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Development of Polyaniline Composite based Humidity Sensor

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***Abstract*: Humidity is an important environmental element because it influences weather, climate, and global climate change. Understanding how interior conditions are affected by humidity will aid in the storage of sensitive material. A sensor is a device that detects and responds to information or facts about the environment. The relevant input could be light, fire, motion, moisture, friction, or any other type of environmental existence. Among the numerous types of sensors accessible are temperature sensors, pressure sensors, humidity sensors, gas and alcohol sensors, and so on. Each sensor has a particular operating principle depending on the sort of physical quantity that is detected.**

***Keywords*: Polyaniline, Humidity, Polymers.**

1. Introduction

Climate management in greenhouses, plantation protection, soil moisture monitoring, and grain storage are all applications for humidity sensors in agriculture. Humidity sensors are employed in a variety of applications in general industry, including chemical gas purification, dryers, ovens, film desiccation, paper and textile manufacturing, and food processing. Among the most preferred mate materials are electrolytic metal oxides, alumina thin films, and ceramics. The most common materials used to monitor humidity are electrolytic metal oxides, alumina thin films, and ceramics. Polymeric humidity sensors have been intensively researched and used in industry for more than 30 years. Thin film humidity sensors made of polymers have a high processability, allowing for the manufacture of a wide range of geometry, including smaller sensor designs.

2. Literature Survey

Ramprasad and Rao [1] proposed a paper on the creation of a new processable and humidity sensitive chitin–polyaniline blend. PANI is blended with chitin using the solution blending process. Under atmospheric conditions, the free-standing films of blends are stable. The stability was checked, and the samples remained stable even after 75 cycles. The thickness of blend films can be minimized to minimize hysteresis and reaction time. The built humidity sensor achieves very strong results in the 10–100% humidity range, and the operating temperature range is found to be 20–60 C. It should also be remembered that the sensor has very high-water resistance and that the humidity reaction can be replicated with the sensor even after a year.

Kulkarni et al [2] have demonstrated conducting polyaniline-based humidity sensors that were ink-jet printed. At room temperature, PANI has been used for humidity sensing. A single-step chemical oxidative polymerization technique was used to create PANI-based aqueous ink-jet printable ink. This is a one-step polymerization approach for the direct synthesis of the polymer's conducting emeraldine salt process as an ink formulation. The resistance changed in response to a change in the percent RH. The authors discussed the configuration of the sensor using transmittance and absorbance properties in the discussion, and the experimental curve is also presented with the experimentation.

Lekha et al [3] have discussed about the subject of interfacially polymerized polyaniline /dodeca tungstophosphoric acid nanocomposites. Conductivity and humidity sensing have been improved. Interracially polymerized conducting polymer and its hybrid with grain sizes ranging from 10 to 50nm have discernible moisture content, which is critical in the dehydration temperature conduction mechanism. For polyaniline, the temperature and frequency dependent ac conductivity obeys the Corelated Barrier Hopping (CBH) and Overlapping Large Polaron Tunnelling (OLPT) models (PANI). The Grotthuss mechanism is responsible for the response to humidity in the high RH zone.

Biju and Jain [4] have discussed about Effect of polyethylene glycol additive in sol on the humidity sensing properties of a titanium dioxide (TiO2) thin film. The use of Polyethylene glycol (PEG) as an intermediate in the sol increases the humidity sensitivity of TiO2 thin films. The increased humidity exposure is caused by a decrease in crystallite size and the presence of nanopores. Sol-gel and spin coating methods were used to create TiO2 thin films. An analogous circuit that was well suited to experimental data was taken from the Cole-Cole plots. It has been discovered that as resistance is compared to

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capacitance in all samples, the resistance varies dramatically. At low humidity, a film prepared from the PEG-added sol sample showed increased sensitivity, which could be attributed to the presence of nanopores.

Zeng et al [5] have successfully demonstrated how a humidity sensor based on polyaniline nanofibers was built and its reaction to humidity was studied. The sensor was discovered to behave differently than widely accepted conducting polymer-based sensors. The sensor usually responded to low relative humidity (50 percent RH) by decreasing electrical resistance as humidity increased. At higher RH, however, the sensor reversed its responses by increasing electrical resistance with humidity. Carbon/graphite paste ink was used to print screen printed electrodes (SPEs) used as a substrate for PANI fabrication and conductivity calculation. Until application, aniline was vacuum distilled to remove impurities. Using the chemical deposition process, a PANI nanofibers film was fabricated onto the screen-printed electrodes.

