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Study of Temperature and Frequency Dependent Physical Properties of Conducting Polymer

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ABSTRACT

In recent years, considerable attention was given to the uses conducting polymers. As one of the most important conducting polymers, polyaniline because of its chemical stability and relatively high conductivity and its derivatives have been extensively studied in different fields of science because of the demand for high performance materials in advanced technologies. In the current studies, polyaniline (PANI) and its composites with semiconductor was prepared chemical oxidation method in the presence of different bronsted acids from aqueous solutions. The effect of thermal treatment on electrical conductivity (DC, AC), and dielectric constant of the pure PANI, PANI+10% ZnO, PANI +15% ZnO and PANI +20% ZnO, conducting polymers were investigated. It is found that conductivity of PANI enhancing due to stretching polymeric chain cause due to interaction with ZnO.

I. INTRODUCTION

Organic polymer is a large high molecular weight molecule built up by the repetitions of small simple chemical unit called monomer. They contain a carbon, hydrogen as major element. Essentially almost all of the known organic polymers were insulators at room temperature. Conductive organic polymers often have aromatic unit with a charge. This creates a band structure like silicon, but with localized states. This conductivity property in pure polymer is enhanced by oxidation doping. The group of the post doctoral researches discovered conducting polymers and the ability to dope these polymers over the fall range from insulator to metal. This was particularly exciting because it created a new field of research on the boundary between chemistry and condensed matter. Conducting polymers opened the way to progress in understanding the fundamental chemistry and physics of π-bonded macro-molecules. Conducting polymers offered the promise of achieving a new generation of polymer which exhibit the electrical and optical properties of metals or semiconductors and which retain the attractive mechanical properties and processing advantage of polymer.

II. EXPERIMENTAL

1) D.C.ELECTRICAL CONDUCTIVITY:

Electrical conductivity of the synthesized conducting polymer was measured by resistively measurement technique. The resistance in the pellet form prepared under the hydraulic pressure was done by conventional method. There are two methods generally employed for resistance measurement of the sample.

A. Four probe method.
B. Two probe method or LCR technique.

2) A.C. CONDUCTIVITY:

A.C. conductivity of a polymer compound is given by quantum mechanically tunneling model. This shows

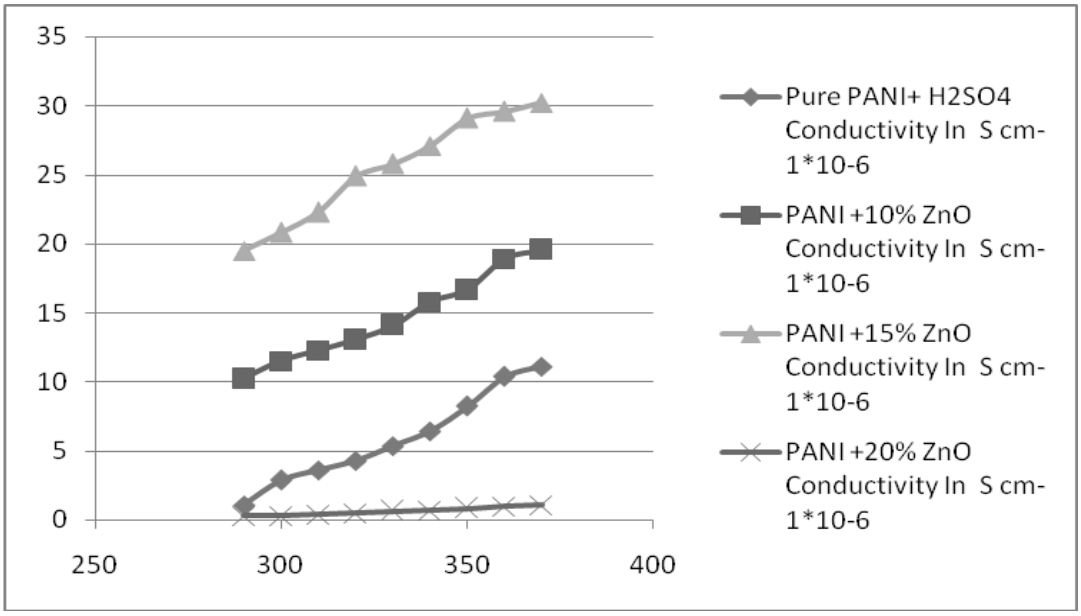
that frequency may be a temperature dependent. Pike and Elliot have suggested that a.c. conductivity is a phenomenon due to hopping of charge carries over the barrier. The increase of conductivity with frequency is due to the presence of various kinds of in- homogeneity present in the material. The most interesting observation is that conductivity is frequency dependent rather than temperature dependent in a.c. conductivity.

