Co-Effect of pH Control Agent and pH Value on the Physical Properties of ZnO Thin Films Obtained by Chemical Bath Deposition for Dye-Sensitized Solar Cells Applications

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Abstract

This study presents the co-influence of pH control agent and pH value on the physical properties of ZnO thin films obtained by chemical bath deposition. ZnO thin films were deposited on glass substrates using precursor solutions of different pH prepared from two bases: sodium hydroxide (NaOH) and ammonia NH_3. The effect of pH control agent and pH values on the morphological, structural, and optical properties of ZnO thin films was investigated using X-ray diffraction (XRD), scanning electron microscopy (SEM), Fourier transform infrared spectroscopy (FTIR), and UV-Visible spectroscopy. XRD results show that all the ZnO thin films elaborated are polycrystalline and crystallize in a hexagonal wurtzite structure. The crystallites size, calculated using the Debye-Scherrer formula, varied from 10.50 nm to 11.69 nm for ZnO thin films obtained with NH_3 and from 20.79 nm to 27.76 nm for those obtained with NaOH. FTIR analysis confirms the presence of functional groups. SEM images indicate that not only the base affects the films surface morphology but the pH also influences the films morphology through the grains shape. However, the ZnO thin films obtained with NaOH look more mesoporous compared to those obtained with NH_3. Optical characterization results show that whatever the base used, the pH of the precursor solution affects the ZnO thin films transmittance. Films elaborated with NH_3 exhibit the best transmittance (80%) at pH 8.5, while for films elaborated with NaOH, the best transmittance (81%) is obtained at pH 8 in the visible region. Based on structural and morphological properties, ZnO films obtained from NH_3 at pH 8.5 are found to be more suitable for DSSC applications.

Keywords

Zinc Oxide, Thin Film, Physical Properties, pH Control Agent, Chemical Bath Deposition, Dye-Sensitized Solar Cells