Zapiski iz Predavanj

Optoeleketronika

Svetloba in Optika

(58)
povezava hitrosti, frekvence in valovne dolžine

$$c_0 = v \cdot \lambda_0$$

Energija fotona $E_{ph}(J, eV)$

$$E_{ph}[J] = h \cdot v = h \cdot \frac{c}{\lambda}$$

$h \rightarrow$ Planckova konstanta 6.626·10-34 Js
$q \rightarrow$ osnovni naboj (1.6 ·10-19 As)
$v \rightarrow$ frekvenca svetlobe
$c \rightarrow$ hitrost svetlobe co = 3·108 m/s
$\lambda \rightarrow$ valovna dolžina svetlobe

parametri s katerimi opišemo lastnosti materiala

$\epsilon \rightarrow$ dielektričnost (permitivnost) snovi
$\mu \rightarrow$ permeabilnost snovi

Lomni količnik (69)

$$N(\lambda) = n(\lambda) - jk(\lambda)$$

$N \rightarrow$ kompleksni lomni količnik
$n \rightarrow$ realni lomni količnik
$k \rightarrow$ koeficient slablenja

$$\alpha(\lambda) = \frac{4\pi k(\lambda)}{\lambda}$$

$\alpha \rightarrow$ absorpcijski koeficient (72)

Odboj in lom (prepuščanje) svetlobe (78)

pravokotni vpad
Fresnelova koeficienta r in t

$$r = \frac{N_1 - N_2}{N_1 + N_2}$$

N $\rightarrow$ kompleksni lomni količnik

Polarizacija svetlobe (81)

TE $\rightarrow$ transverzalna električna, s
TM $\rightarrow$ transverzalna magnetna, p

Geometrisja optika (97)

uporabljamo Snell-ov lomni zakon dvakrat

različne valovne dolžine se lomijo drugače.

interferenčni efekti (102)

debelina prodiodbojne plasti, d

$$d = \frac{\lambda}{4}$$

Odboj in Lom Svetlobe (80)

Snellov lomni zakon

$$\frac{\sin \phi_{inc}}{\sin \phi_T} = \frac{N_2}{N_1}$$

pri TE polarizaciji

$$r_{TE} = \frac{\cos \phi_{INC} - \sqrt{\frac{N_2^2}{N_1^2} - \sin^2 \phi_{INC}}}{\cos \phi_{INC} + \sqrt{\frac{N_2^2}{N_1^2} - \sin^2 \phi_{INC}}}$$

pri TM polarizaciji

$$r_{TM} = \frac{\sqrt{\frac{N_2^2}{N_1^2} - \sin^2 \phi_{INC}} - \frac{N_2^2}{N_1^2} \cos \phi_{INC}}{\sqrt{\frac{N_2^2}{N_1^2} - \sin^2 \phi_{INC}} + \frac{N_2^2}{N_1^2} \cos \phi_{INC}}$$

