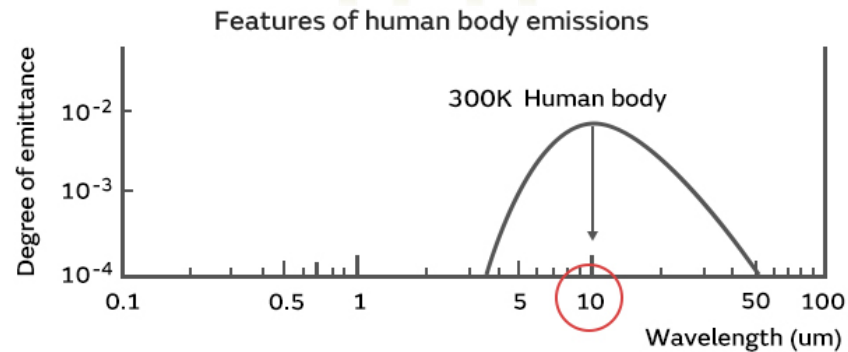
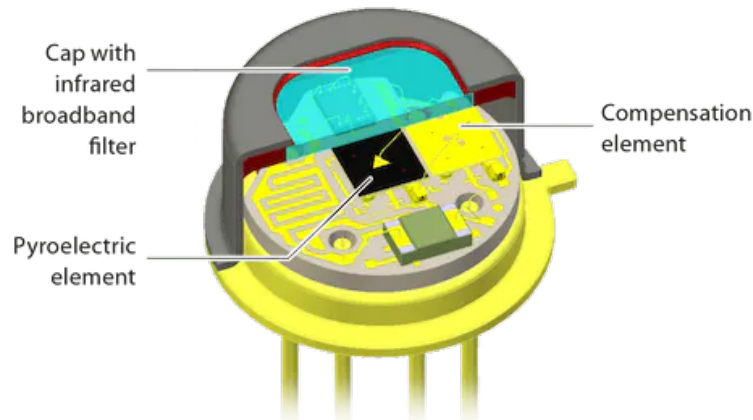


