

XAFS study for nano particle of titanium oxide

Youhei SHIRAISHI¹, Kouji KINUTA¹, Gousuke TATENO¹,
Nobuyuki ISSHIKI¹ and Kiyotaka ASAKURA^{2*}

¹Materials Science Research Laboratory, Kao Corporation,
Minato 1334, Wakayama City, Wakayama 640-8580, Japan

²Catalyst Research Center, Hokkaido University,
Kita21Nishi10, Kita-ku, Sapporo City, Hokkaido 001-0021, Japan

Introduction

Titanium oxide nanoparticles obtained by the reaction from titanium alcoxide and organic cations for example amines or tetraalkylammoniumhydroxides[1] show high transparency and refractive index. However, the structure is still unknown because it is difficult to study the structure for dispersed nanoparticle with diffraction techniques. This study aimed to clarify the local structure of titanium oxide nanoparticle and its dependency on the reaction agents and cations.

Experimental

The titanium oxide nanoparticle dispersions were obtained by the reaction by titanium tetraisopropoxide and tetramethylammoniumhydroxide (TMAOH) or tetrabutylammoniumhydroxide (TBAOH) in distilled water. The XAFS measurements were carried out at BL-9A and BL-12C of PF. The X-ray monochromatized with a Si(111) double crystal monochromator. The 4 wt% titanium oxide nanoparticle dispersed in water was loaded to 0.5mm thick stainless cell with 0.05mm polyimide windows. The experiments were carried out by a transmission mode.

Results and discussion

Figure 1 shows Ti K-XANES spectra for (a): dispersion of titanium oxide nanoparticle obtained by the reaction with TMAOH, (b): with TBAOH and (c): powder sample of protonated titanate with layered structure. The titanium oxides have significant pre-edge peak at 4966-4967 eV and weak peaks at 4964 eV and 4970 eV. These pre-edge structures indicate the nanoparticles have layered titanate structure rather than anatase or rutile[2]. This suggestion was supported by Raman spectroscopy.

Figure 2 shows Ti K-EXAFS oscillation for titanium oxide nanoparticles obtained by the reaction with TMAOH or TBAOH. Larger EXAFS oscillation for the titanate with TBAOH than that for the titanate with TMAOH, indicates larger particle size or higher crystallinity for titanate with TBAOH. It is assumed that the particle size dependency of the titanium oxide nanoparticle was caused by the difference of behavior of the organic cation as capping agent to the surface of the titanate.

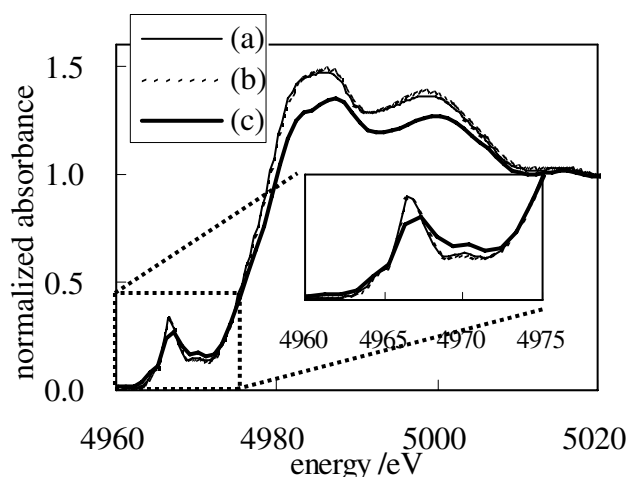


Figure 1. Ti K-edge XANES spectra for (a) titanium oxide nanoparticle obtained by the reaction with TMAOH, (b) with TBAOH, and (c) protonated titanate by HCl aq treatment for Cs-Ti-O with lepidocrocite-type structure. Absorbance of each spectrum was normalized with the absorbance at 5020eV.

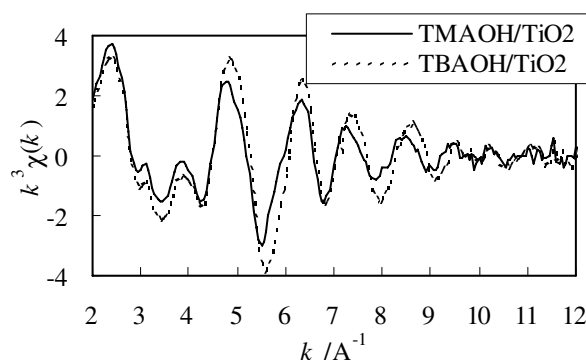


Figure 2. Ti K-edge EXAFS oscillation for titanium oxide nano particles.

References

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* askr@cat.hokudai.ac.jp