Table 1. Properties of the catalysts after H2 pretreatment at 773K.

<table>
<thead>
<tr>
<th>catalysts</th>
<th>BET surface area / m²·g⁻¹-cat</th>
<th>H2 consumption a) / 10⁻³ mol·g⁻¹-cat</th>
<th>Ni-based reduction degree b) / %</th>
<th>H2 adsorption c) / 10⁻⁵ mol·g⁻¹-cat</th>
<th>Dispersion d) / %</th>
<th>Particle size of Ni metal e) / nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ni/CA</td>
<td>17.4</td>
<td>1.40</td>
<td>89</td>
<td>4.1</td>
<td>5.9</td>
<td>16.6</td>
</tr>
<tr>
<td>Pt/Ni/CA</td>
<td>18.8</td>
<td>1.51</td>
<td>96</td>
<td>4.2</td>
<td>5.6</td>
<td>17.5</td>
</tr>
<tr>
<td>Ni/CMA</td>
<td>17.6</td>
<td>0.46</td>
<td>29</td>
<td>4.1</td>
<td>17.8</td>
<td>5.4</td>
</tr>
<tr>
<td>Pt/Ni/CMA</td>
<td>19.2</td>
<td>0.47</td>
<td>30</td>
<td>3.9</td>
<td>16.6</td>
<td>5.9</td>
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<tr>
<td>Ni/MA</td>
<td>9.0</td>
<td>0.16</td>
<td>10</td>
<td>2.6</td>
<td>32.5</td>
<td>3.0</td>
</tr>
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<td>Pt/Ni/MA</td>
<td>9.1</td>
<td>0.24</td>
<td>15</td>
<td>2.4</td>
<td>20.0</td>
<td>4.9</td>
</tr>
</tbody>
</table>

a) H2 consumption below 773 K in TPR profiles shown in Figure 3.
b) Based on the assumption that Ni²⁺ + H2 → Ni⁰ + 2H⁺, and the reduction of Pt and CeO₂ was neglected.
c) H2 adsorption is total adsorption at room temperature, and H/Ni = 1 is assumed.
d) 2 × (H2 adsorption) / (H2 consumption) × 100.
e) Particle size of Ni metal is calculated by the relation: (particle size / nm) = 9.71 / (dispersion / %) × 10.
Table 2. Curve fitting results of Ni K-edge EXAFS of the Pt/Ni/CA and Pt/Ni/CMA catalysts.

<table>
<thead>
<tr>
<th>Catalyst</th>
<th>Condition</th>
<th>Shells</th>
<th>CN(^a)</th>
<th>(R / 10^1) nm(^b)</th>
<th>(\sigma / 10^1) nm(^c)</th>
<th>(\Delta E_0 / \text{eV})(^d)</th>
<th>(R_f / %)(^e)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pt/Ni/CA</td>
<td>reduction</td>
<td>Ni-Ni</td>
<td>10.4±1.5</td>
<td>2.49±0.008</td>
<td>0.073±0.012</td>
<td>-0.5±2.0</td>
<td>0.1</td>
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<tr>
<td></td>
<td>reaction</td>
<td>Ni-Ni</td>
<td>6.8±1.0</td>
<td>2.49±0.009</td>
<td>0.076±0.012</td>
<td>-5.0±2.0</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td>regeneration</td>
<td>Ni-Ni</td>
<td>10.7±1.6</td>
<td>2.49±0.008</td>
<td>0.072±0.012</td>
<td>-0.7±2.0</td>
<td>0.1</td>
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<tr>
<td></td>
<td>reduction</td>
<td>Ni-O</td>
<td>2.1±0.2</td>
<td>2.10±0.007</td>
<td>0.060±0.009</td>
<td>-2.4±0.5</td>
<td>0.9</td>
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<tr>
<td></td>
<td>Ni-Ni</td>
<td>8.5±0.1</td>
<td>2.49±0.003</td>
<td>0.077±0.001</td>
<td>-1.1±0.1</td>
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</tr>
<tr>
<td></td>
<td>Ni-O-Ni</td>
<td>2.8±0.3</td>
<td>2.93±0.005</td>
<td>0.068±0.013</td>
<td>8.5±0.5</td>
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<tr>
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<td>Ni-O-Mg</td>
<td>1.4±0.4</td>
<td>2.94±0.018</td>
<td>0.069±0.017</td>
<td>3.4±1.4</td>
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<tr>
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<td>reaction</td>
<td>Ni-O</td>
<td>1.8±0.2</td>
<td>2.10±0.009</td>
<td>0.072±0.018</td>
<td>-4.7±1.9</td>
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<td>2.93±0.004</td>
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<td>Ni-O-Mg</td>
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<td>2.94±0.000</td>
<td>0.071±0.019</td>
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<tr>
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<td>regeneration</td>
<td>Ni-O</td>
<td>2.1±0.8</td>
<td>2.10±0.018</td>
<td>0.068±0.013</td>
<td>-3.3±1.7</td>
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<tr>
<td></td>
<td>Ni-Ni</td>
<td>8.6±0.1</td>
<td>2.49±0.000</td>
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<td>Ni-O-Ni</td>
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<td>2.93±0.006</td>
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<td>Ni-O-Mg</td>
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<td>Ni-O</td>
<td>6</td>
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<td>2.94</td>
<td>0.060</td>
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<td>-</td>
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</table>