Case Study

MEMS Thermal Sensors

Pyroelectric sensor

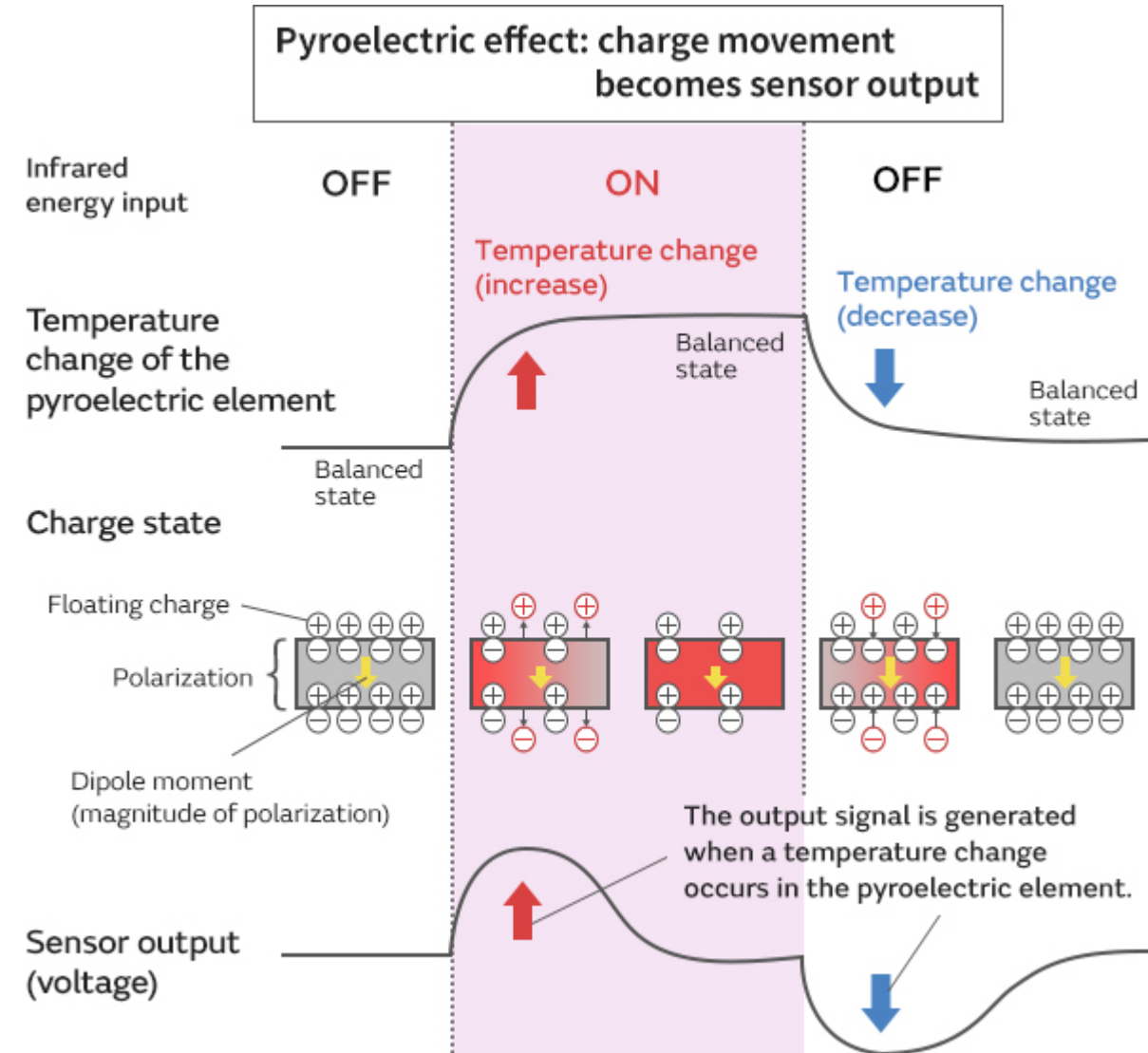


- Working principle

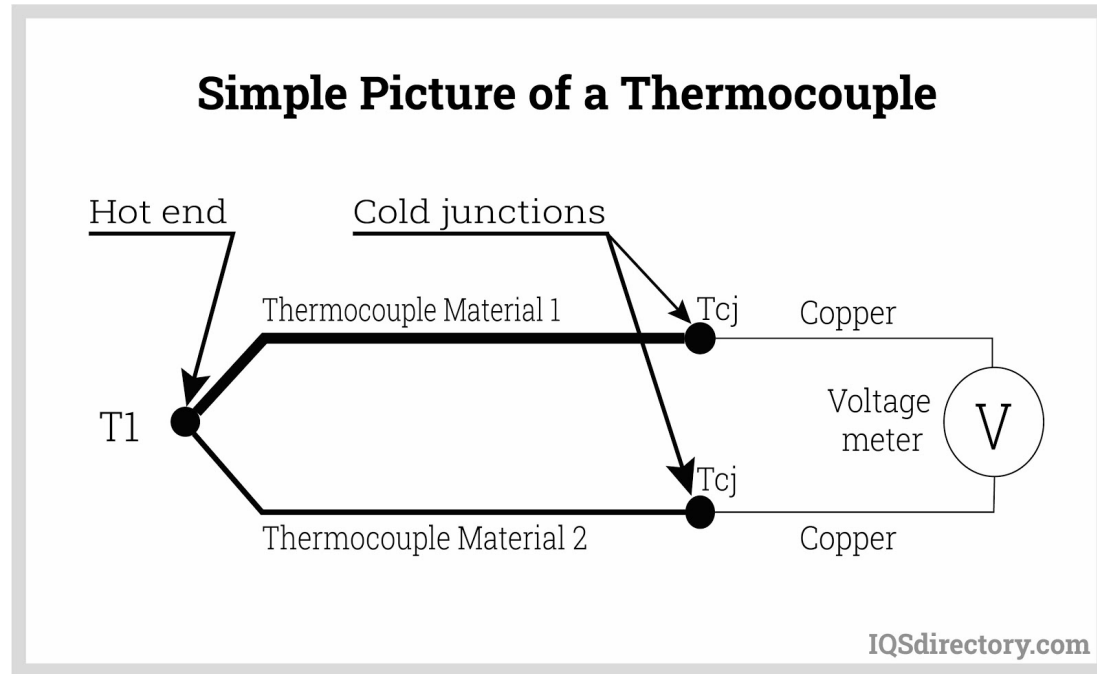
- <https://www.infratec.eu/sensor-division/service-support/glossary/pyroelectric-detector/>
- <https://www.murata.com/en-eu/products/sensor/infrared/overview/basic/about>
- <https://www.newport.com/n/pyroelectric-physics>

