Flexible piezoelectric sensor for podiatric applications with wireless communication

Samia Adrar[*], Mohammed El Gibari[*], Philippe Saillant[**], Arnaud Chambellan[**], Marc Jubeau[**] and Raynald Seveno [*]

[*]IETR, UMR CNRS 6164, University of Nantes (France)

[**]MIP, EA 4334, University of Nantes (France)

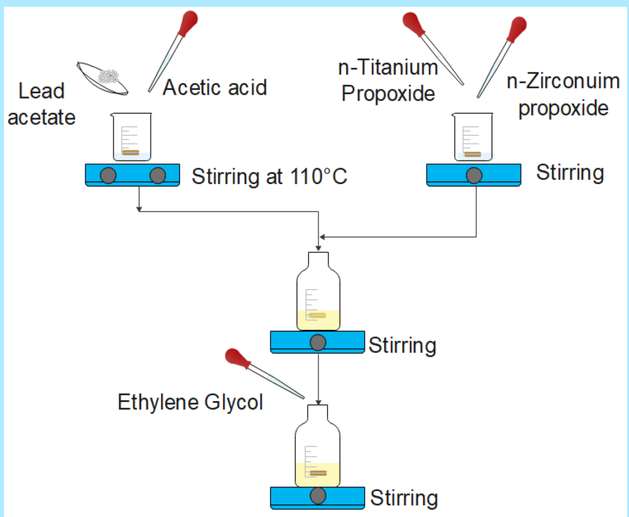
Email : samia.adrar@etu.univ-nantes.fr

Abstract

The subject of this project falls into the category of research themes on systems for medical applications with the objective of monitoring the patient at home via tools adapted to his pathology. In this context, three years will be devoted to developing a connected sole to find the relationship between the type of walking and some diseases (Diabetes, Parkinson's..). The first part of this work is based on improving the performance of flexible piezoelectric sensors developed at the IETR [1],[2] and adapting the different characteristics to our study, the second part consists in creating a system for acquiring and transmitting data from the output of the sensors while respecting the constraints (size, energy and economy).

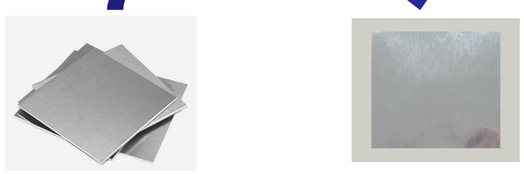
PZT Piezoelectric thin film sensors

Precursor solution of PZT



Substrate preparation

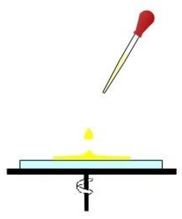
Stainless steel plate is used as support for commercial aluminum (Al) foil as substrate



Advantages of using commercial aluminum foil :

- ✓ **Resistant to high temperatures.**
- ✓ **we can find it everywhere.**
- ✓ **It is a cheap product.**

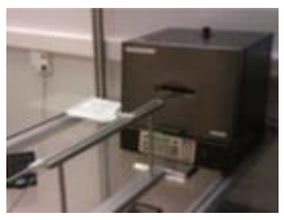
Deposition of PZT precursor solution by spin-coating



Put the sample in the oven

Repeat the operation 9 times

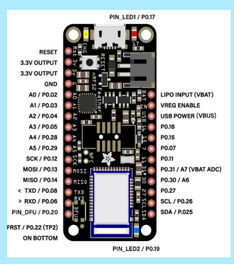
Depositing the solution

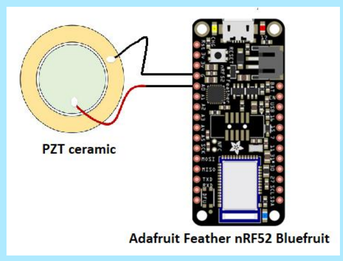


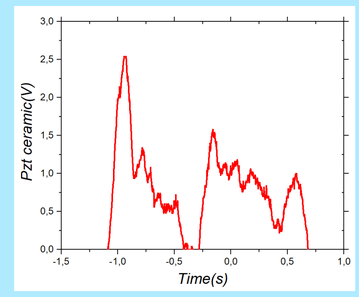
PZT Piezoelectric films have been elaborated by a Chemical Solution Deposition process; structural and electrical characterizations have been performed to check the piezoelectric properties of the sensors.

