

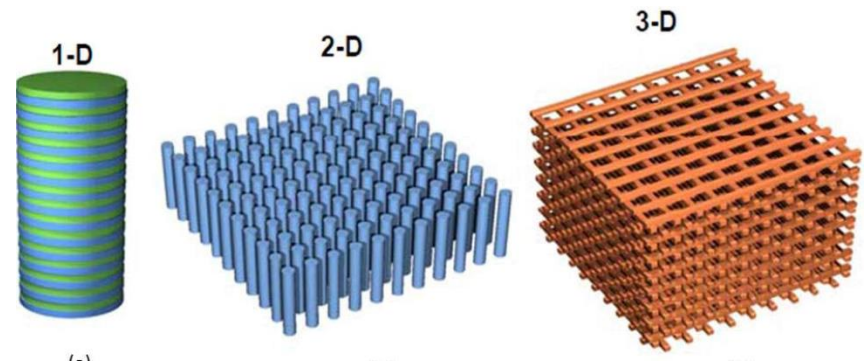
Photonic Crystal Vertical Cavity Surface Emitting Laser (PC-VCSEL)



Photonic Crystal Vertical Cavity Surface Emitting Laser PC-VCSEL

Photonic Crystal (PC)

- Periodic structure that guide OR stop the wave in certain direction.
- It can be a 1D, 2D, and 3D structure
 - Note, the DBR mirrors used in VCSEL can be considered as a 1D PC.



Robinson, S., and R. Nakkeer. 2013. 'Photonic Crystal Ring Resonator Based Optical Filters'. Advances in Photonic Crystals. InTech. doi:10.5772/54533.

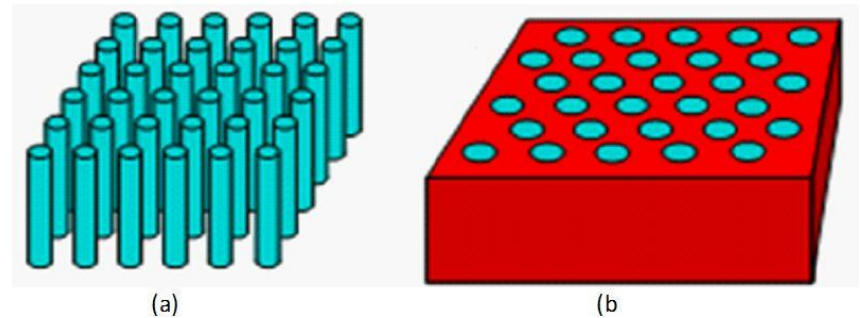


Photonic Crystal Vertical Cavity Surface Emitting Laser PC-VCSEL

 Photonic Crystal (PC)

 2D PC

- PC structure with 2D periodic and homogenous in the third direction
- Two main general variants
 - Dielectric rods in air
 - Air holes in dielectric region



Robinson, S., and R. Nakkeer. 2013. 'Photonic Crystal Ring Resonator Based Optical Filters'. Advances in Photonic Crystals. InTech. doi:10.5772/54533.



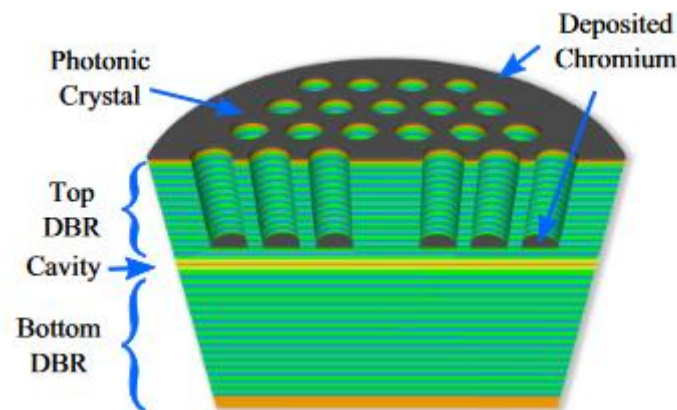
Photonic Crystal Vertical Cavity Surface Emitting Laser PC-VCSEL

 Photonic Crystal (PC)

