ECE121: Electronics (1)

Lecture 6: The Optical Diodes
Laser Diodes and Photodiodes

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Lecture Outline:

1. Introduction.
2. Basic Operation of Laser Diodes.
3. Applications of Laser Diodes.
4. Photo-diodes.

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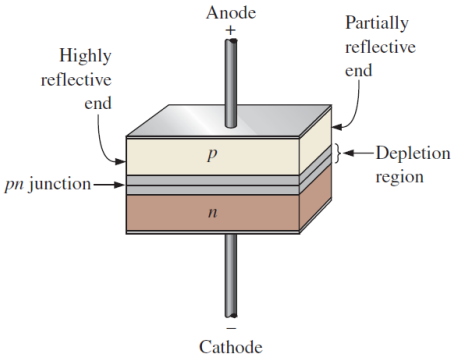
Introduction:

- The term **LASER** stands for **L**ight **A**mplification by **S**timulated **E**mission of **R**adiation.

Laser Diode Construction:

- A pn junction is formed by two layers of highly doped gallium arsenide.
- A highly reflective surface at one end of the pn junction.
- A partially reflective surface at the other end, forming a resonant cavity for the photons.
- External leads provide the anode and cathode connections.



Laser light is monochromatic (a single color) and a coherent light (a single wavelength).

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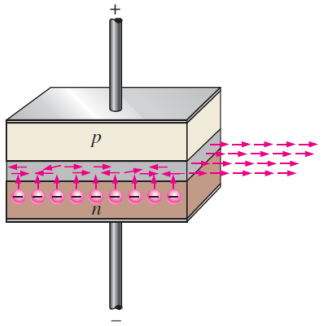
Basic Operation of Laser Diodes:

- The laser diode is forward-biased by an external voltage source. As electrons move through the junction, recombination occurs just as in an ordinary diode.



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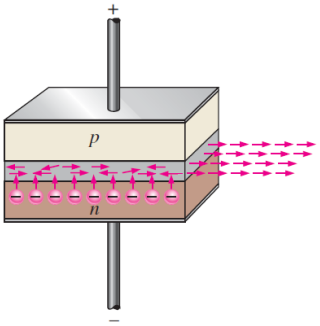

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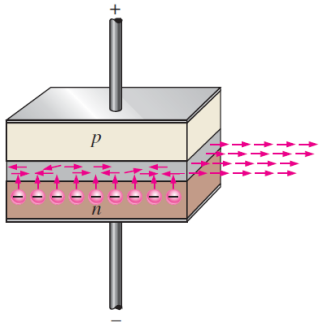
- A released photon can strike an atom, causing another photon to be released.



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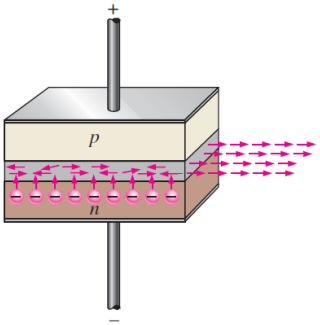
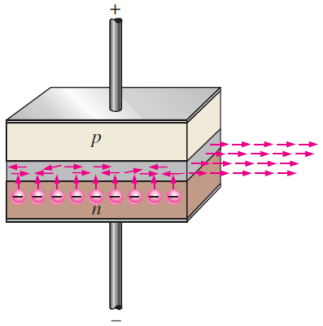
- As electrons fall into holes to recombine, photons are released.
- A released photon can strike an atom, causing another photon to be released.
- As the forward current is increased, more electrons enter the depletion region and cause more photons to be emitted.



Basic Operation of Laser Diodes:

- Some of the photons that are randomly drifting within the depletion region strike the reflected surfaces perpendicularly.



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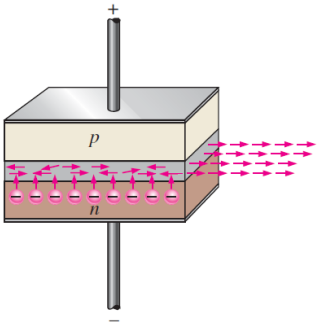
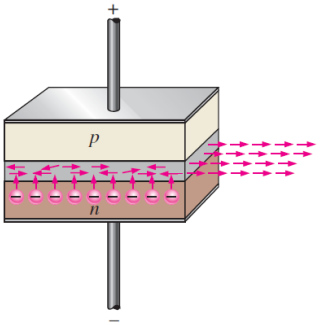
- Some of the photons that are randomly drifting within the depletion region strike the reflected surfaces perpendicularly.
- These reflected photons move along the depletion region, striking atoms and releasing additional photons.



Basic Operation of Laser Diodes:

- Some of the photons that are randomly drifting within the depletion region strike the reflected surfaces perpendicularly.
- These reflected photons move along the depletion region, striking atoms and releasing additional photons.
- This **back-and-forth** movement of photons increases as the generation of photons until a very intense beam of laser light is formed that pass through the partially reflective end of the pn junction.