\(a\) Coordination number. \(b\) Bond distance. \(c\) Debye-Waller factor. \(d\) Difference in the origin of photoelectron energy between the reference and the sample. \(e\) Residual factor.

Fourier transform range: \(30-160\) nm\(^{-1}\), Fourier filtering range: \(0.126-0.292\) nm.
Figure 1. Catalytic performance in steam gasification of cedar wood over the catalysts after H₂ reduction.
Conditions: biomass; 60 mg/min (H₂O 9.2 %, C 2191 μmol/min; H 3543 μmol/min; O 1475 μmol/min), N₂ flow rate; 60 ml/min, (added H₂O)/C=0.5 (steam flow rate 1110 μmol/min), reaction time; 15 min, H₂ reduction 773 K, 30 min.

Figure 2. Catalytic performance in steam gasification of cedar wood over the catalysts after H₂ reduction.
Conditions: biomass; 60 mg/min (H₂O 9.2 %, C 2191 μmol/min; H 3543 μmol/min; O 1475 μmol/min), N₂ flow rate; 60 ml/min, (added H₂O)/C=0.5 (steam flow rate 1110 μmol/min), reaction time; 15 min, H₂ reduction 773 K, 30 min.

Figure 3. Catalytic performance in steam gasification of cedar wood at 923 K as a function of time on stream over the catalysts without H₂ reduction.
(a) Pt/Ni/CA (b) Pt/Ni/CMA
Conditions: biomass; 60 mg/min (H₂O 9.2 %, C 2191 μmol/min; H 3543 μmol/min; O 1475 μmol/min), N₂ flow rate; 60 ml/min, (added H₂O)/C=0.5 (steam flow rate 1110 μmol/min).

Figure 4. TPR profiles of the catalysts.
(a) Pt/Ni/CA (b) Ni/CA (c) Pt/Ni/CMA (d) Ni/CMA (e) Pt/Ni/MA (f) Ni/MA
TPR condition: heating rate 10 K/min, Room temperature to 1273 K, and the temperature was maintained at 1273 K for 30 min. 5 % H₂/Ar flow rate 30 ml/min.
Sample weight: 200 mg.

Figure 5. TEM images of the catalysts after H₂ pretreatment at 773K.
(a) Pt/Ni/CA (b) Pt/Ni/CMA

Figure 6. Catalytic performance in steam gasification of cedar wood as a function of time on stream over the catalysts at 923 K.
(a) Pt/Ni/CA (b) Pt/Ni/CMA
Conditions: biomass; 60 mg/min (H₂O 9.2 %, C 2191 μmol/min; H 3543 μmol/min; O 1475 μmol/min), N₂ flow rate; 60 ml/min, (added H₂O)/C=0.5 (steam flow rate 1110 μmol/min), H₂ reduction at 773 K, 30 min.
Figure 7. Catalytic performance in steam gasification of cedar wood as a function of time on stream over the catalysts at 873 K.
(a) Pt/Ni/CA (b) Pt/Ni/CMA
Conditions: biomass; 60 mg/min (H₂O 9.2 %, C 2191 μmol/min; H 3543 μmol/min; O 1475 μmol/min), N₂ flow rate; 60 ml/min, (added H₂O)/C=1 (steam flow rate 2220 μmol/min), H₂ reduction at 773 K, 30 min.

