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Electrical performance of soft polymer ionic membranes with mono and multi polymer systems

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Abstract

We prepared the Polyvinyl alcohol (PVA)/$CdCl_2$ and PVA/Polyvinylpyrrolidone (PVP)/$CdCl_2$ composites by solution blending known as the soft polymer ionic membrane (SPIM). The loading of $CdCl_2$ divalent ions demonstrates an influence over the electronic structure was confirmed by UV analysis. The bright divalent ionic morphology observed by scanning electron microscopy (SEM). The optimization of specific capacitance (C_p) and the dielectric constant disclosed as a function of an external DC bias potential. The trend of polarization was inversely proportional to the DC bias with the PVA system and directly to the PVP system. We disclosed the dielectric constant as a function of ionic loading. The optimized dielectric constant for various applications.

Keywords: Ionic composite; Electronic structure; Morphology; Dielectric; DC bias

1. Introduction

PVA is a unique water soluble polymer used for casting the films due to easy processing [1]. The varying grades of PVA exhibit interesting electrical properties [2]. The modification of virgin PVA achieved by inducting alkyl halide, lead oxide and piezoceramics to improve electrical properties [3–5]. Ion inducted polymer membranes was highly applicable for battery electrolyte, fuel cells [6]. Polymer Polyvinylpyrrolidone (PVP) is well known as Polyvidone or Povidone. It is water-soluble polymer consist of the monomer N-vinylpyrrolidone. It preferred for various bio and pharmacy applications due to an inhibitor of recrystallisation property. PVP is especially useful as an additive for batteries, ceramics, fiberglass, inks, inkjet paper and in the chemical-mechanical planarization process [7]. The solution blending of PVA with PVP achieved homogeneously due to common solvent as water [8]. The $CdCl_2$ is having a polycrystalline and divalent in nature. It exhibit impulse electrical properties as a function of the temperature control the activation energy 0.52 eV [9]. The breed bio membrane studies of $CdCl_2$ in veterinary science able to administer the drug and maintain the morphological abnormalities were reported [10,11]. By using the electrophoereric technique and thermodynamic effect structure of $CdCl_2$ in the solute form was confirmed

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and co-related to the diffusion coefficient [11]. Recently the experimental and simulated studies on the variation of electrical properties related to the decrease in crystallization of PVA inducted $CdCl_2$ was confirmed to know the role of divalent ions [12]. In our previous report structure, morphology, electrical impedance and conductivity of these composites shown feasibility for electrolyte application [13]. The loading of divalent ions exhibits modification of structure and decrease in conductivity from 10^{-10} to 10^{-8} S/m. We proposed the CdCl2 dispersion with PVA and PVA/PVP systems. We disclosed the role of an external DC bias potential under wideband of a frequency range at ambient condition. The ionic-interface issue is well understood by microscopic morphology. This investigation is done in view of basic research to obtain dielectric constant under external control of DC bias potential.

2. Importance of Cd compouds

The Cd ions were occured in the form of compounds with various organic and inorganic elements. Based on the nature of compounds it would preferred for the various applications from thin films, batteries (with Ni compound) to polymer composite domain. Cadmium chloride is used in electroplating, photocopying, calico printing, dyeing, mirrors, analytical chemistry, vacuum tubes, and lubricants and as a chemical intermediate in production of cadmium-containing stabilizers and pigments. Hence in the present work $CdCl_2$ preferred to obtain the soft polymer ionic memberane by mono and multipolymer system [13].

3. Experimental and materials

Polymer PVA with MW 1,25,000, LR grade make SD fine Chem., Mumbai and PVP with MW 10,000 AR grade, make sigma Aldrich used as received. Distilled water was used as solvent to prepare the polymer syrup. White powder of $CdCl_2$ MW 228.35 (make-Thomas Baker) dissolved with polymer syrup in distilled water by the loading of $CdCl_2$. The samples were dried for 36 h at room temperature 35 °C. Soft polymer composites were obtained and used as it is for further characterization.

3.1. Synthesis of polymer/$CdCl_2$ composites

The protocol to obtain the polymer/$CdCl_2$ composites shown in Fig. 2 a–b). The polymer syrup was

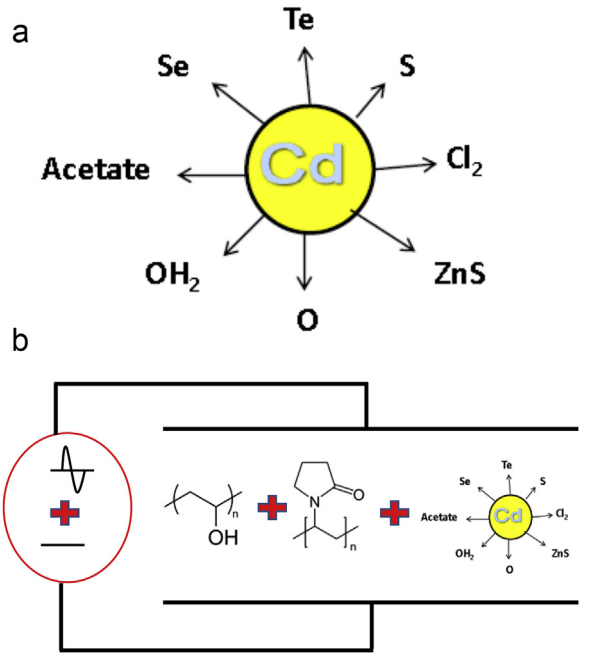

Fig. 1. a)Cd compounds with organic and inorganic elements, b) Basic protocol of SPIM testing under DC bias circuit mono and multi-polymer systems composites (5, 10 wt% $CdCl_2$).

mixed with $CdCl_2$ powder (by wt%). The mixture was poured into a petri dish to obtain ion inducted polymer membrane. Samples labeled as C_1–C_3 were PVA/$CdCl_2$. C_4–C_6 were polymer with equal amount of PVA and PVP/$CdCl_2$. The loading of $CdCl_2$ is inducted by 5, 10, 15 by wt%.

3.2. Basic principle of the SPIM test

The SPIM kept across the electrode fixture assembly with impedance analyzer and an external DC bias voltage supplied (in the range 0–40 V) simultaneously. Combined AC and DC will increase the strength of input signal across the electrode. The exact circuit is shown Fig. 1. It is having unique advantage to control the polarization as bulk property of SPIM externally. In our previous work we have made an attempt to address the electrical properties of polymers, composites, gels as function of DC bias [2,3,5,6,17].

4. Results and discussions

4.1. UV–visible spectroscopy

Optical Properties of PVA/PVP films doped with different concentration of $CdCl_2$ were investigated using UV–visible in the wavelength range