Enačba tanke leče

$$\frac{1}{F} = \frac{1}{O} + \frac{1}{S}$$

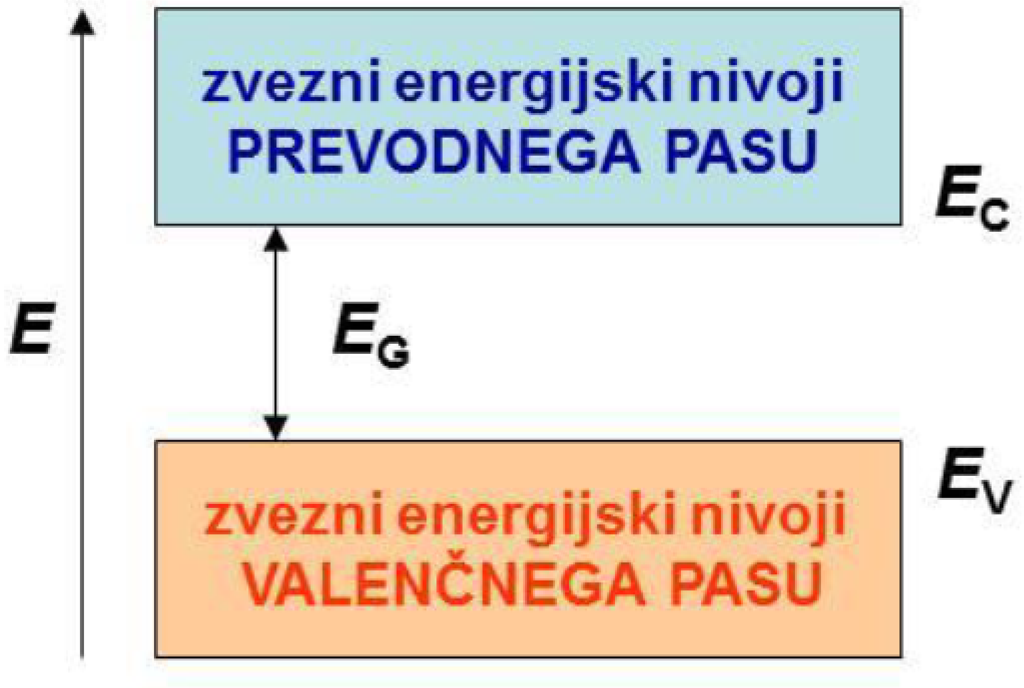
Optični viri (163)

- Naravni

- Umetni
    - Žarnice
    - sijalke na osnovi ionizacije plina
    - elektroluminiscenčni viri
    - laserski izvori
    - ostalo

Polprevodnik - Energijski Pasovi (180)

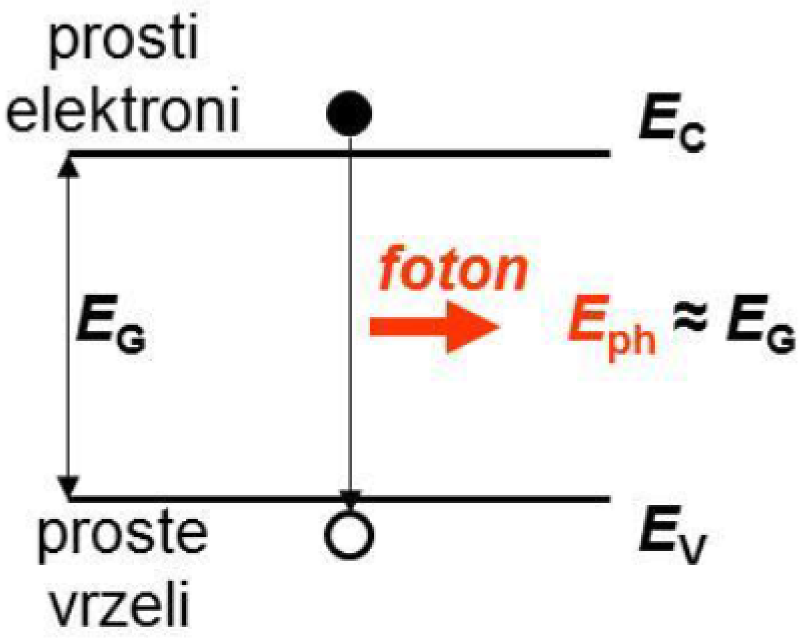
izoliran atom Ge diskretni energijski nivoji $\longrightarrow$ mnogo vezanih atomov polprevodnika zvezni energijski nivoji (pasovi)