- Available products

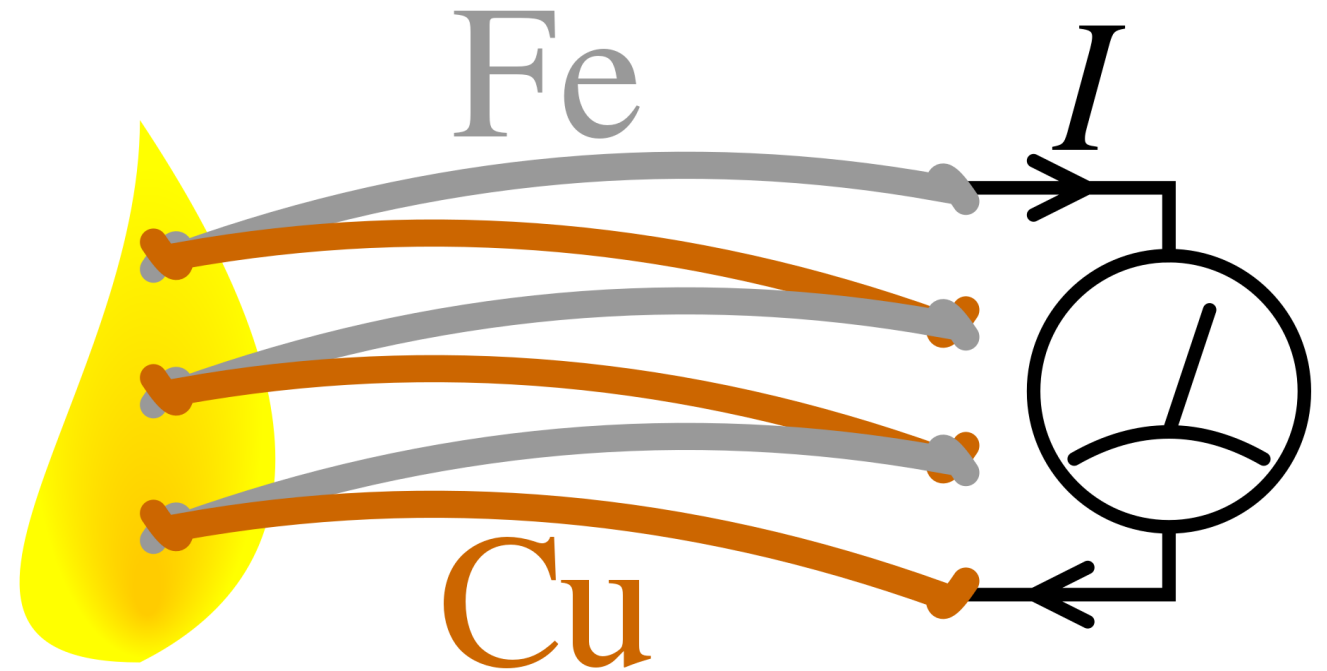
- <https://www.infratec.eu/sensor-division/pyroelectric-detectors/>



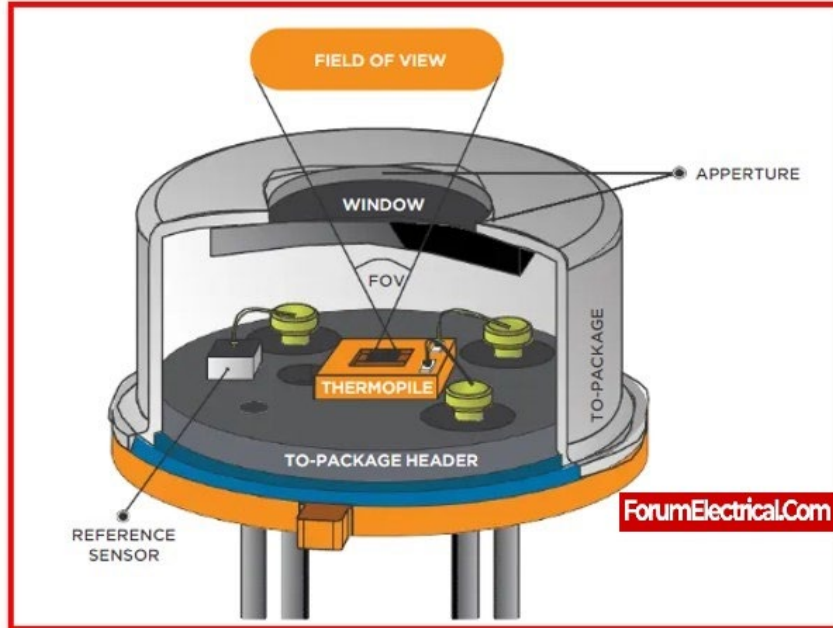
Thermocouple and Thermopile



<https://www.iqsdirectory.com/articles/thermocouple.html>
https://en.wikipedia.org/wiki/Thermoelectric_effect



