## Local charge-carrier dynamics of a particulate Ga-doped La<sub>5</sub>Ti<sub>2</sub>Cu<sub>0.9</sub>Ag<sub>0.1</sub>O<sub>7</sub>S<sub>5</sub> photocatalyst and the impact of Rh cocatalyst

(<sup>1</sup>*Chuo University*, <sup>2</sup>*AIST*, <sup>3</sup>*The University of Tokyo*) OKenji Katayama,<sup>1</sup> Tatsuya Chugenji,<sup>1</sup> Zhenhua Pan,<sup>1</sup> Vikas Nandal,<sup>2</sup> Kazuhiko Seki<sup>2</sup>, Kazunari Domen, 3 **Keywords**: Charge Carrier Dyanmics; Microscopy; Photocatalyst; LTCA; Co-catalyst

<u>Charge carrier dynamics of highly active p-type photocatalytic particle materials were</u> <u>clarified for particle-by-particle observation</u>. We could distinguish the difference in the charge carrier responses due to co-catalysts by the local observation of each spot of the particles. The photocatalyst was Ga-doped La<sub>5</sub>Ti<sub>2</sub>Cu<sub>0.9</sub>Ag<sub>0.1</sub>O<sub>7</sub>S<sub>5</sub> (Ga-LTCA), which is a promising p-type photocatalyst for solar hydrogen generation. We could make this measurement possible with our home-built time-resolved microscopy combined with informatics analysis such as image recovery and clustering of time-resolved data.<sup>1</sup> We could successfully identify the electron trapping at the co-catalyst sites (Rh) from the difference in the charge carrier behavior.<sup>2</sup>

In our measurement, a pulse light with a pattern is illuminated to a sample, and the timeresolved phase-contrast image sequence is obtained with nanosecond time resolution. (Figure left) <u>We could clearly detect time-resolved local responses at each photocatalytic particle or</u> <u>agglomerates.</u> By selecting one of the regions, the time responses at all the image regions were analyzed by the clustering analysis, which provided the categorization of different charge carrier types. (Figure right top) We could assign each response due to the surface-trapped electrons and holes.



Figure The time-resolved image sequence for the particulate Rh doped Ga-LTCA. The bottom drawing corresponds to the pattern of the pump light illumination. The square 1 was cut off and the time responses were analyzed by the clustering analysis to categorize the responses depending on the charge types. The categorized map and the corresponding responses are shown at the bottom, which corresponds to holes and two types of electrons.

1) M. Ebihara, et al. Nat. Commun. 2021, 12, 3716. 2) T. Chugenji, et al. PCCP. 2022, 24, 17485.