 2D PC

 PCSEL

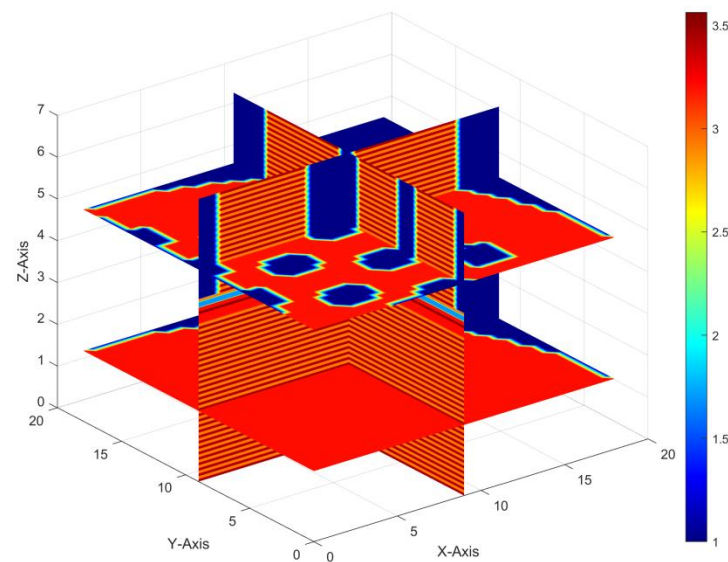
- A 2D PC is drilled inside the top DBR layer to focus the optical mode inside the cavity



Photonic Crystal Vertical Cavity Surface Emitting Laser PC-VCSEL



- Structure
 - Only quarter of structure was analyzed
 - Using the symmetrical / asymmetrical Boundary conditions to calculate optical modes

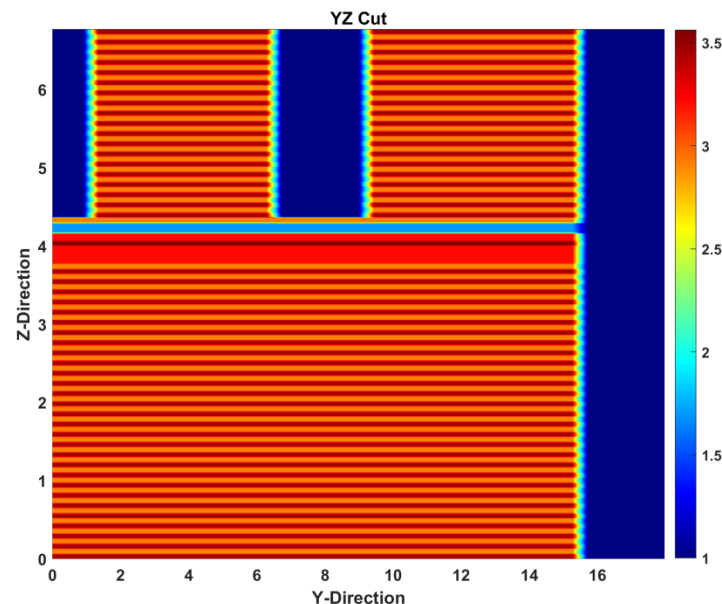


Photonic Crystal Vertical Cavity Surface Emitting Laser PC-VCSEL



□ Structure

- Only quarter of structure was analyzed
- Using the symmetrical / asymmetrical Boundary conditions
 - @ $X = \text{LenX}/2$

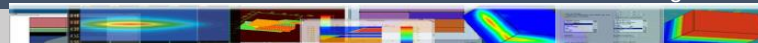
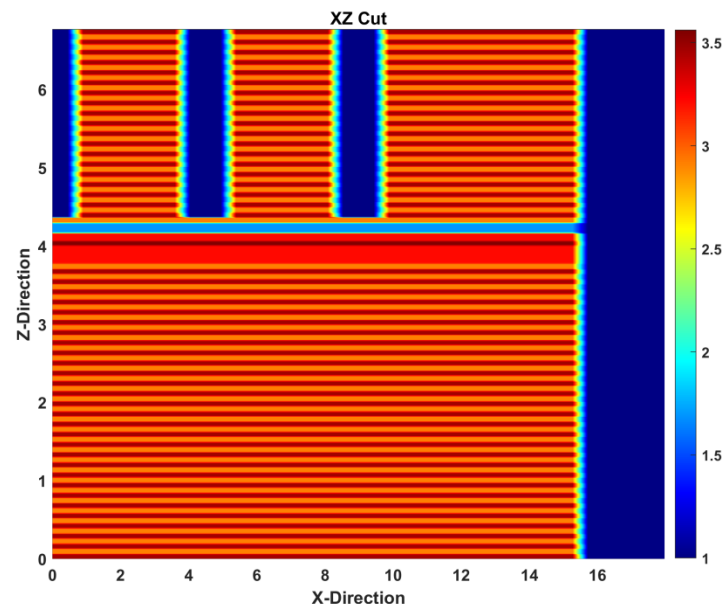


