AIRO JOURNALS
Free / Unpaid
Peer Reviewed
Multidisciplinary
National
ISSN: 2321-3914
Volume:1 Issue:1
January 2021
Impact Factor: 5.7
Subject Engineering

A STUDY OF DEVELOPMENT OF INTEGRATED WIRLESS SENSOR NETWORK FOR HUMIDITY DETECTION

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ABSTRACT

The primary target of the current paper is to build up a smart wireless sensor network (WSN) for humidity location. Extraordinary kind of sensor testing chamber was intended for the LC sensors. Primarily glass, Teflon and acrylic materials were utilized. The electrical qualities of the Sensor1 have been resolved in glass office of volume ~1000 cc with ¼' delta and outlet pipe association. . The impedance analyzer was interfaced to a work area PC with the assistance of information securing framework. The electrical portrayal of the sensors has been conveyed to assess the exhibition of the sensor at various humidity levels. The whole testing set up was organized in a way to limit magnetic field twisting. Static and dynamic reactions were caught to get the affectability, reaction time and reproducibility of the sensor.

KEY WORDS: wireless, sensor, electrical, network, humidity.

I. INTRODUCTION

With the headway of communication and information technologies, sensor networks have become a rising innovation to be produced for the people to come. This innovation empowers savvy associations between gatherings of sensors and advances the self-ruling climate for future life. Notwithstanding conventional sensor prerequisites, for example, affectability and selectivity, low-power utilization, in-situ information preparing ability, and wireless communication are likewise basic sensor system attributes to be executed inside the sensor network innovation. To manufacture universal sensor networks, additionally, the little system structure factor ought to be routed to consistently coordinate the sensor system into conditions. To coordinate the above prerequisites, solid sensor engineering has been proposed and executed by micro-electro-mechanical system (MEMS) innovation for quite a long time. In any case, the majority of past works experience the ill effects of the chip

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territory devoured by sensor gadgets, i.e., detecting zone is a lot bigger than the circuit zone. As an outcome, novel sensor chip models should be created. Among the different detecting amounts looked for in changed applications, humidity is one of the main components. Thus, various types of materials, for example, artistic and semiconductor have been researched as humidity detecting materials. Be that as it may, a large portion of these humidity detecting materials are either intricate to incorporate with CMOS chip due to the raised operational temperature or have high force utilization. This prompts the way that conventional humidity sensors are not appropriate to consolidate with rising technologies, for example, sensor networks or machine-to-machine systems. In this manner, polymer-based humidity sensors have pulled in much consideration on account of their likely adaptability, straightforwardness of creation, and minimal effort. Among the various types of polymer-based humidity detecting materials, polyaniline is one of the most encouraging candidates to accomplish ease and low force utilization humidity detecting gadgets. Likewise, our past investigation showed an answer based polyaniline humidity detecting material with high affectability of 0.09 [Log ΔI/Δ RH (%)], great selectivity in CH4, CO and CO2 climate, and great temperature steadiness of 7.85 × 10−10 A/°C. In this work, as an outcome, a heterogeneous sensor system-on-chip for humidity detecting is proposed, planned, and actualized. With the circuits created by a CMOS cycle, explicitly the Fe-Al-polyaniline humidity detecting material is micro-stepped on the highest point of CMOS circuits to shape the pseudo three-dimensional (3D) sensor chip engineering. 3D coordination is one of the strategies to incorporate heterogeneous layers with interconnecting metal lines to improve execution or make new elements of chips. With this heterogeneous joining, the created humidity detecting material can be coordinated with CMOS circuits to meet the necessities of sensor network technologies. In light of this work, a completely utilitarian sensor system-on-chip for humidity detecting in future sensor network applications is executed and tentatively illustrated. Wireless sensor network (WSN) is a system made out of RF handset (radio recurrence), regulator, power source, and sensors. It is exceptionally valuable when applied to systems that require numerous sensors or a spot hard to reach, for example, observing the quality of an extension, checking systems of atmosphere, volcanoes, farming, and so on. Flow research shows that WSNs have been applied in atmosphere checking, agribusiness, for example, green house venture, controlling soil fruitfulness, and animal husbandry, for example, bring forth eggs in poultry ranches, and so on. One of the communication conventions utilized in WSNs is ZigBee that

