Fundamentals of Solid State Physics

Optical Emission

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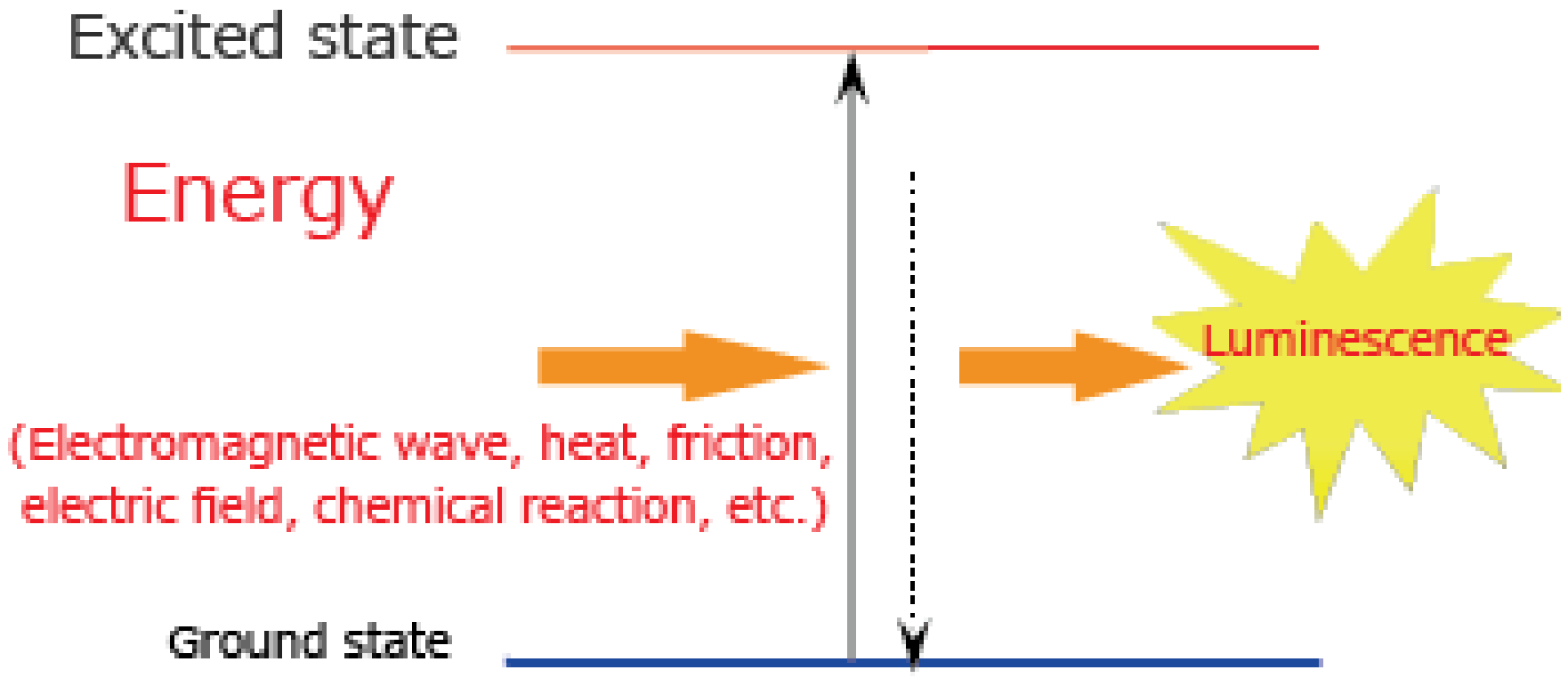
Optical Emission



