

# Dielectric Constant Properties of UV- irradiated Pure and Polyblends Polystyrene- Polyvinyl acetate Thin Films

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## Abstract

The main objective of this study is to determine the dielectric constant ( $\epsilon_r$ ) of UV-radiation irradiated pure PS (polystyrene), pure PVAc (poly vinyl acetate) and Polyblends of PS-PVAc at varying temperature and also at the different frequencies (1 KHz to 1MHz) using 4284 LCR source meter. It is found that the dielectric constant varies with the temperature of pure and blends. From the results, it was also attributed that as these polymer thin films are exposed to UV radiation, their dielectric constant varies with temperature.

**Keywords:** Polystyrene (PS), Polyvinyl acetate (PVAc), Polyblends of PS-PVAc, Dielectric constant, UV-radiation

## 1. Introduction

Polymer blending is one of the most important contemporary ways for the development of new polymeric materials. Polymeric materials are exclusively recognized by its uses of day-today life as well as in high-technology industries such as electronics, aerospace and medicine. So polymeric materials have been in the greater scope through research interest in the past few years because of their importance in applications in many areas. The correlation between their atomic structures and their behavior towards various properties has been studied extensively theoretical and experimental approach for many years. The electrical and structural properties of polymeric material studied by using different type of solvents during the synthesis process of polymeric materials. Beth A. Miller-Chou *et al* [1] studied effects of various solvents on extensive properties of synthesized material. So it remarkable that the properties of the solvents used in synthesis processes are very critical for surface formation in of these polymer material. Solvent properties such as polarity, volatility and specific interaction properties with the polymer material are very important factors in the process of the surface formation and defect formation. The polymer blends composition of polystyrene (PS) and poly (vinyl acetate) (PVAc) have been widely investigated. "The copolymer of PS and PVAc is a typical amphiphilic system in which the PS segment is hydrophobic and the PVAc segment is hydrophilic" [2]. Remarkable research has been performed on the graft copolymer of PS and PVAc, including their micelle behavior.

Mohammed M. Kummali *et-al* studied the phase separation process of the polymer blend thin films and also synthesized polystyrene in toluene at a 4% solution concentration. Atomic forced microscopy of polystyrene gives meticulous information about the topographical features and the mechanical phase shift imaging of the sample. This phase shift can be correlated with specific mechanical properties which affect sample interaction confirmed by quantitatively measuring the value of the dielectric permittivity [3-4].

The present paper focused on studies of solvent effects in AC electrical conductivity and dielectric constants at different temperatures of polyblends (PS-PVAc). The solvent plays a very crucial role while mixing two or more different types of polymer material.

## 2. Experimental

Poly (styrene) and Poly(vinyl acetate) were supplied by SIGMA –ALDRICH, Co., 3050 spruce street, St. Louis. MO 63103 USA 314-771-5765. Tetrahydrofuran (THF-E-Merck India Ltd., Mumbai) is being used as a solvent for poly-blending process. In the present work, thin films were prepared by isothermal evaporation technique.

### 2.1. Preparation of Blends

Poly (styrene) and poly (vinyl acetate) were dissolved in tetrahydrofuran (THF). Stirring was continued for one hour before deposition of film. The total concentration of the polymeric mixture in solvent was kept 5%. Films of polymer blends were prepared by isothermal evaporation technique.

### 2.2. Measurements

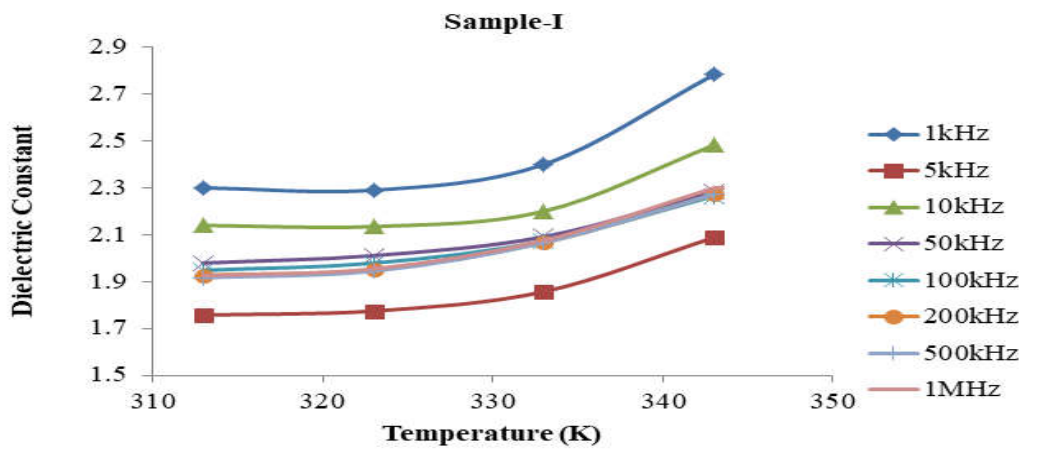
The ac frequencies were applied (in the range 1 KHz –1 MHz) across the all samples by using the 4284 A precision LCR source meter (20 Hz –1 MHz) [Agilent Technologies, Singapore].

