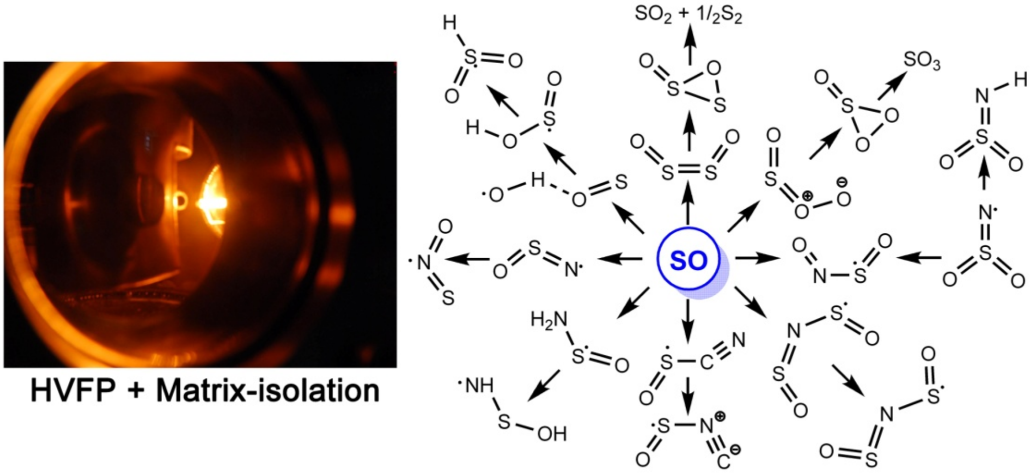
Reactions of Sulfur Monoxide: Intermediates and Implications in Interstellar Chemistry

Zhuang Wu[1] and Xiaoqing Zeng[1]*

[1]Department of Chemistry, Shanghai Key Laboratory of Molecular Catalysts and Innovative Materials, Fudan University, 200433 Shanghai, China; E-mail: xqzeng@fudan.edu.cn

Sulfur is the tenth most abundant element in the universe, and sulfur chemistry plays vital importance not only in the biological systems on the Earth but also in the atmospheres of all the planets in our Solar system. Particularly, the photochemistry of volatile sulfur-containing compounds including volcanic sulfur oxides has great impact on the sulfur cycle due to the formation and evolution of hazes and clouds in the upper atmospheres of Solar system planets such as Earth, Venus, Jupiter, and the moon Io. [1] Among these sulfur oxides, the chemistry of sulfur monoxide (SO)−the simplest sulfur oxide−remains largely unexplored due to its high reactivity at ambient conditions, although its existence in interstellar medium (ISM) and also in atmospheric SO_2 chemistry has already been established.[2] Based on the efficient gas-phase generation of SO through high-vacuum flash pyrolysis (HVFP) of ethylene episulfoxide, fundamental reactions of SO including dimerization, oxidation, radical association, and related photochemistry have been studied by combining matrix-isolation spectroscopy and quantum chemical calculations. In addition to the identification of new forms of sulfur-containing species, their implications in the interstellar chemistry have also been discussed.[3]



[1](a) Charlson, R. J., Lovelock, J. E., Andreae, M. O. & Warren, S. G. Oceanic phytoplankton, atmospheric sulphur, cloud albedo and climate. *Nature* **326**, 655–661 (1987); (b) Marcq, E., Bertaux, J. -L., Montmessin, F. & Belyaev, D. Variations of sulphur dioxide at the cloud top of Venus's dynamic atmosphere. *Nat. Geosci*. **6**, 25–28 (2013); (c) Cassini imaging of Jupiter's atmosphere, satellites, and rings. *Science* **299**, 1541–1547 (2003).

[2](a) Photolysis of sulphuric acid as the source of sulphur oxides in the mesosphere of Venus. *Nat. Geosci.* **3**, 834–837 (2010); (b) Russell, C. T. & Kivelson, M. G. Detection of SO in Io's exosphere. *Science* **287**, 1998–1999 (2000).

[3]For examples, see: (a) Wu, Z. et al. The near-UV absorber OSSO and its isomers. *Chem*. *Commun*. **54**, 4517–4520 (2018); (b) Lu, B. et al. Spectroscopic characterization of HSO_2• and HOSO• intermediates involved in SO_2 geoengineering. *J. Phys. Chem. A* **125**, 10615–10621 (2021); (c) Chen. C. et al. Capture of the sulfur monoxide–hydroxyl radical complex. *J. Am. Chem. Soc.* **142**, 2175–2179 (2020); (d) Wu, Z. et al. The near-UV absorber OSSO and its isomers. *Chem*. *Commun*. **54**, 4517–4520 (2018).