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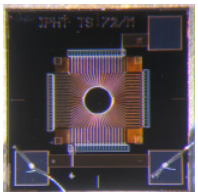
Construction and function of thermopiles

physical principle of work

Thermoelements consist of two different connected metals or semiconductors. They generate a voltage depending on the temperature difference at their open ends (thermo voltage). This effects is named “Seebeck-effect” after it's discoverer Thomas Johann Seebeck. When there are some thermo elements connected together, this new device is called thermopile. It generates a higher thermo voltage compared to a single thermoelement.

Common material combinations are made of bismuth-antimony and silicon-aluminium. Thermopiles basing on silicon and aluminium are produced quite easily, because they base on the classic technology of integrated circuit production. Thermopiles delivered by MICRO-HYBRID Electronic GmbH combine bismuth and antimony. They are produced by thin film technology at a basis of silicon. Bi-Sb-thermopiles are known as the most sensitive wide-band IR-detectors produced in series.

construction



At a detector chip thermoelements are placed in a special form. The active (hot) junctions are situated in the centre of the chip. Heat radiation increases the temperature in this centre. The passive (cold) junctions are placed around the centre of the chip. They are thermally connected. The connections are bond pads at the border of the chip. The chip is placed at a socket and bonded to the pins. The cap is supplied with an aperture and an optical filter. It is welded to the socket in a backfill gas athmosphere.

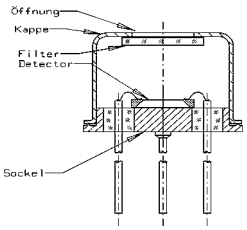
influences on detector parameters

By the change of various characteristics a thermopile is adjustable to special tasks and applications.

detector chip

The chip determines the main properties of a thermopile. There are detector chips available up to 200 thermo pairs. Chips differ mainly in form and their area of active junctions, in sensitivity, in the time constant and the inner resistance.

Aperture



A big aperture creates a high signal voltage. In some cases this is not the goal. Often a smaller aperture is used to reduce the entry angle for analysing a smaller measurement or for lower sensitize at a high power heat beam. A second inner aperture can reduce the entry angle supplementary for saving a special optic in many applications. Quad detectors are applied with a supplementary inner aperture to reduce the cross talk between the channels.

backfill gas

The backfill gas has an important influence on the sensitivity and on the time constant of a thermopile. The following table shows data for some gases.

gas	time constant	sensitivity
N2	100%	100%
Kr	180%	180%
Ne	66%	66%

window

The optical window determines the frequency range where the thermopile has to detect the heat radiation. There are windows of various wave lenghts and band wides available.

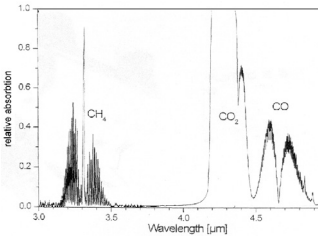
applications

thermopiles for temperature measuring

Every object with a surface temperature of more then 0K radiates in infrared. This radiation is converted at the active area of the chip into a temperature change. The output voltage of a thermopile is proportional to the temperature difference between the active and the passive part of the chip. To determine the real temperature a reference temperature is required. This is measured by a thermistor which is thermally connected to the passive area. For temperature measurement windows with wide band are used. By a suitable choose temperature differences with higher resolutions are detectable.

thermopiles for gas analysis

Many gases have permanent or non-permanent seperated positive and negative charge centres. They are able to absorb special frequencies in infrared. This property can be used for gas analysis. A thermopile is applicated with a small range optical filter. The transmission frequency of the filter is the absorption frequency of the gas to detect. Is there some of this gas in the measuring chamber it absorbs the infrared radiation of this frequency and becomes detectable. Measuring errors caused by dust and particles in measuring chamber or the fading of the infrared radiation source are usually removable by the help of a reference channel.

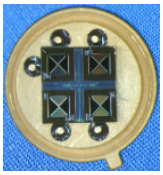


types

single channel detector

The single channel detector is the standard device for most applications. It can be used for temperature measuring and gas analysis.

multi channel detector



The main application of dual- and quad detectors is gas analysis. Up to three channels are used for the gas detection, the additional channel serves as reference channel.

The four-channel detector is also useful for the positioning of infrared sources.

thermo line module

The thermo line consists of 64 pixels placed in a line. Each pixel is a complete single thermopile. Typical applications of the thermo line module are spectrum analysis and recognition of temperature profiles.

use

The following table shows different areas of use. The table is not complete, it contains the multiple possibilities of thermopile detectors.

Area	Use	Application
Automotive industrie	Exhaust gases Tyres Engine technique	Gas analysis Temperature Temperature
Medical	Breathing air Anesthesia Body temperature	Gas analysis Gas analysis Temperature
Industry	Steel industry Rolling mills Mechanical engineering Industrial plants	Temperature Temperature profile Temperature Temperature
Agriculture	Greenhouses Foods	Gas analysis Temperature
Air condition technology	Room air	Gas analysis
Security	Gas concentration	Gas analysis
Military equipment	Protection from poisonous gases Troop movements	Gas analysis Temperature profile