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 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$_3$ 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$_2$O (CO$_2$ + 2e$^- + 2H^+ \rightarrow CO + H_2O$). These days, we succeeded in designing highly selective photocatalytic conversion of CO$_2$ by H$_2$O 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$_2$O$_4$/Ga$_2$O$_3$[1,2], La$_2$Ti$_2$O$_7$[3], SrO/Ta$_2$O$_5$[4], ZnGa$_2$O$_4$[5] and ZnTa$_2$O$_6$[6], and Sr$_2$KTa$_4$O$_9$[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.

References


[2] Zheng Wang; Kentaro Teramura; Zeai Huang; Saburo Hosokawa; Yoshihisa Sakata; Tsunehiro Tanaka, Tuning the selectivity toward CO evolution in the photocatalytic conversion of CO$_2$ with H$_2$O through the modification of Ag-loaded Ga$_2$O$_3$ with a ZnGa$_2$O$_4$ layer. Catalysis Science & Technology. 6, 1025-1032 (2016). doi:10.1039/C5CY01280E


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