Implantable blood pressure sensors with an analogic thermal drift compensation

S. Mbacke*, M. El Gibari*, B. Lauzier#, C. Gautier# and H. W. Li*

** Université de Nantes, CNRS, IETR UMR 6164, Faculté des Sciences et Techniques, 2 Chemin de la Houssinière, BP 92208, 44322 Nantes cedex 3, France*

 # Université de Nantes, INSERM, CNRS, l'institut du thorax, INSERM UMR 1087/CNRS UMR 6291, 8 quai Moncousu, BP 70721, 44007 Nantes Cedex 1, France

I. Introduction

- Cardiovascular diseases accounts for around 40% of the number of deaths worldwide [1]. To reduce the death rate from these cardiovascular diseases, many engineers and researchers are working to understand the tools necessary in the evolution of these diseases and are trying to develop more effective treatments
- One of the effective solutions is the use of implantable biomedical sensors. These sensors are in the preclinical of animal studies and the final objective is to use them for the monitoring of patients with chronic cardiovascular diseases [2].
- This poster presents our work aimed at developing an analog and economic technique for compensating the thermal drift of implantable piezoresistive blood pressure sensors.

II. Context

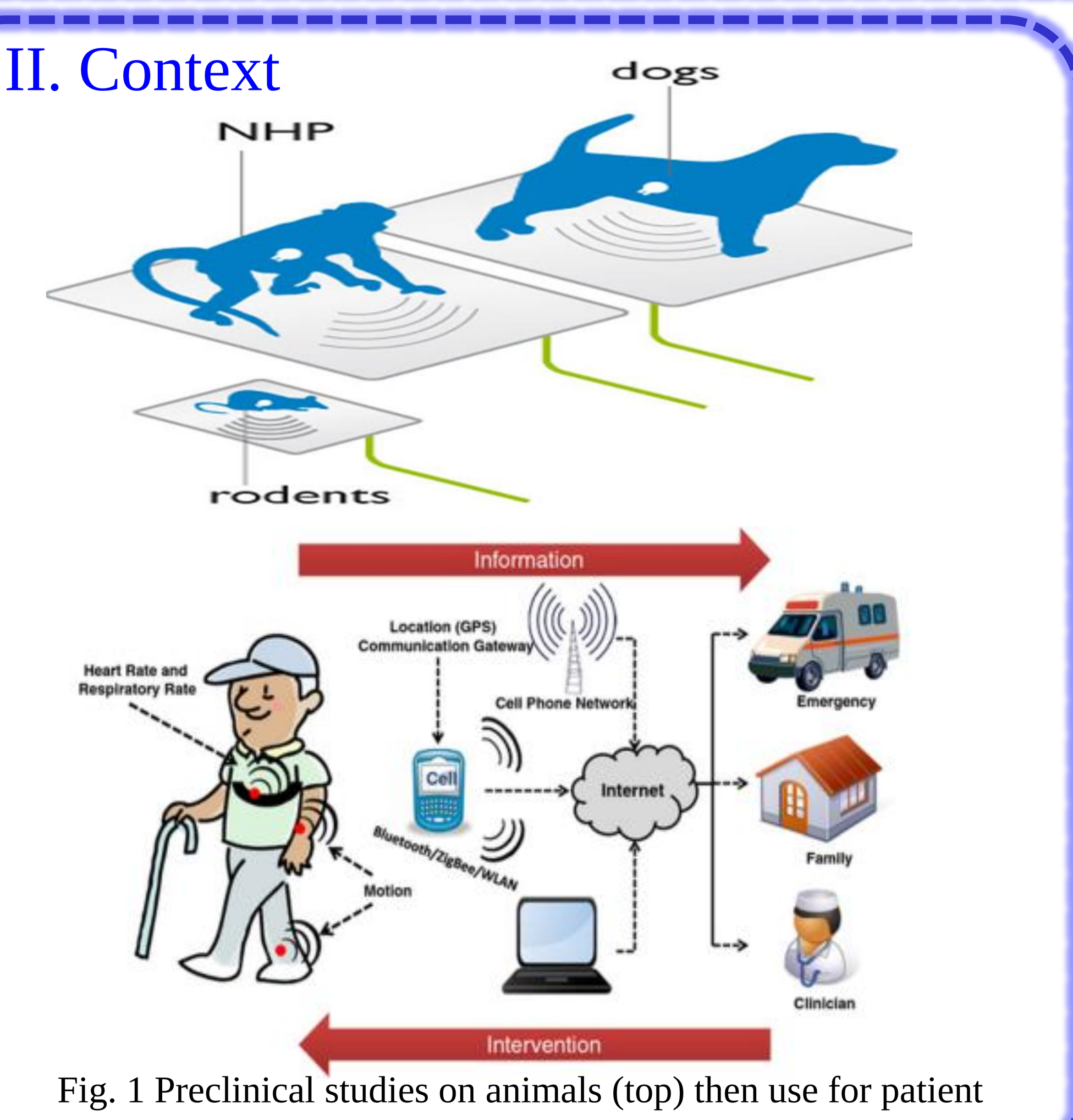

Fig. 1 Preclinical studies on animals (top) then use for patient surveillance (down)

