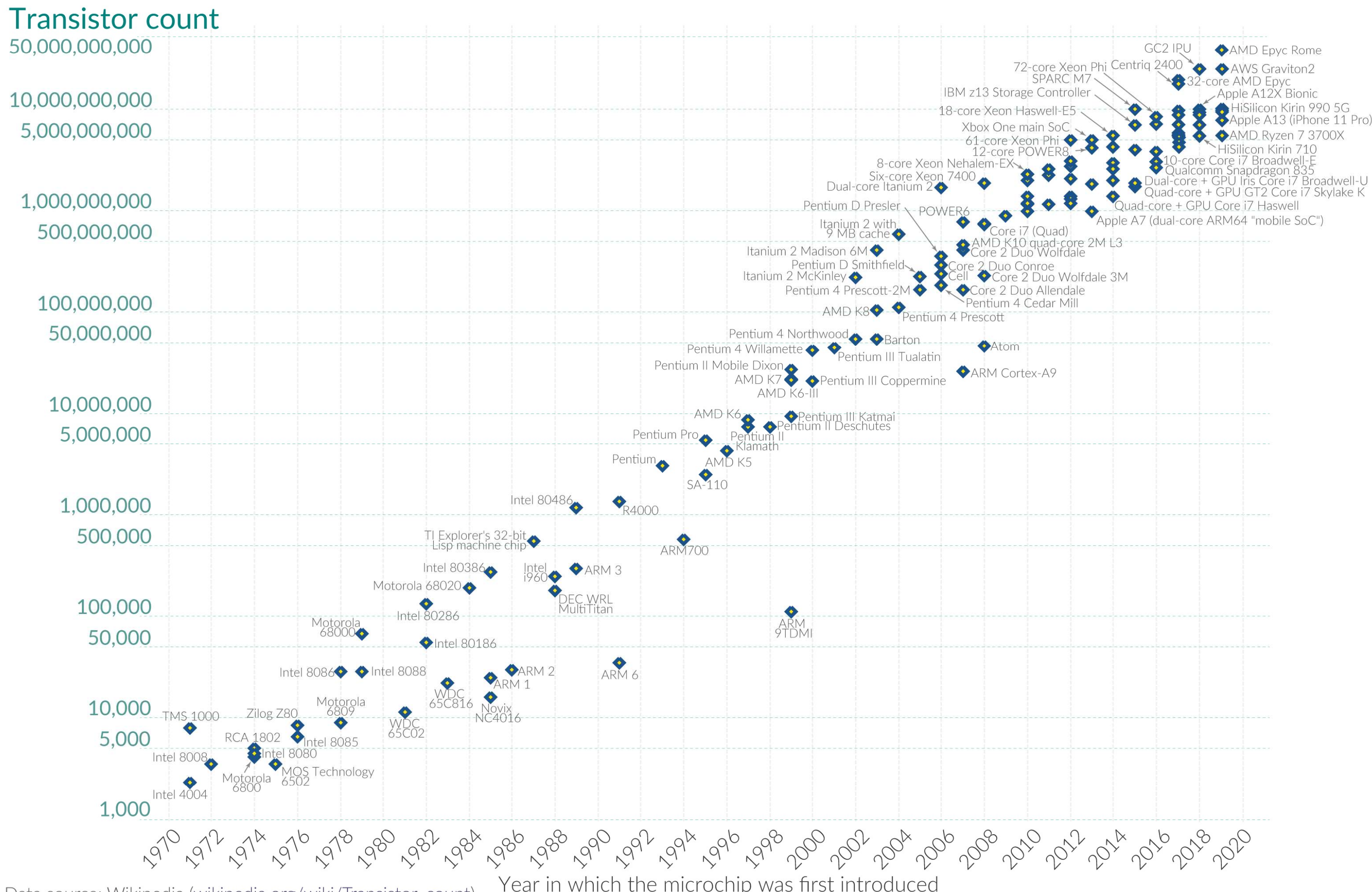
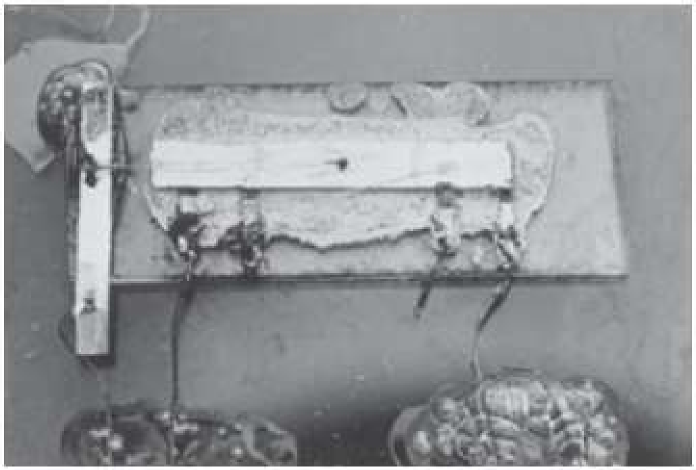
Moore's Law: The number of transistors on microchips doubles every two years