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utilizations radio wave handset with recurrence of 2.4 GHz and it is one of the Wireless Personal Area Networks (WPANs) standards IEE 802.15.4. XBee RF is a cheap and low-power module that underpins the ZigBee convention. An XBee Pro (60 mW) can communicate information at the farthest separation of 90 m indoor and up to 1.5 km outside. The voltage activity of XBee is 3.3 V and it very well may be arranged to convey highlight multipoint, broadcast, and distributed, and it tends to be utilized in WSN applications. Liu, et al. planned a WSN application for natural conditions checking, for example, temperature and humidity of an industrial facility incubation center. The system was made by utilizing the ZigBee convention in which the information was shipped off the observing focus or organizer where the information obtaining programming was made utilizing the Visual Basic program. As a rule, estimated information of a WSN, which are acknowledged by the facilitator, are demonstrated locally on a PC associated with the organizer, in this manner causing the information to don't generally got to. Now and again, it is imperative to get to the information unreservedly. Along these lines it is essential to plan a WSN system in which the information can be gotten to unreservedly without contingent upon spot and time. In this paper, we built up a WSN-based checking system that is associated with the web or a web worker by means of a SIM900 GSM module.

II. RADIO FREQUENCY IDENTIFICATION

RFID is a developing innovation that utilizes wireless communication. The convention was initially created for short-range item distinguishing proof, commonly covering the 2 mm - 2 m read range, and has been advanced as the substitution innovation for the optical standardized identification found, with the utilization of EPC (Electronic Product Code). RFID can permit energy to enter certain products and to peruse a label that isn't noticeable. There are numerous unmistakable conventions utilized in the different RFID systems, some utilizing the lower end of the range (135 KHz) and others utilizing the too high recurrence (SHF) at 5.875 GHz. RFID systems are included three principle parts: the tag or transponder, the per user or handset that peruses and composes information to a transponder, and the PC containing data set and information the executives programming. RFID labels can be dynamic, detached or semi-latent. Detached and semi-inactive RFID send their information by reflection or regulation of the electromagnetic field that was produced by the Reader. The ordinary perusing range is between 10 cm and 3 m. The battery of semi-aloof RFID is just used to control the sensor and recording

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rationale. The communication of dynamic RFID is fueled by his own personal battery. This empowers higher sign quality and stretched out communication scope of up to 100 meters; yet the usage of dynamic communication requires bigger batteries and more electronic parts. The average cost of dynamic RFID is between five or multiple times the cost of semi-latent ones. RFID has been effectively applied to food coordination and flexibly chain the executive's measures due to its capacity to distinguish, sort, and deal with the progression of products. Additionally, electronic distinguishing proof of steers utilizing RFID is a typical practice in numerous ranches. In any case, late improvements in RFID equipment furnished with sensors broaden its scope of utilization. Murkovic et al. built up a RFID inactive tag with a synthetic sensor and its optoelectronic interface. The gadget is without battery, has the size of a charge card and is viable with the ISO 15693. It estimates pH in the reach 5.0-8.5, utilizing wireless energy move to control the sensor and read its reaction. There are business dynamic and semi-inactive labels that can gather temperature information. Other semi-uninvolved labels furnished with sensor are a work in progress, similar to humidity, stun/vibration, light and convergence of gases, for example, acetaldehyde or ethylene. In horticulture, dynamic labels are fascinating, particularly for creature conduct examines. They consequently send driving forces, so the creatures can be recognized by even inaccessible per users. This capacity is ensured by utilizing a force battery. These gadgets can be utilized to screen creatures in average size open air pens, giving advanced information that can be effectively automated.

