The Nucleus, **46** (1-2) 2009: 37-42

The Nucleus
A Quarterly Scientific Journal of Pakistan Atomic Energy Commission
NCLEAM, ISSN 0029-5698

SYNTHESIS AND CHARACTERIZATION OF $Zn_{1-x-y}Cd_xLi_yO_\delta$ SOLID SOLUTION

M. KAMRUZZAMAN[1], M. K. R. KHAN[2], M. M. RAHMAN[2], *M. A. S. KARAL[1]

M. SHAHJAHAN[2] and M. G. M. CHOWDHURY[2]

[1]Department of Physics, Bangladesh University of Engineering and Technology, Dhaka-1000, Bangladesh

[2]Department of Physics, University of Rajshahi, Rajshahi-6205, Bangladesh

(Received November 26, 2008 and accepted in revised form February 24, 2009)

$Zn_{1-x-y}Cd_xLi_yO_\delta$ (x=0.30; y=0.05, 0.10, 0.15, 0.20 and δ= 0.975, 0.95, 0.925, 0.90) samples have been prepared by conventional solid state reaction method and studied their electrical, magnetic and structural properties. The dc electrical resistivity measurement shows that all samples are highly resistive (~10^6 ohm-cm) upto a transition temperature (T_t), above which resistivity falls drastically that reveals the samples are semiconducting in nature and T_t decreases with increase of Li. The activation energies vary from (0.74-0.51) eV depending on doping concentrations, i.e. the activation energy is lower for higher concentration of Li in the solution. Magnetic mass susceptibility measurement shows negative sign that indicate the samples are diamagnetic. From XRD analysis, there exist two phases one is hexagonal ZnO and another is cubic CdO which suggests the formation of superlattice structure of the system. Crystallite size at planes (100), (002), (101), (102), (110), (103), (200), (112) and (111), (200), (220) for ZnO and CdO ranges from 20 to 50 nm and for Li ranges from 27 to 40 nm.

Keywords: Zinc oxide, Lithium, Solid solution, DC resistivity, Mass susceptibility, XRD

1. Introduction

Zinc oxide (ZnO) is one of the most promising materials due to its unique combination of attractive properties like non-toxicity, good electrical, optical such as light emitting diode (LED), laser diode (LD) in ultra-violet or blue spectral and piezoelectric behavior with its low cost [1-4]. The excellent optical properties of ZnO make it suitable for use in surface acoustic wave devices [5], electrodes in solar cells [6], flat panel displays [7] and for energy conversion and storage [8]. To achieve applicable ZnO based opto-electronic devices, there have been considerable experimental investigations focused on the preparation of p-type ZnO sample and its band gap engineering by impurity doping and various alloying methods [9-10].

On the other hand, cadmium oxide (CdO) is important due to its applications, specifically in the field of optoelectronic devices such as solar cells [11-12], photo transistors [13] and diodes [14], transparent electrodes [15], gas sensors [16], etc. These applications of CdO are based on its specific optical and electrical properties. For example, CdO films show a high transparency in the visible region of the solar spectrum, as well as a high ohmic conductivity. The intensity of optical and electrical effects of CdO depends on the deviations from the ideal CdO stoichiometric, as well as on the size and shape of the particles [17].

ZnO is a hexagonal wurtzite-type structure and an exitonic binding energy of ~60meV much larger than ~25 meV of CdO, which permits the efficient exitonic stimulated ultra-violet emission even at room temperature [18-19]. So, both ZnO and CdO have high transparency in the visible and near infrared region and both show n-type conductivity.

CdO has direct band gap of 2.2-2.7 eV [20] and indirect band gap of 1.36 eV [21]. So CdO presents the advantage of a low resistivity with respect to the high values obtained for ZnO, but this exhibits a higher transparency, having a room temperature band gap ~3.2 eV [22]. Obviously, it is

* Corresponding author : asayem221@yahoo.com