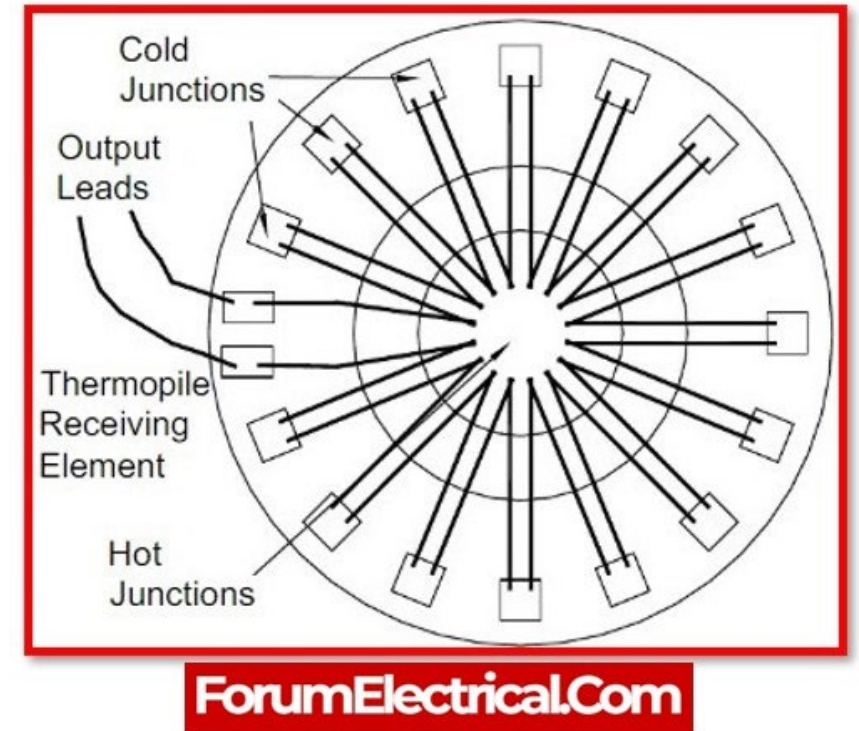
Thermopile



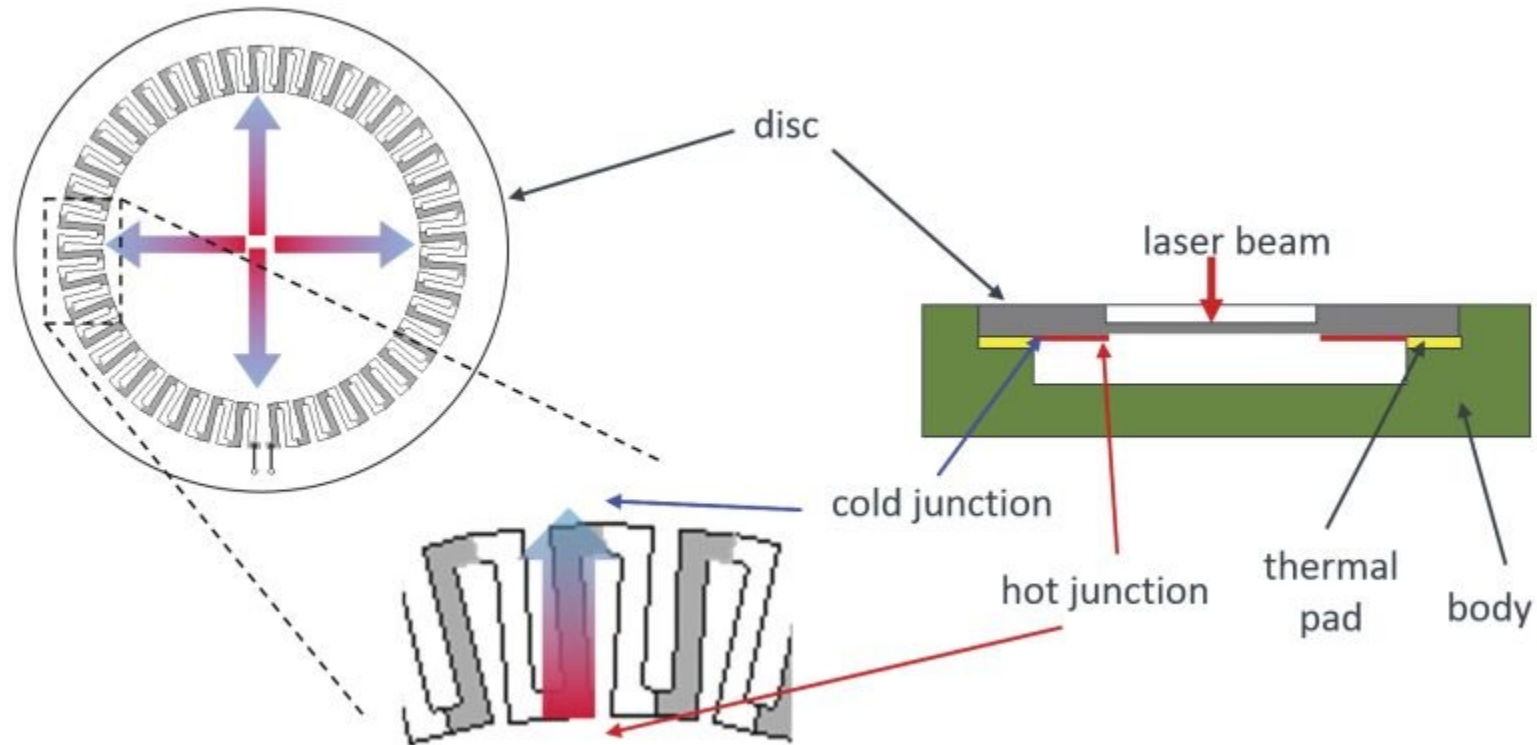
Example arm materials

- Chromel & constantan
- Antimony (Sb) & bismuth (Bi)
- n-type & p-type Poly-Silicon

