Studying the Effect of $CrCl_2$ Addition on the Electrical Properties of Polystyrene

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Abstract

In this work, samples of pure polystyrene and polystyrene (PS) doped with ($CrCl_2$) were prepared using casting method .The effect of addition of chromium chloride concentration on electrical properties of polystyrene have been studied, also the effect of the concentration of chromium chloride and temperature on the electrical conductivity was studied, then the variation in activation energy of D.C electrical conductivity have been investagated. The results show that the electrical resistance was decreased with increasing temperature and the activation energy was decreased with increasing the concentration of chromium chloride, also the electrical conductivity was increased with increasing the concentration of chromium chloride.

Key words: polymer**,** PS**,** chromium chloride, electrical properties, conductivity.

1. Introduction

A polymer of a particular group is characterized by the molecular weight of the monomer unit. Polystyrene (PS) is amorphous polymer with bulky side groups. General purposes PS is hard, rigid, and transparent at room temperature and glass like thermoplastic material which can be soften and distort under heat. It is soluble in aromatic hydrocarbon solvents, cyclohexane and chlorinated hydrocarbons [1].

Many researchers succeeded to prepare PS as films deposited on various substrates such as glass or silicon wafer [2,3], this interest was by the technological importance of film stability (e.g Toys and novelties, rigid packaging, refrigerator

trays, boxes, cosmetic packs and costume jewelers, lighting diffusers, audio cassette and CD cases).

Polymer capped inorganic nanoparticle composites have attracted much attention recently due to their enhanced optical and electronic properties. For example, CdSe–polymer composites can be used to make blue light emitters [4, 5]. The altering and enhancement of the polymer's properties can occur through doping with various nano-fillers such as metals, semiconductors, organic and inorganic particles and fibres, as well as carbon structures and ceramics [6-9].

The present study will help in understanding the effect of different concentrations of chromium salt on the D.C conductivity of polystyrene.

2. Experimental Part

Polystyrene solution was prepared by dissolving it in cloroform by using magnetic stirrer in mixing process to get homogeneous solution. The wieght percentages of $CrCl_2$ are (4, 8 and 12)wt .% were added and mixed for 10 minute to get more homogenous solution.

Casting Method was applied by using Petri dish that leaved to dry at room temperature for three days. The dried film was then removed easily by using tweezers clamp.

The resistivity was measured over range of temperature from (30 to 80)^{o}C using Keithly electrometer type (616C) .The volume electrical conductivity σ_v defined by :

$$\sigma_v = \frac{1}{\rho_v} = \frac{LV}{AI} \text{..... .....(1)}$$

Where :

A = guard electrode effective area.

V/I=R = volume resistance (Ohm) .

L = average thickness of sample (cm) .

In this model the electrodes have circular area $A= D^2\pi/4$ where $D= 0.5\ cm^2$.

The activation energy was calculated using equation :

$$\sigma = \sigma_o \exp(-E_a/k_BT) \quad \text{.....(2)}$$

σ = electrical conductivity at T temperature

σ_0 = electrical conductivity at absolute zero of temperature

K_B = Boltzmann constant

E_a = Activation Energy

3. Results & Discussion

3.1 The The Effect of concentration of chromium chloride on D.C electrical conductivity

Fig. (1) shows the variation of D.C electrical conductivity of composite with different concentrations of salt, it is found that the electrical conductivity was increased with increasing of salt concentration, this related to increase the numbers of carries charges in composites.

3.2 The variation of the D.C electrical conductivity with temperature

Fig. (2) shows the variation of D.C electrical conductivity of composites with different temperature, it is found that the electrical conductivity was increased with increasing the temperature this due to increase the movement of polymer chain and ions of salt, also increase the carries charges with increase the temperature.

3.3 Activation Energy

Fig (4). shows the variation of activation energy of D.C electrical conductivity of composite with salt concentration. From this figure, the activation energy was decreased with increasing of salt concentration, this behavior attributed to decrease the distance between conduction band and valance band .

4.Conclusions

The addition of chromium chloride concentration was effected on electrical properties of polystyrene. The electrical conductivity was increased with increasing the concentration of salt and temperature, also activation energy was decreased with increasing the weight percetages of chromium chloride.

