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Gas Sensor Technology and Applications

Introduction

Gas sensors can detect concentration levels of classes of chemicals in the air. The creation of semiconductor combustible gas sensors, solid electrolyte oxygen sensors and humidity sensors in the 1970s lead to the rise in popularity of gas sensors. These sensors have applications in health, safety, environmental protection, and energy savings. With decades to develop, the market for gas sensors has matured. [1] This paper reviews various kinds of gas sensors, but focuses on alcohol sensors.

Commercial Applications of Gas Sensors

Consumer

The average household contains multiple gas sensors to detect harmful chemicals in the air. The gas concentration (in ppm) threshold before the sensor sets off an alarm is determined by legislature specific to the chemical. [1] One example of a common gas sensor in households is the carbon monoxide sensor. In the United States, 30 states have legislation regarding carbon monoxide sensors with requirements that pertain to some combination of households, hotels, and schools. [2]

Law Enforcement

One kind of gas sensor, the breathalyzer, is popularly used by law enforcement to determine a person's blood alcohol concentration. Evidential testers, which are highly accurate breathalyzers, can even be used as evidence in court proceedings. [3] One kind of breathalyzer on the market, the Draeger Alcotest 6820, costs $800.

Police officers also use passive alcohol sensors which are built into standard police flashlights. These passive sensors are less reliable than breathalyzers because a passive sensor reads in recycled air six inches from a person's face instead of requiring that a person directly exhales into the breathalyzer. [3] Passive alcohol sensors use an expensive fuel cell that can reliably detect small amounts of alcohol. One kind of passive alcohol sensor manufactured by Alcopro costs $645. [4] The primary benefit of using passive alcohol sensors is that legally it does not count as a "search" under the fourth amendment, but instead is considered an extension of the officer's nose. [3]

Technology of Gas Sensors

Breathalyzer

A breathalyzer first takes in air from a person's lungs. If alcohol is present in his/her breath, it reacts with a potassium dichromate solution inside of the device which reduces the yellow intensity of the

solution. A photodiode measures the light intensity from a laser shone through the solution, which is inversely proportional with the concentration of alcohol present. [5]

Semiconductor Combustible Gas Sensors

Semiconductor combustible gas sensors contain a heated coil which burns a gas into acetic acid and produces a current proportional to the gas concentration between Al and SnO_2 plates. [1] The MQ-3, a semiconductor combustible gas sensor manufactured by Henan Hanwei Electronics Co which detects alcohol, can be purchased for $4.95. It is popularly used in analog circuitry and can detect a broad range of alcohols including isopropyl alcohol and ethanol. [6]

Solid Electrolyte Gas Sensors

Solid electrolyte gas sensors can be used to detect carbon dioxide and operate through two half reactions. On one side, carbon dioxide reacts with sodium and oxygen to create sodium carbonate. On the other side, a solid electrolyte (such as NASICON) splits into sodium and oxygen. The first takes electrons and the second releases electrons so a current proportional to the amount of carbon dioxide present is produced. However, these devices are not used commercially because they cannot operate reliably under humid conditions. [1]

Implementation of Gas Sensors

Semiconductor Combustible Gas Sensors in Circuitry

Using a semiconductor combustible gas sensor such as the MQ-3, MQ303A, or MR513 in an analog circuit to measure alcohol concentration is straightforward. Each of these sensors has pins to control operational parameters such as heater voltage and an output pin that governs a current which varies directly with alcohol concentration. [6] The factors to consider when deciding on a specific sensor to use are the levels of sensitivity required for the application, power, and parameter operation point. [1]

References

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