Study on photodeposition process of Pt nanoparticles on TiO_2 photocatalyst by XAFS spectroscopy

Y.Nakano,[a] M.Akatsuka,[a] M.Yamamoto,[a] T.Tsukada,[b] S.Ogawa,[a] S.Yagi,[a,b] T.Yshida[a,c]

[a] *Graduate School of Engineering, Nagoya University, Nagoya 464-8603, Japan*

[b] *Insitute of Materials and Systems for Sustainability,Nagoya 464-8603, Japan*

[c] *Advance Research Institute for National Science and Technology, Osaka City University, Osaka 558-8585, Japan*

TiO_2 is one of the representative photocatalysts used, for example, to purify water and air. In order to enhance the activity of the TiO_2 photocatalyst, Pt nanoparticles are often deposited on the surface[1]. In this study, we aimed to investigate the photodeposition process of Pt nanoparticles on TiO_2 using Pt L_3-edge XAFS spectroscopy focusing on the bonding states of Pt on TiO_2 surface and local structures around Pt atoms.

Before irradiation, the feature of Pt L_3-edge XANES spectrum of the TiO_2 sample adsorbing the Pt precursor was similar to that of PtO_2. The energy position of the main peak of XANES shifted to lower X-ray energy with the photoirradiation time, indicating a decrease in the ratio of Pt^{4+} ions by reduction.

All XANES spectra were reproduced with the linear combination of two XANES spectra of PtO_2 and Pt metal, and the fractions of Pt^{4+} and Pt^0 for all the Pt/TiO_2 samples were directly evaluated. Fig.1 shows irradiation-time dependence of edge jump intensity at 11740 eV and the fraction of Pt^0. The edge jump intensity corresponds to the deposited Pt concentration.

Before photoirradiation, only 20% of Pt^{4+} ions were adsorbed on TiO_2. The Pt^{4+} ions increased to 45% by photo-assisted adsorption after 5 minutes, in which most of the adsorption sites of Pt on the TiO_2 surface would be occupied. Subsequently, the adsorbed Pt^{4+} ions were gradually reduced during the following 5 to 20 minutes of photoirradiation. In the successive period for 20–30 min, the amount of the adsorbed Pt^{4+} ions drastically increased and the reduction of Pt^{4+} to Pt^0 drastically occurred. After that, the fraction of Pt^0 gradually increased by further photoreduction.

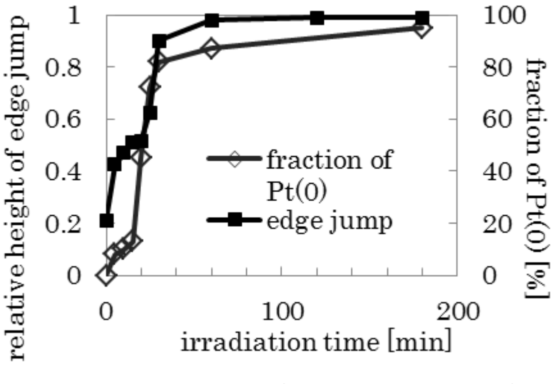

Fig.1 Dependence of relative height of edge jump in Pt L_3-edge XANES and fraction of Pt^0 on the photoirradiation time.

[+] Author for correspondence: nakano.yuuji@j.mbox.nagoya-u.ac.jp

[1] G. R. Bamwenda, S. Tsubota, T. Nakamura and M. Haruta, J. Photochem. Photobiol A . **89**, 177(1995).