



# ENGINEERING PHYSICS

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Department of Science and Humanities

# **ENGINEERING PHYSICS**

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

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**Class #44**

**Semiconductor laser**

**Heterojunction laser**

**Charge confinement**

**Photon confinement**

### ➤ *Suggested Reading*

*2. Optical Electronics, A. Yariv*

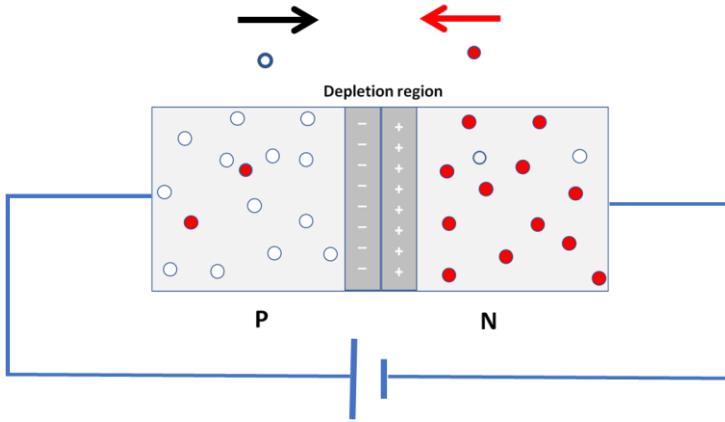
*2. Course material developed by the Department*

### ➤ *Reference Videos*

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

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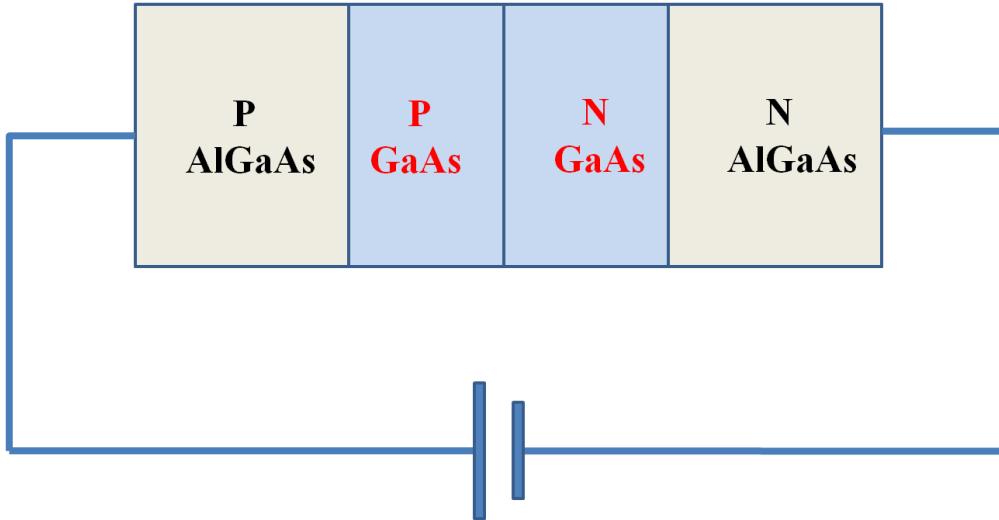
## Semiconductor laser



