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Conduction Mechanism in Canada Balsam

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Abstract

Conduction mechanism in canada balsam for the sample of thickness 1.5×10^{-3} m at temperatures 323 K, 343 K and 363 K have been investigated from the plot of $E^{1/2}$ versus LnJ. The value of LnJ is sharply increases up to 2.15×10^{2} V/m but due to phase change beyond this applied field the slope of the plot decreases for all temperature. The slope beyond the critical field 2.15×10^{2} V/m is increase with increase of temperature and shows molionic conduction.

INTRODUCTION

Canada balsam, is a turpentine which is made from the resin of the balsam fir tree (*Abies balsamea*) of boreal North America. Canada balsam is amorphous when dried and it does not crystallize with age. Since it has poor thermal and solvent resistance it is used for making permanent microscope slides. Due to its high optical quality and the similarity of its refractive index to that of crown glass (*n* = 1.55), purified and filtered Canada balsam was traditionally used in optics as an invisible-when-dry glue for glass, such as lens elements. Lenses glued with Canada balsam (or with other similar glues) are called *cemented* lenses. In modern optical manufacturing, UV-cured epoxies are often used to bond lens elements.

In recent years, there has been a great deal of interest in the study of liquid dielectrics, because of their application in electrical insulation engineering [1]. Attention was drawn to this by Sillars [2] and other interconnection between viscosity and the structure of polymer liquids is clearly shown in the work by Golik [3] and coworkers. The paper gives an account of the in Canada balsam of thickness 1.5×10^{-3} m of different temperatures. The plot of LnJ versus $E^{1/2}$ shows the molionic conduction. In molionic conduction processes come into play in a variety of ways in polymeric materials. In conventional plastic for electrical applications, which exploit insulating properties, control of ionic impurities becomes especially important. On other hand, the extremely low conductivity that is characteristic of many polymers proves to be troublesome in certain products. The problem is the accumulation of static charges which are unable to leak away. The presence of charge leads to the attraction of dust, cling of films, and in some circumstances even to generation of electric shocks and sparks. Antistatic agents that are used to alleviate problems are normally based on molionic conduction, providing just the minimum conductivity to allow charge to flow to effectively. Ate the other ends of the scale, polymers that are tailored to have high levels of molionic conductivity are now are finding the application as solid electrolytes for batteries and fuel cells.

EXPERIMENTAL:

A parallel plate condenser consisting of a liquid under observation between its two plates was used. To keep the sample thoroughly intact between its two electrodes, a circular cavity of diameter slightly greater than the electrode was made into Bakelite sheet, the lower electrode being rigidly tightened with a screw, which provides for a terminal connection. Over this cavity stands, on metal base another sheet of Bakelite fitted with a spherometer-type arrangement. A spring fitted in the upper electrode keeps it in contact with the stud of the spherometer. Thus, the upper electrode moves without rotation with the movement of the stud fitted with the spherometer. The liquid sample under the study was poured into the cavity of the sample holder and the upper electrode was slowly pushed down to the desire thickness with the help of the spherometer. Both the electrodes were kept embedded in the bulk of the sample to avoid the possibility of the surface conduction. The sample between the electrodes was kept short circuited for about 24 hour to make ready for observations.

A high voltage d c unit and a resistor of 1 MΩ were connected in series with the electrodes. The voltage drop across this resistor was measured with a digital multimeter (Model-210). The sample was maintained at a particular temperature with the help of Thermostat U-10 by heating the liquid for about an hour to attain a particular temperature.

RESULT AND DISCUSSION:

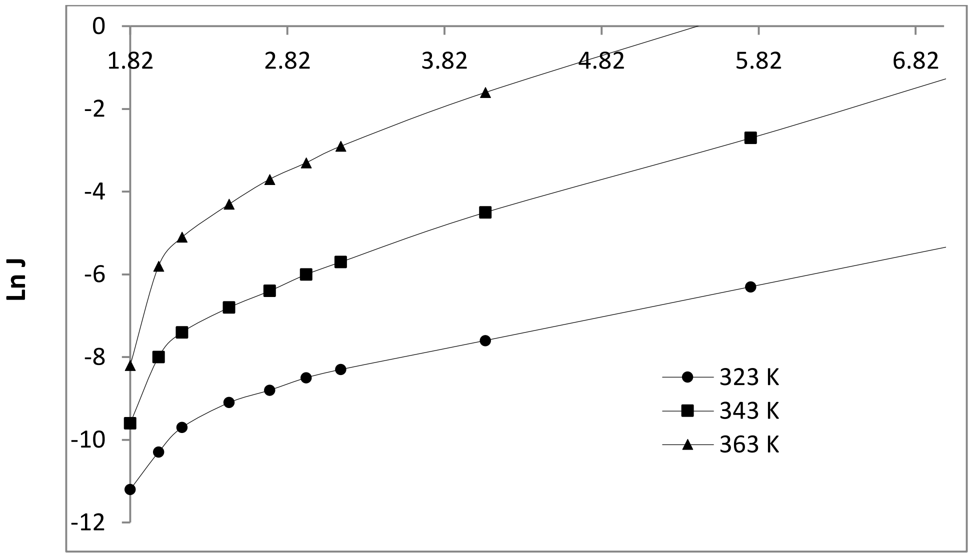
Fig exhibits the variation of LnJ with $E^{1/2}$ for various temperatures 323 K, 343 K and 363 K of thickness 1.5 $\times 10^{-3}$ m. The plot of $E^{1/2}$ versus LnJ show exponential increase in LnJ . The value of LnJ is sharply increases up to 2.15×10^2 V/m but due to phase change beyond this applied field the slope of the plot decreases for all temperature. The slope beyond the critical field 2.15×10^2 V/m is increase with increase of temperature.

