Superconductivity

In 1911 Kamerlingh Onnes first observed the phenomena of superconductivity during his experiments on the electrical resistivity of many metals and alloys at sufficiently low temperatures .

The study of variation of resistance of mercury with temperature is to be observed .

It concludes that the resistance falls sharply near 4.2 K and vanished completely below this temperature .

The resistance is small and finite above this temperature but this temperature it becomes zero .

Hence the phenomenon in which the electrical resistivity of the material suddenly falls to nearly zero when it is cooled to a very low temperature is known as superconductivity .

Critical Temperature (T_C) :

The temperature at which the material undergoes a phase transition from a state of normal conductor to superconductor is known as critical temperature .This is also called transition temperature .

The superconductivity can be explained by free electron model as follows :The resistivity of a metal is given by

$$\rho = m / ne^2 \tau \qquad (1)$$

Where m = mass of an electron

e = charge of an electron

n = number of electron per unit volume

and τ = collision time

As the temperature decreases the variation of the ions in a crystal decreases. Thus the probability of an electron – ion collision decreases or we can say that collision time τ increases or temperature decreases .

From (1) we can also say that ρ tends to zero. Thus the resistivity vanishes completely for infinite value of τ at sufficiently low temperatures.

When the temperature of the specimen is below the critical temperature T_C , the major part of electrons have infinite collision time and they become superconducting . The scattering is not possible for these electron even the material may contain some impurities .Thus these electrons are the cause of superconductivity .