Non-platinum group metal catalysts for ammonia synthesis from NO using CO-H_2O reductant

([1]*Fukushima Renewable Energy Institute, AIST*, [2]*Tokyo Inst. Tech.*)
○Chandan Chaudhari,[1] Keisuke Kobayashi,[1] Yuchi Manaka,[1,2] Tetsuya Nanba[1]
Keywords: NO reduction; NH_3; Nickel; Cost-effective; CeO_2

Ammonia has a key role in agricultural for production of fertilizers. Traditionally, ammonia is produced by Haber-Bosch method with high energy consumption. Ammonia synthesis from air pollutant such as nitrogen oxide (NO) is an attractive way on the background of NO abatement. Several attempts have been reported for the synthesis of ammonia from NO using Pd, Rh or Pt catalysts. Recently, our group also developed Pt/TiO_2 catalyst for ammonia synthesis on NO-CO-H_2O reaction.[1] However, the cost of Pt group metals is a barrier for their industrial applications. In this study, we have developed the cost-effective Ni/CeO_2 catalyst for ammonia synthesis using NO-CO-H_2O reaction.

CeO_2-supported Ni catalysts were prepared by an incipient wetness method with different Ni precursors. All catalysts were characterized by BET and CO adsorption. The catalytic activity was measured by a fixed-bed flow reactor. For NO-CO-H_2O reaction, the feed gas was composed of 0.1 % NO, 0.3% CO and 1% H_2O ppm with dilution by Ar. The total flow was set to 250 mL/min. The product gases were analyzed online Fourier transform infrared spectroscopy and gas chromatography.

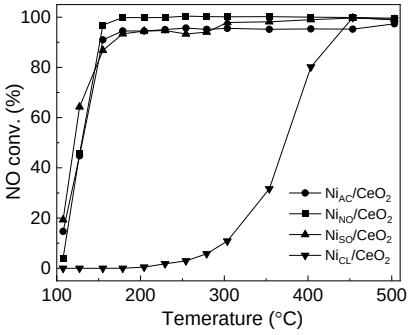

Figure 1 NO conversion over different Ni/CeO_2 catalysts

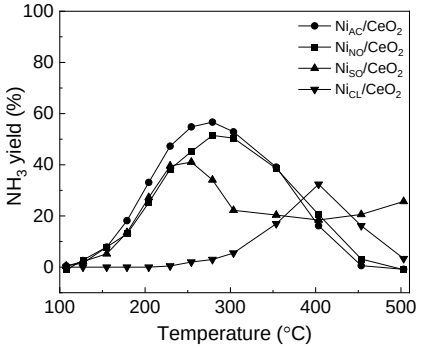

Figure 2 NH_3 formation over different Ni/CeO_2 catalysts

Initially, we synthesized Ni/CeO_2 catalyst using different precursor such as $Ni(CH_3CO_2)_2$, $Ni(NO_3)_2$, $NiSO_4$ and $NiCl_2$ which were denoted as AC, NO, SO, CL respectively. As shown in figure 1, all catalysts showed high NO conversion above 200 °C except Ni_{CL}/CeO_2 catalyst. Figure 2 shows ammonia yield over different Ni/CeO_2, all catalysts showed low ammonia yield below 200 °C. When the temperature increased to 280 °C, Ni_{AC}/CeO_2 showed superiority (57%) for ammonia synthesis. Ni_{NO}/CeO_2, Ni_{SO}/CeO_2 and Ni_{CL}/CeO_2 catalysts gave 51%, 34% and 3% ammonia yield respectively.

In summary, Ni/CeO_2 prepared from $Ni(CH_3CO_2)_2$ precursor was an effective catalyst for ammonia synthesis over NO-CO-H_2O reaction.

1) K. Kobayashi, *Catal. Sci. Technol.* **2019**, *9*, 2898.