Influence of cocatalysts on photo-excited charge carrier dynamics in titanium oxide photocatalysis observed using Pattern-Illumination Time-resolved Phase Microscopy

([1]*Chuo University*) ○Kana Matsumoto,[1] Yuki Nakatsukasa,[1] Yuta Egawa, Kenji Katayama[1]
Keywords: Charge Carrier Dynamics, Titanium Oxide, Platinum Cocatalyst

Loading a cocatalyst is a common method to promote interfacial reactions for photocatalysts. Although it is well known that cocatalysts can improve reactivity, their effect on the reaction mechanism, namely—charge carrier dynamics has not been fully understood, as there has been no way to directly observe it. Therefore, we have developed Pattern-Illumination Time-resolved Phase Microscopy (PI-PM). [1] Combined with the clustering analysis, we could succeed to classify different types of charge carriers based on the pixel-by-pixel response shapes. In this study, we investigated the effect of a typical cocatalyst—platinum—on the photo-excited charge carrier dynamics of titanium oxide by this microscopy.

Figure 1 shows result for the clustering analyses of (A) TiO_2, (B) Pt/TiO_2 in acetonitrile. Different charge carrier types (electron/hole/trapped carriers) were distinguished from the effects of scavengers, and the sign dependence of refractive index changes. The positive and negative responses were attributed to the electron the hole dynamic, respectively. A new slow response (green) was observed with Pt loading, and its area was significantly increased, was attributed to electrons transferred to the Pt cocatalyst. The elongation of the electron lifetime indicates the suppression of recombination, supporting the photocatalytic activity.

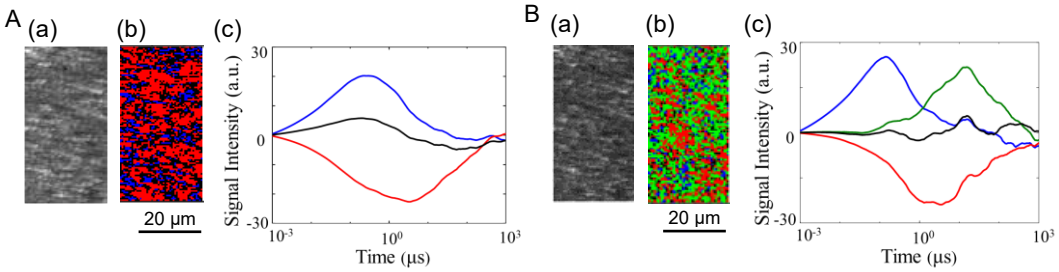

Fig.1 The clustering analyses of (A) TiO_2, (B) Pt/TiO_2; (a): microscopic images in ACN, (b): categorized map of charge carrier dynamics, (c): average responses of categorized responses

1) K. Katayama, *Phys. Chem. Chem. Phys.* **2024**, *26*, 9783. 2) Y. Egawa, K. Kawaguchi, Z. Pan, K. Katayama, *J. Chem. Phys.* **2024**, 160, 164705.