تحضير خـــلائط بوليميرية ودراســـــة موصليتها الكهربائية

فاطمة أبوالقاسم امحمد المشاي ـ كلية التربية الزاوية ـ جامعة الزاوية

الملخـــص :

فـــي هـــذه الدراســـة ثم تحضير مزيـــج من بولي فينيل كلوريد (PVC) وبولي ايثلين أكسيد(PEO) بواسطة طريقة صب المحلول ، وتمت دراســـة تأثير تحميل بوليمر PEO في الخليط ، وتأثير تغير تردد المجال الكهربـــي المطـبق عند درجات حرارة مختلفة على الموصلية الكهربية للخليط. واظهرت النتائج أن الموصلية الكهربية لمزيج PVC/PEO تتضخم مع الزيادة في تركيزات PEO في العينة، كما تزداد الموصلية الكهربية مع زيادة تردد المجال الكهربائي المطبق على العينة.

الكلمات الافتتاحيـــــة :

خليط – بولي فينيل كلوريد – بولي ايثلين أكسيد – موصلية كهربية.

Preparation of blend polymer and study of its electrical conductivity

Name:- Fatma A. E. Almashy.

University of Azzawia, Faculty of Education, Azzawia – Libya

Abstract

In this paper, Blend of poly (vinyl chloride) (PVC) /poly (ethylene oxide) (PEO) was prepared by solution casting technique, and the effect of PEO polymer loading as and frequency of applied electric field at different temperatures on the a.c.electrical conductivity of blend was studied. The results show that a.c.electrical conductivity of PVC/PEO blend are increased with increase in PEO concentration in sample as and the a.c.electrical conductivity are increases with the increase in frequency of applied electric field.

Key words:

Blend – poly (vinyl chloride) – poly (ethylene oxide) – electric conductivity.

Introduction

Multicomponent polymeric systems or polymeric blends have recently considerable interest and represent a new and important challenge for research. These systems have already become technologically important. A polymer blend can be defined as a combination of two or more polymers resulting from common processing steps eg. mixing of two polymers in molten state. Casting from common solvent etc.

Polymer blends consisting of two polymers which show miscibility usually exhibit one T_g and have mechanical properties which depend in a nonlinear way on the composition. Below the melting temperature blends with crystallizable components are generally heterogeneous. In fact compatible blends of one crystalline polymer with any other polymer should require the formation of mixed crystals, but so far there are no established cases of co-crystallization phenomena thus miscibility in polymer alloys is generally restricted to amorphous phases. The tailoring of thermal, dielectric, electrical and mechanical properties can be better achieved with the help of copolymers, composites , dopants and with polyblends.The attention of researchers has been drown to the study of the effect of doping because the electrical properties of polymers can be tailored to a specific requirement by the addition of suitable dopant materials.[1-4]

In this work PVC/PEO blend polymer was prepared and its electric conductivity was studied.

The polymer poly(vinyl chloride)(PVC) was chosen for blending because of its excellent miscibility and compatibility properties with low or high molecular weight polymers , as well as providing good mechanical strength.[5,6]

and the polymer poly(ethylene oxide)(PEO) was chosen for its high ionic conductivity(10^{-3} -$10^{-4}\Omega$ cm^{-1}) ,it is achieved at the temperature range of (80-100^{o}c),while at low temperature PEO exhibits low conductivity (10^{-7}-10^{-8} Ω cm^{-1}) because of the high crystallinity of PEO .[7-9]

Many studies been conducted regarding PVC/PEO polymer blend and effect of addition of suitable materials on their properties:

Khan et.al.[10] studied polymer electrolyte systems consisting of PVC/PEO as host polymers, lithium perchlorate($Liclo_4$) as inorganic salt and ethylene

carbonate(Ec) as plasticizer are prepared. The maximum ionic conductivity is found to be $2.39*10^{-6}\Omega\ cm^{-1}$ at room temperature for polymer electrolyte system containing 20 wt % of $Liclo_4$ salt .

Hajar et.al.[11] studied effect of carbon loading on electrical conductivity of PVC/PEO films. The result shows that the electrical conductivity increased with the increase of carbon black loading.