**Homojunction diode**

**Light emission is very low because of diffused holes and electrons**

**Chance of recombination very low**



**Heterojunction 'diode'**

**Charge confinement**

**Light Confinement**

**Works at low voltage**

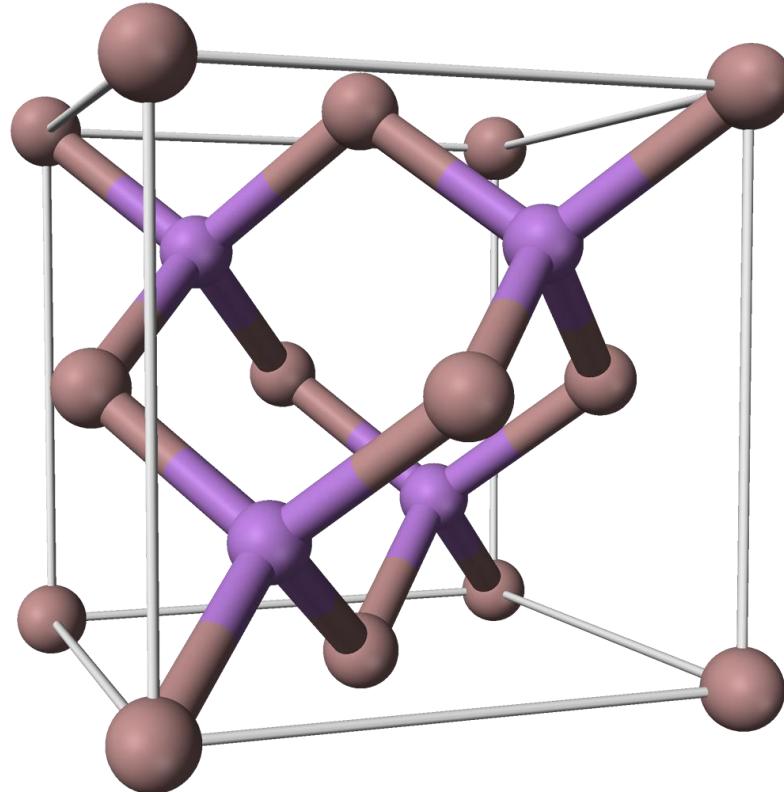
