PRINCIPAL PROPERITIES OF SEMICONDUCTORS IN PHYSICS

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Abstract: *Today, in our country, as well as in the whole world, great attention is being paid to the development of the field of physics. Special attention is being paid to the physics of semiconductors, which is one of the important fields of physics, and its development. This article focuses on the main, essential properties of semiconductors. Brief information about them is given.*

Key words: *Semiconductors, Thermal resistance, devices, electrical network, electrons.*

Absrtakt: *Bugungi kunga kelib yurtimizda, shuningdek butun jahonda fizika sohasi rivojiga juda katta e'tibor qaratilmoqda. Fizikaning muhim sohalaridan biri bo'lgan yarimo'tkazgichlar fizikasiga, uni yanada rivojlantirishga alohida e'tibor berilmoqda. Ushbu maqolada yarimo'tkazgichlarning asosiy, muhim xossalariga to'xtalinib o'tilgan. Shuningdek ular haqida qisqacha ma'lumotlar keltirilib o'tilgan.*

Kalit so'zlar: *Yarimo'tkazgichlar, issiqlikka chidamlilik, qurilmalar, elektr sistema, elektronlar.*

In applications requiring wide ambient temperature ranges, compact form factors, limited airflow, or high power dissipations, thermal design can pose a significant challenge. The basic concepts behind heat transport and thermal modeling are very straightforward, and device datasheet parameters and thermal response curves provide valuable tools to estimate device junction temperatures. Steady−state, transient, and periodic power inputs can all be modeled, and the results allow for accurate estimation of resulting temperatures and heat sinking requirements. In addition, thermal models can be used to assess the likelihood of thermal runaway and to demonstrate the thermal stability of a design.

Three basic processes govern the removal of heat from the rectifier junction to the ambient air: conduction (heat traveling through a material); convection (heat transfer by physical motion of a fluid); and radiation (heat transfer by electromagnetic wave propagation). Heat flows by conduction from the die to the package mounting surface in stud−, base−, or surface−mount pads, but it flows from the die through the leads to the mounting terminals in a lead−mounted part. This thermal conduction can be modeled and designed for, so that the devices in question do not exceed their maximum junction temperatures. Steady state, periodic and transient thermal conditions can all be modeled and solved, allowing the design to maintain proper thermal operating points, ensure device lifetimes and prevent thermal runaway.

Thermal resistance may be used to form simple models to compute steady state operating temperatures for a circuit under DC or periodic conditions. With the addition of thermal capacitance, transient conditions may also be accurately modeled. The results depend on the operating conditions, including power consumption (heat generation), mounting methods, airflow and ambient temperatures. Nevertheless, the concept provides a very valuable tool for handling thermal problems.

Using a thermal model, complex thermal systems may be easily analyzed using electrical network theorems, including ohm’s law, Thévenin’s theorem, Norton’s theorem and superposition. These techniques may be applied to case–mounted and lead–mounted devices, with one or more active die, under constant, periodic, and transient conditions.

In addition, some devices may have material inserted between the die and the package to reduce stress or provide electrical insulation. Differing coefficients of thermal expansion between the die and the case can require an extra material at the interface to relieve the stress, allowing a hard solder die attachment technique and improving temperature cycling behavior. In some packages, the package exterior is typically electrically connected to the die, and these parts may be manufactured with insulation inserted between the die and the

package to prevent this connection. These materials, if present, add another component to the thermal resistance of the assembly.

Semiconductors can be classified as:

1. Intrinsic Semiconductor.

2. Extrinsic Semiconductor.

Extrinsic Semiconductors are further classified as:

1. n-type Semiconductors.

2. p-type Semiconductors.

Intrinsic Semiconductor :

Semiconductor in pure form is known as *Intrinsic semiconductor*

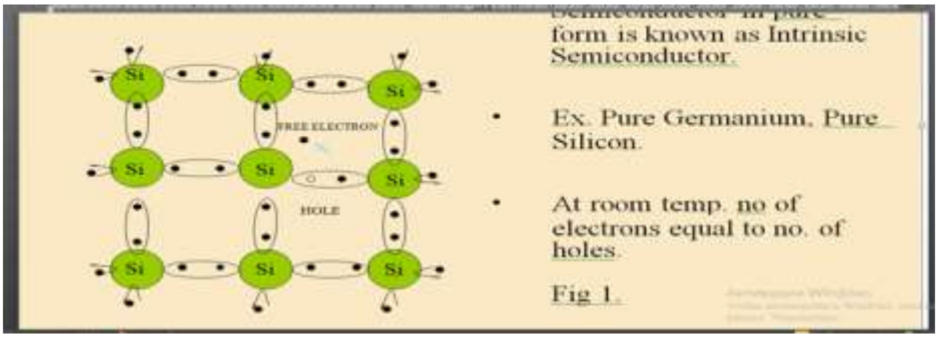
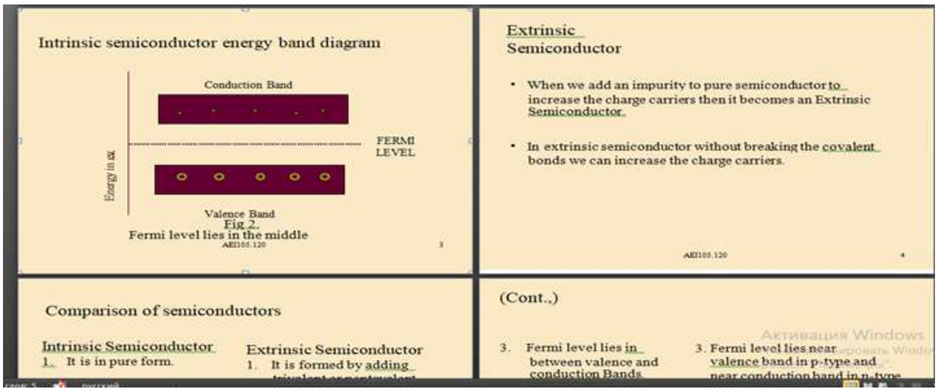


Figure 1.

Intrinsic semiconductor energy band diagram:



Extrinsic Semiconductor*:*

When we add an impurity to pure semiconductor to increase the charge carriers then it becomes an Extrinsic Semiconductor.

In extrinsic semiconductor without breaking the covalent bonds we can increase the charge carriers.

N-type

- Pentavalent impurities are added.
  - Majority carriers are electrons.
  - Minority carriers are holes.
  - Fermi level is near the conduction band.

P-type

- Trivalent impurities are added.
  - Majority carriers are holes.
  - Minority carriers are electrons.
  - Fermi level is near the valence band.

The datasheets for most discrete semiconductors will state the minimum and maximum operating and storage temperatures for the device; for rectifiers this is usually from −65C up to 150C or 175C. While it is possible to operate a device at the maximum junction temperature for a short time, this parameter is the peak temperature the junction of the device can operate at. The normal operating point of the device junction in the application should be designed at a lower temperature. Operating a device at the maximum temperature risks failure from a transient thermal spike, and reduces the device lifetime. Thermal resistance denotes the resistance along a specific path. When using true thermal resistances all paths must be taken into account to compute power and temperature relationships. There is a related set of characterization parameters that denote the relationship between power dissipation and temperature, ignoring path dependent relationships. Computationally, they are nearly identical to thermal resistance values.

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