



ENGINEERING PHYSICS

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ENGINEERING PHYSICS

Unit IV : Application of Quantum Mechanics to Optical Waves: LASERS



Class #43

Semiconductor lasers

Band structure

Direct Band gap

Indirect Band gap

Light emission

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Semiconductor lasers



➤ *Suggested Reading*

1. *Optical Electronics, A. Yariv*
2. *Course material developed by the Department*

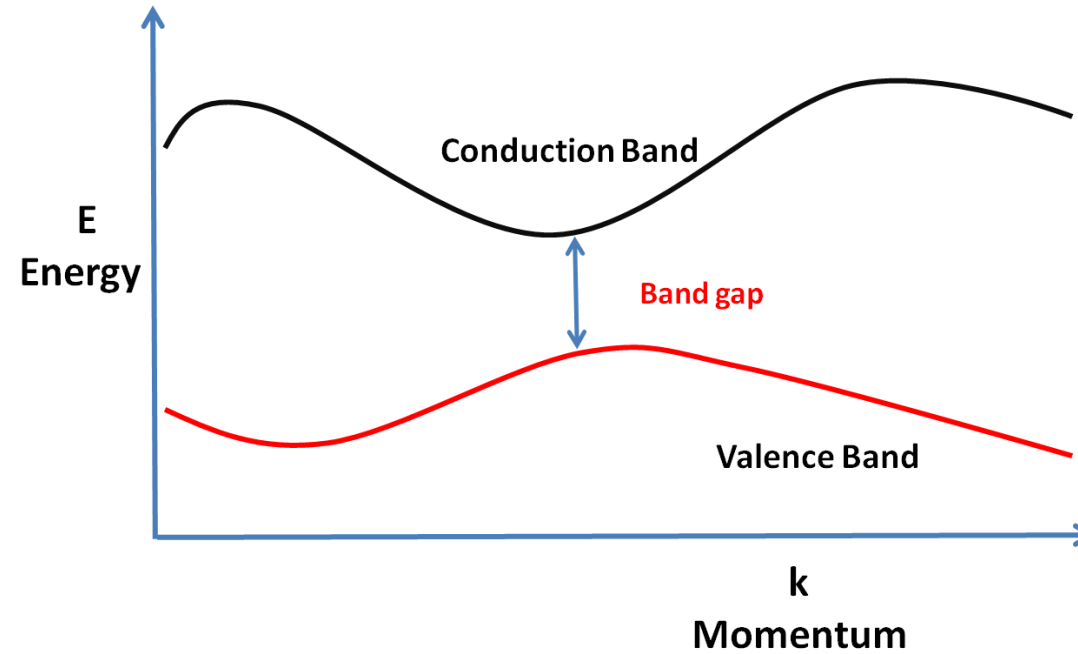
➤ *Reference Videos*

<https://ocw.mit.edu/resources/res-6-005-understanding-lasers-and-fiberoptics-spring-2008/laser-fundamentals-i/>

