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Development and Prospect of Humidity Sensor Technology

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Abstract. Humidity sensor is an important sensing device, which can reflect the dryness and wetness perception of the environment. The main application fields are as follows:industrial process control, medical health monitoring, environmental monitoring, smart home appliances, and Internet of Things (IoT) terminals. Three key technical indicators including relative humidity, absolute humidity and dew point temperature are depicted in this paper. Then the applicable scenarios and technical characterization requirements of humidity sensor are summarized. Subsequently, three mainstream humidity sensors (capacitive, resistive and piezoelectric) are shown according to the operational mechanisms and technical characteristics. The critical parameters of humidity sensor (measurement accuracy, response speed, operating temperature, humidity range, stability, power consumption, etc) are summarized and elaborated in detail. In the future, humidity sensors are evolving toward high precision, miniaturization, low power consumption, intellectualization and multi-parameter integration based on the technological iteration, application expansion and industrial implementation. it comprehensively analyzes the development prospects of humidity sensors, affirming their steady evolution toward high precision, miniaturization, low power consumption, intelligence, and multi-parameter integration.

Keywords: humidity sensor, capacitive, resistive, optical, flexible

1. Introduction

Humidity can directly reflect the dryness and wetness of the environment, which connects natural ecological balance, industrial production safety, and the quality of human daily life [1]. The development of humidity detection technology has always been focused on the key goal of breaking through environmental limitations and improving measurement efficiency. Humidity sensors, by converting the physical quantity of humidity into quantifiable electrical signals, have achieved high precision and convenience in humidity detection. Today, humidity sensors have evolved from simple environmental monitoring components into core sensing nodes that empower the digital transformation of numerous industries [2].

Although humidity sensors have been applied successfully in many important fields, there still exists some challenges: insufficient response sensitivity in extremely low-humidity environments, measurement deviations caused by temperature coupling, and lack of anti-interference capability in complex industrial scenarios [3], all of which urgently need to be addressed depending on new

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technologies (material innovation, algorithm optimization, etc.). With the in-depth integration of nanomaterials and intelligent algorithms humidity sensors are accelerating their evolution toward high precision, miniaturization, low power consumption, and intelligence [4].

In order to sort out the latest technological development of the humidity sensor, the paper presents an in-depth review in the following aspects: core classifications, key parameters, multi-field application practices, and the forecast of future development trends. The paper can guide the future research of humidity sensor for both academic community and engineering industry.

2. Core quantitative of humidity

The accurate quantification of humidity is the basis for effective monitoring and regulation. Divided by measurement dimensions, common humidity indicators mainly include the following three core forms:(1) Relative Humidity (RH): As the most commonly used humidity indicator, it refers to the percentage of the actual water vapor pressure in the current air to the saturated water vapor pressure at the same temperature. The humidity mentioned in daily weather forecasts belongs to this category, which can directly reflect the dryness and wetness perception of the environment.(2) Dew Point Temperature: It refers to the temperature at which air is cooled to a saturated state when the water vapor content remains unchanged and the air pressure is constant. It is mainly used to warn of condensation risks in industrial scenarios, such as cold chain transportation and the operation and maintenance of high-voltage electrical equipment.(3) Absolute Humidity: It refers to the mass of water vapor contained in a unit volume of air, which can accurately reflect the actual water vapor content. However, it needs to be interpreted in combination with temperature data to reflect the dryness and wetness perception of the environment, so it is mostly applied in professional scenarios such as laboratory calibration and high-precision meteorological observation.

3. Classification, key parameters and technological progress of humidity sensors

The core principle of humidity sensors is to detect the influence of water molecules in the air on the physical or chemical properties of the sensors. According to the working principles, they can be divided into several categories. Sensors of different categories have different focuses on technical characteristics and application scenarios. Meanwhile, the pros and cons of key parameters directly determine the applicable scope of sensors, which are the core basis for selection and application.

3.1. Core classifications of humidity sensors

Based on the differences in operating principles, humidity sensors can be classified into capacitive, resistive, optical, flexible, and other special types. Each type of sensor is suitable for different application scenarios by virtue of its unique technical characteristics. The operating mechanisms, technological innovations, and application practices of various sensors will be elaborated in detail below.

