

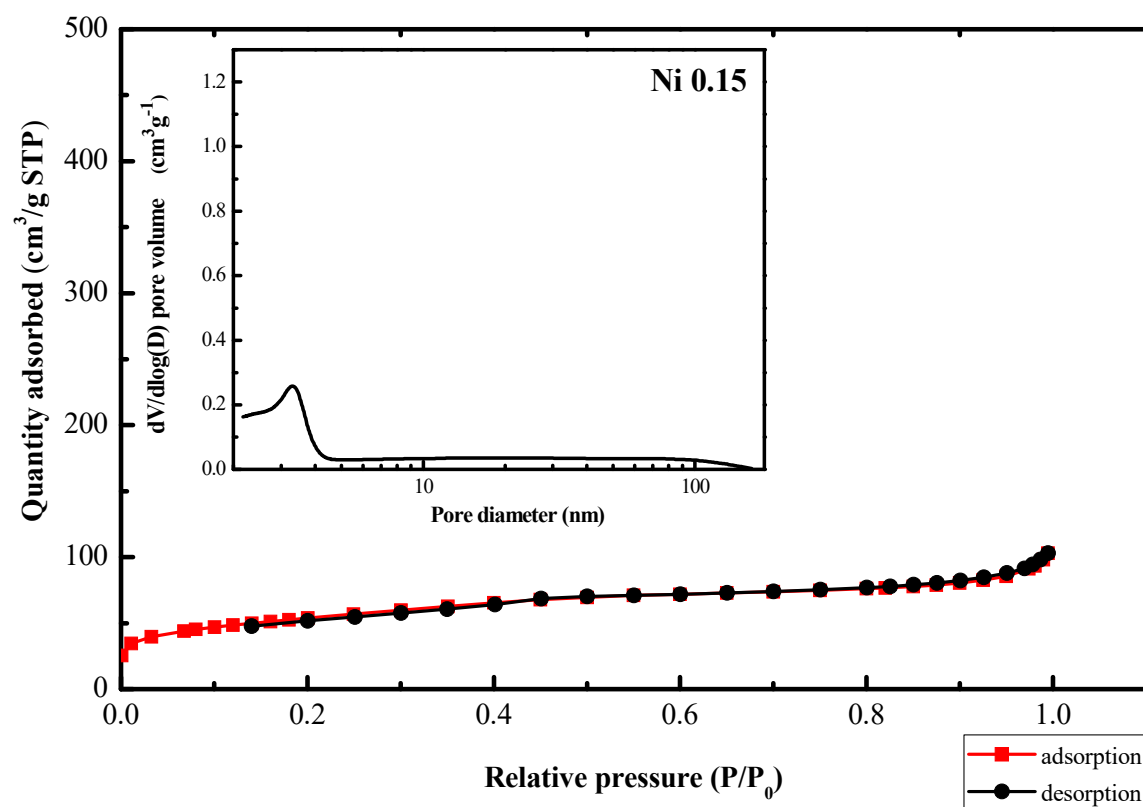
## **List of Supplementary data**

**Supplemental figure S1.** Isotherm and pore size distribution (inset) of Ni-Ce-ZrO<sub>2</sub> catalysts

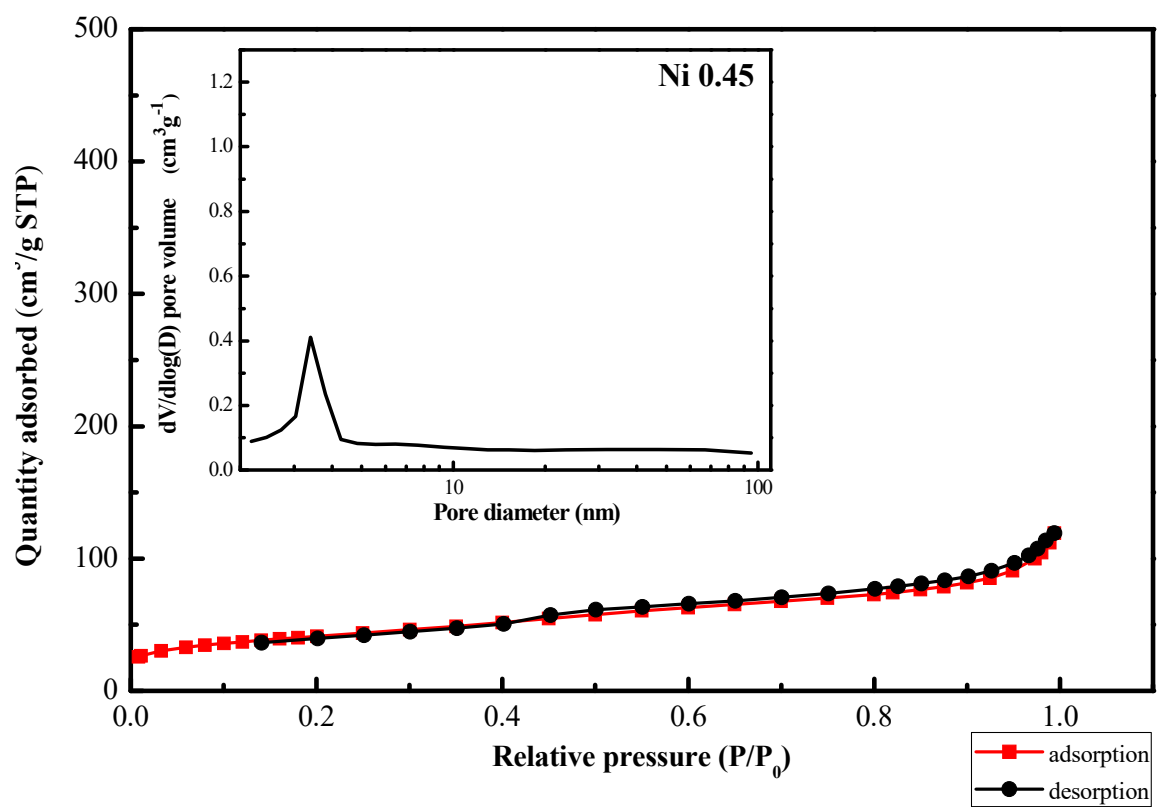
**Supplemental table S2.** XPS core level electron binding energy of Ni-Ce-ZrO<sub>8</sub> catalysts for different Ni content