<https://forumelectrical.com/what-is-thermopile-and-how-it-functions/>



MEMS Thermopile



<https://www.newport.com/n/thermopile-physics>

Thermopile for home/office applications

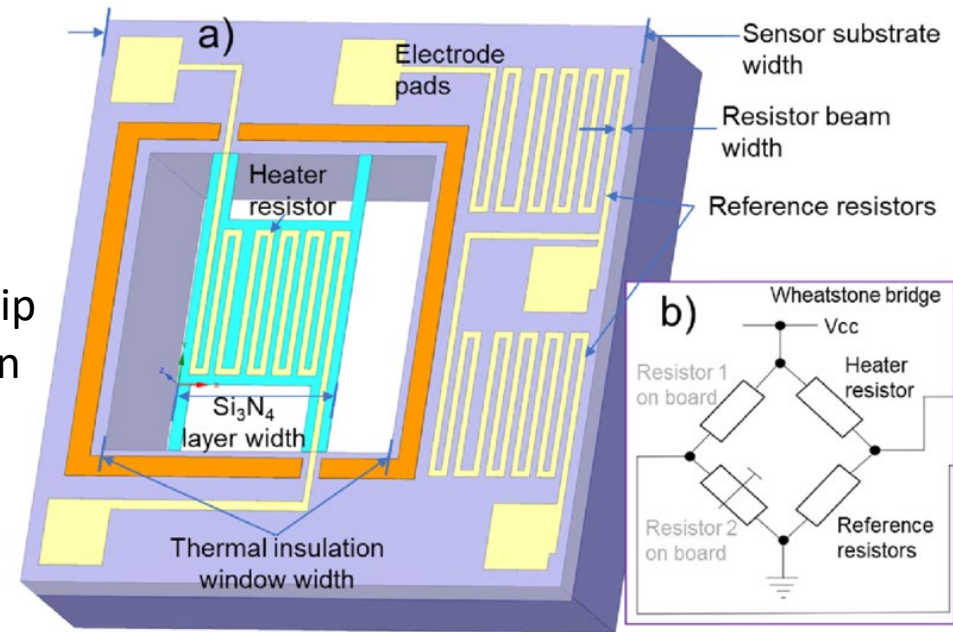
- <https://components.omron.com/sg-en/solutions/sensor/mems-thermals-sensors>
- https://components.omron.com/us-en/sites/components.omron.com.us/files/ds_related_pdf/A289-E1.pdf

Thermopile for non-contact fever measurement

<https://www.hahn-schickard.de/en/projects/success-stories/infrared-temperature-sensor>

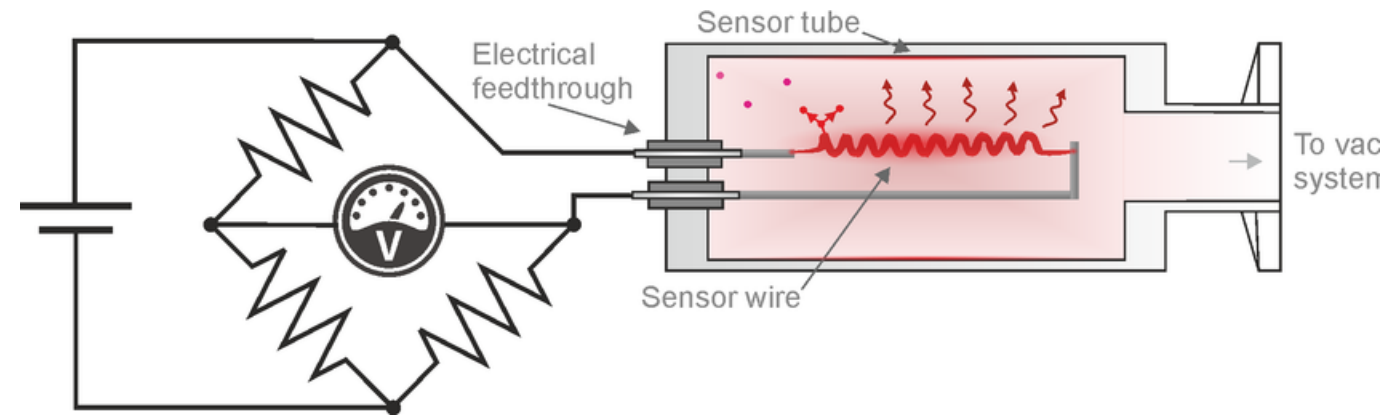
Thermopile for vacuum measurement

The sensing element of Posifa's Pirani gages is based on the company's proven second-generation thermal conductivity chip, which is made with world-class microfabrication processes that ensure precision and uniformity. The sensor chip measures thermal conductance in an embedded cavity with an integrated thermopile to achieve exceptional sensitivity and repeatability.