## 3. Results and Discussion

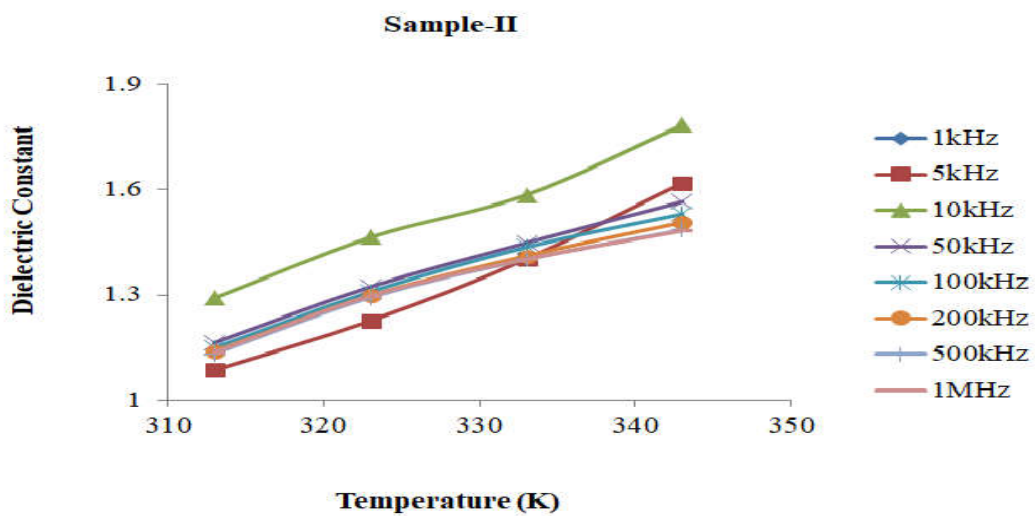
### 3.1. Dielectric Constant Studies

Synthesized Unexposed polymer thin films which were named as pure PS (Sample-I), pure PVAc (Sample-II), Polyblend of PS-PVAc (Sample-III) and UV-irradiated (expose) polymer thin films were named as pure PS UV-irradiated (Sample-IV), pure PVAc UV-irradiated (Sample-V), Polyblend of PS-PVAc UV-irradiated (Sample-VI).

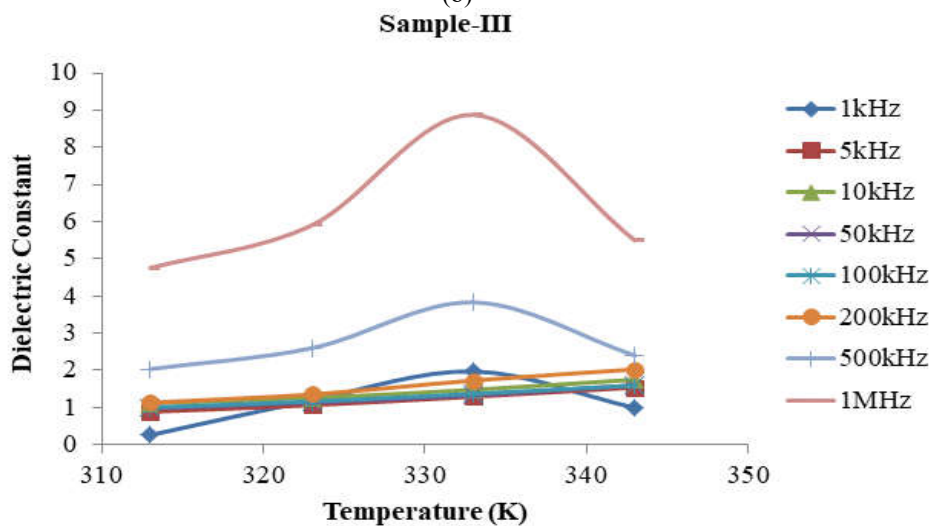
Figure 1(a, b and c) shows the relation between dielectric constant( $\epsilon_r$ ) and frequency at different constant temperatures 313K, 323K, 333K and 343K. Plot shows rise in dielectric constant with increasing temperatures. The rise of dielectric constant due to increasing temperature is a common respond for polymeric samples [5-6].



(a)



(b)



(c)

**Fig.1 (a, b and c): Variation between dielectric constant ( $\epsilon_r$ ) with temperatures.**

From graphs depicts that sample -III shows maximum dielectric constant among sample-I and sample-II. It is due to the tremendous increase in the mobility of charge carriers in the composite film [7].

