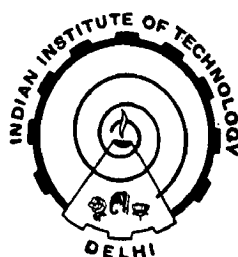


ZnO BASED NONLINEAR CERSEMS

by

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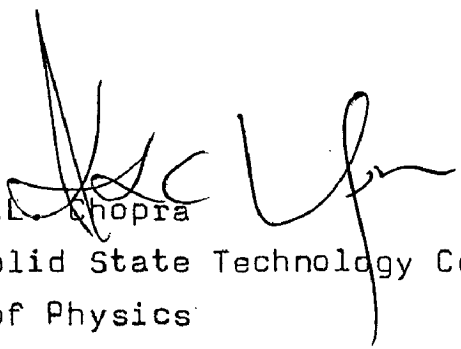
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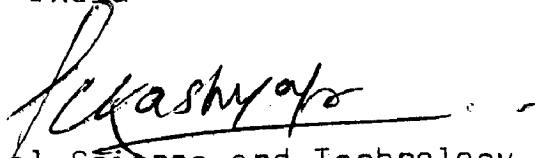
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ABSTRACT

Microstructural, compositional, electrical, electronic and dielectric properties of ZnO based ceramic semiconductors (cersems) have been investigated by employing various techniques such as scanning electron microscopy, Auger electron spectroscopy, I-V characteristics, response time, Hall measurements, capacitance-voltage measurements, dielectric measurements and voltage contrast secondary electron microscopy.

Effect of a large number of additives/impurities such as Bi_2O_3 , Sb_2O_3 , PbO , CoO , In_2O_3 , BaO etc. on sintering kinetics and microstructure of ZnO have been investigated. A two phase microstructure in which ZnO grains are enveloped in thin layers ($< 50 \text{ \AA}$) of segregated additives is essential for observing a nonlinear behaviour in I-V characteristics. A liquid phase sintering in Bi_2O_3 gives rise to such a two phase microstructure and hence initiates nonlinear behaviour. Devices with high nonlinearity are extremely useful in electrical, electronic and communication industries. By employing a simultaneous addition of two to four additives various device parameters can be adjusted to a desired value. Explicit role of various additives in modifying device parameters like resistivity, nonlinearity parameter, breakdown voltage, power handling capacity and device capacitance have been established. Devices with varied voltages (20 volts to few kilovolts) and wattages (1 watt/cm^2 to 10 watt/cm^2) have been fabricated.

Effect of sintering temperature, sintering time and composition on the dielectric parameters of the cersems have been investigated. Variation of dielectric parameters with frequency and measurement temperature have been carried out. High dielectric constant of the cersems has been explained on the basis of depletion layers existing at grain-intergranular interface and extending into ZnO grains. The nonlinear behaviour also arises because of these depletion layers which give rise to potential barriers. High dielectric constant, temperature dependence of I-V characteristics and capacitance voltage measurements support the presence of grain boundary barriers. The potential barriers have been revealed directly by employing voltage contrast secondary electron microscopy. Breakdown occurs by tunnelling of carriers through these barriers at high applied fields.

The present study reveals that the electrical and dielectric properties of ZnO cersems are governed by their microstructure. Either highly conducting (degenerate) or highly insulating (linear/nonlinear) cersems can be developed by controlling the microstructure.

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