IMPACT IONIZATION IN InP AND GaAs

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The impact ionization rates for holes, β, and for electrons, α, in both InP and GaAs will be discussed. In InP the impact ionization rate for holes is greater than that for electrons. This is true for electric fields oriented in both the <100> and the <111> directions. It might be expected that the electron ionization rate would be suppressed along the <111> direction because the first conduction band is so narrow that there are no states in this direction with energies high enough for impact ionization. However, there is no experimentally observed difference in the ratio β/α between the <100> and the <111> directions. This indicates that the electrons undergo several scattering events that randomize the momentum vector before reaching the threshold for impact ionization. These results have been confirmed by Monte Carlo calcuations.

In GaAs , in the <100> direction, the ratio of α to β is experimentally found to be greater than one, in contrast to InP. This is true for temperatures from 77 K to room temperature. This difference can be explained in terms of the ionization threshold energies and the density of states. The ionization threshold energies for both holes and electrons are the same in GaAs whereas in InP the hole threshold energy is smaller than the electron threshold energy. The density of states in the valence and conduction bands would tend to make the electron rates greater than the hole rates in both materials. Because of the equal threshold energies α is greater than β in GaAs; however, in InP, the smaller hole threshold energy causes β to be greater than α.