III. Biomedical Sensor Studied

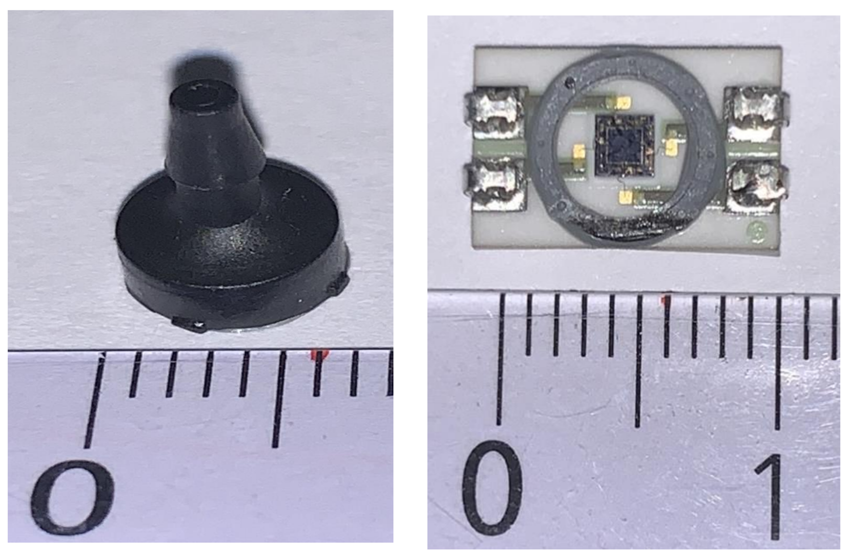

Fig. 2 : The pressure probe studied with and without hood

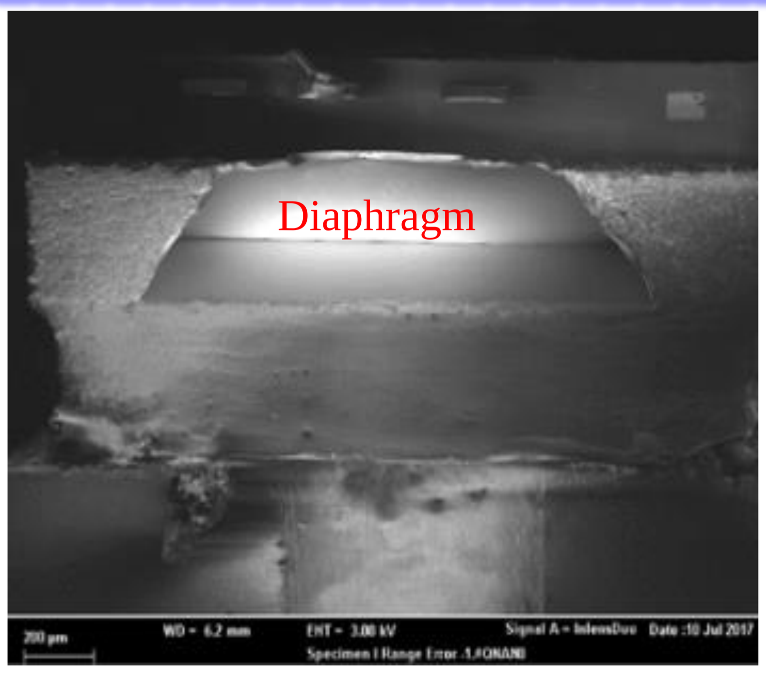

Fig. 3 : Sectional view of the probe under a Scanning Electron Microscope

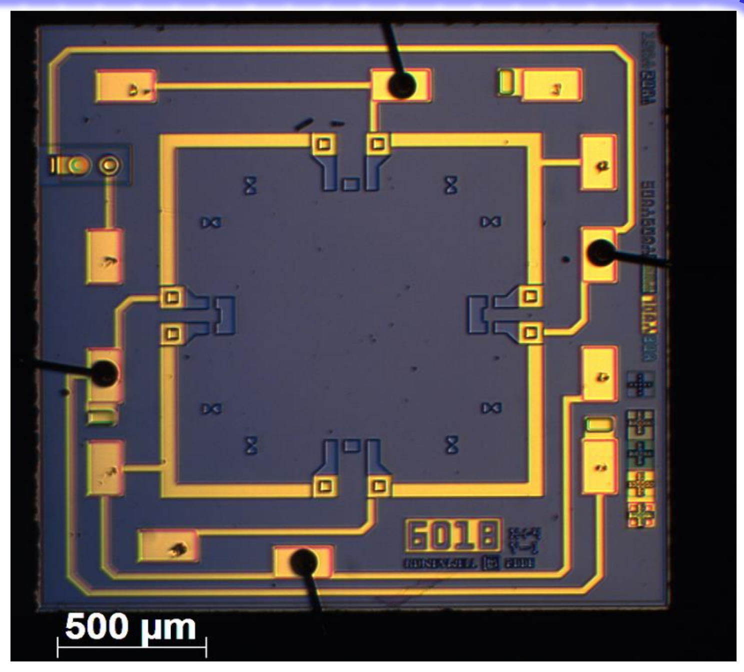

Fig. 4 : Wheatstone bridge circuit of the probe observed using an optical microscope

- The piezoresistive probe studied is a Wheatstone bridge consisting of four piezoresistors (fig.2) whose output varies as a function of pressure, but also temperature unfortunately.
- Its operation is based on a diaphragm (fig.3) which deforms when pressure is applied. This deformation causes a change in the structures of the 4 piezoresistors placed on the 4 sides of the diaphragm (fig.4).

