Development of Recovery and Removal Techniques of Dilute Reactive Nitrogen to Realize Nitrogen Circulating Society

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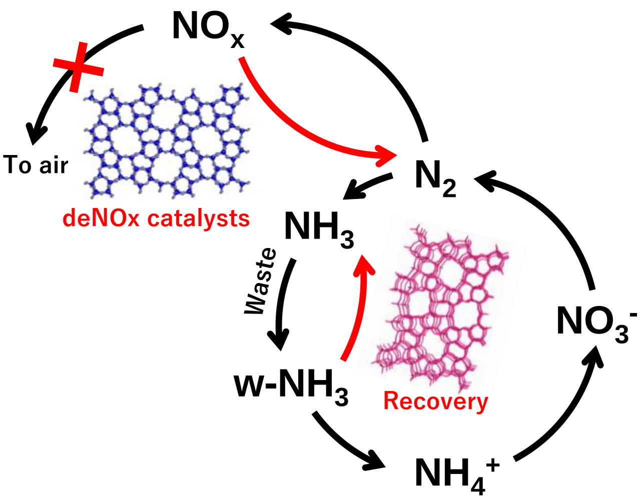
Summary

Nitrogen, phosphorous and water are ubiquitously present in air, soil, plants, lakes, oceans, rivers and ecosystems; and nitrogen, the target of this project, exists in a large circulation system on the earth. Nitrogen is not only a crucial component of amino acids that create life forms but also the key nutrients that sustains the growth of plants. Clearly, the construction of a sustainable nitrogen circulation system is a topic of paramount significance.

While it's an established process to convert ammonia to nitrates and then nitrogen via biological methods, a great effort has been devoted to produce ammonia. The Haber-Bosch process generates the emission of about 2.07 ton CO_2 for producing 1 ton NH_3, and in total, this process yields a CO_2 emission of 260-450 million tons, equaling to 1% of the overall anthropological CO_2 emission. This situation calls for an efficient method for ammonia recovery. Considering that ammonia is highly permeative and often present in low concentrations, it is necessary to design and fabricate nanostructured zeolites as based adsorbents that are of low cost, have a high affinity toward ammonia and allow to selectively enrich ammonia.

To address the emission of NOx from internal combustion engines, it is necessary to develop more efficient catalysts than the current zeolite-based SCR catalysts in terms of activity and durability. In the future, it will become possible that the engines powered by mixed fuels can increase the fuel efficiency by 20-30% from the current level. For example, 76.98 million tons of CO2 were emitted from trucks in Japan in the year of 2018, while it holds potential to reduce the CO_2 emission by 15~23 million tons if the mixed-fuel-engines are commercialized. This prospect, however, brings about new requirements for emission control technologies for such lean-burn engines, in particular, under low temperatures. To maintain a sustainable development, it is a key issue to fabricate highly active and ultra-stable SCR catalysts that can work under both cold-start and high-speed driving stages.



Targets by 2030

FY2022: Develop zeolites withstand at 900°C steaming. Reduce N_2O emissions during SCR to half that of the current catalyst. Achieve NH_3 recovery of 50% from wastewater.

FY2024: Develop zeolites that retain their crystallinity even after exposure to 10% steam at 900°C for 5 hours. Develop a catalyst with a purification rate of 50% without NH_3.

FY2029: Develop a catalyst with a purification rate of 80% and N_2O emissions of 1/10 of the current catalyst. Demonstration will be conducted using pilot facilities.

Implementation

The University of Tokyo, National Institute of Advanced Industrial Science and Technology (AIST), Japan Fine Ceramics Center (JFCC), Mitsubishi Chemical Corporation