Resistance with Different Cross-Sectional Area

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1 Aim

The aim is to determine the relationship of electrical resistance of a metal rod to cross-sectional area.

2 Apparatus

See lab sheet.

3 Procedure

See lab sheet.

4 Data Collection

Category	#1	#2	#3	#4
rod length L [cm]	25	25	25	25
rod diameter d [cm]	2.38	3.18	3.97	4.76
voltage given [V]	0.1	0.1	0.1	0.1
voltage from meter V [V]	2.9×10^{-3}	1.7×10^{-3}	1.0×10^{-3}	8.0×10^{-4}
current from meter I [A]	0.71	0.728	0.68	0.72
*cross sectional area A [cm^2]	4.4488	7.9423	12.3786	17.7952
*resistance R [Ω]	4.084×10^{-3}	2.335×10^{-3}	1.471×10^{-3}	1.111×10^{-3}
*resistivity ρ [$\Omega\,\mathrm{cm}^{-1}$]	1.16×10^{-4}	6.8×10^{-5}	4.0×10^{-5}	3.2×10^{-5}

Table 1: Data Collected

*: data is calculated instead of measured, where specifically

$$\text{cross sectional area } A\ [\mathrm{cm}^2] = \pi(\frac{d}{2})^2$$

resistance $R\ [\Omega] = \dfrac{V}{I}$

resistivity $\rho\ [\Omega\,\mathrm{cm}^{-1}] = \dfrac{RA}{L}$

5 Data Analysis

5.1 Resistance R

By using V voltage from meter, and I current from meter, we can calulate the resistance by using

$$R = \frac{V}{I}$$

Hence we can graph such data as below.

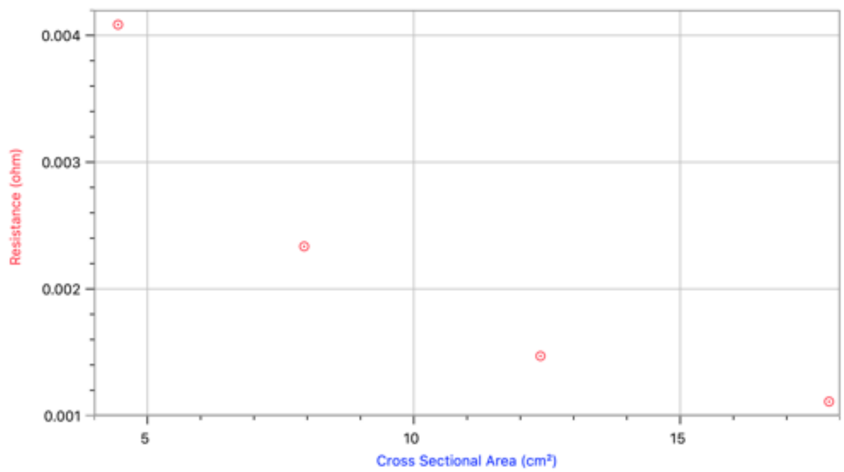

Figure 1: Resistance vs. Cross-sectional Area

That looks like it is having a Inverse Proportionality! Let's linearize it by setting the X-axis value (which at here represents the Cross Sectional Area) to $\frac{1}{x}$

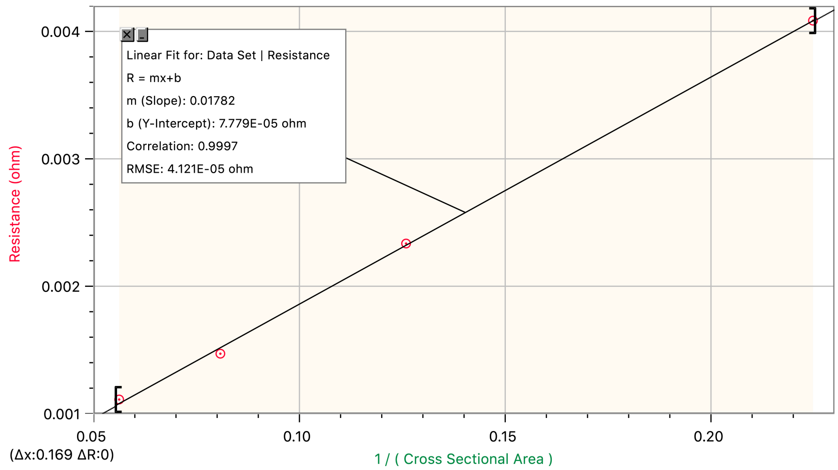

Figure 2: Resistance vs. $\dfrac{1}{\text{Cross-sectional Area}}$ (Figure 1 Linearized)

5.2 Resistivity ρ

We know that resistivity equals to

$$\rho = \frac{RA}{L}$$

So that its unit then can be derived as

$$\rho = \frac{[\Omega] \cdot [\text{cm}^2]}{[\text{cm}]} = [\Omega \cdot \text{cm}]$$

Such value has been calculated and filed in Table 1

5.3 Collaboration

By working with some other groups who did the similar experiment but they changed the types of metal or length of metal instead of the diameter of metal like what we did, we have some other finding that:

- As the **length** *increased*, R has also increased.
- Different types of metal have significant difference on R, which Stainless Steel has the highest R across their testing, and Cooper hsa the lowest R.

6 Conclusion

By investigating the relationship between R and A we could see that they are having an inverse proportionality: as A goes higher, R becomes smaller. This is because that there are more rooms for the electrons to path though, hence lower the R. By involving resistivity ρ we could link the three factors, R, L and A together. Also, by collaborating with other groups we found that as L increases R also increases (due to longer distance to travel hence more 'restriction', R), and different types of metal can have significant difference on R, specifically R is the one has smallest R, which is why it has been widely used across the IT industry due to its insignificant power loss.