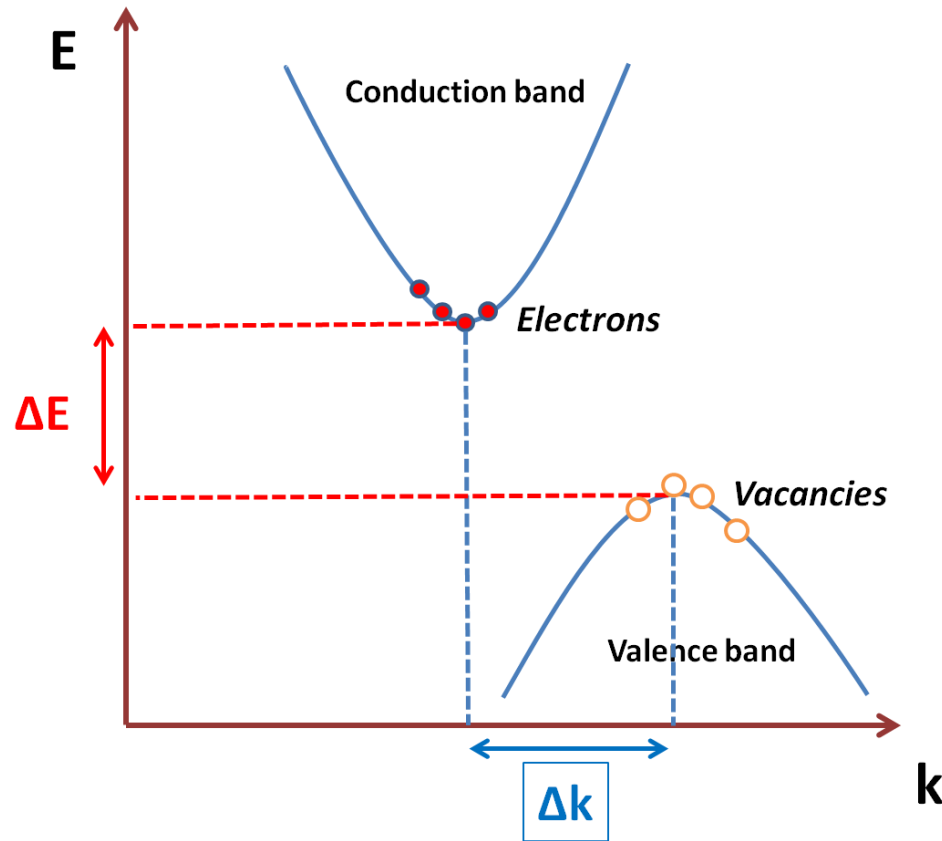
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Band structure in solids

- E – k diagram
- Kronig -Penney Model



- Materials such as Si, Ge possess this kind of band structure
- Light emission generally prohibited as photons cannot account for large Δk



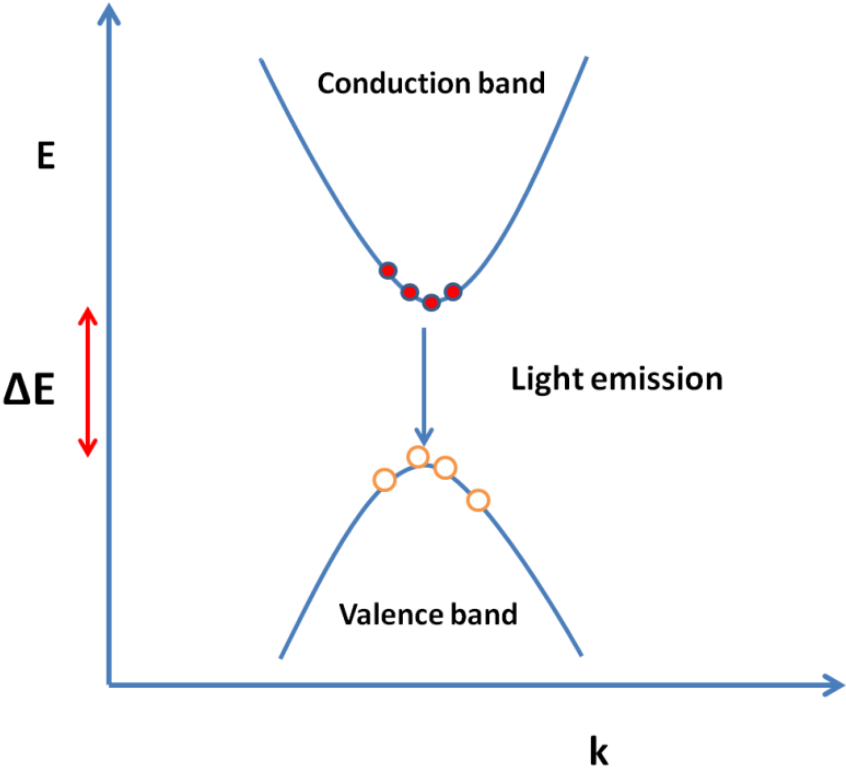
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Direct Band Gap

Materials such as GaAs, InP etc.

