



## 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

# ENGINEERING PHYSICS

## Semiconductor lasers

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### ➤ *Suggested Reading*

*2. Optical Electronics, A. Yariv*

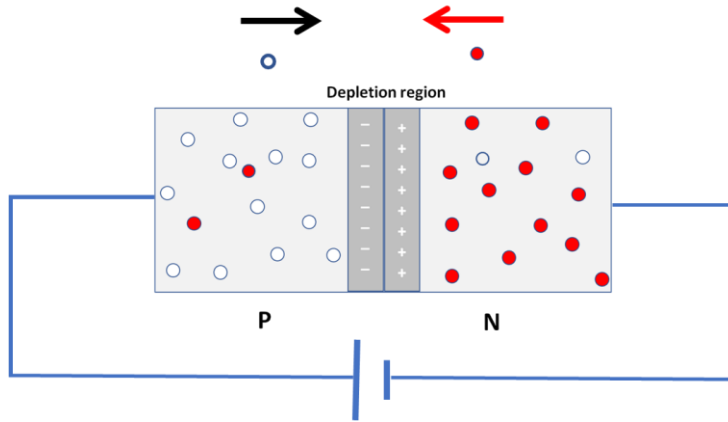
*2. Course material developed by the Department*

### ➤ *Reference Videos*

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

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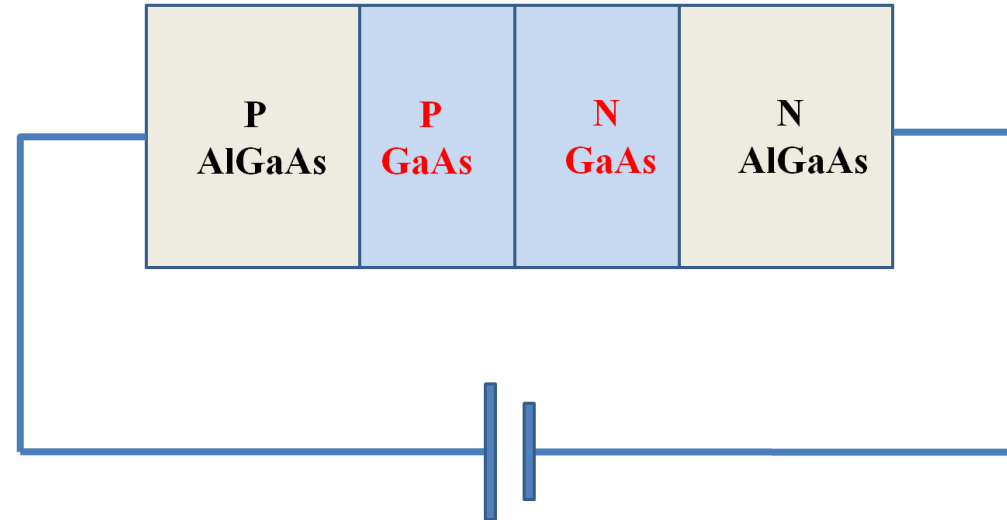
## Semiconductor laser



