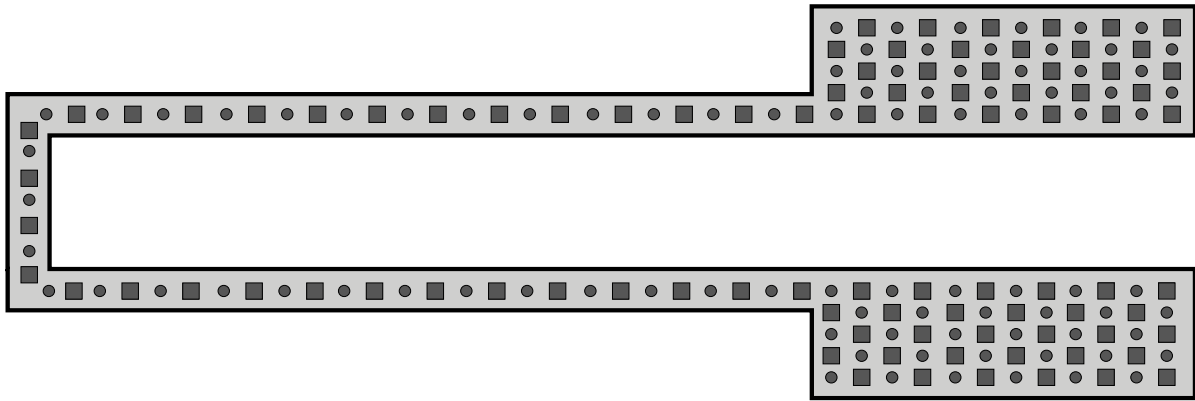


Pencil's graphite strain gauge sensor



1. Description:

At INSA Toulouse, students have crafted a graphite-based strain sensor inspired by the techniques described in the article "Pencil Drawn Strain Gauges and Chemiresistors on Paper." This innovative device utilizes a simple fabrication method where a standard piece of printed paper is layered with graphite from a pencil. These graphite layers form a network of fine powders that act as a strain gauge. The choice of paper as a substrate offers a naturally porous medium, which enhances the deposition area for the graphite within the cellulose fibres of the paper.

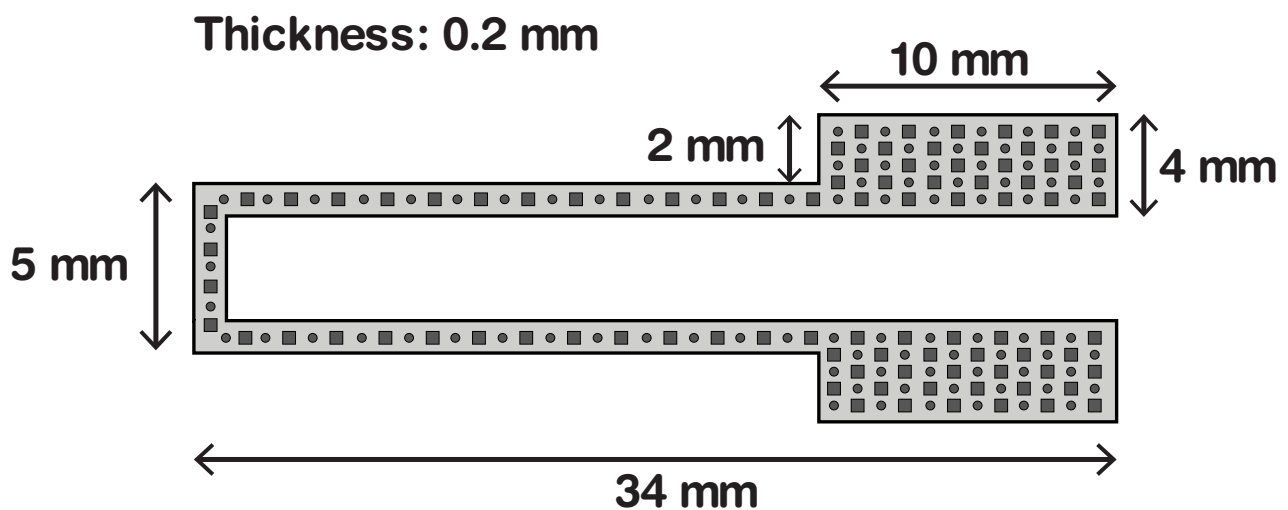
The functioning of the sensor is characterized by reversible resistance changes when subjected to various mechanical deformations, due to alterations in the average spacing between the graphite particles. This granular system's behaviour was thoroughly examined using commonly available HB and B pencils to vary the curvature radius of the sensor.

