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MEASURERMENT OF DIELECTRIC CONSTANT OF CHEMICALLY SYNTHESIZED COPOLYMERS

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Abstract- Chemical oxidative copolymerization of pyrrole and aniline was performed for three feed ratios at room temperature (30oC) using FeCl3 as an initiator. The synthesis was carried out for two different initiator concentrations. The dielectric constant was determined for each sample in the temperature range of 313-673K at a fixed frequency of 1KHz.
Keywords- Aniline, copolymer, dielectric constant, pyrrole.

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Introduction

The usability of new conducting materials with better performances for applications like thermal, electrical, photovoltaic cell , electromagnetic shielding properties , display properties, etc have received much attention nowadays. The designing of new microstructures via copolymerization serve out to be one of the effective tools for the researchers. Thus a cross linked or hetero associated material with modified primarily existing polymeric chain can be designed and further employed to meet industrial and scientific requirements. Among various conducting polymers polypyrrole and polyaniline are rigorously investigated due to their ease of preparation, environmental stability and high electrical conductivity. Despite of these advantages, it is observed that the two monomers are thermally quiet unstable. This puts restriction on the use of these materials for higher temperature applications. Many researchers have employed electrochemical copolymerization technique for synthesizing a copolymer having pyrrole aniline units. But these studies involve only room temperature or low temperature synthesis conditions. Again they have reported only room temperature conductivity of these prepared copolymers.

Thus in the present work, we report studies on chemical copolymerization of pyrrole and aniline for three different proportion of the comonomers. The polymerization was carried out at room temperature i.e. (30^{o}C) using $FeCl_3$ as an initiator with two different concentrations. The variation of dielectric constant with respect to temperature has been studied. The various polarization mechanisms have been discussed.

Experimental Procedure

Sample Preparation

Aniline (SRL Mumbai) and Pyrrole (SRL Mumbai) were purified by distillation process prior to use. Also sulphuric acid (Qualigen, Mumbai) was used to generate acidic medium and anhydrous $FeCl_3$ (SRL Mumbai) was used as an initiator. In the present work the copolymerization has been carried out chemically by taking the monomers in the three proportions. For this the two monomers were taken in desired proportion and the mixture was stirred for about 5 minutes, to it 30ml of 0.5M H_2So_4 was added and the solution was stirred till it became clear. Finally measured quantity of anhydrous $FeCl_3$ (0.1M and 0.25M) was added to this and the whole reaction mixture was stirred for about 50 minutes, continuously at a temperature of 30^{o}C. The reaction mixture was then kept as it is for 24 hrs. It was then filtered and the precipitate was washed with distilled water till the filtrate became clear. The precipitate was then further dried and the weight of the material was recorded. The nomenclature of the samples prepared with two different initiator concentrations has been given in table I.

Table I - Designation of samples & their percentage conversion at constant temperature.

Synthesis Temperature	Initiator Concentration	Sample Designation	Percentage Conversion
	0.1M	X2	15.91%
	0.1M	Y2	6.13%
	0.1M	Z2	28.96%
30°C	0.25M	X5	36.40%
	0.25M	Y5	13.26%
	0.25M	Z5	54.52%

Where X, Y & Z represents the different proportions of the monomers indicated as

Designation	Pyrrole : Aniline
X	01:01
Y	01:02
Z	02:01

Measurement of dielectric constant

The dielectric constant of the sample was measured with the help of LCR meter (type VLC 2) is used. The analysis was carried out at constant frequency of 1 KHz. The capacitance of the sample was recorded in the temperature range 313 K – 673 K. The dielectric constant was calculated by using the formula $\epsilon = C / C_o$. The graphs showing variation of dielectric constant with respect to temperature has been plotted in the same temperature range for various samples.

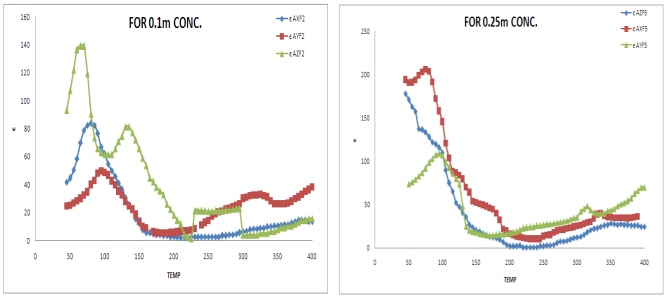

Fig. I- Variation of Dielectric constant with temperature.

Results and Discussion

Copolymerization of pyrrole and aniline was carried out at room temperature (30oC) using $FeCl_3$ as an initiator. The Percentage conversion of these samples has been tabulated in table I. From table it can be observed that the percentage conversion depends upon the concentration of the initiator. As the amount of initiator increases, polymerization of respective units also increases due to increased oxidation of monomer units. Similarly with increase in the relative percentage of pyrrole monomer, yield increases. This could be attributed to the fact that $FeCl_3$ supports polymerization of pyrrole.

The dielectric constant for the samples synthesized with 0.1M initiator concentration shows two transitional peaks whereas samples synthesized with 0.25M initiator concentration show only one transitional peak. This may be due to the collision of monomer units with the salt ($FeCl_3$ ions) species in the solution, disturbing their internal geometry. Further the copolymer chain is heterogeneous, hence both the monomer units respond differently to the applied frequency and hence variations have been observed.

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