



# ENGINEERING PHYSICS

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# **ENGINEERING PHYSICS**

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

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**Class #43**

**Semiconductor lasers**

**Band structure**

**Direct Band gap**

**Indirect Band gap**

**Light emission**

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## Semiconductor lasers

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### ➤ *Suggested Reading*

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

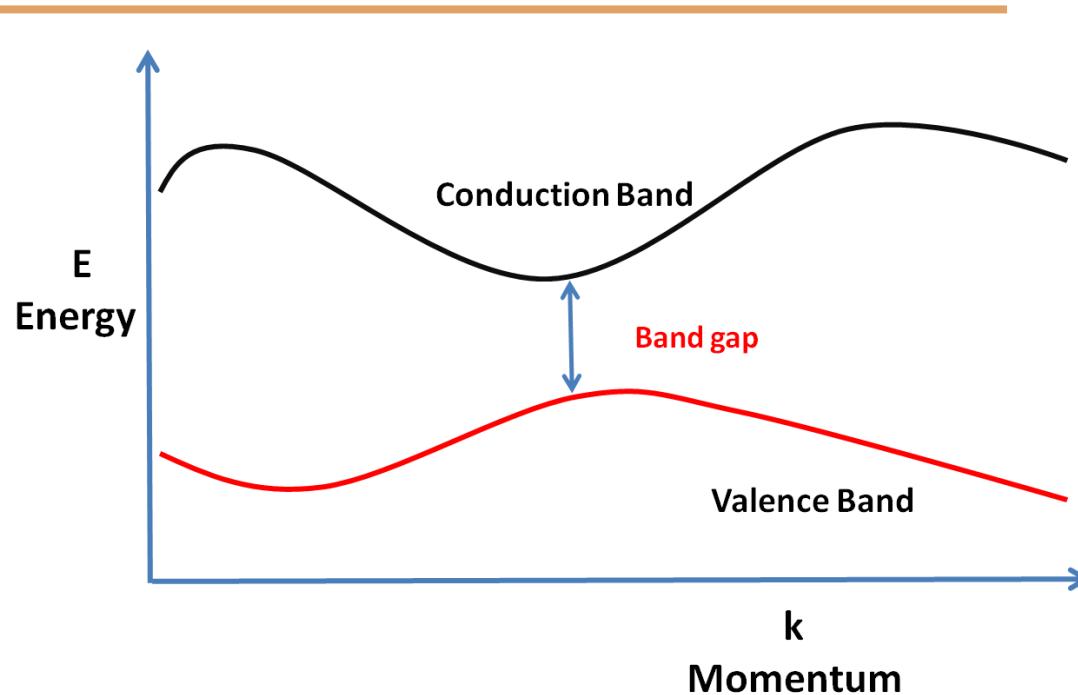
### ➤ *Reference Videos*

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

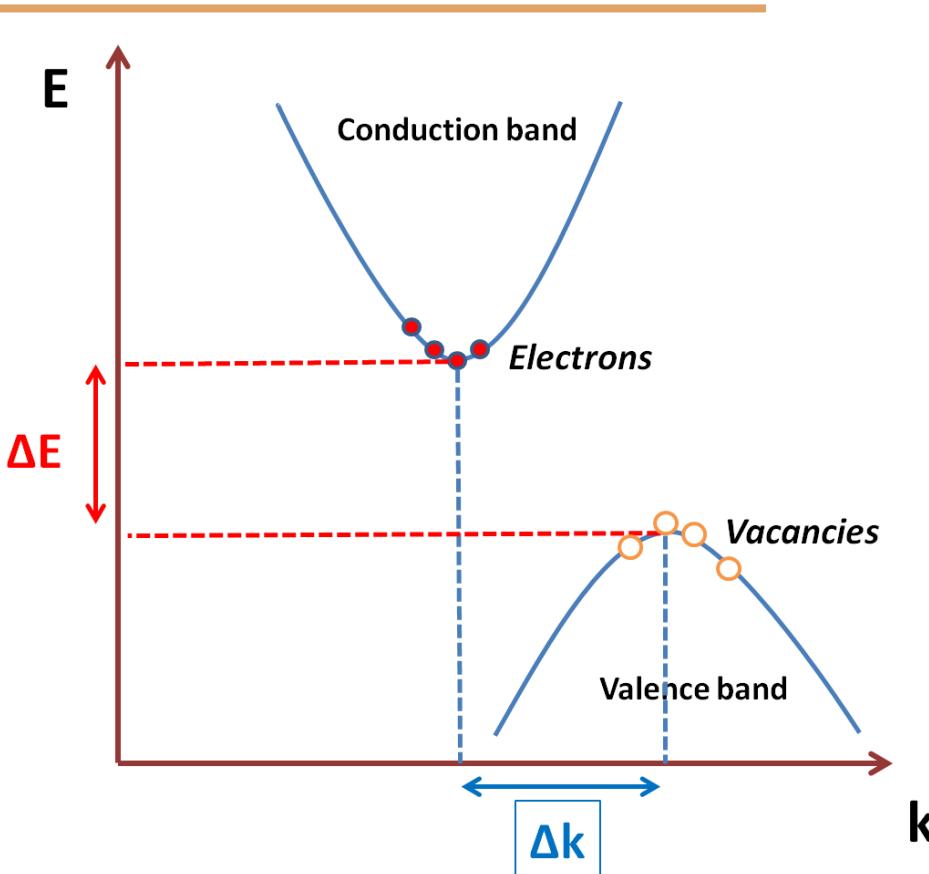
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## Band structure in solids

- 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  $\Delta k$



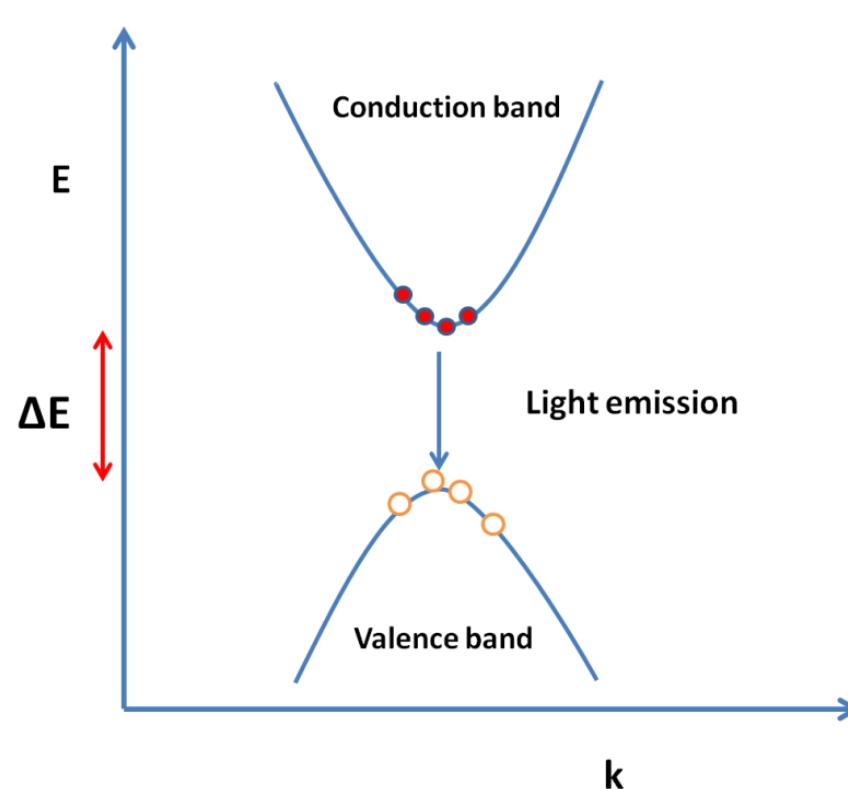
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## Direct Band Gap

Materials such as GaAs, InP etc.

