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Thickness Dependence of AC Conductivity in Plasma Poly(Ethylene Oxide) Thin Films

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Abstract : Plasma poly(ethylene oxide) (pPEO) thin films were deposited between Aluminum (Al) electrodes on glass substrates by plasma assisted physical vapor deposition (PAPVD). The deposition was operated inside Argon plasma under 10^{-3} Torr and the thicknesses of samples were determined as 20, 100, 250, 500 nm. The plasma was produced at 5 W by magnetron connected to RF power supply. The capacitance C and dielectric loss factor tan δ were measured by Novovontrol Alpha-A high frequency empedance analyzer at freqquency and temperature intervals of 0,1 Hz and 1MHz, 193-353K, respectively. AC conductivity was derived from these values. AC conductivity results exhibited three different conductivity regions except for 20 nm. These regions can be classified as low, mid and high frequency regions. Low frequency region is observed at around 10 Hz and 300 K while mid frequency region is observed at around 1 kHz and 300 K. The last one, high frequency region, is observed at around 1 kHz and 200 K. There are some coinciding definitions for conduction regions, because these regions shift depending on temperature. Low frequency region behaves as DC-like conductivity while mid and high frequency regions show conductivities corresponding to mechanisms such as classical hopping, tunneling, etc. which are observed for amorphous materials. Unlike other thicknesses, for 20 nm sample low frequency region can not be detected in the investigated freuency range. It is thought that this is arised because of the presence of dead layer behavior.

Keywords : plasma polymers, dead layer, dielectric spectroscopy, AC conductivity
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