influnce of lithium phosphate concentration and temperature on the electrical conduction and dielectri properties of vanadium phosphate class

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The present study deals with an experimental investigation for(76V20S-24P20S)I_x(Ll3P04)Xglass to follow up some of their physicalproperties.The glass samples (76V2Os- 24P 2Os) I-X(Ll , P04)x(where x= 0.0,0.01 , 0,02 0,01 and 0,15) have been prepared by quenching the melt toroom temperature .Characterization of the glasses has been done using X- ray diffractionand differential thermal analysis (DTA).X-ray diffraction study for allsamples illustrated the amorphous nature of glasses. Differential thermalanalysis (DTA.) reveals that the characteristic glass transition temperatureof the samples glass (Tg) shifts toward higher temperature with increasingthe lithium phosphate content.The de electric conductivity of the glass samples was studied over atemperature range from room temperature to 593K.The general behaviorshows two regions, one at relatively low temperature range and the otherone at the higher temperature range. At the high temperature range (abOve8nl2), the conduction mechanism is explained according to the hopping ofsmall polaron to the nearest empty sites . In the temperature range below8nl2 , the conduction process could be explained as a contribution of twoprocesses . The first is the electron hopping between filled and emptylocalized states which dominate at low temperature range and the second isdue to small polaron hopping .An increase of the activation energy with increasing LithiumPhosphate was obtained which was attributed to :I) An increase of the phosphate group in the glass matrix which reduces thevanadium fraction and subsequently the electrical co ductivity.2) The glass hydration which leads to a contrib ion of protons inconduction process in the glasses .3) The increase of lithium ion conduction in the glass.The current - voltage (I - V) characteristic 0 the glasses has beenstudied as a function of both temperature and Lithi phosphate content.The I - V characteristic exhibits threshold switc . g with differentialnegative resistance. It is found that the threshold voltag (VdJ decreases andthe threshold current (lib) increases with increasing te , while theyvary inversely with increasing lithium phosphate con nt. The behavior ofthe Off - state region is analyzed according to PooI- F nkel effect besidesthe joule heating . The switching to the negative res~ region has been,discussed according to the electrothermal model. The ~nduction process inthe negative resistance region are interpreted accor~ to the activation ofcharge carrier under the influence of the high field ,the j~ule heating, and theself generation of a.c signal in the conduction path

filam~t .,The total conductivity (Oiot) of the glasses are studied in the frequencyrange (0.2 - 100 kHz) and the temperature range (1290- 493 K) .Theconductivity - frequency dependence relation is divid¥ into two regions ;One at low frequency while the other appears at relative~ higher frequencyrange . The low frequency conductivity region refers to d.c conductivityand is found to be strongly dependent on temperature . relatively higherfrequency conductivity region obeys a power law relation, u= A roS . Theobtained values of the power s lie in the range (0.5 :5; s :5; I) in the case ofvanadium phosphate glass sample and that of low oflithium phosphatecontent (0.01 ,0.02) which confirms the electron hopping between ”0+and yS+ ions .The values ofs for the glass sample of the higher lithiumphosphate content, the values of s less than 0.5 confirm the dominationof ionic conductivity in the investigated glasses .The frequency and temperature dependence of the dielectricconstant e’ , the dielectric loss s” and the dielectric loss tangent. Arestudied the dielectric constant and the dielectric loss decrease as thefrequency was increased for all glass samples . A slight decrease isobserved at low frequency range while a strong dependence appears athigher frequency range . The dielectric constant increases slightly withincreasing temperature . The effect of frequency assists electronhopping between v” and V5+ ions, while increasing temperaturecauses the glassy network relaxes from which the ionic motionbecomes easier .The bulk conductivity of the glasses is obtained by the compleximpedance technique. It increases with increasing temperature obeyingArrhenious relation :DBT = O”Bo exp (- ED / ka T)The obtained values of the activation energy Eb lie in the ~e(0.348 - 0.467 eY) . In addition the bulk conductivity is found todecrease with increasing lithium phosphate content.