IV. Thermal Drift Compensation of the Sensor

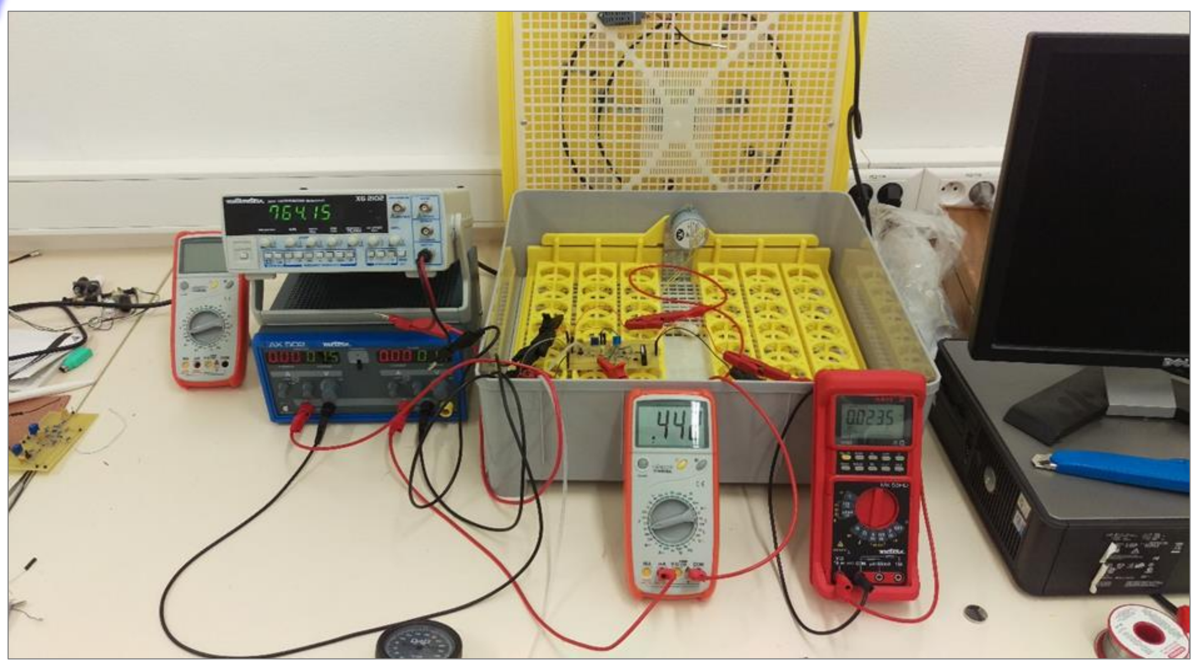

Fig. 5 : Characterization bench of piezoresistive pressure sensors