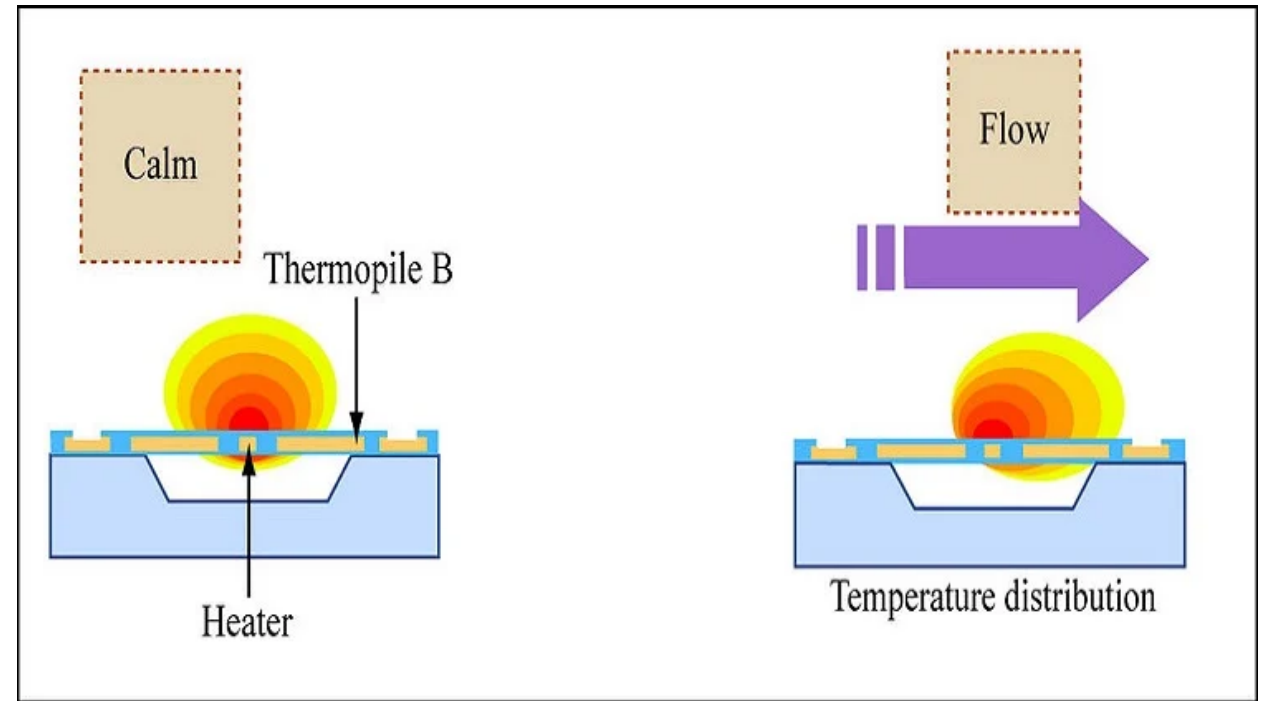
- https://www.researchgate.net/figure/Schematic-view-of-the-Pirani-vacuum-MEMS-sensor-design-with-surrounding-circuit-a_fig3_364279260
- <https://posifatech.com/vacuum-gauges/>
- <https://posifatech.com/vacuum-sensors/pvc3000/>
- https://posifatech.com/wp-content/uploads/2022/03/Datasheet_PVC3000_Vacuum_RevC_C12.pdf