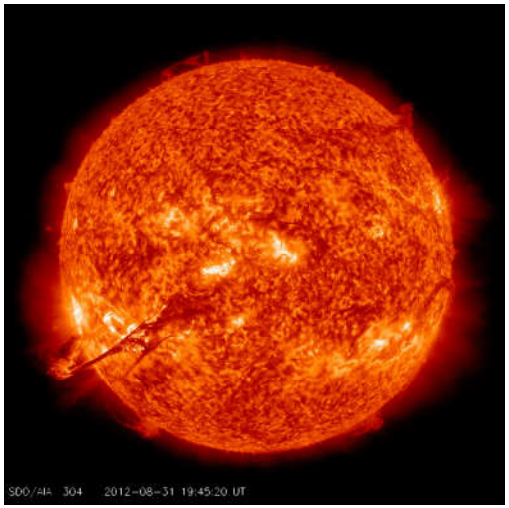
Optical Emission

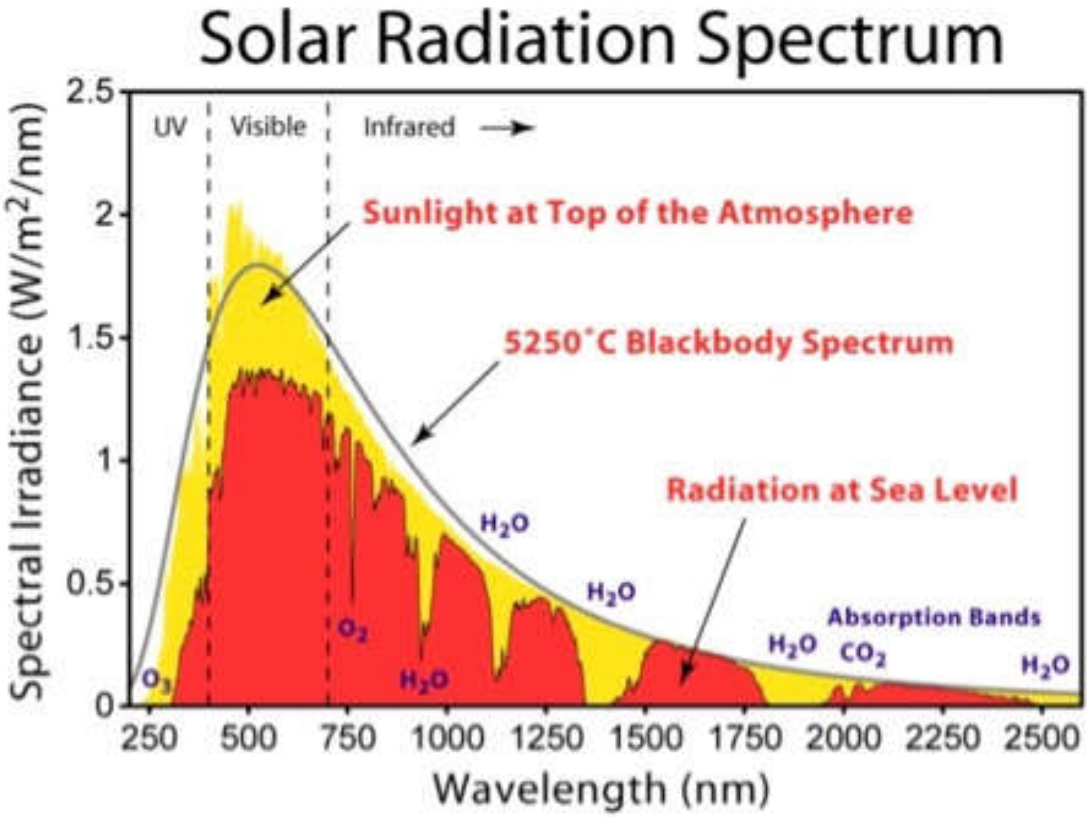
- Thermal radiation 热辐射
- Photoluminescence 光致发光
- Electroluminescence 电致发光
- Others
  - Chemiluminescence 化学发光
  - Bioluminescence 生物发光
  - Sonoluminescence 声致发光
  - ...