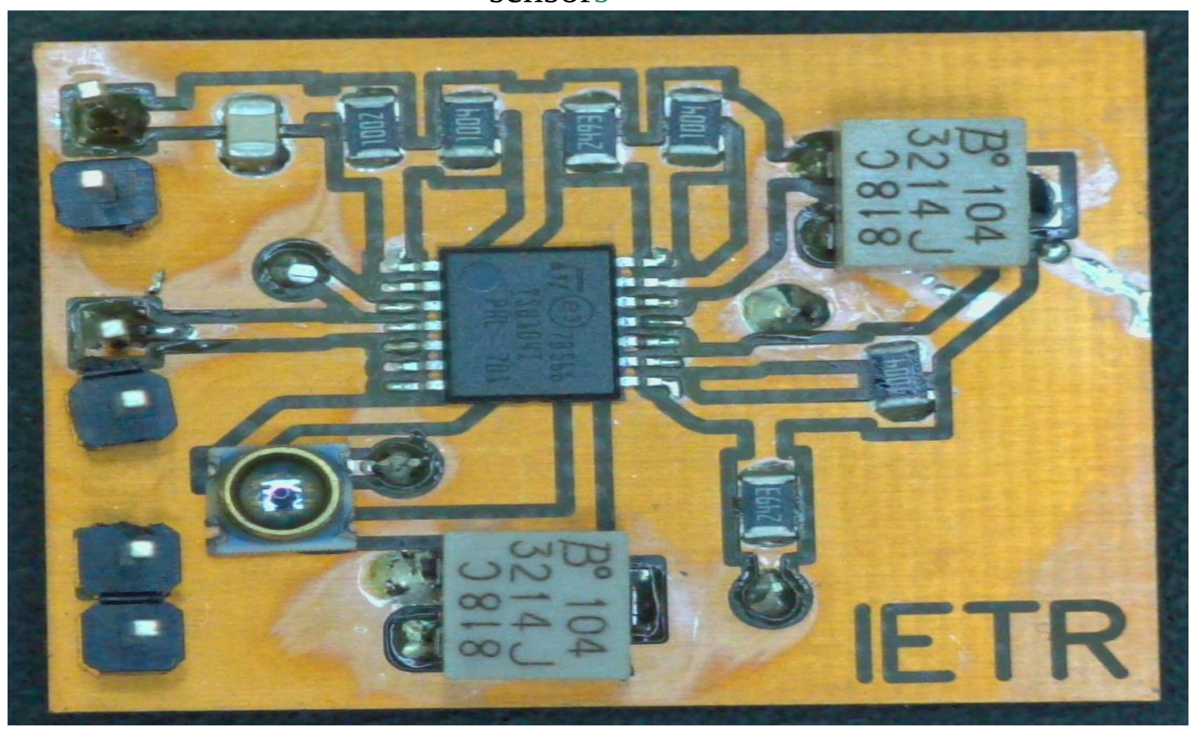

Fig. 6 Realization of the sensor with the conditioning circuit

