GSense

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Datasheet: graphite sensor project

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Abstract

In this project, we have developed a PCB mounted on an Arduino shield that is able to measure data both from a commercial flex sensor and from a handmade graphite sensor. The aim of the project is to prove that a handmade graphite sensor can be more sensitive to flexion than a commercial flex sensor, at least for very high resistance values (of the order of 50 to 100 MOhm). For developing this project, we have based our work in the publication from Wei et al. "Pencil drawn strain gauges and chemiresistors on paper" (2014).

Keywords: graphite sensor, chemristors, Arduino, Android application, flex sensor

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1 Main features of the graphite-based sensor

The graphite-based sensor used for this project is obtained with 160g paper, on which a particular shape is drawn using pencil as can be seen in figures 1 and 2. The shape is then colored in using the same pencil.

There are pencils that are "softer" than others. The 3B pencil is the softest studied in this project, and the 2H the "hardest". The softer a pencil is, the more graphite it contains, and vice-versa.

The main **features** of the graphene-based sensor are:

— It can act as a **strain gauge**
— **Low-tech**
— **Low-cost**
— **Low power consumption**

2 How does the graphene-based sensor work?

This low technology graphite-based sensor is based on the publication “Pencil drawn strain gauges and chemiresistors on paper” from Wei Lin et al. (1). This strain gauge is composed of a piece of paper on which layers of graphite are deposited by drawing with pencils. These strain gauges can be used to measure resistance of the order of the giga-ohm.

The principle of this sensor is based on the link between resistance and the mean distance between graphite particles. With deformation, in tension and compression, the particles' mean distance changes, as well as the resistance.

Before using these strain gauges, an electrical circuit is needed to amplify the sensor signal. The circuit can be found in this README file.

For further information on the phenomena behind the resistance change and the electrical circuit to measure it, please visit our GitHub.

3 Sizes of the graphite-based sensor

In this part are presented the sensor's main features.

Dimension Capteur (mm)	A	4	B	10	C	1
	D	24	E	2		

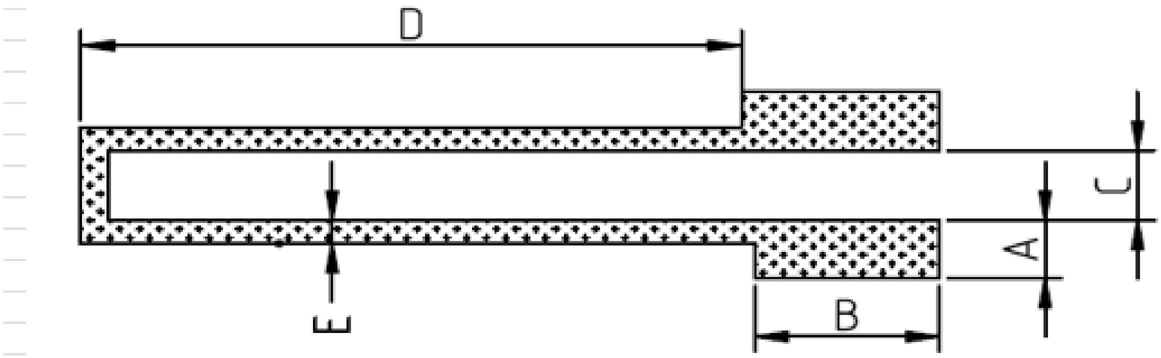

Figure 1 – Sensor dimensions in millimeters. Extracted from Gaich and Stephen's GitHub.

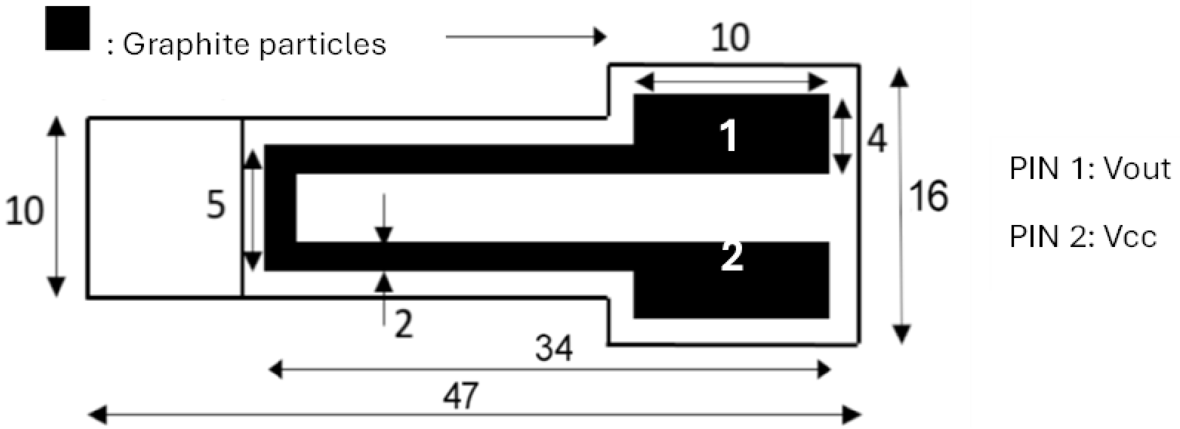

Figure 2 – Diagram for the graphene-based sensor. The units are in mm. Extracted from the work of Paul Besnard and Niels Brun, available on GitHub.

