

MT: 105 Electrical and Electronic Materials

Tutorial 3

1. a Treating electron as a particle and applying classical mechanics, derive Ohm's law using Drude's Model of classical theory.

b State the assumptions and limitations of this model.

2. a Explain with neat sketches the microscopic processes that cause the scattering of electrons in metals.

b How does the scattering affect the electrical conductivity, σ that is equal to $en\mu_d$?

3. Calculate and compare the drift mobility of free electrons in case of Ag and Cu at room temperature (20°C). Given:

Element	Atomic Mass	Conductivity	Density
Ag	107.8 g/mol	$6.3 \times 10^5 \Omega^{-1}\text{cm}^{-1}$	10.49 g/cm ³
Cu	63.5 g/mol	$5.9 \times 10^5 \Omega^{-1}\text{cm}^{-1}$	8.96 g/cm ³

4. a What is lattice – scattering- limited resistivity?

For pure metal derive an expression, $\rho_T = AT$

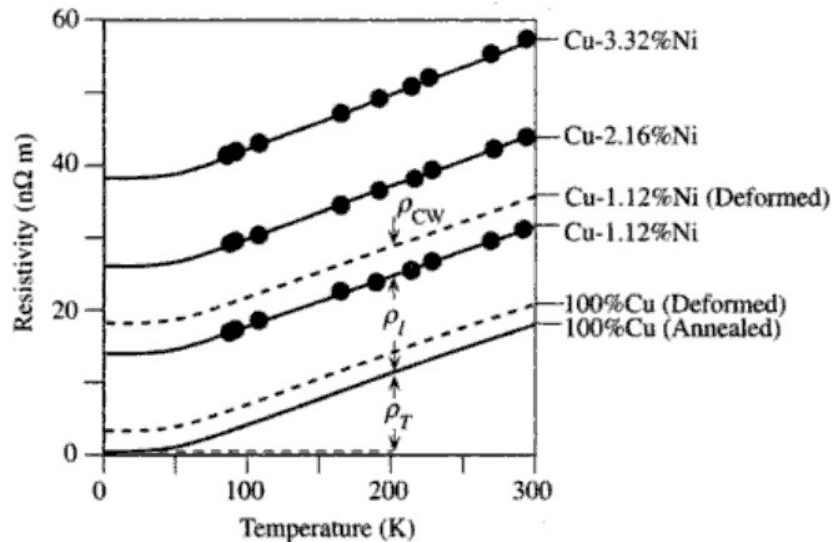
b Calculate the % change in the electrical resistance of a pure metal wire between winter (5°C) and summer (40°C). Neglect the changes in the dimensions of the wire.

c How will the out-door cable power losses be affected?

d Connecting cable for your experimental set-up when given Ag, Cu and Al wires, which one would you prefer? Justify your answer.

5. a What is the significance of **Mathiessen's** rule used for finding ρ of metals and alloys?

- b Explain the typical resistivity, ρ versus temperature (absolute) behavior for the given copper alloys containing various amounts of nickel, pure copper sample that is annealed and two samples that are cold- worked (deformed) to give same amount of plastic deformations.



6.
 - a What is the composition of nichrome?
 - b Why nichrome is widely used as a heater wire in house hold and industrial furnaces?
 - c What is Nordheim's rule? State the limitations of this rule.
 - d What is the significance of Nordheim's coefficient? Why it is modified to taken into account of solid solutions with higher concentrations?
 - e For low voltage dc electrical appliances, the alloy Au-15 wt. %Cu is used. Calculate the resistivity of the alloy. Given : Nordheim's coefficient ,C when Cu is dissolved in Au to form solid solution is, 450 $\text{n}\Omega \text{ m}$.
7.
 - a Show with neat sketches, the effective resistivity of composite materials, i) along a direction perpendicular to the layer, ii) along a direction parallel to the plane of the layer and iii) material with dispersed phase in a continuous matrix.
 - b. For a binary alloy system with partial solid solubilities (i.e. having two terminal solid solutions) estimate the nature of resistivity behavior with concentration. Show with neat sketch taking an example.
8.
 - a What is Hall effect? Give an example of a material used for a particular application.
 - b Explain how the conduction occur in ionic crystals and glasses in an applied electric field.
 - c Compare the electrical conductivity with the thermal conductivity of metal.