Figure captions for supplementary information

Fig. SI 1 CH_4 (a) and CO yield (b) of TiO_2 and 10wt%Ni-$Ce_xTi_{1-x}O_2$ (x = 0, 0.003, 0.05, 0.10 and 0.15) catalysts

Fig. SI 2 CO_2 conversion (a), CH_4 yield (b) and CO yield (c) of NiO, CeO_2, TiO_2 and 10wt%Ni-$Ce_{0.003}Ti_{0.997}O_2$.

Fig. SI 3 Relationship between energy edge shift of metal compounds from XANES spectra and the oxidation states of metals; Ni oxidation state for fresh, pretreated and used 10wt%Ni-TiO_2 (a) and 10wt%Ni-$Ce_{0.05}Ti_{0.95}O_2$ (b) and the oxidation state of Ce for fresh, pretreated and used 10wt%Ni-$Ce_{0.05}Ti_{0.95}O_2$ (c).

Fig. SI 4 Relationship between edge energy shift of Ni compounds and the oxidation states of Ni for fresh and pretreated 10wt%Ni-$Ce_{0.003}Ti_{0.997}O_2$ and 10wt%Ni-$Ce_{0.003}Ti_{0.997}O_2$ at reaction temperature of 350 and 550 ^oC.

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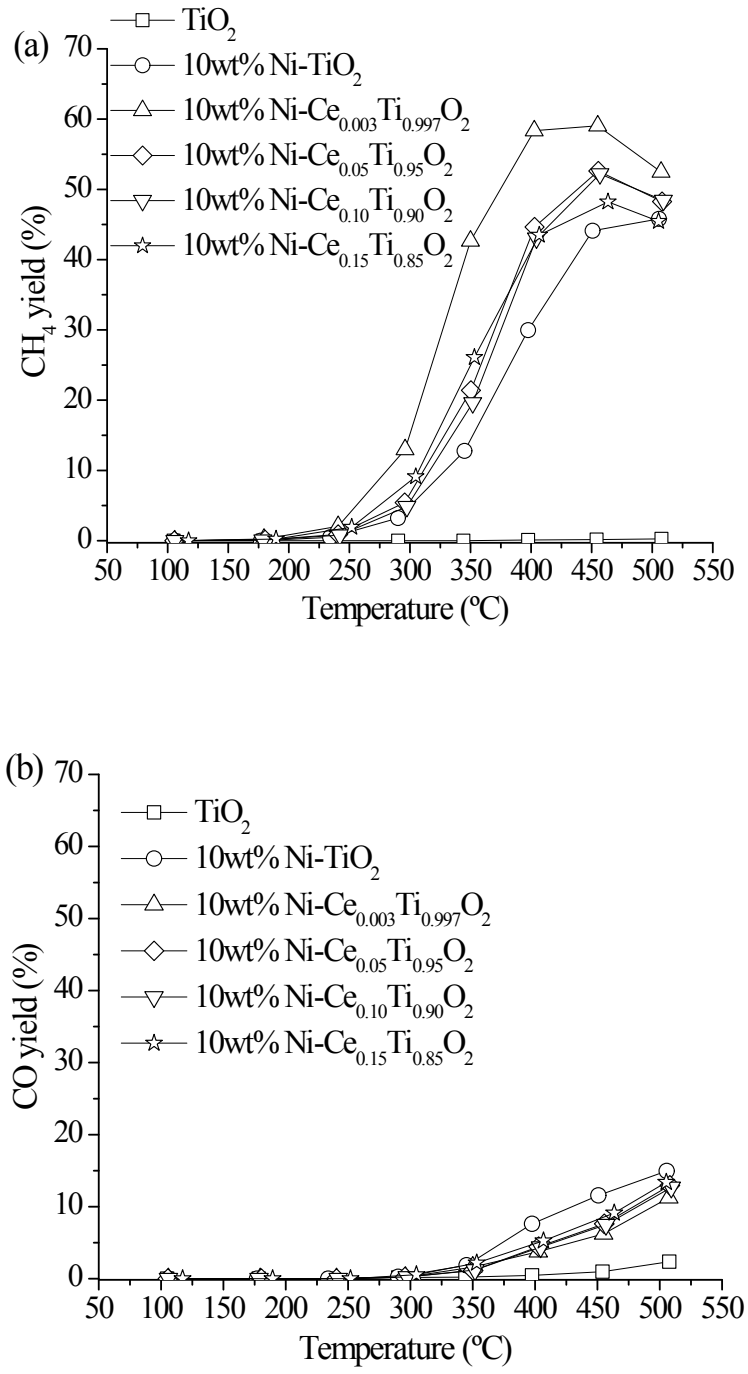
(a)
TiO2
10wt% Ni-TiO2
10wt% Ni-Ce0.003Ti0.997O2
10wt% Ni-Ce0.05Ti0.95O2
10wt% Ni-Ce0.10Ti0.90O2
10wt% Ni-Ce0.15Ti0.85O2
CH4 yield (%)
Temperature (ºC)
(b)
TiO2
10wt% Ni-TiO2
10wt% Ni-Ce0.003Ti0.997O2
10wt% Ni-Ce0.05Ti0.95O2
10wt% Ni-Ce0.10Ti0.90O2
10wt% Ni-Ce0.15Ti0.85O2
CO yield (%)
Temperature (ºC)

