Low-tech Strain Sensor based on graphene particles

Main features

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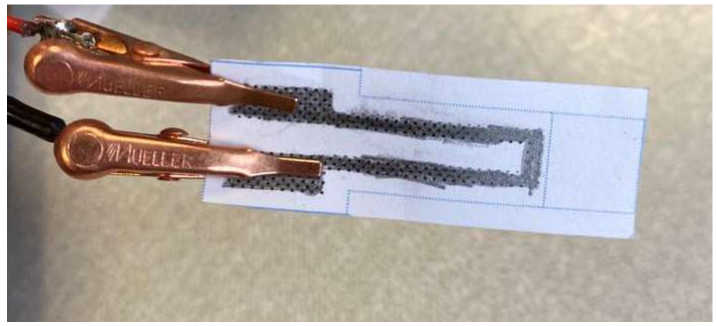
- Low-tech
- Easily replaceable
- Easy-to-use
- Low power consumption
- Low cost
- Small size



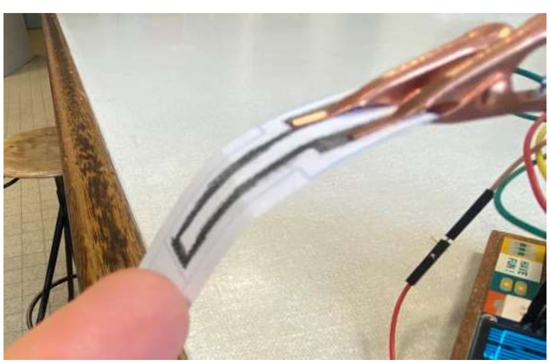
Description

This low-tech strain sensor consists of pencil marks on paper that can then be used as a gauge to detect compression and extension.

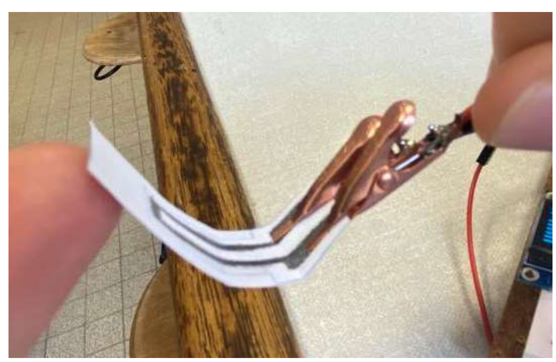
During the friction between the paper and the pencil lead, graphite particles remain attached to the paper fibres, organised in a fine granular conductive network. When the sensor and thus the network of graphite particles contracts or expands, the inter-molecular interactions change. This results in a change in the overall electrical conductivity.

It is this change in conductivity and therefore in resistance that we measure, allowing us to retrieve the value of the deformation.

Thus it is possible to produce strain sensors quickly and with easily accessible materials.



Sensor in tension mode

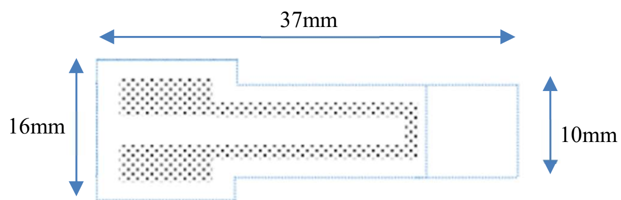


Sensor in compression mode

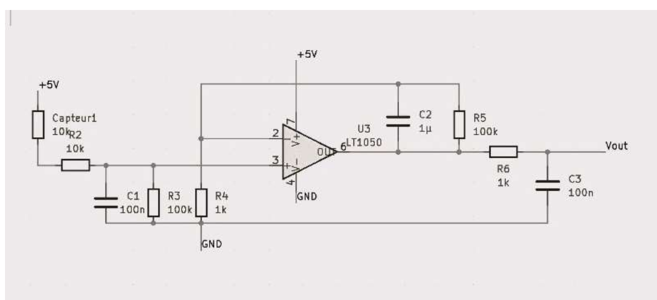
Specifications

Type	Strain Sensor
Sensing type	Passive Sensor
Materials	○ Paper ○ Graphite ○ Crocodile Clips
Power supply requirement	5V
Nature of output signals	Analog
Nature of measurands	Voltage

Dimensions



Example of integration



Above is an example of an integration circuit used to interface the strain sensor with an Arduino. The operational amplifier will convert and amplify a current proportional to the resistance of the strain sensitive element (here Capteur1) to a voltage signal, which will be read by the Arduino.

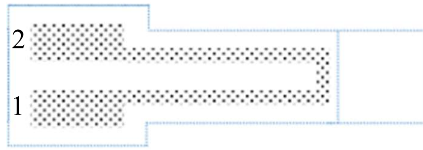
Use condition

Air quality	/	Normal air
Temperature	°C	20±2
Humidity	%	60±5

Pin connection

Vcapteur

Vcc



Disclaimer : *The sensor we use depends on the disposition of graphene particles on the sheet of paper, this can induce differences between each test due to :*

- *Graphene particles being removed by the clips*
- *Degradation of the sheet of paper*
- *Randomness of the particles disposition*

This implies that a calibration is needed before using the strain sensor.

Electrical characteristics

	Units	Values		
		Min	Typical	Max
HB	MΩ	-	50	150

In order to test our strain sensor, we used a 3D printed structure composed of circular arcs with different known curvature radius. We were able to retrieve the deformation using the following formula :

$$\varepsilon = \frac{e}{2 * r}$$

With e being the thickness of the paper sheet

On the next page you can find the characteristic graphs of the relative resistance of the sensor in function of its deformation, you will find two different graphs, one for the deformation in compression and one in tension.

WARNING : All the electrical characteristics in this datasheet correspond to a sensor made with an HB pencil, indeed using a different type of pencil would change the amount of graphene deposited on the paper, thus changing the sensor characteristics.

It would have been interesting to test our sensor with different kinds of pencil however due to a lack of time we were not able to do it and decided to focus on the HB paper

Characteristic graphs of relative resistance in function of the deformation