Preparation and characterization of chitosan and chitosan/PVA thin films

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Materials with high relative permittivity draw the attention of researchers due to its applications in electric and electronic devices. Thin films of chitosan (Chit) and chitosan with 5% polyvinyl alcohol (Chit/PVA5%) can be applied as dielectric substrates due to their physicochemical properties. Chitosan is a biodegradable, biocompatible and non-toxic polysaccharide with cationic properties; it can be obtained from natural and renewable sources and is employed in pharmaceutical, biomedical and biotechnology industries [1]. Polyvinyl alcohol (PVA) is a water-soluble synthetic polymer that presents hidroxyl as lateral group and has properties directly related to its molar mass and hydrolyzation degree. Thin films of Chit and Chit/PVA5% were prepared via casting method and characterized via Fourier Transform Infrared (FTIR) spectroscopy with wavenumber range of (4000-600) cm^{-1} and impedance spectroscopy (IS) with frequency range of 100 Hz – 1 MHz. The FTIR spectra presented absorption bands between 3640-3000 cm^{-1} related to symmetric stretching vibrations of NH and -OH groups for both Chit and Chit/PVA5%, which are also related to the presence of inter and intramolecular hydrogen bonds. PVA presented bands related to -OH stretching, resulting in stretching vibration superposition between chitosan and PVA. At 1656 cm^{-1} there is an absorption band related to C=O bond in PVA was superposed by the more intense functional groups of chitosan. At 1062 cm^{-1} and 1028 cm^{-1} there is a absorption band related to C-O group. At 658 cm^{-1} there is a absorption band related to -NH (amide-IV). A synergy between chitosan and PVA has been verified [1]. The IS spectra shows highly capacitive behavior for both samples, with Chit having better performance as and dielectric than Chit/PVA5%. Chit/PVA5% presented smaller impedance magnitude and phase angle closer to 0° due to having bigger dielectric losses compared to Chit. PVA introduced more (-OH) charge carriers in the polymeric chain of Chit/PVA5%, increasing its charge density and conductivity compared to Chit [1]. An equivalent circuit composed of two parallel constant phase elements (CPE) was fitted via nonlinear complex least square method to the AC response of each sample. The fitted parameters indicated that both samples present a nearly capacitive element ($Q = 14.31(2)$ $pF.s^{1-n}$ and n = 0. 99229(8) for Chit; $Q = 23.17(3)$ $pF.s^{1-n}$ and n = 0. 9899(1) for Chit/PVA5%) and a diffusion element with phase angle close to a Warburg element ($Q = 38.2(2)$ $pF.s^{1-n}$ and n = 0. 5614(8) for Chit; $Q = 128.8(3)$ $pF.s^{1-n}$ and n = 0.6186(3) for Chit/PVA5%), where the increase of Q in the diffusion element in Chit/PVA5% shows the effect of the extra (-OH) charge carriers introduced by PVA.

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References

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