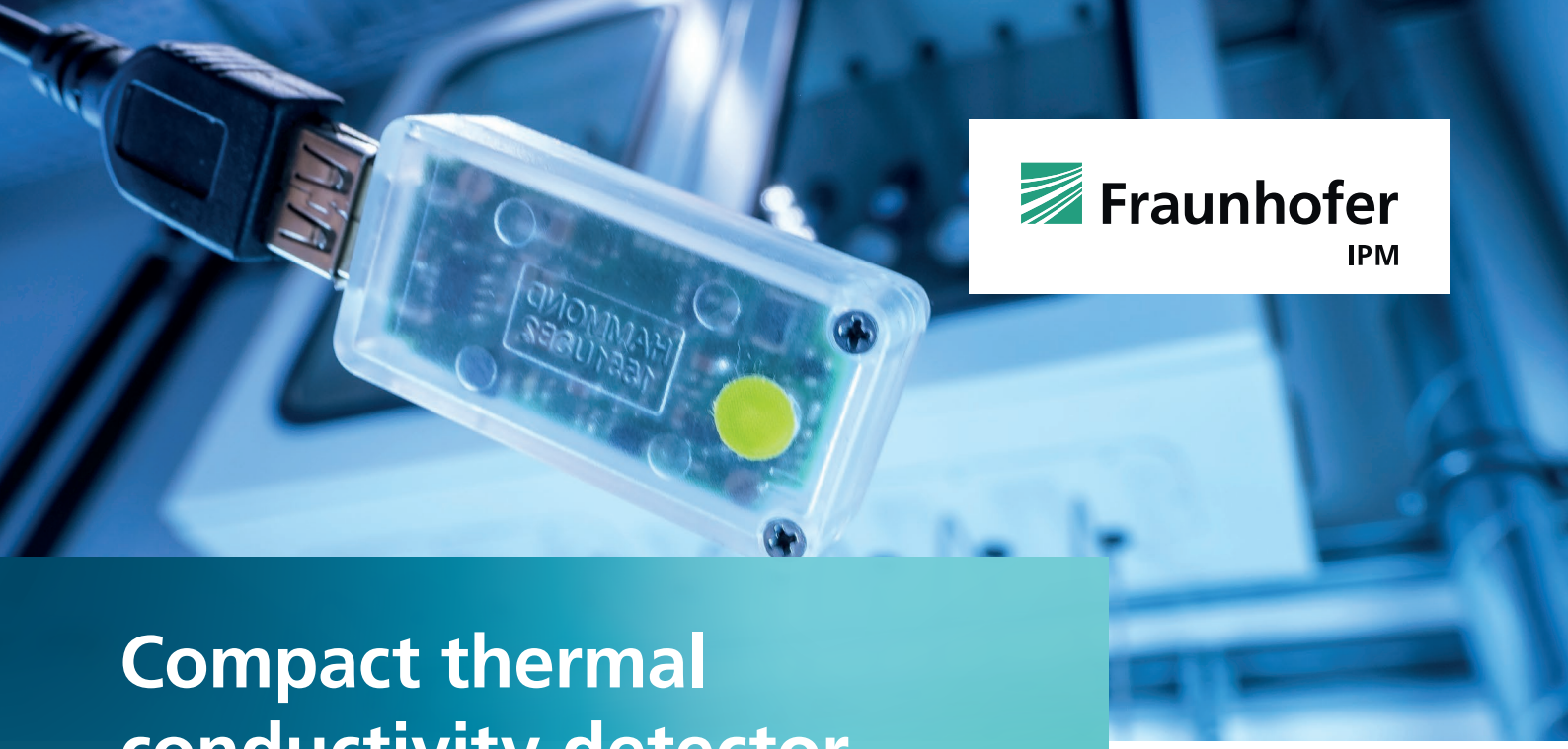


Fraunhofer IPM

Compact thermal conductivity detector

For hydrogen detection

This compact sensor detects H_2 quickly and with a high degree of sensitivity. Being fabricated in MEMS technology, its energy consumption is very low.

Hydrogen (H_2) is set to be used as a future energy source in industry, heat supply and transportation. Storage tanks, pipelines and supply points must be continuously monitored for leaks to ensure this gas is used safely. Fraunhofer IPM has developed a particularly energy-efficient H_2 sensor, which detects the gas quickly and with a high degree of sensitivity.

