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AC Conductivity and Dielectric Behavior of Ethyl Cellulose/Polyvinyl Alcohol Polyblend Thin Films

Abstract

The study investigates the AC conductivity and dielectric behavior of ethyl cellulose (EC) and polyvinyl alcohol (PVA) polyblend thin films, aiming to explore their potential applications in electronic and dielectric devices. The objective of this study is to analyze the electrical conductivity and dielectric constant of Ethyl Cellulose (EC) blended with polyvinyl alcohol (PVA) at different temperatures (303K,313K, 323K, 333K, and 343K) and across a frequency range of 1 kHz to 1 MHz's Measurements were conducted using a 4284 LCR meter. The results indicate that the AC conductivity of the thin film changes with temperature for all frequency values and also increases with frequency at a constant temperature. Additionally, the dielectric constant exhibits variations with increasing temperature in the polymer blends.

Keywords: Ethyl Cellulose, Polyvinyl alcohol, dielectric constant, conductivity, polyblend

Introduction

Polymer-based thin films have gained significant attention in recent years due to their promising electrical, dielectric, and mechanical properties, making them suitable for applications in flexible electronics, energy storage devices, and insulating materials. Among various polymeric materials, ethyl cellulose (EC) and polyvinyl alcohol (PVA) have emerged as excellent candidates due to their biocompatibility, film-forming ability, and dielectric characteristics.[1,2]

AC conductivity plays a crucial role in determining the charge transport mechanism in polymer thin films [3]. Polymeric materials play a crucial role in both everyday applications and high-tech industries such as electronics, aerospace, and medicine. Due to their wide-ranging applications, these materials have been a significant focus of research in recent years [4]. In recent years, because of the need for electrostatic charges dissipation, electromagnetic shielding etc, new polymers with electrical conductivity have been formulated. The importance of polymers is mainly because polymers are still regarded as a cheap alternative material that is manufactured easily. In polymer nanocomposites conductivity depends on various factors such

3 as filler morphology, size, loading concentration, and interfacial interaction. The dramatically larger chain-particle interface area in the case of nanocomposites makes effects appearing negligible in microcomposites very prominent in Nano composites [5, 6]. Therefore, The polymer blends composed of Ethyl Cellulose (EC) and polyvinyl alcohol) (PVA) have been widely investigated.

2. Experimental

2.1. Materials

Ethyl cellulose and polyvinyl alcohol were supplied by SIGMA –ALDRICH, and Ethanol and
1 double distilled water are being used as a solvent for polyblending process. In the present work, thin films were prepared by isothermal evaporation technique.

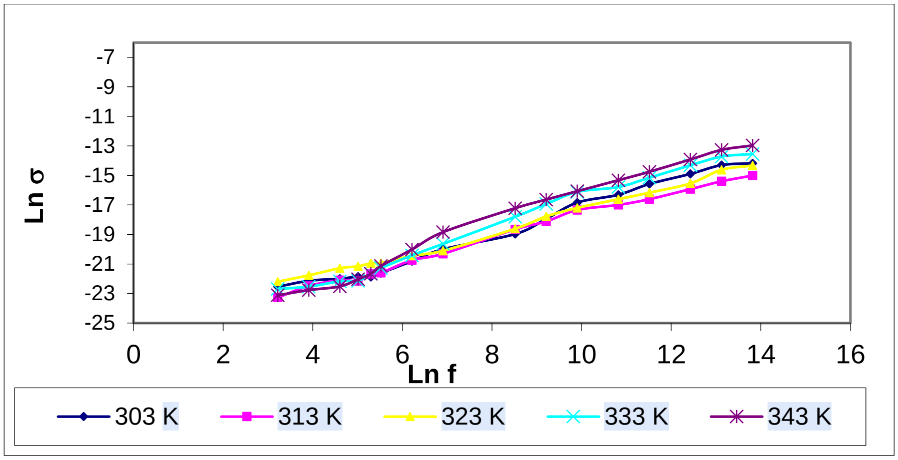
Preparation of blends

11 The two polymers EC and PVA were taken in the different weight ratios 1:1, dissolved in two different solvents Ethanol and double distilled water separately. Preparing individual EC and PVA Solution & mix the two solution &stir combined solution for 30minutes until a uniform, viscous solution is formed then
5 add dopant as phosphoric acid (5%) dissolved in prepared blended solution of EC and PVA. The solution was then heated at 60°C for one hour to yield clear solution. A glass plate (15cm x15cm) cleaned with hot water and then with acetone was used as a substrate. pour the blended
15 solution in to the glass plate aloe the solution to air dry at room temperature for one day to form homogeneous films after drying the films will be obtained [7].

