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Synthesis of 3-D structured ionic membrane by using PVA/PSSA and banana peel as a dielectric medium site

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ABSTRACT

The three-dimensional ionic structure of polyvinyl alcohol-Poly(styrene sulfonic acid) (PSSA) – banana peel(BP) – polyvinyl alcohol/ polyvinyl alcohol/Poly(styrene sulfonic acid) (PSSA) were proposed for dielectric application.. The 3-D structure of PVA-PSSA/BP-PVA/PVA-SSA were synthesized for the determination of basic properties such as conductivity, dielectric cosntant, dissipation factor, real and imaginary impedance. PSSA is a polyelectrolyte which enhanced the conducting properties of the membrane. The BP works as dielectric intermediate in the 3-D ionic polymer membrane. The dielectric and electric properties were analyzed using impedances measurement devices. The 3-d membrane shows the ac conductivity 4x10-7 S/cm at the frequency range between 20Hz to 10mHz. Banana peel with PVA is sandwich between the two layer of PVA-PSSA (conducting layer).

Keywords: PVA; PSSA, ionic membrane, 3-Dimension Structure, banana peel

INTRODUCTION

Hundreds of thousands of inventions have altered the path of human history. Among the most prevalent inventions are electronic devices. A capacitor is a fundamental component in electrical circuit building. The fundamental function of capacitors is to store electrostatic energy [1] in an electric field and release it as needed by the circuit. They allow AC to flow while blocking DC, preventing a dangerous circuit breakdown. The capacitor is replaced with a two layer capacitor due to its low energy capacity, restricted energy storage, and decreased stored energy due to internal losses [2]. Electrolytic capacitors have a 10–100 times lower energy density than double layer capacitors. Since the 1970s and 1980s, polarized electrolytes [3] have been developing for electrochemical capacitors, gold capacitors, and farad capacitors. The most important thing is to maintain high ionic conductivity with flexibility. There is excellent contact at the electrolyte-electrode junction. This is especially essential in the case of electrochemical capacitors [4], which use large surface area carbons as active materials. The electrochemical capacitance is created by charge separation on the interface between the electrolyte and also base for supercapacitors energy storage. Current collectors, electrodes, electrolytes, and separators are just a few of the components that make up a supercapacitor. The function of the separator is similar to that of the battery separator. It separates the two electrodes, enabling ions to pass between them while preventing a

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short circuit. PVA was utilized as a base material for preparing the 3-d structure or three layers since it has strong mechanical and chemical stability. Enhance proton conductivity[5] and hydrophilicity[6] by employing poly (4-styrenesulfonic acid).

Experiments

Materials

The main constitute of the 3-d structure membrane are polyvinyl alcohol (PVA), Polysuphoinc acid (PSSA) and Banana peel paste. PVA and PSSA were purchased from sigma-Aldrich, India. The banana peel paste was prepared in our laboratory.

2.2Preparation of 3-d (PVA-PSSA/BP-PVA/PVA-SSA) structure ionic membrane

1 gm of PVA solute particle mixed in 19ml distilled water (DI) on a magnetic stirrer at 100°C with 200 rpm for several hours to achieve the stage of homogenous mixture. When we have a clear solution in that time frame. Add the PSSA (0.3 ml) aqueous solution and mix for 4 hours on a magnetic stirrer. The solution was prepared in a 1:10 (that means 1gm of PVA, PSSA (0.3 ml) was mixed in 19 ml DI water). After 2 hours, pour the entire solution into a glass petri dish and place it on a magnetic stirrer at 100°C to allow the solution to settle. Place the petri dish on a magnetic stirrer and keep it there until the solution is dry to 80%. Same procedure was followed for second layer of PVA and banana peel, that means 1 gm PVA and 1 gm banana peel paste is mixed in 19 ml DI water and place it on a magnetic stirrer for 5 hours. Once the solution of PVA and banana peel was entirely mixed, it is poured into the first layer, which is 80% dry, and further dried both the layer at 100 C. After drying the second layer 80%, a third layer dropped into pervious two layer to the first layer of PVA/PSSA is placed in the same Petri disc. It takes 72 hours to thoroughly dry (all three layers). Because the layer has a condensate web-like or plastic-sheet structure, water molecules cannot easily vaporize. The 3-d structural membrane was then delicately stripped off from the petri disc. It has flexible in nature and all three layer distinguish by naked eye.