Photonic Crystal Vertical Cavity Surface Emitting Laser PC-VCSEL



□ Structure

- Only quarter of structure was analyzed
- Using the symmetrical / asymmetrical Boundary conditions
 - @ $X = \text{LenX}/2$
 - @ $Y = \text{LenY}/2$

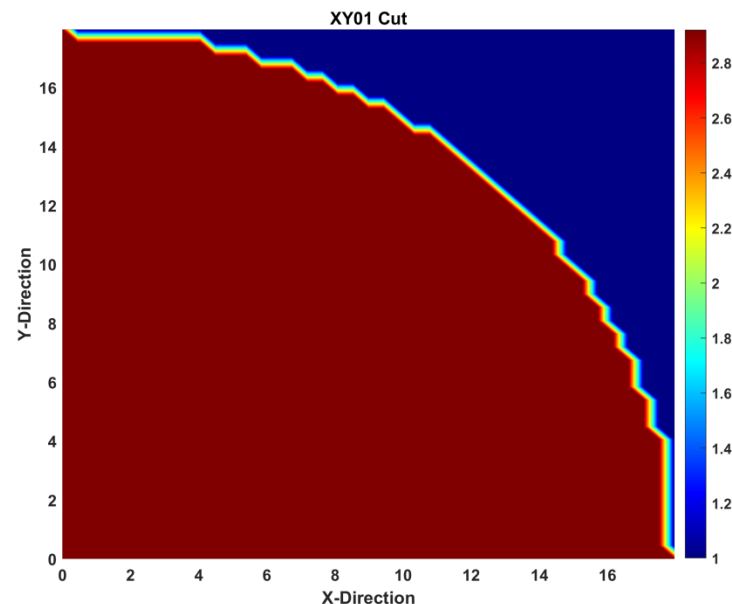


Photonic Crystal Vertical Cavity Surface Emitting Laser PC-VCSEL



□ Structure

- Only quarter of structure was analyzed
- Using the symmetrical / asymmetrical Boundary conditions
 - @ $X = \text{LenX}/2$
 - @ $Y = \text{LenY}/2$
 - @ $Z = \text{LenZ} * 0.25$

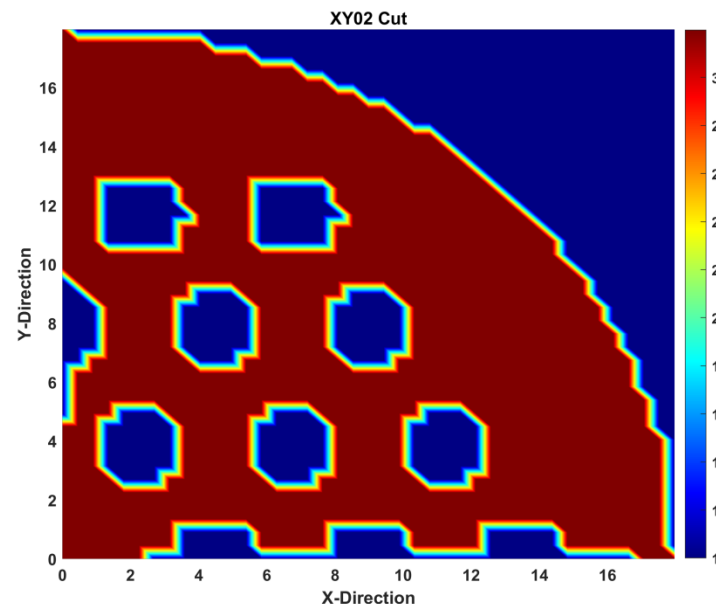


Photonic Crystal Vertical Cavity Surface Emitting Laser PC-VCSEL



□ Structure

- Only quarter of structure was analyzed
- Using the symmetrical / asymmetrical Boundary conditions
 - @ $X = \text{LenX}/2$
 - @ $Y = \text{LenY}/2$
 - @ $Z = \text{LenZ} * 0.25$
 - @ $Z = \text{LenZ} * 0.75$

