

A Study on Screening Method for Catalysts Using Arc-Plasma Deposition (Part 2)- Exploration of NH₃ Selective Catalytic Oxidation Catalysts

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Urea selective catalytic reduction (SCR) is widely used to reduce NO_x emissions from diesel engines. An ammonia slip catalyst (ASC) is installed downstream of the SCR catalyst to oxidize unreacted NH₃. However, undesirable N₂O and NO_x can be formed during NH₃ oxidation. Therefore, selective catalytic oxidation of NH₃ (NH₃-SCO), which preferentially converts NH₃ to N₂, is important for improving ASC performance⁽¹⁾. In our previous study, arc-plasma deposition (APD) was applied to screen various binary catalysts under identical conditions⁽²⁾. In this study, candidate catalysts were evaluated under model exhaust-gas conditions, and the resulting catalyst design was transferred to a wet-processed catalyst for practical ASC application.

Binary APD catalysts consisting of Pt, Pd, or Ir and various secondary metals were prepared on metallic honeycomb substrates. After heat treatment at 500 °C for 10 h, NH₃ oxidation tests were conducted between 150 and 500 °C using 300 ppm NH₃, 8% O₂, 10% H₂O, and 10% CO₂. NH₃ oxidation activity was evaluated by T₅₀, the temperature for 50% NH₃ conversion, together with N₂O and NO_x yields. Based on the screening results, Pt-Cu was selected and transferred to a wet-processed Pt/CuOx/Al₂O₃ catalyst. A dual-layer ASC consisting of a Pt/CuOx/Al₂O₃ oxidation layer and an upper Cu-SCR layer was evaluated after hydrothermal aging at 650 °C for 100 h.

Figure 1 shows the relationship between NH₃ oxidation T₅₀ and N₂O and NO_x yields for Pt-, Pd-, and Ir-based APD catalysts. Pt-based catalysts exhibited higher low-temperature activity than Pd- and Ir-based catalysts, with T₅₀ values mainly between 200 and 300 °C. However, Pt-APD showed a relatively high N₂O yield. Addition of secondary elements significantly affected N₂O formation, and Pt-Cu-APD exhibited the lowest N₂O yield among the catalysts with T₅₀ ≤ 250 °C. Pt-Cu-APD was therefore selected as a promising composition for NH₃-SCO. Comparison of Pt-, Pt-Cu-, and Cu-APD showed that Pt-Cu-APD retained relatively high NH₃ oxidation activity while increasing the maximum N₂ yield to approximately 60%. Structural analysis revealed co-localized Pt and Cu species, suggesting that their coexistence contributes to improved N₂ selectivity.

Based on these findings, Pt/CuOx/Al₂O₃ was applied to the oxidation layer of a dual-layer ASC. After hydrothermal aging, the developed ASC showed an NH₃ oxidation T₅₀ of 243 °C and N₂ yields of 83–90% between 300 and 500 °C. Compared with a conventional ASC, it maintained comparable NH₃ oxidation activity while reducing N₂O and NO_x formation by 37% and 32%, respectively. This improvement is attributed to N₂O suppression by the CuOx-containing oxidation layer combined with NO_x reduction by the upper Cu-SCR layer.

In conclusion, APD screening identified Pt-Cu as a promising composition balancing low-temperature NH₃ oxidation activity and N₂O suppression. The resulting catalyst design was successfully transferred to a wet-processed Pt/CuOx/Al₂O₃ catalyst, demonstrating that APD screening can provide useful design guidelines for practical exhaust-gas aftertreatment catalysts

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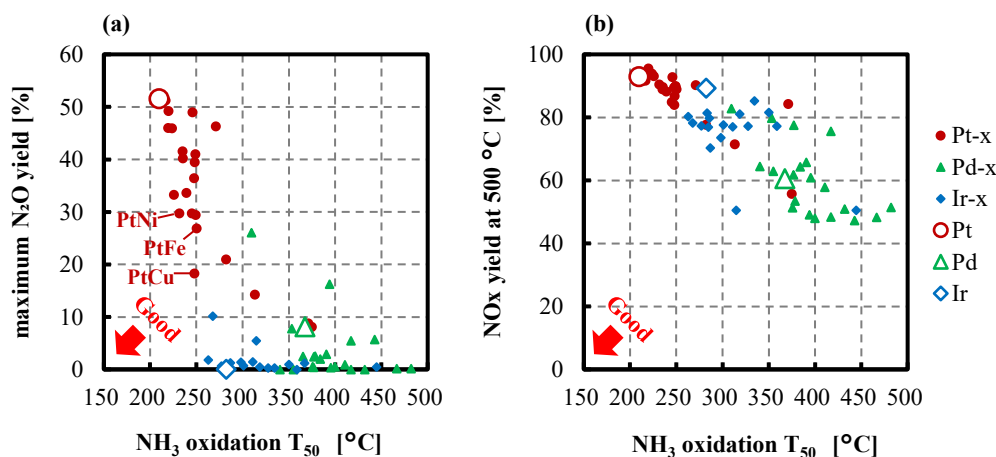


Fig. 1 Results of the NH₃ oxidation tests for Pt-, Pd- and Ir-based APD catalysts: (a) maximum N₂O yield observed between 150 and 500 °C as a function of the NH₃ oxidation T₅₀, and (b) NO_x yield at 500 °C as a function of the NH₃ oxidation T₅₀.