4 Handmade graphite sensor vs. commercial flex sensor: results

The complete results can be found in our GitHub, in an Excel file, where the results can be found for each of the five types of pencil studied. It was chosen not to study the 3H and the HB pencils, since we thought we had enough data for drawing a conclusion with the five pencils studied.

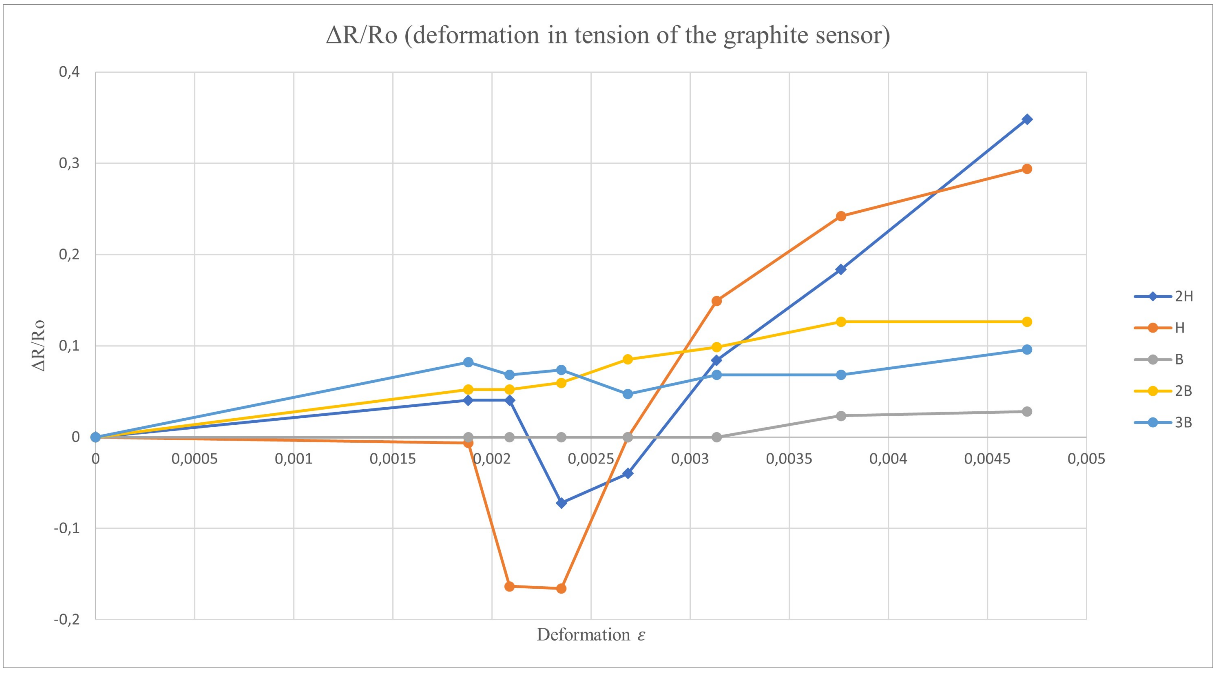

Figure 3 – Results obtained for the graphite sensor for a deformation in tension and for different H and B values.