3.1.1. Capacitive humidity sensors

Capacitive humidity sensors are currently the most widely used and technically mature mainstream type. Their operating principle is to utilize the characteristic that the dielectric constant of humidity-sensitive materials (usually polymer composites or metal oxides) varies with ambient humidity. The material is placed as a dielectric between two electrodes to form a capacitor. Changes in humidity will cause variations in capacitance, which are then converted into standard electrical signal outputs

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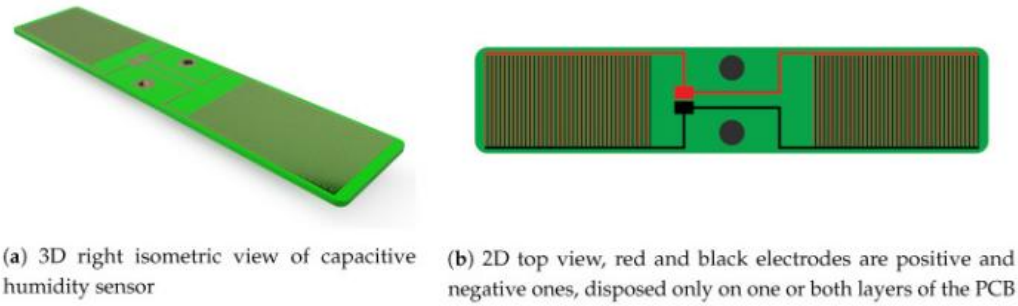
through a measurement circuit. Such sensors have distinct advantages including high precision, fast response, excellent linear output, wide measurement range (0%~100%RH), low power consumption, small size, and easy integration, thus being extensively applied in multiple fields. In terms of technological innovation, scholars such as Adrian-Razvan Petre et al. [5] have developed a PCB-based interdigitated capacitive (IDC) soil humidity sensor (interdigital capacitive humidity sensor) [see Figure 1].



(a) 3D right isometric view of capacitive humidity sensor

(b) 2D top view, red and black electrodes are positive and negative ones, disposed only on one or both layers of the PCB

Figure 1. Interdigital capacitive humidity sensor

It provides a low-cost alternative to existing commercial sensors and lowers the application threshold in agricultural scenarios. The parallel-plate capacitive humidity sensor proposed by Asad Ulla et al. [6] [see Figure 2] uses copper foil tape as electrodes and tissue paper as the dielectric sensing layer. It boasts the characteristics of low cost, flexibility, ease of fabrication and environmental friendliness, together with excellent performance—with a response time of approximately 1.5 seconds, a recovery time of around 2.2 seconds, stable results in repeated experiments (4–5 times), and a precision of ±0.1%. It can maintain stable response in different temperature environments, enabling rapid adaptation to diverse application scenarios.

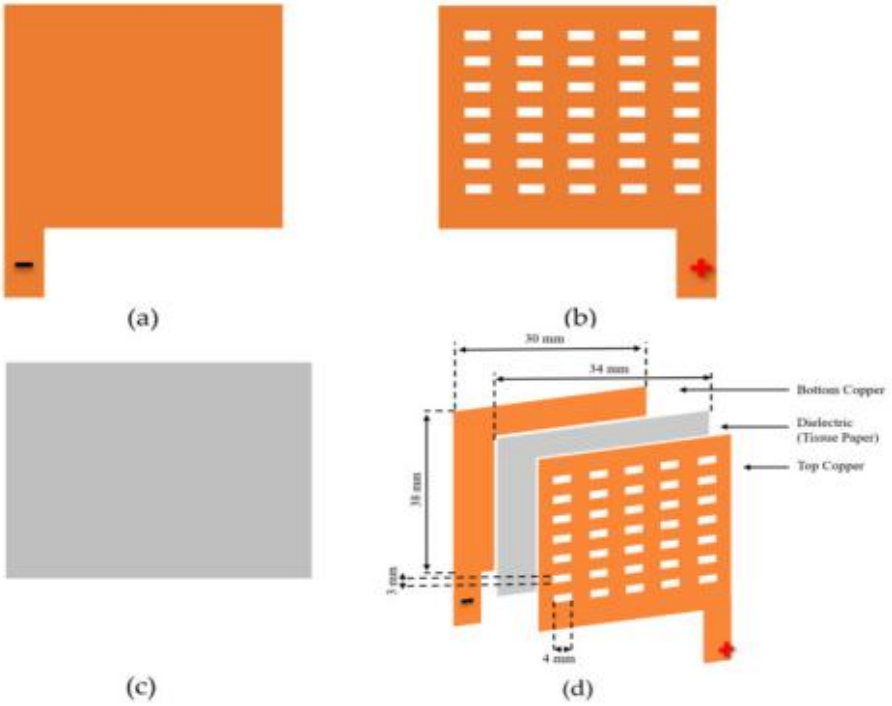


Figure 2. Copper-based parallel-plate capacitive humidity sensor: (a) bottom side; (b) top side with mesh structure; (c) tissue paper as the sensing layer; (d) fabricated sensor

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The carbon black/polyimide composite capacitive humidity sensor developed by Jihong Kim et al. [7] [see Figure 3] achieves performance improvement by optimizing the carbon black dosage: as the carbon black content increases, the sensor sensitivity is gradually enhanced, the hysteresis error is reduced from 2.17% to 1.80%, the response speed of the sensor containing 0.05wt% carbon black is about 10% faster than that of the pure polyimide sensor, and it also exhibits excellent long-term stability.

