

## PRESS RELEASE

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### Barium ruthenate: A high-yield, easy-to-handle perovskite catalyst for the oxidation of sulfides

**(Tokyo, July 9)** Researchers at Tokyo Institute of Technology have developed a ruthenium-based [perovskite catalyst](#)<sup>1</sup> that shows strong activity even at low temperatures (down to 313 K). The reusable catalyst does not require additives, meaning that it can prevent the formation of toxic by-products. The oxidation of sulfides is a commercially important process with broad applications ranging from chemicals production to environmental management.

A research group led by Keigo Kamata and Michikazu Hara of Tokyo Institute of Technology (Tokyo Tech) has succeeded in developing a barium ruthenate ( $\text{BaRuO}_3$ ) perovskite — the first catalyst of its kind shown to be capable of the selective oxidation of sulfides under mild conditions, with molecular oxygen ( $\text{O}_2$ ) as the only oxidant and without the need for additives.

Reporting their findings in *ACS Applied Materials & Interfaces*, the researchers state that  $\text{BaRuO}_3$  has three advantages over conventional catalysts.

Firstly, it exhibits high performance even at 313 K, a temperature much lower than the 373–423 K range reported in previous systems including other ruthenium- and manganese-based catalysts. Secondly, its high rate of oxygen transfer indicates that it has many potential uses; for example, it is applicable to the [oxidative desulfurization](#)<sup>2</sup> of dibenzothiophene, which can produce a 99% yield of pure sulfone. Thirdly, the new catalyst is recyclable — the present study showed that  $\text{BaRuO}_3$  could be reused at least three times without loss of performance.

The achievement overcomes several classic limitations, such as the need for additives, toxic reagents and high reaction temperatures to achieve good catalytic performance.

The catalyst has a rhombohedral structure (see [Figure 1](#)). While other ruthenium-based catalysts investigated to date such as  $\text{SrRuO}_3$ ,  $\text{CaRuO}_3$  and  $\text{RuO}_2$  can all be described as having corner-sharing octahedral units,  $\text{BaRuO}_3$  has face-sharing octahedra. This configuration is thought to be one of the main reasons behind the catalyst's higher oxygen transfer capability.

The way in which BaRuO<sub>3</sub> was synthesized — based on the [sol-gel method](#)<sup>3</sup> using malic acid — was also important. The researchers say: “The catalytic activity and specific surface area of BaRuO<sub>3</sub> synthesized by the malic acid-aided method were higher than those of BaRuO<sub>3</sub> synthesized by the polymerized complex method.”

The study highlights the importance of subtle changes in the nanoscale structure of perovskite catalysts, and could provide promising leads for further research on a wide range of perovskite-based functional materials.

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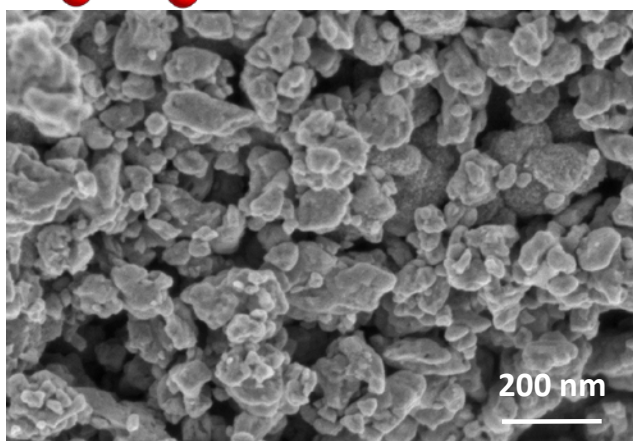
### Face-sharing octahedral unit

(BaRuO<sub>3</sub>)



### Corner-sharing octahedral unit

(SrRuO<sub>3</sub>, CaRuO<sub>3</sub>, RuO<sub>2</sub>)



**Figure 1.** Structure and image of the BaRuO<sub>3</sub> catalyst

**Top:** Schematic representations of the face-sharing unit in rhombohedral BaRuO<sub>3</sub> and corner-sharing unit in tetragonal RuO<sub>2</sub>, cubic SrRuO<sub>3</sub>, and orthorhombic CaRuO<sub>3</sub>.

**Bottom:** Scanning electron microscope (SEM) image of BaRuO<sub>3</sub>.

### Technical terms

<sup>1</sup> [Perovskite catalyst](#): Referring to a family of catalysts with the general formula ABO<sub>3</sub>, which are of great interest due to their structural simplicity, flexibility, good stability and controllable physicochemical properties.

<sup>2</sup> [Oxidative desulfurization](#): An important reaction process for sulfur removal — this is particularly relevant to the fuel industry and efforts to curb sulfur emissions.

<sup>3</sup> [Sol-gel method](#): A process widely used to prepare novel materials by converting monomers in a colloidal solution (sol) to a network of polymers (gel).

### Related Links

[A ruthenium-based catalyst with highly active, flat surfaces outperforms metal-based competitors](#)

[Reusable ruthenium-based catalyst could be a game-changer for the biomass industry](#)

### References

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