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A NOVEL METHOD OF FABRICATED PVA RESISTIVE BASED HUMIDITY SENSOR

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ABSTRACT

This paper presents an optimal design for a new humidity sensor composed of a Resistive based of the sensing device. To improve the corrosion resistance of the sensor chip, copper electrodes were used to form the comb resonator. Prior to device fabrication, the coupling of modes (COM) model was used for the performance prediction and optimal design parameters determination. Two SAW comb resonators with copper electrodes were fabricated. A PVA thin coating was deposited onto the resonator cavity of the sensing device by a spinning approach as the sensor material for relative humidity (RH) detection. The physical character also study using SEM.it has high detection sensitivity, quick response; good repeatability and stability were observed from the sensor experiments at room temperature.

Key words:Humidity sensor, Nano fiber, LCR meter.

I.INTRODUCTION

Relative humidity (RH) is one of the most important physical parameters for assessment of air quality in controlled rooms, monitoring food conservation, detecting water damage in enclosed walls, buildings, and archives. There is a demand for precise, consistent, robust, passive and low-cost sensor for RH measurement. Researchers are working towards a RH sensor having high sensitivity, wide dynamic range, stability, low hysteresis and ease of mass- production. In this regard, the investigation on humidity sensing layer materials for humidity sensor is one of the prime focuses of research. For instance, humidity sensor based on ceramic sensing materials was reported in. These materials are oxide based sensing materials including Al_2O_3, TiO_2 and SiO_2, independent of temperature, and sensitive to low humidity levels. In contrast, polymer-based humidity sensors have humidity sensitivity for wide moisture conditions. Most of the sensing polymers are either hydrophilic or hydrophobic, which implies that they show considerable structural reform in presence of water. Hence these materials exhibit conductive or dielectric change with environmental humidity which can be quantified for RH monitoring. Humidity sensors utilizing the change of electrical property of a material can be categorized in two types, resistive and capacitive sensors. Capacitive sensors have the features of ease of fabrication, low power requirement and linear response. Capacitive sensors utilize a hygroscopic dielectric layer whose dielectric constant changes with environmental RH. Humidity sensors using polyvinyl-alcohol (PVA) as sensing dielectric was reported in. In humidity sensor was fabricated with comb shaped electrodes coated with PVA. In PVA coated SAW devices was reported to have significant humidity sensitivity. The RH sensitivity of PVA based SAW sensor was presented in regards of dynamic range, calibration curve, hysteresis and comparative analysis Moreover, RH sensitivity of PVA is compared with a commercially available dielectric hygroscopic polyamide Kapton. Also, RH sensitivity curve is determined to realize real time RH monitoring. In addition to resonant frequency shift, a novel parameter `resonance slope' is introduced in this paper to determine accurate RH sensitivity.

II.AIM AND OBJECTIVE

Humidity Basics and Measurement Parameters

Steam levels are defined in the atmosphere of moist air or other gases. The humidity parameters are said in various ways and are based on the measurement technique used by the corresponding units. The most commonly used terms are weight or volume and dependent moisture (RH) "," per million (PPM) "by" Dew / Frost Point (D / F PT) ", with two sub-subclasses" absolute humidity "(AB). Water meters can be applied to the measurement results, as the water's steam content can measure directly to the value of the steam content, but the water's steam values measure Complete moisture (steam density) is defined as the air mass of air steam in air gases, a gram of one cubic meter or one gram of a cubic foot (grains 1/7000 lb)

$$AB = m_w / v \qquad (1)$$

Where AB is the absolute humidity (g/m3 or grains/ft3), mw is the mass of water vapour (gram or grain) and v is the volume of air (m3 or ft3).

Relative humidity (abbreviated RH) is calculated as the ratio of moisture content of the maximum amount of moisture content (saturated), which keeps the air at the same temperature and gas pressure. RH is temperature dependent, so it is a comparative measurement. The RH measurement is determined by a percentage and expression:

$$RH\% = (Pv/Ps) \times 100 \qquad (2)$$

where P_v is the actual partial pressure of moisture content in air and PS is the saturated pressure of moist air at the same given temperature (both in Bar or KPa).

