

Systematic Synthesis of Sulfur-Based Materials via Elemental Sulfur Activation

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	Project Information	Project Number : 26B204	Project Period (FY) : 2026-2028
		Keywords : Organic Synthesis, Polymer Chemistry, Electrochemistry, Coordination Chemistry, and Inorganic Chemistry	

Purpose and Background of the Research

● Outline of the Research

Elemental sulfur is a simple and stable substance. It mainly exists as an eight-membered ring composed of sulfur atoms (S_8) and is easy to handle as a yellow solid. Every year, enormous amounts of sulfur are produced worldwide - about 70 million tons, including 1.5 million tons in Japan. However, this huge production is not driven by demand for sulfur itself. Instead, it is produced as a byproduct during petroleum refining. In other words - "We need petroleum, but we don't need sulfur" - this project aims to change this situation.

How can we make better use of this excess sulfur?

Chemists have long used sulfur in many reactions, especially in organic synthesis, but in most cases, sulfur has been considered just one reagent among many. What has been missing is a broader perspective using sulfur as an unavoidable surplus resource in our oil-based society.

This project focuses on developing general and unified strategies to convert stable sulfur into functional materials. The central concept is "sulfur activation" - changing unreactive elemental sulfur into reactive species that can be used for diverse chemical transformations. Six young chemists from different backgrounds (organic, electrochemistry, polymer, coordination chemistry, inorganic, and analytical chemistry) will each develop their own activation methods and collaborate to share their original techniques. This will open up new synthetic methodologies from abundant elemental sulfur to a wide range of sulfur-based functional materials, including small molecules, polymers, metal complexes, and inorganic materials.

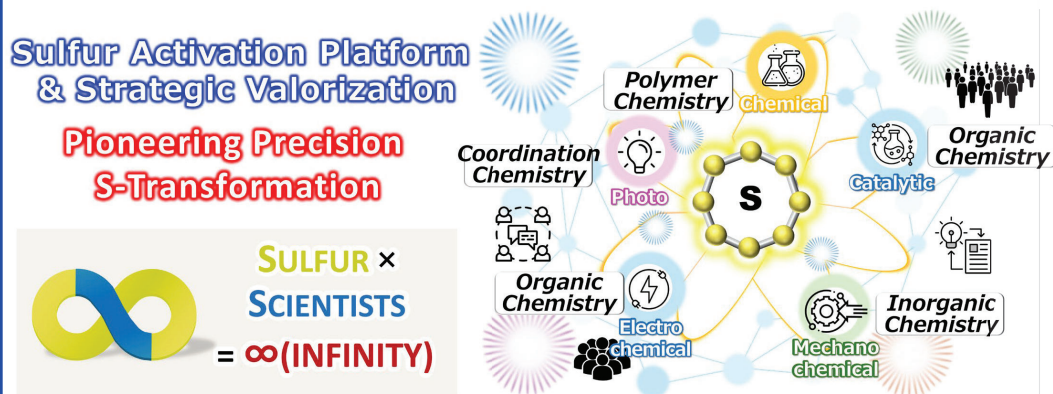


Figure 1. Overview of our research project

Expected Research Achievements

● Goals

This team aims to establish a new platform for the precise transformation of elemental sulfur. The keyword of this collaboration is, again, "sulfur activation" by means of various approaches: organic, electrochemical, catalytic, photochemical, and mechanochemical ways. This collaborative framework and concept - based on activation - is potentially applicable to other elements, such as Se and P. We believe this project extends beyond sulfur and will expand a broader scientific community for element activation in the future.

● Organization, Challenge, and Research Area

X00 Administrative Group

Leader : OGIWARA Yohei

Co-investigator : KOBAYASHI Yuichiro, TSUKADA Satoru, KATO Kunihiro

"Systematic Synthesis of Sulfur-Based Materials via Elemental Sulfur Activation"

A01 Organic Group (Research Area : Catalysis, Electrochemistry)

Leader : OGIWARA Yohei (Gifu University)

Co-investigator : WATANABE Hikari (Tokyo University of Science)

"Selective and Efficient Sulfur Installation in Organic Synthesis via Elemental Sulfur Activation"

A02 Polymer Group (Research Area : Polymer Synthesis, Characterization)

Leader : KOBAYASHI Yuichiro (Osaka University)

Co-investigator : KIDA Takumitsu (University of Shiga Prefecture)

"Tailor-Made Precision Polymer Synthesis via Elemental Sulfur Activation"

A03 Metal Complex Group (Research Area : Coordination Chemistry)

Leader : TSUKADA Satoru (Chiba University)

"Clean and Well-Defined Synthesis of Metal Complexes via Elemental Sulfur Activation"

A04 Inorganic Group (Research Area : Mechanochemistry)

Leader : KATO Kunihiro (Gifu University)

"Mechanochemical Precision Synthesis of Inorganic Sulfides via Elemental Sulfur Activation"

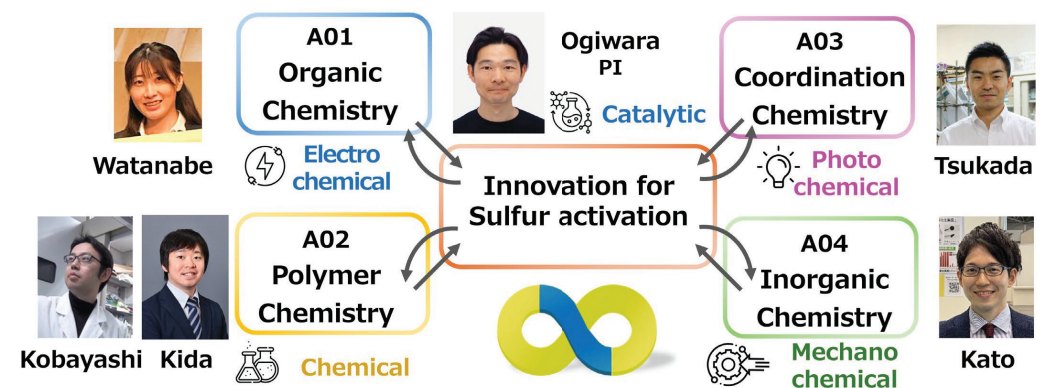


Figure 2. Organization

Website(s)

Sulfur Activation Research Area Website <https://sulfur-activation.eng.gifu-u.ac.jp>