Catalytic ammonia decomposition over Ni/BaCe$_{0.75}$Y$_{0.25}$O$_{3-δ}$ catalyst
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1. Introduction

In recent years, ammonia is considered as one of the most promising hydrogen sources because it contains high hydrogen content (17.5 wt. %) and is easy to be liquefied at ambient temperature and mild pressure. Ammonia decomposition has received intensive attentions since it generates carbon-free hydrogen on-site which is favorable for fuel cells. Our group reported that Ni/BaCe$_{0.75}$Y$_{0.25}$O$_{3-δ}$ (Ni/BCY) catalyst exhibited high catalytic activity for ammonia decomposition. 1) In this work, the optimal preparation condition for Ni/BCY was investigated in detail.

2. Experimental

BaCe$_{0.75}$Y$_{0.25}$O$_{3-δ}$ (BCY) was prepared from corresponding metal nitrates and citric acid by a citric acid complex method. The as-prepared precursor was calcined in air at 1100 °C for 5 h. Other supporters, including Y$_2$O$_3$, La$_2$O$_3$, Al$_2$O$_3$, MgO, and CeO$_2$, were commercial products. Ni catalyst (40 wt.%) was loaded on the supports from nickel nitrate by a impregnation method. After the impregnation, the obtained powders were calcined at 600 °C for 5 h.

Each sample was uniaxial-pressed at 50 MPa to form a disk, and then pulverized to 7-11 mesh. Prior to the catalytic activity evaluation, 0.3 g of each sample was reduced in 50% Ar-50% H$_2$ for 2 h under atmospheric pressure at 600 °C. Subsequently, ammonia a space velocity of 6000 L kg$^{-1}$ h$^{-1}$ was supplied in the heating process from 350 to 600 °C. The ammonia conversion rate was calculated according to the total amount of N$_2$ and H$_2$ in the outlet gas measured by the flow rate meter. The specific surface areas of each sample and Ni in each sample were obtained by the BET method and CO pulse test, respectively.

3. Results and discussion

The catalytic activities of Ni catalyst on different supports for ammonia decomposition are shown in Fig. 1. The performance of the catalysts orders as follows: Y$_2$O$_3$ > BCY > La$_2$O$_3$ > Al$_2$O$_3$ > MgO > CeO$_2$. Considering the relative small specific surface of Ni/BCY catalyst, the catalytic activity of Ni/BCY is attractive. Moreover, since the BCY supporter possesses high proton conductivity, Ni/BCY could serve as an excellent anode with high ammonia decomposition catalytic activity for direct ammonia solid oxide fuel cells.

![Fig. 1. Catalytic activity of Ni/Y$_2$O$_3$, Ni/MgO, Ni/BCY, Ni/Al$_2$O$_3$, Ni/CeO$_2$, and Ni/La$_2$O$_3$ for ammonia decomposition.](image-url)

Acknowledgment

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1) Jun Yang, Tomoharu Akagi, Hiroki Muroyama, Toshiaki Matsui, Koichi Eguchi, Development of Ni cermet anodes for direct ammonia solid oxide fuel cells, Fuel cell symposium, Tokyo, 2013.

Table 1. Specific surface area of Ni/Y$_2$O$_3$, Ni/MgO, Ni/BCY, Ni/Al$_2$O$_3$, Ni/CeO$_2$, and Ni/La$_2$O$_3$, Ni: 40 wt. %.

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<tr>
<th>Supporter</th>
<th>Y$_2$O$_3$</th>
<th>MgO</th>
<th>BCY</th>
<th>Al$_2$O$_3$</th>
<th>CeO$_2$</th>
<th>La$_2$O$_3$</th>
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<tbody>
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<td>total</td>
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<td>36.8</td>
<td>3.54</td>
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<td>0.94</td>
<td>3.96</td>
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