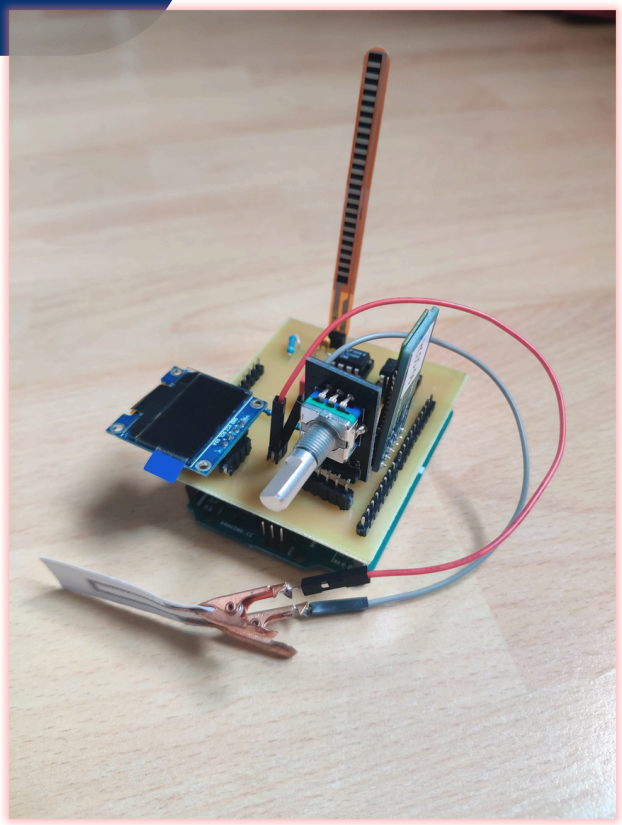
Low-Tech Graphite Flex Sensor

Tlili Maxime - Sisteedhur Lakshitaa - 4GP



General Description

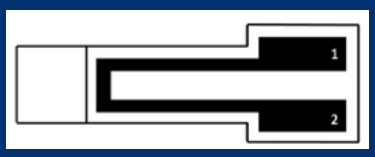
The sensor comprises a paper sheet coated with graphite, functioning as a strain gauge. It is based on the publication *Pencil Drawn Strain Gauges and Chemiresistors on Paper.*[1] When subjected to mechanical stress, the spacing between graphite particles alters, thereby impacting electrical resistance. Closer particles result in decreased resistance, while increased distance leads to higher resistance.
By gauging resistance levels, the strain gauge's deformation can be ascertained. The conductivity is influenced by various pencil grades (B, HB, 6B, 2B, H, 2H).

To read resistance values on an Android phone we use a transimpedance amplifier and Arduino Uno equipped with an OLED screen and Bluetooth module. These results can be compared with those obtained from a flex sensor to evaluate quality.

Main feature

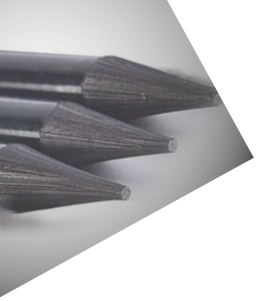
- Low-tech
- Low cost
- easy to fabricate
- easily transportable

Model

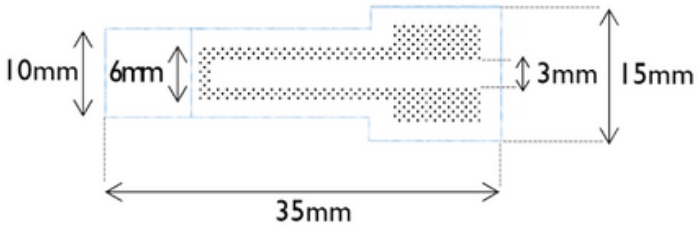


Pin 1	+5V
Pin 2	Vin

[1] Lin, C.-W., Zhao, Z., Kim, J. & Huang, J. Pencil Drawn Strain Gauges and Chemiresistors on Paper. Sci. Rep. 4, 3812; DOI:10.1038/srep03812 (2014).