Polprevodnik - Nastanek Svetlobe

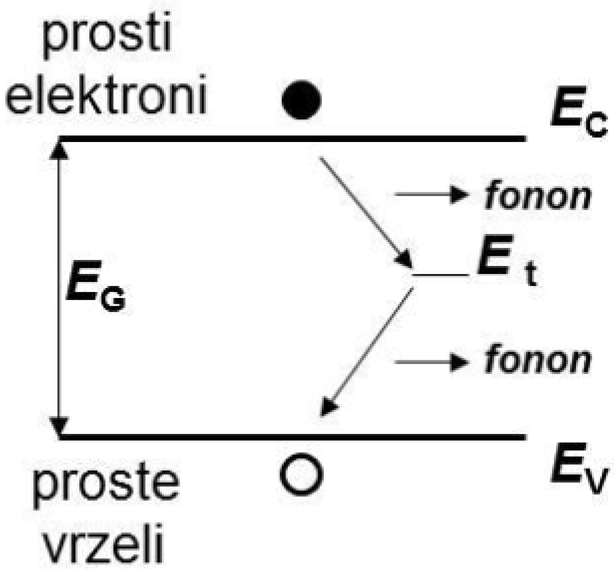
Rekombinacije prostih nosilcev

- Direktni



Sevalne rekombinacije

- Indirektni (posredni)



Nesevalne rekombinacije (185)

Indirektni polprevodnik v splošnem ne sevajo (veliko) svetlobe. Direktni prehodi iz E_C v E_V so le malo verjetni. Obstajajo prehodi preko vmesnih energijskih nivojev E_t v reži (defekti strukture).
Namesto fotonov se ustvarijo **fononi** (vibracije strukture) primer: Si, Ge, GaP

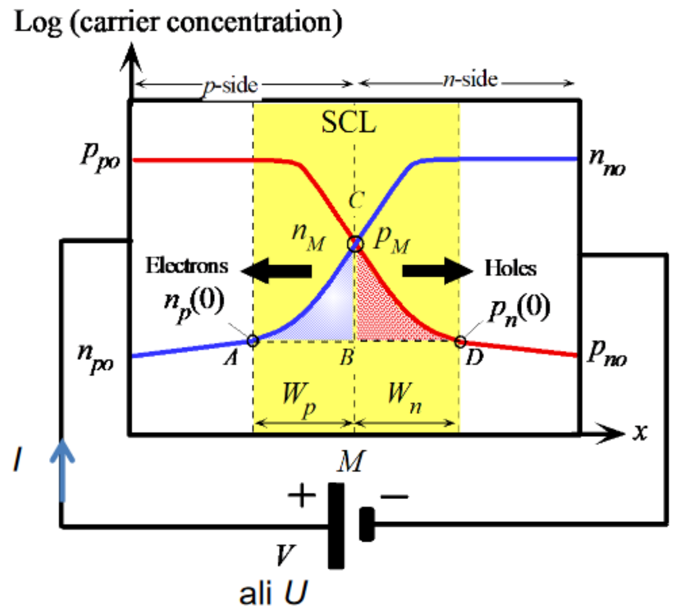
Svetleče Diode (LED) (192)

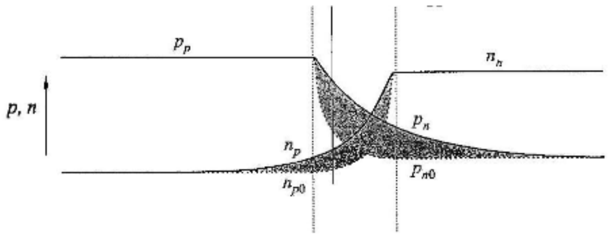
Led Emitting Diode

- na osnovi polprevodnikov
- na osnovi organskih materialov (OLED)

princip delovanja (200)

