Egg Membrane based Humidity Sensor

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Abstract

A bio material based membranous humidity sensor can be designed using surface electrical conduction of the membranous part lying immediately beneath the hard shell of egg. Surface ionic conduction is quite different from bulk ionic conduction. Surface of egg membrane shows sensitivity towards humidity. Study of A.C. (Alternating Current) impedance, Optical absorbance and potentiometric response proves the worth of the membrane as humidity sensor. The membrane carries the qualities like no toxicity, eco-friendliness, economic and long lasting with its long lasting sensing property.

1. Introduction

The egg membrane is the soft membranous part stuck to the inner portion of the hard egg shell. The membrane is rich in Keratin **[**1, 2, 3**]** in fibrous form. Keratin contains 4 to 5% Sulphur [4]. Lipid layer is also present in egg membrane [5]. Egg membrane suffers change in its dielectric property due to exposure of pulsated moisture. Hen eggshells are more compact, which causes clear influence of moist environment to the porous structure of eggshells. Temporary inclusion of water molecules to the surface molecules of the egg membrane generates a signal voltage. This very phenomenon enhances the scope to design a potentiometric humidity sensor of surface mode with moderate response and recovery time and of low cost profile.

2. Experimental

2.1. Material

The membranous part from the inner side of the hard shell of hen egg with average thickness 25-30µm was discriminated carefully and washed and shaped properly to put beneath two well-polished cupper sheets lying 5 mm apart, thus forming a proto cell of surface mode. The surface mode device was fitted to the following circuit followed by a resistance of 1 MΩ as shown in Figure 1. The voltage across the proto cell as well as the resistance changes with changing humidity level.

2.2. Electronic Circuit

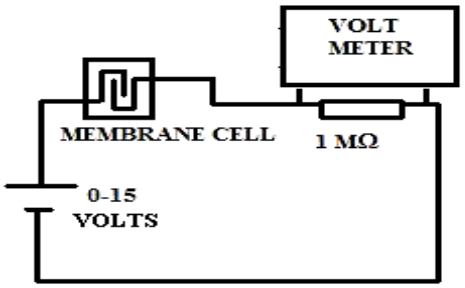

Figure 1. Circuit for studying cell response towards humidity.

2.3. Realisation of sensor

The surface mode proto cell with egg membrane as transducer shows clear change in impedance with the change in red-ox environment. The change in cell voltage with the change in humidity shown in Figure 4 and response voltage, response time and recovery time in Table 1 due to exposure of humid pulse to the surface mode proto cell prove the worth of the membrane as humidity sensor.

2.4. Study of A.C. Impedance

A.C. impedance of the proto cell was measured using HIOKI (Japan) MODEL 3522 LCR/Z analyzer, between frequencies 1 Hz to 100 KHz. A.C. electrical experiments were carried out at room temperature (29 ^{o} C, Humid) to investigate greater aspect of charge transport through the specimen.

2.5. Study of Optical Absorbance

Optical absorbance of the egg membrane with dry and hydrated condition were studied in the wave length range 660-990 nm using Systronics (India) 2020 UV-VIS,spectrophotometer.

3. Results & Discussion

3.1. Impedance analysis

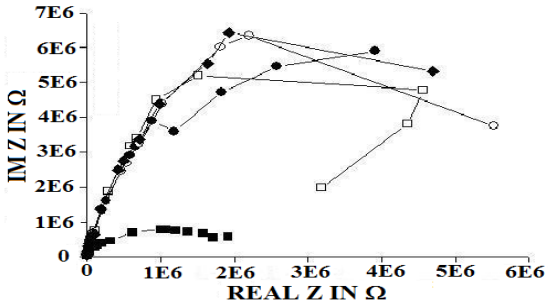

Figure 2. Cole Cole Plot for Egg membrane: (■) - Blocking electrode with one side of the membrane; (□) - Blocking electrode with the reverse side of the membrane; (●) – with porous electrode; (○) - with porous electrode and with the reverse side of the membrane; (♦) - porous electrode with exposure to pulsated humidity (with reverse side of the membrane); Measurement condition- AC volt– 1V, AVG- 32.

3.2. Study of Optical Absorbance

A part of the optical absorbance vs. wavelength plot shows water has negligible effect on the structure of the egg membrane. Presence of Keratin in the membrane causes this. This protein is the main constituent of nails, feathers etc. [2, 4]. It is insoluble in water. Figure 3 shows a weak change in peak near 903 nm. Response of the membrane towards humidity is therefore due to physisorption.

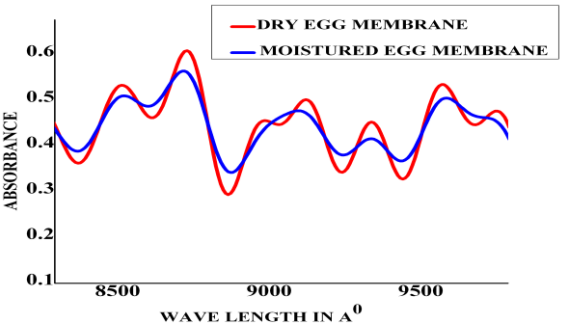

Figure 3. Optical absorbance vs. Wavelength

3.3. Study of response towards humidity

Exposure to humidity in pulsated form a voltage generated across the proto cell. In Table 1 a study of response voltage, response time and recovery time has been presented. It is observed that the recovery time in the membrane is longer compared to the response time. The cell potential falls gradually with decrease in humidity nonlinearly (Figure 4).

Table 1.

ROOM TEMP. 26.8° C	RESPONSE VOLTAGE (IN VOLTS)	RESPONSE TIME (IN SECONDS)	RECOVERY TIME (IN SECONDS)
SUPPLY VOLT 6.63 V	0.151	13	176

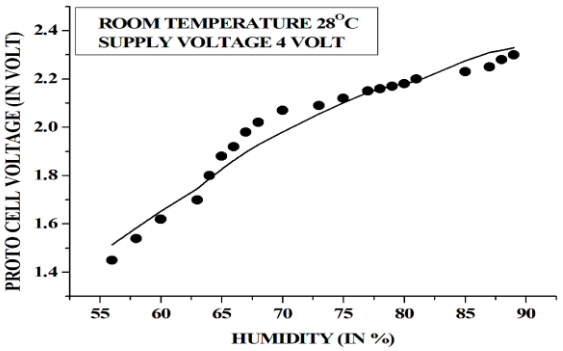

Figure 4. Variation in Cell potential with humidity

4. Conclusion

The egg membrane is natural, eco friendly and non toxic and economic bio-material. Water molecules are added to the membrane surface through physisorption and released within a short interval. It is sensitive to humidity and using simple electronics a humidity sensor of low cost profile has been fabricated out of this material.

Acknowledgement

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