Effect of process parameters on the morphologies and properties of non-catalytically growth ZnO Nanostructures

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Abstract:

Among the wide range of semiconducting nanomaterials, the nanostructures of II-VI semiconductor ZnO acquired a special place because of its diversity in properties, such as direct wide band gap (3.37 eV), large saturation velocity (3.2 x 10^7 cm/s), high breakdown voltage and large exciton binding energy (60 meV) at room temperature. Due to these properties of ZnO, it provides itself as an opportunity to recognize as one of the effective material for the fabrication of efficient nanodevices and nanosystems. It is also an attractive material for ultraviolet optoelectronic devices, laser operating at room temperature and efficiently serves for the fabrication of mechanical devices, sensors, field emitters etc. As the versatility in different applicable areas, the ZnO nanomaterials are the subject of extensive research now days. Various kinds of ZnO nanostructures fabricated by different fabrication techniques have been reported in the literature till date.

In this paper, it is researched that the nanostructures of ZnO are quite dependent on kind of substrate and growth technique as well as the process variables such as temperature, concentrations of oxygen and zinc, pretreatment, and growth time. It was observed from the detailed morphological and structural studies that substrate temperature, distances between source material and substrates, concentration of zinc vapors, zinc partial pressure, concentrations of reactant gases, and choices of substrates have serious impact on the morphologies and structural properties of as-grown products. Therefore, within certain reaction parameters, specific morphologies can be obtained. In addition to this, the morphological evolution in the ZnO nanostructures, were also observed by hydrogen pretreatment step on silicon substrates by the thermal evaporation.

The as-grown ZnO nanostructures were characterized in terms of their structural and optical properties. The structural and optical properties of ZnO nanostructures were examined using XRD, TEM, selected area electron diffraction (SAED), Raman, and photoluminescence (PL). The detailed structural observations confirmed that the as-grown products are single-crystalline with the wurtzite hexagonal phase and grown along the [0001] directions. Raman-scattering and room-temperature photoluminescence (PL) studies revealed that the as-grown products have good crystallinity with good optical properties