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Improved electrical, optical, and structural properties of undoped ZnO thin films grown by water-mist-assisted spray pyrolysis

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Undoped ZnO thin films were prepared using the ultrasonic spray pyrolysis deposition technique with zinc acetylacetonate dissolved in N,N-dimethylformamide as the source materials solution. The addition of water mist in a parallel flux to the spray solution stream was also used during deposition of the films. The addition of water mist improved the electrical characteristics of the ZnO films. Fresh ZnO samples were then thermally annealed in a H_2 reducing atmosphere. X-ray diffraction patterns show mainly the wurzite crystalline ZnO phase in the films. An electrical resistivity (ρ) of around 2.7×10^{-2} Ω cm was measured at room temperature for the best undoped ZnO film. ρ is approximately one order of magnitude lower than the resistivities found in undoped ZnO films obtained by means of similar non-vacuum deposition techniques.

1 Introduction

Zinc oxide (ZnO) is a non-toxic material with excellent physical and chemical properties. ZnO finds applications as an active semiconductor in optoelectronic devices because of its wide band gap and high mobility [1, 2], and in solar-cell manufacturing as a transparent electrode, as well as an anti-reflecting coating [3, 4]. ZnO is also used as a sensitive layer in gas-sensor devices [5]. For example, excellent ZnO sensors have been developed by Martins et al. [6]. ZnO has been fabricated with different deposition techniques, involving vacuum or non-vacuum deposition methods. Highly transparent undoped ZnO films with a resistivity (ρ) in the vicinity of 10^{-4} Ω cm have been prepared by means of physical vacuum-dependent deposition methods, such as magnetron sputtering [7] and molecular beam epitaxy [8]. The Metal Organic Chemical Vapor Deposition (MOCVD) technique has been used to obtain undoped ZnO films with resistivities around 1.2×10^{-3} Ω cm using diethylzinc ($Zn(C_2H_5)_2$) and H_2O as source gases [9]. However, alkylmetal compounds such as diethylzinc and dimethylzinc are both difficult to handle and supply because of the expensive MOCVD zinc sources. The use of metallic complex salts such as

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