Manjunatha et al [6] have explored how a Polyaniline-Tungsten Disulphide (PANI-WS2) composite was generated using an in-situ polymerization technique. The humidity sensing activity of a PANI-WS2 composite synthesized using in situ polymerization was checked. A scanning electron microscope micrograph revealed a uniform distribution of micro sheets of WS2 in the matrix of PANI, with an enhanced porous structure that facilitated water molecule adsorption. The occurrence of WS2 in PANI was verified by EDX analysis. With an improvement in percent RH, the resistance and sensitivity component of the composite changed almost linearly. The response and recovery times of the as synthesized composite were adequate for designing an effective resistive form humidity sensor.

Manjunatha et al [7] have investigated the humidity sensing activity of PANI-Tantalum Disulphide (TaS2), a hybrid material/composite tested in the 10-97 percent relative humidity range. Electrical connections were created by painting silver paste on both sides of the pellets to analyse the room temperature humidity sensing properties. The samples' humidity sensing properties were investigated using a lab-fabricated sensor setup. To keep the sample pellet, all of the glass chambers were fitted with rubber corks through which the electrodes were passed. An interfaced programmable wireless multimeter is wired to the other end of the electrodes. Equation was used to measure the humidity sensitivity of the samples at room temperature.

Nagaraju et al [8] have explored the humidity sensing properties of surface modified polyaniline metal oxide composites. In situ polymerization was used to create composites of praseodymium oxide (Pr2O3) of varying weight percentages. Fourier transform infrared spectroscopy, X-ray diffraction, and scanning electron microscopy were used to classify the composites. The temperature-dependent conductivity demonstrates that the conductivity is caused by the jumping of polarons and bipolarons. In addition, the experimental system for the humidity sensors is illustrated using a polyaniline synthesis.

Pawbake et al [9] describe the highly transparent wafer-scale synthesis of crystalline WS2 nanoparticle thin film for photodetector and humidity sensing applications. The modified Hot Wire Chemical Vapor Deposition (HWCVD) technique was used to create a wafer-scale size highly crystalline WS2 nanoparticle thin film in a single phase. As a result, multiple pathways for growing another TMDCs nanoparticle thin film for wide area nanoelectronics and industrial applications are now available. The WS2 nanoparticle thin-film dependent humidity sensor had a maximum sensitivity of 469 percent, a reaction time of 12 seconds, and a recovery time of 13 seconds. Under white light illumination, the reaction time is 51 seconds and the recovery time is 88 seconds, with a sensitivity of 137%.

Wang et al [10] have published a paper in which they present an ideal design of a polyaniline-coated Surface Acoustic Wave (SAW) dependent humidity sensor. A two-port SAW resonator with an Aluminum-Gold (Al/Au) electrode as the feedback portion of the oscillator was planned as the perfect configuration for a modern PANI coated SAW-based humidity sensor. A 300 MH SAW-based humidity sensor was designed using PANI as the sensitive material for humidity detection, and the sensor output was thoroughly characterized. In low humidity detection, ideal linearity was observed, as well as very good stability, owing to the sensor chip's good corrosion resistance when using Al/Au electrodes.

Chani et al [11] have explored the fabrication and sensing reaction of a PANI thin film-based humidity sensor. The humidity sensing properties of drop-cast polyaniline films is studied. The samples' capacitance and impedance were measured when humidity was present. It was discovered that as the relative humidity increased, the capacitance of the sensor increased and the impedance decreased. It was discovered that the impedance humidity relationship exhibits more consistent changes in the 36 percent -90 percent RH interval than the capacitance humidity relationship, which exhibits less consistent changes in this interval. This sensor's humidity-based impedance makes it suitable for use in an impedance humidity metre. The impedance humidity metre can be used in environmental measurement and humidity evaluation instruments.

McGovern et al [12] have discussed how polyaniline was combined with either polyvinyl alcohol or a butyl acrylate/vinyl acetate copolymer and used as a sensing medium in the development of a resistance-based humidity sensor. As conducting electrodes, 125 m polyester-insulated platinum wire was dip-coated in conducting polymer. The sensors had a final thickness of less than 150 m and demonstrated high sensitivity, low resistance, and decent reversibility with no hysteresis. Any response drift was due to slow oxidation of the polyaniline, which could be minimized by using suitable barrier coatings.

3. Conclusion

The proposed humidity sensor is made from Polyaniline Composite, which accurately measures moisture content present in the surroundings. Further it should be noted that, sensor has got very good durability against water and humidity response can be reproduced with sensor even after 1 year.

Hence it proves to be a competent material as humidity sensor.

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