prevodno polariziran pn-spoj iz **direktnega** polprevodnika

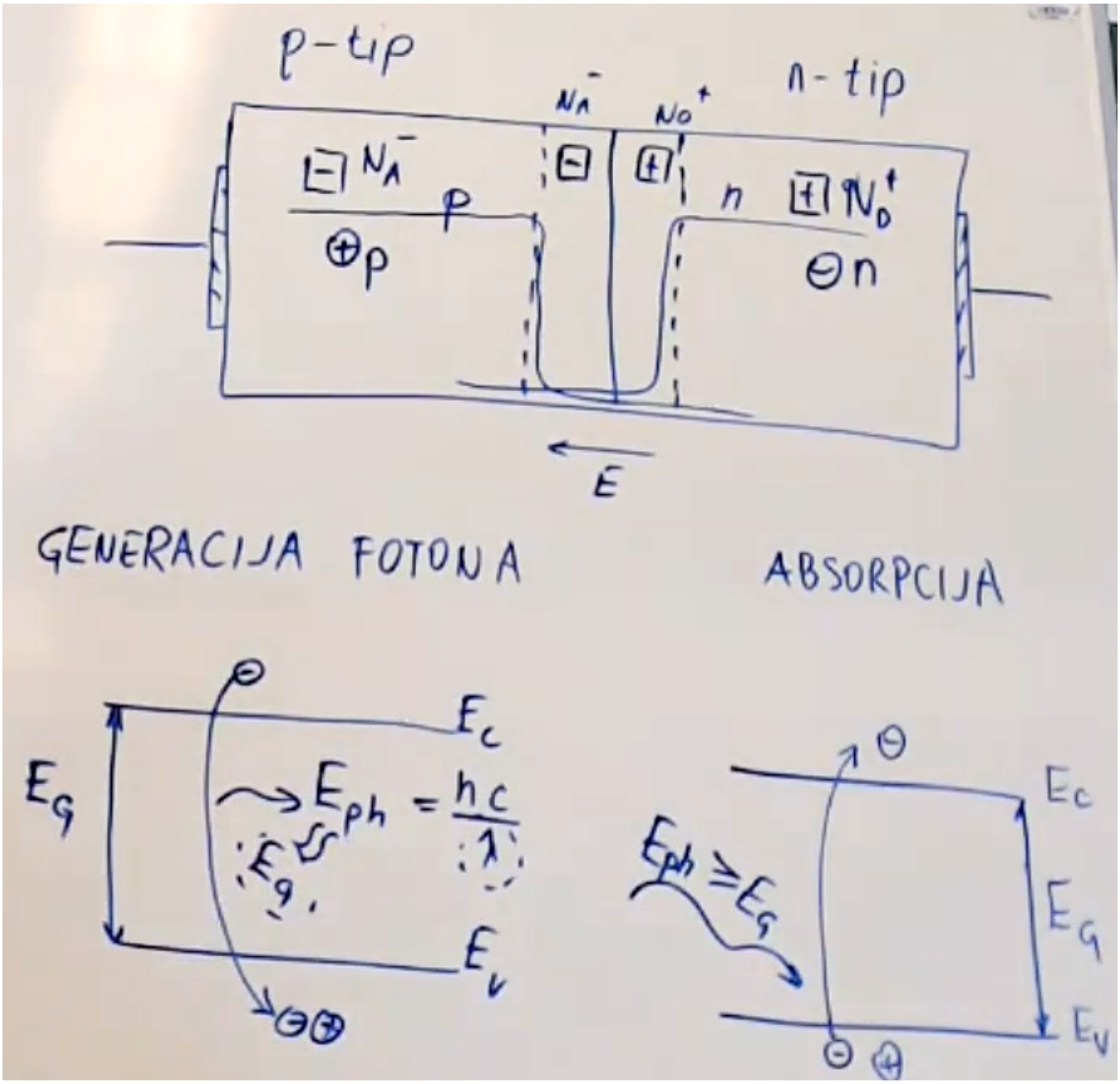




povečanje koncentracij obeh tipov nosilcev prehodnem območju v primeru priključene napetosti (slika s PE)

Dva pojava

- generacija fotona
- absorpcija fotona



struktura, ki je še bolje kot PN spoj

LED z dvojnim heterospojem - DH LED (206)

rabimo tri plasti

ChatGPT explains
Double heterojunction LED (DH LED) works by using two different semiconductor materials to construct the LED. One material is used for the active layer, where the majority of the light is generated, and the other material is used for the cladding layers. The cladding layers help to confine the light generated in the active layer and improve the overall efficiency of the LED.