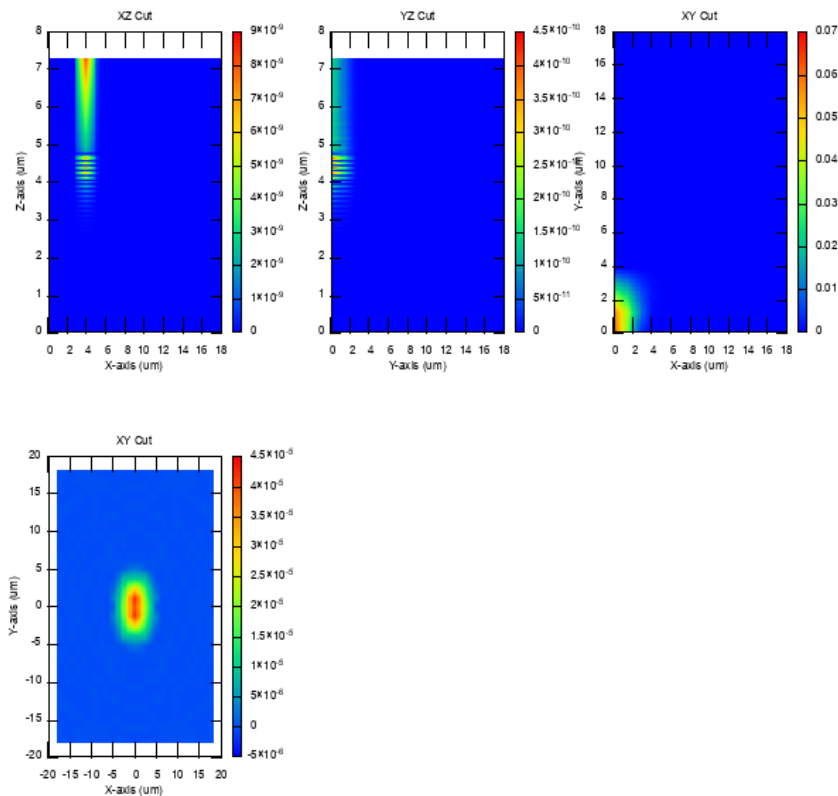


Photonic Crystal Vertical Cavity Surface Emitting Laser PC-VCSEL



PCSEL

- Structure
- Optical Modes
 - Mode #01
 - Res-Lambda0 = 0.84201793 μm

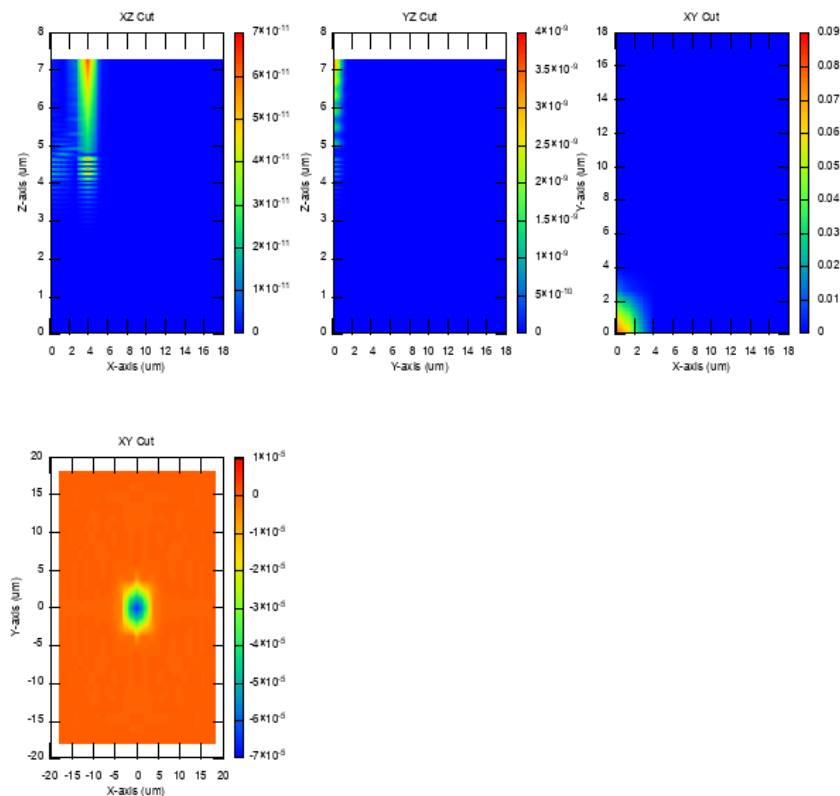


Photonic Crystal Vertical Cavity Surface Emitting Laser PC-VCSEL



PCSEL

- Structure
- Optical Modes
 - Mode #02