**High efficiency**

**Site Doping**

$\text{Al}_x \text{Ga}_{1-x} \text{As}$

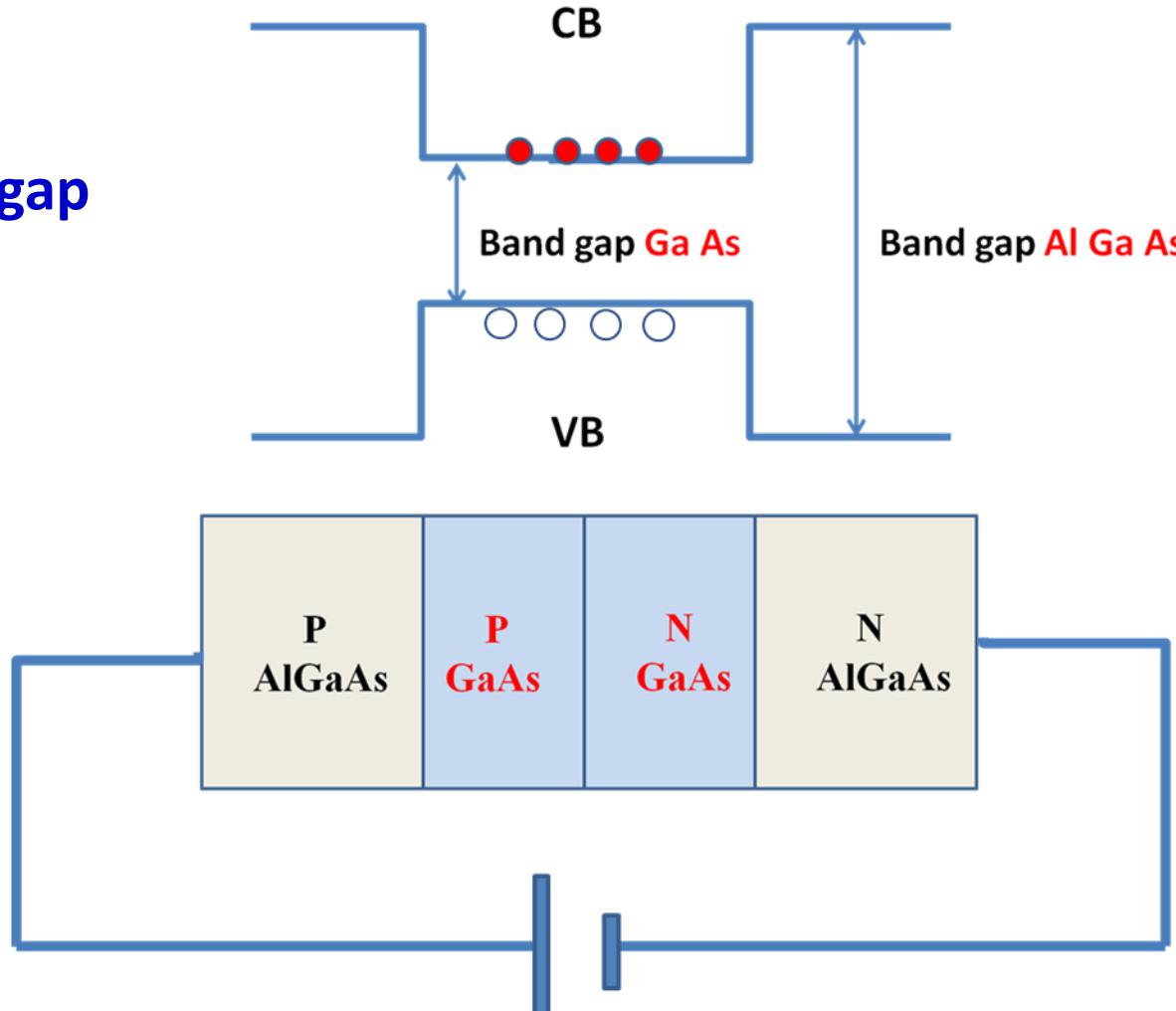
**Example**

$\text{Al}_2 \text{Ga}_{98} \text{As}_{100}$

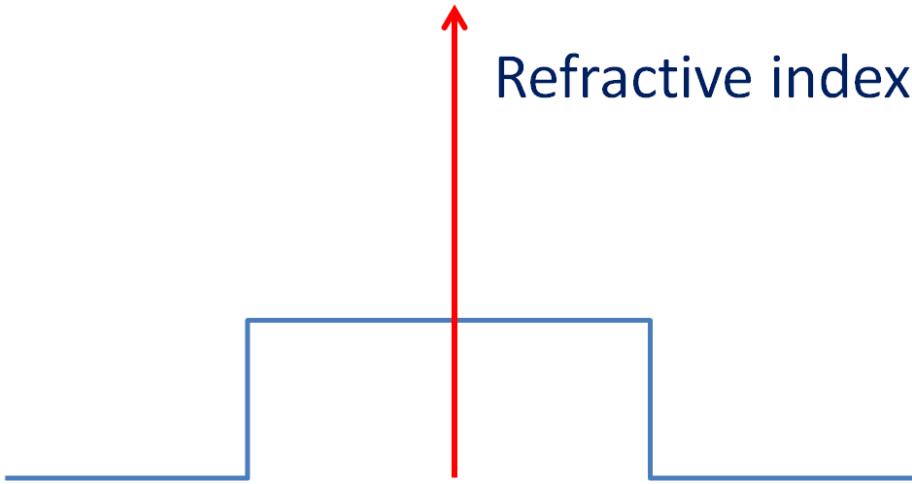


## Heterojunction laser: Charge confinement

GaAs has lower band gap compared tp AlGaAs