Saturation Humidity is defined as the ratio of the mass of water vapour at saturation to the volume of air:

$$SH= (m_{ws})/v(3)$$

Where SH the saturation humidity (g/m3), m_{ws} is mass of water vapour at saturation (g) and v is the volume of air (m3). The saturation humidity is a function of temperature and can provide the maximum amount of moisture content (mass) in a unit volume of gas at a given temperature.

According to Equation (3), Relative Humidity can be represented in other way by calculating the ratio of absolute humidity to saturation humidity as a percentage as follows:

$$RH \%=(AB/SH) \times 100 \qquad (4)$$

Parts per Million by volume (PPMv) is defined as volume of water vapour content per volume of dry gas, and Parts Per Million by weight (PPMw) is obtained by multiplying PPMv by the mole weight of water per mole weight of that gas or air. PPMv and PPMw are among the absolute humidity measurements.

Water temperatures begin to drain in liquid water (temperature above 0 ° C) and frost point temperatures (below 0 ° C) are a water vapor of ice. D / F statistic parameters are the activity of gas pressure, but are both independent and absolute humidity measurements from temperature. In other words, the snow point is steam steam pressure at the water's equilibrium of water vapor (in the atmosphere). The difference between ambient temperature and snow statistics is the measure of ambient humidity.

III.METHODOLOGY

Preparation

The spin coating machine has an ability to rotate the substrate uniformly at 1000 rpm, 2000 rpm and 3000 rpm. The PVA solution is prepared by dissolving in the ratio of 6wt% with warm water. The sample with two copper electrodes is fabricated with the comb structure resistive sensor by etching the PCB of copper with specified line width and gap width. Then the substrate is cleaned with solvents and the ultrasonic cleaner is used to remove the micro particles on the surface of the substrate. After formation the fabricated electrode is coated with the PVA solution prepared and samples have been prepared. The prepared PVA films have been studied for structure properties using the SEM to ensure the formation of crystalline nature. The samples are calcinated for 70 degree Celsius up to five hours to improve the sensitivity. The resistance of the samples varies by change humidity. And the resistance with respect to voltage with constant frequency has been studied in a various level ratio. Preparation of resistive based humidity sensor has been fabricated.

Fig. 1: Pure PVA Humidity Sensor

More or less all the samples coated in uniform thickness and a film formed show the resistance with respected to thickness of film.

Fig 2Sensor holding connection with LCR and Humidity meter

IV.RESULT AND DISCUSSION

Structural characteristic of PVA

The thin film surface morphology and functional group of PVA was characterized using scanning electron microscope (SEM) the shows the SEM images of PVA. The PVA thin film has a large smooth area, indicating formation of transparent film, which has coated by spin coating method and cubic structure has been formed in the coated film, the structure of image has been shown in the FIG 3. Some of the crystalline nature also occurred in this film.

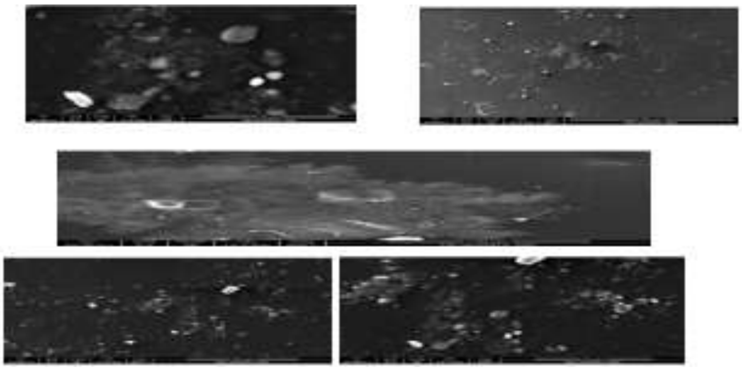

Fig. 3 SEM Image of PVA Thin Film

V.STUDY OF RELATIVE HUMIDITY OF SPIN COATED PVA SAMPLES

The PVA thin film from 6 wt % solution concentration has been fabricated in protected environment with the help of zig for removing moisture in the air and impurity. First the polymer has dissolved in a solvent, depends on material the solvent has been varied, after the preparing solution has kept over a spinner on electrolytic material, when the machine gets started with respected motor speed and coating timing, the thickness of thin film also get varied.