Our World in Data

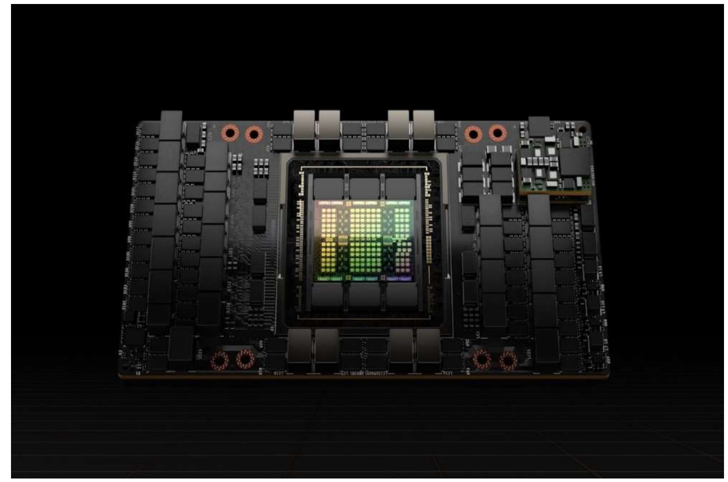
Moore's law describes the empirical regularity that the number of transistors on integrated circuits doubles approximately every two years.
This advancement is important for other aspects of technological progress in computing – such as processing speed or the price of computers.



Data source: Wikipedia (wikipedia.org/wiki/Transistor_count)
OurWorldinData.org – Research and data to make progress against the world's largest problems.



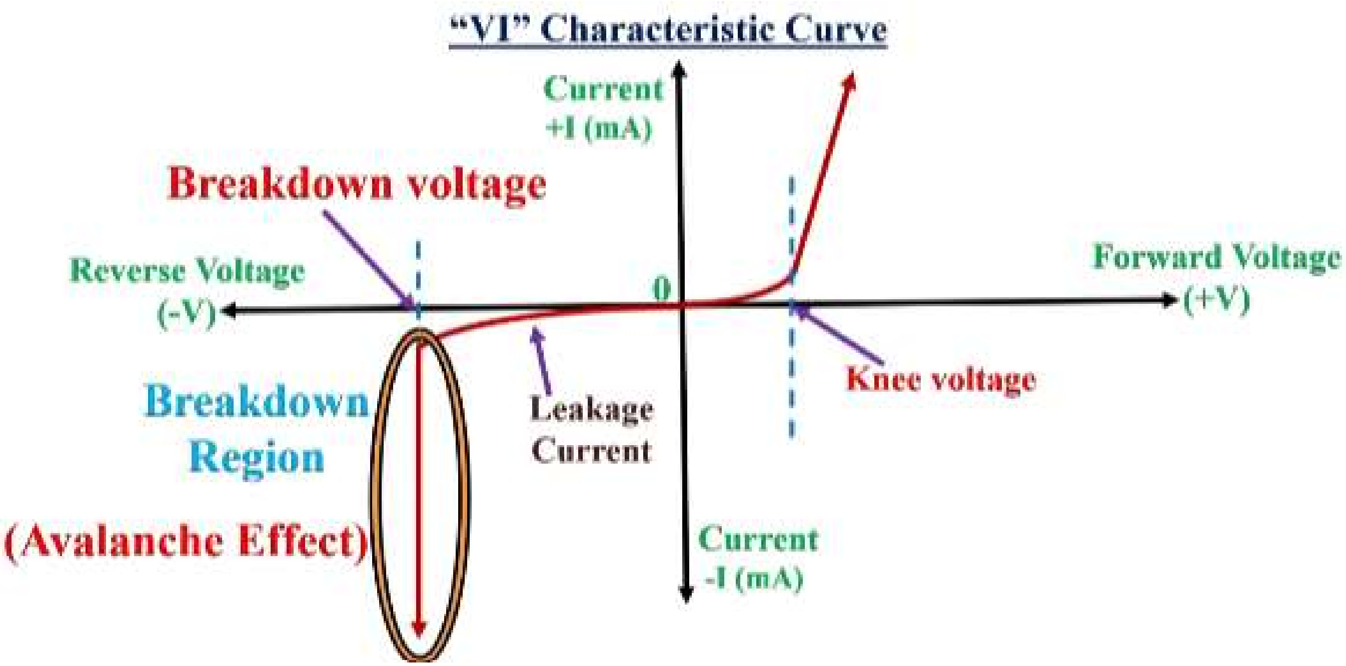
The first integrated circuit, a phase-shift oscillator, invented by Jack S. Kilby in 1958. (Courtesy of Texas Instruments.)