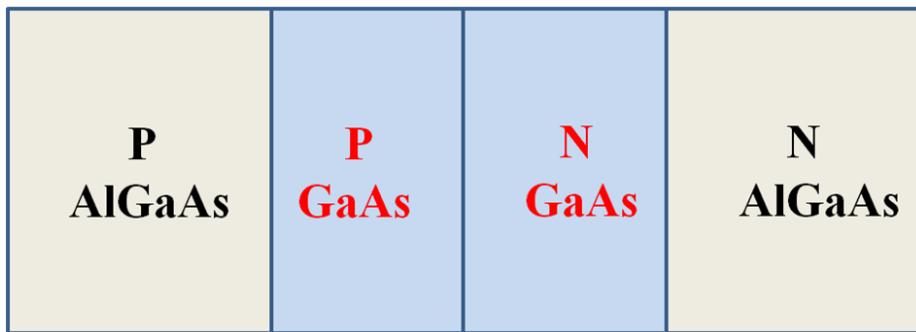


## Photon confinement



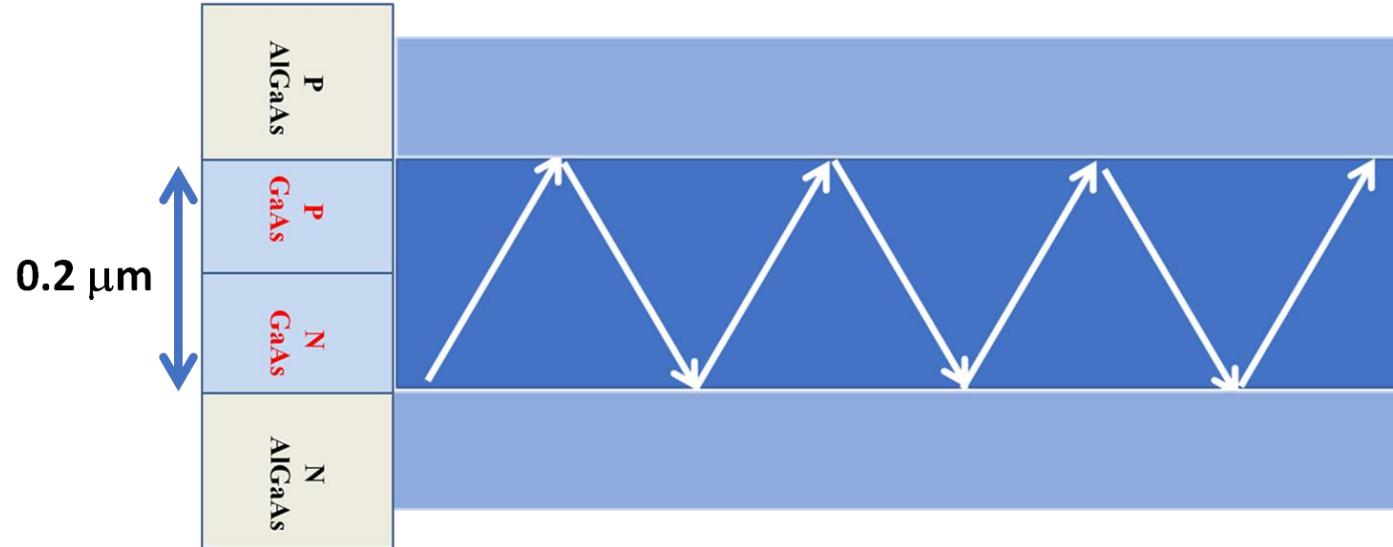
**GaAs has higher RI than AlGaAs**  
**GaAs has lower band gap**

**Happy coincidence!**



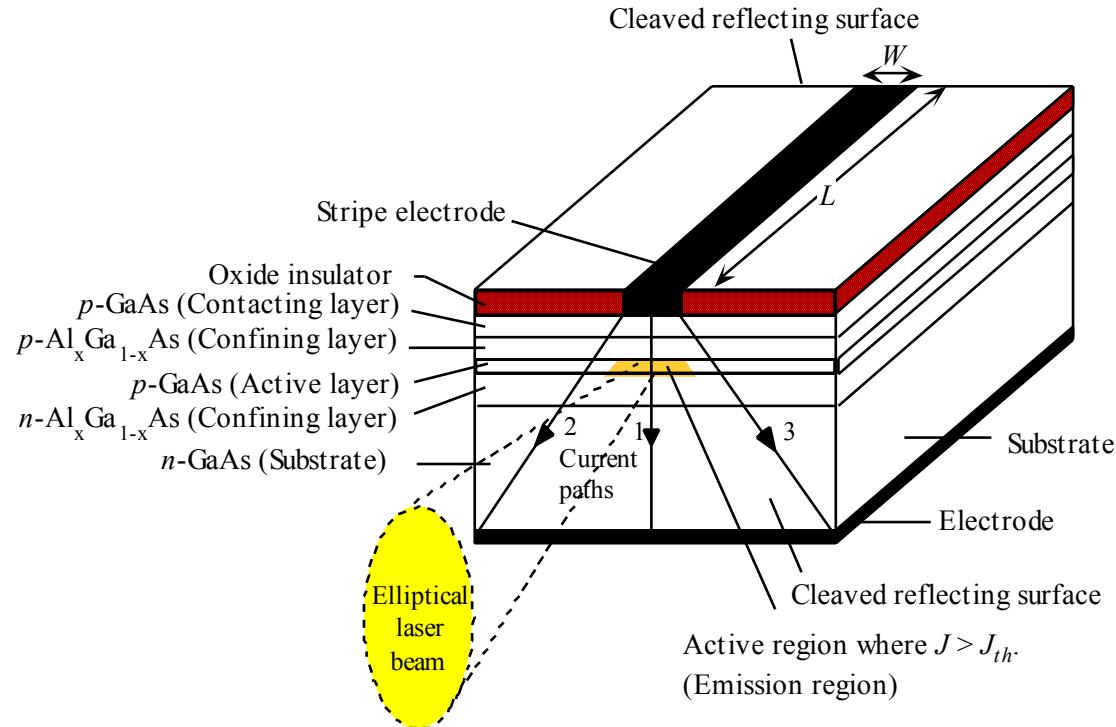
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## Photon Confinement



