Chapter

Roles of Cobalt Doping on Structural and Optical of ZnO Thin Films by Ultrasonic Spray Pyrolysis

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Abstract

Here we report a systematic study of structural, optical, and magnetic measurements of $Zn_{1-x}Co_xO$ (x = 0–0.22 at.%) by Ultrasound pyrolysis spray technique. The hexagonal wurtzite structure of our films is confirmed by X-ray diffraction with an average crystallite size estimated in the range of 18–30 nm. For the optical propries, using the Levenberg–Marquardt least squares rule, the experimental transmission measurements were perfectly adapted to the transmission data calculated by a combination of the Wemple-DiDomenico model, the absorption coefficient of an electronic transition and the Tauc-Urbach model. The concentration of the NCo absorption centers and the oscillator intensity f of the d-d transition of Co2+ ions are determined by the Smakula method. The presence of high concentrations of localized states in the thin films is responsible for the reduction in the width of optical bandgap.

Keywords: thin films, X-ray diffraction, optical properties

1. Introduction

Zinc oxide is a transparent direct gap and wide band gap semiconductor (3.37 eV) with a fairly high excitonic binding energy of 60 meV at room temperature, it is attracting more and more attention from researchers because of its wide range applications, in particular in the field of spintronics [1–4]. Zinc oxide is a transparent material with a transmission value of 0.9 in the visible, crystallizes in a wurtzite-like structure defined by a hexagonal lattice where zinc ions occupy the centers of the tetrahedral sites and oxygen ions occupy the vertices.

The improvement of the properties of thin ZnO layers is commonly achieved through doping. Among the different dopants, cobalt (Co) thanks to the similarity between the ionic rays (r_{Co2+} = 0.058 nm) and (r_{Zn2+} = 0.060 nm). In order to obtain what is called Diluted Magnetic Semi-conductor (DMS), these DMS play an important role as they allow the integration of certain components of spintronics and optoelectronics [5–10].

Different technological processes can be used to deposit cobalt-doped ZnO in thin films [11–14]. The doping of ZnO with transition metal ions such as Co (substitution of Zn + 2 ions by Co + 2 ions) induces magnetic properties due to its