Table 1: Composition of 3-d structure of ionic membrane

S.No	Layers	Material	Quantity (gm)
1	First layer	PVA	1
		PSSA	.3
2	Second	PVA	1
		BP	1
3	Third	PVA	1
		PSSA	.3

Fig.1 Schematic diagram of 3-d structure of ionic membrane

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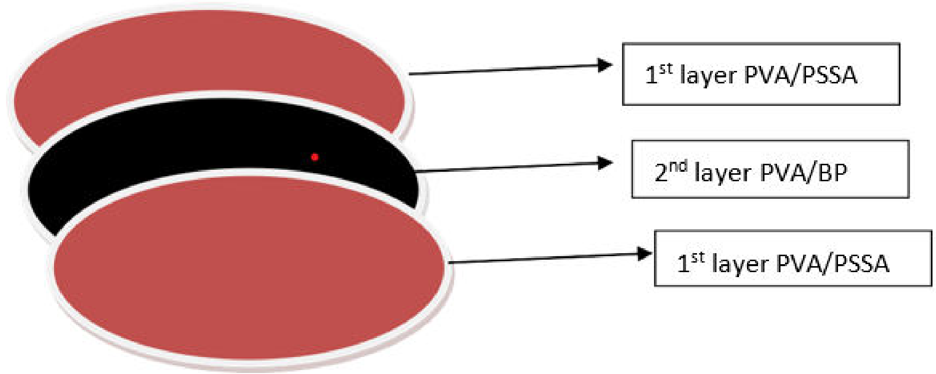

Result and discussion

3.1Dielectric Analysis

Fig.2. represent the dielectric constant (ε') of a 3-d ionic membrane reduced as frequency increased [7], because there are no surplus dipole[8] molecules at high frequencies, and ion diffusion does not have enough time to align itself in the direction of the electric field [8,9]

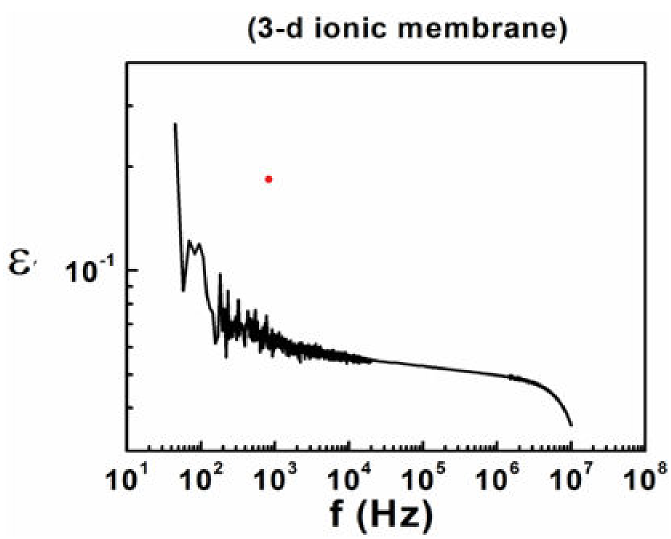

Fig.2 Dielectric analysis of 3-d ionic membrane

In this the banana peel act as a dielectric medium. PVA has poor proton conduction [6] as same the banana peel also has poor conduction so by adding both the membrane formed which is completely dielectric.

3.2AC Conductivity Analysis

The AC conductivity (σ) of 3-d ionic membrane with respect to frequency is shown in Fig.3.The conductivity is increased with increase frequency. Also the conductivity is increases by adding the electrolyte PSSA. PVA itself base as well as conducting in nature because it does not contain any negative charged ion [6]. PSSA is a polyelectrolyte chemical compound that can be made by sulfonating polystyrene. [10]. The main work of the PSSA is ion exchange membrane and also used

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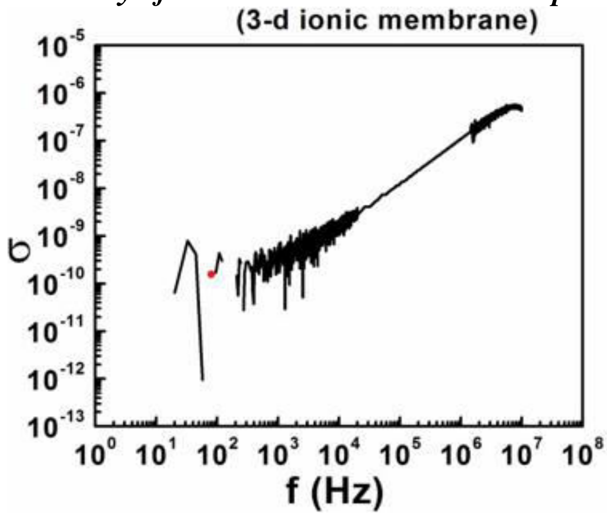
in electrochemical devices as a proton[11] conducting material.

