

Infrared Detector Arrays for Thermal Imaging Tutorial "Infrared Detectors"

B. Thermal Detector Arrays (Micro-Bolometers)

A research project aiming at fabrication of high resolution infrared detector arrays of the thermal type (in contrast to the photon detector type) is in progress at Acreo. The project is conducted in cooperation with the Royal Institute of Technology (KTH), Stockholm, and the Defence Research Establishment (FOA), Linköping, Sweden.

The major advantage of this type of detector is room temperature operation and monolithic design of the complete sensor unit including multiplexer, which permits a low price per camera system. The application in sight is thermal imaging for e.g. surveillance purposes and the car industry.

The principle of operation of a thermal infrared detector can be described in two steps:

1. Infrared absorption gives rise to a temperature increase of the detector element
2. This temperature increase is detected by an integrated temperature sensor

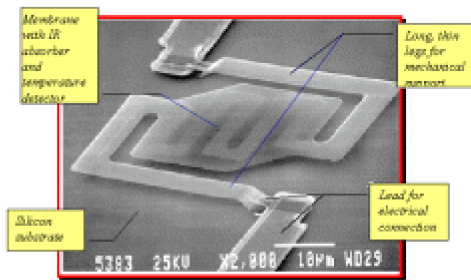
The requirement on detector arrays comprising the detectors integrated with readout electronics is a temperature resolution NETD (Noise Equivalent Temperature Difference) < 0.1 K, for a camera optics f-number = 1 and 50 Hz frame rate.

The major requirement for achieving high sensitivity is an efficient thermal insulation between the detector element and the substrate. This necessitates vacuum encapsulation of the detector. Next in importance is a sensitive means of temperature detection. Semiconductor based layers (thermistors) with large temperature coefficient, and pyroelectric materials, are good choices.

[Surface micromachining](#) is used for the fabrication of the detector elements, consisting of thin bridge structures or membranes (see Fig. 11). Advantages of this technique are, in addition to providing efficient thermal insulation, that post-processing of membranes onto wafers with CMOS readout circuitry is feasible. Since the membranes can be made on top of such circuitry, a very high fill factor of the picture elements can be achieved. A picture element of size 50×50 μm is shown in Fig. 11. The membrane, mechanically supported by two long thin legs, should be noted.

Fig. 11. Scanning electron micrograph of a detector element showing the silicon nitride membrane with the IR absorbing layer (silicon interferometric structure), and structure for temperature detection (platinum resistor).

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Important Publications on Thermal Detectors

1. P. Eriksson, J. Y. Andersson and G. Stemme, "Interferometric low thermal mass IR absorber for thermal infrared detectors", *Physica Scripta*, T54 (1994) pp. 165-168.
2. P. Eriksson, J. Y. Andersson, and G. Stemme, "Theoretical and experimental investigation of interferometric absorbers for thermal infrared detectors", *Sensors and Materials*, 9 (1997) pp. 117-130.
3. P. Eriksson, "Surface micromachined bolometers intended for long wavelength infrared detector arrays", Thesis for the Licentiate Degree, Dep. of Signals, Sensors and Systems, Royal Institute of Technology, Stockholm, Sweden, TRITA-ILA-9602, ISSN 0281-2878.