Conventional Pirani gauge



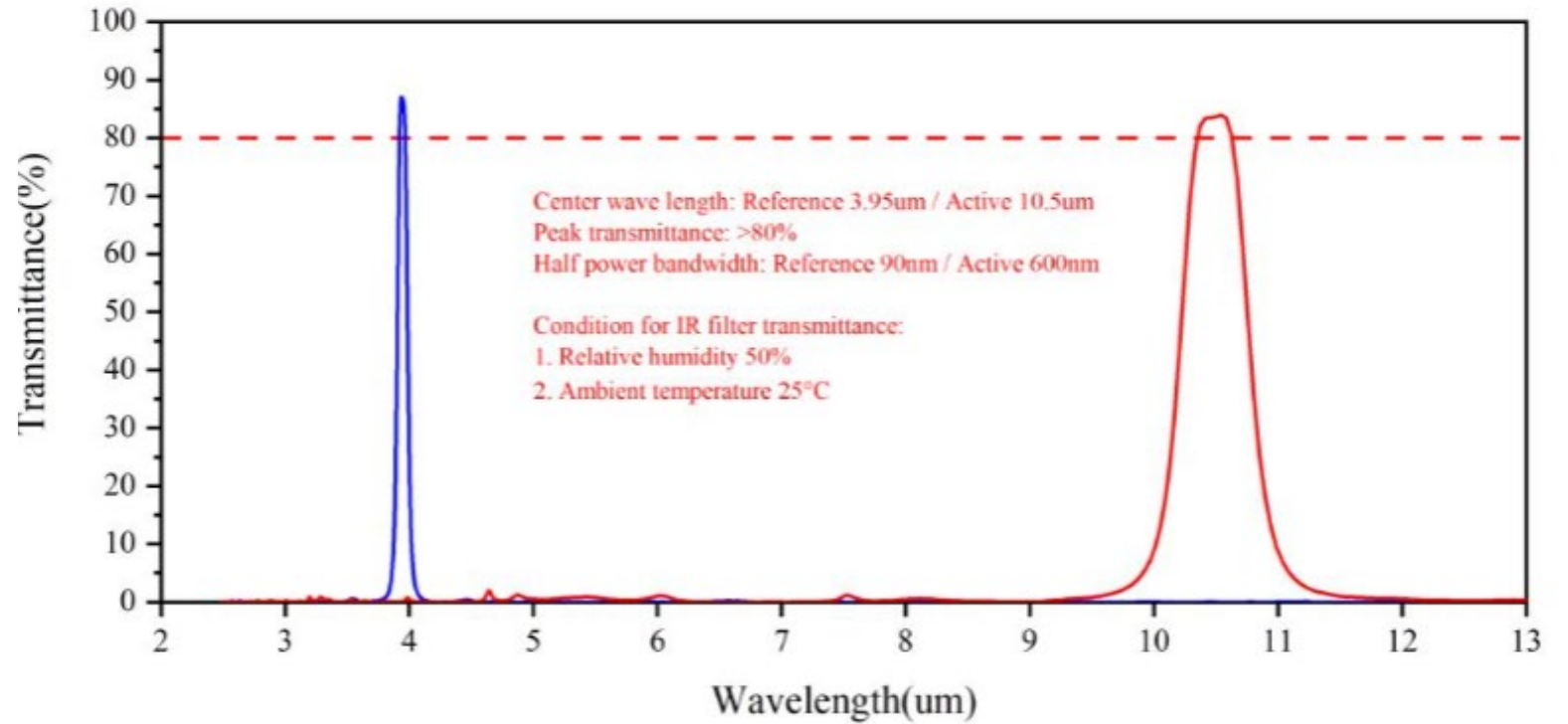
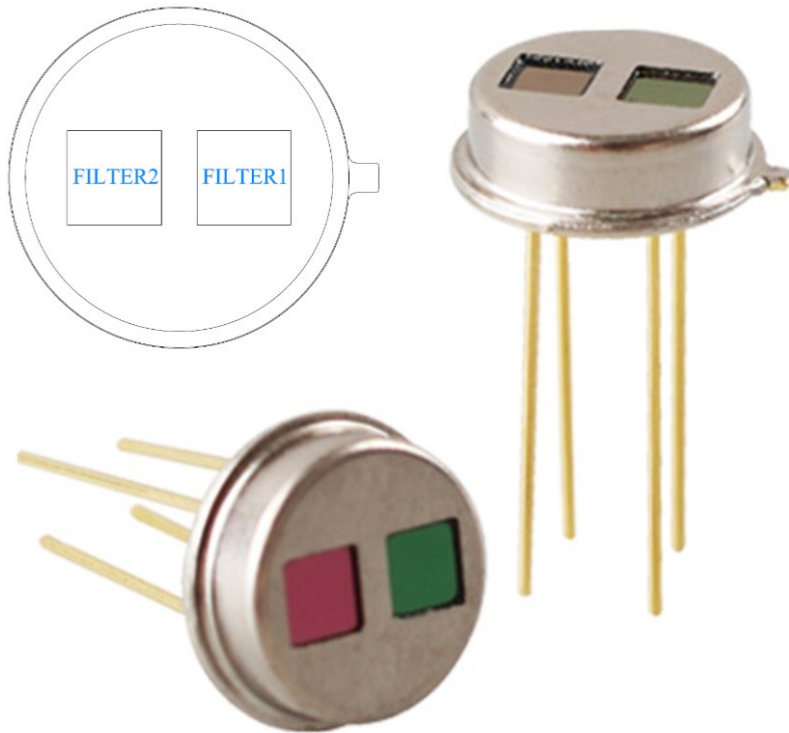
- https://en.wikipedia.org/wiki/Pirani_gauge
- <https://sens4.com/pirani-working-principle.html>

Thermopile for mass flow



- <https://electronics360.globalspec.com/article/15877/mems-flow-sensors-compact-cheap-and-highly-sensitive>
- <https://posifatech.com/mass-air-flow-sensors/>
- [https://posifatech.com/wp-content/uploads/2023/03/Datasheet PMF2000 MassAirFlow RevB C6.pdf](https://posifatech.com/wp-content/uploads/2023/03/Datasheet_PMF2000_MassAirFlow_RevB_C6.pdf)