Thermal Radiation

- **Blackbody Radiation 黑体辐射**
  - ***S*(λ) - radiation power per unit area per unit wavelength (W/m²/nm)**

$$S(\lambda) = \frac{2\pi hc^2}{\lambda^5 (e^{hc/\lambda k_B T} - 1)}$$





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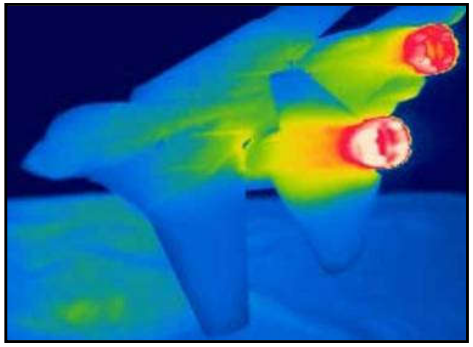
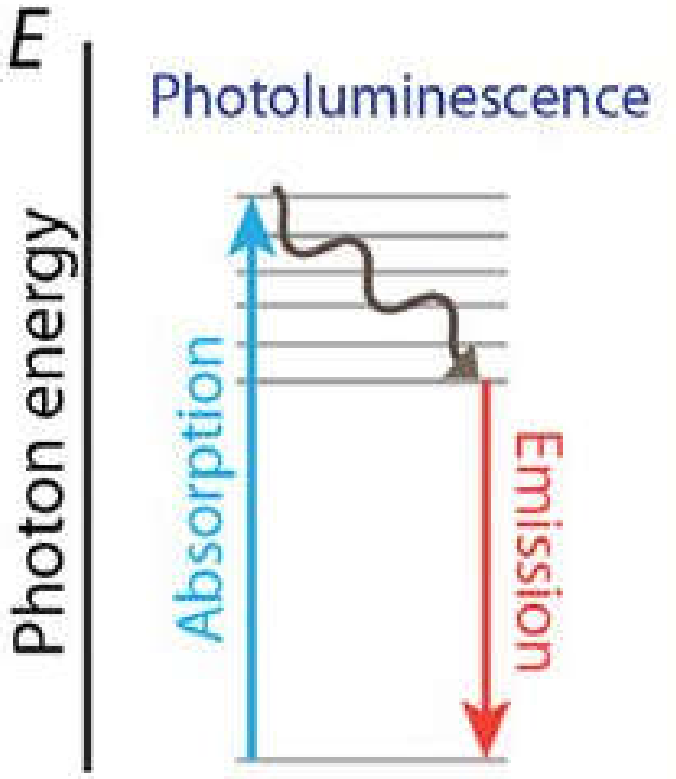