 - Res-Lambda0 = 0.8420158 um

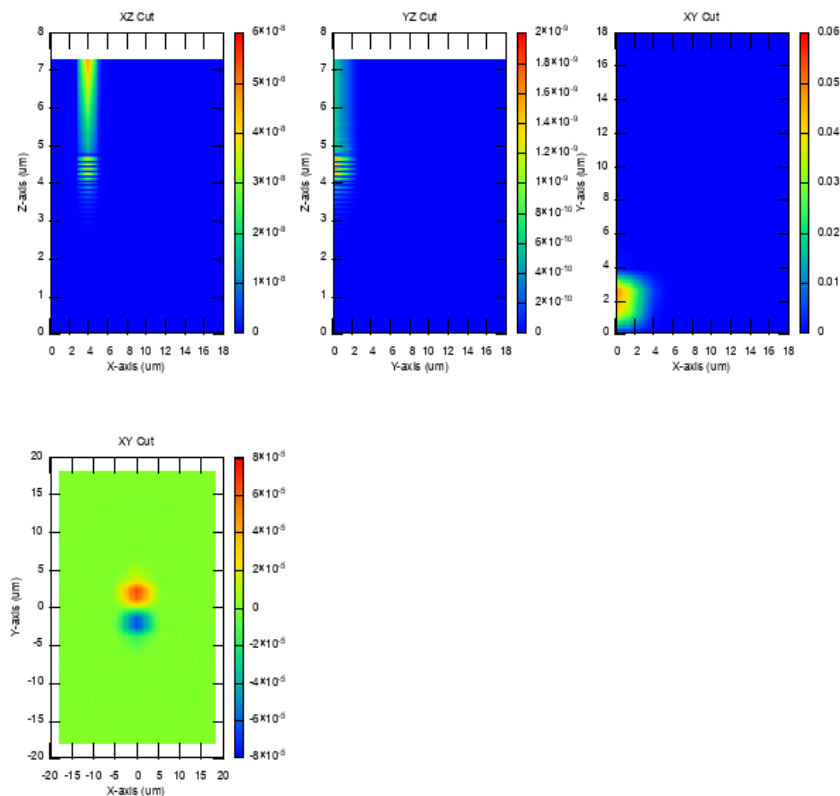


Photonic Crystal Vertical Cavity Surface Emitting Laser PC-VCSEL



PCSEL

- Structure
- Optical Modes
 - Mode #03
 - Res-Lambda0 = 0.8417980 um

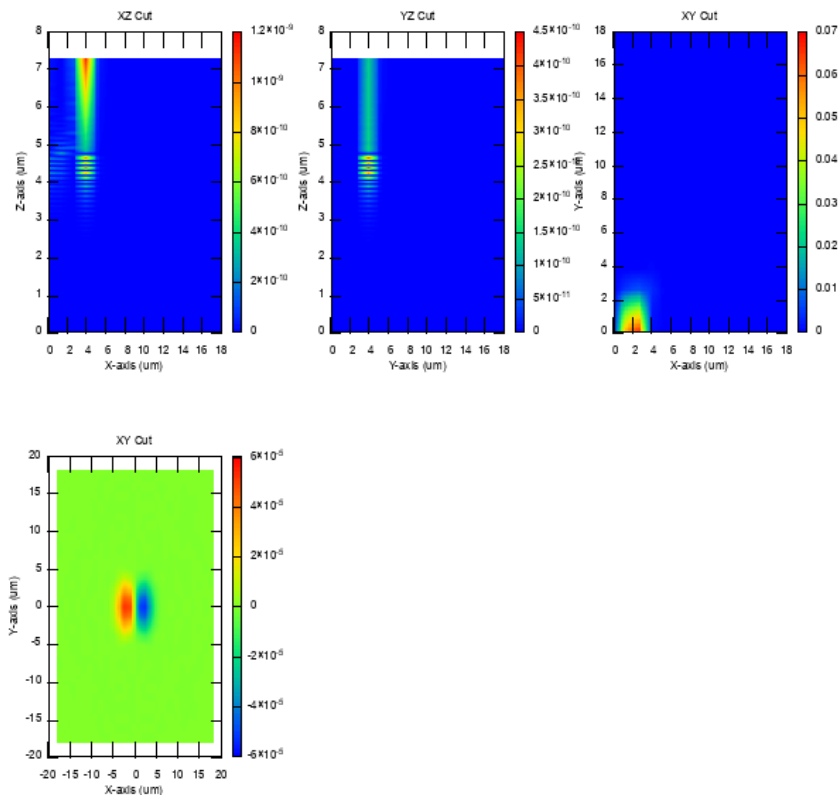


Photonic Crystal Vertical Cavity Surface Emitting Laser PC-VCSEL



PCSEL