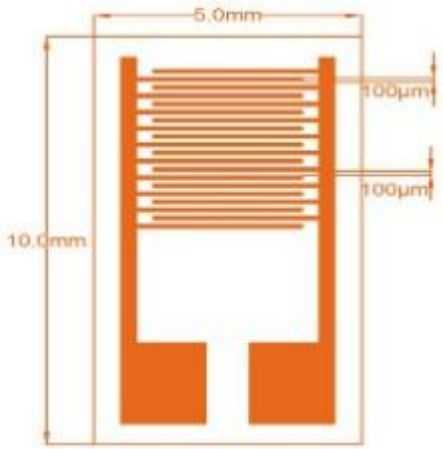

Figure 3. Cross-section of the simplified sensor design

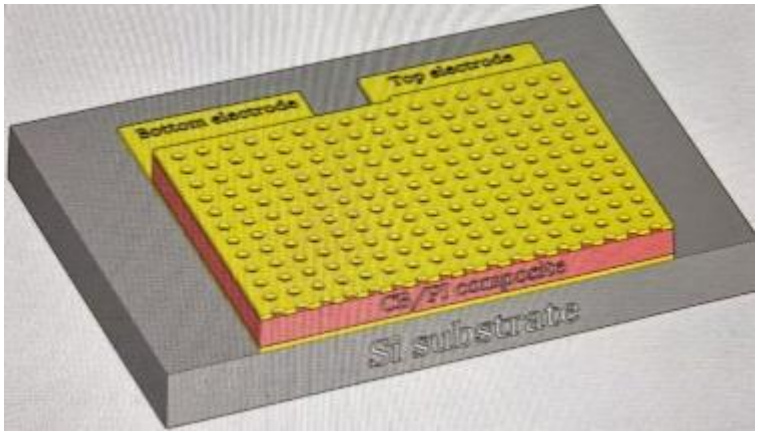

Figure 4. IDE structure and dimensions

In scenario-specific applications, to address the problems of high cost and low popularity of medical respiratory monitoring equipment, Miaoxin Pan et al. [8] designed a low-cost wearable flexible capacitive humidity sensor [see Figure 4]. This sensor can clearly distinguish different breathing patterns such as normal breathing, resting breathing, deep breathing, and rapid breathing, and can also identify changes in vocal pitch during speech. It provides a new pathway for cost-effective and convenient wearable respiratory monitoring, and is expected to be applied in daily health monitoring and professional medical diagnosis.

The team led by Guo Chen et al. [9] improved the sensor performance through structural optimization. A molybdenum (Mo) metal layer was introduced into the semiconductor process of the MEMS capacitive humidity sensor, serving as both a heating layer and a shielding electrode layer. This effectively reduced humidity hysteresis and parasitic capacitance. Combined with fluorine-containing PI humidity-sensitive materials, the sensitivity was further enhanced. Tests show that the

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sensor has the advantages of high sensitivity, good repeatability, low hysteresis effect, and small device size [see Figure 5].

Li Zheng et al. [10] optimized the heater structure via simulation and improved the film-forming process of the humidity-sensitive membrane. While enhancing the sensor sensitivity, this design reduced humidity hysteresis and response time, and could also effectively remove liquid water droplets on the sensor surface, thereby improving adaptability to complex environments [see Figure 6].