### 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

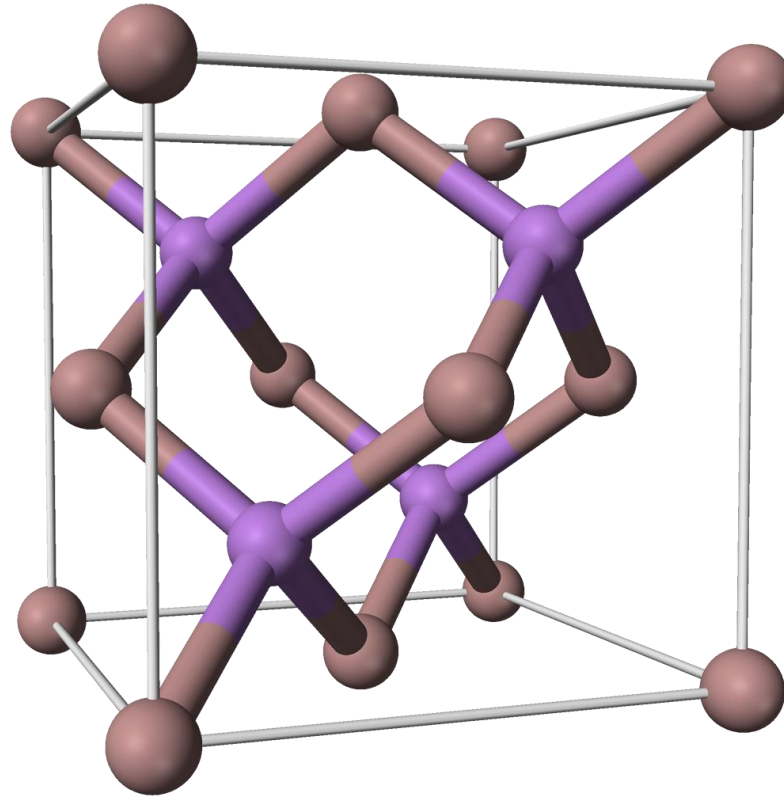
High efficiency

Site Doping

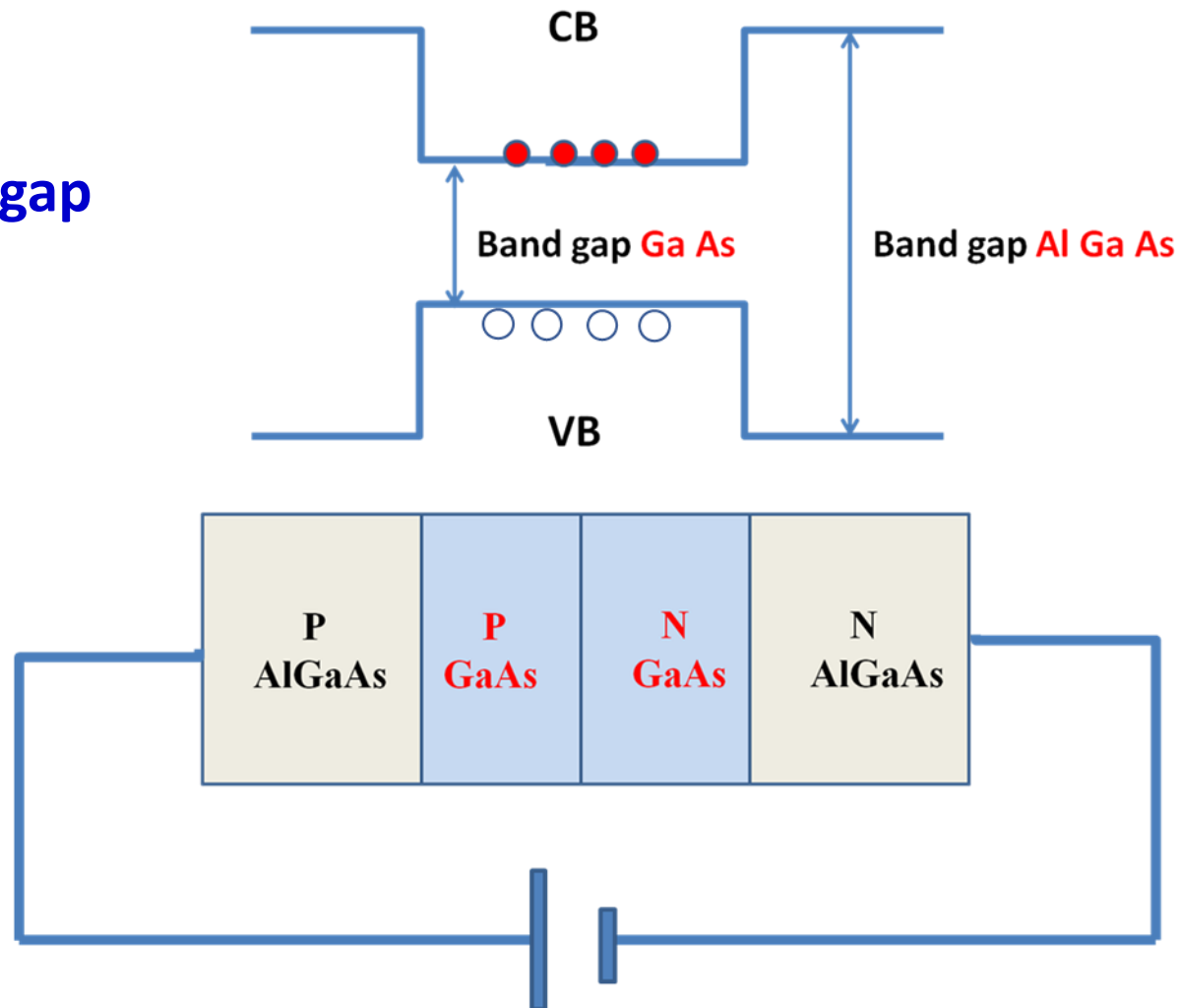
$\text{Al}_x \text{Ga}_{1-x} \text{As}$