Fig. SI 1

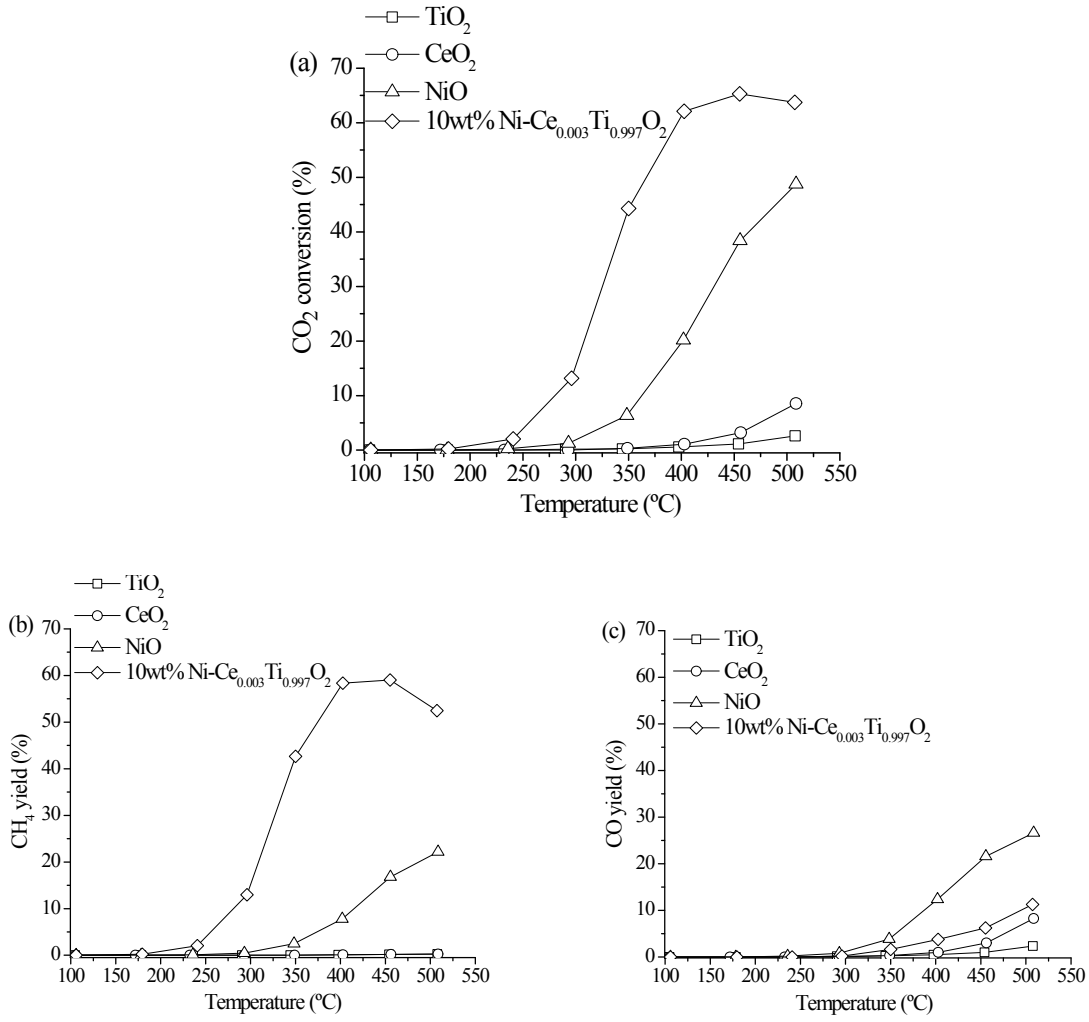
(a)
TiO2
CeO2
NiO
10wt% Ni-Ce0.003Ti0.997O2
CO2 conversion (%)
Temperature (ºC)
(b)
CH4 yield (%)
(c)
CO yield (%)

