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Study of Electro-Chemical Properties of ZnO Nanowires for Various Application

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Abstract : The development in the field of piezoelectrics has led to a renewed interest in ZnO nanowires (NWs) as a promising material in the nanogenerator devices category. It can be used as a power source for self-powered electronic systems with higher density, higher efficiency, longer lifetime, as well as lower cost of fabrication. Highly aligned ZnO nanowires seem to exhibit a higher performance compared with nonaligned ones. The purpose of this study was to develop ZnO nanowires and to investigate their electrical and chemical properties for various applications. They were grown on silicon (100) and glass substrates. We have used a low temperature and non-hazardous method: aqueous chemical growth (ACG). ZnO (non-doped) and AZO (Aluminum doped) seed layers were deposited using RF magnetron sputteringunder Argon pressure of 3 mTorr and deposition power of 180 W, the times of growth were selected to obtain thicknesses in the range of 30 to 125 nm. Some of the films were subsequently annealed. The substrates were immersed tilted in an equimolar solution composed of zinc nitrate and hexamine (HMTA) of 0.02 M and 0.05 M in the temperature range of 80 to 90 °C for 1.5 to 2 hours. The X-ray diffractometer shows strong peaks at 2Θ = 34.2° of ZnO films which indicates that the films have a preferred c-axis wurtzite hexagonal (002) orientation. The surface morphology of the films is investigated by atomic force microscope (AFM) which proved the uniformity of the film since the roughness is within 5 nm range. The scanning electron microscopes(SEM) (Quanta FEG 250, Quanta 3D FEG, Nova NanoSEM 650) are used to characterize both ZnO film and NWs. SEM images show forest of ZnO NWs grown vertically and have a range of length up to 2000 nm and diameter of 20-300 nm. The SEM images prove that the role of the seed layer is to enhance the vertical alignment of ZnO NWs at the pH solution of 5-6. Also electrical and optical properties of the NWs are carried out using Electrical Force Microscopy (EFM). After growing the ZnO NWs, developing the nano-generator is the second step of this study in order to determine the energy conversion efficiency and the power output.

Keywords : ZnO nanowires(NWs), aqueous chemical growth (ACG), piezoelectric NWs, harvesting enery
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