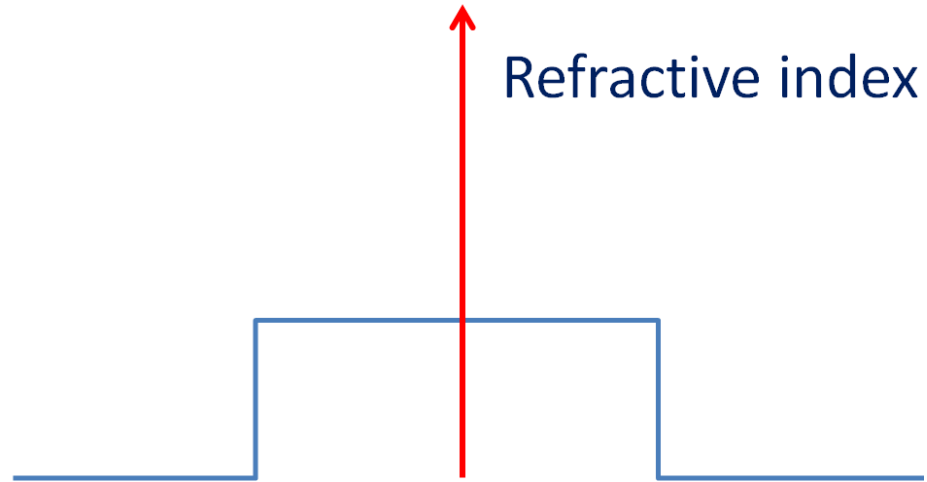
Example

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



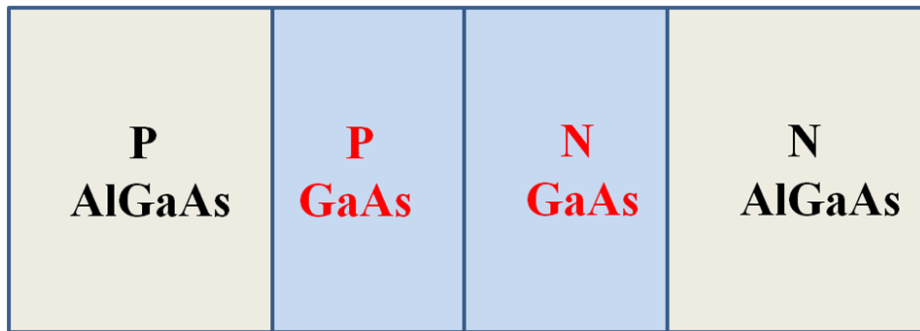
GaAs has lower band gap compared to AlGaAs