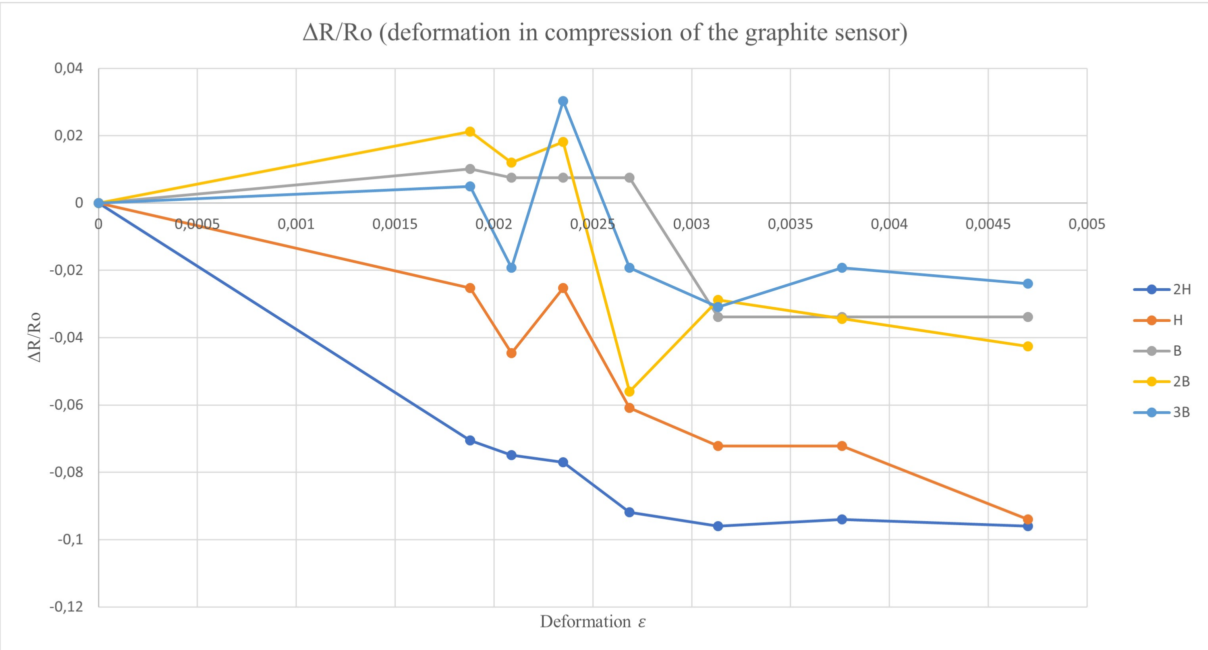

Figure 4 – Results obtained for the graphite sensor for a deformation in compression and for different H and B values.

The conclusion that can be extracted from figures 3 and 4 is that, both for tension and compression, the "harder" the pencil is (in our case the hardest pencil is the 2H), the most sensitive the sensor is. This was also the conclusion extracted from Wei et al. (1).

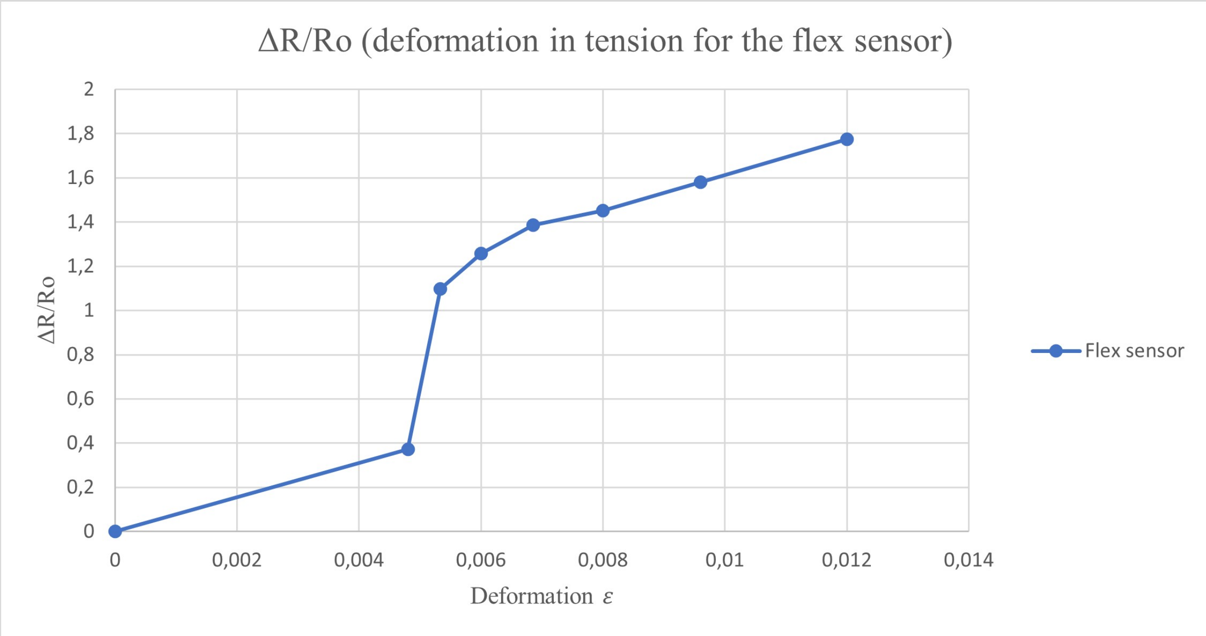

Figure 5 – Results obtained for the commercial flex sensor for a deformation in tension.

It can be seen that, for our case, the commercial flex sensor, which is only capable of measuring tension values, is more sensitive than our handmade graphite sensor. This could mean that our measures were faulty at some point, in the method or in the material being used, since the electrical circuit was the same than the one used in class and it seemed to be correct.

On top of this, some of our colleagues have found that the flex sensor is less sensitive than the handmade graphite sensor, which could mean that the sensitivity of the latter is highly dependent on factors that were not under control in our case.

References

[1] C.-W. Lin, Z. Zhao, J. Kim, and J. Huang, "Pencil drawn strain gauges and chemiresistors on paper," *Scientific reports*, vol. 4, no. 1, p. 3812, 2014.