Supporting information

Influence of surfactants and solution temperature on tin oxide morphologies by a solution plasma technique

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1. Experimental details

The experimental setup consisted of two electrodes in a glass cell with a capacity of 300 ml. The cathode consisted of a Sn wire with a diameter of 1.0 mm and purity of 99.9 mass% (Nilaco, Tokyo, Japan) placed at the center of the glass cell. The upper part of the cathode was shielded by a quartz glass tube to obtain an exposed length of 10 mm. The exposed portion functioned as the actual electrode. The anode consisted of a Pt wire with a length of 1000 mm, diameter of 0.5 mm, and purity of 99.98 mass% (Nilaco, Tokyo, Japan); it was bent into a semi-circular mesh. The surface area of the anode was as much as 50 times larger than that of the cathode. The distance between the electrodes was maintained at 30 mm. A glow discharge plasma was generated around the cathode and was maintained by applying a voltage using a direct-current power supply (ZX800H, Takasago, Tokyo, Japan).

The products were collected by centrifugation and dried at 105 °C for 24 h. Subsequently, the particles were characterized by X-ray diffraction (XRD) using a Miniflex II (Rigaku, Tokyo, Japan) diffractometer. The products were observed by a JSM-7001F (JEOL, Tokyo, Japan) field emission scanning electron microscope (FE-SEM) and a JEM-2010F (JEOL, Tokyo, Japan) transmission electron microscope (TEM).

2. Plasma generation

To produce SnO crystals, a dilute 0.001 M K_2CO_3 solution was used as the electrolyte because a Sn wire dissolves readily in concentrated alkaline solutions. The electrode dissolved prior to plasma generation when the electrolyte concentration was high. Previously, the voltage was applied at a rate of 0.5 V/s until the plasma was formed. However, the Sn electrode melted before plasma generation because of resistance heating by the current. Therefore, in the current experiment, the solution was preheated to 80 ± 3 °C, and the voltage was increased immediately to 400 V. Without preheating of the electrolyte, glow discharge does not begin until the solution temperature becomes high enough to facilitate the formation of a gas layer. A voltage of 400 V was determined on the basis of the results of a preliminary experiment. This procedure prevents the melting of the electrode. Once the plasma layer surrounding the cathode was generated, the current was maintained at a low value.

3. Summary of experimental results

Table S1 Summary of experimental results.

Run	Maximum Temperature (°C)	Surfactants	Morphology	Main phase
1	95.0	No	Square plate	SnO
2	88.7	No	Square plate Colloidal particles	SnO $Sn_6O_4(OH)_4$
3	75.1	No	Colloidal particles	SnO $Sn_6O_4(OH)_4$
4	96.7	SDS	Square plate	SnO
5	97.4	PVA	Octahedron	$Sn_6O_4(OH)_4$
6	92.0	CTAB	Square plate Particle rod	SnO Sn
7	94.9	0.001 M K_2CO_3	Square plate	SnO

4. Effect of PVA on the $Sn_6O_4(OH)_4$ surface

Previous papers have reported that the hydroxyl groups in PVA form hydrogen bonds with other hydroxyl groups[14,24]. Similarly, we speculate that PVA attaches to the specific crystal plane of the $Sn_6O_4(OH)_4$ as a capping agent to form octahedrons. PVA probably prevented the dehydration of $Sn_6O_4(OH)_4$ owing to the fact that it formed a coating on the surface of $Sn_6O_4(OH)_4$.

