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Effect of Plasma Discharge Power on Activation Energies of Plasma Poly(Ethylene Oxide) Thin Films

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Abstract : Plasma Assisted Physical Vapor Deposition (PAPVD) method used to produce Poly(ethylene oxide) (pPEO) thin films. Depositions were progressed at various plasma discharge powers as 0, 2, 5 and 30 W for pPEO at 500nm film thicknesses. The capacitance and dielectric dissipation of the thin films were measured at 0,1-107 Hz frequency range and 173-353 K temperature range by an impedance analyzer. Then, alternative conductivity (σac) and activation energies were derived from capacitance and dielectric dissipation. σac of conventional PEO (PEO precursor) was measured to determine the effect of plasma discharge. Differences were observed between the alternative conductivity of PEO's and pPEO's depending on plasma discharge power. By this purpose, structural characterization techniques such as Differential Scanning Calorimetry (DSC) and Fourier Transform Infrared Spectroscopy (FT-IR) were applied on pPEO thin films. Structural analysis showed that density of crosslinking is plasma power dependent. The crosslinking density increases with increasing plasma discharge power and this increase is displayed as increasing dynamic glass transition temperatures at DSC results. Also, shifting of frequencies of some type of bond vibrations, belonging to bond vibrations produced after fragmentation because of plasma discharge, were observed at FTIR results. The dynamic glass transition temperatures obtained from alternative conductivity results for pPEO consistent with the results of DSC. Activation energies exhibit Arrhenius behavior. Activation energies decrease with increasing plasma discharge power. This behavior supports the suggestion expressing that long polymer chains and long oligomers are fragmented into smaller oligomers or radicals.

Keywords : activation energy, dielectric spectroscopy, organic thin films, plasma polymer
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