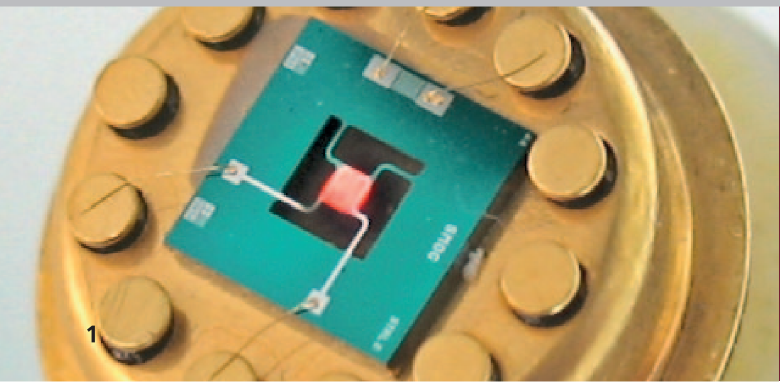
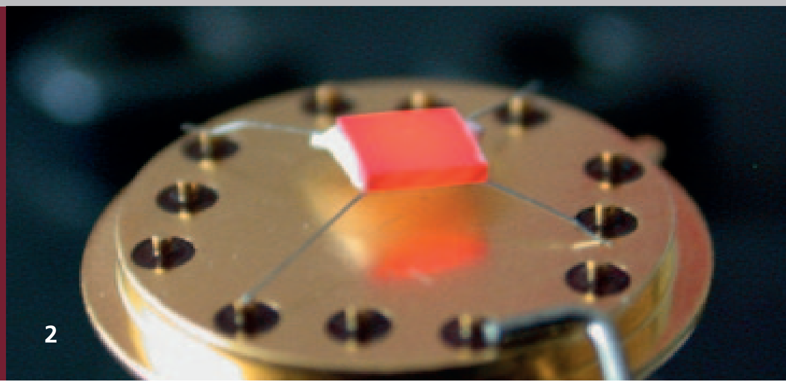
FRAUNHOFER INSTITUTE FOR PHYSICAL MEASUREMENT TECHNIQUES IPM





1 *Microstructured, modulated IR emitter at an operating temperature of approx. 800°C. The emitting surface is freely suspended in the chip.*
2 *Solid state emitter at an operating temperature of approx. 800°C.*

INFRARED EMITTER FOR GAS SENSORS

Gas Detection in the Fingerprint Range

Optical measurement methods, particularly absorption spectroscopy, are often used for the analysis of gases and liquids. Due to the strong and molecule-specific absorption structures in the mid infrared range (MIR: 3-20 µm wavelengths), this spectral range is suitable for sensitive detection. Strong molecule-specific absorption bands, of ammoniac (NH_3), ethylene (C_2H_4), and ethanol (C_2H_6O) for example, exist in the wavelength range from 8 to12 µm, also called the »fingerprint range«. The detection sensitivity of the measuring systems is determined by the power and efficiency of the available light sources. Innovative light sources from Fraunhofer IPM replace conventional incandescent emitters and enable more powerful, more efficient and more cost-effective infrared optical measurement systems.

Thermal Emitters

Fraunhofer IPM develops both IR emitters with fast modulation capabilities as well as solid state IR emitters with increased thermal radiation in the fingerprint range. For more cost-efficient systems, pyrodetectors are currently being used, for example, in filter photometers. These systems require a mechanical chopper that periodically interrupts the light beam. However, the disadvantages include its relatively high price and the stability of the overall system under mechanical load. The thermal emitters with fast modulation capabilities developed by Fraunhofer IPM offer an alternative solution.