TABLES AND GRAPHS:

1) D.C.ELECTRICAL CONDUCTIVITY: At V_{DC} = 5V

Table 1

Temp in ^0K	Pure PANI+ H_2SO_4 Conductivity In S $cm^{-1}*10^{-6}$	PANI +10% ZnO Conductivity In S $cm^{-1}*10^{-6}$	PANI +15% ZnO Conductivity In S $cm^{-1}*10^{-6}$	PANI +20% ZnO Conductivity In S $cm^{-1}*10^{-6}$
290	1.073	10.219	19.5	0.285
300	2.861	11.508	20.8	0.32
310	3.612	12.297	22.3	0.4
320	4.292	13.041	24.9	0.503
330	5.365	14.109	25.8	0.618
340	6.439	15.785	27.1	0.709
350	8.229	16.65	29.1	0.823
360	10.375	18.935	29.6	0.982
370	11.113	19.561	30.2	1.086

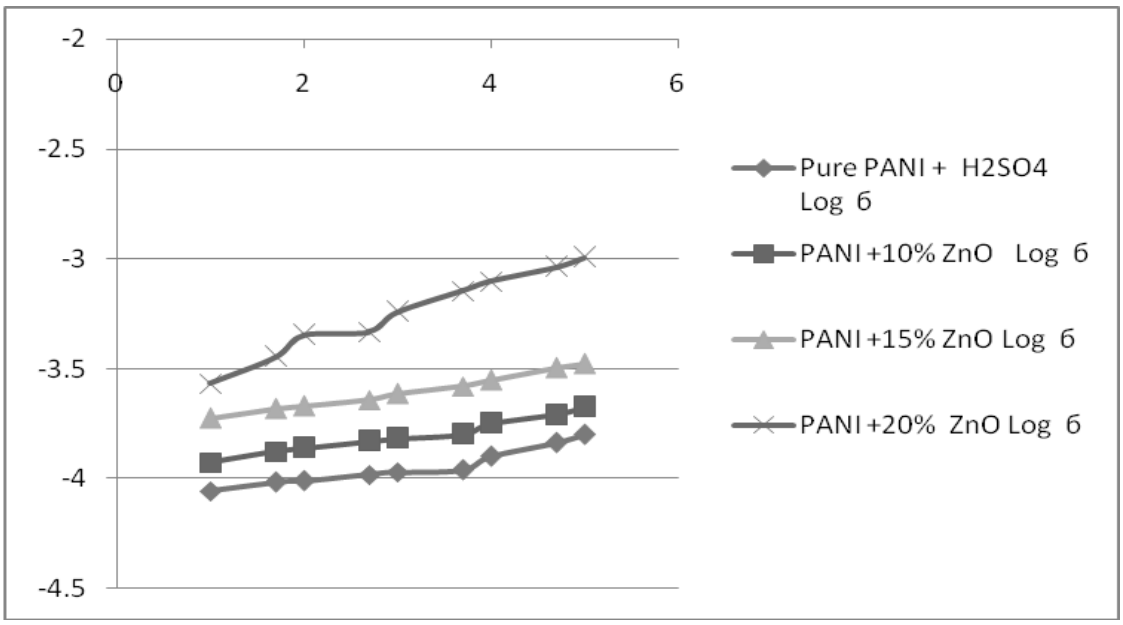


Graph 1

Table 2

Frequency in Hz (w)	Log w	Pure PANI + H_2SO_4 Log б	PANI +10% ZnO Log б	PANI +15% ZnO Log б	PANI +20% ZnO Log б
10	1	-4.057	-3.926	-3.724	-3.5667
50	1.6989	-4.015	-3.877	-3.682	-3.4472
100	2	-4.009	-3.861	-3.668	-3.347
500	2.6989	-3.981	-3.832	-3.643	-3.332
1000	3	-3.97	-3.819	-3.613	-3.2428
5000	3.6989	-3.96	-3.799	-3.579	-3.1469
10000	4	-3.899	-3.75	-3.553	-3.103
50000	4.6989	-3.837	-3.711	-3.496	-3.0374
100000	5	-3.8	-3.676	-3.478	-2.996

2) A.C. ELECTRICAL CONDUCTIVITY: At V_{AC} = 5V



Graph 2

III. RESULTS

1) D.C.ELECTRICAL CONDUCTIVITY:

From the above graph it is indicates that the conductivity of pure polyaniline with H_2SO_4 is explained by hopping mechanism other graphs conductivity of polymers now follows very well. So conductivity of polymer is explained by polaron, biopolarons i.e. hoping mechanism.

As the composition ZnO is added in pure PANI with H_2SO_4 the conductivity of a compound increases. This increase in conductivity shows that the compound become more stretched as compare to pure PANI. As the composition % increases in PANI nature of graph tells that the semiconductor nature arises in compound. As the temp increases, composite PANI shows the semiconductors enhancing conducting property.

2) A.C.ELECTRICAL CONDUCTIVITY:

Plot of log б (w) verses log w at temperature 350^0K for synthesis polymer is shown in graph. From graph it concludes that the conductivity increases with frequency. The characteristic property remains same equal to d.c. conductivity. A.C. conductivity starts at onset frequency. The most interesting observation is that a.c. conductivity attain saturation value at 10^5-10^6 Hz which means that synthesis polymers under study follows the relation

$$\sigma(w)\alpha \text{ Frequency}$$

This frequency dependence is explained as an increase in frequency change in orientation of charges occurs. As frequency increases more fastly orientation occur which results the formation of thermal energy. This rising temp stretched the polymer chain and causes more conduction.

IV. CONCLUSION

From the above studies we have observed that the value of D.C. & A.C. conductivity unusually enhanced by doping polymerization of polyaniline. Again this conductivity enhanced by polymerization with ZnO semiconductor powder. The enhancing conductivity has been attributed due to stretching polymeric chain cause due to interfacial interaction with ZnO

crystallides. This conductivity in pure PANI and its composites is due to hopping mechanism.

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