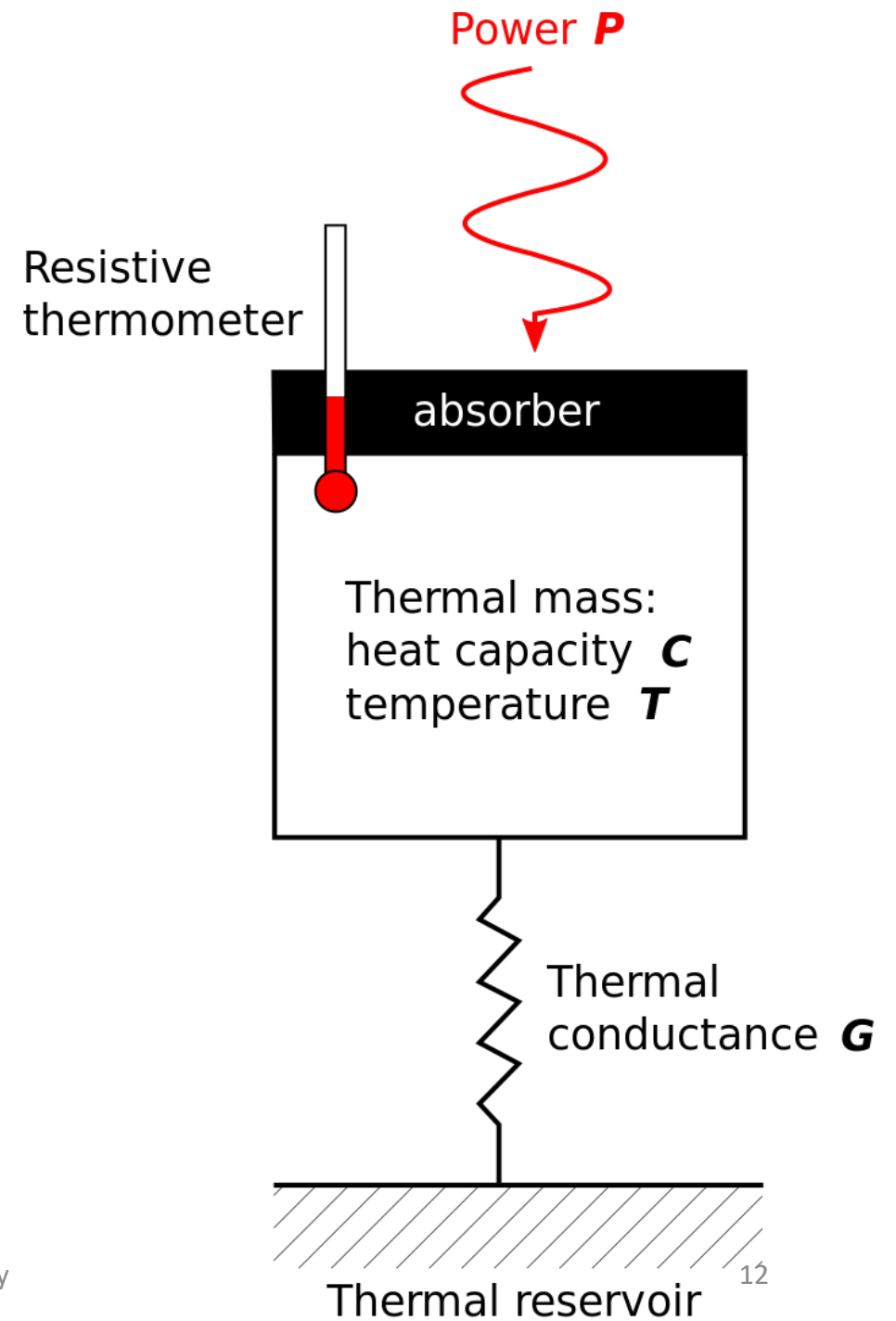
Thermopile for gas sensing



<https://memsf.com/product/mtp20-a6-c2h4/>
<https://memsf.com/product-category/gas-sensor/mems-thermopile-sensor-chip/>

Bolometer

<https://en.wikipedia.org/wiki/Bolometer>



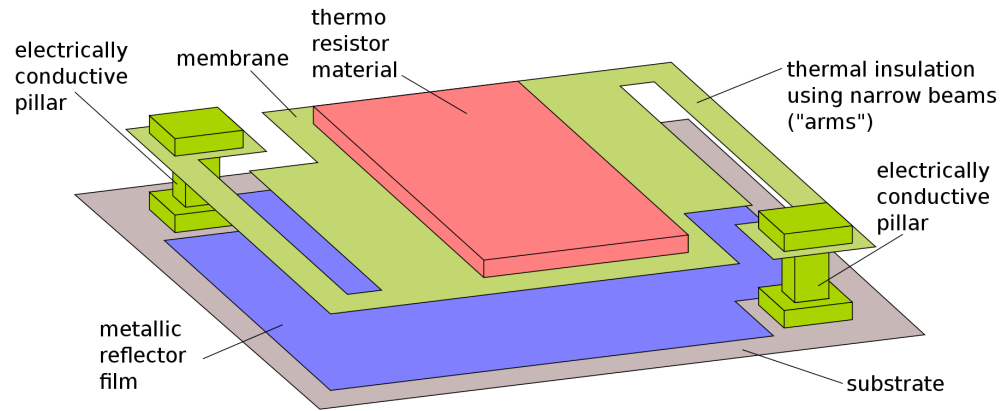
Bolometer: One of the old design

DETAILS

CATEGORY:	Heat
OBJECT NUMBER:	1890-40
MATERIALS:	brass (copper, zinc alloy), leather, plastic (possibly vulcanite) and platinum (metal)
MEASUREMENTS:	overall: 275 mm x x , 43 mm, .41kg
TYPE:	measuring device (radiant energy)
TAXONOMY:	measuring devices L measuring devices L radiometers
CREDIT:	Professor S. P. Langley



Microbolometers



<https://en.wikipedia.org/wiki/Microbolometer>

<https://www.researchgate.net/figure/SEM-micrograph-of-bolometer-element-a-and-bolometer-array-b-formed-using-PS-as-the fig7 231061327>

