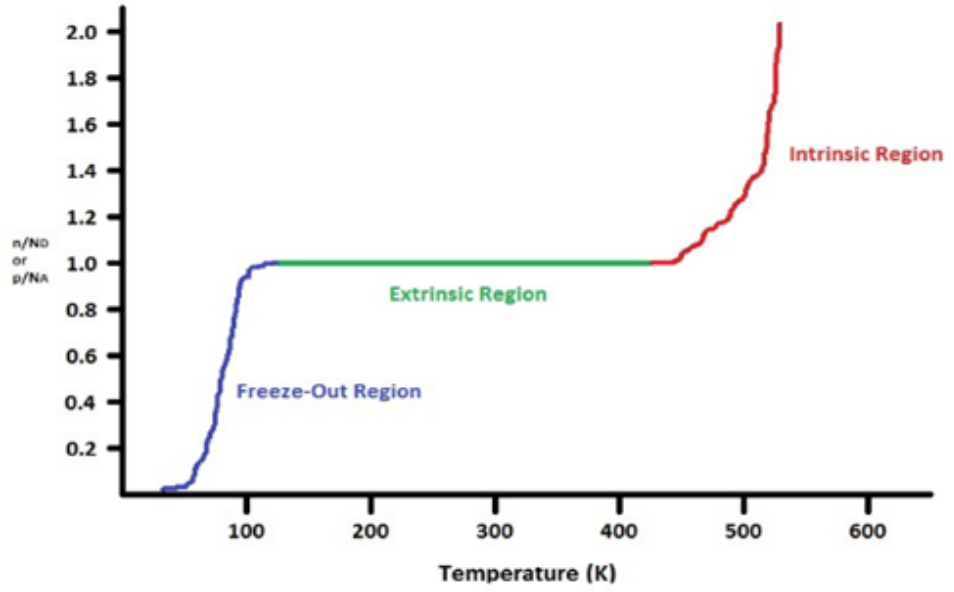
Subject : Engineering Physics

Question : One graph no. of free electron Vs temperature .Sir i want to know that how it act as extrinsic firstly then intrinsic at high temperature how??

Answer :



Temperature dependence of the majority carrier concentration in a semiconductor.

The graph clearly demonstrates the phases an extrinsic semiconductor's majority carrier goes through at high temperatures. In n-type semiconductor, the beginning of the Freeze-Out Region represents the area where the donor ions are situated at the donor level, but the free electrons are unable to move due to the 0 Kelvin temperature.

As the temperature increases, a few of the donor electrons get excited into the conduction band while others are still impeded due to the ionized impurity scattering, which decreases the overall mobility of the electrons.

As the temperature starts increasing toward the Extrinsic Region, the effect of ionized impurity scattering slowly fades away, increasing the electron mobility, and the amount of electrons being promoted from the donor level to the conduction band increases even more. At this point, a minimal amount of the intrinsic electrons are promoted from the valence band (however this is still considered as a negligible effect).

Since conductivity directly depends on electron mobility and the concentration of electrons in the conduction band, which increases with increasing temperature, the conductivity also increases. Here all the donor level electrons are excited into the conduction band and neither scattering effect is prominent, which means that the conductivity increases even more.

Meanwhile, a few more intrinsic electrons from the valence band are promoted into the conduction band, yet this is still negligible compared to the concentration of donated electrons.

As the temperature proceeds into the Intrinsic Region, intrinsic electrons from the valence band are excited into the conduction band at a faster rate and the conductivity continues to increase. (since the electron concentration is more important, conductivity still increases even as mobility begins to decrease).

At extreme temperature, the electrons from the valence band are promoted into the conduction band and create holes in the valence band. As this continues, the n-type semiconductor essentially becomes an intrinsic semiconductor, with all the intrinsic electrons now in the conduction band and the equivalent amount of holes left behind in the valence band.