UNIT IV

Optical properties of Materials

4.6.Exciton

When an electron and a positive hole (an empty electron particle in valence band) combine and are able to move freely through a non-metallic crystal as a unit, then the combination of these two particles is called an exciton

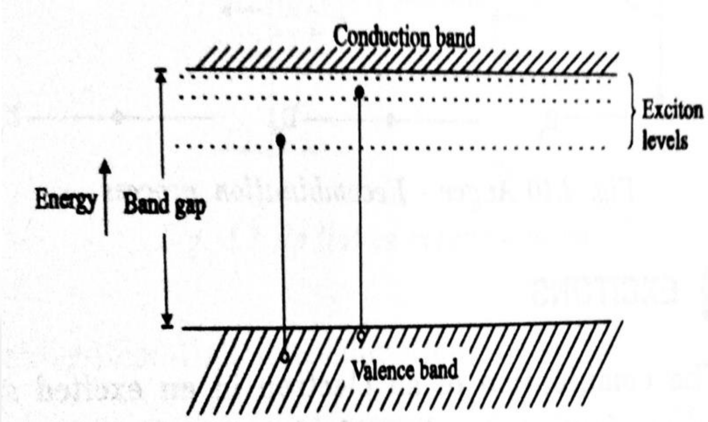

Fig 4.6.1Energy level of exciton

Types

Frenkel Exciton

Yakov Frenkel was the first one who proposed the concept of exciton when he stated about the excitation of atoms in a lattice of a certain excitonic insulator. The Frenkel exciton has a relatively small dielectric constant, and its binding energy is on the order of 0.1 to 1 eV. This takes place because, at times, the Coulomb interaction between the hole and an electron may be forceful and strong. Owing to this extra force, the exciton tends to be small; thus, they carry less dielectric constant. EEX = $-e_2/\epsilon$crystals are a general source where Frenkel excitons are found. Further, they can also be located in organic molecular crystals like anthracene and tetracene.

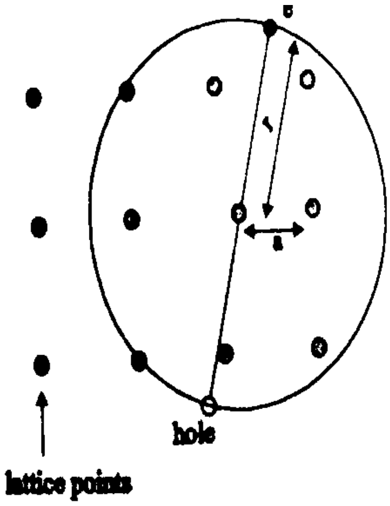

Fig4.6.2 Frenkel Exciton

Wannier–Mott Exciton

The dielectric constant is generally large in semiconductors; owing to this, the electric field screen reduces the interaction which takes place in Coulomb between the particles. Through this process, a Wannier-Mott exciton is formed. The said exciton has a radius that is way larger than the lattice spacing. Large exciton radii are favoured greatly by small masses of electrons which are typical of semiconductors. Through this, the said lattice potential can be put into the masses of electron and hole, which forms an exciton polariton. The binding energy in these is quite low, and it is generally in the order of 0.01 eV. These excitons are typically found in semiconductor crystals and liquids such as xenon.

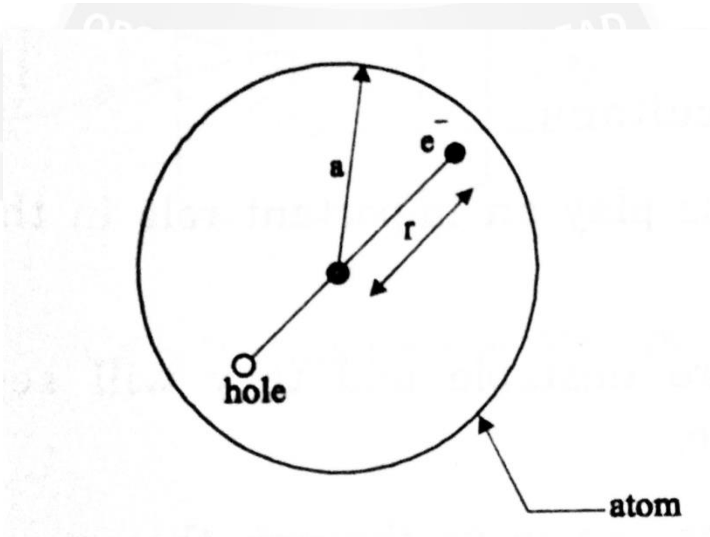

Fig 4.6.3 Wannier–Mott Exciton