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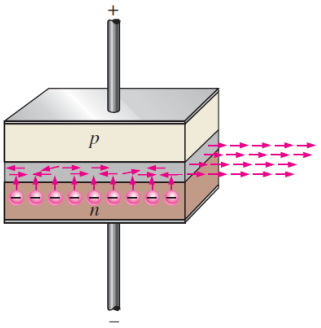
- This **back-and-forth** movement of photons increases as the generation of photons until a very intense beam of laser light is formed that pass through the partially reflective end of the pn junction.
- Each photon produced is identical to the other photons in energy level, phase relationship, and frequency. So a single wavelength of intense light emerges from the laser diode.



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Applications of Laser Diodes:

- Laser diodes are existing in many applications: proximity sensors, cutting machines, laser printers and optical communication.
- One application is in the pick-up system of compact disk (CD) players.
- Audio information (sound) is digitally recorded in stereo on the surface of a compact disk in the form of microscopic "pits" and "flats."
- A lens arrangement focuses the laser beam from the diode onto the CD surface.
- As the CD rotates, the laser light, which is altered by the pits and flats along the recorded track, is reflected back to a photodiode.
- The signal from the photodiode is then used to reproduce the digitally recorded sound.

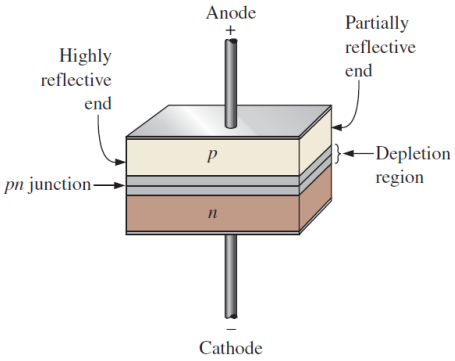

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Photo-diodes:

- The photodiode is a device that operates in reverse bias.
- The photodiode has a small transparent window that allows light to strike the pn junction.
- A photodiode differs from a rectifier diode in that when its pn junction is exposed to light, the reverse current increases with the light intensity.
- When there is no incident light, the reverse current I_λ, is almost negligible and is called the dark current.
- An increase in the amount of light intensity, produces an increase in the reverse current.

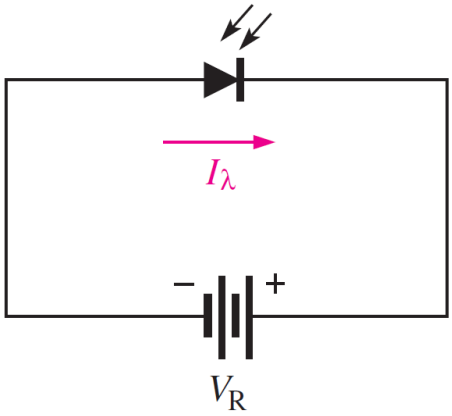
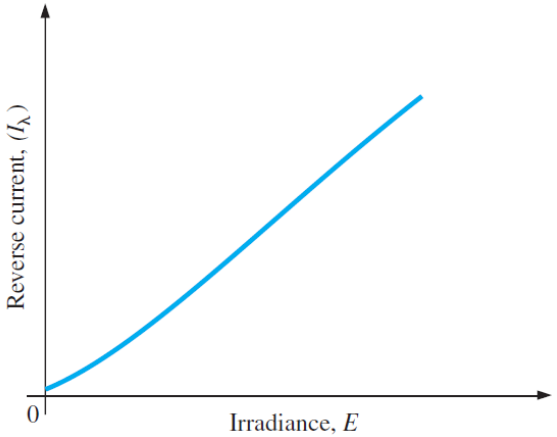


Photo-diodes:

Irradiance Vs. Reverese Current



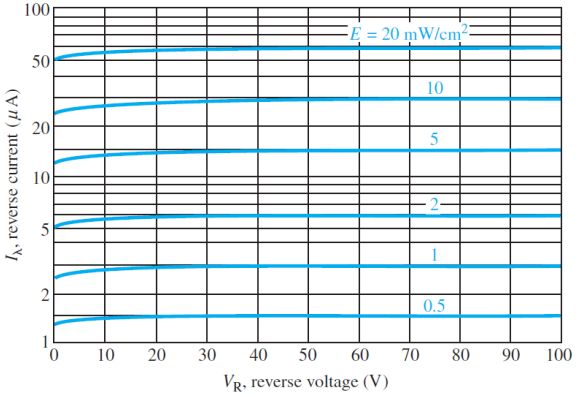
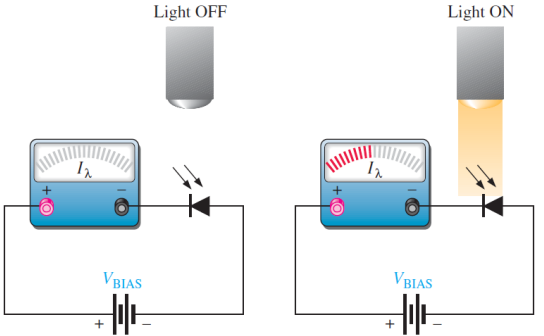


Photo-diodes:

Irradiance Vs. Reverese Current

- The photodiode allows essentially no reverse current (except for a very small dark current) when there is no incident light.
- When a light beam strikes the photodiode, it conducts an amount of reverse current that is proportional to the light intensity (irradiance).



(a) No light, no current except negligible dark current

(b) Where there is incident light, resistance decreases and there is reverse current.

End of Lecture

Best Wishes

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