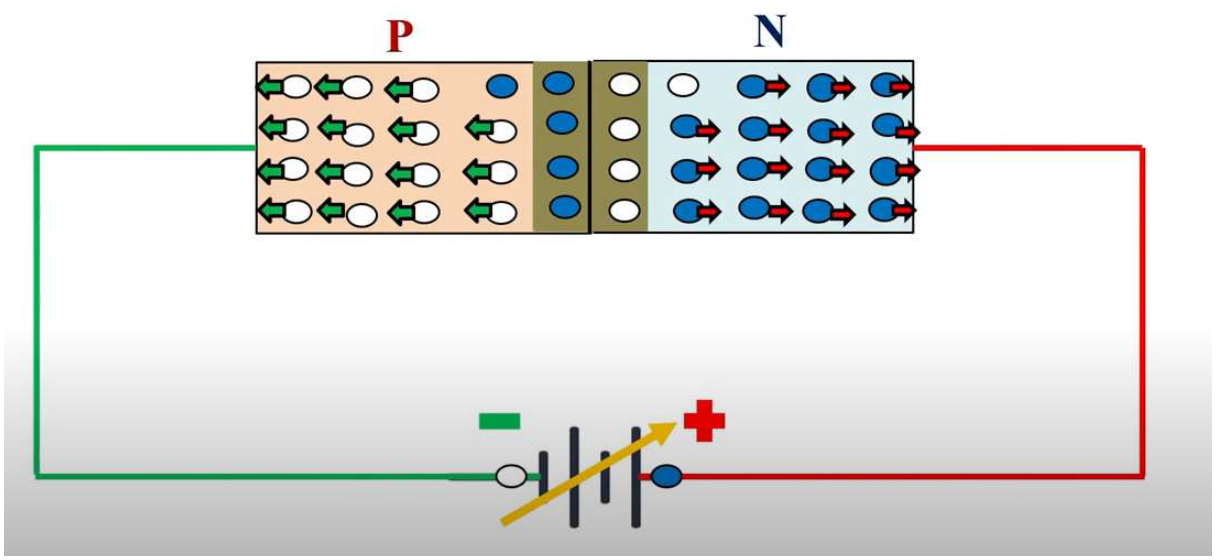
As of 2024, the GPU with the highest transistor count is Nvidia's Blackwell-based B100 accelerator, built on TSMC's custom 4NP process node and totalling 208 billion MOSFETs.

The construction of every discrete (individual) solid-state (hard crystal structure) electronic device or integrated circuit begins with a semiconductor material of the highest quality.

