ni/ZrO_2.

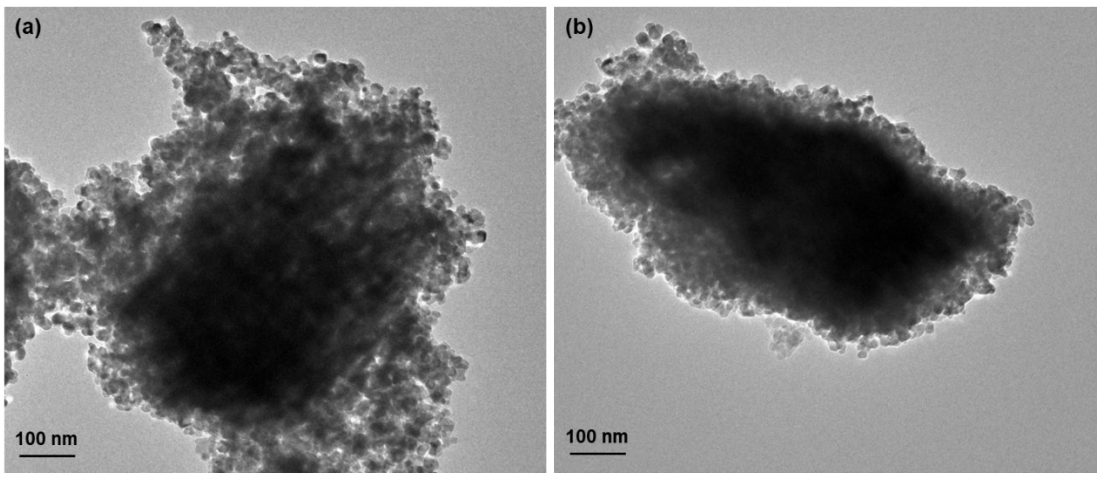

Fig. S8. HR-TEM images of (a) 5%Ni/CeO_2 and (b) 5%Ni/ZrO_2 catalysts.

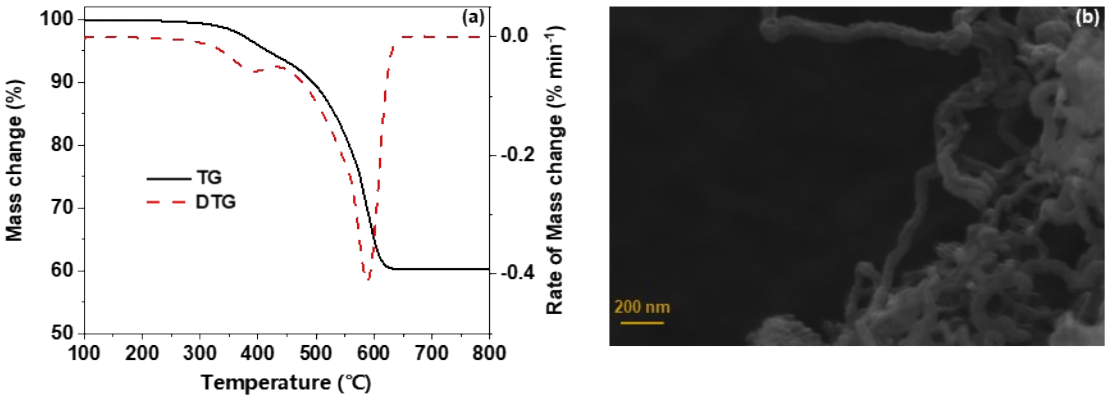

Fig. S9. Characterization of used catalyst after 5 cycles: (a) TGA experiments of the used 5%Ni/CeO_2 catalysts under air atmosphere at the heating rate of 10 °C min^{-1} and (b) morphology of carbon nanotubes on used 5%Ni/CeO_2 catalysts.

Table S1 Proximate and ultimate analyses of the municipal solid waste components.

Municipal solid waste	Proximate analysis (wt.%, dry basis)			Ultimate analysis (wt.%, dry ash-free basis)				
	A	V	FC	C	H	O	N	S
PET	0.1	90.4	9.5	63.0	4.3	32.7	0.0	0.0
HDPE	0.0	100.0	0.0	86.0	11.2	2.6	0.2	0.0
Cabbage	9.9	67.6	22.5	47.5	5.9	41.8	4.1	0.7
Poplar leaf	15.7	68.7	15.6	49.6	5.2	43.3	1.3	0.6
Printed paper	10.7	79.3	10.0	45.1	5.3	0.4	48.9	0.3

A: ash; V: volatile; FC: fixed carbon. The O content was calculated by difference.

Table S2 Comparison of gas yields of HDPE under N_2 and CO_2 atmospheres with and without 5%Ni/CeO_2 catalysts.

Atmosphere, Catalyst	H_2	CH_4	CO
N_2, No catalyst	1.5	4.2	0.1
CO_2, No catalyst	1.7	4.7	0.1
N_2, 5%Ni/CeO_2 catalyst	1.9	4.4	0.2
CO_2, 5%Ni/CeO_2 catalyst	8.5	2.9	31.7

Table S3 Nominal and actual loading of Ni (determined by ICP-AES) in the Ni/CeO_2 catalysts.

Catalysts	Nominal loading (wt%)	Actual loading (wt%)
$2\%Ni/CeO_2$	2	1.9
$5\%Ni/CeO_2$	5	5.3
$10\%Ni/CeO_2$	10	9.4