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Study on Growth Control of Zno Nanowires

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Abstract

With the changes and sustainable development of the times, human beings have now entered the new development stage of the Internet, and new semiconductor nano materials have been applied in many emerging fields. ZnO is a typical wide band gap semiconductor material. Due to its unique electrical, optical and piezoelectric properties, it has been developed rapidly in recent years.

Keywords

ZnO materials; Growth position; Diameter control; Morphology control.

1. Introduction

ZnO is an important class II – VI direct band gap compound semiconductor. Its band gap is 3.37 EV at room temperature, and its exciton binding energy is as high as 60 MeV. It has strong free exciton transition luminescence in the ultraviolet band. These intrinsic advantages make it have great potential in the application of ultraviolet electron. In recent years, the research on one-dimensional ZnO structures (nanorods, nanowires, nanotubes, etc.) is very active, because it can be inferred theoretically that their electronic density of states distribution is more concentrated, the exciton binding energy is larger, and the exciton resonance is stronger, which leads to their absorption, luminescence and other optical transition spectra narrower, and the interaction between light and matter is more effective, This means that ZnO with one-dimensional structure may show better performance in ultraviolet laser, photoluminescence, field emission, sensors, solar cells and other fields. In the research of these fields, the controllable preparation of ZnO one-dimensional nanostructures and the corresponding characteristics are very important, which is the fundamental guarantee to realize the characteristics of various devices [1].

2. Control of Nanowire Growth Orientation

ZnO nanowires tend to grow along < 001 > crystallographic group, and vertical array nanowires can be prepared by controlling reaction conditions and selecting different substrates. For example, ZnO nanowires can be grown vertically on the (110) crystal surface of sapphire (alumina); When the (111) surface of MgO is used as substrate, ZnO nanowires can also grow vertically [2].

3. Control of Growth Position of Nanowires

In the gas liquid solid (VLS) method, the growth position of nanowires can be controlled by adjusting the position of the initial Au clusters. Lithography technologies, such as soft printing, electron beam printing and optical printing, can be used to fabricate initial Au templates, which can determine the growth position of subsequent semiconductor nanowires. Long and flexible ZnO nanowires can be grown on the edge of hexagonal Au pattern. The diameter of the ZnO

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nanowires is 50-200 nm and the length is more than 50 nm μ m. ZnO nanowires can be grown on the Au pattern of the wire frame structure (the Au pattern is located in the a plane of sapphire) only in the area covered by Au. We can also control the growth density of the nanowire growth region by controlling the thickness of the film and using the solution method to prepare Au nanoclusters. In this paper, we can control the area density of ZnO nanowire arrays in the range of 106-1010 / cm2.

4. Nanowire Diameter Control

The diameter of ZnO nanowires can be controlled by controlling the thickness of Au thin layer, and the diameter of the final grown nanowires is related to the size of solvent particles. Smaller Au nanoclusters tend to grow finer nanowires. When the thickness of Au thin layer decreases, the diameter of nanowires will also decrease. ZnO nanowires with diameters of 88110150nm can be grown on sapphire with thickness of 0.5nm, 1 nm and 3nm, respectively. In addition, the diameter of nanowires can be controlled by using Au droplets with uniform size distribution as solvent. For example, when the Au droplet size is 5, 10 and 15 nm, the ZnO nanowires are 5, 10 and 15 nm, respectively [5].

5. Control of Nanowire Morphology

Nanowires with certain superlattice structures can be prepared by controlling different vapor sources. For example, when Zn powder is used as vapor source, comb shaped ZnO nanowires can be obtained in high yield. The nanowires have uniform diameter and are evenly distributed on both sides of the backbone. Under different evaporation conditions, other superlattice structures can be prepared, such as four needle like and tapered nanowires.

6. Prospect of ZnO Nanowires

Feyneman, the Nobel laureate, predicted in the 1960s that if we control the arrangement of objects on a small scale, we can make objects obtain a lot of unusual characteristics, and we will see rich changes in the properties of materials. What he said is nanomaterials.

In nano materials, the interface atoms account for a large proportion, and the arrangement of atoms is different from each other, and the lattice structures around the interface are not related to each other, thus forming a new structural state different from the crystalline and amorphous states. Nanocrystalline and high concentration grain boundary are two important characteristics of nano materials. The arrangement of atoms in nanocrystals can not be treated as an infinite range order. Generally, the continuous energy band of large crystals splits into energy levels close to molecular orbitals. The high concentration of grain boundaries and the special structure of grain boundary atoms lead to the changes of mechanical properties, magnetism, conductivity, superconductivity, optics and even thermodynamic properties of materials.

At present, human beings have entered the information age. With the improvement of device miniaturization and the increase of information storage capacity, the materials with high dielectric constant and low dielectric loss have attracted more and more attention. Nowadays, scientists have found many high dielectric constant and low dielectric loss dielectric materials. However, most of them are prepared by solid-state method, with large particle size and uneven distribution. If prepared by other methods, such as coprecipitation, gel sol, etc., the prepared materials can reach nano size particles with uniform distribution and smaller size. In particular, the dielectric materials with nanometer size may have better properties and some unique properties.

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The 21st century will be the era of nanotechnology, involving various fields. It has a wide application prospect in the fields of mechanical, electronic, optical, magnetic, chemical and biological. The birth of nanotechnology will have a profound impact on human society, and it is possible to fundamentally solve many problems facing human beings, especially the major problems of energy, human health and environmental protection, Nanomaterials will become a brilliant star in the field of materials science.

References

[1] Zhang Qifeng, Dandeneau C S, Zhou Xiaoyuan, ZnO nanostructures for dye-sensitized solar cells [J]. Adv Mater, 2009, 21(41): 4087-4187.

[2] Zhu Kai, Kopidakis N, Neale N R. Influence of surface area on charge transport and recombination in dye-sensitized TiO2 solar cells [J]. Phys Chem: B, 2006, 110(50): 25174-25180.

[3] Yang Zhenzhen, Xu Tao. Enhanced electron transport in dye-sensitized solar cells using short ZnO nanotips on a rough metal anode [J]. Phy Chem: C, 2009, 113(47): 20521-20526.