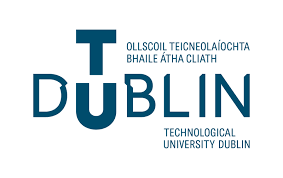
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**TU Dublin – Grangegorman**

**Lab 3: IC Resistors**

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# 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 of 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 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. Assume that M3520 polysilicon resistor is created using technique described in the Appendix (section 2). Assume the following parameters: substrate material is N-type polysilicon, the concentration of donor atoms (phosphorous) Nd = 1016cm-3, P-type polysilicon resistive body is created by diffusion of boron (boron deposition at temperature 900 0C for 2 minutes followed by the drive-in at T = 1100 0C for 120 minutes). Run the “Interactive Mathlab Animations for Understanding Semiconductor Devices”, section 1.3.4: “Visualization of Diffusion Models and Process Simulation” on your PC. Using all the input data given above simulate the diffusion process of the P-type polysilicon resistive body (present the simulated graph showing dopant concentration versus the depth in your lab report).
2. From the graph determine the thickness xj of the polysilicon resistor body.
3. Using the value of xj found in the previous section estimate the resistivity ρ of the P-type polysilicon.

## 2.3. Metal sheet resistance

Calculating the metal sheet resistance. Figure 2 shows a very long metal aluminium runner connecting to two bonding pads. 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

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Figure 2 - 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.

# 3. Conclusion

After conducting the lab experiment, the resistance decreases as the length of the polysilicon resistor increases.

# 4. References

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