References

1. Saeed A. A., Ph.D. Thesis, 2000, the Effects of Antimony Compounds on the Electrical and Optical Properties of Polyisres and Polyster. Baghdad University, College of Science, Physics Department.
2. Maebayashi M., Matsuoka T., Koda S., R., Hashitani T., Nishio and Kimura S., 2004, Study on Polystyrene Thin Film on Glass Substrate by Scanning Acoustic Microscope. Elsevier, Polymer, 45(22):p.7563-7569.
3. BaoLi O., DuXin L., 2007 Preparation of Polystyrene/silica Nanocomposites by Radical Copolymerization of Styrene with Silica Macromonomer. Sci. China. Ser. B-Chem., 50(3): p. 385-391.
4. V. Colvin, M. Schlamp, A.P. Ahvestors, Nature (London) 370 (1994) 354.
5. B.O. Dabbousi, M.G. Bawendi, O. Omtduku, M.F. Rubne, 1996, Appl. Phys. Lett. 66, 1316.
6. Glushanin, S.; Topolov, V. Y.; Krivoruchko, A. V.; **2006** "Features of piezoelectric properties of 0-3 PbTiO3-type ceramic/polymer composites", *Materials Chemistry and Physics* 97 (2-3), 357-364.
7. Hine, P.; Broome, V.; Ward, I.; **2005** "The incorporation of carbon nanofibres to enhance the properties of self reinforced, single polymer composites", *Polymer* 46 (24), 10936-10944,
8. Cioffi, N.; Torsi, L.; Ditaranto, N.; Tantillo, G.; Ghibelli, L.; Sabbatini, L.; Bleve-Zacheo, T.; D'Alessio, M.; Zambonin, P. G.; Traversa, E.; **2005**, "Copper nanoparticle/polymer composites with antifungal and bacteriostatic properties", *Chemistry of Materials* 17 (21), 5255-5262,
9. Pelaiz-Barranco, A.; Marin-Franch, P.; **2005** "Piezo-, pyro-, ferro-, and dielectric properties of ceramic/polymer composites obtained from two modifications of lead titanate", *Journal of Applied Physics* 97 (3).

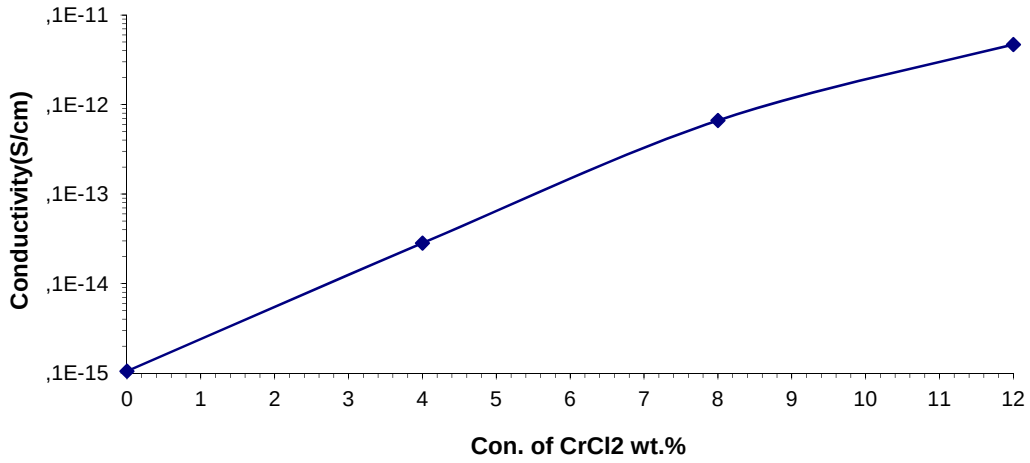

FIG.1
Variation of D.C electrical conductivity with CrCl2 wt.% concentration of composite.