The change in resistance of the sample with respect to the change in humidity for both the sample is analysed and the changing time is noted constant for each sample also the stability for lower value of Relative Humidity (RH) analysed for the samples.

After coating a film its resistance characteristics has been studied using LCR meter (TH2826). Resistance reading with respected to voltage as shown. The LCR meter voltage and current are kept as starting value 1V respectively.

The sample of PVA has the dimensions of 3.5cm 1cm the PVA pure FIG 1. The humidity sensing would depend upon the gap width, the length of the finger and the breadth of the finger and No. of fingers. The gap widths for both fabricated samples are kept constant of 1mm and the No of fingers kept as 18 for PVA sample. The sensitivity can be measured only by change in time of the output impedance for change in humidity. The log value of impedance and RH can give accurate value of measurement.

For the sensing purpose, change of resistance for the voltage is measured using the experimental setup and the values are analysed for the RH change. The PVA with Hydroxyl group will make conduction when the voltage

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is applied for the film at depend upon increase in humidity. Hence by testing it normally shows that increase in humidity increases the conduction and forms the resistance decrease.

VI.TABULATION: 1- PVA SAMPLE FIG 1

The RH is kept constant of 69% at temperature 29.5 degree Celsius. And the reading has been taken.

Table: 1

S.No	Volt V	Resistance Ω
1	0.5	2.762
2	1	4.415
3	1.5	9.567
4	2	14.201
5	2.5	19.382
6	3	24.064
7	3.5	28.176
8	4	31.903
9	4.5	34.384
10	5	38.548

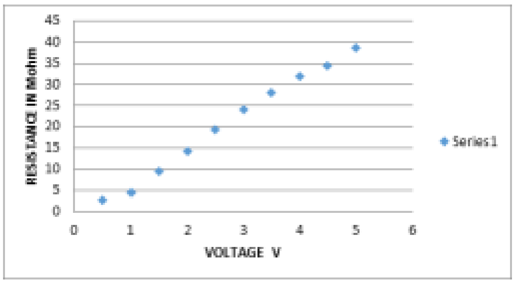

Fig.4Voltage Vs resistance

Table 1 Describes relative humidity measurement voltage vs Resistance has been shown in above graph

By this graph the conclusion is the change in resistance when applying voltage shows that the film fabricated can with stand the Voltage of up to 10V and it could give the precise reading up to 5V which shows the linearity of increase in resistance.

Table: 2

S.No	RH %	Resistance MΩ
1	72	4.35
2	71	6.36

3	70	11.67
4	69	13.57
5	68	16.01
6	67	20.95
7	66	28.39
8	65	36.87
9	64	47.18
10	63	57.15
11	62	63.51
12	61	86.97
13	60	97.82

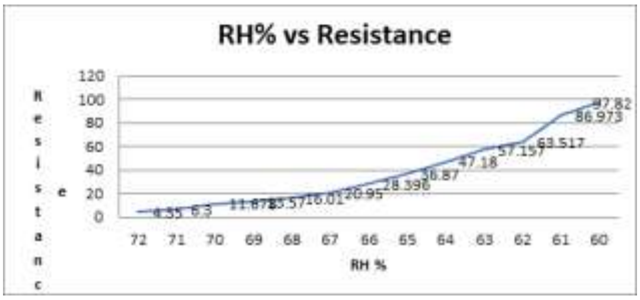

Fig.5RH% vs. Resistance

Table 2 has been describe RH% vs Resistance in a constant voltage AS 1V for PVA humidity sensor , the graph shown resistance has been increase with respected to RH%. RH is kept and desiccant decreases it upto 59%. The change in resistance has been noted. Which shows decrease in resistance gives increase in value humidity