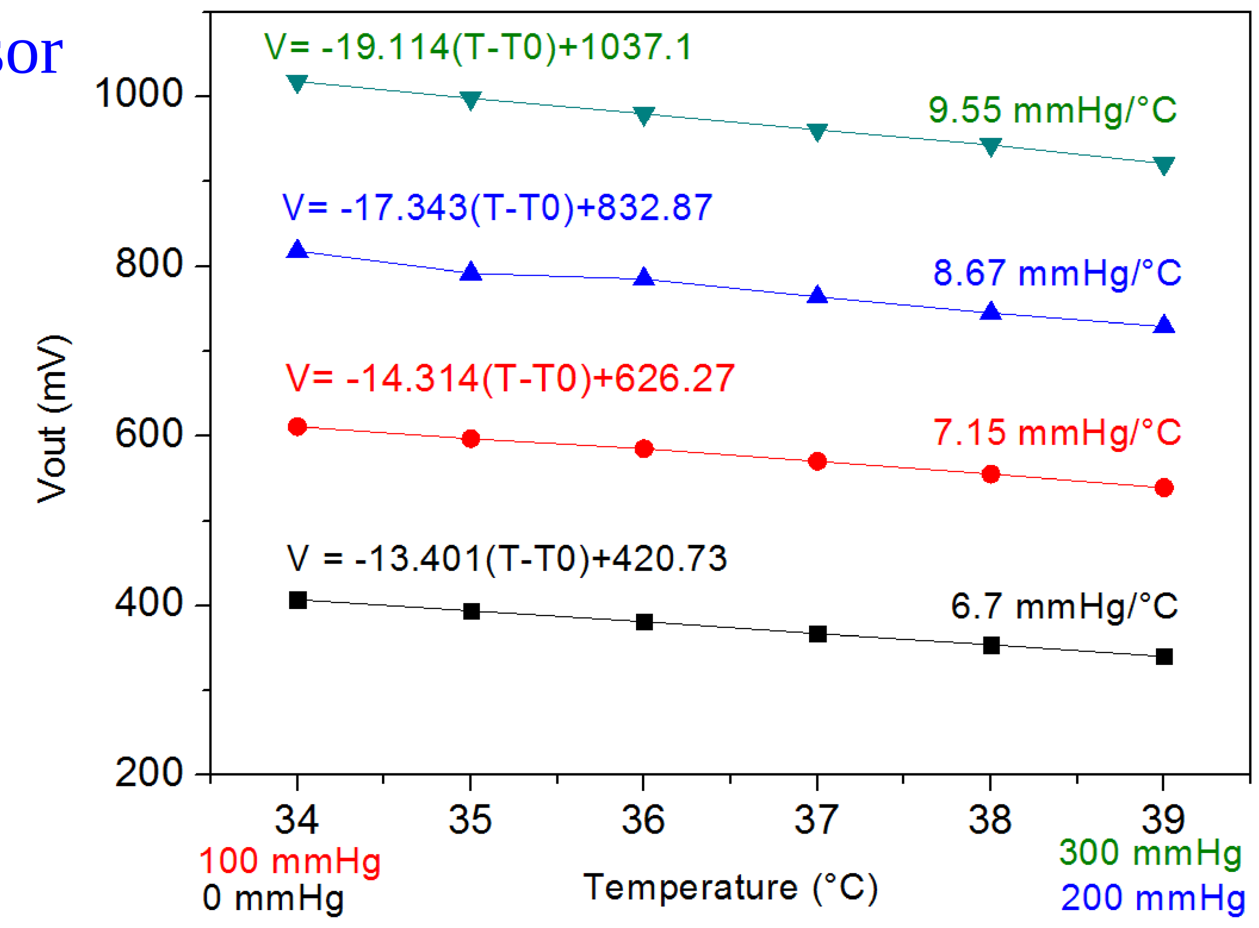

Fig. 8 : Variation of sensor output and sensitivity as a function of temperature without compensation, , with To=34 °C