Light emission is possible as  $\Delta k$  involved is not very large

$$\Delta E = h\nu$$

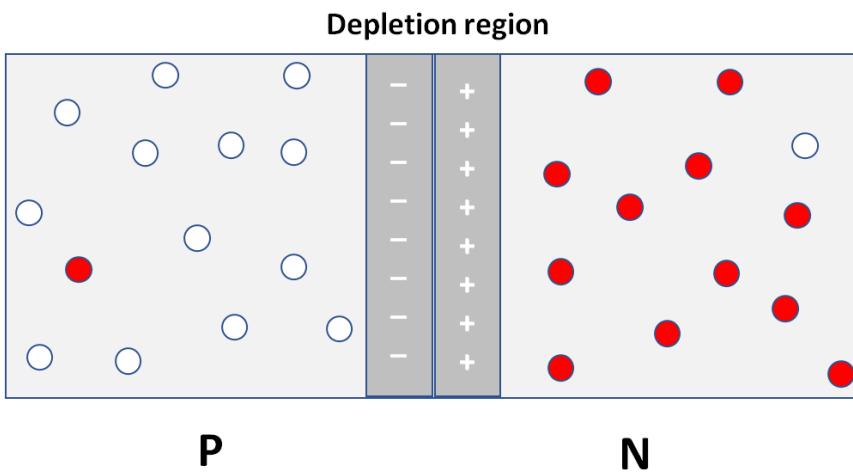
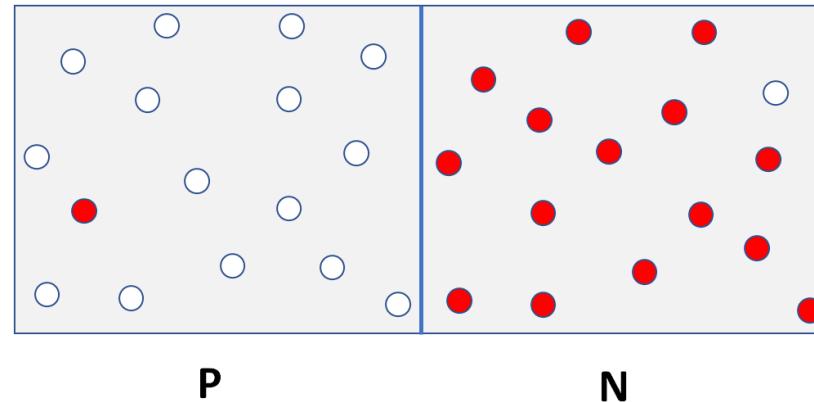


