Semiconducting Light-Emitting Devices

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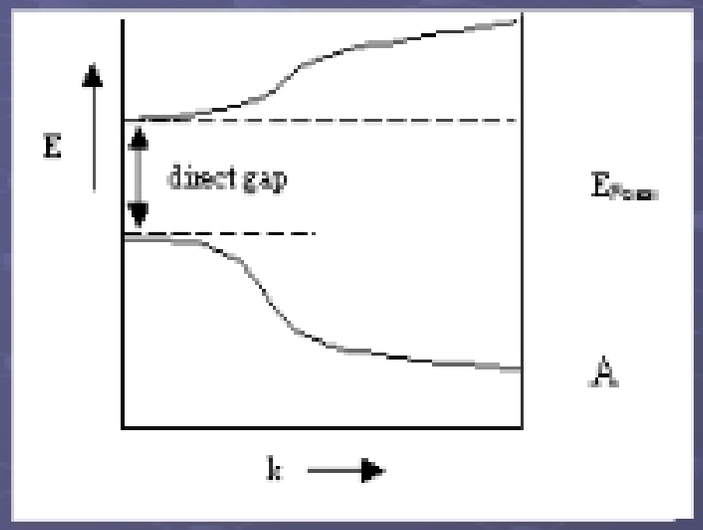
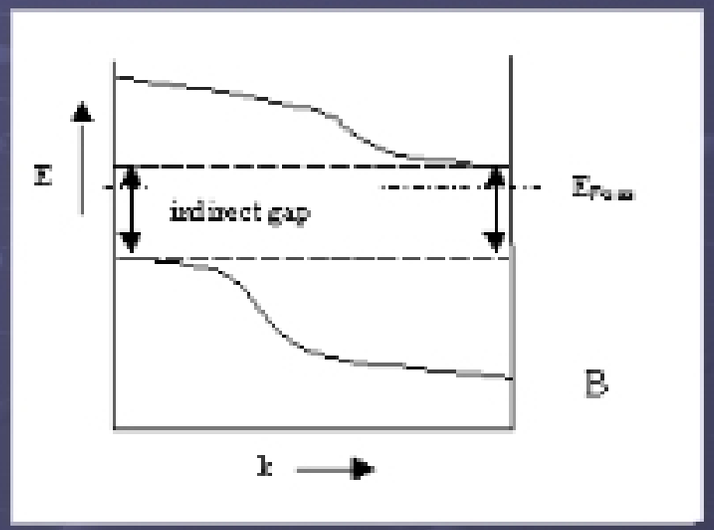
Semiconducting Materials

Direct Semiconductors



- Conduction band exists directly "above" valence band.
- Electrons and holes may recombine without diverting energy to maintaining conservation of momentum.
- Excess energy resulting from recombination is converted to photons.
- Prime example of direct semiconductor material is Gallium Arsenide (GaAs)

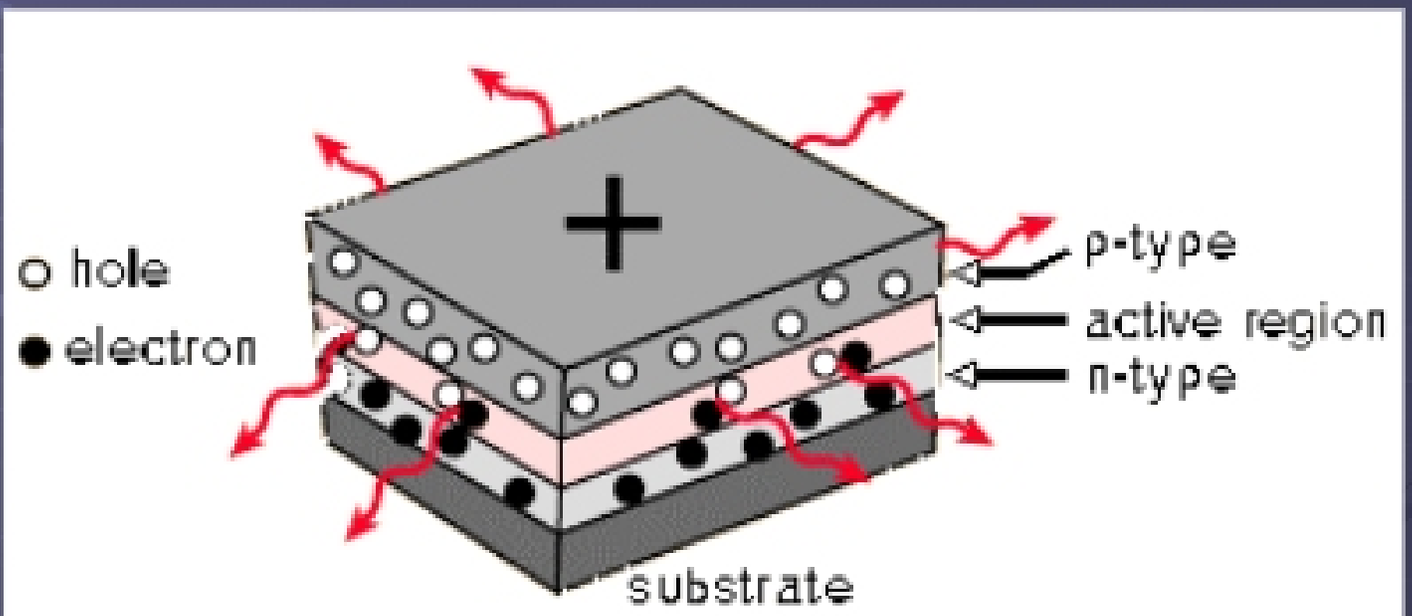
Indirect Semiconductors



- Conduction band and valence bands are offset by some vector k.
- In order for electrons and holes to recombine, they must travel across the k-space.
- Traveling across k-space requires conservation of energy and momentum.
- Energy that would have become photons in direct semiconductor is used for travel.
- Conservation of momentum is attained by production of phonons.
- Prime example of indirect semiconductor material is Silicon (Si)

Light-Emitting Device Structure

- Four layers in the basic Light-emitting device structure: Substrate, n-type material, active region, p-type material.
- Substrate is typically constructed from n-type Si or Sapphire.
- n-type layer is typically a GaAs or GaN based alloy.
- Active region is typically p-type GaAs or GaN.
- p-type layer is typically a p^+-type GaAs or GaN based alloy.



- Common gallium based alloys include:
  - Indium Gallium Arsenide - InGaAs
  - Aluminum Gallium Arsenide - AlGaAs
  - Indium Gallium Nitride - InGaN
  - Aluminum Gallium Nitride - AlGaN