研究チーム 研究成果 ニュース イベント

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deNOxからreNOxへ 燃焼排ガス中のNOxを利用した アンモニア生成触媒プロセス開拓 from deNOx to reNOx NH<sub>3</sub> generation by use of NO in combustion exhaust

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12050年までに、地球環境再生に同けた特徴可能な資源機構を多 産業活動由来の希薄な窒素化合物の循環技術創出ープラネタリーパウンダリー

## content

- I. from deNOx to reNOx
- II. take-home message

consumption-oriented to recycling-oriented society





## outline~What is reNOx?

deNOx: <u>the catalytic processes for the removal of nitrogen oxides</u>, have been studied, typically emitted from automobiles. As a "**reactive nitrogen compound**(反応性窒素化合物)", NOx, ammonia, and urea are involved in the deNOx catalytic system.

This approach to environmental issues has led us to turn in the direction of synthesizing ammonia from NOx in an energy-saving manner. ...reNOx

Catalytic and scientific approaches to the recycling-oriented society in the future, is introduced, including our preliminary, latest results as well as our motivation.







#### 国内における反応性窒素の主な発生/排出源(単位: 千トン-N/年)

DISTRIBUTE OF TAXABLE PROPERTY.

our energy enjoyment society  
based on oxidizing/consuming reactions  
酸化・消費型社会である現代  
$$X + O_2 \rightarrow XO_2 \quad \Delta_r H < 0$$
  
 $CO_2 \qquad => Energy$   
 $NO_x$   
=> Environmental issues  
CO<sub>2</sub> and environmental problems are produced simultaneously with energy.

=Ex

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### shift to a society based on reducing/producing reactions 還元・生産型社会へ $XO_2 + R \rightarrow X(or X') + RO_2$ = Energy $\Delta_r H < 0$ $H_{2}$ C = Reductant NH<sub>3</sub>

CO<sub>2</sub> and NOx are used to regenerate energy (re)sources. =>reNOx



# from deNOx to reNOx production of valuable N compounds by energy-less catalytic process





## representative "catalysis" so far

#### deNOx for environmental issue

direct decomposition  $\rightarrow N_2 + O_2$  the most ideal and difficult reduction

 $+HC \rightarrow N_{2} + CO_{2} + H_{2}O$  $+CO \rightarrow N_{2} + CO_{2}$ 

 $+NH_3 \rightarrow N_2 + H_2O$ 

 $N_2 + H_2 \rightarrow NH_3$ 

the current technology in gasoline-engine deNOx less selective in  $O_2$ 

the current technology in stationary and heavy duty deNOx urea needed from external

#### production of NH<sub>3</sub> for food problem

the Haber-Bosch process under high T and P conditions



## NOx as the source of NH<sub>3</sub>



### our target of NTA (NOx-to-Ammonia) reNOx





#### 2 step NTA team



Our strategy: Placing an adsorbent capable of separating and recovering NO even under oxygen-rich conditions to recover only NO. The concentrated NO is fed to the NTA catalyst in the subsequent step, where it reacts with a reductant to produce  $NH_3$ .





#### summary of the result by the 2 step NTA



# take-home message

- from the society dependent on internal combustion: oxidizing and consuming
- to a society with recycling-oriented materials/resource: reducing and producing 酸化消費型の社会から, 還元生産型の社会へ
- our approach "reNOx", producing NH<sub>3</sub> not from N<sub>2</sub> but NOx, resulting in a deNOx method in a style of "local production for local consumption" N<sub>2</sub>から生産しているNH<sub>3</sub>をNOxから生産するreNOxに挑戦 ="地産地消型"のdeNOx