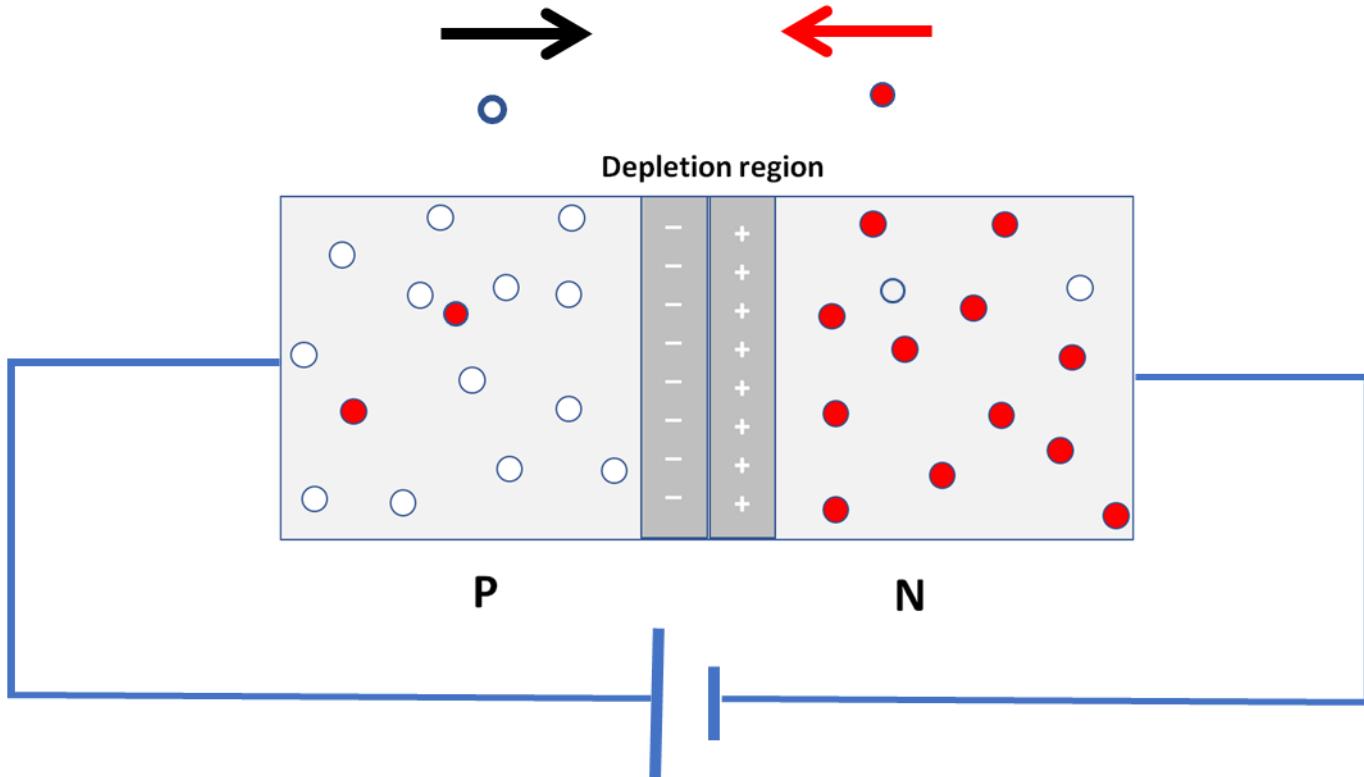
Toptica Photonics

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## PN Junction

- Electrons
- Vacancies

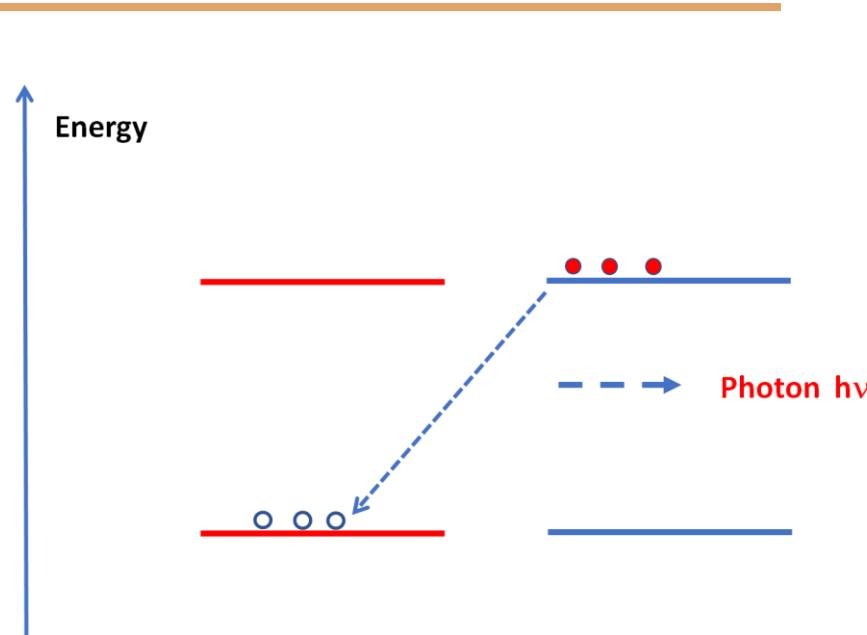




**PN junction light emission**

Requires large current density  
of the order of  $10000 \text{ A/cm}^2$

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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