Transient and catalytic NO direct decomposition by irradiating microwave

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Significance and Relevance

Nitrogen oxides could be removed by a two-step catalytic process using pulsatile microwave irradiation onto the adsorbents of nitrogen oxides such as Pd/zeolites and Pt-Ba/Al_2O_3, followed by an active catalyst for direct decomposition of nitric oxides such as Cu/zeolites.
Preferred choice for the topic: Automotive and stationary emission control
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Introduction and Motivations

Purification of nitrogen oxides NOx from combustion exhausts is still highly required in terms of higher efficiency in the combustion process at higher temperatures to decrease carbon dioxide CO_2 emission. Ammonia NH_3 or urea is now utilized as the selective reductant of NOx toward not only heavy-duty mobile sources, but also to ships, power stations, and so on to generate energy for our lives. The NH_3-utilized selective catalytic reduction using Cu/zeolites and vanadia-type oxides are well known catalytic technologies, but the system to dose NH_3 or urea to the exhaust, as well as catalytic process for eliminating residual NH_3 in the exhaust is quite complicated to load on the mobile sources. Although oxidizing atmosphere in combustion exhaust is preferable to catalyze oxidation, CO_2 is inevitably formed during the NOx reduction when hydrocarbons and/or carbon monoxide are used as the reductant. We are highly requested to find a simple and good catalyst/catalytic system for NOx removal without any CO_2 emission. Therefore, we revisited to investigate NO direct decomposition. To realize minimum energy catalytic process, pulsatile microwave irradiation is adopted onto adsorbed NO at lower temperatures on typical NOx adsorbents such as Pd/zeolites and Pt-Ba/Al_2O_3. The lower temperatures mean where the catalysis is never expected, therefore we use adsorption and concentration of NOx prior to activate NO decomposition activity on Cu/zeolites by microwave[1].

Results and Discussion

Figure 1 shows the amounts of adsorbed NOx in excess O_2 at 473 K (left bar), and desorbed NOx colored by temperatures for the desorption (right bar), on each typical NOx adsorber[2]. The difference between the amounts could be explained by catalysis on Cu/ZSM-5 for NO direct decomposition occurred at high temperatures over 773 K, and by strong adsorption of NOx on Pt-Ba/Al_2O_3 even at 773 K. Pd/zeolites are known as a PNA material at lower temperatures, so that the amounts of NO adsorbed on and desorbed from the Pd/Beta were well balanced, and never showed NO decomposition activity. Pt is quite important to store NOx on Ba species, so that Ba/Al_2O_3 did not show its efficiency for NOx storage. Therefore, the combination of NOx adsorber even in O_2-rich atmosphere and NO decomposition catalyst will induce higher efficiency for NO removal without using any reductant in the stream, which will be presented in the conference.

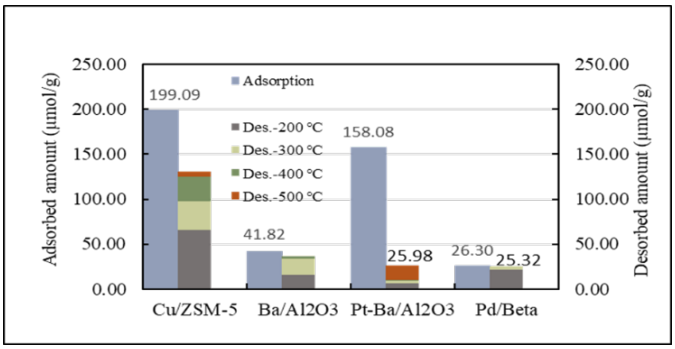

Figure 1 NOx adsorption/desorption properties on NOx adsorbers.

References

1. S. Harada, T. Ohnishi, M. Ogura, *Chem. Lett.* **2016**, *45*, 1283. K. Kawakami, M. Ogura, *Catal. Today* **2015**, *242B*, 343.
2. M. Chatterjee, M. Ogura, in preparation.