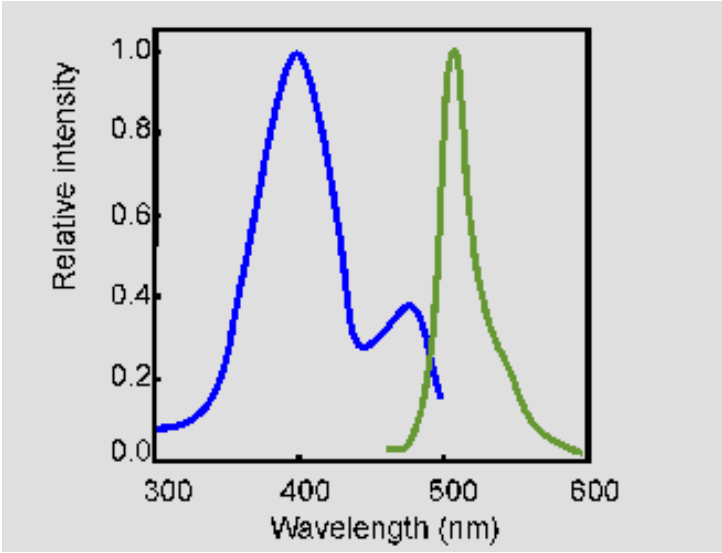
Photoluminescence

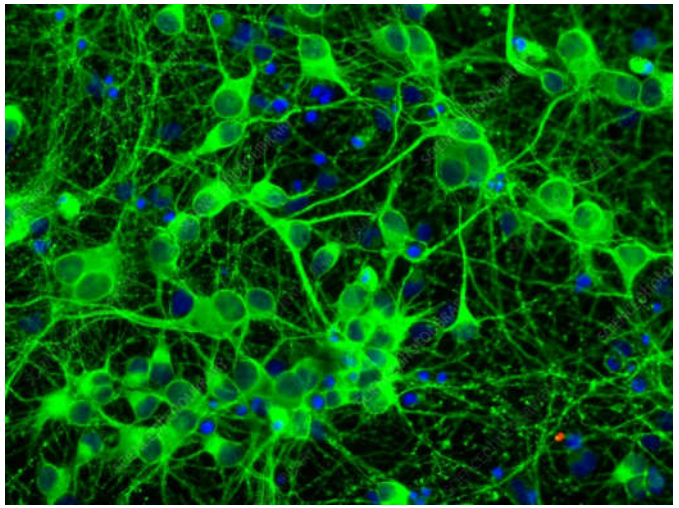


GFP
绿色荧光蛋白

M. Chalfie, *et al.*, *Science* 263, 802 (1994)

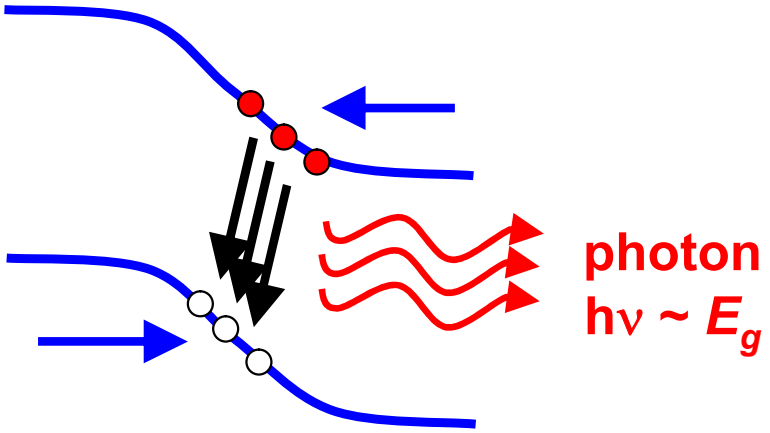