III. SENSOR's HUMIDITY SENSING MECHANISM

The humidity detecting properties of alumina depend on ionic and electronic conduction. At first, physisorption of water happens on the dynamic surface. Physisorption of water molecules is appeared in Figure 1. The water molecule is broken into H+ and (OH) - ions. The negatively charged oxygen of the water molecule is appended to the positively charged cation site. One of the positively charged hydrogen particles is connected to the anionic site. They make two chemisorbed hydroxyl (OH) bunches as appeared in Figure 1. After that another water molecule is ingested through hydrogen bonding on the two neighboring hydroxyl bunches as appeared in Figure 1. The top connected water molecule isn't allowed to move because of the restriction from the two hydrogen bonding (Figure 1). Along these lines this layer or the first truly adsorbed layer is stable and there are no hydrogen bonds shaped between the water molecules in this layer. Accordingly, no proton could be led in this stage. As water keeps on gathering on the

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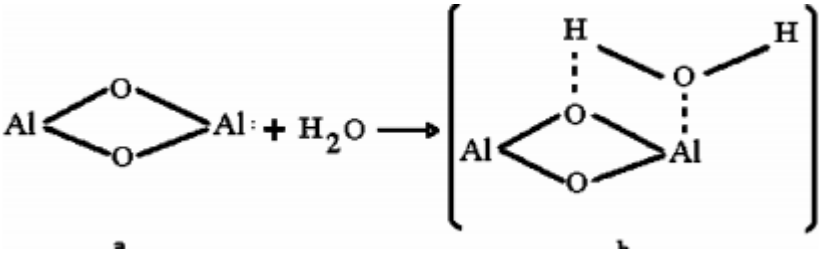
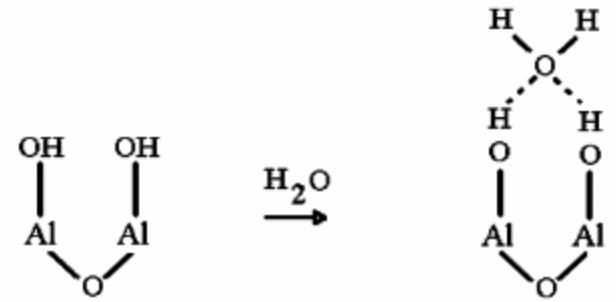
outside of the material because of expansion in dampness concentration, another layer on top of the primary truly adsorbed layer is framed as appeared in Figure 2. This layer is less arranged than the first genuinely adsorbed. For instance, there might be just a single hydrogen bond locally. In the event that more layers gather, the requesting from the underlying surface may continuously vanish and protons may have increasingly more opportunity to move inside the condensed water.



(a)



(b)

Figure 1 Schematic illustration of interaction of a water molecule with an alumina surface.

This conduction of proton from one water molecule to neighbor water molecule by means of hydrogen bonding framing a proton burrow is known as Grotthuss instrument. At the end of the day, from the second physisorbed layer, the water molecules become versatile and at long last, gotten practically indistinguishable from the mass fluid water, and the Grotthuss instrument gets predominant. This component shows that sensors dependent on water-stage protonic conduction would not be very delicate to low humidity, at which the water fume could infrequently frame constant versatile layers on the sensor surface. Two stationary layers, the chemisorbed and the first physisorbed layer can't add to proton conduction movement. However,

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ISSN: 2321-3914
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they could give electron burrowing between contributor water sites.