Modulated IR Emitter

The modulated IR emitter is based on micro hotplates. The basic concept of this approach is the microsystem-based struc-

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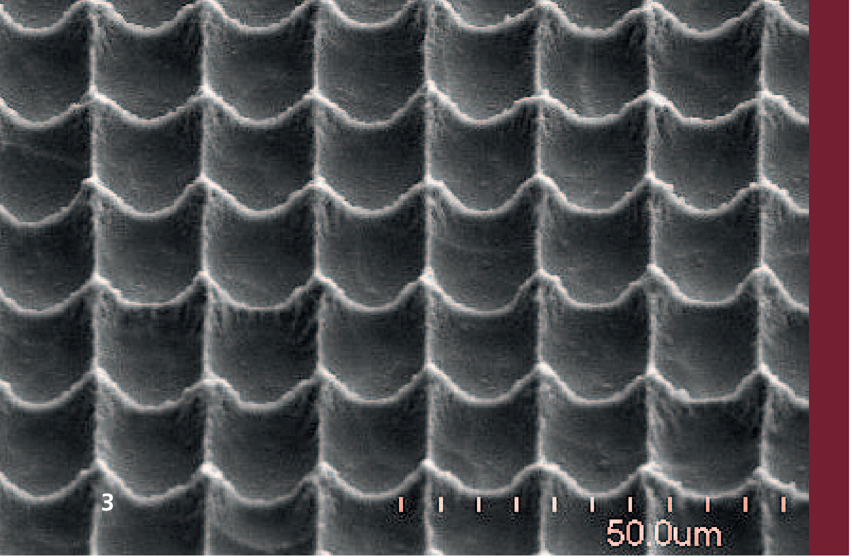

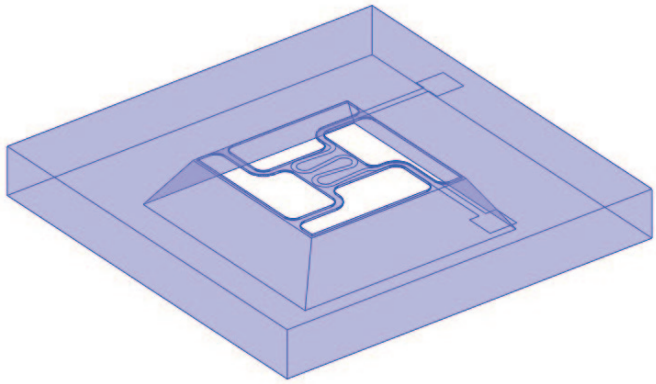

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turing of an IR emitter on a dielectric layer that is a few millimeters thick and has low thermal conductivity. Thermal decoupling of the active area from the required chip periphery greatly reduces the heating power consumption. In addition, such designs allow operation with rapid temperature changing cycles, since the thermal mass of the active area is much smaller than of solid state MIR emitters.
Consequently, the active area can have a surface of 500 x 500 µm² and a thickness of 20 µm. The emitting surface is freely suspended in the substrate on 60 µm wide bars. At a modulation frequency of 10 Hz, the hotplate is deflected by 40 µm. The maximum plastic deformation is 4 µm.

	Thermal Emitter for IR	
	Modulated Emitter	*Solid State Emitter*
Comparison	*Low thermal mass enables operation with quick temperature changing cycles; mechanical chopper not required.*	*Large emitting surface enables high optical output; mechanical chopper required.*
Emitting surface	*0,5 × 0,5 mm²*	*3 × 3 mm²*
Power consumption for 750°C	*500 mW*	*2 to 2,5 W*
Response times (t90 / t10)	*40 / 45 ms*	*Constant operation*
Frequency	*1 to 10 Hz (120 to 750°C) (at 30 Hz or higher max. 600°C)*	*Constant operation*
Housing	*TO5 Contact via Au bonding*	*TO8 Contact via Pt welding*

Solid State Emitter

The solid state emitter consists of a freely suspended carrier chip. A heating structure on the back lets the chip be heated to more than 800°C. Due to the high temperature, the chip emits heat radiation in the MIR range. The emissivity and thus the blackbody property can be further increased through the use of special, functional surfaces. This property can be obtained by applying emission layers such as Al_2O_3 or MgO as well as by using microsystem-based structuring of nanopores (called »microcavities«). These types of emitters are very compact and robust. However, due to their relatively high thermal mass, operation with quick temperature changing cycles is not possible. The thermal response times of these emitter models are in the several seconds range.

3 *Increasing the emissivity of the emitter through macroporous structuring of the emitting surface, which was created through reactive ion etching.*

4 *Layout of a modulated thermal emitter; the »micro hotplate« has a surface area of 500 µm × 500 µm, for example.*