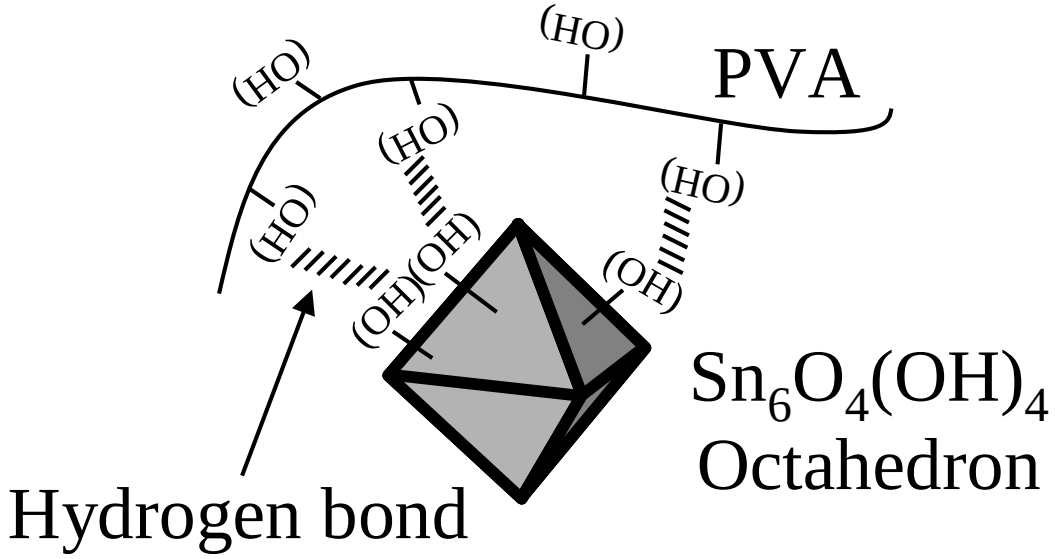

Fig. S1. Schematic diagram of the effect of PVA on the $Sn_6O_4(OH)_4$ surface .

5. Detailed observation of the products.

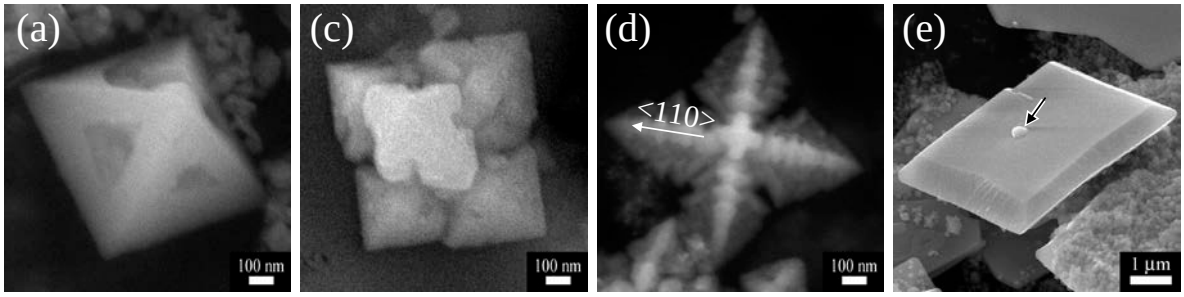

Fig. S3. SEM images of the product (obtained by Run 5) having different morphologies.

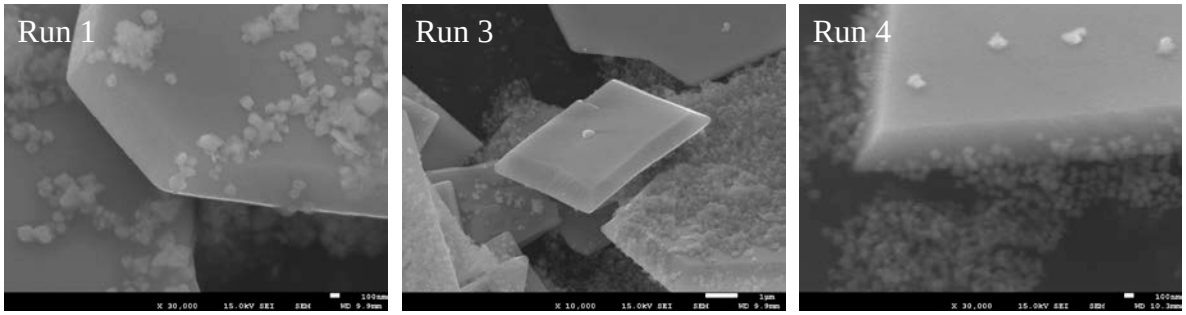

Fig. S4 The SEM images of the products edges.

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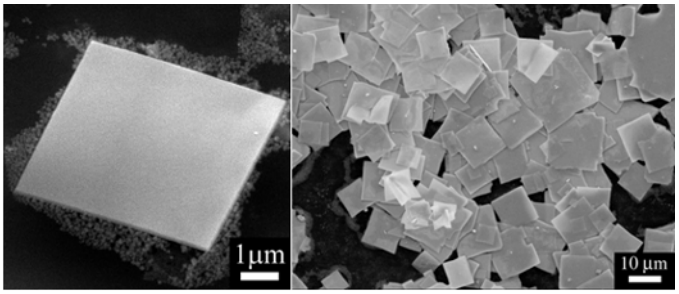

Single-crystalline tin oxide (SnO) plates were synthesized by a solution plasma technique. These plates were single-crystalline tetragonal SnO, where the faces of the plate were on the (001) plane.