Preparation and Characterization of In_2O_3 and SnO_2 nanosrtuctures

外国人研究員 E.M. El-Maghraby

We have synthesized In_2O_3 nanostructures grown at three different growth temperatures; 700, 800 and 900 °C for 1 h reaction time by using the thermal evaporation method. Samples have been prepared inside a quartz tube in which Ar was introduced. Source material (In metal) and substrates were located within an alumina boat placed in the central part of the quartz tube, which was inserted into a tubular furnace.

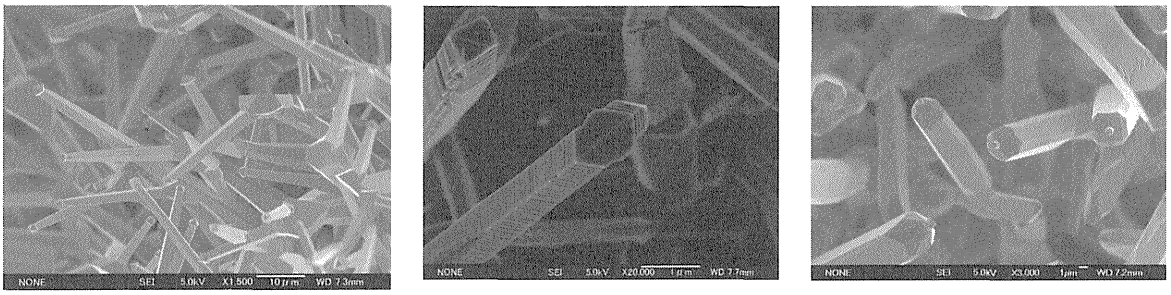
We used argon gas of 100 sccm as carrier gas in our furnace system. Before heating, Ar gas was introduced in the tube for 20 min at a flow rate of 100 sccm.
For characterization of as-grown samples, we used field-emission scanning electron microscopy (FE-SEM, JEOL JSM 6700F) and transmission electron microscopy (TEM, JEOL JEM 2010F) to investigate the morphology and microstructure. The compositions were analyzed using energy dispersive spectrometry (EDS) attached to the TEM. Selected area electron diffraction (SAED) confirmed the crystal orientation of In_2O_3 nanocrystals. The analysis of crystallographic structure was performed by the XRD measurement with CuKα radiation using a diffractometer (Shimadzu XRD 6100).

The amount of nanostructure was found to be dependent on the growth temperatures and position of the substrate. Glancing at the FE-SEM image of the samples deposited at 700 °C in the center of the furnace, we find morphology resembling nanowires (See Fig. (a) below). At a higher magnification, we saw a beautiful capped like-monuments nanostructure. On a substrate 2mm from the center, aggregation of the source was precipitated, and on a substrate 4mm far from the center of the furnace we observed no materials. This work is now under publication. In an FE-SEM image of the samples deposited at 800 °C on a substrate at the center of the furnace, a nanotower structure was observed (Fig. (b)). A higher FE-SEM showed a variety of nano-tower shapes. FE-SEM image of the samples deposited at 900 °C in the center of the furnace clearly showed densely deposited nano-pencils with high crystallinity (Fig. (c)). The nano-pencils are well-facetted, and the edges and corners are distinguished.

Also large-scale synthesis of In_2O_3 nanoparticles, nanowires and nanorods were realized by improved chemical vapor deposition method on Au-coated silicon substrate. Field emission scanning electron microscopy revealed that the flow of carrier argon gas has profound effect on the shape and morphology of In_2O_3 nanostructures. Detailed structural analysis showed that the In_2O_3 nanostructures are single crystalline with a cubic crystal structure. Room temperature PL spectrum showed broad and intense blue emission at 375 nm. The In_2O_3 nanowires sensor can successfully detect hydrogen gas

with response time as low short as 50 s at 250°C. This work was accepted for publication.

Also, we grew tin oxide (SnO_2) nanostructures at 900 °C for 1 h on SiO_2 substrates with Au coating and without Au coating. During growth, Ar gas was introduced at a flow rate of 100 sccm in the quartz tube inserted into the furnace. After the furnace was cooled down naturally to room temperature, the Ar gas was turned off. White wool-like products were observed around the Sn grains as a raw material. The gas sensing property of this material will be investigated soon.



(a) (b) (c)

FE-SEM images (a), (b), and (c) are for In_2O_3 nanostructures deposited on a substrate placed at the center of the heating furnace at temperatures of 700, 800, and 900 °C, respectively.

Publications

A Generic Approach for Controlled Synthesis of In_2O_3 Nanostructures for Gas Sensing Applications

Ahsanulhaq Qurashi, E. M. El-Maghraby, Toshinari Yamazaki, Yanbai Shen, Toshio Kikuta

Journal of Alloys and Compounds, accepted for publication.

Catalyst-Free Shape Controlled Synthesis of In_2O_3 Pyramids and Octahedron: Structural Properties and Growth Mechanism

Ahsanulhaq Qurashi, E. M. El-Maghraby, Toshinari Yamazaki, Toshio Kikuta

Journal of Alloys and Compounds, accepted for publication.