Structure and dimension



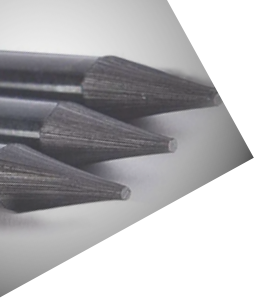
Specification

Type	Strain sensor
Materials	• Paper • Graphite
Compatibility	B, HB
Sensor type	Passive
Output signal	Analog
Measurand	deformation
Life cycle	10 to 15 usage

Recommended Operating Conditions

	MIN	TYP	MAX	Unit
Supply voltage	-	5	-	V
Operating Temperature	0	25	100	°C
Humidity	30	45	60	%

May cause permanent damage to the components outside the range



Electrical Characteristics

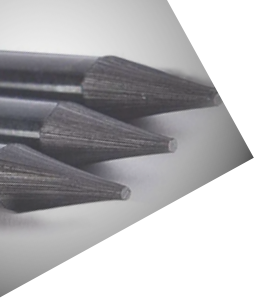
	MIN	TYP	MAX	Unit
Voltage	-	5	-	V
Sensor Resistance	0	25	100	MΩ
Output Current	-	100	-	nA
Output Voltage	0	x	5	V
Resistivity B	9	15	20	MΩ
Resistivity HB	2,3	3	4,2	MΩ

Physical properties

The deformation ε of the sensor is found with the formula below:

$$\varepsilon = \frac{\sigma}{E} = \frac{e}{2r}$$

The extent of deformation is contingent upon both the thickness (e) of the sensor sheet - set at 0.16mm corresponding to a sheet weight of 140g/m^2 - and the radius (r) of curvature for a circular shape.



