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Highly Concentrated CO Evolution for Photocatalytic Conversion of CO_2 by H_2O as an Electron Donor

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Abstract

The reduction in human-induced emissions of CO_2 from automobiles, factories, power stations etc., over the next 15 years is currently one of the most important issues facing the planet. We should therefore attempt to develop industrial processes using CO_2 as a feedstock in order to build a sustainable society in the near future. Linear CO_2 molecules adsorbed on the surface of the solid bases are converted into unique structures, such as bicarbonate and carbonate species possessing lattice oxygen atoms. We believe that the process involves the capture and distortion of CO_2 upon adsorption on a solid base through activation by photoirradiation. Unstable CO_2 species adsorbed onto the surface can then be reduced by electrons with protons derived from H_2O ($CO_2 + 2e^- + 2H^+ \rightarrow CO + H_2O$). These days, we succeeded in designing highly selective photocatalytic conversion of CO_2 by H_2O as the electron donor, by the simultaneous use of an inhibitor of the production of H_2 and a material for CO_2 capture and storage, such as $ZnGa_2O_4/Ga_2O_3$ [1,2], $La_2Ti_2O_7$ [3], SrO/Ta_2O_5 [4], $ZnGa_2O_4$ [5] and $ZnTa_2O_6$ [6], and $Sr_2KTa_5O_{15}$ [7] with the modification of Ag cocatalyst. An isotope experiment using $^{13}CO_2$ and mass spectrometry clarified that the carbon source of the evolved CO is not the residual carbon species on the photocatalyst surface, but the CO_2 introduced in the gas phase. In addition, stoichiometric amounts of O_2 evolved were generated together with CO.

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