**Supplemental figure S3.** The stability of Ni6.0 catalyst at 300 °C for 48 h

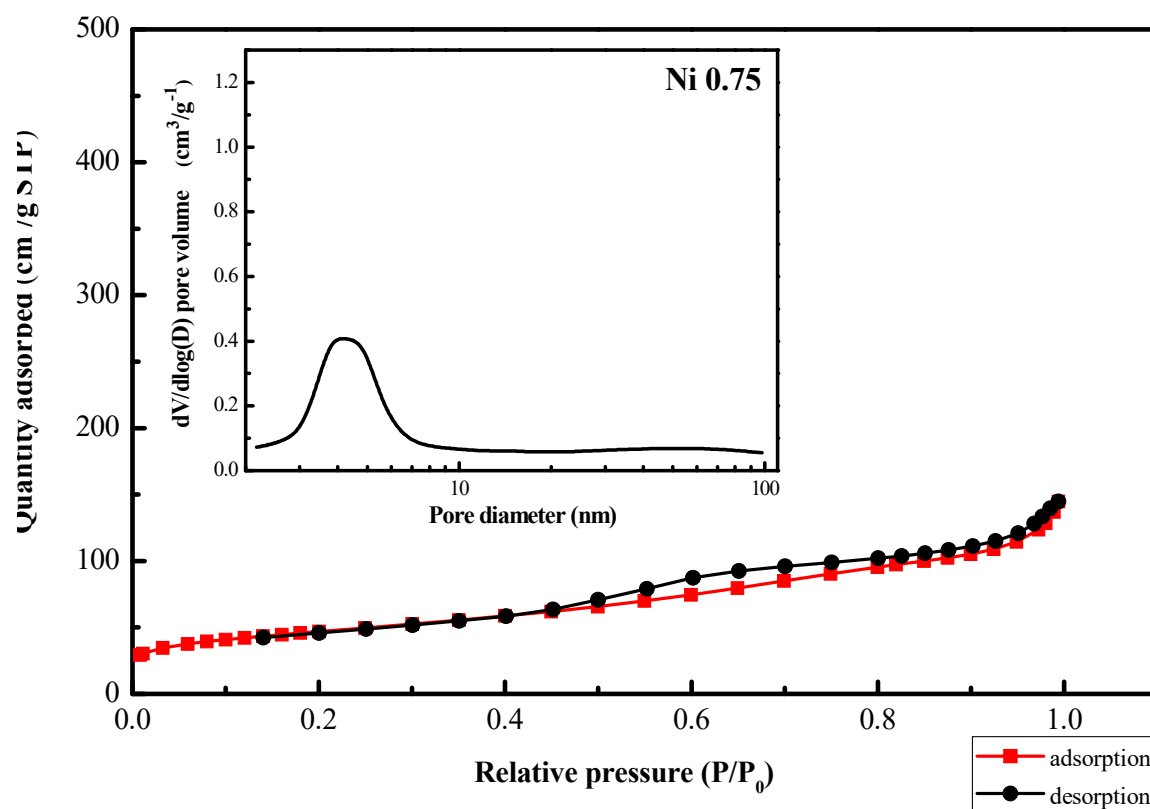
**Supplemental figure S4.** TEM images of (a) fresh and (b) spent Ni6.0 catalysts. Reaction conditions: GHSV = 10,000 