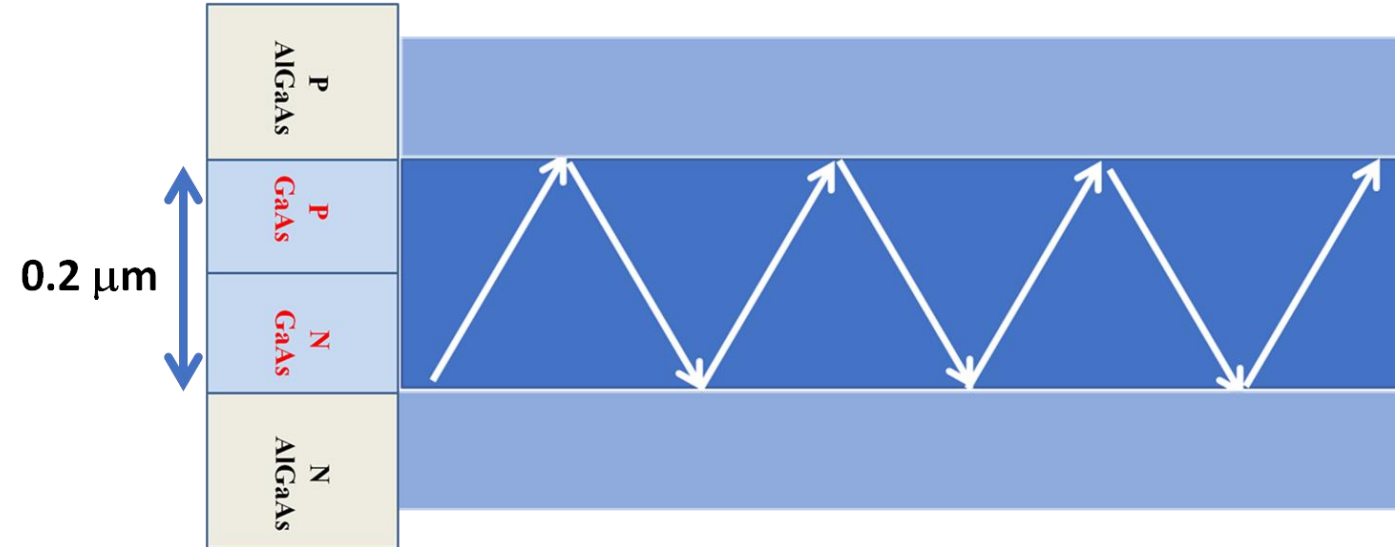
**GaAs has higher RI than AlGaAs**  
**GaAs has lower band gap**