Hydrogen is highly flammable and, when mixed with air, it becomes explosive over a wide concentration range. The lower explosion limit of H_2 in air is 4 %. A dangerous oxyhydrogen gas explosion can occur if such a mixture comes into contact with an ignition source. Even the smallest leaks in tanks or pipelines therefore represent a high safety risk. Hydrogen is temporarily stored in high pressure containers during transportation. Systems that carry H_2 must be particularly well secured and permanently monitored by means of sensor technology.

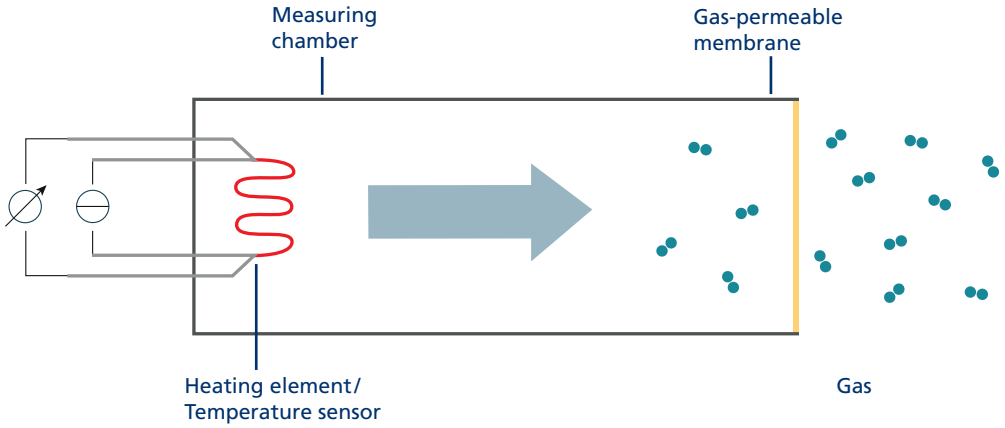
Using thermal conductivity for H_2 detection

The specific thermal conductivity of H_2 can be used to detect the gas. Along with helium, H_2 is one of the gases with the highest thermal conductivity. This is what clearly differentiates it from other flammable gases. Hydrogen conducts heat around seven times better than air. This means that even the smallest concentration of this gas can be detected in air, or in other gases, by measuring thermal conductivity levels.

Thermal conduction in gases is based on the movement of molecules, which transfer part of their kinetic energy to each other when they collide. This results in energy being transported from a place of higher temperature (i. e. higher average energy) to places of lower temperature. Thermal conduction mechanisms differ between gases, liquids and solids. In a solid, for example, atoms are bound to a stable equilibrium, while in gases they can move freely.

Our offer

- Development of sensors and sensor systems including read-out circuits according to customer needs and application
- Gas-dependent characterization of sensors
- Design of manufacturing processes
- Technology consulting



Functional principle of a thermal conductivity detector: The heating element serves as a temperature sensor of the gas matrix.

Operating temperature below 100 °C

Fraunhofer IPM develops cost-effective, self-testing thermal conductivity detectors (TCD) and integrates them within compact sensor systems. The operating principle behind a TCD has been proven to be effective and is already used in many applications. The sensors essentially consist of a heating element, which also serves as a temperature sensor. The heat output of the sensing element is proportional to the temperature and therefore to the gas concentration level. If the sensor is exposed to only a mixture of H_2 and air, with any cross-influence from helium ruled out, it is possible to determine the H_2 concentration.

The TCD typically consists of a gas-permeable membrane, a measuring chamber and a heat resistor. Measurements are taken at sensor temperatures of 100 °C or less. This means that the operating temperature remains well below the ignition temperature of H_2 (585 °C). A thermal conductivity sensor covers a wide measuring range from < 1 % to 100 % H_2 in air.

Low energy consumption thanks to MEMS technology

Commercially available sensors occasionally react very sensitively to interferences such as high humidity or convection. By combining the TCD principle with smart signal processing, as is being developed at Fraunhofer IPM, it is possible to compensate for these interferences to the greatest possible extent.

In addition to control software, Fraunhofer IPM is also developing TCD sensors using MEMS technology. This requires even less energy than previous solutions and means that these sensors can also be used for building battery-driven systems. While energy consumption is low, H_2 concentrations of less than 0.4 % in air can be detected.

H_2 sensors for rough environments

By structuring the sensors on ceramic substrates, the thermal conductivity of the gas matrix can be measured even in harsh process environments. Sensors developed at Fraunhofer IPM can be used to detect the H_2 concentrations in process gases, for example.

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