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Morphology Control of ZnO Nanostructures via tuning Source Material

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Extended Abstract

Zinc Oxide (ZnO) is one of the most interesting materials due to a wide band gap of 3.37 eV and a large exciton binding energy of 60 meV at room temperature (RT). This makes it a promising material for applications in electronic and optoelectronic devices such as ultraviolet (UV) light emitting devices, transparent conducting electrodes, gas sensor and solar cells. Particularly, an excitonic laser emission has been observed under low lasing threshold even at RT, which is ascribed to the strong exciton binding energy of 60 meV larger than thermal energy at RT. Recently, room temperature UV laser emission from ZnO nanowires was detected. This spurred extensive interest in studies on the fabrication of ZnO nanostructures. In the recent years, ZnO nanostructures have been synthesized by various methods such as thermal evaporation, magnetron sputtering, laser ablation, chemical vapor deposition and solution process. Among them, thermal evaporation technique is very simple and low cost. Thus, it is widely used to synthesize nanostructures.

In this presentation, we report a simple method capable of controlling the morphology of ZnO nanostructures via thermal evaporation of different source materials. Various source materials were used for the synthesis of ZnO nanostructures. The source material was put in an alumina crucible and inserted into an oxidation furnace. Then the furnace was heated to oxidation temperature and the source material in the alumina crucible was oxidized in air. The furnace was turned off and cooled down after the oxidation process.

The as-synthesized ZnO products were composed of ZnO nanostructures. The morphology of ZnO nanostructures was significantly dependent on the source materials. Brush- and tetrapod-shaped ZnO nanostructures were synthesized by using mixtures of Al-Zn with different weight ratios of Al/Zn under air atmosphere. The hexagonal nanowires grew at the six corners of hexagonal micro-rod, which made the brush shape. The tetrapod shape was composed of four legs extending from the center. The leg had conical shape to decrease in diameter with growing from the center to edge. Bottle-shaped ZnO nanostructures were synthesized when Al-Zn-Au mixture was used as the source material. The bottle shape consisted of two parts. One was a hexagonal micro-rod base stem and the other was a hexagonal bottleneck. The bottle shaped ZnO nanocrystals had well defined hexagonal facets. ZnO nanostructures with tubular shape were also obtained by controlling the weight ratio of Al/Zn/Au in Al-Zn-Au mixture. The tubular shape had well defined hexagonal facets, which indicated that the tubular ZnO crystals were grown along the c-axis direction. One end of the tubular structure was open and the other end was closed. Comb-like ZnO nanostructures were obtained after the oxidation of Al-Zn-C mixture. The comb shape consisted of a belt-like stem and teeth. The teeth were formed on one side of the stem. Besides, a variety of ZnO nanostructure including octahedron shape and bat shape were synthesized with various different source materials.