Experiment 5
Experiment 5-A : Resistivity and Conductivity of Metals

Objectives

To determine the resistivity and conductivity of different metal alloys, and compare the obtained values with tabulated standard values.

Theory

One way of classifying solid materials is according to the ease with which they conduct an electrical current, namely, their *electrical conductivity*. Accordingly, there are four groups of materials; *insulators, semiconductors, conductors,* and *superconductors.* The relationship between the electrical current (I), voltage (V), and resistance (R) is described by Ohm's law

$$V = I\,R$$

Where the SI units for V, I and R are volts (V), amperes (A=C/s), and ohms (Ω) respectively.The value of R is dependent not only on the specimen material but also on its geometry, and thus cannot be considered a pure property of material. The resistance can be made a pure material property by normalization with respect to the sample dimensions. Thus, material *resistivity* ρ (Ω.m) can be defined as:

$$\rho = \frac{R \times A}{L}$$

where A is the sample cross sectional area and L is the sample length.
The *electrical conductivity* (σ),is simply the reciprocal of the resistivity:

$$\sigma = \frac{1}{\rho}$$

Apparatus

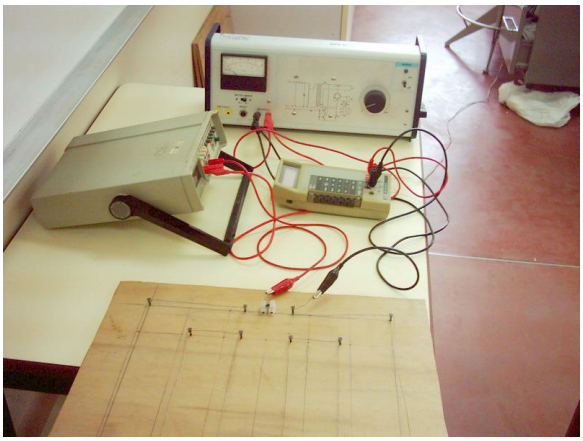

Figure 5A-1 Experimental set up used in resistivity measurements

1. DC power supply.
2. 2 Digital multimeters (or a voltmeter and an ammeter).

3. A limiting resistor.
4. Caliper or micrometer (recommended).
5. Two different metal wires, 3m long.
6. Crocodile clip ended connecting leads.

Procedure

The procedures for the determination of metal wires resistivity and conductivities are as follows:

1. You will be provided with two metal wires. Label the two wires as wire A and B.
2. Using a connection board, similar to that shown in Fig.5A- 2, connect only the limiting resistor to the connecting leads.
3. Connect the power supply across the resistor and one of the multimeter or the voltmeter across the power supply. Also, connect the second multimeter or the ammeter in the circuit loop as illustrated in Fig. 5A- 2.
4. Switch the power supply ON and adjust its output such that the voltmeter reads 1V output. Observe the ammeter reading and record it in Table 5A-1.

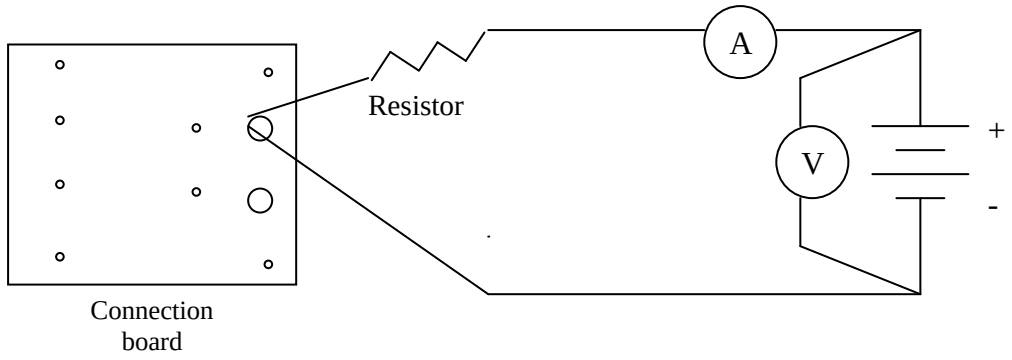

Figure 5A-2 Schematic illustration of resistance measurement of circuit assembly without a wire.

Table 5A- 1

Metal wire	Wire length (m)	Wire diameter (m)	Measured Current, I (A)		Calculated circuit resistance, R (W)		Calculated wire resistance R_{wire} (W)	Metal resistivity r (W.m)
			no wire	with wire	no wire	with wire		
A								
B								

5. Switch ON the power supply and adjust its output such that the voltmeter reads 1V output. Observe the ammeter reading and record it in Table5A-1.
6. The applied circuit voltage of 1V and the measured current represent the total resistance of the power supply, the limiting resistor, and the connectors. Calculate the circuit resistance and record the result in Table 5A-1.
7. In the following procedures, make sure that the same connectors used in the previous part are used too.
8. Now, for the wire labeled A measure its diameter using the caliper and enter your reading in the corresponding cell in Table 5A-1.
9. Using the same wire, assemble the circuit shown in Fig. 5A- 3, leaving the power supply OFF with one terminal unconnected. Consult the lab demonstrator for proper connections of the voltmeter and the ammeter.
10. Measure the active wire length while connected to the circuit assembly and record your measurement in Table 5A-1.
11. Connect the open power supply terminal to the circuit assembly and switch it on. Connect the voltmeter across the power supply and adjust its output to 1 V. Observe the ammeter reading record the current through the circuit in Table 5A-1.
12. From the applied circuit voltage of 1V and the current measurement in 11, calculate the total circuit resistance with the wire and record the result in Table .1.
13. Calculate the wire resistance from the difference in the measured circuit resistance with and without the wire. Record the result in Table 5A-1.
14. Repeat steps 7–13 for wire B.

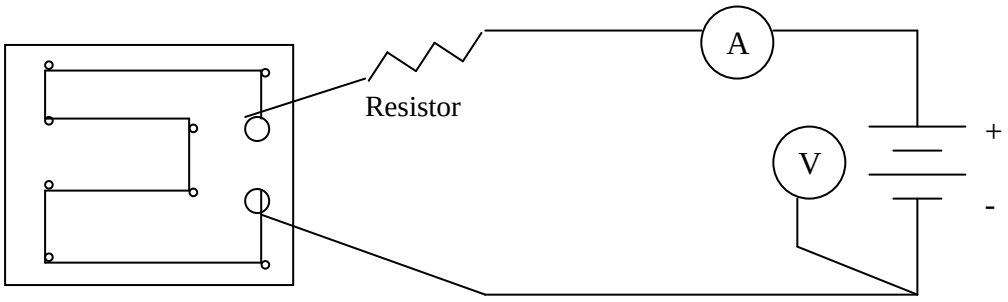

Fig.5A-3: Schematic illustration of resistance measurement of circuit assembly with a wire.

Data Analysis

From the results obtained in the previous steps calculate the resistance R of wires A and B using the measured length L and the diameter d. From the resistance R, the values of the resistivity, and hence the conductivity can be calculated.

Discussion and conclusions

Write a concise account of the experiment and the results obtained.