

Xi Li

Linda S Milor

Shouku, team14

Comparison of Humidity Sensor Products

Humidity Measurement and Humidity Sensor

Introduction:

Sensors are devices that acquire physical, chemical, or biological quantitative information and convert them into readable signals. For every interactive device, sensors support devices to get information from the surrounding environment. Humidity measurement is one of the most important physical properties which are closely related to a huge variety of manufacturing, storage and testing processes which are humidity-critical. Humidity sensors are used wherever a industry needs to prevent condensation, corrosion or other products that need protection. The humidity measurement is highly related to food, chemical, wood processing, electrical systems, and more products. [1][8].

Humidity Sensors types:

Current humidity sensors can be divided into two categories, absolute humidity sensors and relative humidity sensors. Absolute Humidity(AH) is calculated by ratio of mass of water vapor in air to the volume of air, while the Relative Humidity(RH) is defined as ratio of the amount of moisture in the air to the saturated moisture level that air can hold at the same temperature and pressure condition.[7] In the market, the relative humidity type is more popular than absolute humidity type because it is simpler to make RH sensors and thus cheaper. There are more sub-types of RH sensors with technology development. Since 2005, RH sensors can be categorized into 3 types, ceramic, semiconductor and organic polymer types.[2] All of them measure changes in the physical and electrical properties when the atmospheric humidity condition changed. The ceramic type of sensor based on metal oxides has several advantages compared to other types in thermal capability, physical stability, and resistance to chemical reaction. [2]

Water vapor is normally invisible, and behaves like a gas [8], so the humidity measurement of sensors measures humidity by electrical impedance and conductance, because of the adsorption of water molecules of impedance-sensitive type material. For instance, the polyimide layers with different thickness and morphologies will change its capacitance with respect to change in humidity [3]. To categorize from how to respond to change of humidity, ceramic type humidity sensor has two types, resistive type and capacitive type.

Among different types of sensors discussed above, in general, ceramic and semiconductor type of humidity sensors usually cost lower than other types, but this type cannot take the polymer as sensing material. Thin or thick film fabrication processes can take the polymer as sensing material, but they cost higher than ceramic fabrication.

Commercial applications of Humidity measurement technology:

Most products of humidity sensors in the market are relative humidity sensors. Here is the comparison between three of the most popular RH sensors for: HS1101LF, DHT11 and HIH-4000-001.

HS1101LF has the highest price-performance ratio. It has the cheapest price which only costs \$5.9, and it has a wider operating temperature range and storage temperature range, both from -60 to 140 °C, compared to the other two. It also has the widest humidity measurement range, from 0% -100%RH.[4]

HIH-4000-001 has similar measurement and storage temperature range, but it has the highest price among these three sensors. HIH-4000-001 costs \$23.34. However, it is resistive to chemical reaction. This sensor can work properly under most application hazards, such as dust, oil, or environmental chemicals. This characteristic allows HIH-4000-001 to be used in many unideal working environments.[6]

Another competing product is DHT11. DHT11 has an immediate price, but it has a narrow range of operating temperature, storage temperature. Its humidity measurement range is also narrow, only from 20-90%RH. However, this sensor has an embedded 8-bit microcontroller so that it has compatibility with microcontroller products. Its datasheet provides users with clear wire connection and its communication protocol. [5]

Implementation of capacitive RH sensors:

There are so many types of humidity sensors and each of them has a unique fabrication process, so discussion here will only include the most popular type, the capacitive RH sensor. There are two typical configurations of capacitive humidity sensors, a sandwiched structure with two electrode surfaces on each side, or an interdigitated structure with comb electrodes. The two metal electrodes are deposited on the substrate and coated with a thin film layer of a dielectric polymer or a porous ceramic metal oxide. In the

sandwich configuration, the upper electrode is always a water vapor permeable film[9]. There is a humidity sensitive polymer between two electrodes. Lead wires will be connected to the lower electrode so that the changed signal can be transmitted through wires

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