VII.CONCLUTION

The PVA humidity sensors have been fabricated and the characteristics have been studied. Above humidity sensor shows decrease in resistance because of the conductivity of –OH hydroxyl group. In this PVA humidity sensor better sensitivity. So PVA sample is used for the fabrication of RH humidity sensor. The change in resistance with respect to time is increased by doping the PVA and increases the sensitivity. The accuracy is compared with normal humidity measurement which shows the exact value of it. And so the fabricated sensor sample is more sensitive than the normal humidity sensor used for measurement. So this makes costless humidity sensor fabrication with effective in resistivity change and accuracy. This small change in humidity can also be measured and so it can be used for some of the industries dependencies for humidity measurement.

REFERENCE

[1] Hamid Farahani, Rahman Wagiran ,Mohd Nizar Hamidon, Humidity Sensors Principle, Mechanism, and Fabrication Technologies, *Sensors 2014, 14, 7881-7939; doi:10.3390/s140507881*.

[2] Fraden, J. Handbook of Modern Sensors; Springer New York: New York, NY, 2010; pp. 445–459.

[3] HIH Series Humidity Sensors; Psychometrics and Moisture, Reference and Application Data. Honeywell*: Morristown, NJ, USA; pp. 145–147.*

[4] BasudamAdhikari, SarmishthaMajumdar, "Polymers in sensor applications," Prog. Polym. Sci. 29 (2004) 699–766.

[5] P.R. Story, D.W. Galipeau, R.D. Mileham, "A study of low-cost sensors for measuring low relative humidity," *Sensors and Actuators B 24-25 (1995) 681-685.*

[6] P. Bruno, G. Cicala, F. Corsi, A. Dragone, A.M. Losacco, "High relative humidity range sensor based on polymer-coated STW resonant device," *Sensors and Actuators B 100 (2004) 126–130.*

[7] M. Bruzzi , S. Miglio , M. Scaringella , G. Bongiorno ,P. Piseri , A. Podesta, P. Milani, "First study of humidity sensors based on nanostructure carbon films produced by supersonic cluster beam deposition,," *Sensors and Actuators B 100 (2004) 173–176.*

[8] Dae-Uk Kim, Myoung-Seon Gong, "Thick films of copper-titanate resistive humidity sensor," *Sensors and Actuators B 110 (2005) 321–326.*

[9] Pi-Guey Su , Chao-Jen Hob, Yi-Lu Sunc, I-Cherng Chen, "A micromachined resistive-type humidity sensor with a composite material as sensitive film," *Sensors and Actuators B 113 (2006) 837–842.*

[10] Zongwu Yao, Mujie Yang, "A fast response resistance-type humidity sensor based on organic silicon containing cross-linked copolymer," *Sensors and Actuators B 117 (2006) 93–98.*

[11] Pi-Guey Su, Chao-Shen Wang, "Novel flexible resistive-type humidity sensor*," Sensors and Actuators B 123 (2007) 1071–1076.*

[12] E. rusu, A. airinei, "Some investigations on films of poly (vinyl alcohol) with pendant p-azidobenzoate groups," *Optoelectronics and Advanced Materials – Rapid Communication*s*", Vol. 2, No. 12, December 2008, p. 886 – 890.*

[13] TBoltshauser, M Schonholzer, 0Brand and H Baltes, "Resonant humidity sensorsusingindustrialtechnology combined with post processing," J. Micromech. Microgen. 2 (1992) 205-207. Printed in the UK.

[14] SiminMehrabani, Philip Kwong, Malancha Gupta, and Andrea M. Armani, "Hybrid microcavity humidity sensor," *Applied physics letters 102, 241101 (2013).*

[15] Vierajacnovicova, milanmikula, and zuzanabekova, "the sorption and barrier properties of polymer layers based on unsaturated poly (vinyl alcohol) derivatives," *Chem. Listy 107, s101, 202 (2013.*