

Mechanism of Formation of Hierarchical-structured Bismuth-tungstate Hollow Particles through Hydrothermal Reaction

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The particle shape has attracted much attention as one of the significant factors influencing activity of metal oxides as photocatalysts. It has frequently been reported that polyhedral-shaped photocatalyst particles exposing specific crystal lattice planes and hierarchically structured photocatalysts as specific-shaped assemblies of fine crystallites show high photocatalytic activity. The former faceted particles might be produced to have the least surface energy (SE), but the latter particles, e.g., flake ball-shaped (FB) bismuth-tungstate (BWO) particles [1], seem to have high SE and thereby be produced through a different mechanism. The FB BWO particle was showed by FE-SEM images (Fig. 1) [2].

In this study, the mechanism of the formation of FB BWO particles was studied using the samples prepared by hydrothermal reactions under standard conditions (tungsten/bismuth ratio of 0.55 in feed; 433 K; 20 h) and the other modified conditions, and their structural characteristics were analyzed by powder X-ray diffraction (composition and crystal structure), field emission-type scanning electron microscopy (FE-SEM) (morphology), focused ion-beam etching followed by FE-SEM (inner void structure), ultrahigh-voltage transmission electron microscopy (inner void structure) and low-voltage scanning electron microscopy with energy-dispersive X-ray spectroscopic analysis (morphology and elemental distribution).

Based on the results, a novel two-step mechanism consisting of (1) formation of aqueous bismuth-oxyhydroxide droplets covered by tungstic acid (BOx@HWO) with fluidity and (2) reaction of inner bismuth and outer tungsten components at the BOx@HWO surface to yield BWO flakes is proposed as a one of the most plausible pathways that are consistent with the hollow structure of FB BWO and observations of the products prepared with shorter hydrothermal reaction (Fig. 2) [2].

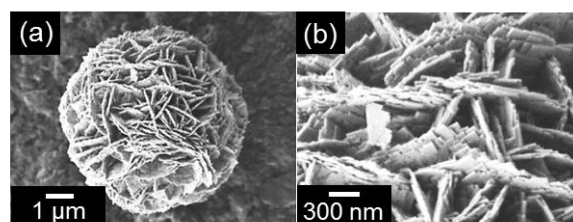


Fig. 1 FE-SEM images of FB BWO particles (W/Bi = 0.55) of different magnifications.

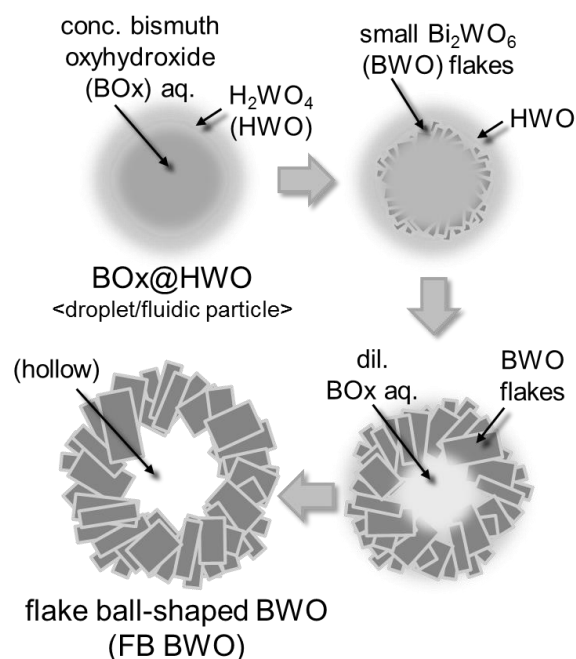


Fig. 2 Schematic representation of the mechanism of FB BWO-particle production.

REFERENCES

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