3. Results and Discussion

1 ### 3.1. AC Electrical Conductivity and Dielectric Constant Studies

Figure 1 (a) shows the relation between ac conductivity and frequency at different constant temperatures 303K, 313K, 323K, 333K and 343K. Plot shows rise in conductivity with increasing frequencies from 1 KHz to 1MHz. The rise of conductivity upon increasing the frequency and temperature is a common respond for polymeric and semiconductor samples. It is due to the tremendous increase of the mobility of charge carriers in the composite film i.e. at higher frequencies blends of molecules starts vibrating with large amplitude within the polymeric chains hence the effect of increase in conductivity of blends



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a) 1:1 EC-PVA (5% PA)

4 **Fig 1 (a): Variation between Ac Conductivity and Frequency at Different Constant Temperatures**

Figure 1 (b) shows the relation between dielectric constant and frequency at different constant temperatures 303K 313K, 323K, 333K and 343K. Plot shows dielectric constant decreasing with increasing frequencies from 1 KHz to 1MHz.. The decrease of dielectric constant with increasing frequency is the expected behaviour in most dielectric materials. This is due to dielectric relaxation which is the cause of anomalous dispersion. From a structural point of view, the dielectric relaxation involves the orientation polarization which in turn depends upon the molecular arrangement of dielectric to be material. So, at higher frequencies, the rotational motion of the polar molecules of dielectric is not sufficiently rapid for the attainment of equilibrium with the field, hence dielectric constant seems to be decreasing with increasing frequency [8]

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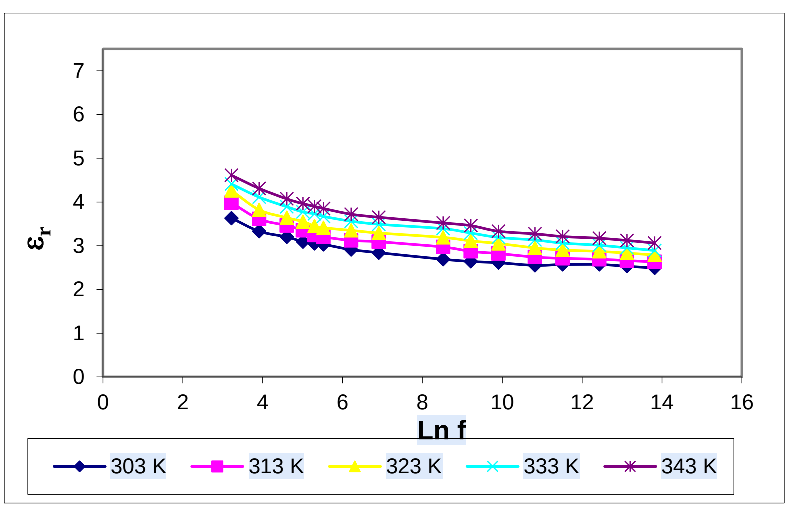

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a) 1:1 EC-PVA (5% PA)

1 **Fig 1 (b): Variation between Dielectric Constant and Frequency at Different Constant Temperatures.**

Conclusion

AC electrical conductivity and dielectric constants have been measured at different temperatures and at the different frequencies, it is found that ac conductivity of thin film increases with increase in temperature for all values of frequencies and it increases with increase in frequencies at constant temperature. The decrease of dielectric constant with increasing frequency is the expected behaviour in most dielectric materials. This is due to dielectric relaxation which is the cause of anomalous dispersion. From a structural point of view, the dielectric relaxation involves the orientation polarization which in turn depends upon the molecular arrangement of dielectric to be material. So, at higher frequencies, the rotational motion of the polar molecules of dielectric is not sufficiently rapid for the attainment of equilibrium with the field, hence dielectric constant seems to be decreasing with increasing frequency.

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