Dielectric Studies on Polyethylene Oxide Thin Film by Spin Coating Technique

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Abstract: In this work reported the dielectric behavior of Polyethylene oxide complexes with sodium bicarbonate on well cleaned glass substrate. The thin samples were prepared by spin coating technique with different solvents. Dielectric constant and electrical impedance values are determined and tabulated.

Keywords: Polyethylene Oxide, Thin film, Spin coating technique.

1.1 INTRODUCTION

Thin film science and technology plays an important role in the high-tech industries. Thin film technology has been developed primarily for the need of the integrated circuit industry. The demand for development of smaller and smaller devices with higher speed especially in new generation of integrated circuits requires advanced materials and new processing techniques suitable for future Giga Scale Integration (GSI) technology. Polymers are playing important role than silicon because they are cheaper and more biocompatible. Sabiha Sultana et al [1] presented a paper on Preparation, morphology, and thermal and optical properties of thin films of ferric chloride/polyethylene oxide composites by solution cast technique. U. Sasikala et al [2] presented a paper on structural, electrical and parametric studies of PEO based polymer electrolyte battery applications. Jibril Al-Hawarin et al [3] presented a paper on Dielectric and thermal properties of PEO doped with Cadmium Chloride salt. They investigate the effect of salt concentration on the dielectric properties and melting behaviour of PEO/$CdCl_2$ complexes. The dielectric study was carried out over a frequency range 10-335 kHz and a temperature range 25°C-450 °C.

2.1 MATERIAL AND METHODS

2.1.1 Solution preparation

The solution of Polyethylene oxide is prepared by using Water and Methanol as solvent at different concentrations. The different weight percentage solutions are prepared by dissolving a known quantity of polymer in Water and Methanol. The weight of the solute is measured by using the digital balance.

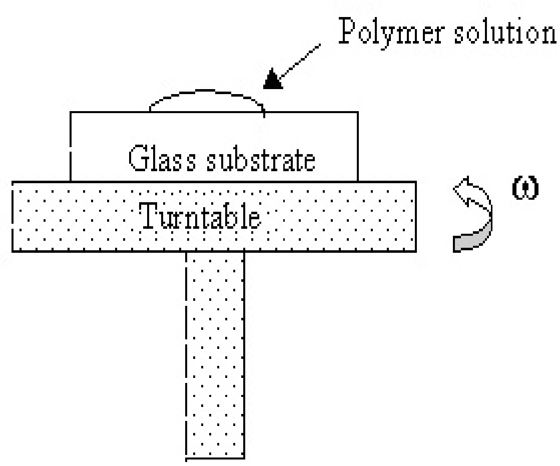

Fig (2.1) Schematic diagram of the Spin -Coating Process

2.1.2 Cleaning of substrate

The substrate must be cleaned well before coating the prepared solution. The glass substrate is used for studying optical properties of thin film. The glass substrate was cleaned using the soap solution, and then rinsed with distilled water. Finally, the glass substrate is cleaned with acetone using filter paper.

2.1.3 Spin coating technique

The polymer solution is deposited onto the substrate surface. Then the substrate is rotated to a very high speed step to thin the polymer solution. Then the substrate is dried well, so that Methanol evaporates, leaving the polymer film over the surface of the substrate.

3.1 RESULTS AND DISCUSSION

3.1.1 Dielectric Constant

The variation of dielectric constant with frequency has been tabulated in the table (3.1A, 3.1B, 3.1C, 3.1D). According to this table we can say that the PEO and PEO complexes with NaHCO3 thin films have low dielectric constant at higher frequency due to space charge polarization effect [4]. The dielectric behavior of PEO and PEO complexes with $NaHCO_3$films were shown in figure (3.1A, 3.1B, 3.1C, 3.1D).