absorption **emission**

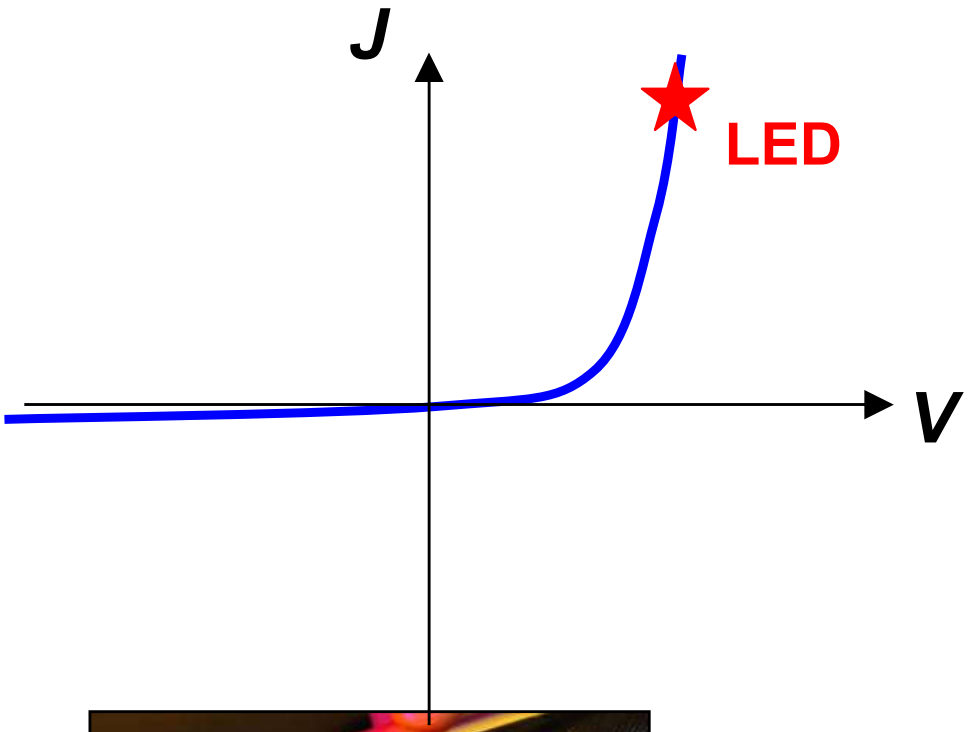




neuron cells

Electroluminescence



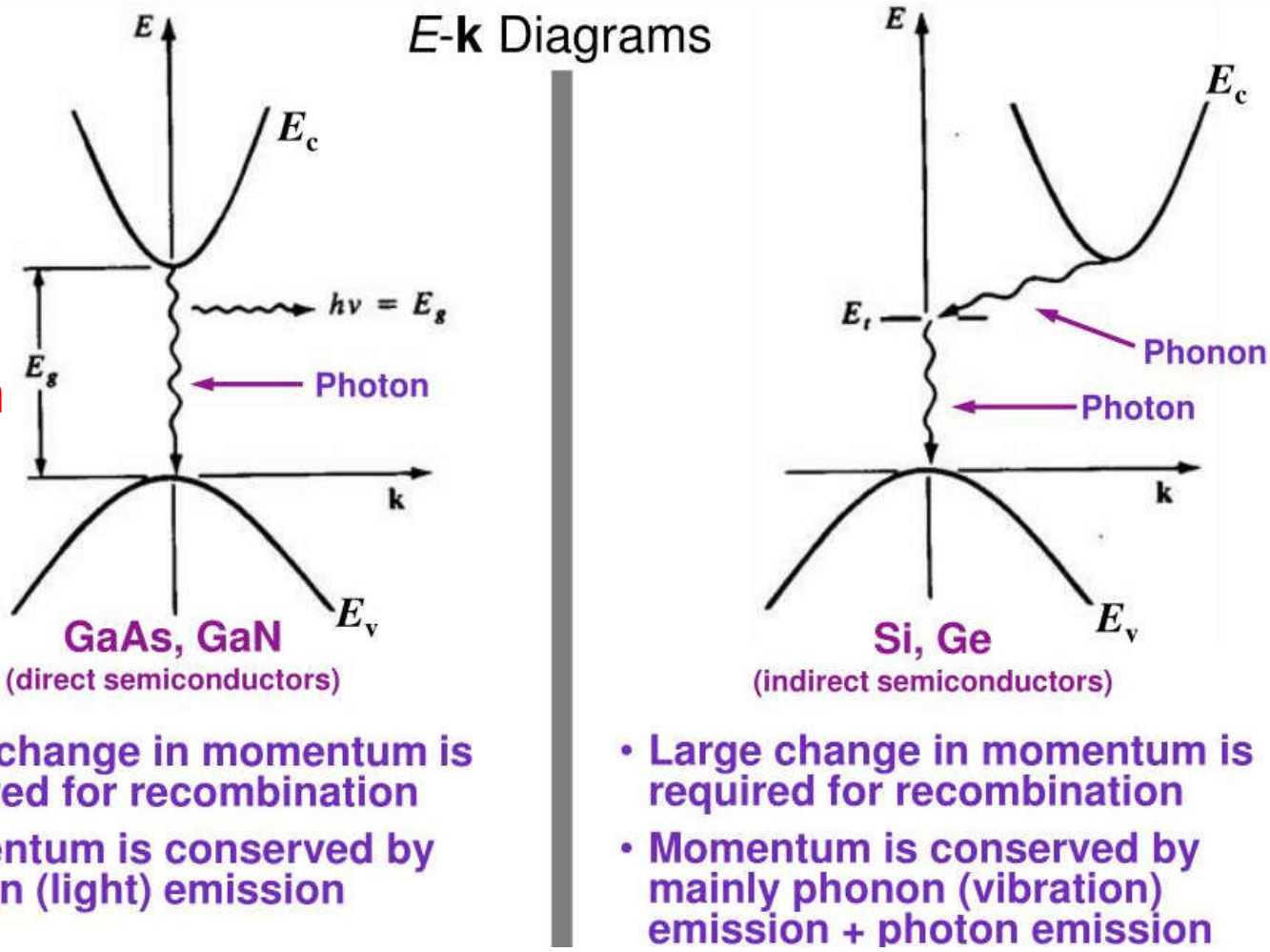


LEDs

lasers

Light Emission Efficiency