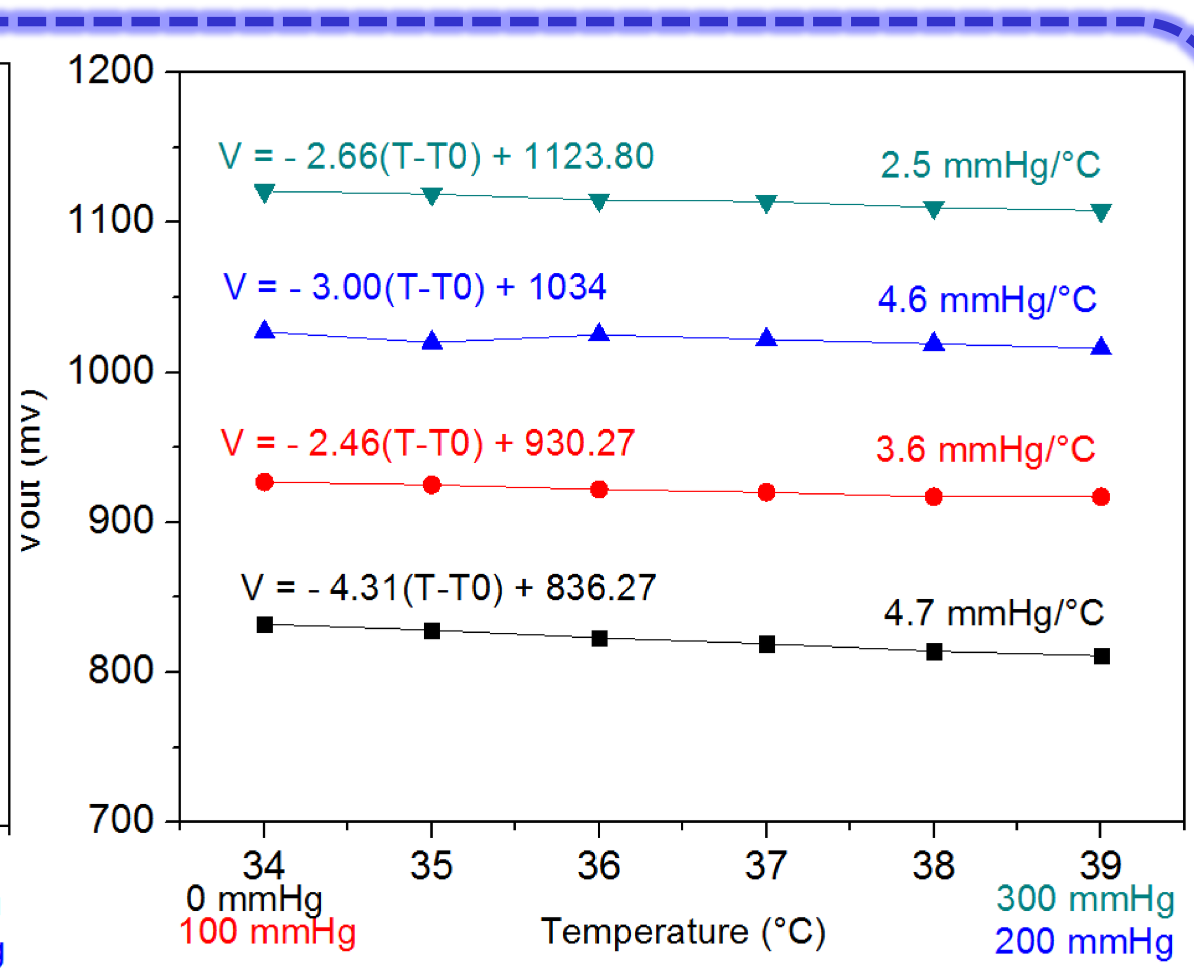

Fig.9 : Sensor output voltage as a function of temperature compensated with amplification, , with To=34 °C