Table :(3.1A) Variation of Dielectric Constant with Frequency

Material	Frequency(Hz)	Dielectric Constant
PEO Dissolved In Water	$1.00x10^6$	4.27
	$7.94 x10^5$	9.49
	$3.16 x10^5$	3.77
	$1.26 x10^4$	3.28
	63.1	2.57
	39.8	55.8

Table :(3.1B) Variation of Dielectric Constant with Frequency

Material	Frequency(Hz)	Dielectric Constant
PEO Dissolved In Methanol	$1.00 x10^6$	13.8
	$5.01 x10^5$	8.92
	$1.00 x10^5$	15.2
	79.4	8.31
	12.6	7.90
	3.98	20.5
	3.16	5.58

Table :(3.1C) Variation of Dielectric Constant with Frequency

Material	Frequency(Hz)	Dielectric Constant
$PEO + NaHCO_3$ Dissolved In Water	1.00 $x10^6$	5.75
	3.98 $x10^5$	4.25
	1.26 $x10^3$	5.70
	50.1	44.7
	25.1	12.1
	20	148
	3.16	9.14

Table :(3.1D) Variation of Dielectric Constant with Frequency

Material	Frequency(Hz)	Dielectric Constant
$PEO + NaHCO_3$ Dissolved In Methanol	1.00 $x10^6$	11.3
	3.98 $x10^5$	31.7
	39.8	24.1
	31.6	23.7
	15.8	15.1