h<sup>-1</sup>, H<sub>2</sub>/CO<sub>2</sub> = 4, reaction temperature = 300 °C and reaction time 30 min.



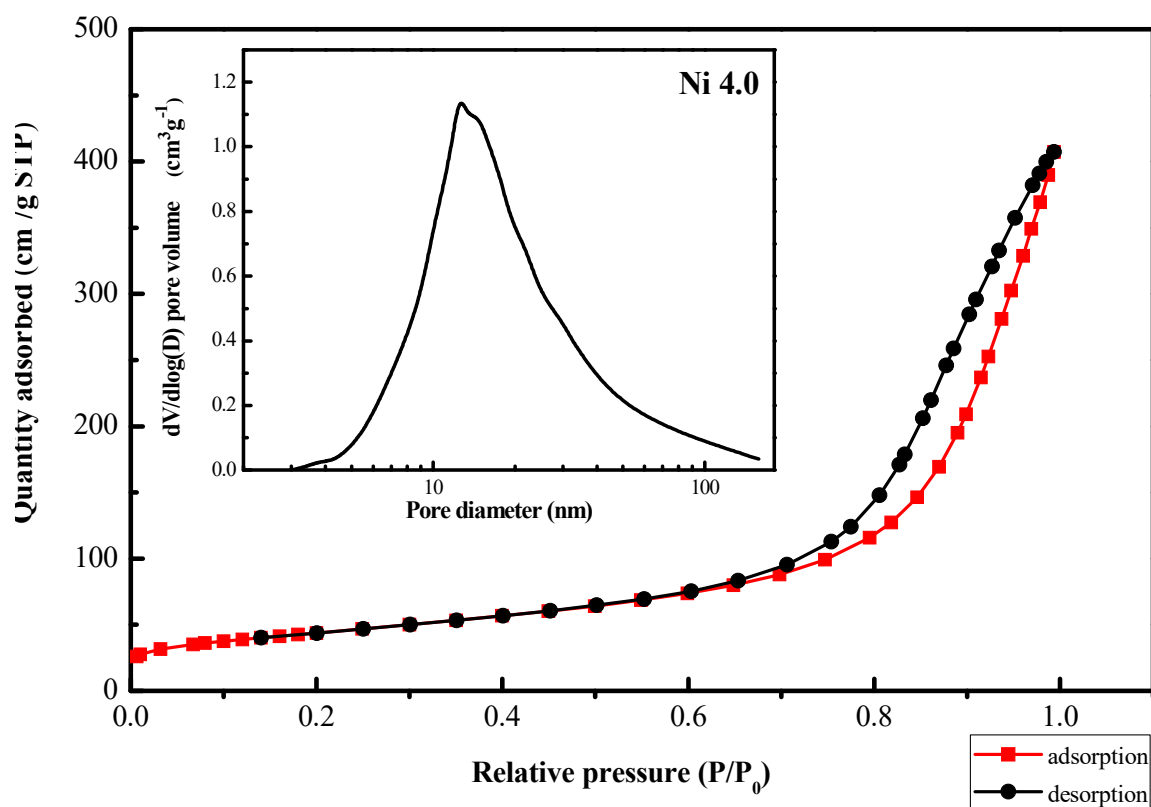
**Supplemental figure S1.** Isotherm and pore size distribution (inset) of Ni-Ce-ZrO<sub>2</sub> catalysts



