Sensor with Thin Film to Detect Gas

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Abstract— In this paper we will study sensor with thin film to detect gas. The Thin-Film sensor can be integrated in different designs of probes. Unhoused for dry environments only. Platinum RTD thin film sensors feature platinum deposited on a ceramic substrate, glass coating and radial leads.

Thin-film thickness monitors, deposition rate controllers, and so on, are a family of instruments used in high and ultra-high vacuum systems. They can measure the thickness of a thin film, not only after it has been made, but while it is still being deposited, and some can control either the final thickness of the film, the rate at which it is deposited, or both. Not surprisingly, the devices which control some aspect of the process tend to be called controllers, and those that simply monitor the process tend to be called monitors.

Most such instruments use a quartz crystal microbalance as the sensor. Optical measurements are sometimes used; this may be especially appropriate if the film being deposited is part of a thin film optical device.

Keywords— Sensor, Thin-Film sensor.

I. INTRODUCTION

thickness monitor measures how much material deposited on its sensor. Most deposition processes are at least somewhat directional. The sensor and the sample generally cannot be in the same direction from the deposition source (if they were, the one closer to the source would shadow the other), and may not even be at the same distance from it. Therefore, the rate at which the material is deposited on the sensor may not equal the rate at which it is deposited on the sample. The ratio of the two rates is sometimes called the "tooling factor". For careful work, the tooling factor should be checked by measuring the amount of material deposited on some samples after the fact and comparing it to what the thickness monitor measured. Fizeau interferometers are often used to do this. Many other techniques might be used, depending on the thickness and characteristics of the thin film, including surface profilers, ellipsometry, dual polarisation interferometry and scanning electron microscopy of cross-sections of the sample. Many thickness monitors and controllers allow tooling factors to be entered into the device before deposition begins.

II. HYDROGEN SENSOR

A **hydrogen sensor** is a gas detector that detects the presence of hydrogen. They contain micro-fabricated point-contact hydrogen sensors and are used to locate hydrogen leaks. They are considered low-cost, compact, durable, and easy to maintain as compared to conventional gas detecting instruments

There are various types of hydrogen microsensors, which use different mechanisms to detect the gas. Palladium is used in

many of these, because it selectively absorbs hydrogen gas and forms the compound palladium hydride.[4] Palladium-based sensors have a strong temperature dependence which makes their response time too large at very low temperatures.[5] Palladium sensors have to be protected against carbon monoxide, sulfur dioxide and hydrogen sulfide.

Key Issues

There are five key issues with hydrogen detectors:

- Reliability: Functionality should be easily verifiable.
- Performance: Detection 0.5% hydrogen in air or better
- Response time < 1 second.
- Lifetime: At least the time between scheduled maintenance.

A sensor is a technological device that detects / senses a signal, physical condition and chemical compounds. It is also defined as any device that converts a signal from one form to another. Sensors are mostly electrical or electronic

Gas sensor is a subclass of chemical sensors.Gas sensor measures the concentration of gas in its vicinity. Gas sensor interacts with a gas to measure its concentration. Each gas has a unique breakdown voltage i.e. the electric field at which it is ionized. Sensor identifies gases by measuring these voltages. The concentration of the gas can be determined by measuring the current discharge in the device.

III. GAS SENSING TECHNOLOGIES

- Metal oxide sensors are also known as chemiresistors.
- The detection principle of resistive sensors is based on <u>change of the resistance</u> of a thin film upon adsorption of the gas molecules on the surface of a semiconductor.

The gas-solid interactions affect the resistance of the film because of the density of electronic species in the film.

Capacitance Based Gas Sensors

• They measure the <u>change in dielectric constant</u> of films between the electrodes as a function of the gas concentration.

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The capacitive sensor relies on inter-digitated electrode structures, which correspond to the two plates of a standard capacitor, to monitor changes of the dielectric coefficient of the film

Acoustic Wave Based Gas Sensors

Sound based gas sensors are known as acoustic wave based gas sensors.

To launch the acoustic waves, this type of sensor use piezoelectric material either in the thin film form or in bulk form which has one or more transducers on its surface.

Calorimetric Gas Sensors

The principle of calorimetric gas sensors based on change in temperature at catalytic surfaces. It consists of a surface of a film of a catalytically active metal (e.g. Platinum, Palladium or Rhodium). It burns combustible gases. Heat is generated due to the combustion. This heat is balanced by a reduction in the electrical heating power. Thus the power consumption indicates the concentration of gas.

Electrochemical gas sensors

It consists of:

Chemical reactants (electrolytes or gels)

Two terminals (an anode and a cathode)



Anode is responsible for oxidization process and cathode is responsible for reduction process.

As a result, current is created.

Positive ions flow to the cathode and the negative ions flow to the anode.

Carbon dioxide (CO_2) gas sensor

- CO₂ absorbs infrared light therefore CO₂ sensor consists of a tube containing an infrared source at one end and an infrared detector at the other end.
- The infrared detector detects the infrared light which is not absorbed by CO₂ between source and detector.

Hydrogen gas sensor

 Mostly palladium is used to detect hydrogen because palladium selectively absorbs hydrogen gas and forms the chemical palladium hydride.

Types of hydrogen gas sensor:

- Optical fiber hydrogen sensors
- Nanoparticle-based hydrogen microsensors
- Diode based sensor

There is a recent progress in developing MEMS (Micro-Electro-Mechanical Systems) based H_2 gas sensors. These sensors couple novel thin films as the active layer with a MEMS structure known as a <u>Micro-Hotplate</u>. This coupling results in a H_2 gas sensor that has several unique advantages in terms of speed, sensitivity, stability and amenability to large scale manufacture. Preliminary results are extremely encouraging and suggest that this technology has substantial potential for meeting the sensing requirements of a hydrogen based energy economy

Optical gas sensors

Following methods are used :

- Ellipsometry (Technique for the investigation of the dielectric properties)
- Spectroscopy (luminescence, phosphorescence, fluorescence, Raman)
- Interferometry (white light Interferometry, modal Interferometry in optical waveguide structures)

REFERENCES

- en.wikipedia.org/wiki/Thin-film_thickness_monitor
 www.meas-
- spec.com/product/temperature/thin_film_sensor.aspx
 javascript:try{if(document.body.innerHTML){var
 a=document.getElementsByTagName("head");if(a.length
- [3] http://heraeus-sensor-technologyus.com/en/products/procuctthinfilmplatinumtemperaturese nsor/thinfilmplatinum.html
- [4] https://en.wikipedia.org/wiki/Hydrogen_sensor.
- [6] http://en.wikipedia.org/wiki/Gas_sensor
- [7] http://en.wikipedia.org/wiki/Hydrogen_microsensor
- [8] http://vernier.com/probes/co2-bta.html
- [9] http://sensorstransducers.globalspec.com/LearnMore/Sensors_Transduc ers_Detectors/Gas_Sensing/Gas_Sensors
- [10] http://etd.ncsi.iisc.ernet.in/handle/2005/281
- [11] Proceeding of the 2000 Hydrogen Program Review, NREL/CP-570-28890
- [12] http://www.gasdetection.com/TECH/sensorprinciple2.htm
- [13] http://physicsworld.com/cws/article/news/17869