PEO IN WATER

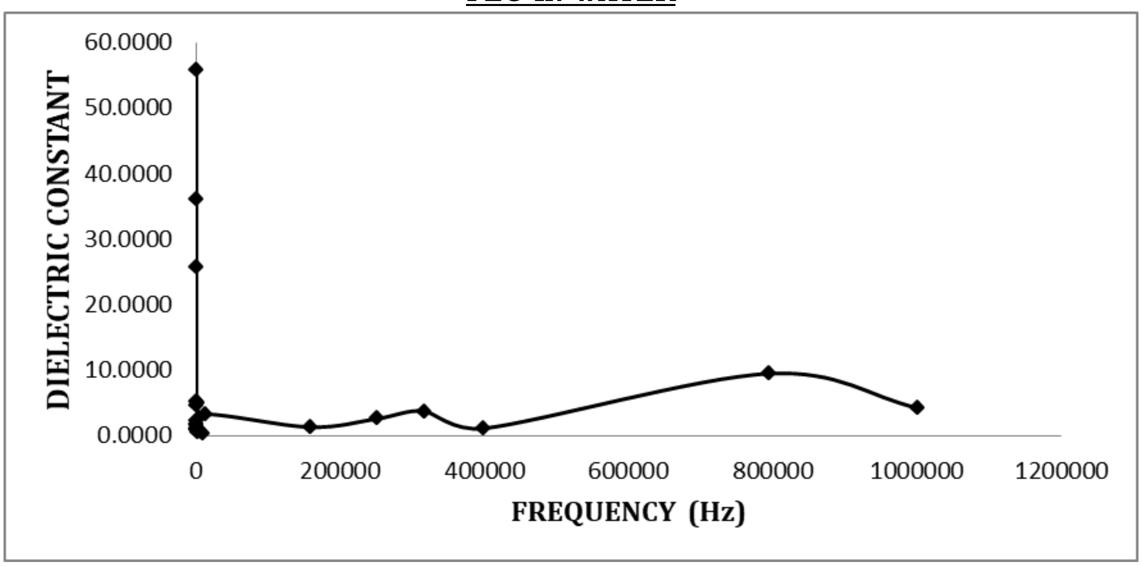

Fig :(3.1A) Variation of Dielectric Constant with Frequency

PEO IN METHANOL

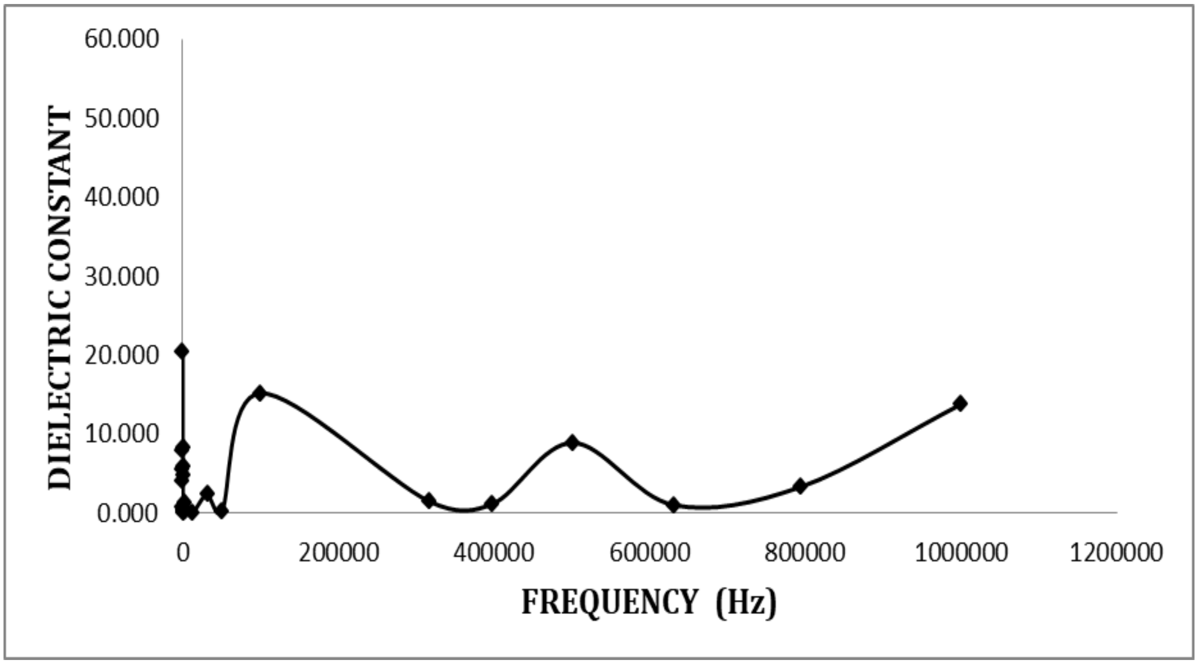

Fig :(3.5B) Variation of Dielectric Constant with Frequency

PEO+ $NaHCO_3$ IN WATER

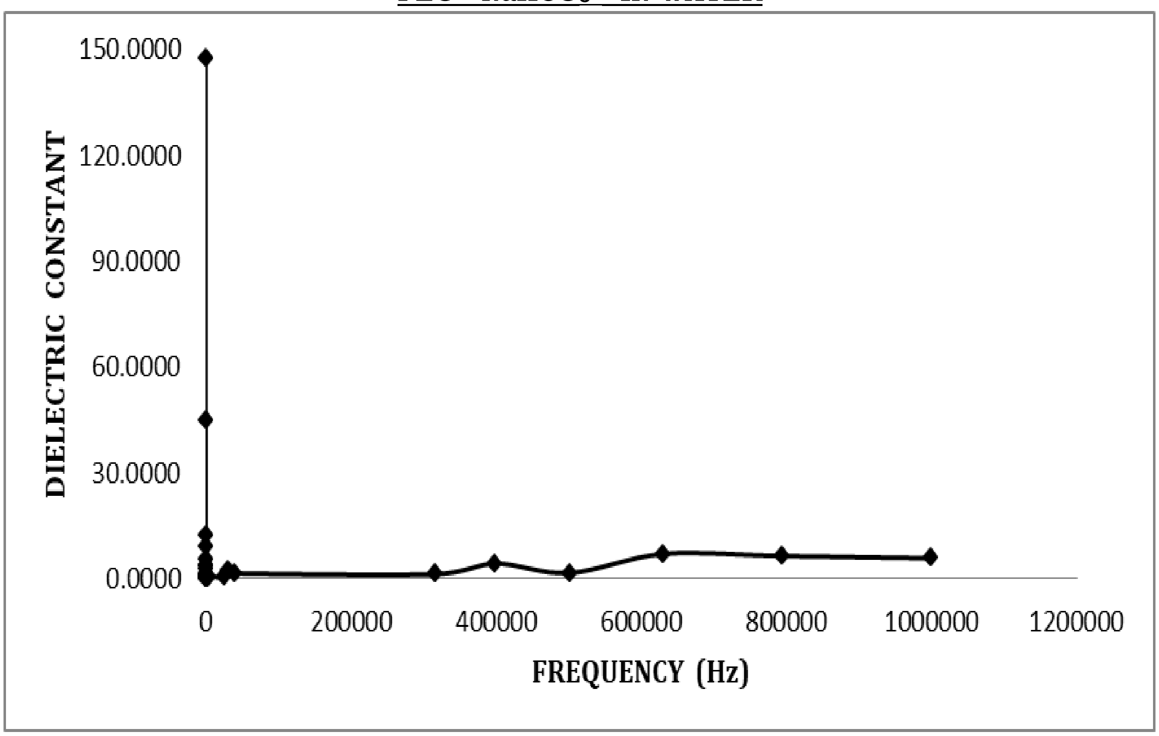

Fig :(3.1C) Variation of Dielectric Constant with Frequency

PEO+ $NaHCO_3$ IN METHANOL

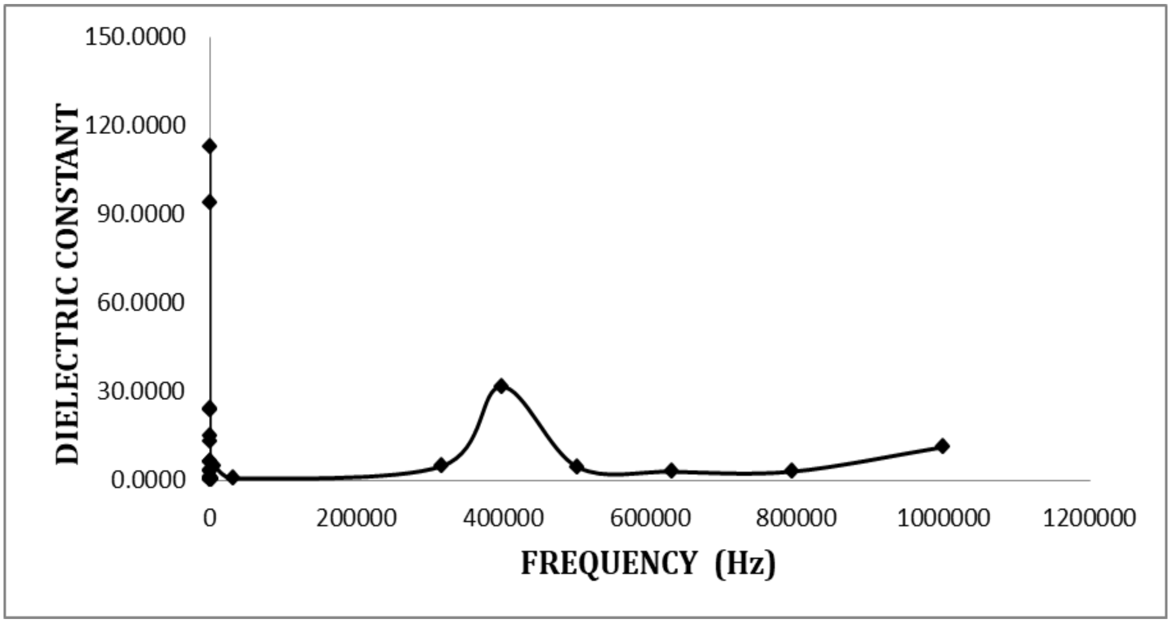

Fig :(3.1D) Variation of Dielectric Constant with Frequency

3.1.2 Impedance Measurement

The graph is drawn between the impedance with frequency of PEO and PEO complexes with $NaHCO_3$ thin films were shown in the figure (3.2A, 3.2B, 3.2C, 3.2D), the values of impedance with corresponding frequency is tabulated in table (3.2A, 3.2B, 3.2C, 3.2D). According to the table, the value of impedance decreases with increasing the frequency [5]. From this impedance value the dielectric constant were measured with corresponding frequency. The value of dielectric constant is tabulated in the table (3.1A, 3.1B, 3.1C, 3.1D).

Table (3.2A) Variation of Impedance with Frequency
PEO IN WATER

Frequency(Hz)	Impedance(Ω)
1.00×10^6	9.88×10^2
3.16×10^5	3.54×10^3
1.26×10^4	1.02×10^5
3.16×10^3	1.65×10^6
1.00×10^3	8.57×10^6
3.16×10^2	1.41×10^7
31.6	2.90×10^7
5.01	4.93×10^8
1.58	7.38×10^7

Table (3.2B) Variation of Impedance with Frequency
PEO IN METHANOL

Frequency(Hz)	Impedance(Ω)
1.00 x10^6	1.76 x10^2
3.16 x10^5	5.05 x10^3
1.00 x10^5	1.59 x10^3
3.16 x10^4	3.22 x10^4
3.16 x10^3	1.37 x10^6
3.16 x10^2	4.78 x10^7
1.58 x10^2	2.63 x10^7
25.1	2.23 x10^8
3.16	1.37 x10^8

