ABSTRACT

The growth mechanism, morphology, structure and optical properties of the ZnO nanostructures grown on bare and gold-coated silicon substrates using carbothermal reaction at atmospheric pressure were investigated under different growth conditions. The ZnO nanostructures formed were studied as a function of substrate location, furnace temperature, Ar gas flow rate, deposition time and ZnO powder to carbon powder mass ratio. The morphology and structure of the samples were characterized using the field-emission scanning electron microscopy (FESEM), energy dispersive x-ray spectroscopy (EDX) spectrum, x-ray diffraction (XRD) and high resolution transmission electron microscopy (HRTEM). It was found that in both silicon and gold-coated silicon substrates, the morphology of the ZnO nanostructures was strongly dependent on the location of the substrate from the Zn source and to the furnace temperature. On the other hand, deposition time, gas flow rate and the different ratios of reactant materials played an important role in changing the size of ZnO nanostructures. The density of the ZnO nanostructures grown with Au catalyst was much higher than that of ZnO nanostructures without catalyst. XRD result shows that the ZnO nanostructures grown without catalyst have a better preferential orientation along the [002] orientation than that grown with gold catalyst. The ZnO nanostructures grown with and without Au catalyst can be attributed to the vapor-liquid-solid (VLS) model and self-catalytic (VLS) processes, respectively.

PL spectrum of ZnO nanostructures grown with Au catalyst exhibited a strong defect-related deep-level emission. It demonstrated that the ZnO nanostructures grown with Au catalyst were more defective that grown on bare silicon substrate. It has been found that there is a strong relationship between the furnace temperature and the emission peak. PL study shows that the green emission band peak, which is mainly due to defects in ZnO, can be lowered by increasing the furnace temperature and the best temperature for the removing defects in ZnO nanostructures was found to be 1200°C. Moreover, the post annealed of grown sample at the air atmosphere was also found to reduce the green emission, hence low growth defects. ZnO nanostructures doped with phosphorus have been successfully synthesized. It was found that P incorporation has caused more defects in the ZnO nanostructures, which was confirmed by XRD and PL analysis. While, FESEM results showed that the doping process caused structural change in the ZnO shape from nanowires to nanoballs.

To

My Father's Soul

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