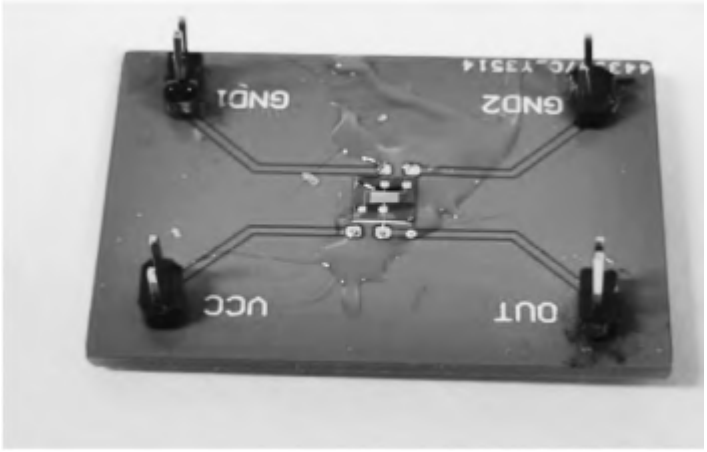

Figure 5. Humidity sensor chip

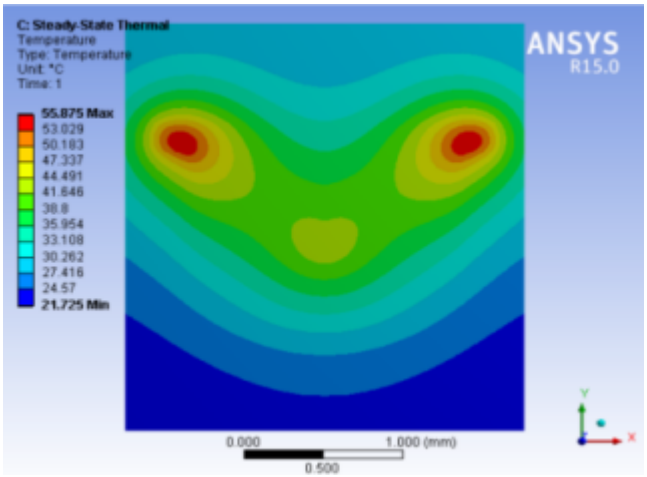

Figure 6. Simulation results of heating functionhalf width figures

3.1.2. Resistive humidity sensors

The operating principle of resistive humidity sensors relies on the characteristic that the resistance value of humidity-sensitive materials (such as lithium chloride, semiconductor ceramics, and carbon-based composites) varies with humidity—changes in humidity lead to alterations in the ionic conductivity of humidity-sensitive materials, which in turn cause fluctuations in resistance value. Humidity measurement is achieved by detecting such resistance changes.

Compared with capacitive humidity sensors, resistive sensors have certain disadvantages in terms of stability and linearity. In the design of new equipment, unless there are special scenario requirements, capacitive sensors are usually a more reliable and cost-effective choice. Nevertheless,

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resistive sensors still have innovative breakthroughs in the fields of flexibility and low cost. The team led by Ana R et al. [11] developed a flexible resistive humidity sensor [see Figure 7]. Silver interdigitated electrodes (IDTs) were prepared on polyimide films via screen printing technology, and multi-walled carbon nanotubes (MWCNTs) dispersed in polyvinyl alcohol (PVA), a water-soluble polymer, were used as the active layer. Among them, the MWCNT/PVA sensor with a MWCNT content of 1% exhibited the best performance—in an environment with 99% relative humidity, the relative resistance change ($\Delta R/R_0$) reached 509%. It also has the advantages of simple structure, environmental friendliness, and high sensitivity, and can be easily integrated into wearable devices for motion monitoring, medical health, and other applications.

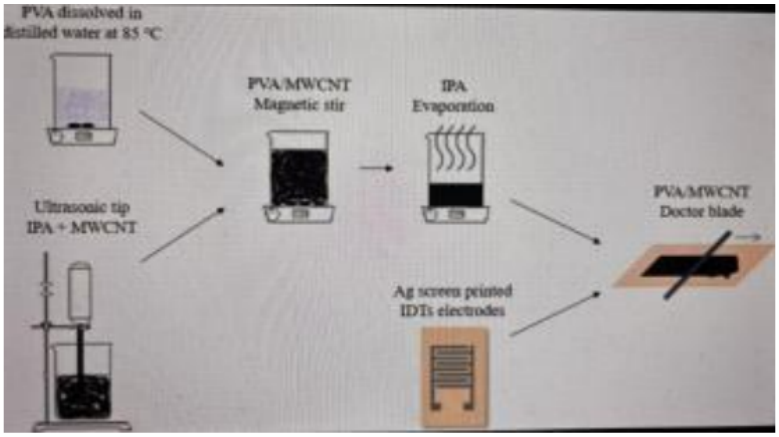

Figure 7. Schematic diagram of the fabrication process for mwcnt/pva-based humidity sensors

The team led by Deshuai Meng et al. [12] focused on the demands for high sensitivity and fast response. They developed a resistive humidity sensor that can not only realize human respiratory monitoring, but also achieve non-contact response to human fingers [see Figure 8], thus providing technical support for short-range humidity sensing scenarios.

