

## PRESS RELEASE

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Japan Science and Technology Agency

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Subject line: **Great strides for carbon capture using earth-abundant elements as photocatalytic system**

(Tokyo, November 29, 2018) **Researchers at Tokyo Institute of Technology have designed a CO<sub>2</sub> reduction method based only on commonly occurring elements. Achieving a 57% overall quantum yield of CO<sub>2</sub> reduction products, it is the highest performing system of its kind reported to date, raising prospects for cost-effective carbon capture solutions.**

As global warming presents one of the biggest challenges to humanity in the 21st century, the quest to curb mounting CO<sub>2</sub> emissions is more pressing than ever.

In a study published in the *Journal of the American Chemical Society*, [Osamu Ishitani](#) and colleagues at Tokyo Institute of Technology (Tokyo Tech) and Japan's National Institute of Advanced Industrial Science and Technology report a [photocatalytic](#)<sup>1</sup> system that brings scientists closer to achieving artificial photosynthesis — the goal of creating a sustainable system similar to the way that plants convert CO<sub>2</sub> to useful energy by using earth abundant metals.

Although metal-complex photocatalytic systems have been reported for CO<sub>2</sub> reduction, many of them used noble- and/or rare-metal complexes. Compared to these approaches that utilize rare metals (such as ruthenium and rhenium), the use of earth abundant metals is “greener” and inexpensive, and has thus attracted much interest.

Their new process is made up of two components (see **Figure 1**): 1) a copper complex (CuPS) that behaves as a [redox photosensitizer](#)<sup>2</sup> and 2) a manganese-based catalyst, Mn(4OMe).

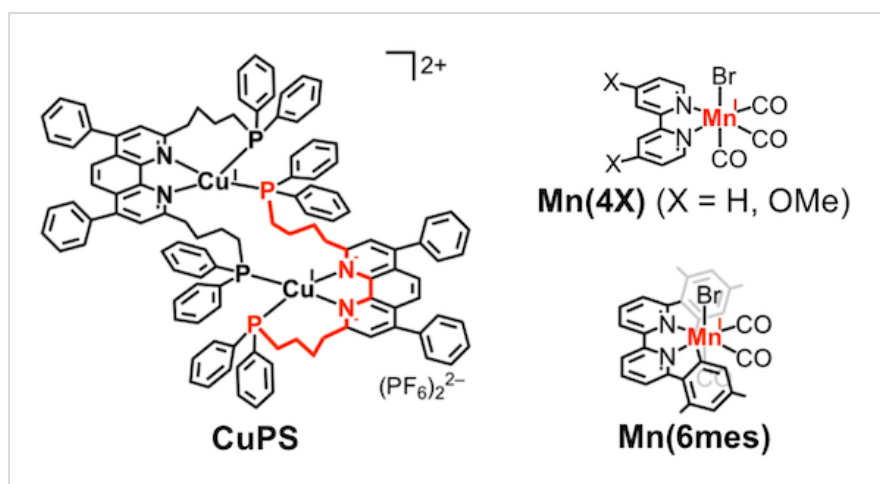
CuPS proved to be a stable and efficient redox photosensitizer, as decomposition was only 2% after 12 hours of irradiation. In addition, CuPS exhibited a much stronger reduction capability compared to other photosensitizers investigated to date.

The team reported that the total quantum yield of CO<sub>2</sub> reduction products was 57%, the turnover number based on the manganese catalyst was over 1300 and the selectivity of CO<sub>2</sub> reduction was 95%.

In particular, the figure of 57% is remarkable, as the researchers comment: "To the best of our knowledge, this is the highest quantum yield for CO<sub>2</sub> reduction using abundant elements and the yield would be comparable to that obtained with rare metals."

The study highlights the way that incremental advances in chemistry may have a large impact on the wider goal of working towards a fossil-fuel-free future.

The research was supported by the Japan Science and Technology Agency's [CREST](#) program aimed at accelerating strategic innovation.



**Figure 1. The photocatalytic system consists only of earth-abundant metals**  
Structure of CuPS, the copper complex that behaves as a redox photosensitizer, and the manganese-based catalyst developed in the study.

### Technical terms

<sup>1</sup> [Photocatalytic](#): Referring to a light-driven process that can accelerate a particular reaction of interest.

<sup>2</sup> [Redox photosensitizer](#): A component that initiates the photochemical one-electron transfer from a reductant to a catalyst.

### References

Hiroyuki Takeda, Hiroko Kamiyama, Kouhei Okamoto, Mina Irimajiri, Toshihide Mizutani, Kazuhide Koike‡, Akiko Sekine and Osamu Ishitani, Highly Efficient and Robust Photocatalytic Systems for CO<sub>2</sub> Reduction Consisting of a Cu(I) Photosensitiser and Mn(I) Catalysts, *Journal of the American Chemical Society* (2018), DOI: [10.1021/jacs.8b10619](https://doi.org/10.1021/jacs.8b10619)

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### **Related links**

Osamu Ishitani - Seeking photocatalysts for chemical energy

[https://www.titech.ac.jp/english/research/stories/faces15\\_ishitani.html](https://www.titech.ac.jp/english/research/stories/faces15_ishitani.html)

Ishitani-Maeda Laboratory

[http://www.chemistry.titech.ac.jp/~ishitani/en/index\\_en.html](http://www.chemistry.titech.ac.jp/~ishitani/en/index_en.html)

Reducing CO<sub>2</sub> with common elements and sunlight

<https://www.titech.ac.jp/english/news/2018/041799.html>

[Mn(bipyridyl)(CO)<sub>3</sub>Br]: An Abundant Metal Carbonyl Complex as Efficient Electrocatalyst for CO<sub>2</sub> Reduction

<https://onlinelibrary.wiley.com/doi/abs/10.1002/anie.201103616>

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