FRAUNHOFER INSTITUTE FOR PHYSICAL MEASUREMENT TECHNIQUES IPM

Micro-structured, modulated IR emitter: The emitting surface is freely suspended in the chip.

INFRARED EMITTERS FOR GAS SENSOR SYSTEMS

Absorption spectroscopy is one of the standard measurement methods for the analysis of gases and liquids. Especially in the middle infrared range (MIR) with wavelengths of 3–20 µm, many gases and liquids show strong and molecule-specific absorption structures. This applies in particular to the so-called "fingerprint range" with wavelengths from 8 to 12 µm. This is where gases such as ammonia (NH_3), ethene (C_2H_4) and ethanol (C_2H_6O) have strong molecule-specific absorption bands. That makes this spectral range suitable for a sensitive detection of different gases and liquids.

IR-emitters replace incandescent emitters

The performance of the light source used is decisive for the sensitivity of an optical gas sensor. Fraunhofer IPM develops infrared emitters (IR emitters) that are more efficient and cost-effective than the incandescent emitters commonly used for gas spectroscopy. The novel light sources developed at the Fraunhofer IPM include both, fast-modulated IR emitters as well as solid-state IR emitters that exhibit increased heat radiation in the fingerprint range.

Solid-state emitters

In a solid-state emitter, the chip is freely suspended in the housing. A heater mounted on the rear heats the chip to an operating temperature of over 800 °C, so that it emits heat radiation in the MIR range. The emissivity and thus the black body property can be further increased by using functional surfaces. These include emission layers from Al_2O_3 or MgO as well as nano-pores structures (so-called "micro cavities") manufactured by means of microsystems engineering. The emitters are compact and robust. However, a rapid temperature change ope-

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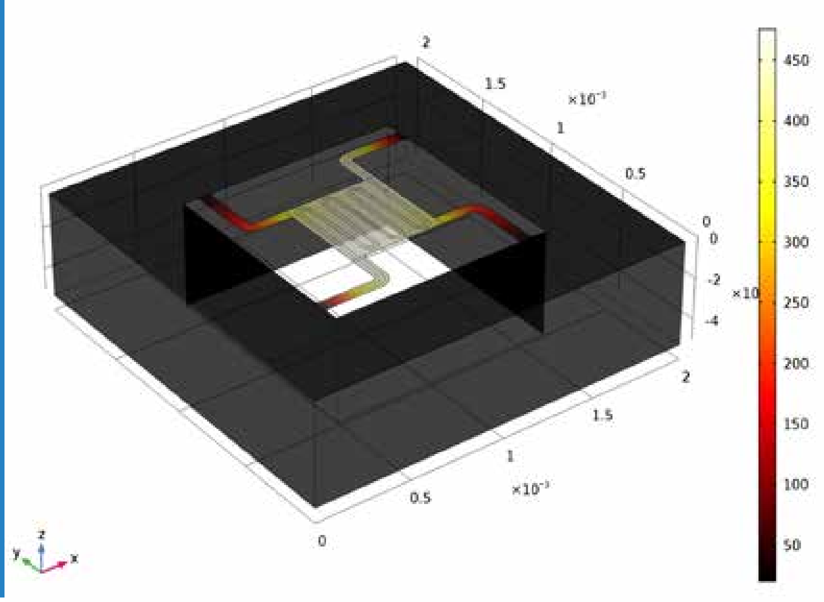

^ The FEM simulation shows the homogenous temperature distribution on the hotplate surface. Due to the free suspension, the chip is thermally decoupled, so that the IR radiation is emitted exclusively by the hotplate.

ration is not possible due to their relatively large thermal mass. The thermal response times of such an emitter lies in a range of several seconds.

Modulated IR emitters

Today, one way of producing more cost-effective systems is the use of pyrodetectors in a filter photometer. These require a mechanical chopper that periodically blocks and opens the beam path. The relatively high prices for choppers and the instability of the entire system under mechanical pressure, however, are major drawbacks of this concept. The fast-modulated thermal emitters developed by Fraunhofer IPM provide a solution.

Modulated IR emitters allow operation with rapid temperature changing cycles, since the thermal mass of the active area is much smaller than that of solid-state MIR emitters. Modulated emitters are based on so-called "micro hotplates". In the manufacture of "micro hotplates", a dielectric layer with a thickness of just a few micrometers and low thermal conductivity is structured using microsystems engineering. Heat power consumption is greatly reduced through thermal decoupling from the chip periphery. The emitting area has a surface of 500 × 500 µm² and a thickness of 20 µm. The emitting surface is freely suspended in the substrate on bars measuring 60 µm in width. At a modulation frequency of 10 Hz, the hotplate is deflected by 40 µm. The plastic deformation lies at a maximum of 4 µm.

Technical data	***Modulated IR emitters***	***Solid-state emitters***
Properties	Low thermal mass for temperature change operation, no need for mechanical chopper	Large emitting surface for high optical performance, mechanical chopper necessary
Emitting surface	0,5 × 0,5 mm²	3 × 3 mm²
Power consumption for 750 °C	500 mW	2 to 2,5 W
Response time (t90 or t10)	30 ms	Constant operation
Frequency	1 to 10 Hz (120 to 750°C) (> 30 Hz to max. 600°C)	Constant operation
Housing	TO5: contacting using Au-bonds	TO8: contacting using Pt-gap welding

All specifications and features are subject to modification without notice.