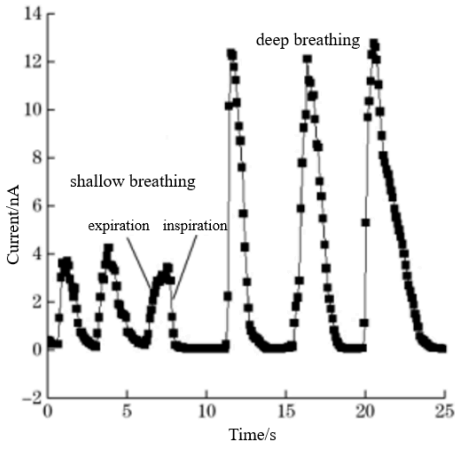

Figure 8. Sensor response to human respiration

3.1.3. Optical humidity sensors

Optical humidity sensors represent the high-end development direction of humidity measurement technology. Their core advantage lies in the fact that they do not rely on changes in the electrical

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properties of humidity-sensitive materials; instead, they realize direct humidity measurement based on the optical characteristics (such as absorption, reflection, and interference) of water molecules on light of specific wavelengths. Therefore, they have irreplaceable advantages in harsh environments such as high temperature, strong electromagnetic interference, and corrosive conditions.

Classified by operating principles, optical humidity sensors mainly include chilled-mirror optical dew point meters and optical absorption sensors. In recent years, with the development of materials and optical technologies, new types of optical humidity sensors have been emerging continuously. Scholars such as Naffseh Tobeiha et al. [13] prepared graphene/graphene oxide (G/GO) nanosheets via sonochemical exfoliation. After physical property analysis [see Figure 9], they developed an optical humidity sensor based on this material, which improves the detection sensitivity by utilizing the optical characteristics of nanomaterials.

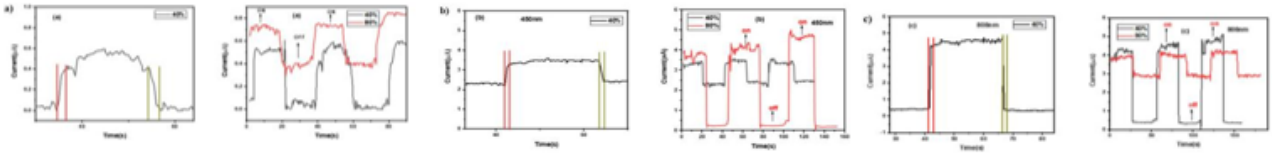

Figure 9. (a, b, c) Responsiveness and recovery under 40% humidity, dark conditions, and irradiation with 450 nm and 880 nm lasers; as well as image stability of (a, b, c) under 450 nm and 808 nm laser irradiation, with and without laser irradiation, at 40% and 80% humidity

Zijun Liang et al. [14] presented an allfiber highsensitivity dualparameter sensor capable of simultaneous humidity and temperature detection, featuring excellent humidity stability and an ultrafast response time of only 0.26 s. It demonstrates great application potential in scenarios such as dynamic medical respiratory monitoring and environmental monitoring for precision equipment. To enhance the sensitivity of optical fiber humidity sensors, Ma Xingchao et al. [15] proposed a sensitivityenhanced design based on the vernier effect of parallel fiber FabryPérot interferometers (FPIs). This sensor is characterized by simple fabrication, compact size, and high sensitivity, providing a novel solution for highprecision humidity measurement. Tang Yaqi et al. [16] developed an optical fiber humidity sensor with sensitivity enhancement via the optical vernier effect. Within the relative humidity range of 40%–65%, the original sensitivity of a single FP fiber sensor is X %RH/nm, while the sensitivity of this enhanced sensor is increased to 4.05X %RH/nm, representing a 4.05fold improvement compared to the single FP fiber sensor, further expanding the precision boundary of optical humidity sensors.

3.1.4. Flexible humidity sensor

The core innovation of flexible humidity sensors lies in endowing the originally brittle sensing system with flexibility through "material selection" and "structural design". These sensors can conform to the irregular and dynamically changing surfaces of human skin, organs, or wearable devices, enabling long-term stable monitoring.

Their operating principle framework is as follows: external humidity stimuli act on flexible functional materials/structures (with temperature as the primary interfering factor), inducing regular changes in the electrical properties (such as resistance R and capacitance C) of the materials. Flexible electrodes and circuits then collect the electrical signals, which are processed and analyzed to convert into corresponding humidity values.

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The ultra-flexible relative humidity sensor developed by Moumita Deb et al. [17] can detect a wide relative humidity range of 15%–70% and identify small relative humidity increments ranging from 0.1% to 2.2%. When attached to a mask, it can real-time analyze human breathing patterns in slow, normal, and fast modes, fully verifying its application value in wearable electronic devices and respiratory monitoring. The relative humidity sensor based on high-sensitivity cubic silicon carbide (3C-SiC) nanoparticles proposed by Arjun Wadhwa et al. [18] is fabricated via a full-printing process with low cost. Integrated into commercial KN95 masks, it enables real-time monitoring of parameters such as respiratory rate [see Figure 10], providing a new direction for the integrated application of sensors in the field of human health monitoring.