The double heterojunction structure creates an energy band alignment between the active layer and the cladding layers. This alignment prevents recombination of electrons and holes in the cladding layers, which leads to a higher external quantum efficiency (EQE) and brighter light output. Additionally, the *double heterojunction structure also helps to reduce the amount of heat generated during operation, which can lead to a longer lifespan for the LED.*

Overall, the use of double heterojunction technology in DH LED lights allows for greater efficiency and higher brightness compared to traditional LED lights.

Svetleče diode, ki sevajo belo svetlobo

- RGB izvedba
- luminiscenčna prevleka (fosforna)

barvna temperatura

- na koliko kelvinov bi mogli segret črno telo da bi sevalo s tako barvo

CRI - Color rendering index (243)

pol mamo pa se **RA** parameter, tako da lahko primerjamo barve

Definicije izkoristkov LED

Notranji kvantni izkoristek:

$$\eta_{\mathrm{int}} = \frac{\text{št. ustvarjenih fotonov znotraj LED na sek.}}{\text{št. elektronov skozi LED na sek.}} = \frac{\frac{P_{\mathrm{int}}}{h\nu}}{\frac{I}{q}}$$

60 %

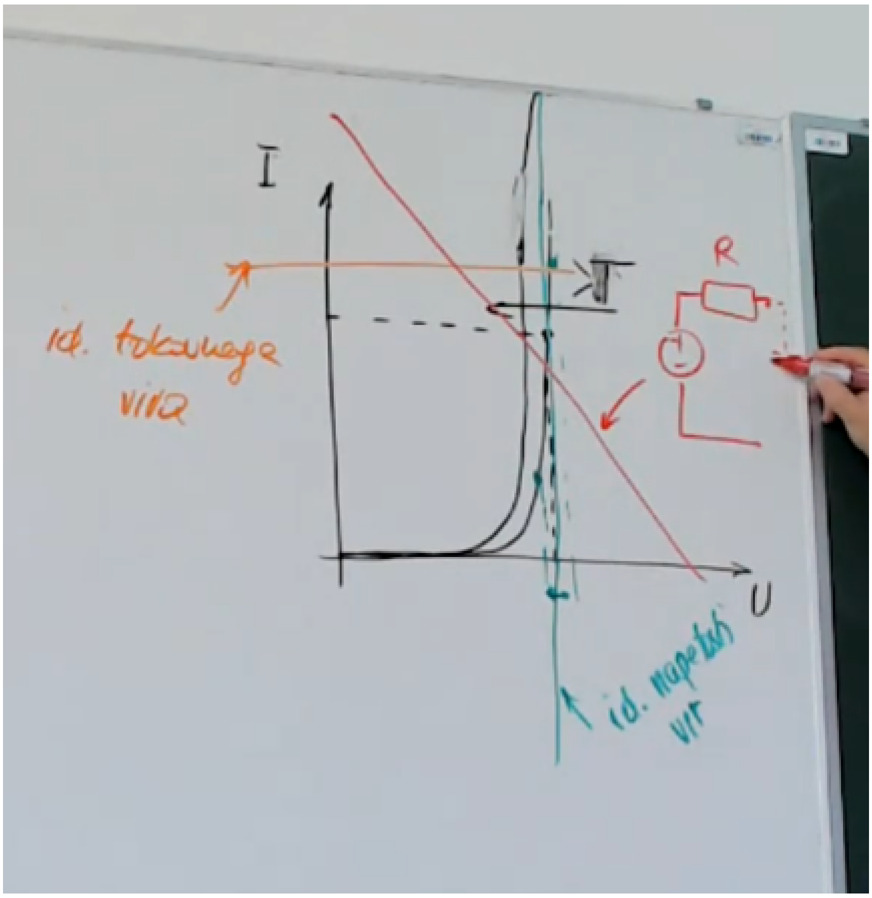
Izkoristek izstopa fotonov:

