Dinuclear ruthenium complex as a photocatalyst for selective CO2 reduction to CO

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Similar to the process of photosynthesis in plants, the conversion and storage of solar energy into chemical energy hold significant promise for addressing critical energy and environmental challenges, including the depletion of fossil fuels and threat of global warming. One promising
avenue in this pursuit involves harnessing light energy to convert CO$_2$ into value-added chemicals.

In a recent study, University of Tsukuba researchers harnessed the potent photocatalytic properties of a ruthenium (Ru) dinuclear complex with self-photosensitizing capabilities to achieve a remarkably efficient CO$_2$ reduction reaction. This process yields a high selectivity for carbon monoxide (CO). Their research has been published in the *Journal of the American Chemical Society*.

When a dimethylacetamide/H$_2$O mixture containing the Ru dinuclear complex as a photocatalyst and a sacrificial reducing agent was exposed to light with a central wavelength of 450 nm in 1 atm CO$_2$ atmosphere for 10 h, all the sacrificial reducing agent was consumed, and the substrate CO$_2$ was converted into CO with a selectivity exceeding 99%.

The maximum quantum yield at 450 nm was determined to be 19.7%. Furthermore, even when the initial CO$_2$ concentration in the gas phase was reduced to 1.5%, the photocatalytic CO$_2$ reduction by the Ru complex proceeded with remarkable efficiency, indicating that nearly all the introduced CO$_2$ could be converted into CO.

In this newly developed Ru dinuclear complex, the two Ru complex moieties engage in photosensitization, enhancing the stability of the complex catalyst under reaction conditions. This enhanced stability is attributed to the extraordinarily strong chelating effect of the ligand employed.

The researchers have future plans for further enhancing the catalytic activity to create a reaction system capable of efficiently driving the CO$_2$ reduction process, even at a lower CO$_2$ concentration equivalent to that of the Earth's atmosphere, which is approximately 420 ppm.

Provided by University of Tsukuba

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