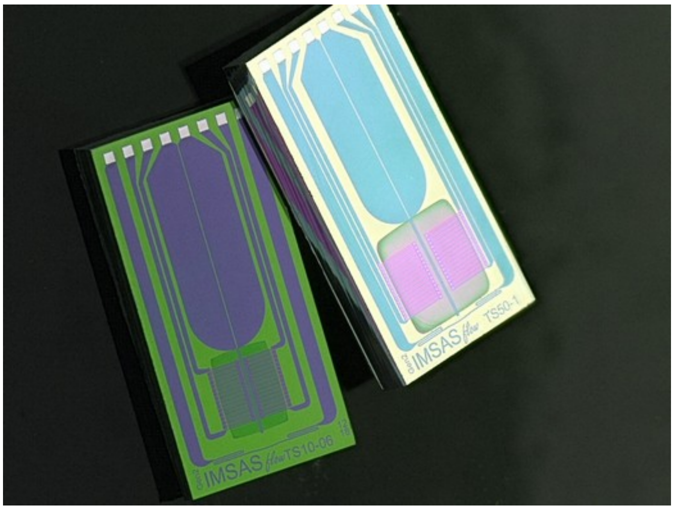
Thermal Flow Sensor Dies

TS05, TS10, TS20, TS50

Description

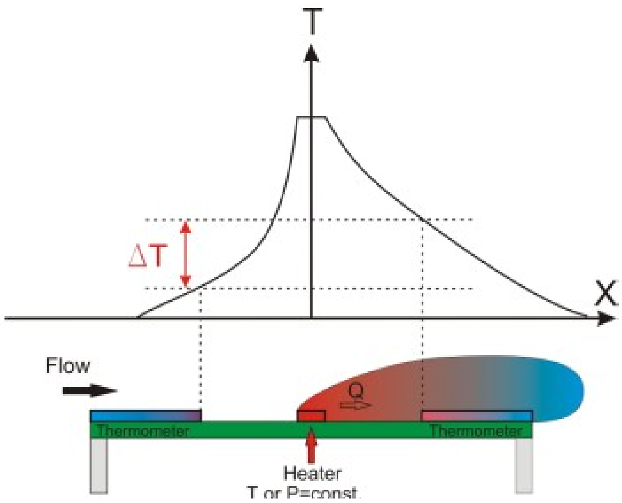
Protron offers a high-temperature stable thermal flow sensor based on a new fabrication process that was developed by the Institute for Microsensors, -actuators, and -systems in Bremen. The key advantage of this new fabrication process is a high-temperature LPCVD (low-pressure chemical vapor deposition) 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.



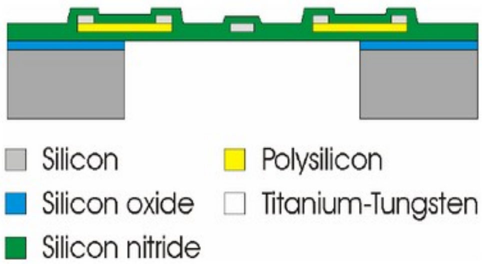
Flow sensor dies

Details

The thermal flow sensor consists of a central heating element and two high-precision thermopiles up- and down-stream of the heater. 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 behavior due to the minimized thermal capacitance and the high grade of miniaturization.