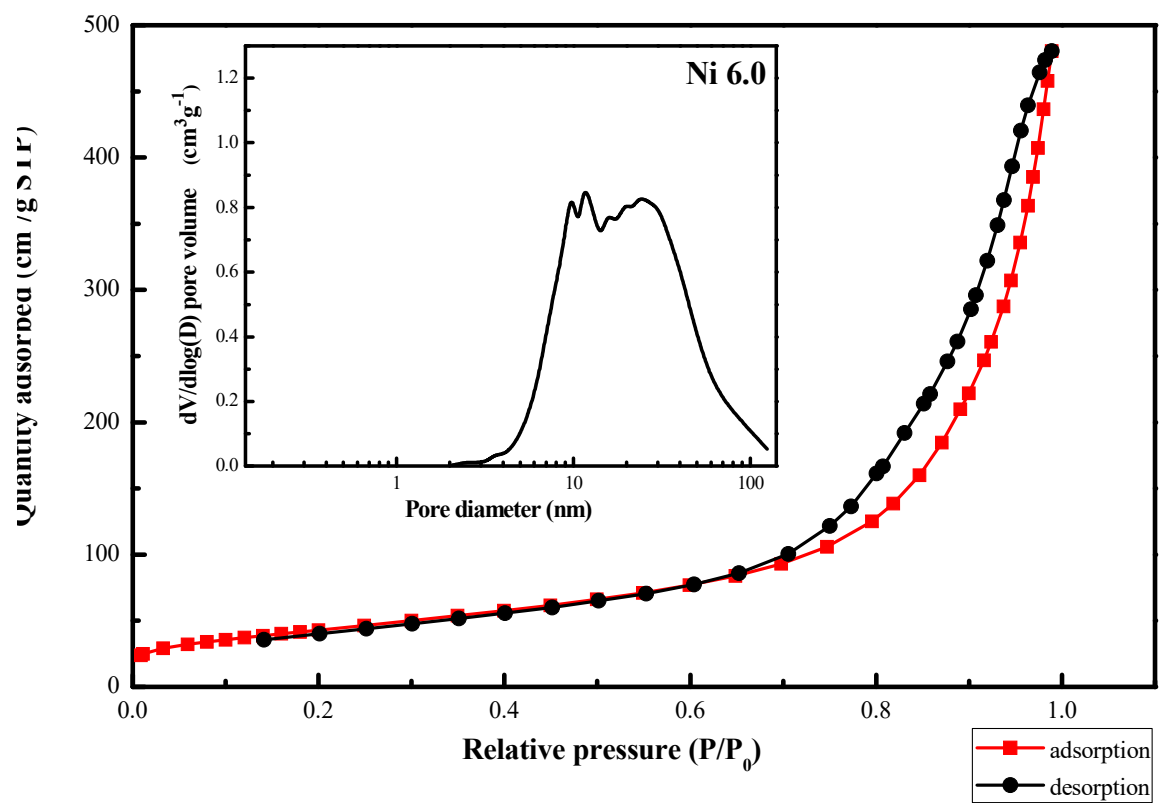
**Supplemental figure S1 (cont.).** Isotherm and pore size distribution (inset) of Ni-Ce-ZrO<sub>2</sub> catalysts