Light emission is possible as Δk involved is not very large

$\Delta E = h\nu$



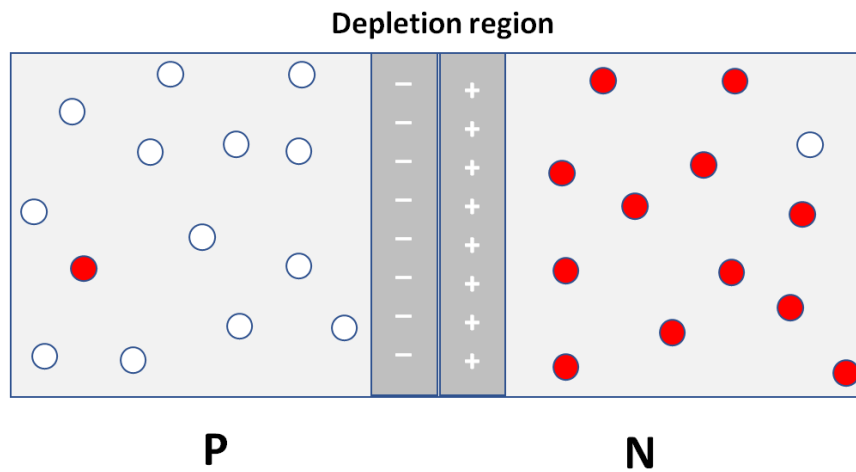
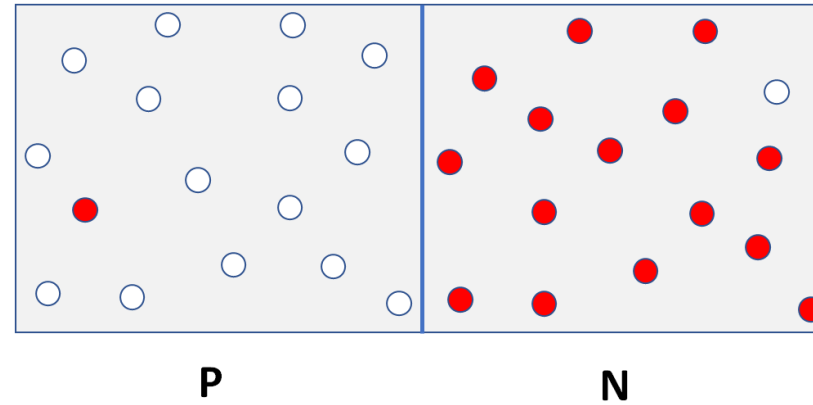
Toptica Photonics