V-I Characteristic Curve

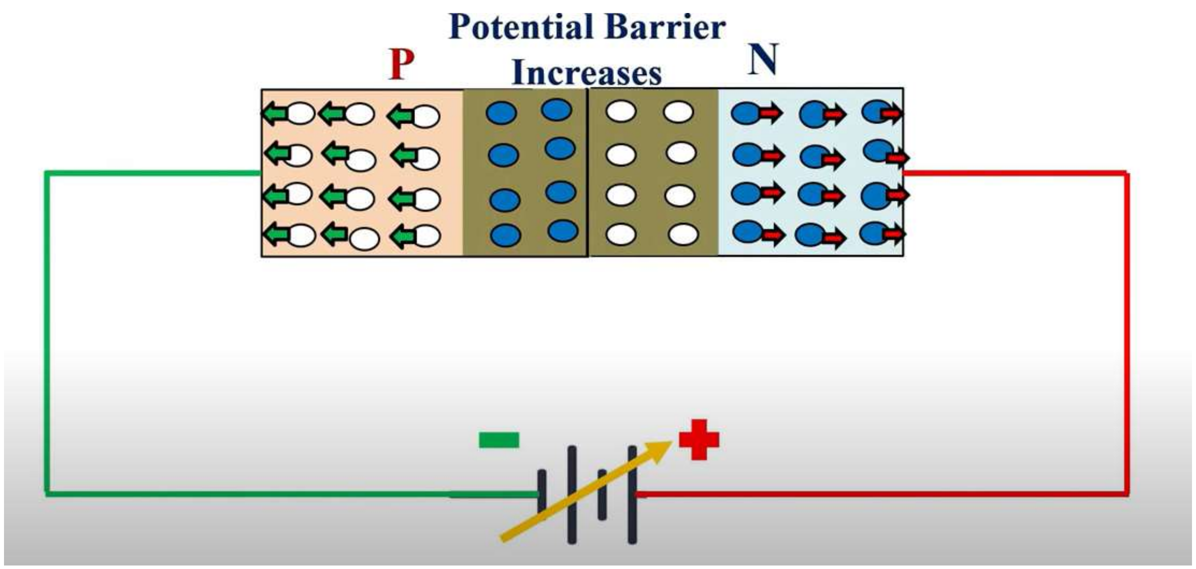


<u>Avalanche Effect</u>



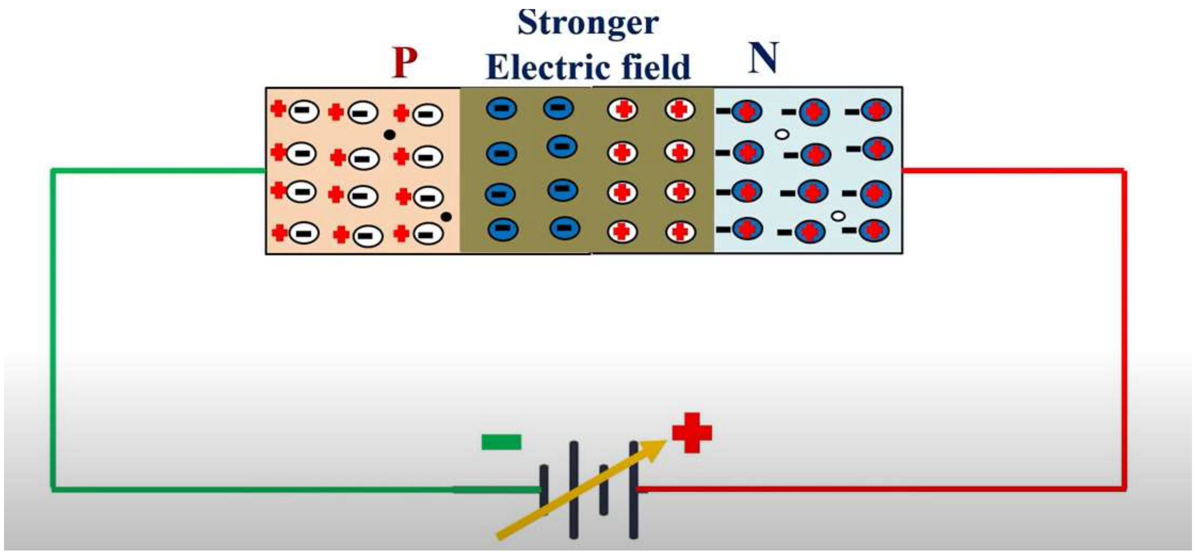
In reverse bias condition, a very small amount of leakage current flows through PN Junction, due to minority charge carriers.

