Sensors Converge

Innovative MEMS-Based Thermal Conductivity Sensors for Hydrogen Detection

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#SensorsConverge

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n.e.t. innovative gas sensing

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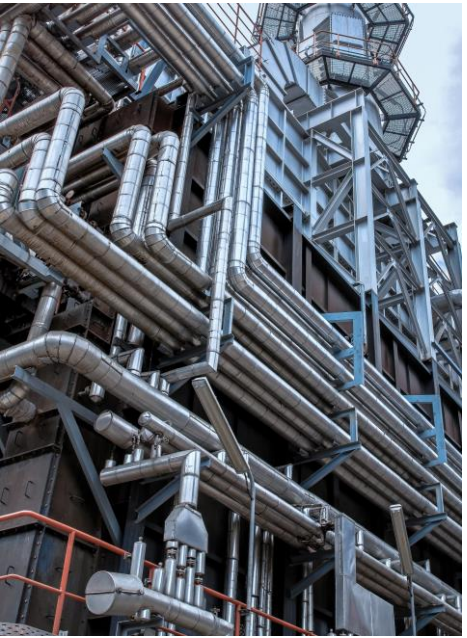
twenty years of advanced solutions for gas detection 20 YEARS ANNIVERSARY

THE HYDROGEN ECONOMY IS UPON US

- A global sustainability effort is undergoing to significantly increase use of hydrogen between here and 2050.
- More and more, in the upcoming future, hydrogen will be used to decarbonize entire economic sectors.
- Hydrogen is highly energetic and extremely environment friendly: it can be created from water using renewable sources such as wind and solar power.
- Hydrogen combustion only releases water vapor into the atmosphere.

APPLICATIONS AND DETECTION SCENARIOS

HEAVY INDUSTRY



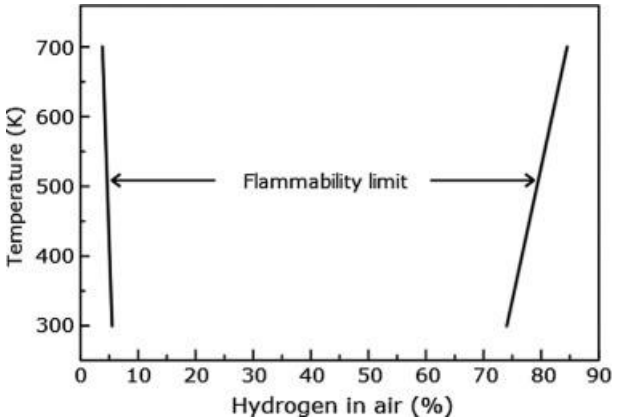
LITHIUM BATTERY LEAKS

NATURAL GAS SUBSTITUTE IN GRIDS

FUEL CELLS

HYDROGEN SAFETY CONCERNS

- Hydrogen is one of the most explosive and oxygen-reacting gases known to man, combusting at even low concentrations (LFL 4% volume, UFL 74%volume).
- Hydrogen is colorless, odorless and tasteless.
- The availability of reliable and selective detection technologies will become vital for a safe transition.



COMMON HYDROGEN DETECTION TECHNOLOGIES

ELECTROCHEMICAL CELLS

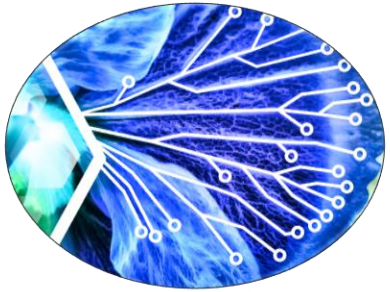
- Detection range: up to 5.000ppm (0.5%vol)
- Typical long-term drift: 2%/month
- Typical operating life: 24 months in air
- Cross sensitivity to other gases
- Potential replacement required after high exposures
- Can only operate in presence of Oxygen

CATALYTIC BEAD SENSORS

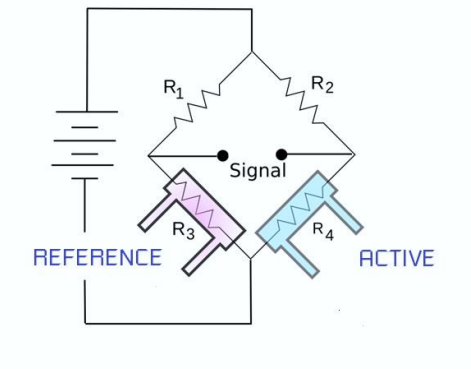
- Detection range: up to 100% LFL (4%vol)
- Effectively Linear to 60% LEL
- Typical long-term drift: 5% LEL/3 Months
- Reacts to any flammable gas
- Potential replacement required after high exposures
- Susceptible to contamination and poisoning
- Can only operate in presence of Oxygen

THERMAL CONDUCTIVITY SENSORS

- A thermal conductivity sensor, also known as a katharometer, is a common technology allowing measurement of the concentration of flammable gases, also above the Lower Flammability Level (LFL).
- Traditional thermal conductivity sensors suffer from high power requirements and demand high level of precision and craftsmanship in manufacturing.
- Employing very repeatable, high-volume Single-wafer CMOS (Complementary metal-oxide-semiconductor) MEMS technology, is significantly lowering production costs and power consumption.



NET KATHAROMETER GAS TECHNOLOGY



Both dies are heated using constant current and run in a classic Wheatstone bridge circuit.

- Thermal conductivity sensors measure the concentration of gases having thermal conductivity significantly different to a reference gas (normally, air), between 0 and 100% volume.
- Thermal conductivity sensors measure the change in heat loss of the active die in the presence of the target gas.
- Thermal conductivity sensors perform best in applications where interfering gases are absent, or their cross sensitivity is within the acceptable margin of error required by the application.

- Thermal conductivity sensors are most effective when detecting gases with low molecular weight, which correspond to greater thermal conductivity – such as **Hydrogen**, possessing possesses the highest thermal conductivity of all known gases, and Helium.

NET MAK (MEMS ANALOGUE KATHAROMETER)

KATHAROMETER

gas technology

- Detection range: ppm to 100% volume
- Long-term reliability (0.5 % F.S./year), no chemical reaction/contamination
- Reliable in harsh environments
- Fast response time (< 1.4 s)
- High resolution (2 ppm of H_2)
- Long expected lifetime
- Internal heat cavity, minimizing conduction and natural convection
- Can operate without the presence of Oxygen
- Industry proven technology (used for flow and vacuum pressure sensors)
- Low working temperature (~2°C above ambient)
- intrinsically safe, while avoiding condensation
- MEMS membrane-based sensor: great resistance to mechanical shocks
- Environmental compensation
- Standard industrial size and footprint
- Standard industrial output (voltage, bridge, Modbus)

CONCLUSIONS

- Thermal conductivity is a promising technology for the detection of Hydrogen
- Effective in different application conditions, included harsh environments
- CMOS MEMS technology ensure reliable and cost-effective production
- Safe and stable technology: no chemicals, no optics/lamps, no resonating/moving parts
- Low power consumption
- A need for a strong environmental compensation and effective calibration

THANK YOU FOR YOUR ATTENTION

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