

Synthesis of Intermetallic Nanoparticles as Co-catalyst on *Anatase* TiO₂ 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 TiO₂ support and intermetallic nanoparticles (NPs) as co-catalyst under room temperature.

2. Experimental

The synthesis of freestanding Pt₃Ti 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 TiO₂ supports were mixed in dry tetrahydrofuran followed by reduced using sodium naphthalide (1.5 mmole) to obtain TiO₂-supported Pt₃Ti NPs.

3. Results and Discussion

The *active interfaces* were introduced between Pt₃Ti NPs and TiO₂ supports (Fig. 1). The ordered TiO₂ supports most likely regulated the formation of ordered structures of Pt₃Ti under room temperature, where Pt₃Ti NPs can be formed solely as disordered structures on other supports (e.g., C, SiO₂, etc.). Fig. 2 shows the HX-PES profiles in the Pt 3*d* region for the reference bulk Pt, bulk Pt₃Ti and Pt₃Ti NPs and TiO₂-supported Pt₃Ti NPs. The bulk Pt₃Ti 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 3*d*_{5/2} peak for bulk Pt₃Ti was shifted to higher binding energy (+0.3 eV) than that of Pt. The Pt 3*d*_{5/2} peaks for the Pt₃Ti NPs were consistent with bulk Pt₃Ti, indicating that the chemical composition and atomic environment of the Pt₃Ti NPs were the same as those in bulk Pt₃Ti.

The details about photocatalytic activity of TiO₂-supported Pt₃Ti NPs would be discussed in the presentation.

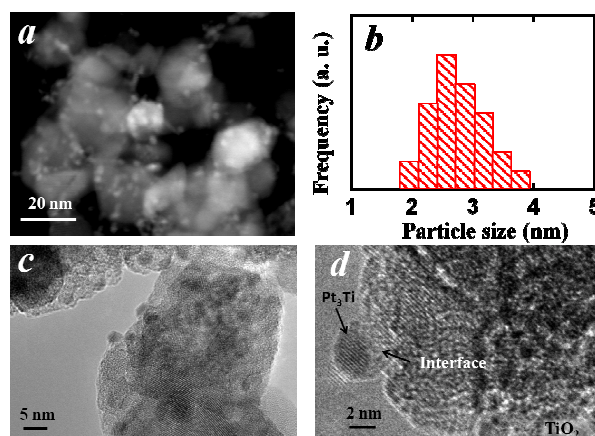


Fig. 1. TEM image of TiO₂-supported Pt₃Ti NPs (a). Histogram of the particle size distribution (b). HR-TEM images of synthesized TiO₂-supported Pt₃Ti ordered intermetallic NPs (c and d).

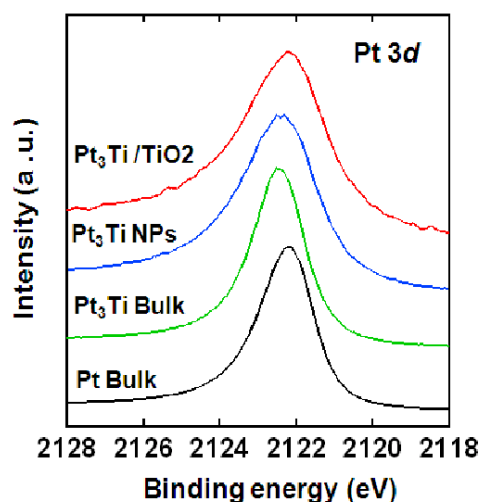


Fig. 2 HX-PES spectral profiles for Pt bulk, Pt₃Ti bulk, Pt₃Ti nanoparticles and TiO₂-supported Pt₃Ti nanoparticles in the regions of Pt 3*d*.

4. References

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- G. Saravanan, H. Abe, Y. Xu, N. Sekido, H. Hirata, S. Matsumoto, H. Yoshikawa, and Y. Y.-Mitarai, *Langmuir*, 26, 11446 (2010).