Name	Job Title	Area of Expertise
ARIKAWA Yasuhiro	Professor	Coordination Chemistry

1. Main Research Topics

Compounds in which a metal ion is coordinated by organic or inorganic molecules, called ligands, are known as metal complexes. Using such metal complexes can convert stable small molecules such as hydrogen, nitrogen, oxygen, and carbon dioxide into valuable compounds or extract energy from them. In our laboratory, we particularly focus on the reduction of nitrogen and sulfur oxides, as well as their oxo-anions, to achieve detoxification and transformation into useful compounds. We also work on the conversion of carbon dioxide into valuable chemicals using visible light.

① **Development of multi-electron reduction reactions of small molecules**

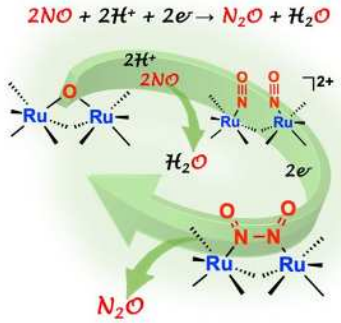


Fig. 1 NO Reduction Cycle

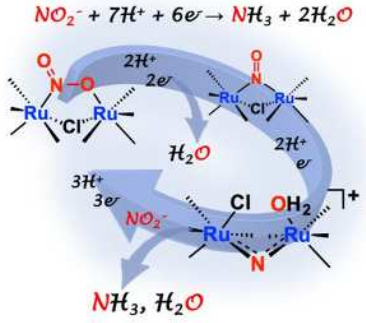


Fig 2 NO_2^- Reduction Cycle

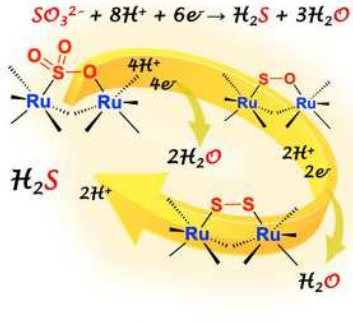


Fig. 3 SO_3^{2-} Reduction Cycle

In our laboratory, we use a dinuclear ruthenium complex, in which two ruthenium metal ions are bridged by pyrazolate ligand, to achieve three distinct reduction cycles:

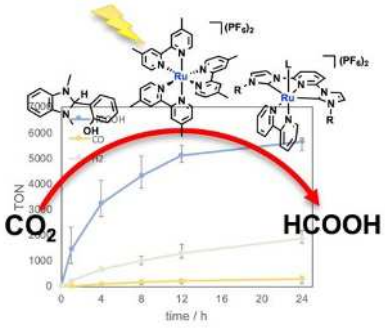
i) Conversion of two molecules of nitric oxide (NO) into nitrous oxide (N_2O) through 2 electron and 2 proton reduction (Figure 1) ($2\ NO + 2\ H^+ + 2\ e^- \rightarrow N_2O + H_2O$). Nitric oxide (NO) is readily oxidized in air to form toxic nitrogen dioxide (NO_2), but by reducing NO to nitrous oxide (N_2O), it can be detoxified.

ii) Conversion of nitrite ions (NO_2^-) to ammonia (NH_3) via a 6electron and 7 proton reduction (Figure 2) ($NO_2^- + 7\ H^+ + 6\ e^- \rightarrow NH_3 + 2\ H_2O$). This transformation is relevant to mitigating nutrient enrichment (eutrophication) in soils and water systems.

iii) Conversion of sulfite ions (SO_3^{2-}) to hydrogen sulfide (H_2S) via a 6 electron and 8 proton reduction (Figure 3) ($SO_3^{2-} + 8\ H^+ + 6\ e^- \rightarrow H_2S + 3\ H_2O$). This reaction is closely related to the global sulfur cycle.

② **Conversion of CO_2 into valuable chemicals using visible light**

Approximately half of the sunlight that reaches the Earth's surface is visible light. Therefore, if we can utilize the energy of visible light to convert CO_2 into valuable compounds, it could contribute significantly to building a sustainable society. In our research, we have successfully converted CO_2 primarily into formic acid (HCOOH) by employing complex catalysts.



2. Keywords

metal complex, nitrogen oxides, sulfur oxides, oxoanions, carbon dioxide, reduction reaction, artificial photosynthesis

3. Remarks and Websites

On Earth, there exists a natural process known as the nitrogen cycle. In this cycle, abundant nitrogen molecules in the atmosphere undergo various transformations through oxidation and reduction reactions. Among these processes, the reduction of nitrate ions to molecular nitrogen is particularly important and is referred to as denitrification. Our research focuses on this denitrification process. Specifically, we investigate the reduction of nitrogen oxides (such as NO and N_2O), sulfur oxides (such as SO), and their corresponding oxoanions (NO_3^-, NO_2^-, SO_3^{2-}) using metal complexes. In addition, we also study the visible-light-driven conversion of CO_2.

researchmap: https://researchmap.jp/arikaway

Laboratory: https://www.cms.nagasaki-u.ac.jp/lab/sakutai/