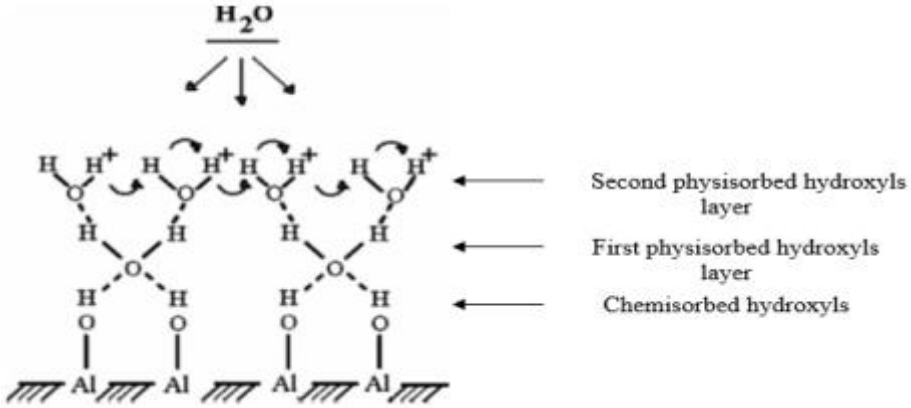

Figure 2 Schematic illustration of build-up of adsorbed water layers

The tunneling impact encourages electrons to jump along the surface anions that are covered by the fixed layers. Subsequently, this adds to the conductivity and it is called electronic conductivity. This system is very useful for identifying low humidity levels, at which there isn't compelling protonic conduction. Because of the electron burrowing impact inside the condensed fixed water layers, permeable Al2O3 is a serious candidate for detecting low humidity levels. Likewise because of narrow condensation of water molecules in the pores, the compelling dielectric steady changes which causes change in the capacitance esteem.

IV. DEVELOPMENT OF EXPERIMENTAL SETUP FOR TESTING THE SENSORS

Plan and advancement of an exploratory arrangement assumes a significant function for deciding the reaction attributes of the sensor during the trial work. Uncommon sort of sensor testing chamber was intended for the LC sensors. Remembering the distortion and impedance of magnetic field, the chamber material was chosen. Basically glass, Teflon and acrylic materials were utilized. The electrical attributes of the Sensor1 have been resolved in glass office of volume ~1000 cc with ¼' delta and outlet pipe connection. The channel pipe of the chamber is associated with a business dew point meter (model no SADPTR-R, UK) for checking the dampness level of soggy N2 gas. The wet gas of various humidity in ppm was acquired by blending the business dry N2 gas with water fume at room temperature (25°C). The dampness concentration was shifted from 100 to 5000 ppm. The Sensor1 was legitimately associated with the impedance analyzer for electrical characterization. The chamber was

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associated with quarter inch Teflon pipe. The whole testing set up was organized in a way to limit magnetic field distortion. The impedance analyzer was interfaced to a work area PC with the assistance of information acquisition system.

V. ELECTRICAL CHARACTERIZATION OF THE SENSORS

The electrical characterization of the sensors has been conveyed to assess the exhibition of the sensor at various humidity levels. Static and dynamic reactions were caught to get the affectability, reaction time and reproducibility of the sensor. The leads of the Sensor1 were associated with the 4294A Agilent impedance analyzer. The AC signal plentifulness was fixed at 500 mV (r.m.s). To acquire the reverberation recurrence at introductory dampness of 102 ppm, the sign recurrence was shifted from 2 MHz to 10 MHz. The impedance reaction in Z, θ method of impedance analyzer is appeared in Figure 3. It shows in the Figure 3 that the reverberation top happens at around 7.0773 MHz at 102 ppm dampness. Investigations have been performed with various dampness concentration to decide the electrical attributes of the sensor, for example, (I) impedance reaction (ii) reverberation recurrence move (iii) change in quality factor.

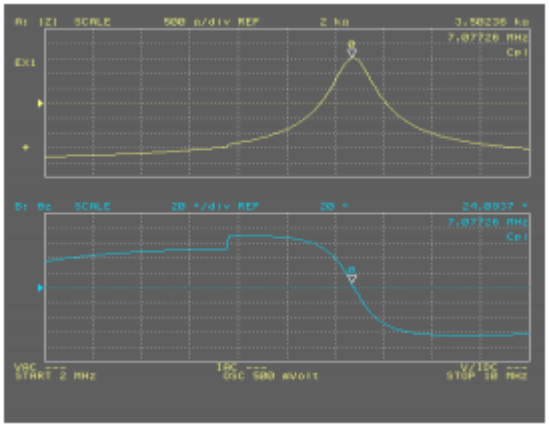

Figure 3 Impedance response curve of Sensor1 at 102 ppm.