Hajar et.al.[12] studied effect of PVC/PEO polymer film graphite loading on electrical and mechanical properties of PVC/PEO polymer films. Electrical conductivity results discovered. The conductivity increased with increasing of filler loading

Experimental

A. Materials

1) Polyvinyle chloride(PVC)

PVC polymer is a white and brittle solid. It is a polymer with good insulation properties, but because of its higher polar nature the electrical insulating property is inferior to non-polar polymers such as polyethylene and polypropylene.

Since the dielectric constant, dielectric loss tangent value and volume resistivity are high, the corona resistance is not very good and it is generally suitable for medium or low voltage and low frequency insulation materials. [13]

PVC is a thermoplastic polymer and its properties are: density (1.38 $g/cm^{3)}$,glass transition temperature melting point (100 ^{o}c) to (260^{o}c) ,resistivity (10^{16} Ωm) and dielectric breakdown voltage (40 Mv/m).[14]

2) Polyethylen oxide (PEO)

PEO polymer is a neutral , nontoxic ,biocompatible and water soluble polymer which it has found numerous applications such as in conductive composites with carbon black , cometology , genetherapy , pharmaceutical products , ets.PEO based graft copolymers have been investigated for their wide range of promising abilities , to enhance their favorable properties and tailor their capabilies.[15,16]

Due to the ionic conductivity the PEO presents there has been much interest in their employment in electrochemical devices. However PEO aids in ionic transportion only in the amorphous phase and being a semi-crystalline

polymer, presents crystallinity at room temperature . PEO properties are: The molecular weight 20000 to 6000000 g mol^{-1} , density (1.13 g/ml) at 25^{o}c and transition temperature T_g=-67^{o}c ,T_m=65^{o}c.[17]

B. Preparation of blend polymer

In this study solvent casting technique was employed to prepare the PVC/PEO blend polymer.Different weight ratios of PVC/PEO ware dissolved separataiiy in tetra hydro furan(THF) and these solutions were then mixed together and stirred for 4 hours at room temperature to obtain a homogenous mixture. The solution was then poured into a petri dish and allowed to evaporate at room temperature for one day. Then the samples were placed inside vacuum oven at 40^{o}c for 24 hours to remove any traces of solvent. The compositions of films were PVC (100%)-PEO (0%), PVC(90%)-PEO(10%), PVC(70%)-PEO(30%) and PVC(50%)-PEO(50%).

C. Preparation of test samples

The samples were in circular forms of (15 mm) thick. And (1.0 cm) in diameter. The two opposite faces of the film were coated with a thin layer of silver paste. Copper wires fixed on both surfaces and the specimen mounted on a sample holder.

D. Measurements (A.C. electrical conductivity)

The conductivity is calculated as a function of frequency by using the relation: $\sigma a.c = \omega_{\circ}\varepsilon_{\circ}\acute{\varepsilon}$

Where: $\omega = 2\pi f$, f: $the\ frequency\ (Hz)$

$\varepsilon_{\circ}$: the permittivity of free space ($\varepsilon_{\circ}$=8.85*10^{-12} F/m

and the dielectric loss of the sample ($\acute{\varepsilon}$) was calculated by using the relation:$\acute{\varepsilon}=\varepsilon'\tan\delta$

Where: tanδ is measured using the balance bridge.

And the dielectric permittivity(ε′)(i.e. The real part of the dielectric constant)of the relation: $\varepsilon' = (\frac{d}{\varepsilon_{\circ}})$*c

Where: C: The capacitance of the sample.

d: The thickness of the sample.

A: The area of the coated surface.

The dielectric measurements were carried out using an auto balance bridge (typ GM Instek LCR-821 meter) in frequency range 10^2-10^5 Hz. The measurements were carried out at various temperatures (300 K,333 K and 353 K).

Results and Discussion

Figure (1) shows the relation between a.c.electric conductivity of PVC/PEO blend and concentration of in sample at frequency (100Hz) and at room temperature.

