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Topic of research: Study of Thermal and Electrical Properties of Selenium based Quaternary Chalcogenide Glasses

Findings

In this work electrical and thermal behavior of bismuth Incorporated Se80Te15-xCd5Bix (x=0, 5, 10) chalcogenide glasses has been discussed. Electrical measurements were done for temperature range of 294K to 351K and frequency range of 100 KHz –1 MHz. This work reports the effect of Bi addition on structure of prepared alloys. Se80Te5Cd5Bi10 has been reported to have higher degree of crystallanity than Se80Te15Cd5 and Se80Te10Cd5Bi5. Characteristic temperatures (Tg, Tc, Tp, and Tm) were found to shift to the higher temperature values with the increase in the heating rates. It was found from the DSC measurements that characteristic temperatures have lower values for Se80Te5Cd5Bi10 than the other two compositions. Calculated values of Avrami index further imply that the crystallization in the Se80Te15Cd5 glass is limited to surface only and for Se80Te10Cd5Bi5 and Se80Te5Cd5Bi10 compositions crystallization is also accompanied by the volume nucleation. Non linearity in DC conductivity with variation in temperature indicates that there are more than one mechanism responsible for the conduction. Values of hopping distance (Rhop) and average hopping energy (Whop) supports the use of Mott's variable range hopping model to demonstrate the conduction mechanism. The dependence of “s” (frequency exponent) justifies the use of CBH model to study the AC

conductivity for the prepared sample. DC and AC conductivity were found to increase with the addition of bismuth and increase in temperature. Dielectric constant (ε′) and dielectric loss (ε″) were found to depend on frequency, temperature and Bi concentration. Bismuth addition resulted in the increase in value of ε′ and ε″. This work also reports thermal properties of quaternary Se80Te15- xSb5Inx (x=0, 5, 10) chalcogenide glasses studied by DSC and DTA technique. Developed Structural and surface modifications on indium incorporation were analyzed with the help of XRD and SEM characterization. Polycrystalline nature of x=5 and x=10 composition was witnessed in contrast to amorphous nature of x=0 compositions. SEM micrographs depicted comparatively larger crystallites present in x=10 composition. Values of thermal parameters show non monotonic behavior for which rigidity percolation and metallic nature of indium are considered to be the possible reasons. The magnitude of thermal parameters first increases on indium incorporation however a decrease in magnitude is witnessed with further increase in indium concentration. Results obtained from structural and thermal analyses were found to be in agreement with each other and it can be speculated that the changes in thermal parameters with composition are the result of structural modification taking place in the alloys on indium incorporation. This work further reports the variation in electrical properties with temperature (294 K-355 K) and frequency (100 KHz-1 MHz) of applied external field. In DC conductivity measurements Values of Rhop and energy required for hopping between localized states (Whop) support the use of Mott's variable range hopping model to demonstrate the DC conduction mechanism. The inverse dependence of frequency exponent "s" on temperature justifies the use of CBH model to study the AC conductivity (σac) for the prepared sample. Values of σdc and σac were found to increase with the increase in temperature and addition of indium. Indium addition resulted in the increase in value of ε′ and ε″. Further, value of the density of states

(N(EF)) found from σdc and σac for the samples was found to increase with addition of indium. This thesis further reports synthesis of multi-component chalcogenide glasses (Se85Te15)100-(x+y)SnxAly by melt quenching technique. Structural, thermal and electrical properties of prepared bulk glasses were studied and effects of doping Al and Sn on these properties are reported. XRD and SEM analysis revealed modification of structure and morphology as a consequence of doping resulted by an increase in crystallite size in the alloy. Further polycrystalline nature of the Al and Sn doped alloys has been confirmed by XRD analysis. Thermal investigation of prepared alloys by DSC at heating rates of 5, 10, 15, 20K/min revealed a decrease in values of characteristic temperatures and activation energy of crystallization in response to doping of metallic impurities in the alloys. Dielectric analyses were carried for temperature range 303K-374K and frequency range of 20 KHz-1MHz. Sample pellets of radius 0.5 cm and thickness 1mm were used to understand the Dielectric behavior and DC conduction in the alloys. Doping of Al and Sn resulted in the enhanced AC and DC conductivity of alloys and an increase in AC and DC conductivity was observed with the increase in temperature of alloys. Increase in the frequency of applied field resulted in the decrease in value of ε′ and ε″ at all temperatures.