radiative recombination



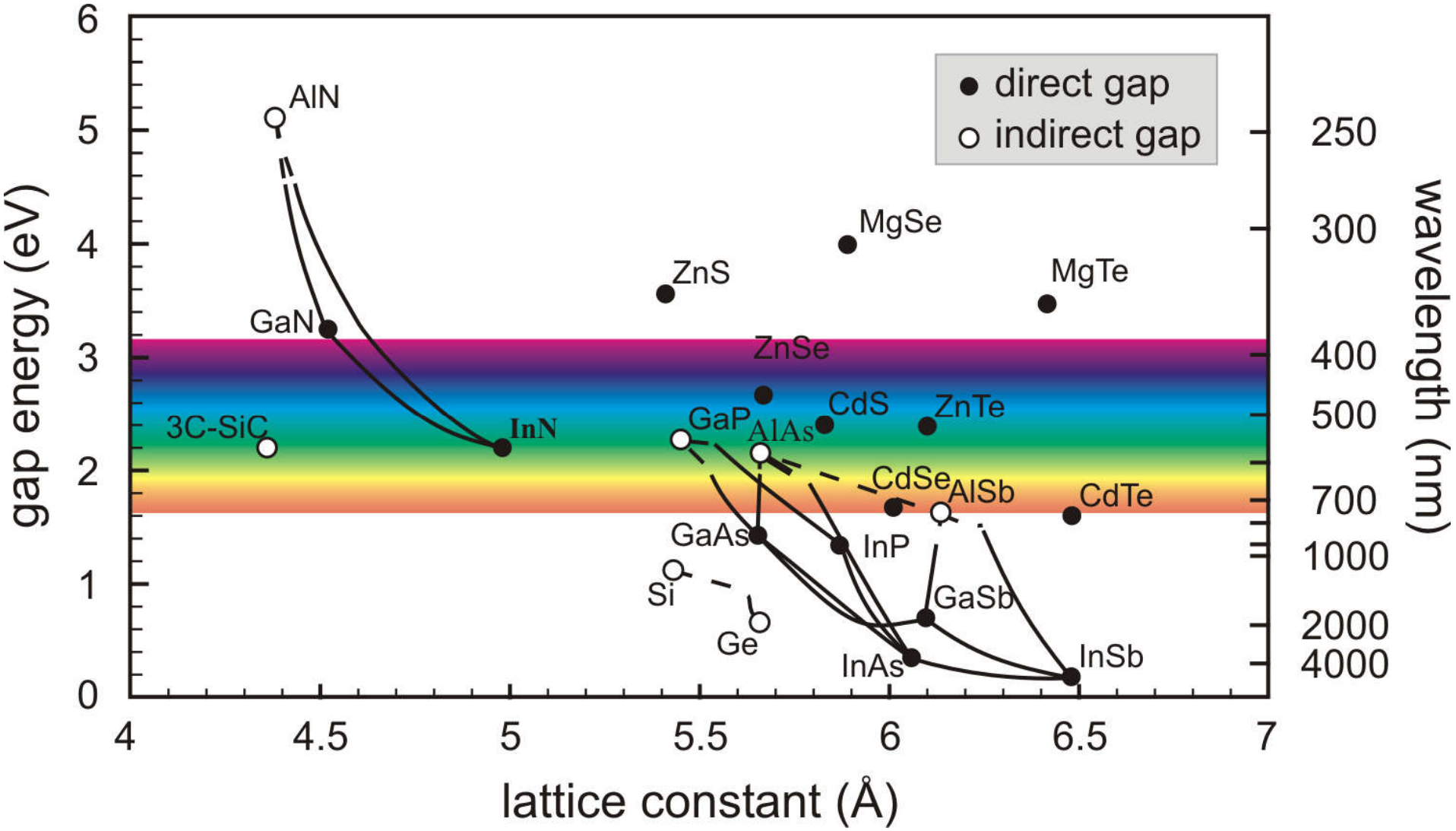
- Little change in momentum is required for recombination
- Momentum is conserved by photon (light) emission