Fig. SI 2

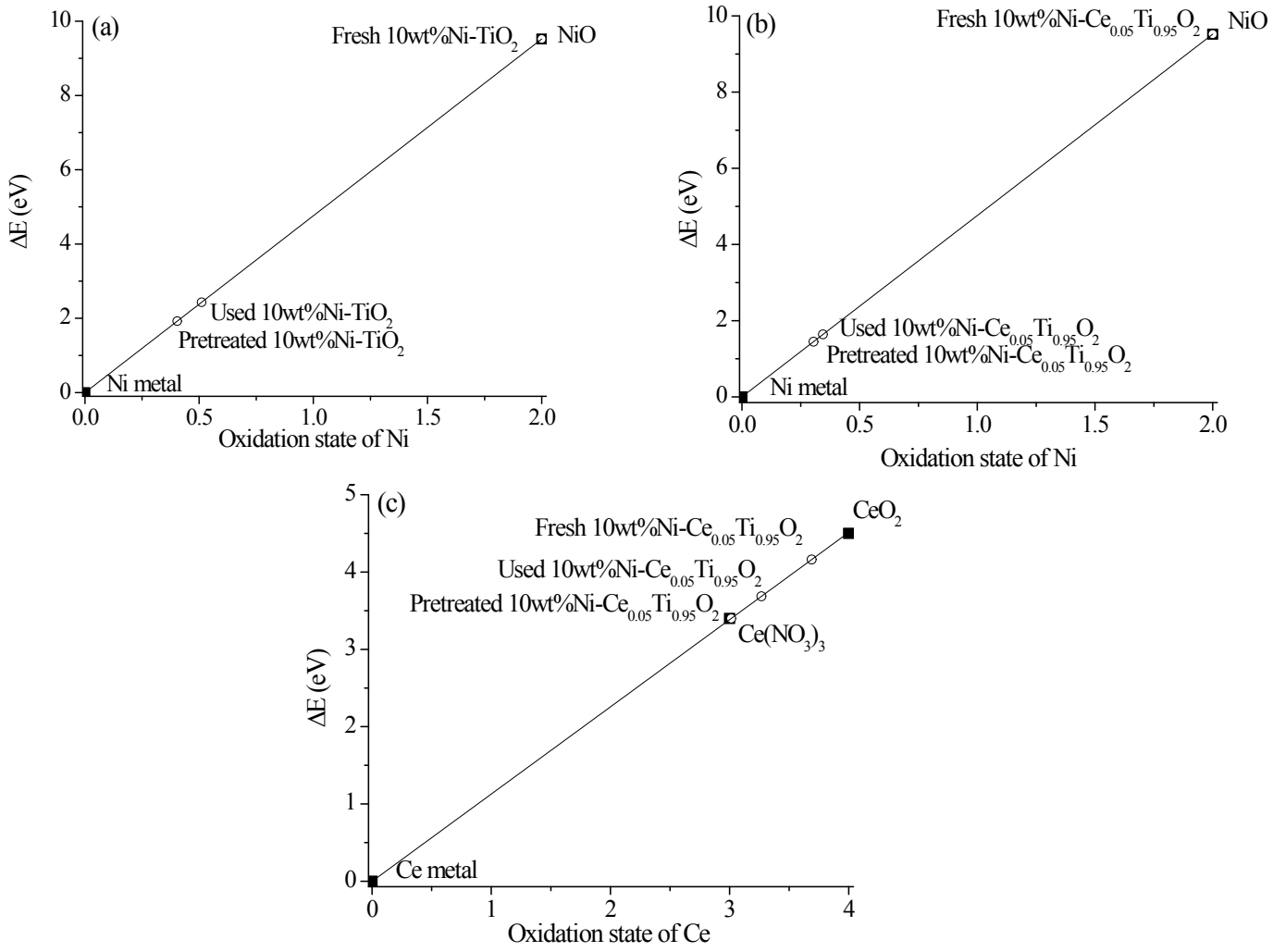
(a)
Fresh 10wt%Ni-TiO2
NiO
Used 10wt%Ni-TiO2
Pretreated 10wt%Ni-TiO2
Ni metal
ΔE (eV)
Oxidation state of Ni
(b)
Fresh 10wt%Ni-Ce0.05Ti0.95O2
NiO
Used 10wt%Ni-Ce0.05Ti0.95O2
Pretreated 10wt%Ni-Ce0.05Ti0.95O2
Ni metal
ΔE (eV)
Oxidation state of Ni
(c)
CeO2
Fresh 10wt%Ni-Ce0.05Ti0.95O2
Used 10wt%Ni-Ce0.05Ti0.95O2
Pretreated 10wt%Ni-Ce0.05Ti0.95O2
Ce(NO3)3
Ce metal
ΔE (eV)
Oxidation state of Ce

Fig. SI 3

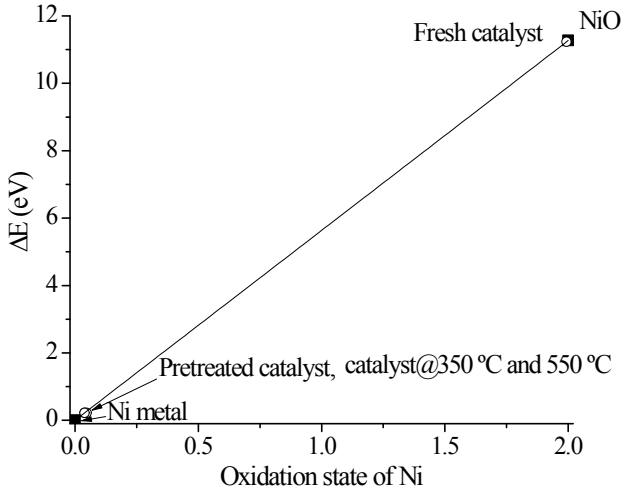
12
10
8
6
4
2
0
ΔE (eV)
0.0
0.5
1.0
1.5
2.0
Oxidation state of Ni
Fresh catalyst
NiO
Pretreated catalyst, catalyst@350 ºC and 550 ºC
Ni metal

Fig. SI 4