Data acquisition

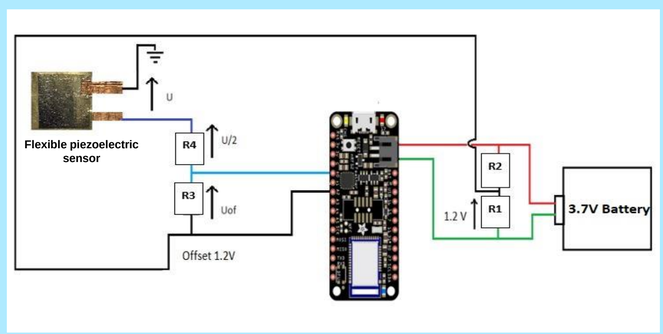
The low energy data acquisition card nRF52 [3] designed and developed by ADAFRUIT company was chosen in our project for many reasons (Low power consumption, small dimension (51mm x 23mm x 8mm), used with free access software, 32 configurable pins and Bluetooth Low Energy ….).





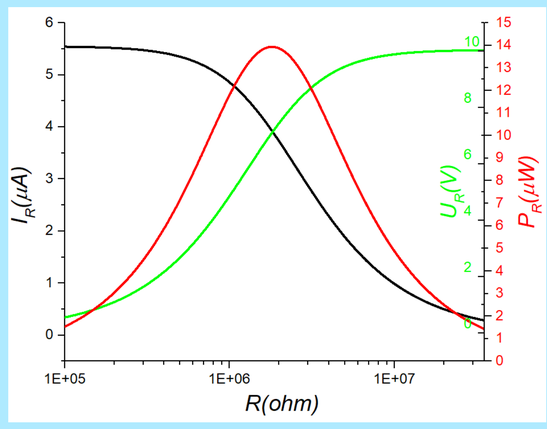


The Adafruit feather card can acquire just the positive part of the signal supplied by the sensor.



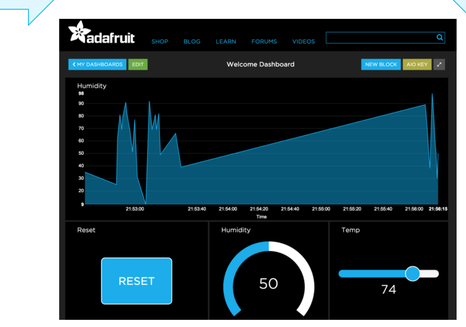
The nRF52 acquisition card is powered by a 3.7V battery, to get an offset of 1.2V, a voltage divider is added to the power supply circuit, this DC signal is finally added to the output signal of the sensor to obtain the entire signal.

The choice of resistance values (R3 and R4) is very important, it is necessary to take into account the curve of the maximum operating points of the sensor to define the impedance of the equivalent circuit to finally obtain a good signal.

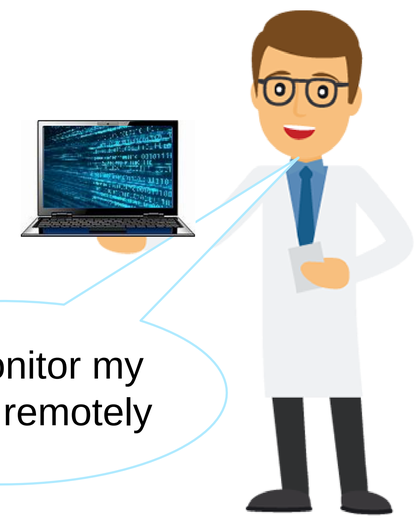


After defining the characteristics of the sensors manufactured at the IETR, we must place them in the sole, **but Where?**

Our work is carried out in collaboration with medical specialist in the field, it makes more sense to work with a podiatrist to define the important pressure points of the feet that can give us the maximum information.



Io Adafruit



The information to retrieve by Bluetooth, is recorded on a private cloud or on the free development interface provided by Adafruit company [4].

Conclusion and perspective

The preliminary results show how to recover the walking signal for future medical surveillance. The test data are compared to those obtained on a podiatry walking mat. For future work, the essential will be on the optimization of all the parameters of the system to correctly recover all the information transmitted by our sensors. After validating the material on a healthy person, it would be interesting to move on to another step, by testing the sole on people with different diseases such as diabetes for example.

References

[1] Seveno, Raynald. « Réalisation et caractérisation de couches minces ferroélectriques et antiferroélectriques de PZT ». *http://www.theses.fr*. Thesis, Nantes, 2000. http://www.theses.fr/2000NANT2074.

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[3] Adafruit Learning System. « Bluefruit NRF52 Feather Learning Guide ». Consulté le 15 avril 2020 https://learn.adafruit.com/bluefruit-nrf52-feather-learning-guide/introduction

[4] « Adafruit Industries, Unique & fun DIY electronics and kits ». Consulté le 21 mars 2021. https://www.adafruit.com/.