Avalanche Effect



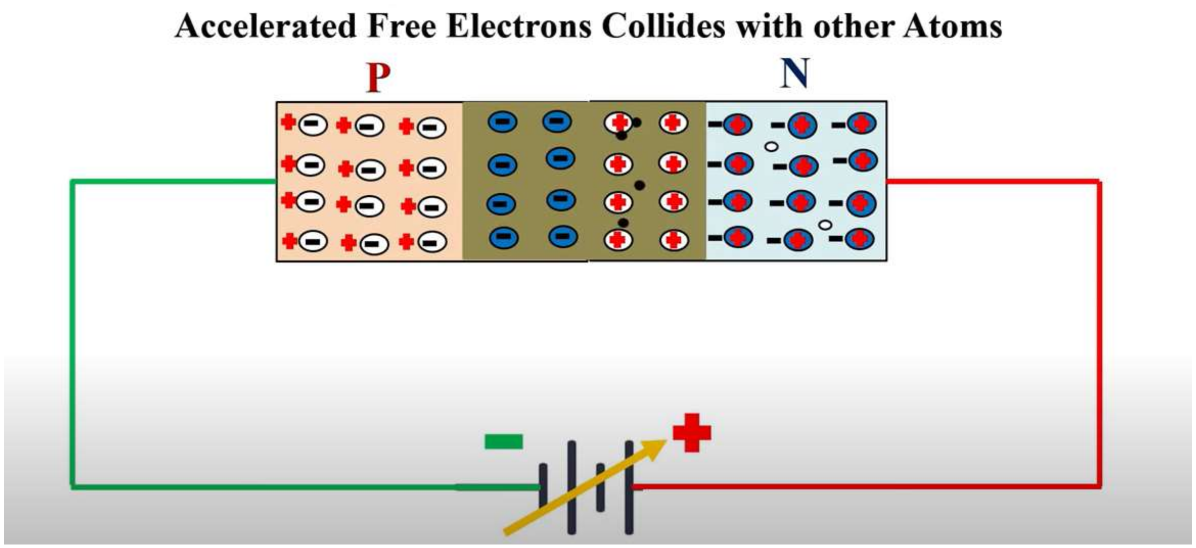
As we increase the applied reverse bias voltage, the width of the depletion region will also increases.

Avalanche Effect



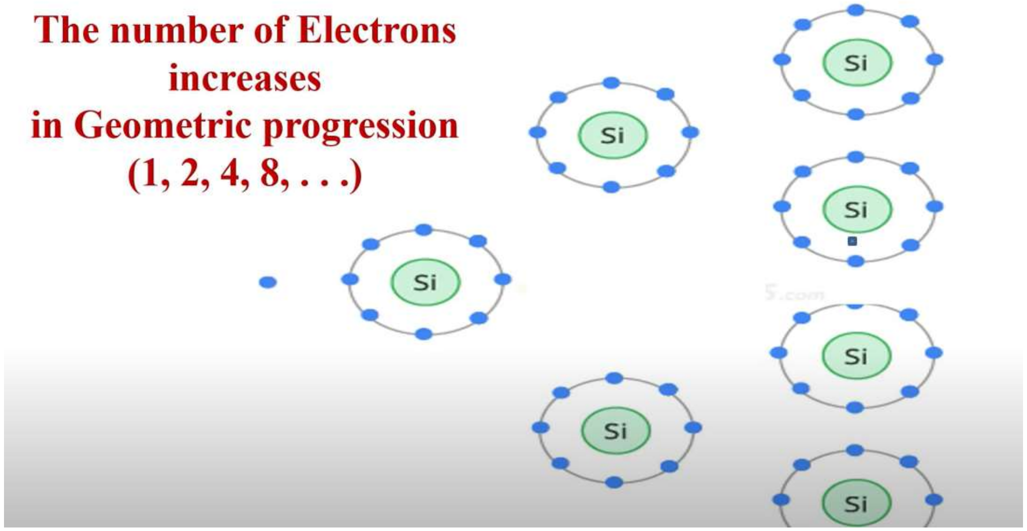
Because of that there will be increase in immobile ions, And there will be a strong electric field in the depletion region.