**Supplemental figure S1 (cont.).** Isotherm and pore size distribution (inset) of Ni-Ce-ZrO<sub>2</sub> catalysts



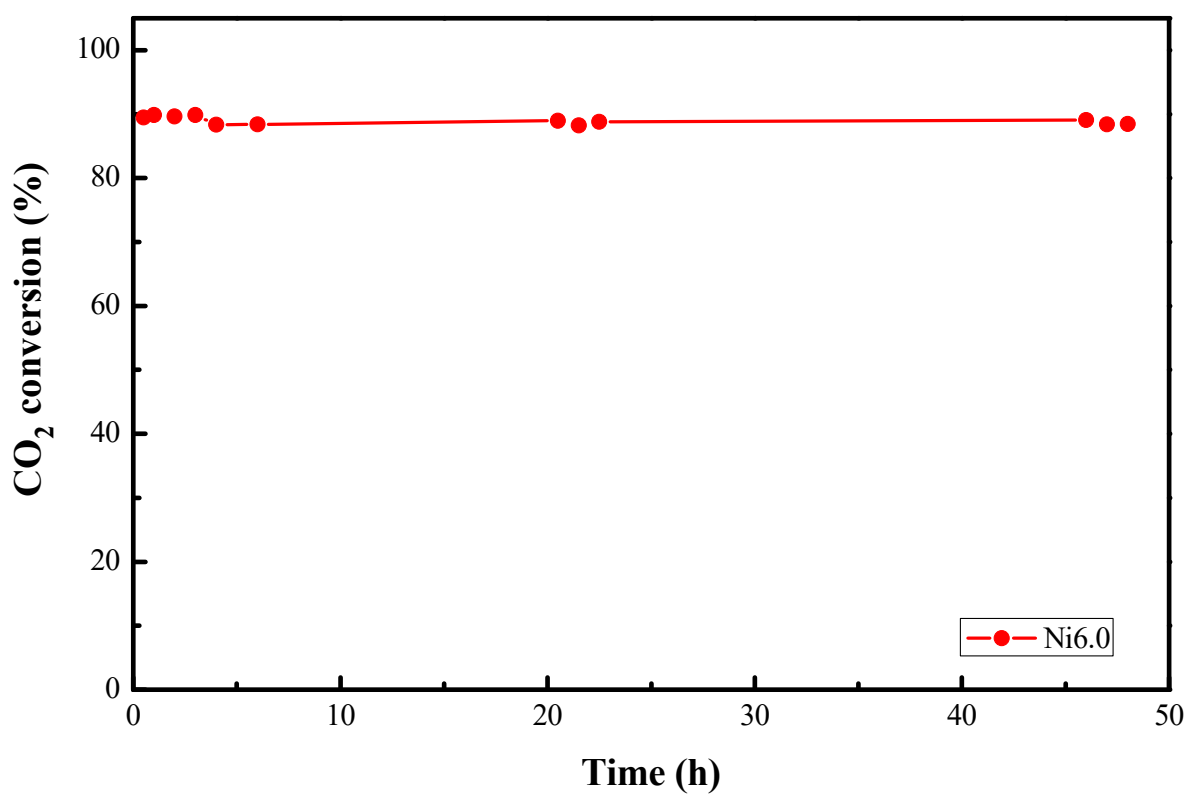
**Supplemental figure S1 (cont.).** Isotherm and pore size distribution (inset) of Ni-Ce-ZrO<sub>2</sub> catalysts



