Estimation of Density of Localized State in Chalcogenide Glasses from Electrical Properties

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In the present thesis, the result of the density of localized states near the Fermi level have been calculated by Mott parameters, space charge limited conduction (SCLC) and optical properties of amorphous semiconductors.

Keeping in view of, we worked on amorphous semiconductor and their alloys. The following systems have been studied in the present research work a-$Se_{100-x}Sb_{x}$, a-$Se_{100-x}Bi_{x}$, a-$Se_{78-x}Te_{22}Bi_{x}$, a-$Bi_{0.5}Se_{99.5-x}Zn_{x}$, a-$Se_{80}In_{20-x}Pb_{x}$, a-$Ga_{5}Se_{95-x}Sb_{x}$, a-$Se_{80}Te_{20-x}Pb_{x}$.

Melt quenching method has been adopted to prepare the amorphous material. The amorphous nature of the glassy alloys was verified by X-ray diffraction.

Amorphous thin films were prepared by the vacuum evaporation technique. The specially designed metallic samples holder assembly made up of brass, is used for the measurements of electrical and I-V characteristic. A JASCO, V-500, UV/ VIS / NIR computerized spectrophotometer is used for measuring optical absorption, reflection and transmission.

LOW AND HIGH FIELD EFFECT

The d. c. conduction is very important for chalcogenide glasses because it provides useful information's about the transport mechanism in chalcogenide glasses. The variation of d. c. conductivity with temperature can be expressed by the usual relation:

$$s_{dc} = s_{0} \exp (- D E / kT)$$

Where D E is the activation energy for d. c. conduction, s_{0} is the pre-exponential factor and k is the Boltzmann constant.

MOTT'S PARAMETER

At low temperature, both the conduction mechanism occurs, simultaneously, i.e., conduction through extended states and conduction via localized states. The variable range hopping mechanism is characterized by Mott's expression.:

Using this model the author reported the low temperature and low dc conductivity on the following samples.

In a-$Se_{100-x}Sb_{x}$, a-$Se_{100-x}Bi_{x}$, $Ga_5Se_{95-x}Sb_{x}$, a-$Se_{78-x}Te_{22}Bi_{x}$, a-$Se_{80-x}In_{20-x}Pb_{x}$ the dc conductivity measurements are reported [1-5]. A higher temperature, conduction takes place by thermally assisted tunneling of electrons in the localized states at the conduction band edge, while at the lower temperature, the conduction is due to variable range-hopping in the localized states at the Fermi level, which is in fair agreement with Mott's conduction of variable range-hopping conduction.

SPACE CHARGE LIMITED CONDUCTION Current -Voltage characteristic were studied [6-7] at temperature in amorphous thin films. At low fields ($< 10^3$ V/cm.), an ohmic behaviour has been observed. However, at higher fields ($\sim 10^4$ V/cm) non-ohmic behaviour has been observed.

Using the LCSC theory the author measured the I-V characteristic and estimate the SCLC measurements.

We also report the measurements on space charge limited conduction in vacuum evaporated amorphous thin films of a-$Se_{100-x}Sb_{x}$, a-$Se_{100-x}Bi_{x}$, a-$Bi_{0.5}Se_{99.5-x}Zn_{x}$, $Se_{80}Te_{20-x}Pb_{x}$. At high fields ($\sim 10^4$ V/cm), the current could be fitted to the theory of space charge limited conduction in case of uniform distribution of localized states in the mobility gap of these materials.

OPTICAL STUDIED:

In amorphous semiconductors the optical band gap and the refractive index [8-9] depend mostly on the film composition. The optical absorption and the optical gap depends on the short rang order in the amorphous structure and defects associated with it. The absorption of light by a semiconduting material depends on the energy (hn) of the incident photon on the optical bandgap of the material.

The optical bandgap (E_g), refractive index (n) and extinction coefficient (k) are the most significant optical parameters in semiconductors.

In a-$Se_{100-x}Sb_{x}$, a-$Se_{100-x}Bi_{x}$ it is found that the optical band gap decreases with the increase in Sb concentration. The value of refractive index (n) decreases with photon energy, while the value of extinction coefficient increases with photon energy.

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