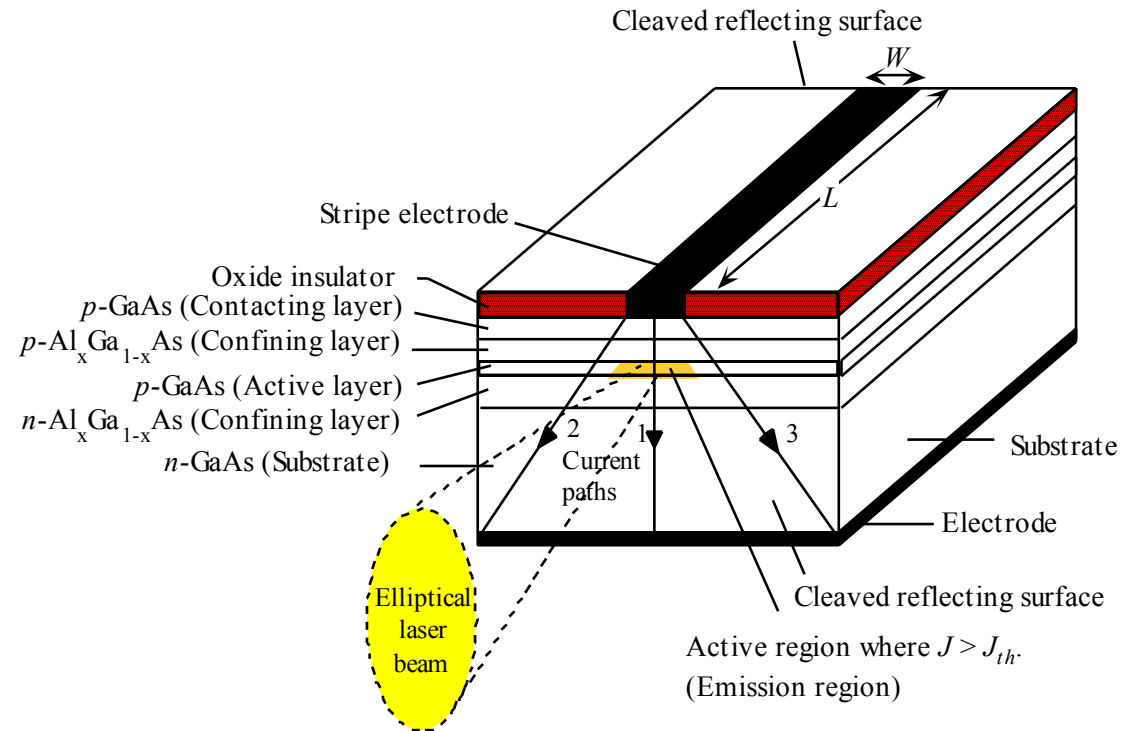
**Happy coincidence!**



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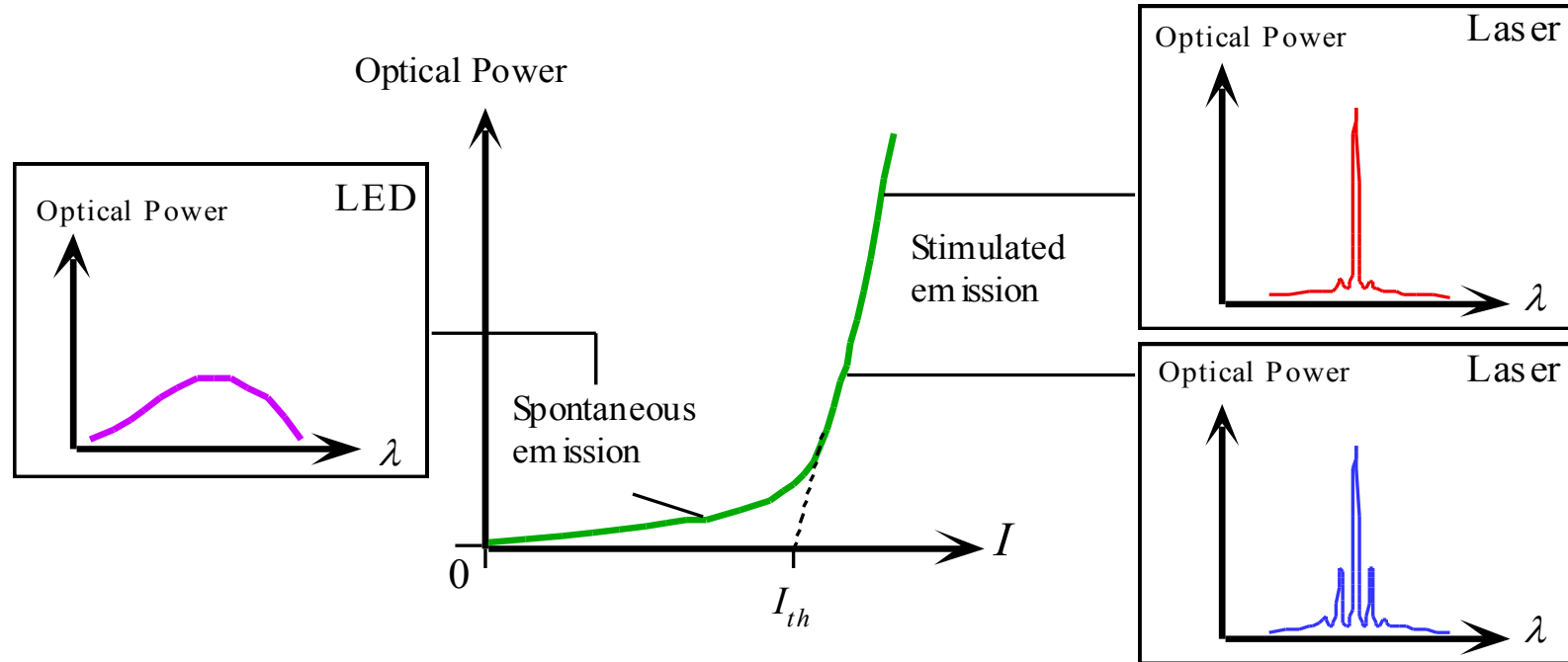
## Photon Confinement





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

© 1999 S.O. Kasap, *Optoelectronics* (Prentice Hall)



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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