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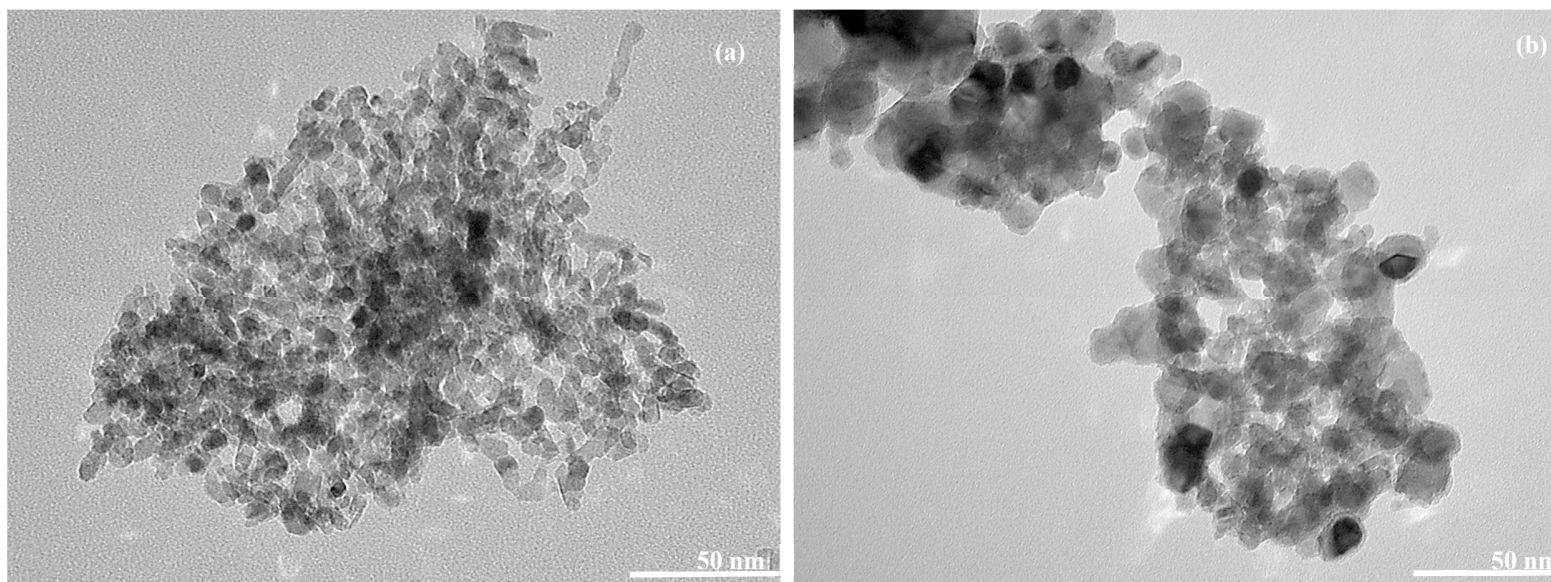
**Supplemental table S2.** XPS core level electron binding energy of Ni-Ce-ZrO<sub>8</sub> catalysts for different Ni content

| Catalysts | Binding energy (eV) |                     |                   |                     |                     |                     | NiO/Ni(OH) <sub>2</sub><br>ratio | Ce <sup>4+</sup> /Ce <sup>3+</sup><br>ratio |
|-----------|---------------------|---------------------|-------------------|---------------------|---------------------|---------------------|----------------------------------|---------------------------------------------|
|           | Zr3d <sub>5/2</sub> | Zr3d <sub>3/2</sub> | O1s               | Ni2p <sub>1/2</sub> | Ce3d <sub>5/2</sub> | Ce3d <sub>3/2</sub> |                                  |                                             |
| Ni0.15    | 181.74              | 184.06              | 528, 530.61       | 855                 | 882, 888,<br>898    | 901, 906,<br>917    | 1.03                             | 4.90                                        |
| Ni0.75    | 182.09              | 184.38              | 529.13,<br>530.83 | 855, 856.5          | 882, 888,<br>898    | 901, 906,<br>917    | 1.15                             | 2.50                                        |
| Ni6.0     | 181.46              | 183.75              | 528.85,<br>531.10 | 853, 855,<br>860.5  | 880, 898            | 901, 917            | 1.41                             | 2.40                                        |



**Supplemental figure S3.** The stability of Ni6.0 catalyst at 300 °C for 48 h





**Supplemental figure S4.** TEM images of (a) fresh and (b) spent Ni<sub>6.0</sub> catalysts. Reaction conditions: GHSV = 10,000 h<sup>-1</sup>, H<sub>2</sub>/CO<sub>2</sub> = 4, reaction temperature = 300 °C and reaction time 30 min.