The transient conduct of Sensor1 was likewise gotten for deciding the reaction and recuperation time. The impedance reaction bend for the Sensor1 with various dampness concentrations in N2 gas is appeared in Figure 4.

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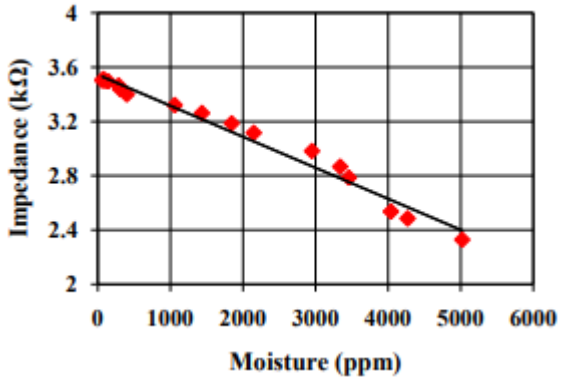

Figure 4 Impedance change at resonance condition with variation of moisture of Sensor1.

To decide the reaction, Sensor1 was presented to certain dampness and then almost 15 m time was permitted to arrive at the harmony condition of dampness in the chamber. The adjustment in reverberation recurrence with dampness is appeared in Figure 5. Since the 2 2.4 2.8 3.2 3.6 4 0 1000 2000 3000 4000 5000 6000 Impedance (k ω) Moisture (ppm) quality factor of the sensor gets influenced at various dampness level, exploratory outcomes for the adjustment in quality factor are appeared in Figure 6. The reaction bends speak to the conduct of the sensor at various dampness concentrations

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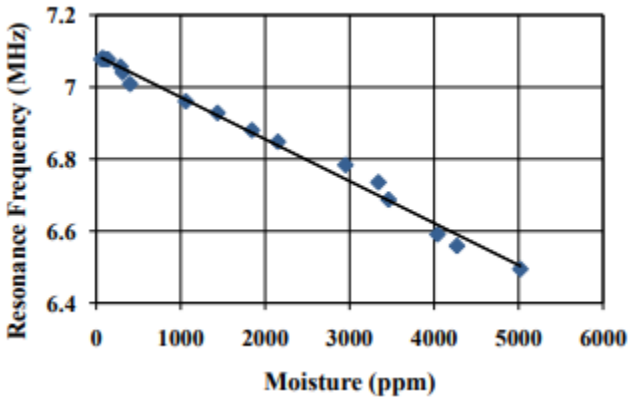

Figure 5 Resonance frequency shift of Sensor1.

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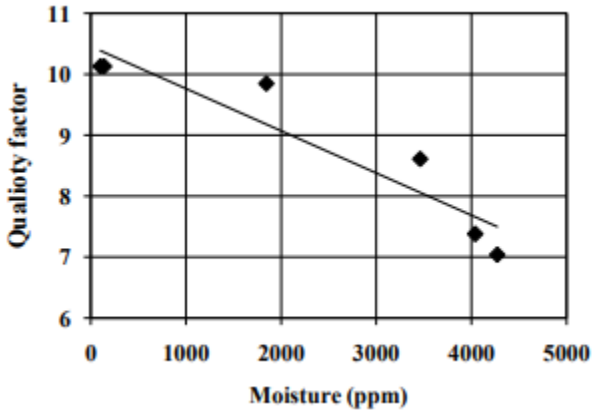

Figure 6 Change in quality factor of Sensor1.