- Large change in momentum is required for recombination
- Momentum is conserved by mainly phonon (vibration) emission + photon emission

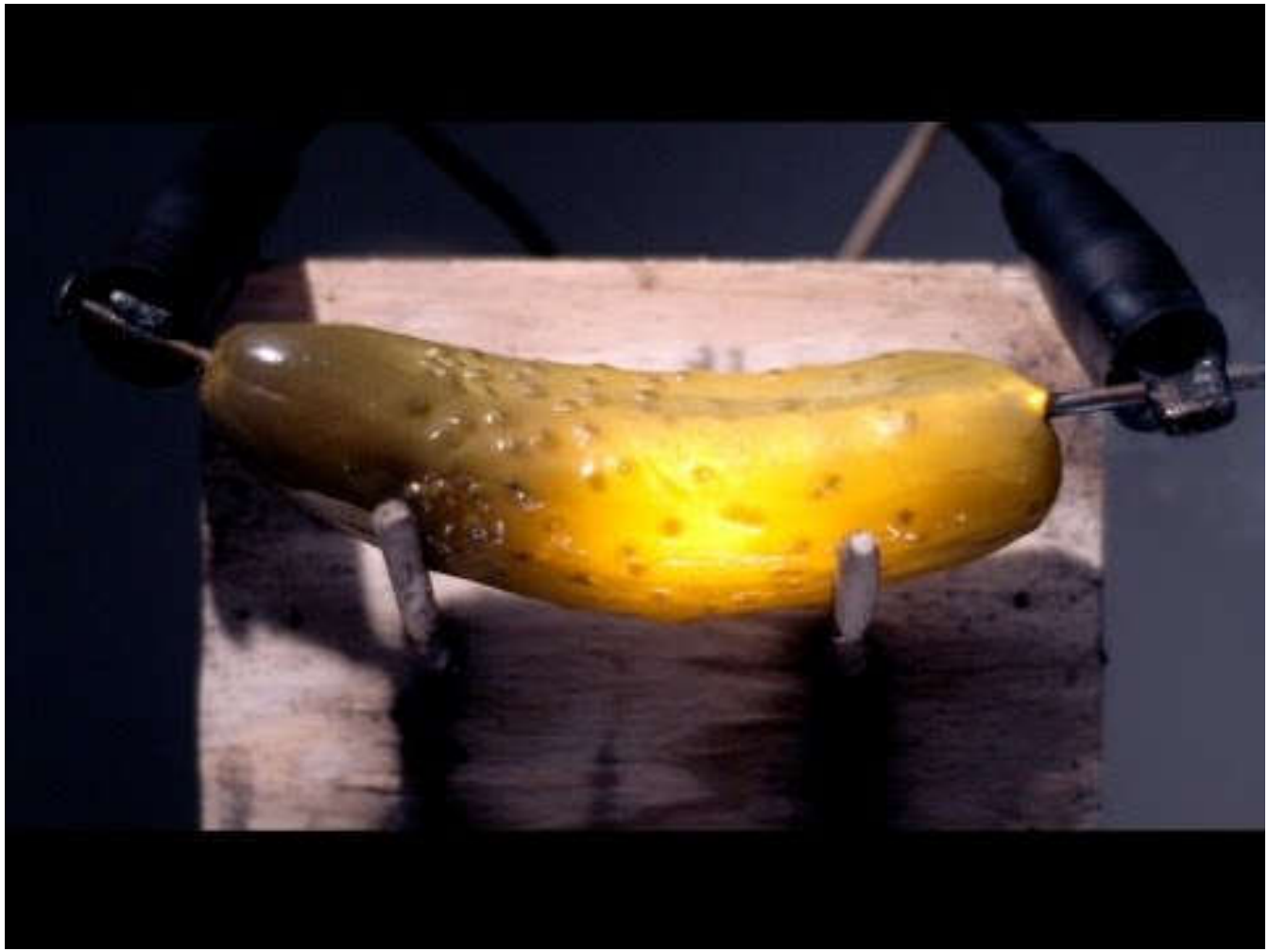
Direct bandgap semiconductors like GaAs, GaN are more suitable for LEDs and lasers