- Structure
- Optical Modes
 - Mode #04
 - Res-Lambda₀ = 0.8417043 μm

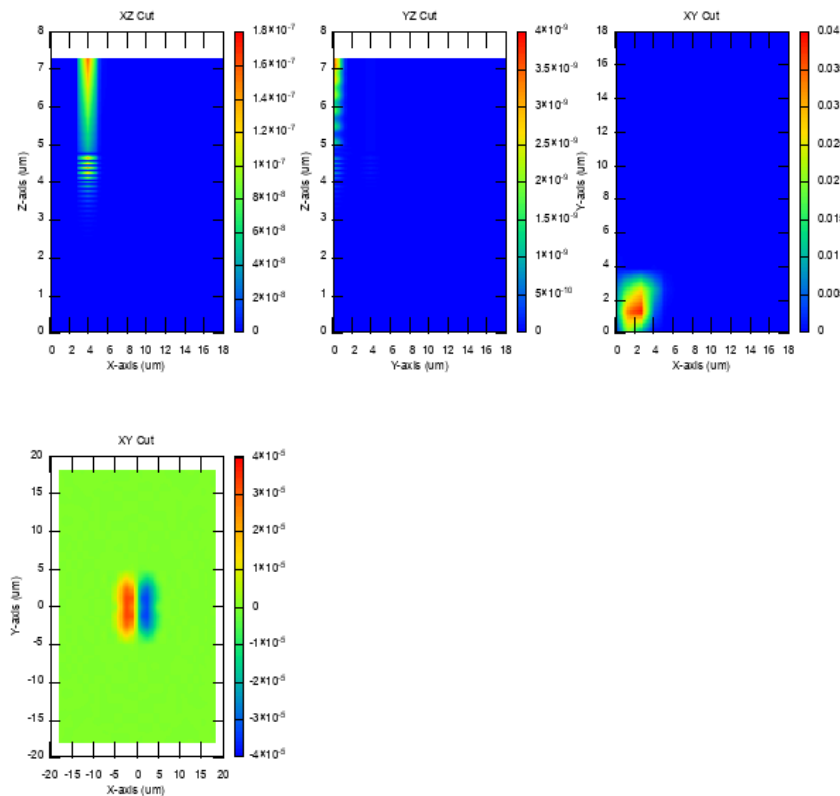


Photonic Crystal Vertical Cavity Surface Emitting Laser PC-VCSEL



PCSEL

- Structure
- Optical Modes
 - Mode #05
 - Res-Lambda₀ = 0.8416719 um

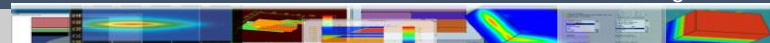
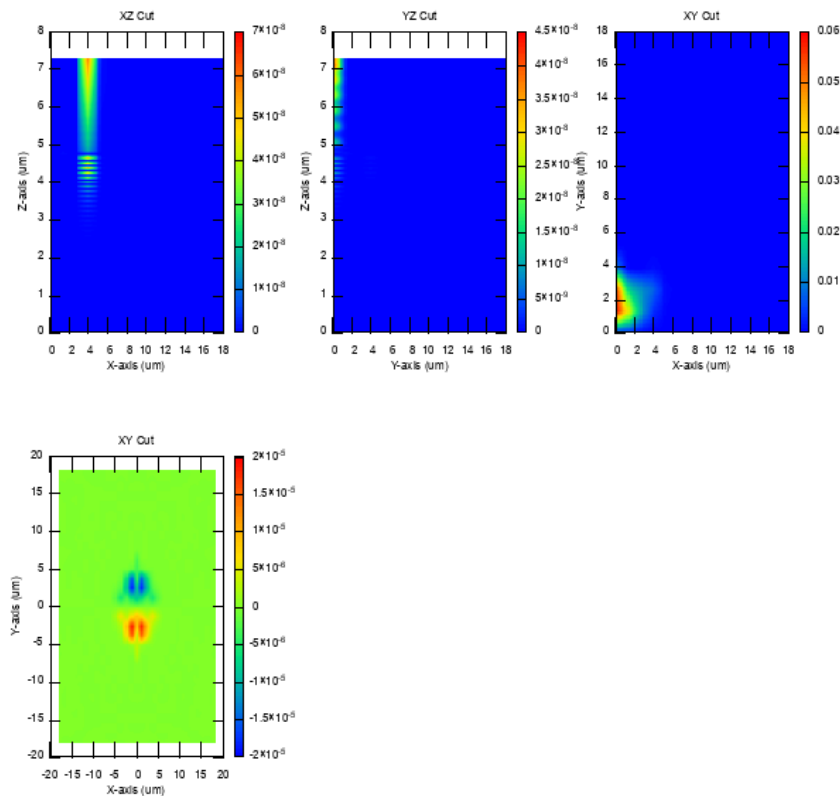


