WiseSKIN: Wireless Sensor Skin for Tactile Prosthetics

J. Baborowski, P. N. Volpe, A. Bionaz, M. Despont, J. R. Farserotu

A sense of tactility is needed to provide feedback for the control of prosthetic limbs and to perceive the prosthesis as a real part of the body. WiseSkin embeds wireless tactility sensors into the cosmetic silicone coating of prostheses. The silicone (PDMS) is structured to host PCBs integrating the sensors and their associated electronics.

The goal of the project is to reestablish a sense of tactility, which is needed to provide feedback for the control of prosthetic limbs and to perceive the prosthesis as a real part of the body. WiseSkin embeds wireless tactility sensors into the cosmetic silicone coating of prostheses. This part of the project is dedicated to the development of the Miniaturized Sensor Module. This module is the base element for the tactile sensing of the subject. Several modules (typically three per finger) are to be placed on the prosthetic. The targeted module includes the pressure sensor, microelectronic controller and radio placed on the common PCB. The module is connected to the artificial skin via the conformal power distribution layer (CPDL). Recently, several aspects have been developed:

- Flexible interconnections obtained on the PDMS substrates by the metallization using the Pt implantation (i-Pt);
- 3D soft (i-Pt on PDMS) interconnections between the pressure sensor (top side) and the external connectors;
- Tests and calibration of the sensors embedded in the PDMS skin with flexible interconnections (Prototype “0”);
- Concept, design and the manufacturing of the miniaturized 3D PCB dedicated for the Prototype “1” and “2”.

A general concept of the module is shown in Figure 1. The individual module consists of a sensor module embedded in artificial skin and connected via CPDL. The tactile sensor is placed on the top of the module and the electronic part on the bottom. The 3D PCB is customized in order to fit with the architecture of the module.

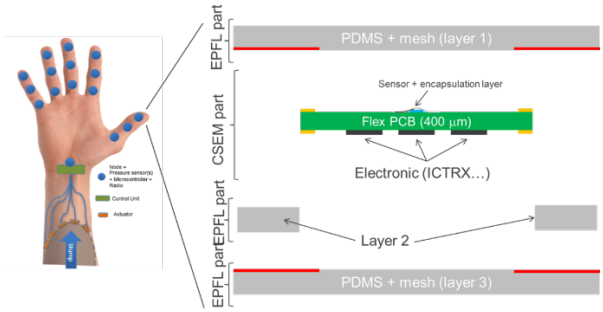
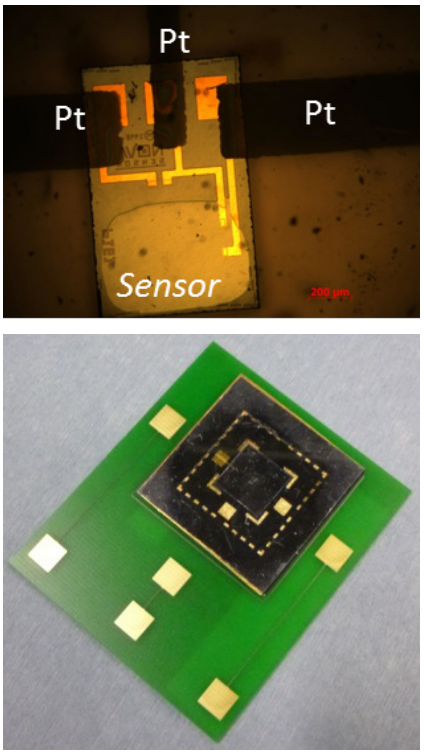


Figure 1: A general concept of the sensing module and integration with CPDL.

Figure 2a shows the single pressure sensor (GE-P161 type, top view) embedded in the PDMS. The PDMS interface (150 µm thick) contains the conducting Pt paths (black lines on Figure 1a) making the electrical connections between the sensor and the external measurement unit. The tight integration between the sensor and PDMS is obtained by plasma activated bonding. The resistivity of the connections (less than kOhm) is compatible with the functionality of the piezoresistive sensor. Figure 2b represents a global view of the Prototype “0”. In this case, the sensor module is integrated on the 3 x 3 cm2 silicon support and a standard PCB for the preliminary tactile tests.



(a)

(b)

Figure 2: (a) Close view of the GE-P161 sensor embedded in the PDMS with the soft interconnections; (b) Global view of the prototype “0”.

The first tactile tests were done at the laboratory level by applying pressure with a finger on the top of the sensor and reading the output voltage (Figure 3). The sensor embedded in the PDMS and connected via the soft Pt paths is sensible enough to transmit the quite large range of the applied pressure. The robustness of the module (mechanical and electrical) was satisfactory, and the tests have been repeated with a dozen of sensing module units. The calibration of the sensor module is still ongoing.

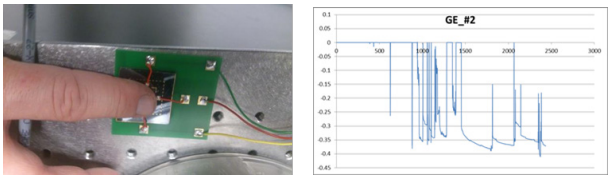


Figure 3: Laboratory level tactile tests performed on the Prototype “0” and the output signal recorded in function of different pressure levels applied.