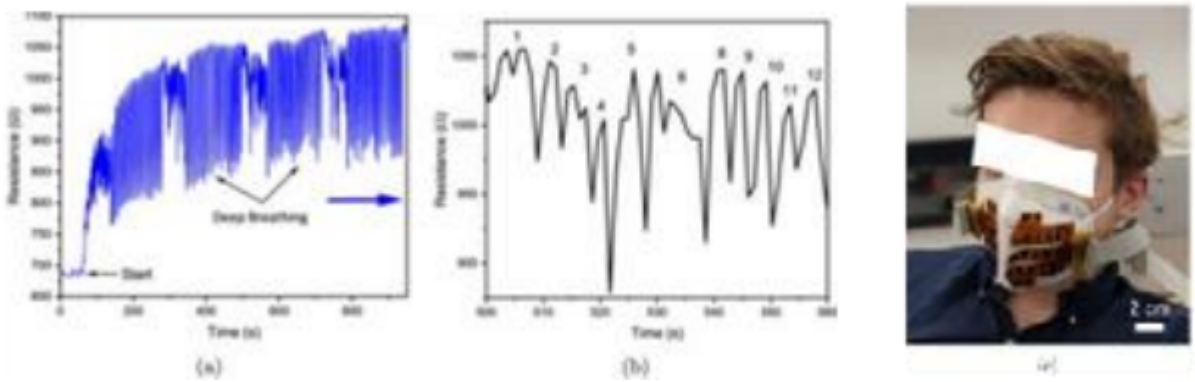

Figure 10. Printed silicon carbide humidity sensor for respiratory monitoring and respiratory rate detection

(a) Human breathing response when the silicon carbide humidity sensor is installed outside the KN95 mask; (b) determination of human respiratory rate based on sensor response; and (c) photograph of the respiratory monitoring device used for measurement.

3.1.5. Other types of humidity sensors

Besides the four mainstream types of sensors mentioned above, other types such as acoustic humidity sensors and ultra-fast response humidity sensors based on functional nanomaterials have also found applications in specific scenarios.

For example, acoustic humidity sensors realize humidity measurement by utilizing the difference in the propagation speed of sound waves in air with different humidity levels, and are suitable for certain special industrial environments. However, due to factors such as cost, volume, and environmental adaptability, the application range of such sensors is relatively narrow, and they have not yet become the market mainstream. Shinya Kano et al. [19] found that ultra-fast response humidity sensors based on functional nanomaterials possess the characteristics of portability and non-invasiveness, and exhibit unique advantages in respiratory monitoring.

3.2. Key selection parameters of humidity sensors

In the process of selecting and using humidity sensors, the following key parameters should be focused on to ensure that the sensors meet the requirements of application scenarios:

(1) Accuracy: As the most important parameter, it refers to the maximum deviation between the measured value of the sensor and the true value, usually expressed as ±%RH (percentage of relative humidity). The level of accuracy directly determines the reliability of the measurement results.

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(2) Measurement Range: It refers to the humidity range that the sensor can measure normally. The selection should be based on the humidity fluctuation range of the application scenario. For example, sensors with a low humidity range are suitable for industrial drying scenarios, while those used in humid environments need to cover a high humidity range.

(3) Response Time: It refers to the time required for the sensor output to reach a certain percentage (usually 63% or 90%) of the stable value when the ambient humidity undergoes a step change. It reflects the response speed of the sensor to humidity changes, and fast response is a core requirement for real-time monitoring scenarios.

(4) Long-term Stability/Drift: It refers to the variation range of the output characteristics of the sensor over time after long-term operation, usually expressed as %RH/year. Poor stability will lead to a gradual increase in the deviation of measurement results, affecting the long-term use effect.

(5) Temperature Coefficient: Since the readings of humidity sensors are easily affected by ambient temperature, the temperature coefficient represents the drift of humidity readings when the temperature changes by 1 ℃. Products with a small temperature coefficient should be selected according to the temperature fluctuation of the application scenario.

(6) Hysteresis: It refers to the phenomenon that the output signals corresponding to the same humidity value are different when the humidity of the sensor rises and falls. Excessive hysteresis will lead to inconsistent measurement results, especially in scenarios where humidity fluctuates frequently.

