Topic : Material science

Atmosphere influence on structural, optical and electrical properties of scandium doped zinc oxide films by sol-gel route

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Abstract

Highly transparent and conductive Scandium doped ZnO;Sc (SZO) films have been prepared by chemical route on corning glass 7059 substrates by sol-gel technique at room temperature in two different atmospheres(air and nitrogen). These films are characterized by using X-ray diffraction, scanning electron microscopy, atomic force microscopy, chemical analysis, optical transmittance. Electrical resistivity and Hall coefficient are determined at room temperature by Van-der Pauw technique. As deposited SZO films are found to be highly textured, with the c axis of the wurtzite structure along the growth direction. It was observed that the c-axis orientation improves and the grain size increases with increase in annealing temperature.

FWHM of x-ray 2θ scan of 0.5% SZO films annealed at 400°C in air was found to be lowest. RHEED pattern reveals the polycrystalline nature of films. Detailed atomic scale characterization rules out the improvements of crystalline and surface nature of SZO thin films as a function of scandium concentration. Optical measurements and x-ray photoelectron spectroscopy confirm the direct substitution of dopant atoms into Zn lattice sites. The free electrons in the doped samples modify the optical properties of SZO films. In the visible region the films are highly transparent, (average transmittance lies between 80-93%) and their spectra are those of dielectrics. The films deposited in air atmosphere show minimum transmittance whereas the films deposited in nitrogen atmosphere show maximum transmittance, enhances the transmittance by 3-5% and prevents the coloration of the films. However, the increase in Scandium concentration deteriorates the transmittance for the films. Hence the concentration of scandium is optimized.

The band gap of the SZO films was found to be more than that of undoped ZnO. The band gap of the SZO films can be tailored in the range of 3.32 to 3.87 eV by changing the dopant concentration in the two atmospheres. The increase in the band gap can be explained by Burstein and Moss effect; however, the measured values of the band gap were less than that predicted by this effect. The difference in the measured and the calculated values can be explained, by the

narrowing of the band gap due to many body interactions. The SZO films deposited by sol gel doped with 0.5 wt % of Scandium, at 400 ^{o}C, in nitrogen is of good quality from the point of view of electrical resistivity and optical transparency. The electrical resistivity of the films decreases by doping with scandium.

REFERENCES;

1.A. V. Singh , R. M. Mehra, A. Yoshida and A. Wakahara, J. Appl. Phys., 91 (2001)5661

2. P. Drude, Z. Phys.1 (1900) 161.

3. E. Burstein, Phys. Rev., 93 (1954) 632.

4.M. Kumar, R.M. Mehra, A. Wakahara, M. Ishida, A. Yoshida, J. Appl.Phys., 93 (2003) 3837

5. Ruchika Sharma, P. K. Shishodia, Akihiro Wakahara and R. M. Mehra,

Material Science- Poland, 27 (2009) 225-237 ISSN 0137-1339

6. Ruchika Sharma, Kiran Sehrawat, Akihiro Wakahara and R. M. Mehra,

Applied surface science 255 (2009) 5781-5788 ISSN 0169-4332

7. Ruchika Sharma, Kiran Sehrawat and R. M. Mehra Current Applied Physics 10 (2010)

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