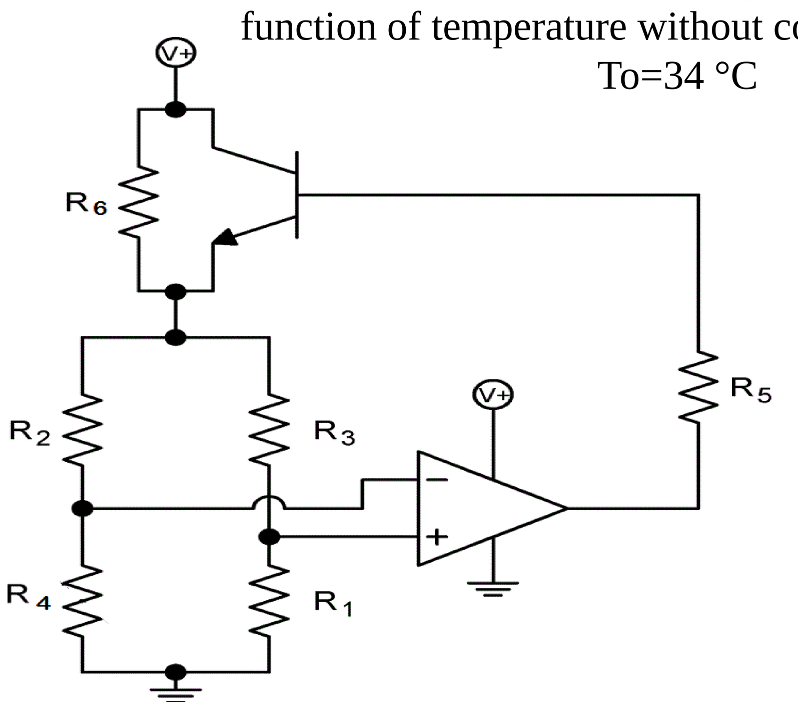

Fig. 7 : The studied piezoresistive pressure sensors with compensation circuit

- ✓ The sensor is subjected to a temperature varying from 34 to 39 °C. The test is carried out on 4 pressure levels (0, 100, 200 and 300 mmHg). The output voltage decreases with temperature. For example, the average drift is 19.11 mV/°C corresponding at 9.55 mmHg/°C to 300 mmHg (fig.8).
- ✓ To compensate for the thermal drift of the sensor, a circuit based on PNP transistor is used. The sensor is compensated. The output voltage remains stable over the entire temperature range with a drift of 2.5 mmHg/°C with the pressure of 300 mmHg (fig.9).

V. Conclusion

- ✓ Study of the internal structure of the probe with an optical microscope (fig. 3)
- ✓ Measurement of the thermal drift of the sensor as a function of temperature and pressure (fig. 8)
- ✓ Development of a compensation method to reduce the thermal drift of the sensor (fig. 9)
- ✓ The result of the compensation is obtained by using a circuit, in series with the sensor, composed of a transistor and two potentiometers (fig 7.). This circuit delivers a voltage which increases as a function of the temperature with a slope opposite to that of the sensor. So we can compensate the sensor.

[1] I. Robert-Bobée, "Population projections 2005-2050: aging of the population in metropolitan France", *Economics and statistics*, Vol. 408 (1) pp. 95-112 DOI: 10.3406 / estat. 2007.7064, 2007.

[2] B. Liang1, L. Fang1, C.L. Tu1, C.C. Zhou1, X.J. Wang1, Q. Wang1, P. Wang1, X.S. Ye1, "A novel implatable saw sensor for blood pressure monitoring" ", *16th International Conference on Semiconductor Sensors, Actuators and Microsystems*, 2011, pp. 2184-2187 (2011).