Fig 3 The conductivity of 3-d ionic membrane with respect to frequency



3.3Dissipation factor Analysis

The dissipation factor (tan d) reveals how inefficient a substance is in storing energy or acting as an insulator. The more efficient the insulator system is, the lower the dissipation factor is. At room temperature, most polymers have a reduced dissipation factor.In fig.4 The dissipation factor is reduced as increased in frequency . It happens when charge fails to follow the reverse field, resulting in a reduction in electric oscillation [12,13] as frequency rises.

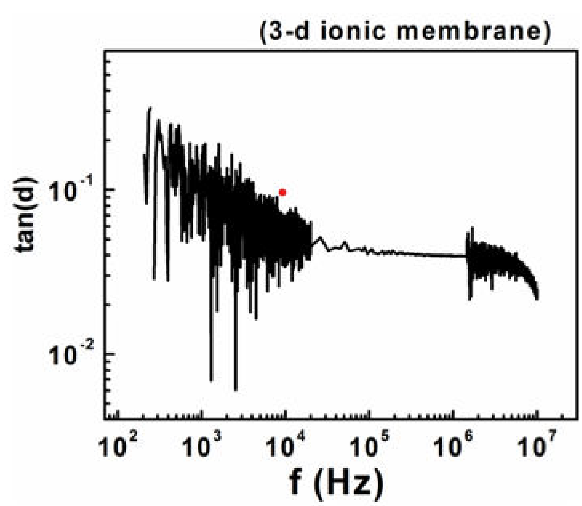


Fig.4 Dissipation factor of 3-d ionic membrane with respect to frequency

Impedance analysis

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Fig.5 depicts the change in the real component of the impedance (Z′) with respect to the imaginary part (Z″) for the 3-d ionic membrane. Complicated electrical impedance as a function of test frequency is measured using an impedance analyzer, which is a form of electronic test equipment. Impedance is a critical metric for characterizing electronic components, circuits, and the materials used to produce them. In this case, the imaginary part of the impedance Z″ indicates energy storage. The electrical behavior [14] of the membrane was studied using the Cole–Cole method [15]. The relaxation frequency can be determined using complex impedance analysis [16].If we draw the intersecting line in (Z') the x value we get is 755.213Ω and the y value is 456.2354 Ω.

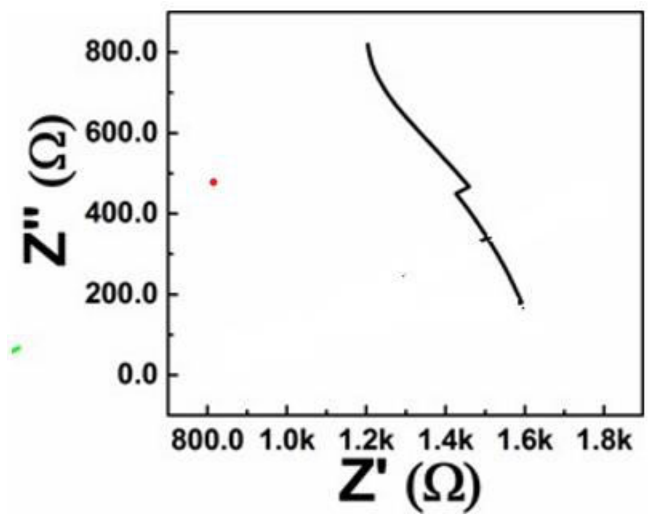

Fig.5 graph represent the real and imaginary impedance of 3-d ionic polymer membrane

Conclusion

In this paper PVA-PSSA/BP-PVA/PVA-SSA 3-D structured ionic membrane was fabricated for dielectric application. The PVA-PSSA/BP-PVA/PVA-SSA showed low values of dielectric constant and dissipation factor. As the alternating current has a propensity to rise in frequency, the conductivity increases. As a dielectric medium, banana peel paste is used. We can make use of the banana peel in this way.The conductivity is now in the range of 4 X 10-7s. Another polymer that can boost conduction, such as nano graphite powder, could be employed in the future. We can employ organic material to make a supercapacitor out of this simple 3-d shape ionic membrane. PVA/PSSA and PVA/banana peel were used to generate this membrane, which has a high AC conductivity.

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