Characteristics graph of resistance variation under deformation

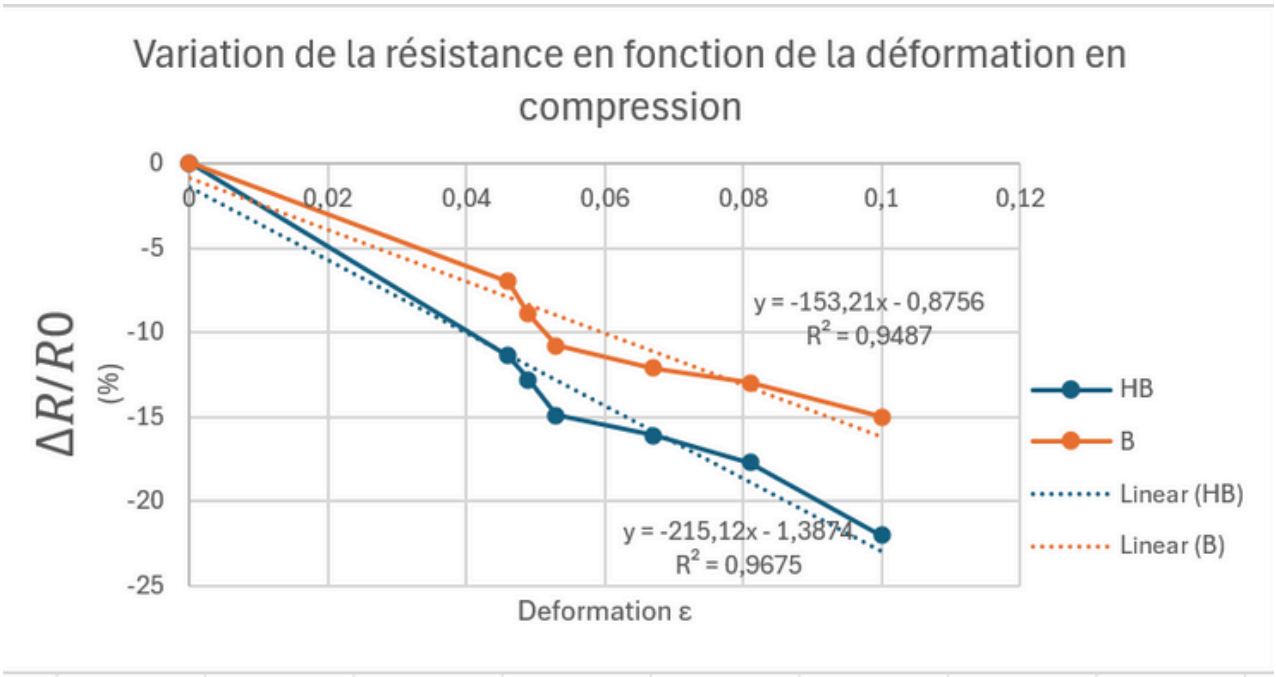


Fig A : characteristics in compression

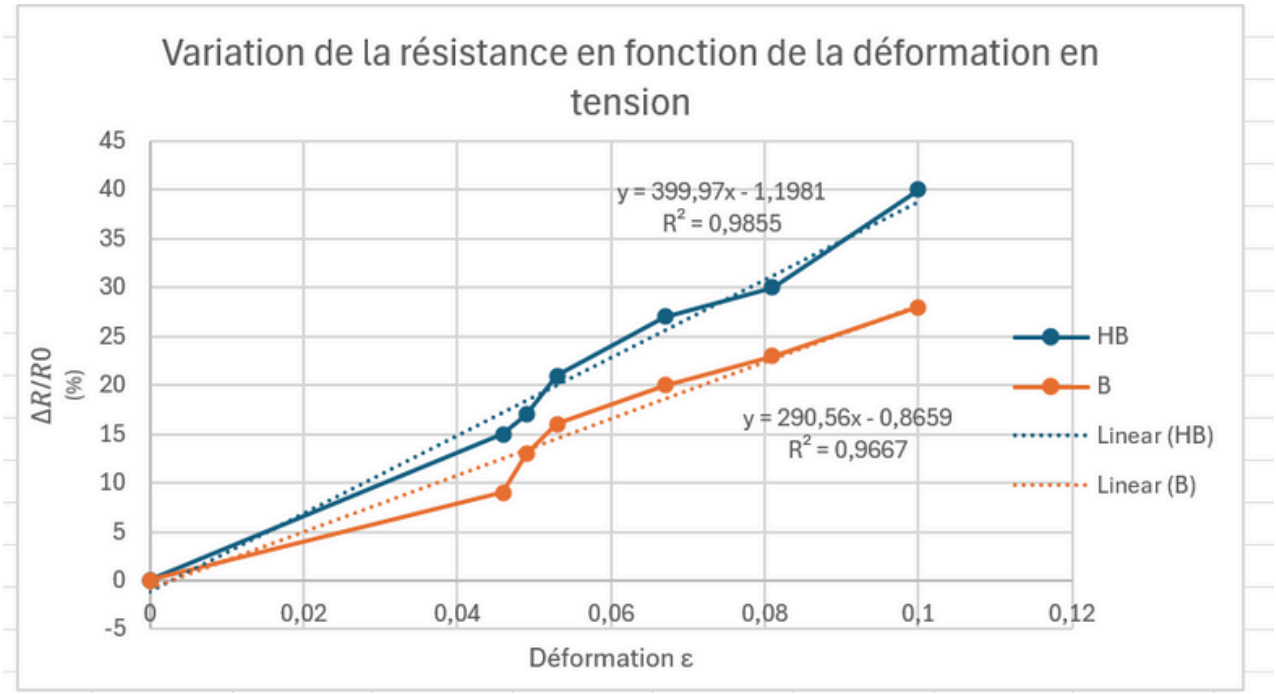


Fig A : characteristics in tension

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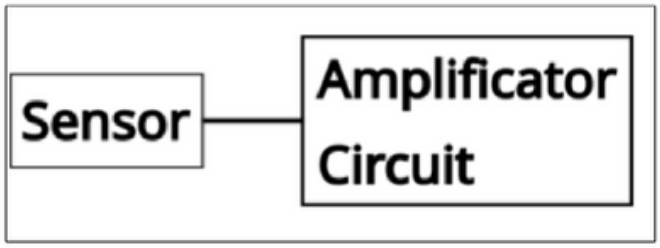
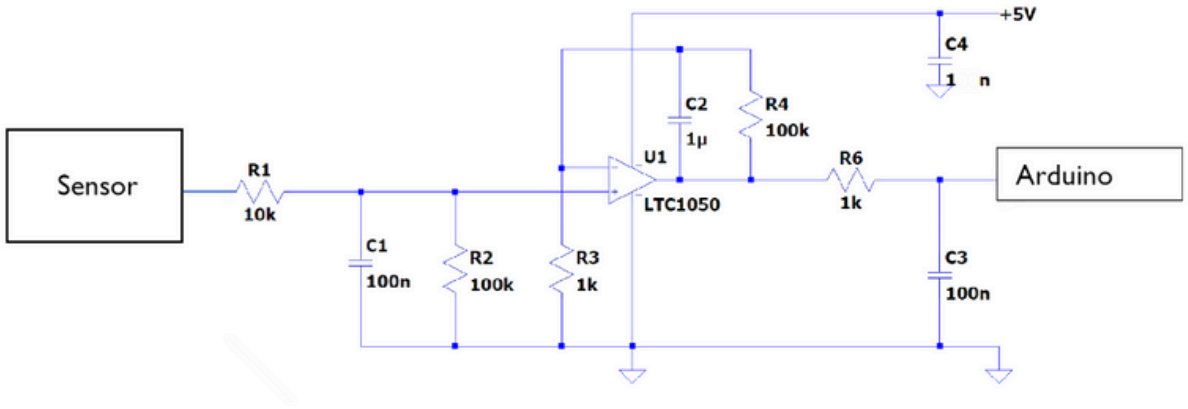
Example of integration



Simplified Schematic

Below is a sample integration circuit used for the connection of the strain sensor to an Arduino:



We employ a transimpedance amplifier circuit to both filter and amplify the signal originating from the sensor. The resistors R1 and R2 in conjunction with capacitor C1 filter current noise. Similarly, following the amplifier, there exists a low-pass RC filter designed to further diminish noise interference.