3.1 Intrinsic and Extrinsic Material -Direct and Indirect Band Gaps

- The optical output from a source is measured in radiance (B).
- Radiance is defined as optical power radiated into a solid angle per unit emitting surface area.
- Radiance is specified in watts/cm / steradia.Radiance is important in defining source to fiber coupling efficiency.
- Two types of light sources used in fiber optics are Light Emitting Diodes (LEDs) and Laser Diodes (LDs).
- LED is monochromatic incoherent source whereas laser diodes are monochromatic coherent sources

Characteristics of Light Source for Communication

- To be useful in an optical link, a light source needs the following characteristics :

i) It must be possible to operate the device continuously at a variety of temperatures for many years.

ii) It must be possible to modulate the light output over a wide range of modulating frequencies.

iii) For fiber links, the wavelength of the output should coincide with one of transmission windows for the fiber type used.

iv) To couple large amount of power into an optical fiber, the emitting area should be small.

v) To reduce material dispersion in an optical fiber link, the output spectrum should be narrow.

vi) The power requirement for its operation must be low.

vii) The light source must be compatible with the modem solid state devices.

viii) The optical output power must be directly modulated by varying the input current to the device.

ix) Better linearity to prevent harmonics and intermodulation distortion.

x) High coupling efficiency.

xi) High optical output power.

xii) High reliability.

xiii) Low weight and low cost.

xiv) High radiance : Radiance is ability of an optical source to emit optical power in a specified direction.

Direct and Indirect Bandgap Materials

- Materials in which a conduction band electron can recombine directly with a hole in the valance band is called **direct bandgap materials.**
- Since electron - hole recombination exists emission of light is possible in direct bandgap materials.
- There is no electron-hole recombination hence light emission is not possible in indirect bandgap materials.
- Direct bandgap materials have minimum energy of conduction band and maximum energy of valance band have the same value of wave vector but indirect bandgap materials have different value of wave vector.
- The energy of photon is hv in direct bandgap materials and life time of charge carriers is very less. The indirect bandgap materials have longer life time of charge carriers.
- Direct bandgap materials are used to fabricate rectifier diodes, transistors for amplifiers, switches and ICs.
- Examples of direct bandgap materials are InP. GaAs and examples of indirect bandgap materials are Si, Ge.

Difference between Direct Bandgap Semiconductor & Indirect Bandgap Semiconductor

Sr. No.	Direct band-Gap (DBG) semiconductor	Indirect Band-Gap (IBG) semiconductor
1.	A Direct Band-Gap (DBG) semiconductor is one in which the maximum energy level of the valence band aligns with the minimum energy level of the conduction band with respect to momentum.	An Indirect Band-Gap (IBG) semiconductor is one in which the maximum energy level of the valence band and the minimum energy level of the conduction band are misaligned with respect to momenttun.
2.	In a DBG semiconductor, a direct recombination takes place with the release of the energy equal to the energy difference between the recombining particles.	In case of a IBG semiconductor, due to a relative difference in the momentum, first, the momentum is conserved by release of energy and only after the both the momenta align themselves, a recombination occurs accompanied with the release of energy.

3.	The probability of a radiative recombination is high.	The probability of a radiative recombination is comparatively low.