Photonic Crystal Vertical Cavity Surface Emitting Laser PC-VCSEL



PCSEL

- Structure
- Optical Modes
 - Mode #06
 - Res-Lambda0 = 0.8415835 um

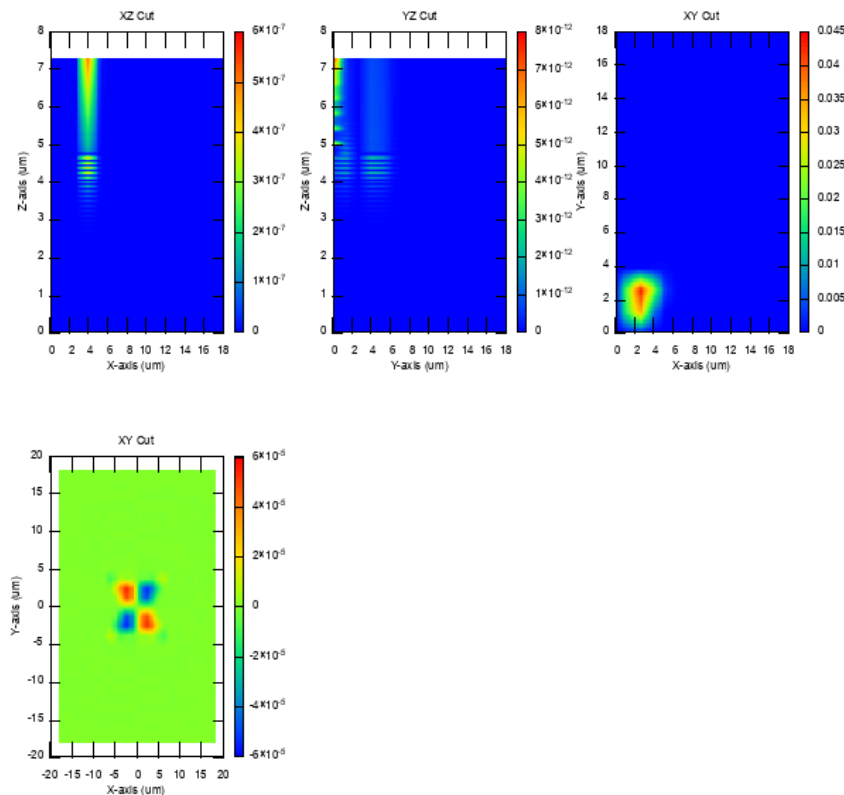


Photonic Crystal Vertical Cavity Surface Emitting Laser PC-VCSEL



PCSEL

- Structure
- Optical Modes
 - Mode #07
 - Res-Lambda0 = 0.8415491 um

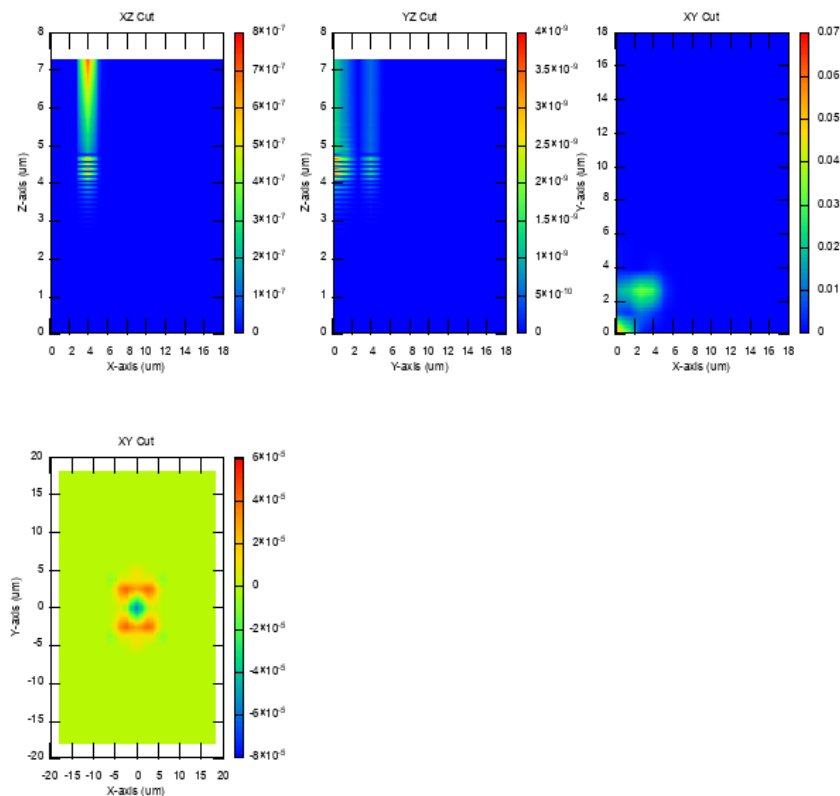


