

Synthesis of Intermetallic Nanoparticles as Co-catalyst on Anatase TiO_2 and Its Photocatalytic Activity

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1. Introduction

The recombination of photoexcited electrons and holes influences seriously the efficiency of the photocatalysts. On the other hand, the efficiency of the photocatalysts can be greatly enhanced by introducing of active interfaces between photocatalytic supports and co-catalyst, which has been anticipated to allow smooth penetration of photoexcited holes or electrons from supports to co-catalysts. We successfully created such *active interfaces* between TiO_2 support and intermetallic nanoparticles (NPs) as co-catalyst under room temperature.

2. Experimental

The synthesis of freestanding Pt_3Ti NPs has been reported in the literature.^{1,2} The organometallic precursors, Pt precursor, Pt(1,5-cyclooctadiene)Cl₂ (99%, STREM Chemicals) (0.04 mmole) and Ti precursor, Ti(tetrahydrofuran)₂Cl₄, (synthesized from TiCl₄ (99%, Kishida Chemicals)) (0.16 mmole) and TiO_2 supports were mixed in dry tetrahydrofuran followed by reduced using sodium naphthalide (1.5 mmole) to obtain TiO_2 -supported Pt_3Ti NPs.

3. Results and Discussion

The *active interfaces* were introduced between Pt_3Ti NPs and TiO_2 supports (Fig. 1). The ordered TiO_2 supports most likely regulated the formation of ordered structures of Pt_3Ti under room temperature, where Pt_3Ti NPs can be formed solely as disordered structures on other supports (e.g., C, SiO_2 , etc.). Fig. 2 shows the HX-PES profiles in the Pt 3d region for the reference bulk Pt, bulk Pt_3Ti and Pt_3Ti NPs and TiO_2 -supported Pt_3Ti NPs. The bulk Pt_3Ti was prepared using an arc torch in pure Ar gas (99.9999 %) beginning with pure Pt and Ti ingots (99 %, Furuya Kinzoku, Ltd.). The Pt 3d_{5/2} peak for bulk Pt_3Ti was shifted to higher binding energy (+0.3 eV) than that of Pt. The Pt 3d_{5/2} peaks for the Pt_3Ti NPs were consistent with bulk Pt_3Ti , indicating that the chemical composition and atomic environment of the Pt_3Ti NPs were the same as those in bulk Pt_3Ti .

The details about photocatalytic activity of TiO_2 -supported Pt_3Ti NPs would be discussed in the presentation.

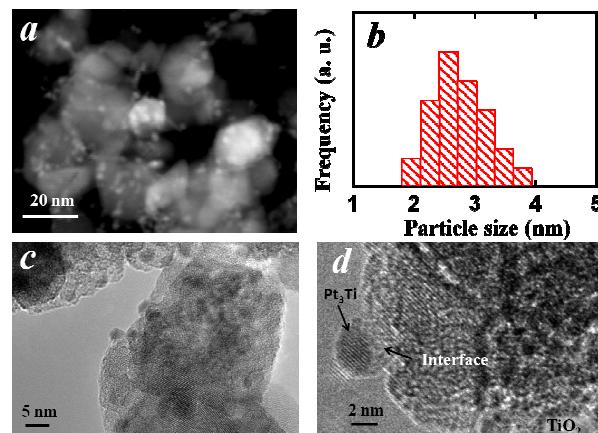


Fig. 1. TEM image of TiO_2 -supported Pt_3Ti NPs (a). Histogram of the particle size distribution (b). HR-TEM images of synthesized TiO_2 -supported Pt_3Ti ordered intermetallic NPs (c and d).

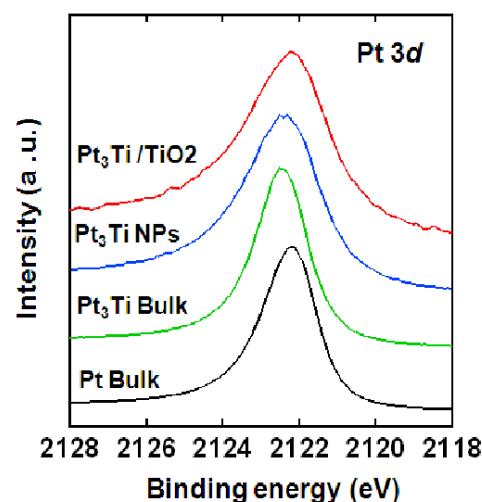


Fig. 2 HX-PES spectral profiles for Pt bulk, Pt_3Ti bulk, Pt_3Ti nanoparticles and TiO_2 -supported Pt_3Ti nanoparticles in the regions of Pt 3d.

4. References

1. H. Abe, F. Matsumoto, L.R. Alden, S. C. Warren, H. D. Abruna, and F.J. DiSalvo, *J. Am. Chem. Soc.*, 130, 5452 (2008).
2. G. Saravanan, H. Abe, Y. Xu, N. Sekido, H. Hirata, S. Matsumoto, H. Yoshikawa, and Y. Y.-Mitarai, *Langmuir*, 26, 11446 (2010).