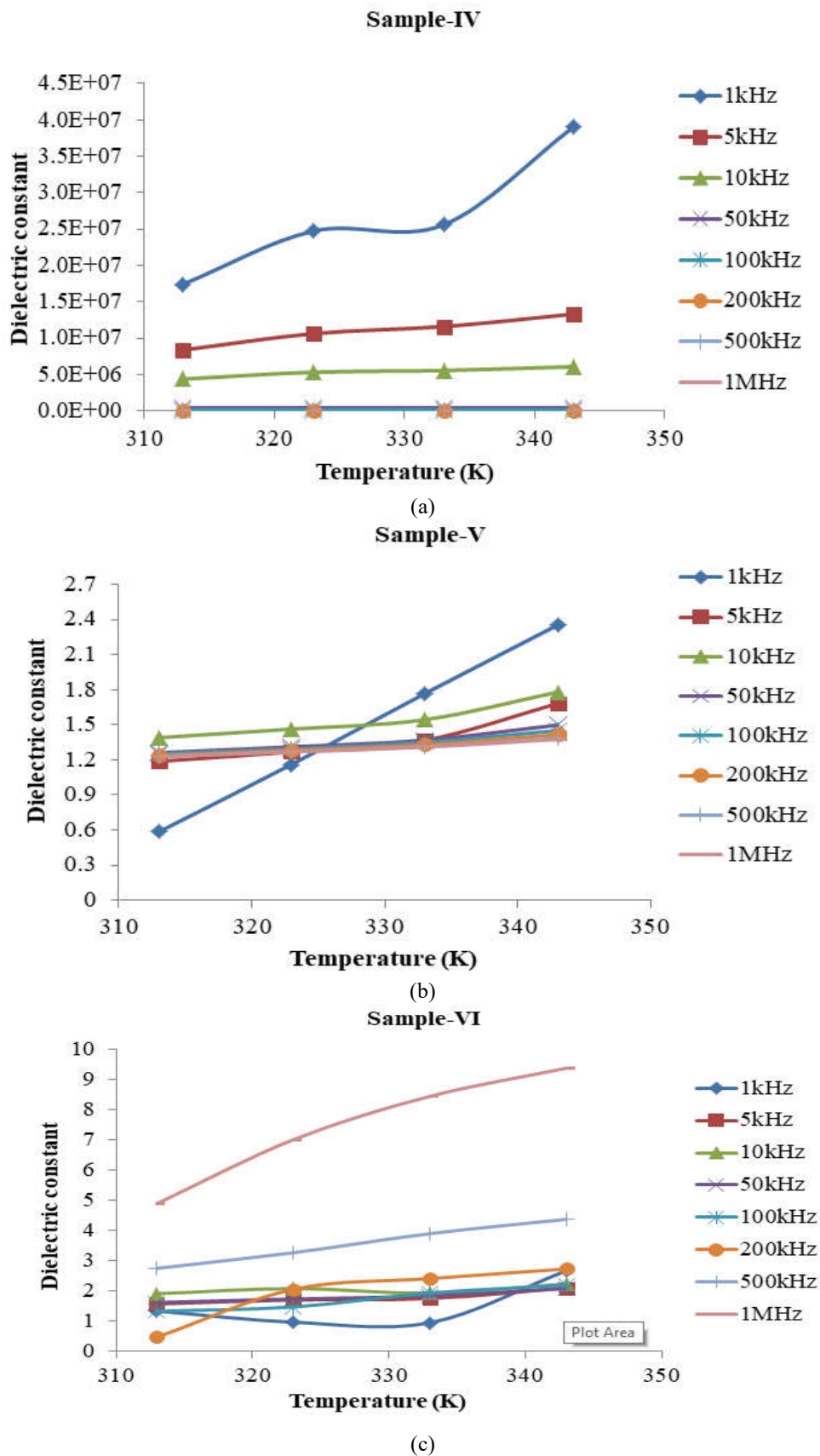


Fig.2 (a, b and c): Variation between dielectric constant ( $\epsilon_r$ ) with temperatures.

When these polymer films were exposed to ultra-violet (UV) radiation, then following outcomes were illustrated in figure 2 (a, b and c). From these figures, it reveals that the dielectric constant increases with the irradiation dosage of UV- radiations were increases. This may be due to the formation of charge dangling bonds on the surfaces of the polymer when films are irradiated with UV- radiations. The increase of dielectric constant with temperature is due to the enhancement of polarization in the polymer film and also as the temperature increase, the chaotic thermal oscillations of molecules are intensified [8]. The outcome of induced radiation on polymers may increase the disorder of the dipole groups so the dielectric properties increase [9].

#### 4. Conclusion

From graphs it were attribute that dielectric constants have been measured at different temperatures and at the different frequencies, it is found that dielectric constant ( $\epsilon_r$ ) thin films increase with an increase in temperature for all values of frequencies and also it increases with irradiating with UV- radiations.

#### Conflict-of Interest

The authors have no conflict of interest to declare. All co- authors have seen and agree with the contents of the manuscript.

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