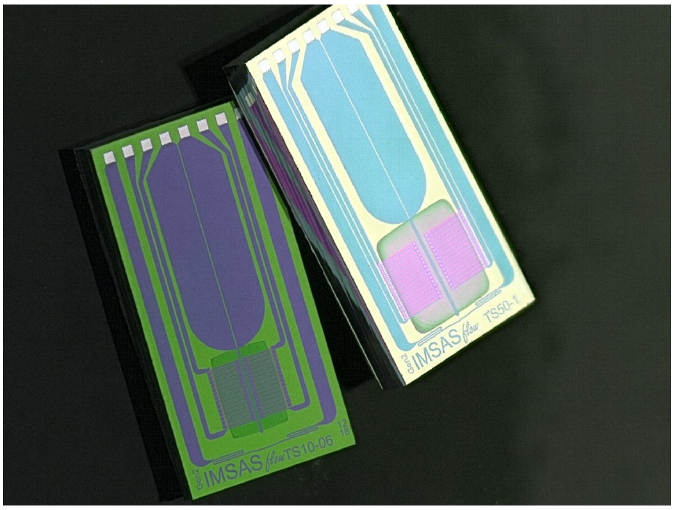
IMSAS
Institut für Mikrosensoren, -aktoren und -systeme

Thermal Flow Sensor

General Description

Protron offers a thermal flow sensor based on a new high-temperature fabrication process that was developed by the Institute for Microsensors, -actuators, and -systems in Bremen. The key advantage of this new fabrication process is a high-temperature LPCVD (low-pressure chemical vapour deposition) passivation layer that makes the sensor superior for liquid applications, such as in hydraulic systems, or for medical and biological sensing. These flow sensors are also excellent for measuring gaseous flow in pneumatic systems or for wind-speed measurement devices.



Thermal flow sensors

Details

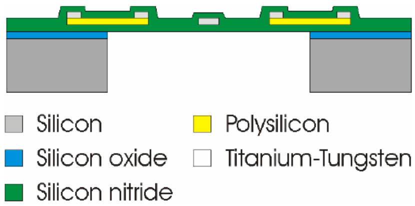
The thermal flow sensor consists of a central heating element and two high-precision thermopiles up- and down-stream of the heater (figure 1). These components are placed on a thin membrane of silicon nitride. The free-standing membrane is used for thermally isolating the electrical components and is responsible for the superb dynamic behaviour due to the minimised thermal capacitance and the high grade of miniaturisation.

Materials

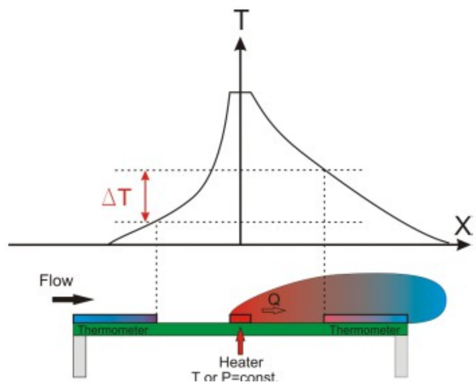
thermopiles	p-doped poly-silicon & WTi
heater	WTi
membrane	silicon nitride
passivation	silicon nitride

thermo power per thermo couple	287 µV/K
thermo power per thermopiles	4.3 mV/K
typical output signal	0 - 25 mV

Sensor Principle



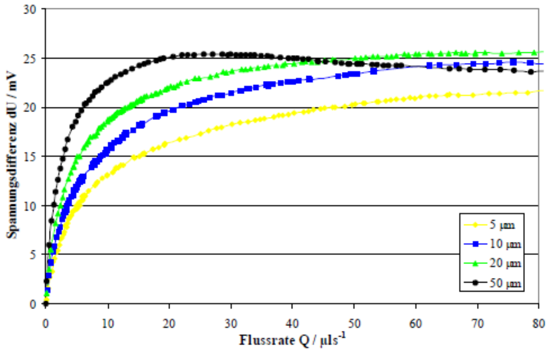
Schematic sensor cross section



Sensor principle

Details

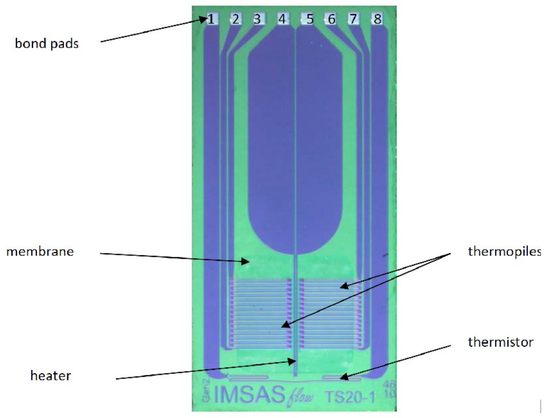
The heater and the thermopiles are embedded between two low stress LPCVD silicon nitride layers. Polysilicon is used as the first thermopile material. An alloy of titanium and tungsten (WTi) is used as the second thermopile and as well as heater material. The use of WTi and a diffusion barrier of reactively sputtered titanium nitride allow a high-temperature protective coating due to the high thermal stability of the thermopiles.
This new high temperature LPCVD passivation has a very low tendency towards defects and pinholes combined with very good step coverage because of the high surface mobility of the deposited molecules. The thermopiles have a measured thermopower of 4.3 mV/K which corresponds to a thermopower of 287 µV/K for each thermo-couple. This is comparable to commonly used Al/poly-silicon or Au/poly-silicon thermopiles. The membrane is finally released by deep reactive ion etching which leads to vertical sidewalls of the etched cavity and a reduction of the chip size.



Typical sensor characteristic for different heater/thermopile distances 5, 10, 20, 50µm

Sensor Dimensions

- chip size — 1.8mm x 3.5mm x 0.38mm
- membrane size — 800µm x 600µm
- distance thermopiles/heater — 5µm, 10µm, 20µm, 50µm



Sensor schematic

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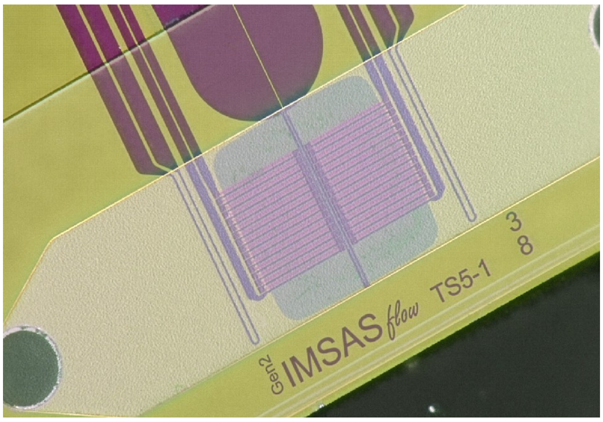

Thermal flow sensor with monolithically integrated channel structure for the measurement of flow rates of a few tens of nanoliters per minute.