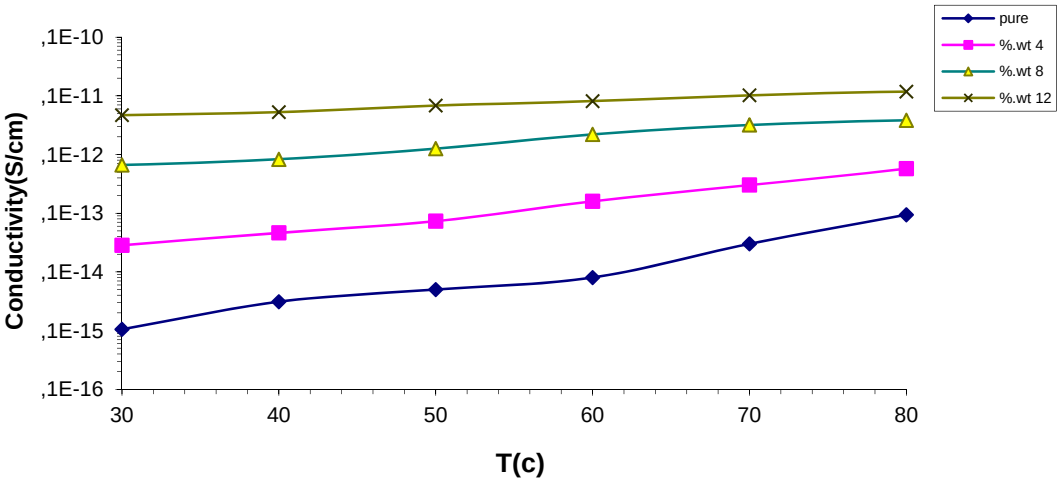

FIG.2
Variation of D.C electrical conductivity with temperature for(PS-CrCl2) composite

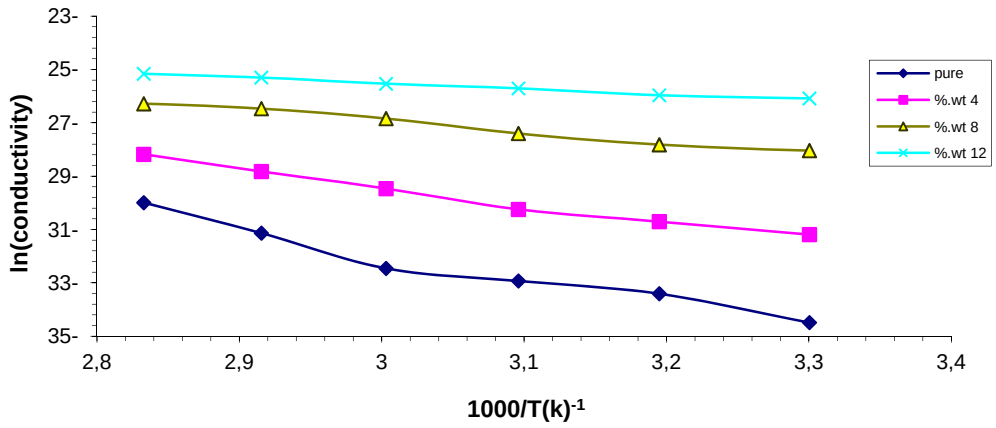

FIG.3
Variation of D.C electrical conductivity with resprocal absoute temperature for (PS-CrCl2) composite.

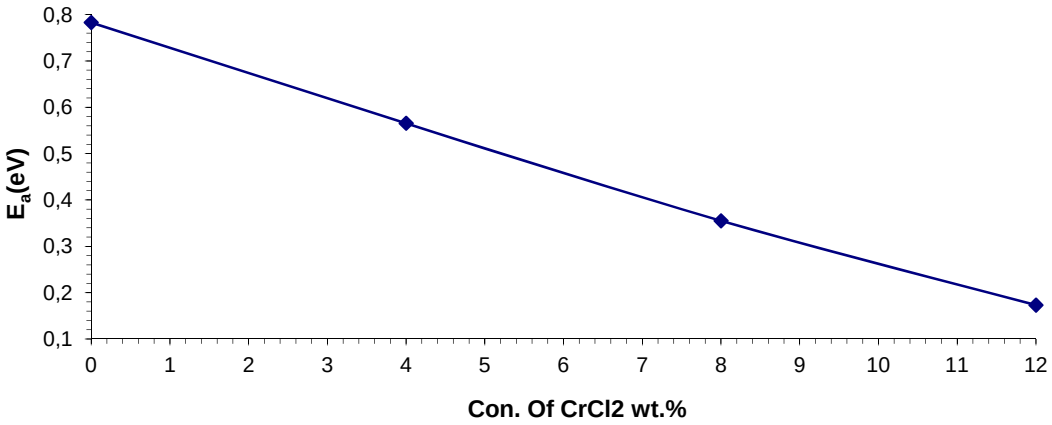

FIG.4
Variation activation energy for D.C electrical conductivity with CrCl2 concentration of composite