Avalanche Effect



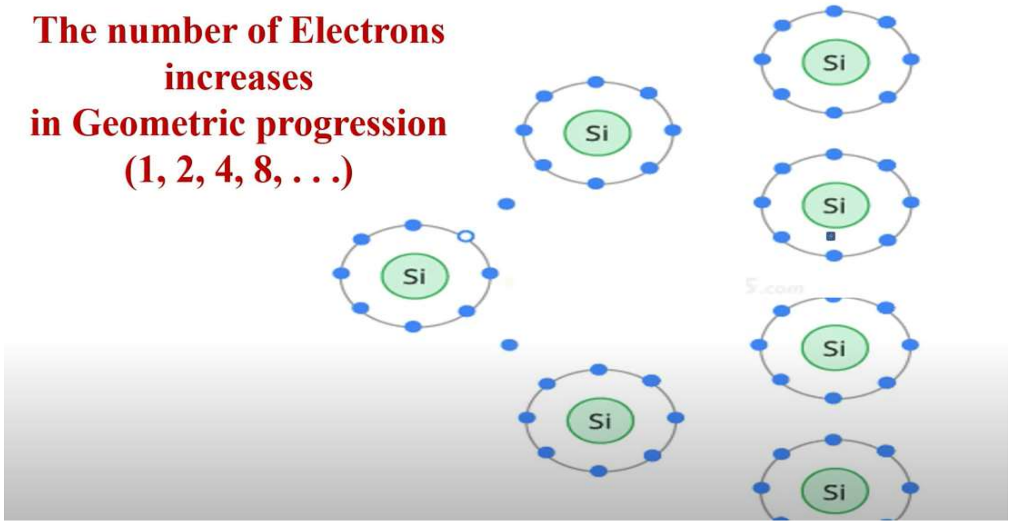
Due to this strong electric field, the minority charge carriers will get accelerated and moves faster through the depletion region, when the applied reverse voltage reaches the break down, these minority carriers moves at very high speed will collide with other atoms and knock off the valance electrons to lose, producing more free electrons.

Avalanche Effect



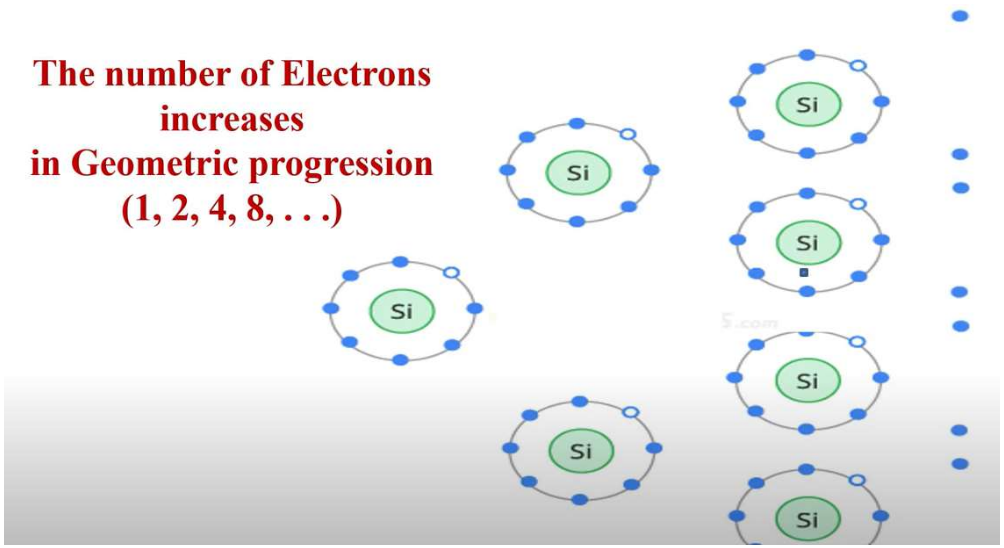
This constant collisions with atoms generates a large number of free electrons, that produces significant amount of reverse current in the diode.

Avalanche Effect



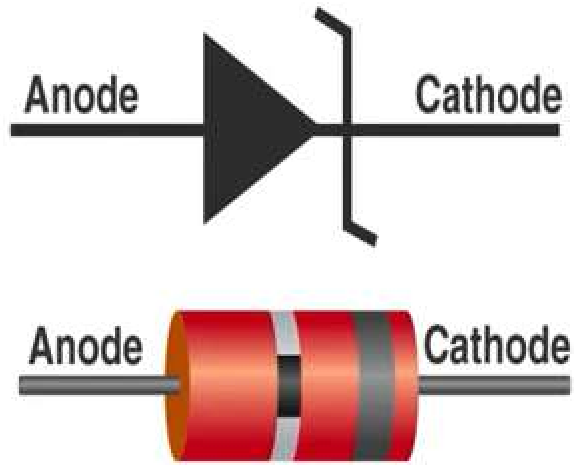
This process continued until the reverse current becomes large enough to destroy the diode. The effect is known as Avalanche effect.

