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ELECTRON AND HOLE TRANSFER FROM PHOTOCATALYST TO COCATALYSTS IN THE VISIBLE LIGHT INDUCED WATER SPLITTING BY Pt- AND CoO_x-LOADED $LaTiO_2N$: STUDIED BY TIME-RESOLVED ABSORPTION SPECTROSCOPY

Akira Yamakata[1, 2]*, Masayuki Kawaguchi[1], Jun Kubota[3] and Kazunari Domen[3]

[1]*Graduate School of Engineering, Toyota Technological Institute, 2-12-1 Hisakata, Tempaku, Nagoya 468-8511, Japan*
[2]*Precursory Research for Embryonic Science and Technology (PRESTO), Japan Science and Technology Agency (JST), 4-1-8 Honcho Kawaguchi, Saitama 332-0012, Japan*
[3]*Department of Chemical System Engineering, the University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-8656, Japan*
**yamakata@toyota-ti.ac.jp*

Photocatalysis has been attracted considerable attention due to the potential applications for water-splitting and degradation of pollutants by using solar energy. Activity of photocatalysts greatly enhanced by loading cocatalysts such as Pt and partially oxidized Co (CoO_x): they are believed to capture electrons and holes from the photocatalysts and decrease the over potentials for H_2 and O_2 evolutions. The electron capture process by Pt cocatalysts has been observed by our previous work and not the hole capturing process. In this work, an attempt to observe the hole transfer process to cocatalyst by means of time-resolved IR spectroscopy (TR-IR) is presented. In the present study, CoO_x-loaded $LaTiO_2N$ is selected, because this catalyst can oxidize water at ~30% quantum efficiency by visible light. The photocatalysts were excited by laser pulses (6 ns, 355 nm) and the decay of photogenerated electrons was monitored by home-built TR-IR spectroscopic setup. First, the decay kinetics of photogenerated electrons in $LaTiO_2N$ were examined by TR-IR. Since photogenerated electrons in the conduction band gave an unstructured broad absorption in mid-IR region, the temporal profiles of the transient absorption reflect the decay process of photogenerated electrons. The lifetime of photogenerated electrons became short by loading Pt. Since Pt loading increased the efficiency of H_2 evolution, this accelerated decay is ascribed to the electron capture by Pt and not due to the enhancement of recombination. It was observed that the lifetime of electron drastically elongated by loading the cocatalyst CoO_x. This deceleration is ascribed to the effective capturing of holes by loaded CoO_x. CoO_x loaded $LaTiO_2N$ catalyst can oxidize water at ~30% quantum efficiency by visible light, therefore, it is elucidated in this work that CoO_x effectively captures holes and prevents the recombination.