VI. RESULTS AND DISCUSSION

It is seen in the above-got reaction bends that both impedance and reverberation recurrence of the LC sensors change fundamentally with the variation of dampness concentration (ppm). At dry condition of 8 ppm the thunderous recurrence was 5.1616674 MHz, which diminishes to 5.10136774 MHz at 100 ppm and to 4.9988574 MHz at 221 ppm. It is likewise seen that both impedance and recurrence change straightly. To decide the nonlinearity of sensor yield, the test information is fitted with straight bend and the nonlinearities in the impedance and recurrence reaction of Sensor1 are 4.62% and 0.70% individually. It has been seen that the reaction bend is practically indistinguishable without indicating any float. The greatest deviation of the progressive pinnacles is just 0.0032%.It has been accounted for by T. Islam et al. that as a result of exceptionally stable material of γ-Al_2O_3, the float in sensor yield because of progress in encompassing temperature and maturing is unimportant. Additionally as for natural fumes, the reaction because of dampness of the sol-gel slim film capacitive sensor is a lot of huge. The overall permittivity of water is a lot higher than the general permittivity of the natural vapor.

VII. CONCLUSIONS

The proposed planar structure of Sensor1 comprises of an equal plate capacitor associated in arrangement with the planar inductor. LC structures detailed in different literary works use inter-digital capacitive humidity sensor or inter-winding capacitance either on polymer or TiO2 sol gel slender film. The sensor is created utilizing truly stable meager film of γ-Al2O3 by sol-gel technique. The sensor shows critical change in recurrence with dampness variation in

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ppm. The move in reverberation recurrence additionally differs directly with dampness. An exceptionally basic, minimal effort and mass producible procedure has been followed to create the sensor. The sensor can be created on dispensable premise if so wanted. Such LC sensor may discover wide application in future in situ or in vivo humidity estimation application. Sensor1 has been used to decide the reaction qualities for estimating humidity in the scope of 100 to 5000 ppm.

REFERENCES

1. G. K. McMillan, Douglas M. Considine, ―Process/Industrial Instruments And Controls Handbook,‖ Fifth Edition McGraw-Hill 1999.

2. H. Abe, D. Lisak, A. Cygan, and R. Ciuryło, ―Reliable, robust measurement system for trace moisture in gas at parts-per-trillion levels using cavity ring-down spectroscopy‖ Review of Scientific Instruments,vol. 86, issue 10,pp. 106-110, 2015

3. Pieter R. Wiederhold, ―Water vapor measurement methods and instrumentation‖, Hardcover, Publisher: CRC Press, 1997.

4. J. Fraden,―Sensor Characteristics, Physical principles of Sensing‖, Handbook of Modern Sensors, Third Edition., Ed. New York: Springer-Verlag, pp.33–119, 2004.

5. F. W. Gole, ―Introduction to Meteorology‖, John Wiley & Sons Inc., New York, 1970.

6. http://www.iceweb.com.au/Analyzer/humidity_sensors.html 2005

7. A guide to Measurement of Humidity, ISBNO-904457-24-91, The Institute of Measurement and Control and NPL(UK), 1996.

8. E. Traversa, ―Ceramic sensors for humidity detection: the state of the art and future developments,‖ Sensors and Actuators B, Vol. 23, pp. 1335-1356, 1995.

9. Hans H. Funke, Brad L. Grissom, Clark E. McGrew, and Mark W. Raynor, ― Techniques for the measurement of trace moisture in high-purity electronic specialty gases,‖ Review of Scientific Instruments, vol. 74, no. 9, 2003.

10. L. Juhász , J. Mizsei, ―Humidity sensor structures with thin film porous alumina for on-chip integration,‖ Thin Solid Films, vol. 517, pp. 6198–6201, 2009.

ISSN: 2321-3914
Volume:1 Issue:1
January 2021
Impact Factor: 5.7
Subject Engineering

11. Ning Wang, Naiqian Zhang and Maohua Wang, ―Wireless sensors in agriculture and food industry - recent development and future perspective,‖ Computers and Electronics in Agriculture, vol. 50, issue 1, pp. 1–14, 2006.

12. Protection training manual published by the New York City Department of health and mental hygiene division of environmental health 125 Worth Street New York, NY 10013, 2012.

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