Avalanche Effect



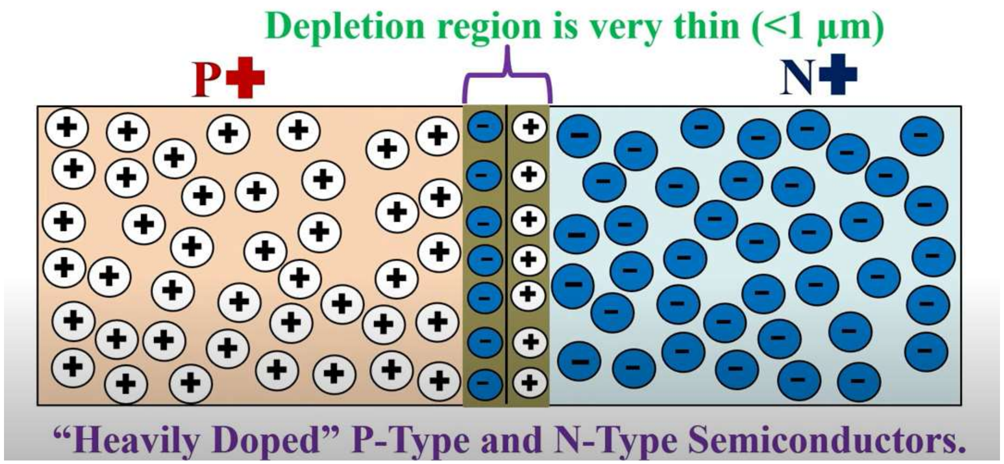
If there is no series current limiting resistor connected with the diode, then due to very high power dissipation diodes get overheated and permanently gets damaged.

<u>Zener Diode</u>



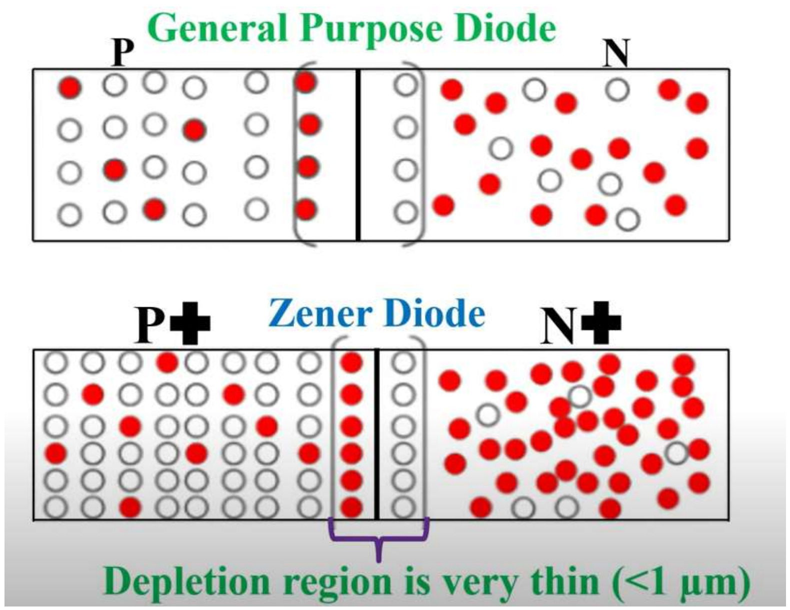
There are some special types of diode that can handle breakdown voltage without any damage. This type of diodes are known as Zener diodes. In Zener diode breakdown effect is different from avalanche effect and is known as Zener breakdown effect.

Zener Breakdown Effect



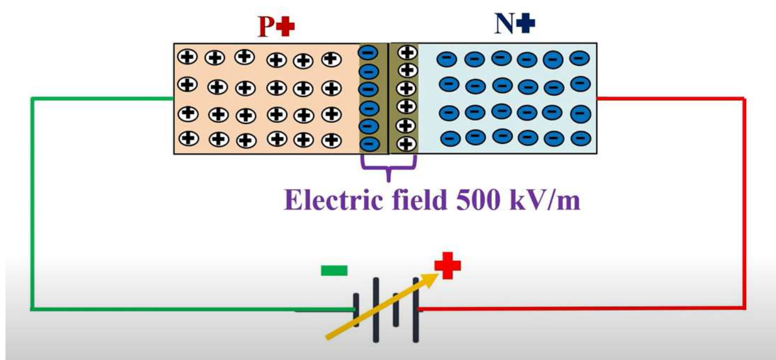
P and N type semiconductors are heavily doped. It means the number of charge carriers in these two regions are more. Due to heavy doping the depletion region will become very thin as compared to normal diode.