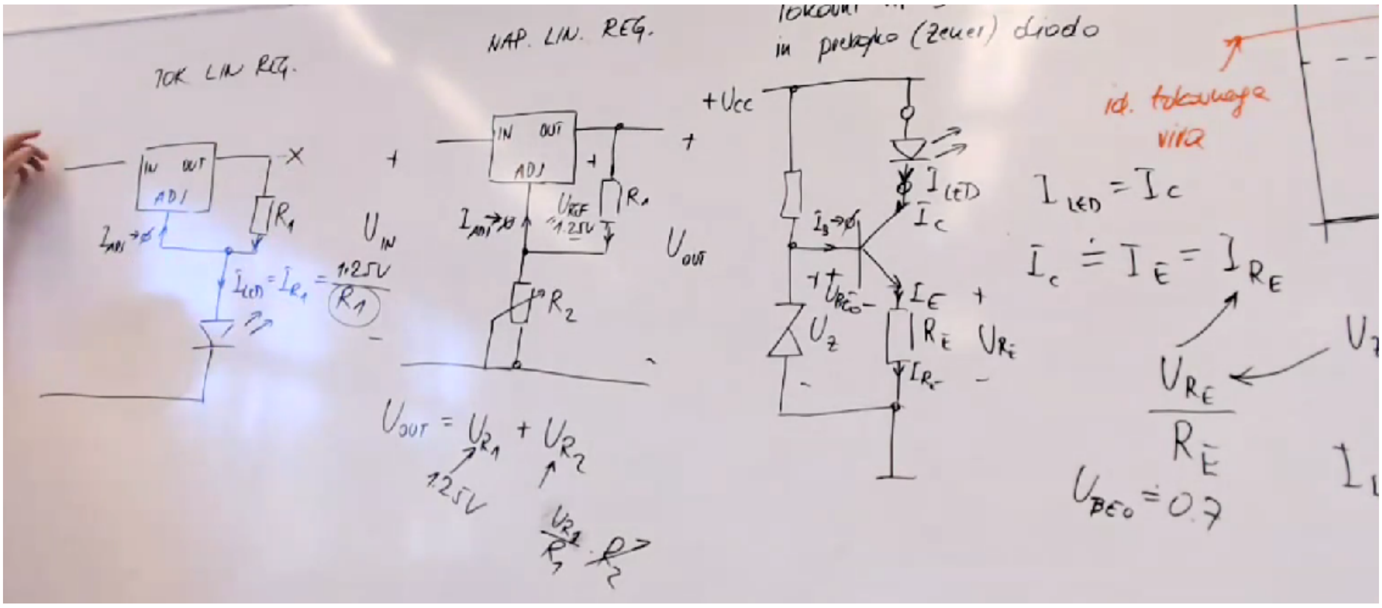
$$\eta_{\mathrm{extraction}} = \frac{\text{št. fotonov, ki izstopi iz LED na sek.}}{\text{št. ustvarjenih fotonov znotraj LED na sek.}}$$

75 %

Osnovne priključitve

tokovno, ne napetostno krmiljenje





OLED

LASER

laser works by generating light through the process of stimulated emission, which is amplified and directed by a resonator.

Stimulated emission occurs when an atom or molecule in an excited state (with an excess of energy) is stimulated by a photon (a particle of light) of the same energy and frequency, to emit its own photon. The emitted photon is in phase with the stimulating photon and travels in the same direction. This process can be repeated many times, causing the light to be amplified.

This process is made possible by the presence of a gain medium, which is a material that amplifies light. The gain medium is chosen to have the appropriate physical and chemical properties to allow the light to be amplified.

The gain medium is a key component of a laser that amplifies light through the process of stimulated emission. It is typically a crystal, liquid, or gas that is chosen to have the appropriate physical and chemical properties to allow the light to be amplified.

The gain medium is excited by an energy source, such as an electrical current or a flash lamp, which causes the atoms or molecules in the gain medium to absorb energy and become excited. Once the gain medium is excited, it begins to emit light, but instead of emitting light in all directions, the light is confined and directed by a resonator.

The light produced by stimulated emission is highly concentrated and intense, and it is directed by a resonator, which is an optical cavity made up of two mirrors, one of which is partially reflective. This allows the light to pass through and be amplified by the gain medium, but also reflects some of the light back into the gain medium.

Laserske diode