Table (3.2C) Variation of Impedance with Frequency
PEO+ $NaHCO_3$ IN WATER

Frequency(Hz)	Impedance(Ω)
1.00 x10^6	4.17 x10^2
3.16 x10^5	6.14 x10^3
3.16 x10^4	3.25 x10^4
3.16 x10^3	1.28 x10^6
1.00 x10^3	6.76 x10^6
1.00 x10^2	2.14 x10^7
10	2.18 x10^8
3.16	8.30 x10^7
1.00	1.08 x10^7

Table (3.2D) Variation of Impedance with Frequency
PEO+ $NaHCO_3$ IN METHANOL

Frequency(Hz)	Impedance(Ω)
1.00 x10^6	4.07 x10^2
3.16 x10^5	3.00 x10^3
3.16 x10^4	1.99 x10^5
3.16 x10^3	4.15 x10^6
1.00 x10^3	8.07 x10^6
3.16 x10^2	1.18 x10^7
1.00 x10^2	7.32 x10^6
31.6	6.13 x10^6
3.16	1.11 x10^8

PEO IN WATER

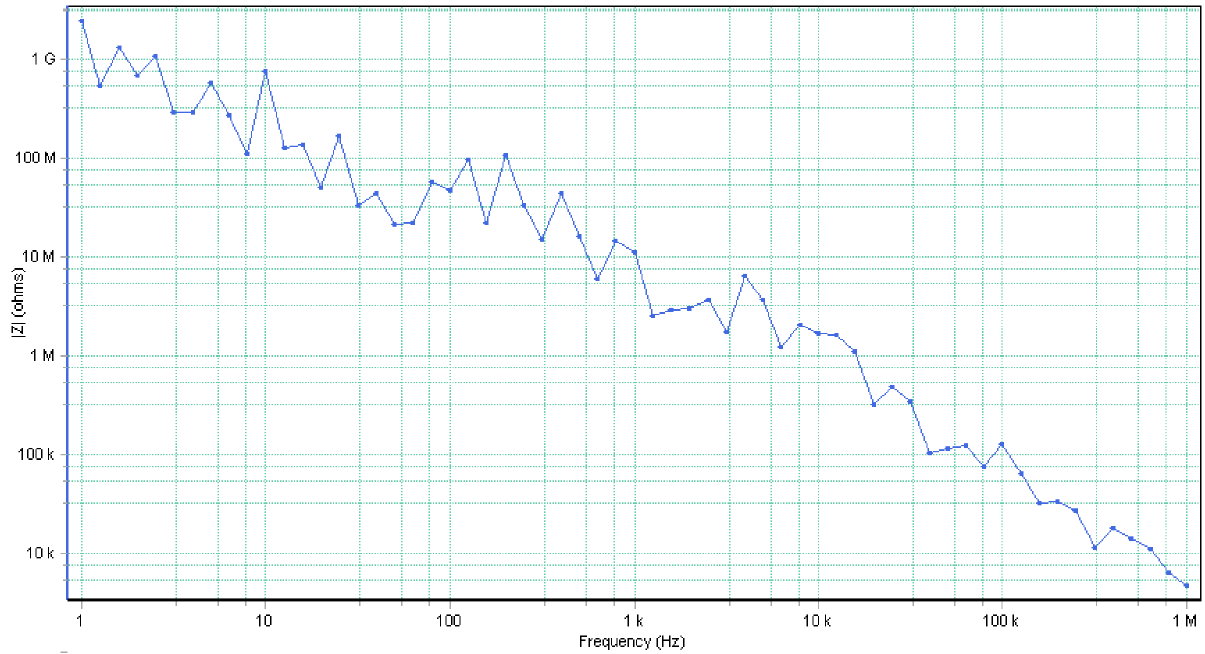

Fig :(3.2A) Variation Of Impedance With Frequency

PEO IN METHANOL

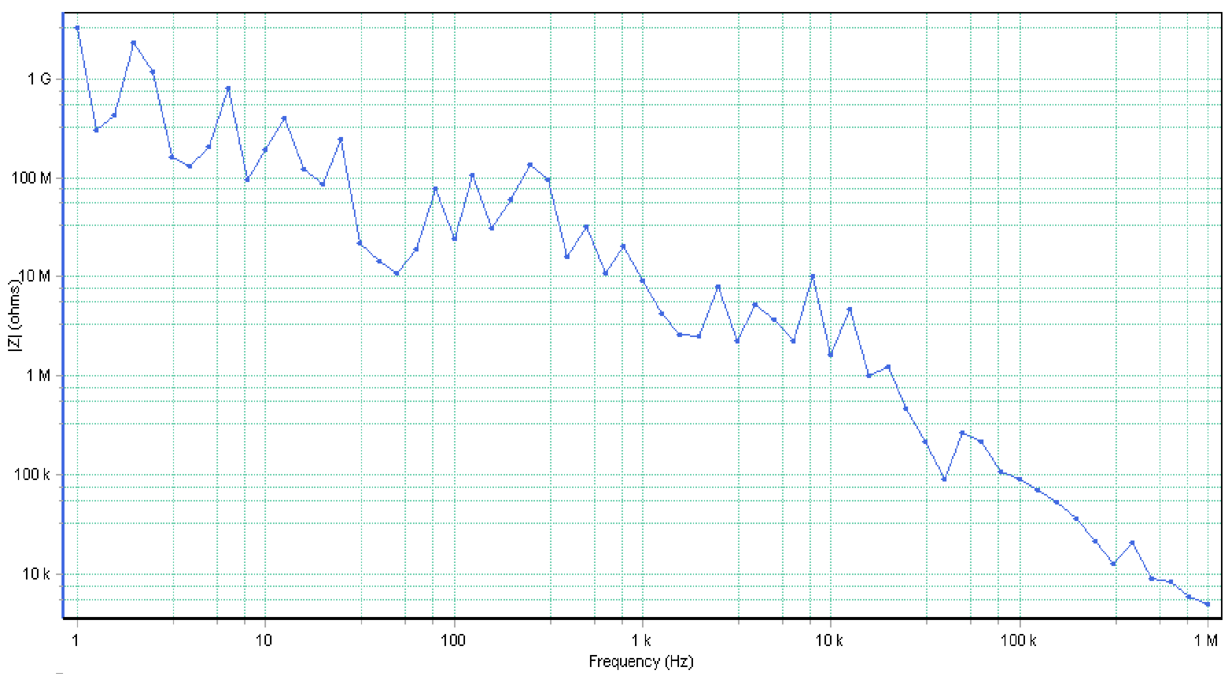

Fig :(3.2B) Variation Of Impedance With Frequency

PEO+ $NaHCO_3$ IN WATER

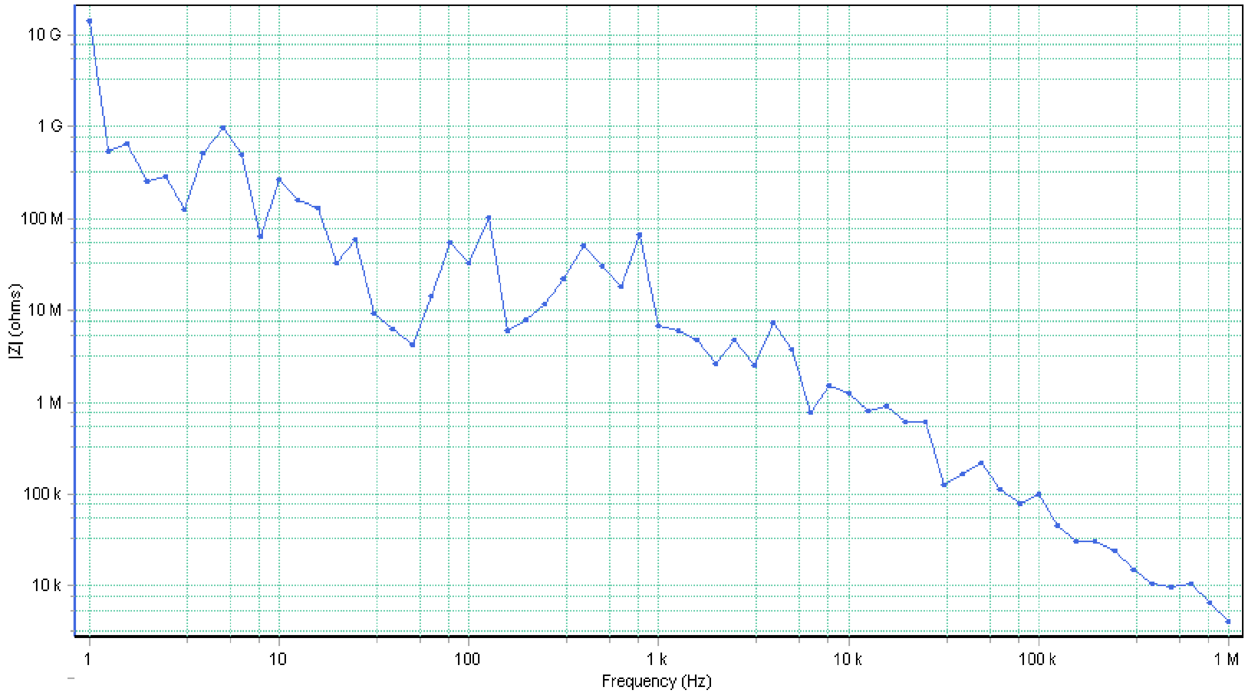

Fig :(3.2C) Variation Of Impedance With Frequency

PEO+ $NaHCO_3$ IN METHANOL

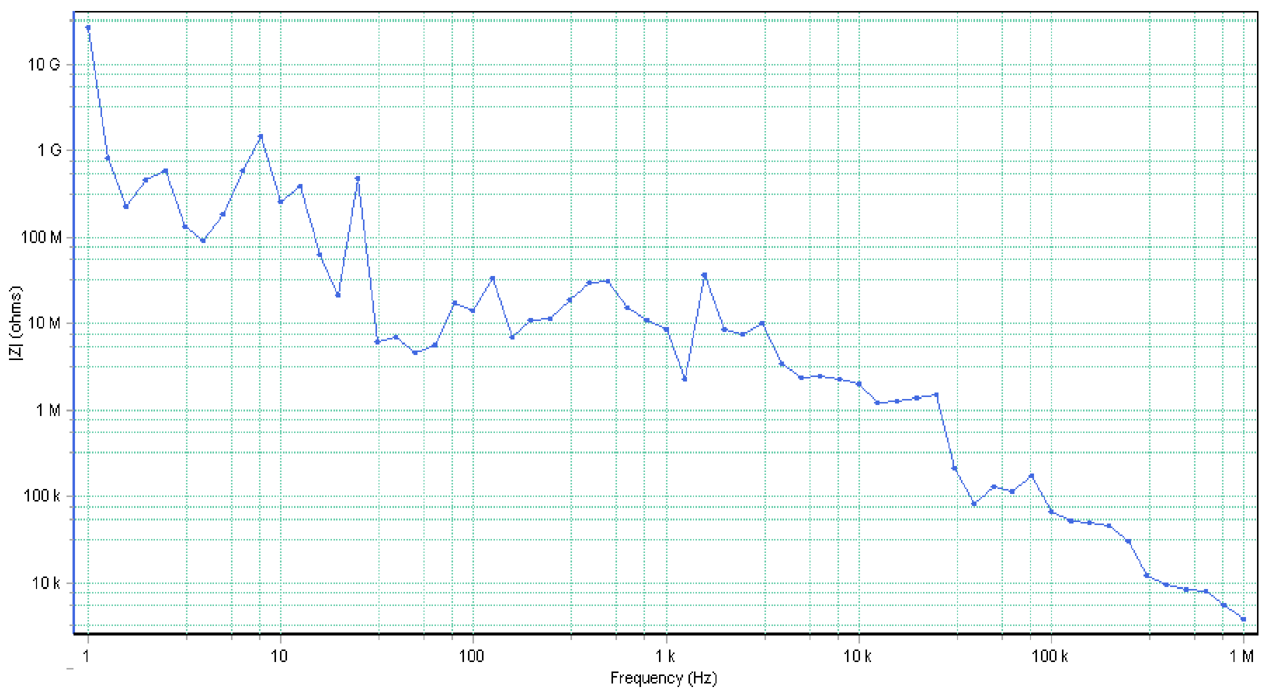

Fig :(3.2D) Variation Of Impedance With Frequency

4.1 CONCLUSION

In the present case, the PEO and PEO complexes with $NaHCO_3$ film has been successfully prepared by spin coating technique using solution casting method. Impedance measurements were done using impedance Spectroscopy. In this study we obtained the impedance values for various frequencies. From this study we got, the value of impedance decreases as the frequency increased. So the conductivity increases when the frequency is increased. The dispersion of dielectric constant with frequency was examined and tabulated. The PEO and PEO complexes with $NaHCO_3$films have large dielectric constant.

5.1 References

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