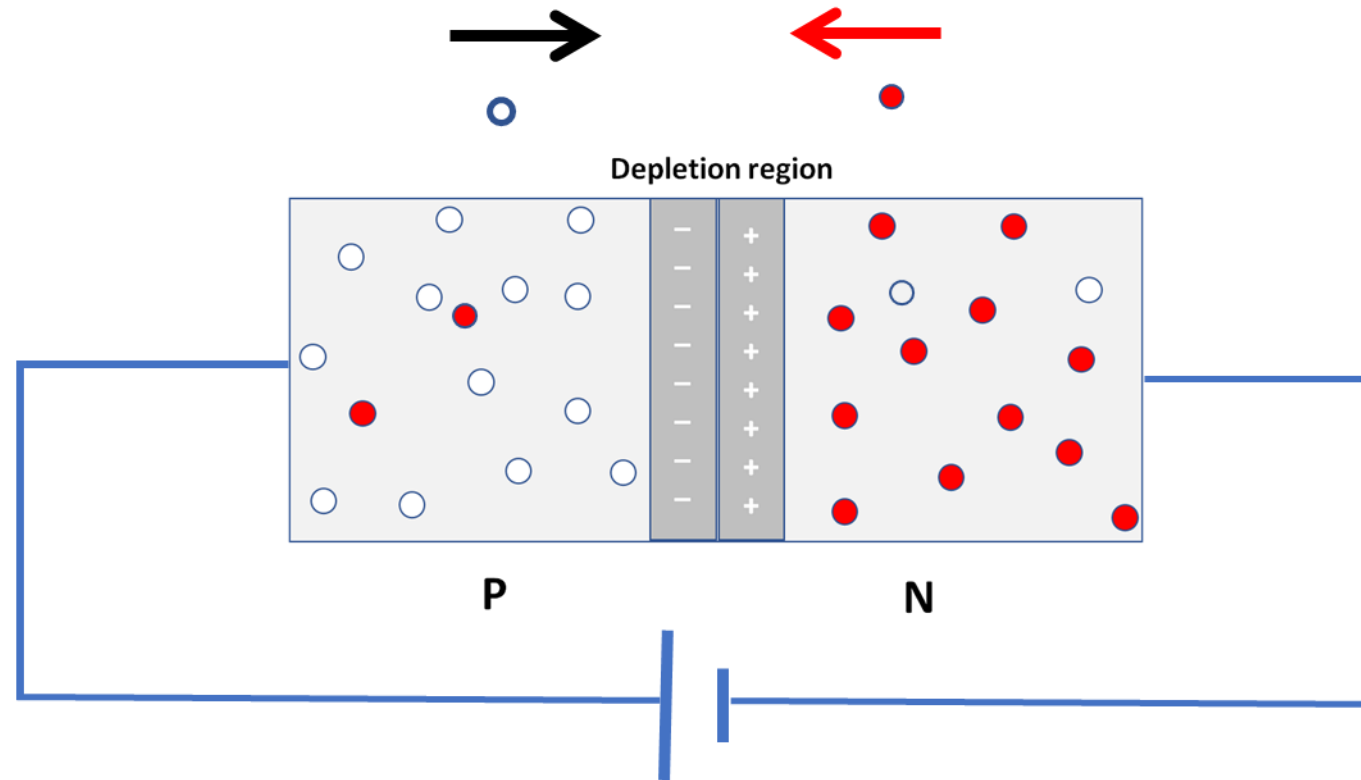
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PN Junction

● **Electrons**

○ **Vacancies**

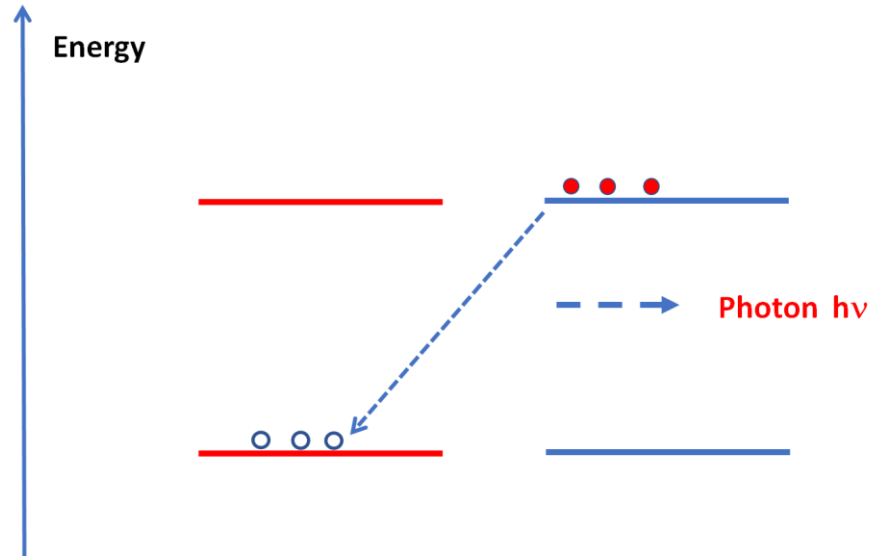




PN junction light emission

Requires large current density
of the order of 10000 A/cm^2

Very Low efficiency



Check Your Understanding (Yes/No)

- 1. Band gap decides the frequency of the emitted laser*
- 2. GaAs is direct band gap semiconductor*
- 3. Semiconductor lasers are created using an indirect band gap material*
- 4. Semiconductor lasers are very efficient*



THANK YOU

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