This low-tech, cost-effective solution is both easy and quick to fabricate, and the sensors are lightweight, portable, and disposable, causing no significant environmental impact during their creation or use. The design's simplicity and the accessibility of materials make the sensor exceptionally suitable for applications in resource-limited environments. For detailed testing and measurement, the sensor is connected to a specially designed PCB board mounted on an Arduino Uno Board, facilitating the monitoring and analysis of its performance.

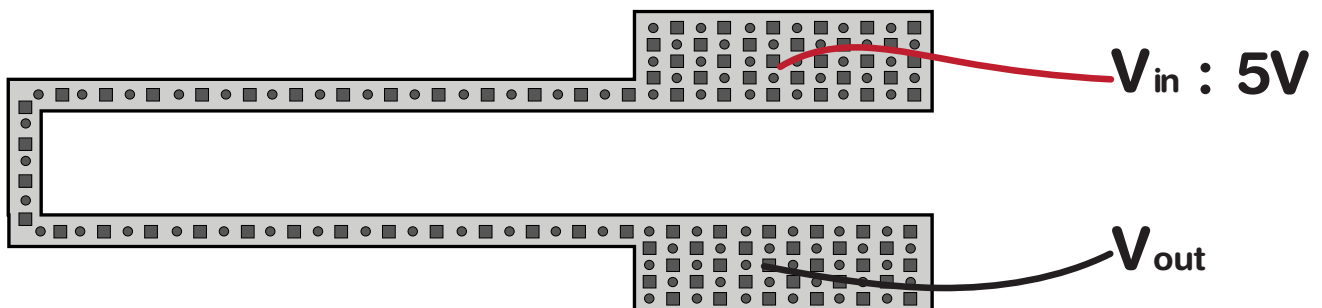
2. Features:

- Low cost
- Low current ($\sim \text{nA}$)
- Environmentally friendly
- Small ($< 10 \text{ cm}^2$)
- Lightweighted ($< 10 \text{ g}$)