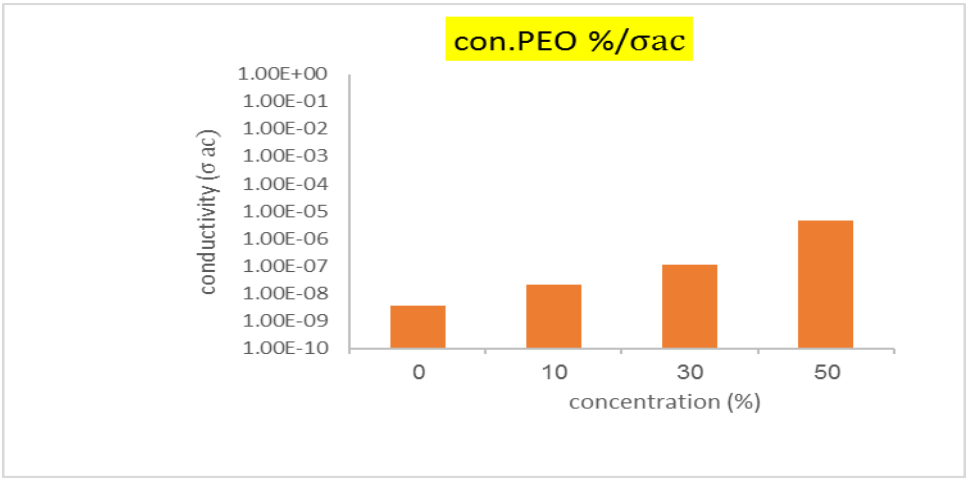

Fig.(1)shows relation between a.c.conductivity v and PEO concentration he results showed that the a.c.conductivity of PVC/PEO blends increased with increasing of PEO loading in sample. This behavior may be due to increasing the density of carriers in polymer matrix.

In figures(2,3and4) show the frequency dependence of a.c.conductivity at different temperatures (300 k,333 k and353 k) for the same blend.

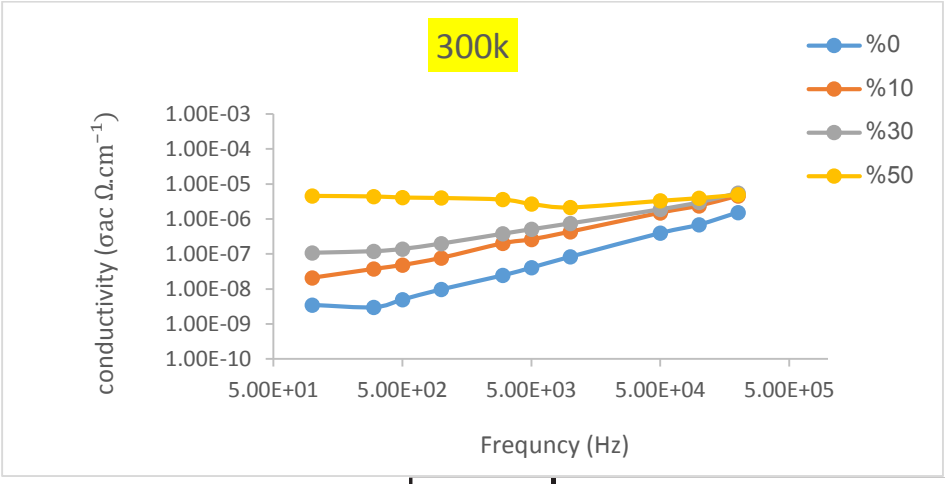

Fig.(2) shows the frequency dependence of a.c.conductivity at 300K

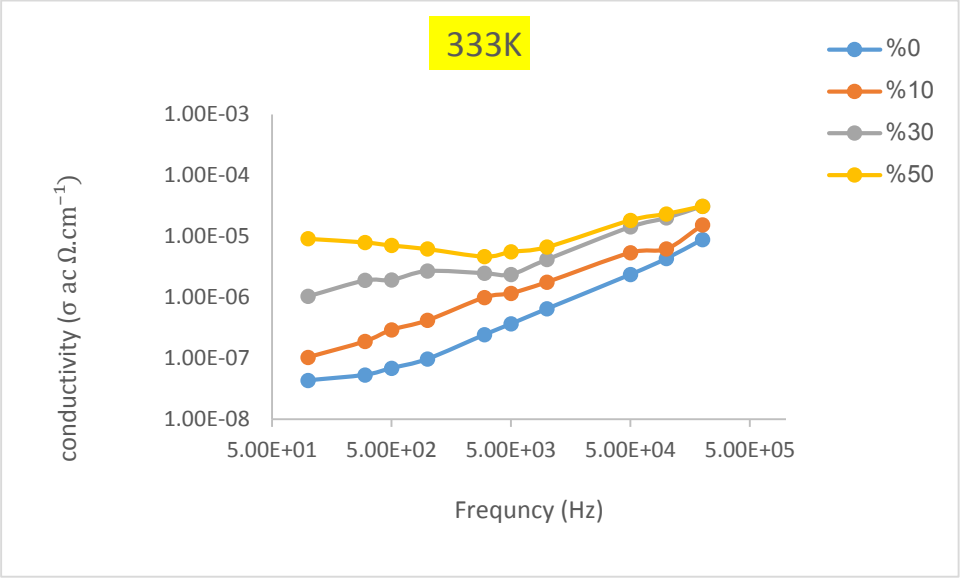

Fig.(3) shows the frequency dependence of a.c.conductivity at 333K

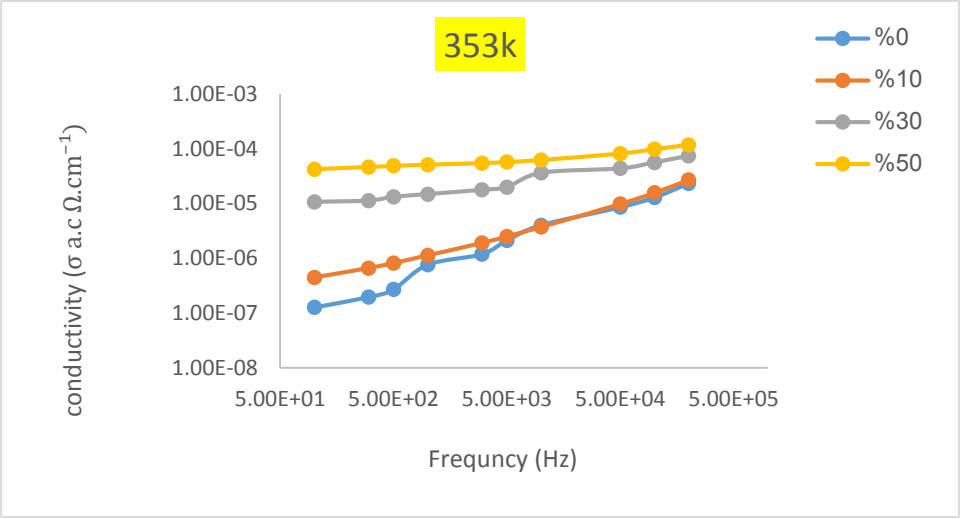

Fig.(4) shows the frequency dependence of a.c.conductivity at 353 K

From the obtained results, it can be seen that ionic conductivity value increased with increasing the frequency. On the other hand, as the frequency is increased further, conductivity goes on increasing and the conductivities of

all blends merge together indicating the formation of excess charge carriers at higher frequencies.

As according to the jump relaxation model.[18]

At low frequencies , ions jump from one site to its neighbouring vacant site . While at higher frequencies ,due to the short time periods ,the probability for ions to go fall back to their original sites increases. More hopping of ions is responsible for the higher conductivity in lower frequencies.

From measurement of ionic conductivity values at different temperatures, it can be found that ionic conductivity values increase with increase in temperature. The increase in ionic conductivity with temperature is in agreement with the theory. [19]

The increase in ionic conductivity with increasing the temperature is due to fact that at low temperature ionic mobility and segmental motions of polymer Chains are restricted due to strong polymer association. While at higher temperature ionic conductivity increases due to decrease in polymer association and increased thermal segmental motion of polymer chains in the electrolytes. [20]

The enhancement in ionic conductivity with increase in temperature can also be linked with increase in chain flexibility due to decrease in viscosity. [21]

Conclusions

PVC/PEO blends were prepared using solution casting technique at different blend ratios. The higher ionic conductivity at room temperature to be ($4.56*10^{-6}\Omega cm^{-1}$) was observed for the system PVC (50%)-PEO (50%).As the a.c.conductivity dependence on frequency and temperature was observe

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