Now, the current density J is

$$J = nqv_e \qquad \text{… … … … (1)}$$

Where n is the number charge carrier in unit volume, q is the charge and v_e drift velocity of the charged particles.

Also $$J = E\sigma \qquad \text{… … … … (2)}$$



$E^{1/2}\times10^2$ V/m

Variation of LnJ versus $E^{1/2}\times10^2$ V/m for the sample of thickness 1.5×10^{-3} m

Then, from (1) and (2) we get the general electrical conductivity formula is express as

$$\sigma = nqu \qquad \text{… … … … (3)}$$

$$i.e. \quad \sigma = n\, q\, \frac{v}{E} \qquad \text{… … … … (4)}$$

where u =v/E, the mobility of the carriers, which is equal to the drift velocity of the charge carrier per unit electric field.

Eq. (3) is common for all possible kind of conduction. In metals, the carriers are electron, while in ionic solids; the conductivity is through transport of ions. Lastly, in molionic conduction, the carriers are the group of charged molecules, i.e. molions. In this case, the flow of current through matter is attended by electrophoresis effect [4].

In its physical essence molionic conductivity is very close to ionic ones. This kind of conduction is observed in colloidal system [5], and it takes the form of two well mixed phase, one phase in the form of fine particles called disperse phase, being uniformly suspended in the other phase called disperse medium.

The stability of colloidal system can be explained by the presence of electric charges on the surface of the particles of the disperse phase. Such charged particle of disperse phase is known as molions. When an electric field is applied on a colloid, a phenomenon of electrophoresis takes place. Thus outwardly, electrophoresis differs from electrolysis in the fact that the former is not attended by formation of new substances and there is only a change in the relative concentration of the disperse phase in various part of the volume of the substance.

In canada balsam, the liquid under investigation which is a viscous organic polymer, the conduction is molionic. The electrical conductivity of amorphous viscous material is appreciably affected by the viscosity of the matter. In molionic conduction, the charged particles are supposed to have the size of the molecule or still larger. In conformity with Stoke's law,the motion of a sphere with a radius r in a viscous liquid medium under the action of a constant force F is uniform and its velocity v is given by;

$$v = \frac{F}{6\pi r\eta} \qquad \ldots\ldots\ldots\ldots (5)$$

Where η is the absolute viscosity of the matter.

Assuming that the motion is spherical and inserting the values of velocity v from Eq. (5) in (4) and the motive force F=qE, where q is the charge of the motion, we get

$$\sigma = \frac{q^2}{6\pi r}.\frac{n}{\eta} \qquad \ldots\ldots\ldots\ldots (6)$$

Further the viscosity decreases exponentially when the temperature rises

In the case of a molionic conduction, the value of *n* does not change when the temperature increases. Thus, from Eq. (6) it is clear that a drop in viscosity with an increase in temperature should raise σ in molionic conduction. Thus the conclusion can be drawn to the effect that at higher temperature, the value of σ in most liquid polymers should increase.

Further, since the viscosity of polymer solutions is closely connected with their structure, an elevation of temperature causes a decrease in the viscosity of a system. The lower the temperature, the more strongly pronounced is structure formation and the greater is the viscosity. Finally the peaks in the figures at critical temperatures (T_c) are the characteristic feature of the change in the viscosity of the polymer solution, indicating the formation of new phase in one phase solution. This occurs when a system approaches conduction with conform to the bimodal as temperature and concentration change. This was shown for the first time when the temperature dependence of the viscosity of polymer solutions in a critical temperature range [6] was studied. Debye *et al* [7] and others detected a sharp increase in viscosity with the subsequent drop, i.e. a characteristic surge is observed on the viscosity polytherm. Later, such a phenomenon was detected also for viscosity solution in the range of concentration, which corresponds to the phase separation of the system [8]. A sharp increase in viscosity indicates the intensively occurring processes of structure formation in a solution, while a drop in viscosity conforms to the separation of a system into two phases.

The evidence of molionic conduction is obtained from studies of the dependence of current on applied voltage, for which a theoretical expression may be derived on the basis of simple model [9]. Suppose that the unit motion of a molion law field is a jump within the matrix of polymer molecules to the neibouring position is exactly energy, passing over a potential- energy of height ΔU. The molecules will be in constant state of vibration when lodge in a potential well, and we can assume that the probability that will pass over the barrier is $exp(-\Delta U/kT)$ in each vibration per second. Now we consider the effect of applying higher uniform electric field E. in the direction perpendicular to the field the potential-energy barrier will be unaffected, but in the direction of field, and against the field, the barrier heights will be changed by $\pm 1/2eEa$, respectively, where a is the distance between the neibouring potential wells.

So, in the above figure the curve is high stiff at low applied field for all temperature which is due to the jumping of the molions within the matrix of polymer molecules to the neibouring position as a result of low viscosity and that at higher field the curve shows less stiff but differs from Ohm's law, is due to increase in viscosity which results the rate motion of the molions is decrease. The number molions n is independent of temperature. It is also clear that the value of Ln J is higher for higher temperature is due to increase in mobility of the molions.

CONCLUSION

The electrical properties of Canada balsam such as conduction mechanism is differ from other type of materials. This material will useful to distinguish electronic devices fabrication with organic materials and polymers from those based on inorganic semiconductors.

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