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The evaluation of dielectric properties of pure polyvinyl pyrrolidone films

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Abstract : Dielectric relaxation are studied by measuring simultaneously the capacitances (permittitivities) and the losses at regularly varying temperatures from 40 to 220°C and at different constant frequencies from 0.5 to 30 kHz, for different electrode configurations of pure polyvinyl pyrrolidone (PVP) films of 20 μm thickness. The capacitances are found to increase with the increase in temperature for similar electrode Al-PVP-Al system, however, in case of dissimilar electrode Al-PVP-Ag combinations, a shoulder peak is found at 105 ± 5°C and remaining variations are the same, as found in case of similar electrode system. The variation of permittivity with temperature is attributed to thermal expansion in the lower temperature region and the orientation of dipolar molecules in the neighbourhood of glass rubber transition temperature *Tg* (~170°C) of PVP. The variation of loss factor with temperature at different constant frequencies show two loss maxima, first at 90 ± 10°C and second at 108±10°C, below and near *Tg* of PVP, corresponding to α- and β-relaxations of the polymer which shift to lower temperatures as frequency is decreased. The increase in losses with the decrease of frequency is ascribed to the increase in conductivity of the polymer.

Keywords : Dielectric relaxation, isothermal immersion technique, polyvinyl pyrrolidone, dipole orientations, crystalline and amorphous phase.

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1. Introduction

Insulators (Polymers) are usually characterized by measuring capacitance (permittivity) and loss factor as a function of temperature and frequency [1]. These quantities are invaluable to engineers in their design of microelectronic equipments. The physicists on the other hand, are more interested in the microscopic processes responsible for the dielectric relaxation. Moreover, the study of dielectric loss factor as a function of temperature and frequency is one of the most convenient and sensitive methods of studying polymer structure. The evaluation of dielectric properties of polymer films is carried out by measuring simultaneously the capacitance and the loss factor over wide range of frequencies and temperature. Although, the dielectric properties of a number of polymers have been investigated in the last two decades [2-7], the molecular orientation behaviour and associated relaxation mechanisms are not fully understood. Very limited work has so far been done on polyvinyl pyrrolidone (PVP), a polymer of great utility in the field of electrical insulation, a growing polymer in the field of pharmaceutical sciences because of its ability to form complexes with many toxins, viruses, drugs; crosslinked PVP containing glycerine is used as a dialysis membrane and in prepefation of conductive coating for television or cathode ray tubes; the addition of PVP to polyoxymethylene improves heat stability and many other uses [8].

This paper reports the results of capacitance (permittivity) and loss behaviour of PVP as a function of temperature of frequency with using similar and dissimilar electrode combinations, with the aim of understanding the relaxation processes in PVP more clearly.

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