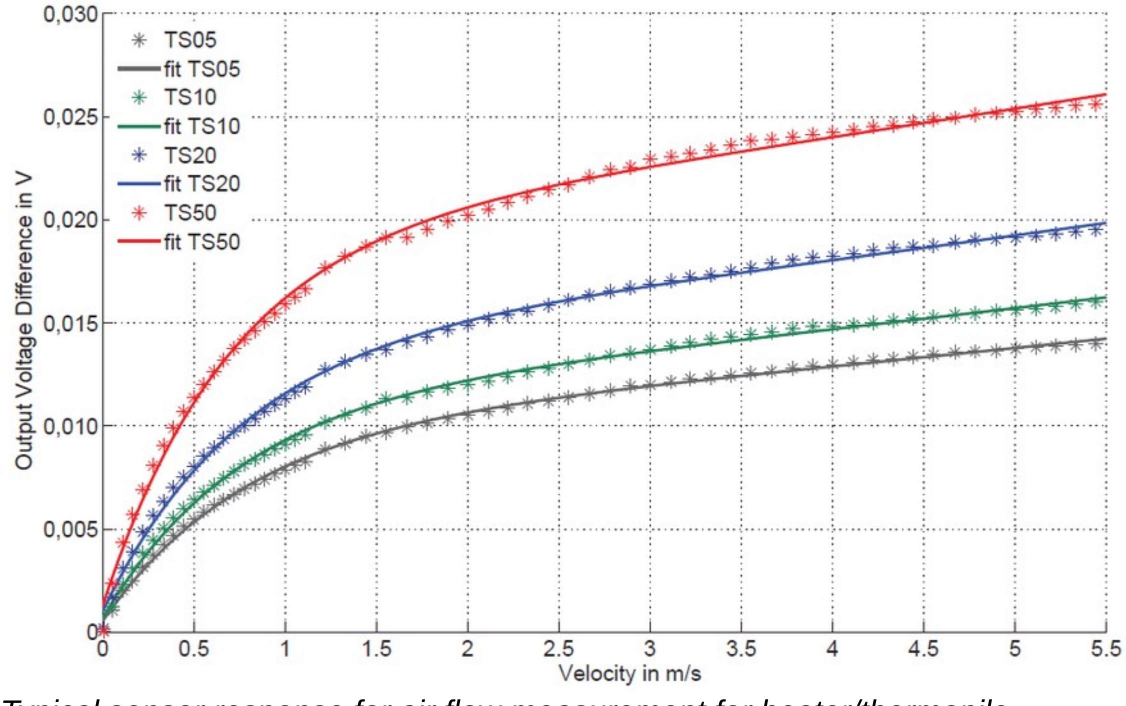


Sensor principle



Schematic sensor cross section

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 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 response for air flow measurement for heater/thermopile distances of 5, 10, 20, 50µm.

Materials

thermopiles	p-doped poly-silicon / WTi
heater	WTi
membrane	silicon-nitride
passivation	silicon-nitride
bond pads	gold

Specifications

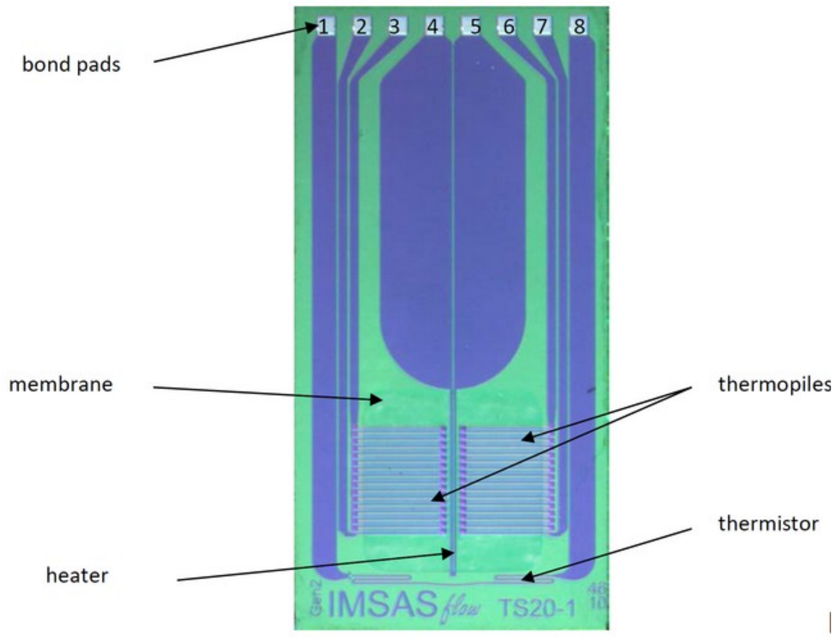
Parameter	min	typ	max	unit	comment
thermo power per thermopile	4.1	4.3	4.5	mV/K	
typical thermopile voltage	250	300	350	mV	3V heater volt.
typical differential output signal		0-25		mV	
heater resistance	600	700	800	Ω	
heater driving voltage	0.5	3	6	V	appl. specific
response time	1.5	2.5	3.5	ms	appl. specific
operating temperature	-50	20	350	°C	
distance thermopiles / heater TS05: TS10: TS20: TS50:		 5 10 20 50		 µm	
thermistor resistance	1.1	1.2	1.3	kΩ	
temperature coefficient of thermistor		0.0046		1/K	

Dimensions

die size	1.8mm x 3.5mm
die thickness	380µm +/- 20µm
membrane size	800µm x 600µm
bond pad size	100µm x 100µm
bond pad grid space	200µm

Connections

pad 1, 8	thermistor
pad 2, 3	thermopile #1
pad 4, 5	heater
pad 6, 7	thermopile #2



Sensor schematic