In addition, the balance between accuracy and cost should be considered during selection. Sensors with appropriate accuracy should be selected on the premise of meeting application requirements to avoid cost waste caused by blind pursuit of high accuracy. Meanwhile, full consideration should be given to the application environment factors, such as whether the environment has high temperature, high humidity, condensation, chemical pollution, dust, etc. These factors directly determine the packaging form and type selection of the sensor. For example, sensors with corrosion-resistant packaging should be selected for chemically polluted environments, and those used in dusty environments need to have dust-proof functions.

4. Development prospects of humidity sensors

Currently, humidity sensors are in a golden development stage featuring rapid technological iteration and expanding market scale. Their prospects present a positive trend driven by multiple favorable factors, including market demand pull, technological innovation drive, application scenario expansion, and policy support guarantee, indicating enormous potential for future development.

From the market perspective, both the global and Chinese humidity sensor markets maintain a high growth rate. The increasing demands for upgraded automated control in the industrial sector, intelligent transformation in consumer electronics, popularization of wearable devices in healthcare, and precision management in smart agriculture continue to drive the market volume of humidity sensors to new heights. It is predicted that in the next few years, the global humidity sensor market will maintain a double-digit compound annual growth rate. Benefiting from manufacturing upgrading and new infrastructure construction, the growth rate of the Chinese market is expected to outpace the global average, making humidity sensors a highly promising category in the sensor segment.

From the technological perspective, humidity sensors are accelerating their evolution toward the direction of higher accuracy, stronger intelligence, more functional integration, and better environmental protection and low power consumption. On one hand, the research and development of new humidity-sensitive materials such as nanomaterials and two-dimensional materials will

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further enhance the sensitivity and stability of sensors. For instance, the application of materials like graphene and metal-organic frameworks (MOFs) has demonstrated significant advantages. On the other hand, the integration of the Internet of Things (IoT) technology and intelligent algorithms has endowed sensors with intelligent functions such as data storage, wireless transmission, and self-calibration. Multi-parameter integration (e.g., integrated detection of humidity, temperature, and pressure) has become a mainstream trend. Meanwhile, continuous breakthroughs in low-power consumption design provide longer battery life support for scenarios such as wearable devices and wireless sensor networks.

From the application perspective, the application boundaries of humidity sensors are continuously breaking through traditional fields and deeply integrating into emerging scenarios such as smart homes, healthcare, smart agriculture, and new energy. In smart homes, sensors can link with air conditioners, humidifiers, and dehumidifiers to automatically adjust indoor humidity and optimize living experiences.

5. Conclusion

This paper systematically reviews the technologies and applications of humidity sensors. Firstly, three core indicators, namely relative humidity, absolute humidity and dew point, are defined together with their applicable scenarios. Afterwards, the working mechanisms and technological innovations of capacitive, resistive, optical and flexible humidity sensors are elaborated categorically, and the improvement paths of these sensors in terms of accuracy, response speed and stability are analyzed, in addition to sorting out the key selection parameters, so as to provide guidance for engineering applications. Finally, the technological development prospects are forecasted, indicating that humidity sensors are evolving towards high precision, miniaturization and integration, low power consumption and intelligence. Research demonstrates that humidity sensors have formed a diversified application ecosystem in industrial, medical, smart agriculture, smart home and other fields, and will become core components empowering the digital transformation of various industries.

At present, breakthroughs have been achieved in various technical routes. With differentiated innovations including low-cost fabrication, wearability and integration, humidity sensors have broken application boundaries and established a comprehensive application ecosystem. Meanwhile, the industry still faces several challenges, such as insufficient adaptability to extreme environments, multi-parameter coupling interference, and excessively high costs of high-end materials. Fortunately, empowered by nanomaterials, Internet of Things, artificial intelligence and other cutting-edge technologies, the future development trend of humidity sensors is distinctly clear.

In the future, efforts should be made to realize the precise alignment between basic research and application demands, strengthen interdisciplinary collaboration, break through technical bottlenecks, optimize production costs and expand application scenarios. It can be predicted that driven by the dual-wheel of technology and market, humidity sensors will upgrade from single sensing elements to key core components that empower the digitalization of all walks of life and intelligent life, providing solid technical support for the construction of an efficient, intelligent and green social development system.

