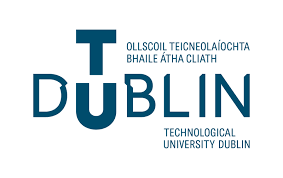
**

SCHOOL OF ELECTRICAL AND ELECTRONIC ENGINEERING

Bachelor of Engineering (Hons) BE in Elect/Cont/Comm/Comp Eng

Program Code: (DT021A)

<YEAR 4>

Name of Module: ([Solid-State Electronics, ELTR2603](https://brightspace.tudublin.ie/d2l/home/179100))

**TU Dublin – Grangegorman**

**Lab 3: IC Resistors**

Student Name: \_Talha Tallat, D18124645 \_\_\_\_\_\_\_\_\_\_\_\_\_\_

Academic Lecturer: \_Yuliya Semenova\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Submission Date: \_30th November 2021\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Table of Contents

[1. Laboratory Objectives 3](#_Toc89789046)

[2. Laboratory Procedure 3](#_Toc89789047)

[2.1. Polysilicon sheet resistance 3](#_Toc89789048)

[2.2. Thickness of Polysilicon Resistor 5](#_Toc89789049)

[2.3. Metal sheet resistance 7](#_Toc89789050)

[3. Conclusion 9](#_Toc89789051)

[4. References 9](#_Toc89789052)

Table of Figures

[Figure 1 - Layout of M3520 IC Resistor [1] 3](#_Toc89789788)

[Figure 2 - The Diffusion deposition of boron at for 2 minutes 5](#_Toc89789789)

[Figure 3 - System parameters 5](#_Toc89789790)

[Figure 4 - The Diffusion drive-in of Boran at 1100°C for 1200 minutes 6](#_Toc89789791)

[Figure 5 - System parameters 6](#_Toc89789792)

[Figure 6 - Layout of resistor R2 [1] 7](#_Toc89789793)

# Laboratory Objectives

This lab aims to cover the following key concepts introduced in IC Resistor:

* Structure of Integrated Circuit resistors.
* Calculating sheet resistance given the layout of a resistor and the measured resistance.
* Calculating resistivity of a material based on the simulations of the technological process of making an IC resistor.
* Observe and understand the structure of the integrated circuit (IC) resistor.

# Laboratory Procedure

## 2.1. Polysilicon sheet resistance

1. Calculating the polysilicon sheet resistance by counting the number of squares for the M3520 IC resistor as shown in the figure below. Assumed that the contact region at the end of the resistor count as one square each and using the effective number of squares for right-angle bends.

A picture containing text, shoji

Description automatically generated

Figure 1 - Layout of M3520 IC Resistor [1]

* 39 squares as counted.
* 4 corners right-angle bends
* 2 resistor ends

4 corner blocks are 0.56 each

2 resistor ends are 0.65 each

1. Calculating the sheet resistance of the polysilicon film using the following formula: , where is the number of squares in a resistor. Neglecting the contribution of the aluminium metal interconnects and polysilicon-aluminium ohmic contacts.

Rearranging the formula to find the sheet resistance .

Its measured resistance R1 = 48.7 k.

Using spacing between grid points which is 1.5 , to find the length of the resistor.

Subbing in calculated values to find sheet resistance.

## 2.2. Thickness of Polysilicon Resistor

1. Running the Mathlab Animations section 1.3.4 to visualize Diffusion Models and Process Simulation using the input data to simulate the diffusion process of the P-type polysilicon resistive body to observe and calculate the thickness of Polysilicon resistance.

Assume the following parameters: substrate material is N-type polysilicon, the concentration of donor atoms (phosphorous) Nd = 1e16cm-3, P-type polysilicon resistive body is created by the diffusion of boron (boron deposition at temperature 900 °C for 2 minutes followed by the drive-in at T = 1100 °C for 120 minutes).

Graphical user interface, bar chart

Description automatically generated

Figure 2 - The Diffusion deposition of boron at for 2 minutes

Graphical user interface, text, application

Description automatically generated

Figure 3 - System parameters

Graphical user interface, application, PowerPoint

Description automatically generated

Figure 4 - The Diffusion drive-in of Boran at 1100°C for 1200 minutes

Graphical user interface, application

Description automatically generated

Figure 5 - System parameters

1. Looking at the graph in the figure above the thickness of the polysilicon, resistor body is 1.9155

Using the value of to estimate the resistivity ρ of the P-type polysilicon, which was calculated to be .

## 2.3. Metal sheet resistance

Calculating the metal sheet resistance. Figure 2 shows a very long metal aluminium runner connecting to two bonding pads. The metal runner has resistance R2 = 580 Ω and given that the width of the runner is 3, therefore, the two decreasing spacing are wide.

Diagram, schematic

Description automatically generated

Figure 6 - Layout of resistor R2 [1]

Calculating the height of the spiral length which is decreasing every turn.

1519.5 – 6

= 1513.5 – 6

= 1507.5 – 6

= 1501.5 – 6

= 1495.5 – 6

**= 1489.5**

Calculating the width of the spiral length which is decreasing every turn.

1119 – 6

= 1113 – 6

= 1107 – 6

= 1101 – 6

= 1095 – 6

**= 1089**

Calculating the total lengths of the height

1519.5 + 1513.5 + 1507.5 + 1501.5 + 1495.5

= 7537.5

Multiplying total length by 2 due to the two sides

Calculating the total lengths of the width

1119 + 1113 + 1107 + 1101 + 1095

= 5535

Multiplying total length by 2 due to the two sides

5535

Adding all the lengths to calculate the total length of the resistor and we know strip from the small end contact square 76.3 and strip from large end to contact square 483 and two end contacts as one square 0.65 .

11070 +15075 + 1519.5 + 76.2 + 483 + 3 + 1.3

Rearranging the formula to find the sheet resistance .

Resistance R1 = 580 .

Subbing in calculated values to find sheet resistance.

# Conclusion

The resistance decreases as the length of the polysilicon resistor increases and the total resistance are proportional to the number of squares, where is the number of squares in a Polysilicon resistor.

# References

**[1]** "Lab 3: IC Resistors", Semenova, Y., 2021. [Online]. [Accessed: 23- Oct- 2021]