3. Dimensions:



4. Pin layout:



5. Ratings:

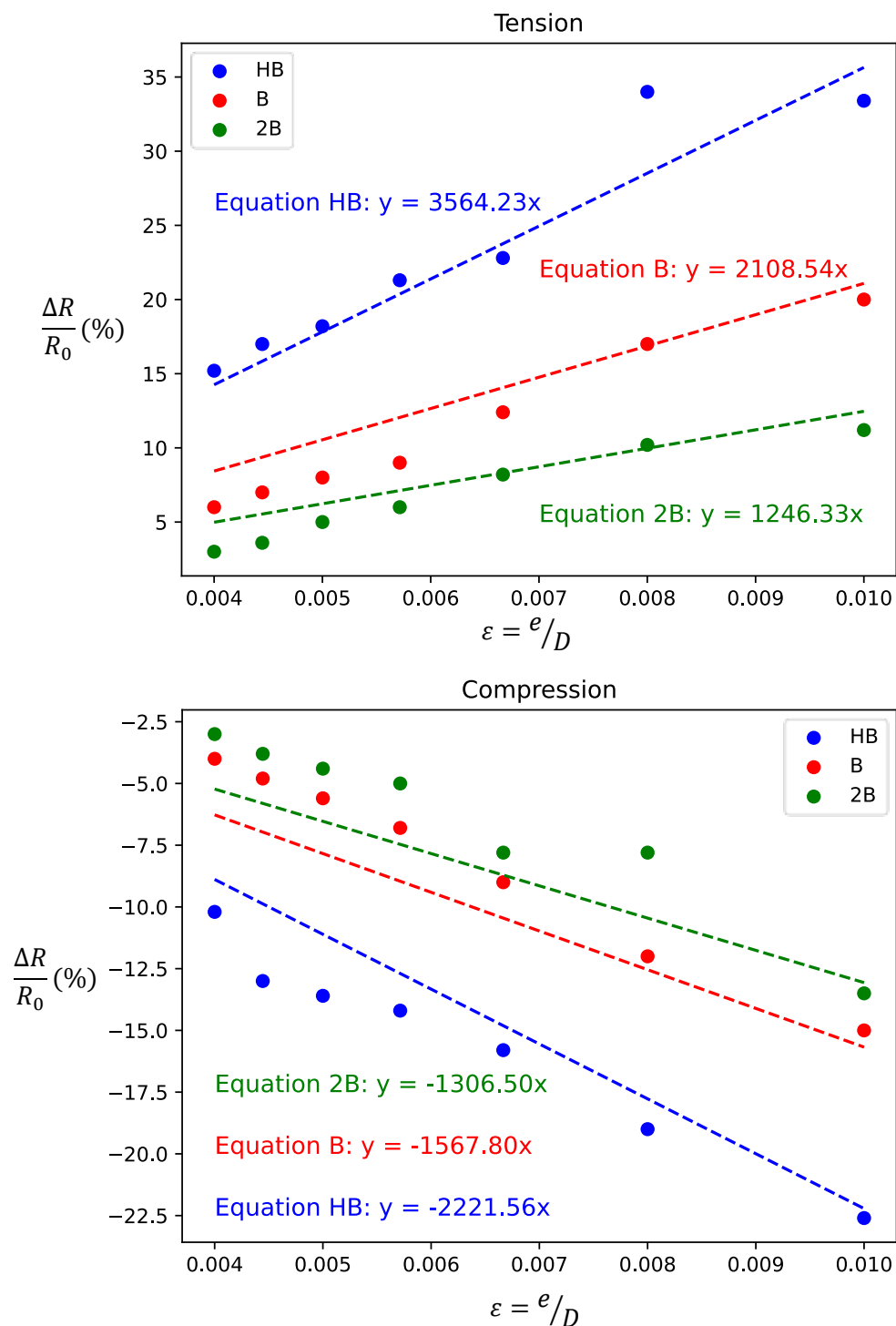
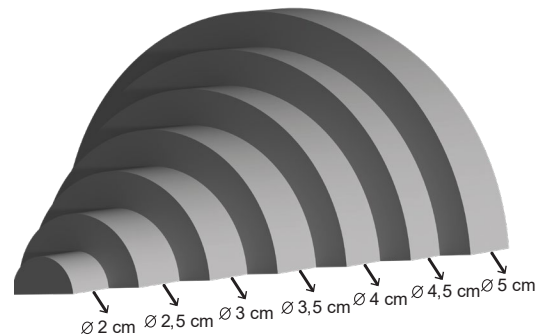
Measurand	Unit	Min.	Typ.	Max.
Tension	V	3	5	7
Temperature	°C	5	20	50
Humidity	%	10	35	80
Pencil's tone		2H	4B	4B

6. Specifications:

Pencil's tone	Unit	Min.	Typ.	Max.
2H	MΩ	400	5000	10000
H	MΩ	200	450	700
HB	MΩ	32	39	46
B	MΩ	9	15	21
2B	MΩ	2.2	3	3.8
4B	MΩ	0.8	1.0	1.2

7. Bench test:

With a shape like this one, one can test and plot the relative resistance variation with different pencil tones.



8. Typical signal amplifier:

