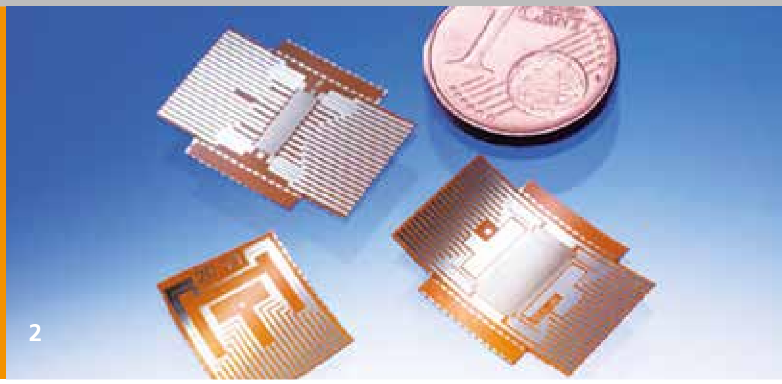
FRAUNHOFER INSTITUTE FOR PHYSICAL MEASUREMENT TECHNIQUES IPM



1 *Microstructured sensors on flexible Polyimide substrate.*
2 *Different thermopile array configurations for time or space resolved measurements.*

MICROCALORIMETERS

MICROFLUIDIC LOW COST CALORIMETERS FOR BIOLOGICAL AND CHEMICAL APPLICATIONS

A new flexibility in sensor technology applies in two ways: sensors of the new generation should be adaptable, which concerns the measuring task, and capable of bending. Fraunhofer IPM works in different projects on the development of electronic sensors on flexible substrates such as Kapton or PET film. These »measuring tapes« are fundamentally capable of determining a large bandwidth of physical variables: from simple temperature measurements, via the measurement of electrical or thermal conductivity and heat capacity, to the determination of parameters such as the Seebeck coefficient or radiation intensity.

Microcalorimeter chips

A mechanically flexible calorimeter chip has been created for biological and chemical applications to measure the heat capacity of liquids. It can be integrated into microfluidics systems. For this purpose an extremely sensitive temperature difference sensor made of bismuth telluride has been deposited and connected on a Kapton substrate. Due to its low thermal conductivity, the mini-calorimeter achieves a high degree of sensitivity. The chip with a size of not even 10 mm × 10 mm is produced using thin-film technology on a 4-inch substrate. The result is an economically priced sensor designed as a disposable product and intended above all to be used for screening measurements in lab-on-chip techniques. The measuring resolution of 15 mV/K can be increased drastically even with the same chip size. In combination with an absorber, the calorimeter can be used as a radiometer. At room temperature, for example, it is therefore possible to measure the increase in chip temperature brought on by the heat radiated from a hand.

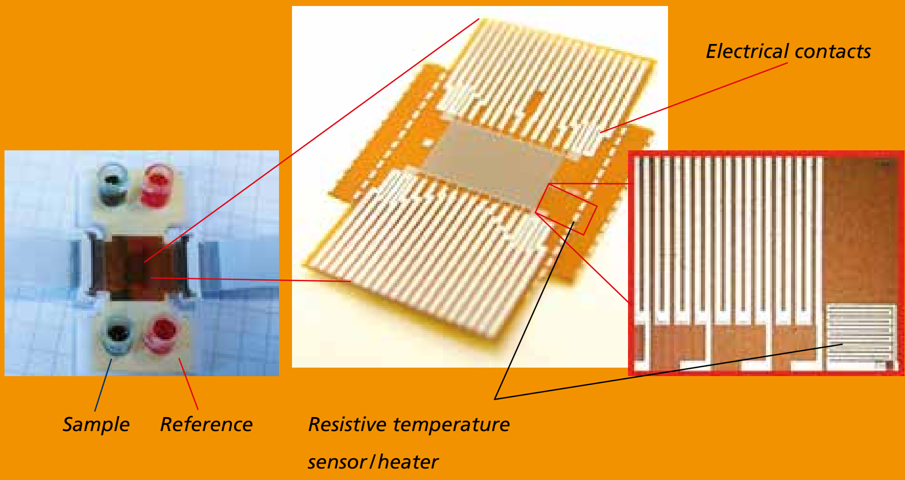
Fraunhofer Institute for Physical Measurement Techniques IPM

Georges-Köhler-Allee 301
D-79110 Freiburg, Germany

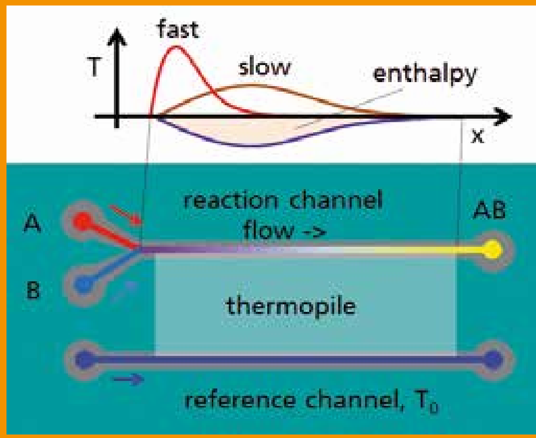
Contact

Martin Jägle
Phone +49 761 8857-345
martin.jaegle@ipm.fraunhofer.de

www.ipm.fraunhofer.de



3



4

Various applications

Thermal analysis or calorimetry is a widely used technique for obtaining both qualitative and quantitative information about thermal transitions associated with a particular material or process. However, the range of potential applications for calorimetry is far wider as every chemical and physical process is characterized by the change of its energetic state. Calorimetry is therefore a universal analytical method for investigating thermal effects resulting from chemical or biochemical reactions and/or changes in physical states.

Miniaturized calorimeters

Moreover, calorimetry does not require any labeling or immobilization of the reactants and is therefore also an attractive methodical approach of detecting biochemical interactions without employing fluorescent markers. However, commercially available classical calorimeters require an unfavorable large test volume and thus a relatively huge amount of test substance. Hence, these calorimeters are not suitable for biochemical or screening applications. These problems can be overcome by applying miniaturized calorimeters containing micro fabricated thermopile chips. Such devices have many significant advantages when applied to biochemical and screening applications including low cost, small sample consumption and fast response times.

Lab on a chip concept

Low cost thermopile chips capable of analyzing small quantities of samples that are easy to use, with fast response times and good operational stability are needed in many biochemical, chemical and clinical diagnostic applications. To fit a wide range of applications the thermopile chip and the microfluidic device is modular developed. The device structure can be adapted easily to enable a wide variety of other standard calorimeter operations. Differential scanning calorimetry (DSC), differential thermal analysis (DTA), reaction calorimeters, and »lab on a chip« concepts are possible for single measurements as well as for high throughput characterization.

3 *Mounted calorimeter chip on a mircofluidic base. A chemical reaction in the sample liquid is monitored against a reference liquid.*

4 *Possible reaction calorimeter configuration using microfluidic channels (grey). While flowing, two chemicals A and B react along the reaction channel to the product AB. The temperature profile along the channel is measured by the thermopile with respect to the temperature in the reference channel. From this, the reaction enthalpy and the reaction time can be determined under quasi-isothermal conditions.*