Indirect bandgap semiconductors like silicon do not emit light efficiently more non-radiative recombinations

Materials Choices for Light Emission



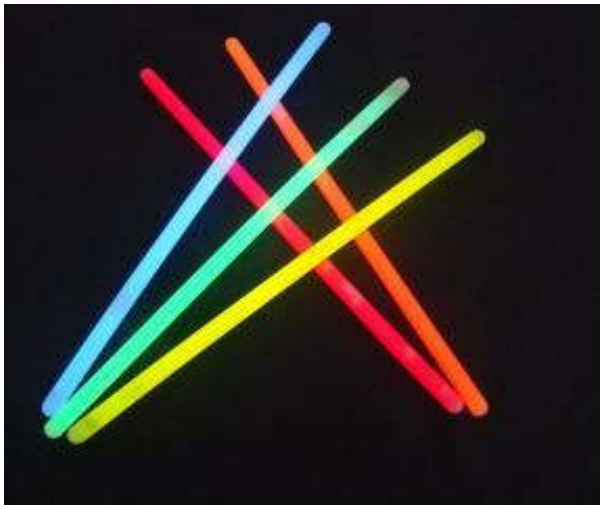
Electroluminescence



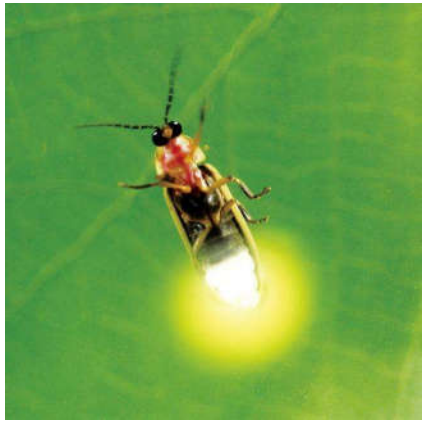
Pickle (腌黄瓜)
at 120 V

Video

Others

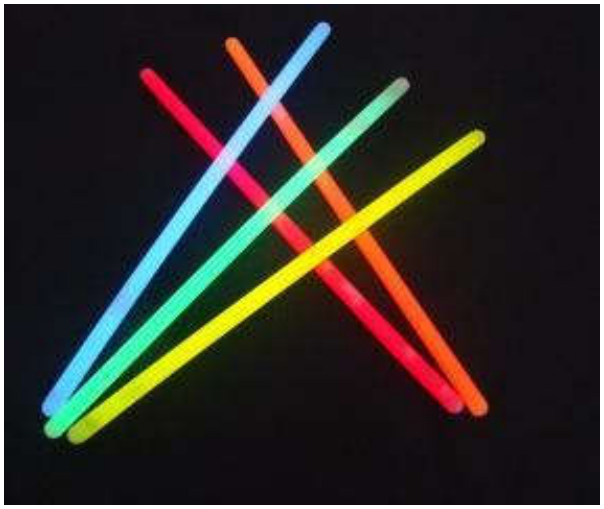


Chemiluminescence

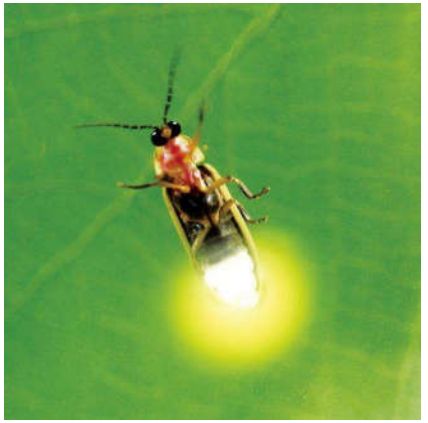


Bioluminescence

Others



Chemiluminescence



Bioluminescence

Triboluminescence

Sonoluminescence

Lighting 照明技术

Incandescent bulb
白炽灯

Fluorescent lamp
荧光灯

LED lamp

Q: What are the differences?

Thank you for your attention