

### **Structure:**

In varactors the p and n type layers are made of either silicon or gallium arsenide. A layer of lightly doped n-type material (cathode layer) is introduced between the p and n type materials. The main p and n regions are heavily doped as the n-type layer is called the substrate. The finished diode is put in a carefully designed die that keeps parasitic resistance to a minimum.

### **Basic idea of operation:**

The n-type and p-type materials come together to form a junction, in which at first electrons go from n to p side and holes go from p to n side which leads to formation of ions on both sides forming a layer in the middle called depletion region. This leads to formation of two types of capacitances. The first is called junction capacitance which results from the dipole in the transition region. The second is called the charge storage capacitance. We will only focus on the former.

### **Characteristics:**

The capacitance of a varactor depends on doping profile. In an abrupt capacitor the doping concentration of the cathode layer with respect to distance from the pn junction is relatively constant while in a hyperabrupt junction, the carrier concentration in the cathode layer is reduced exponentially as the distance from the junction increases. In hyperabrupt the capacitance is more sensitive to voltage changes and gives larger capacitance values than abrupt.

An equivalent circuit consisting of RC elements can be obtained which will help us find the total impedance from the whole device. These are obtained to calculate the quality factor which is a measure of how well the varactor operates. It is obtained by dividing the energy stored by the energy dissipated in the circuit.

### **Applications:**

Varactors are used in manufacture of variable frequency oscillators, resonators, filters, VCO's and by extension audio modulation/output and phase-locked loop.