Variations in optical Constants in Ca doped ZnO thin films

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Abstract Undoped and Ca doped ZnO polycrystalline films having hexagonal wurtzite structure are deposited using sol-gel spin coating method. Dopant concentration is varied from 5% to 15%. All the films show sharp absorption near 300 nm. Absorbance, n and k are calculated. n and k both decrease with increase in dopant concentration. SEM of the samples has also been performed.

The films of undoped and doped zinc oxide (ZnO) are deposited by sol-gel spin coating method on BK7 glass properly cleaned in an ultrasonic cleaner using methanol, acetone and deionized water. The precursor for undoped ZnO films consists of zinc acetate dihydrate, isopropanol and diethanol amine. For obtaining 5%, 10% and 15% calcium (Ca) doped ZnO films appropriate volumes of solution of calcium nitrate tetrahydrate in ethanol is added in the solution made for undoped ZnO. After ageing the precursor for 30 days, spin coating is done and films are dried at 500^0C for 5 minutes. Coating and drying are repeated 10 times to achieve appreciable film thickness. Finally, the films are annealed at 500^0C for 2 hours. Thus four films: undoped ZnO, ZnO:5at.%Ca, ZnO:10at.% and ZnO:15at.% are obtained.

X-ray diffraction (XRD) spectra of the films reveal their polycrystalline nature with hexagonal wurtzite structure.

Transmission spectra of the films show that the films are highly transparent in the visible and IR region with sharp cut-off near 300 nm. Absorbance of films calculated from transmission data is shown in figure1. Absorbance is maximum in the UV region, falls sharply and then becomes almost constant.

Variations in the refractive indices (n) and extinction coefficients (k) with wavelength for all the films are shown in figure 2. The refractive indices of the films are found to decrease with increasing dopant concentration in the range 430 to 500 nm. The extinction coefficients decrease as the dopant amount increases throughout the visible region. Similar behavior if n and k are reported in the case of ZnO single crystals by Srikant et al [1].

Scanning electron micrographs (SEM) of ZnO and ZnO:15at%Ca are shown in figure 3. Small bead-like structures are seen in the undoped ZnO films. For doped films groups of fibrous structure appear as can be seen from figure 3b.

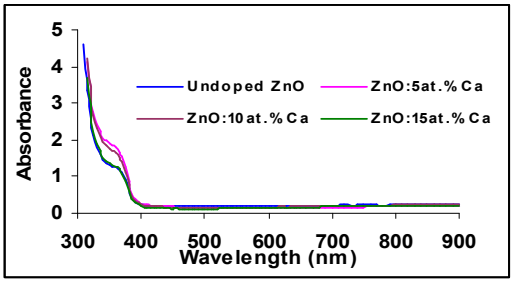

Figure 1: Absorbance spectra of the ZnO films.

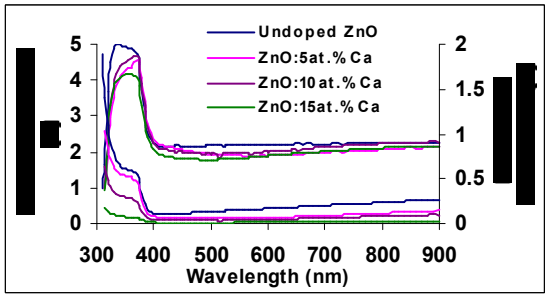

Figure 2: Variations in refractive indices and extinction coefficients in ZnO films.

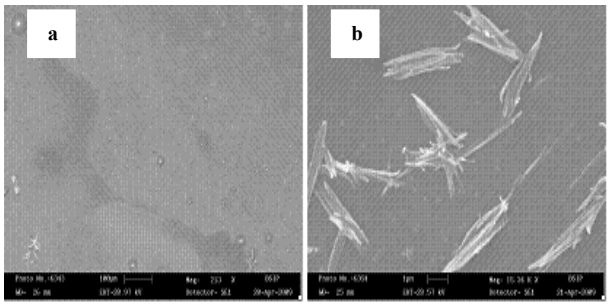

Figure 3: SEM of ZnO films a) undoped ZnO; b) ZnO:15at%Ca.

[1] V. Srikant and D. R. Clark, J. Appl. Phys. **83**(10) (1998) 5447.