References

[1] Xuan X, Wang M, Manickam S, Boczkaj G, Yoon JY, Sun X. Metal-Organic Frameworks-Based Sensors for the Detection of Toxins in Food: A Critical Mini-Review on the Applications and Mechanisms. Front Bioeng

DOI: 10.54254/2755-2721/2026.34158

Biotechnol. 2022; 10: 906374. Published 2022 May 26. doi: 10.3389/fbioe.2022.906374
[2] Lorek A, Majewski J. Humidity Measurement in Carbon Dioxide with Capacitive Humidity Sensors at Low Temperature and Pressure. Sensors (Basel). 2018; 18(8): 2615. Published 2018 Aug 9. doi: 10.3390/s18082615
[3] Melios C, Panchal V, Edmonds K, Lartsev A, Yakimova R, Kazakova O. Detection of Ultralow Concentration NO2 in Complex Environment Using Epitaxial Graphene Sensors. ACS Sens. 2018; 3(9): 1666-1674. doi: 10.1021/acssensors.8b00364
[4] Yang J, Shi R, Lou Z, Chai R, Jiang K, Shen G. Flexible Smart Noncontact Control Systems with Ultrasensitive Humidity Sensors. Small. 2019; 15(38): e1902801. doi: 10.1002/smll.201902801
[5] Adrian-Razvan Petre, Razvan C, Octavian F.Design, Implementation and Simulation of a Fringing Field Capacitive Humidity Sensor [J]. Sensors(Basel, Switzerland), 2020, 20(19): 5644.DOI: 10.3390/s20195644.
[6] Asad Ulla, Hamza M Z, Atif M K, et al.Garage-Fabricated, Ultrasensitive Capacitive Humidity Sensor Based on Tissue Paper [J]. Sensors, 2022, 22(20): 7885.DOI: 10.3390/S22207885.
[7] Jihong Kim, JangHoon C, HyungMan L, et al.Capacitive Humidity Sensor Based on Carbon Black/Polyimide Composites [J]. Sensors, 2021, 21(6): 1974.DOI: 10.3390/S21061974.
[8] Pan M, Zhou J, Weng S, et al.Flexible Chitosan-Based Capacitive Humidity Sensors for Respiratory Monitoring [J]. Sensors, 2024, 24(5): 1352.DOI: 10.3390/S24051352.
[9] Guo C, Cheng T, Zhongxiu W, et al.A high-sensitivity capacitive humidity sensor [J]. JournalofAutomationApplication, 2022, (8): 36-37+41.DOI: 10.19769/j.zdhy.2022.08.010.
[10] Li Z, et al.Research on polymer capacitive humidity sensor with integrated heating function [J]. JournalofSensorWorld, 2023, 29(9): 26-30.DOI: 10.16204/j.sw.issn.1006-883X.2023.09.005.
[11] Santos R A, Viana C J.The Development of a Flexible Humidity Sensor Using MWCNT/PVA Thin Films [J]. Nanomaterials, 2024, 14(20): 1653.DOI: 10.3390/NANO14201653.
[12] Deshuai M, Yang C, Zhenquan L, et al.Research on graphene oxide thin film resistive humidity sensor [J]. JournalofInstrumentTechniqueandSensor, 2024, (4): 19-23+37.DOI: 10.19769/j.zdhy.2024.04.004.
[13] Tobeiha N, Memarian N, Ostovari F.Optical humidity sensor based on G/GO nanosheets [J]. Scientific Reports, 2025, 15(1): 25456.DOI: 10.1038/S41598-025-09766-6.
[14] Liang Z, Wang C, Tang Y, et al.Non-Adiabatically Tapered Optical Fiber Humidity Sensor with High Sensitivity and Temperature Compensation [J].Sensors, 2025, 25(14): 4390.DOI: 10.3390/S25144390.
[15] Xingchao M, Xizi Z, Yun G, Yuchun W, et al.Sensitivity-enhanced fiber humidity sensor based on parallel Fabry-Perot interferometers with Verniere ffect [J]. JournalofOptoelectronics·Laser, 2023, 34(2): 113-119.DOI: 10.16136/j.joel.2023.02.0294.
[16] Yaqi T, Xinyong D.An optical fiber humidity sensor enhanced by optical vernier effect [J]. Journal of Optical Communication Technology, 2022, 46(2): 62-65.DOI: 10.13921/j.cnki.issn1002-5561.2022.02.012.
[17] Moumita Deb, Samit Kundu, Anirban Bandyopadhyay, et al.Ultra-Flexible Humidity Sensor for Wearable Electronics and Respiratory Monitoring [J]. Biosensors, 2023, 13(1): 81.DOI: 10.3390/bios13010081.
[18] Wadhwa A, Perrotton A, Taherian H M, et al.Flexible screen-printed SiC-based humidity sensors [J]. Communications Engineering, 2025, 4(1): 96.DOI: 10.1038/S44172-025-00425-2.
[19] Shinya Kano, Nutpaphat J, Syazwani M, et al.Respiratory Monitoring by Ultrafast Humidity Sensors with Nanomaterials: A Review [J]. Sensors, 2022, 22(3): 1251.DOI: 10.3390/S22031251.