Figure 8. XRD patterns of Pt/Ni/CA (I) and Pt/Ni/CMA (II).
■ = Ni, ● = CeO₂, ▲ = Al₂O₃
(a) After H₂ reduction, (b) after the reaction at 923 K (Figure 6), (c) after the regeneration.

Figure 9. Results of Ni K-edge EXAFS analysis of Pt/Ni/CA.
(a) After H₂ reduction, (b) after the reaction at 923 K (Figure 6), (c) after the regeneration.
I: $k^3$-weighted EXAFS oscillation.
II: Fourier transform of $k^3$-weighted Ni K-edge EXAFS. FT range : 30-160 nm⁻¹.
III: Fourier filtered EXAFS data (solid line) and calculated data (dotted line).
  Fourier filtering range : 0.126 - 0.292 nm.

Figure 10. Results of Ni K-edge EXAFS analysis of Pt/Ni/CMA.
(a) After H₂ reduction, (b) after the reaction at 923 K (Figure 6), (c) after the regeneration.
I: $k^3$-weighted EXAFS oscillation.
II: Fourier transform of $k^3$-weighted Ni K-edge EXAFS. FT range : 30-160 nm⁻¹.
III: Fourier filtered EXAFS data (solid line) and calculated data (dotted line).
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Figure 1. Catalytic performance in steam gasification of cedar wood over the catalysts after H₂ reduction.

Conditions: biomass; 60 mg/min (H₂O 9.2 %, C 2191 μmol/min; H 3543 μmol/min; O 1475 μmol/min), N₂ flow rate; 60 ml/min, (added H₂O)/C=0.5 (steam flow rate 1110 μmol/min), reaction time; 15min, H₂ reduction 773 K, 30 min.
Figure 2. Catalytic performance in steam gasification of cedar wood over the catalysts after H₂ reduction.

Conditions: biomass; 60 mg/min (H₂O 9.2 %, C 2191 μmol/min; H 3543 μmol/min; O 1475 μmol/min), N₂ flow rate; 60 ml/min, (added H₂O)/C=0.5 (steam flow rate 1110 μmol/min), reaction time; 15 min, H₂ reduction 773 K, 30 min.
Figure 3. Catalytic performance in steam gasification of cedar wood at 923 K as a function of time on stream over the catalysts without H$_2$ reduction.

(a) Pt/Ni/CA (b) Pt/Ni/CMA

Conditions: biomass; 60 mg/min (H$_2$O 9.2 %, C 2191 μmol/min; H 3543 μmol/min; O 1475 μmol/min), N$_2$ flow rate; 60 ml/min, (added H$_2$O)/C=0.5 (steam flow rate 1110 μmol/min).
Figure 4. TPR profiles of the catalysts.
(a) Pt/Ni/CA (b) Ni/CA (c) Pt/Ni/CMA (d) Ni/CMA (e) Pt/Ni/MA (f) Ni/MA
TPR condition: heating rate 10 K/min, Room temperature to 1273 K, and the temperature was maintained at 1273 K for 30 min. 5 % H₂/Ar flow rate 30 ml/min.
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(a) Pt/Ni/CA (b) Pt/Ni/CMA

Conditions: biomass; 60 mg/min (H$_2$O 9.2 %, C 2191 μmol/min; H 3543 μmol/min; O 1475 μmol/min), N$_2$ flow rate; 60 ml/min, (added H$_2$O)/C=1 (steam flow rate 2220 μmol/min), H$_2$ reduction at 773 K, 30 min.
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