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LAB REPORT – V
SEEBACK EFFECT

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Objective: identifying type of semiconductor using Seeback effect.

Seebeck Effect:

• The Seebeck effect is a phenomenon in which a temperature difference between two dissimilar electrical conductors or semiconductors produces a voltage difference between the two substances.

• When heat is applied to one of the two conductors or semiconductors, heated electrons flow toward the cooler one. If the pair is connected through an electrical circuit, direct current (DC) flows through that circuit.

• The voltages produced by Seebeck effect are small, usually only a few microvolts (millionths of a volt) per kelvin of temperature difference at the junction.

• If the temperature difference is large enough, some Seebeck-effect devices can produce a few millivolts (thousandths of a volt). Numerous such devices can be connected in series to increase the output voltage or in parallel to increase the maximum deliverable current.

• Large arrays of Seebeck-effect devices can provide useful, small-scale electrical power if a large temperature difference is maintained across the junctions.

Explanation of Seebeck Effect

• The valence electrons in the warmer part of metal are solely responsible for that and the reason behind this is thermal energy.

• Also because of the kinetic energy of these electrons, these valence electrons migrate more rapidly towards the other (colder) end as compare to the colder part electrons migrate towards warmer part.

• At hot side Fermi distribution is soft i.e. the higher concentration of electrons above the Fermi energy but on cold side the Fermi distribution is sharp i.e. we have fewer electrons above Fermi energy.

• Electrons go where the energy is lower so therefore it will move from warmer end to the colder end which leads to the transporting energy and thus equilibrating temperature eventually

In simple words we can come to conclusion that the electrons on a warmer end have a high average momentum as compared to the colder one. Therefore they will take energy with them (more in no.) as compared to the other one.

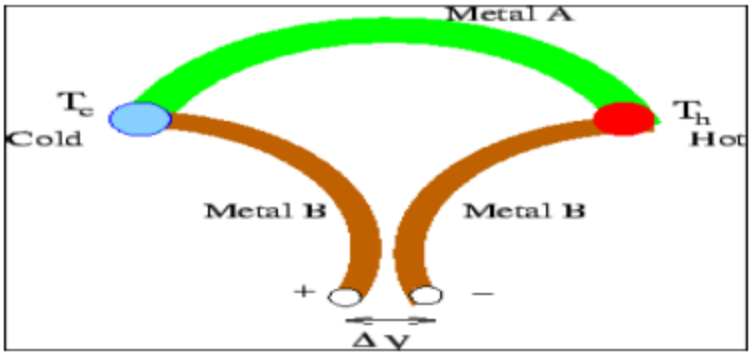
This movement results in the more negative charge at colder part than warmer part, which Leads to the generation of electrical potential. If this pair is connected through an electrical circuit. It results in the generation of a DC.

However the voltage produced is few microvolt (10-6) per Kelvin temperature difference. Now we all are aware of the fact that the voltage increase in series and current increase in parallel.

So keeping this fact in mind if we can connect many such devices to increase the voltage (in case of series connection) or to increase the maximum deliverable current (in parallel). Keeping care of only one thing that a large temperature difference is required for this purpose.

However one thing must keep in mind that we have to maintain constant, but different temperature and therefore the energy distribution at both the end will be different and hence it leads to the successful mentioned process.

$$\Delta V = S_{AB}(T_h - T_c)$$



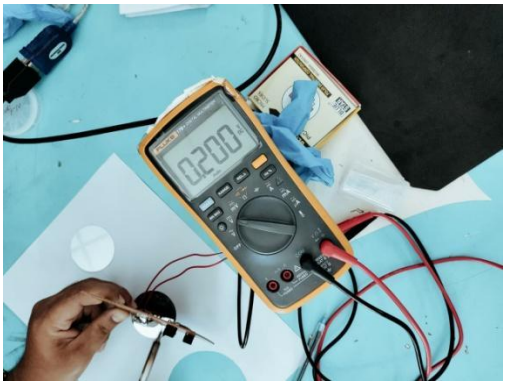
The open circuit potential difference in the circuit whose junctions are maintained at temperatures and is given by where the coefficient of proportionality is known as the thermoelectric power or the Seebeck coefficient. The term thermoelectric power is a misnomer because it does not measure any power and is measured in volt/ K. By convention, Seebeck coefficient's sign is the sign of the potential of the cold end with respect to the hot end.

Steps for Seeback experiment:

1. Take a Si semiconductor sample.
2. Apply heat with the help of electric RN solder. This heat wire is connected to positive terminal (Red) of multimeters.
3. Create contact with cold point on the semiconductor (room temperature) negative terminal of the multimeter.
4. We can find in multimeter positive voltage for p-type substrate. If the sample is n-type we can observe negative voltage in the multimeter.

Results : positive voltage measured it indicates taken sample is p-type

why ?



Negative voltage measured it indicates taken sample is n-type.

why ?