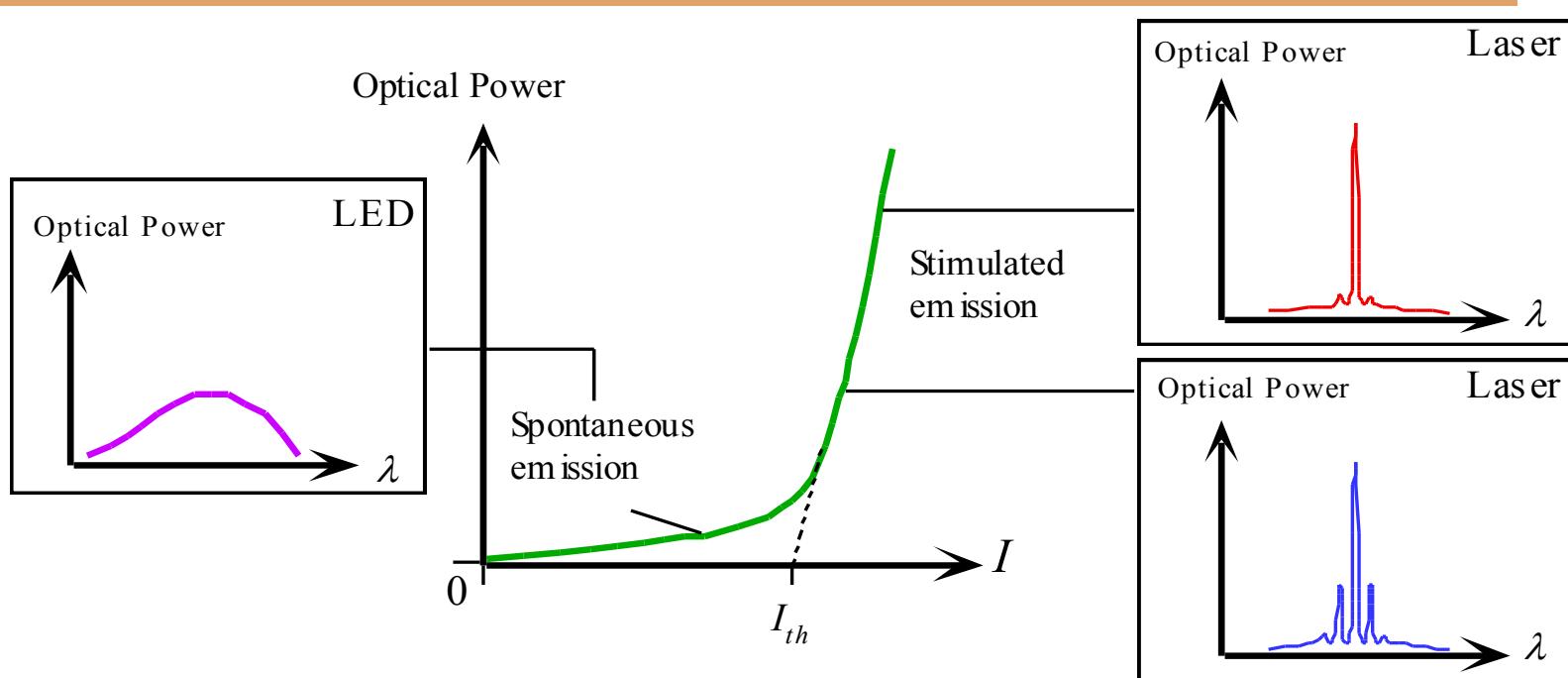
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## Heterojunction laser



Schematic illustration of the the structure of a double heterojunction stripe contact laser diode

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Typical output optical power vs. diode current characteristics and the corresponding output spectrum of a laser diode.

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### ***Check Your Understanding (Yes/No)***

- 1. Heterojunction lasers are made of Direct band gap semiconductors***
  
- 2. Site doping is used to alter band gap***
  
- 3. Photon confinement allows amplification***
  
- 4. Population inversion is achieved by optical pumping***



**THANK YOU**

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