<u>Zener Breakdown Effect</u>



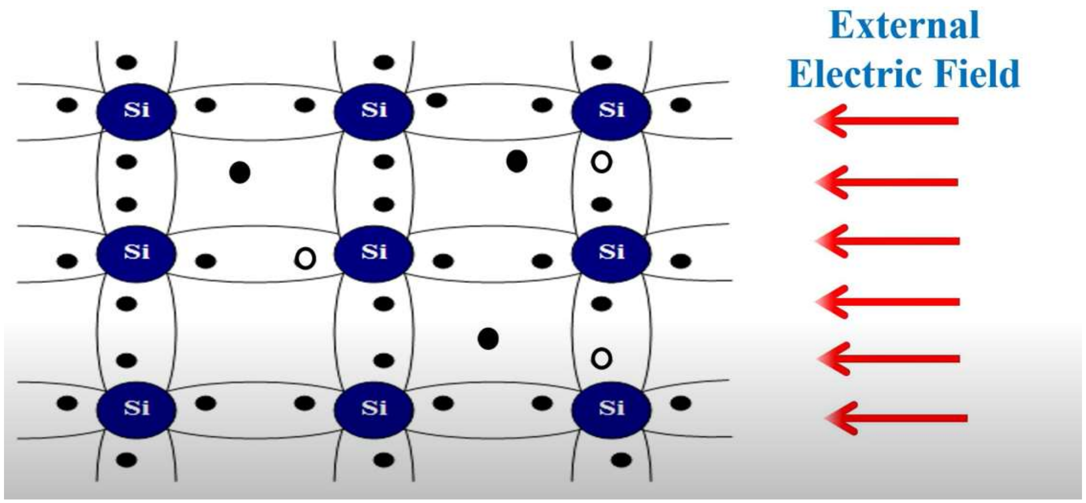
Depletion region is very thin because electrons in Zener diode diffuses near the junction and create the barrier of a large number of immobile ions.

Zener Breakdown Effect



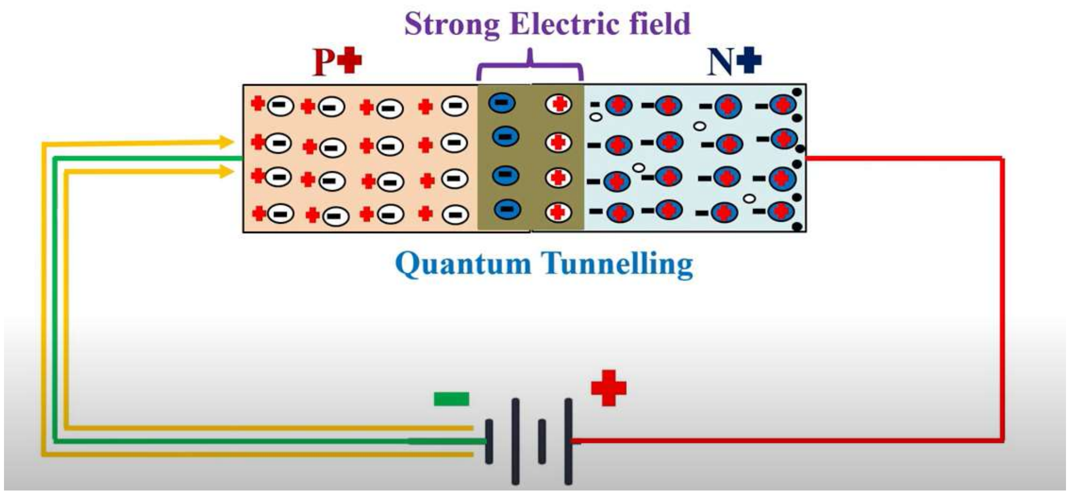
So the built in electric field inside the depletion region will be much stronger. Electric field strength is very high (500 kV/m).

Zener Breakdown Effect



When Zener diode is connected with reverse bias the external field will also get added with this built in electric field. Due to this strong electric field electrons from the covalent bonds comes out.

Zener Breakdown Effect



Due to narrow depletion region, charge carriers can tunnel through barrier by quantum tunneling and reach the other side. This cause high flow of reverse current and the effect is called Zener breakdown effect.

Zener Breakdown Effect