Photonic Crystal Vertical Cavity Surface Emitting Laser PC-VCSEL



PCSEL

- Structure
- Optical Modes
 - Mode #08
 - Res-Lambda0 = 0.8414225 um

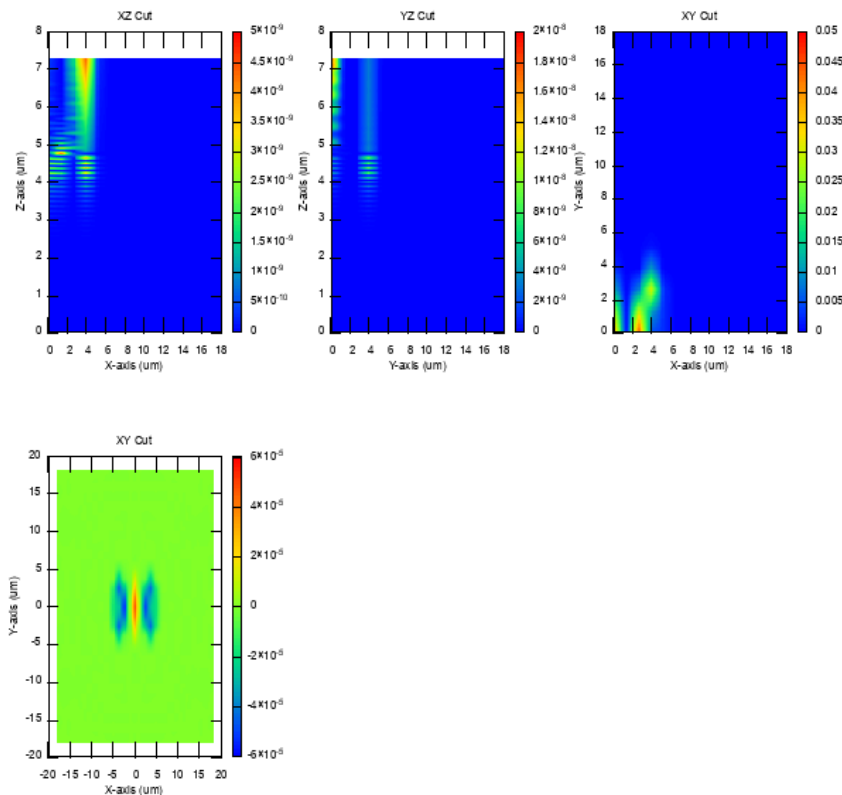


Photonic Crystal Vertical Cavity Surface Emitting Laser PC-VCSEL



PCSEL

- Structure
- Optical Modes
 - Mode #09
 - Res-Lambda0 = 0.8413913 μm

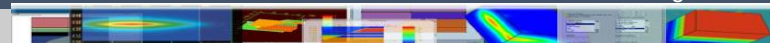
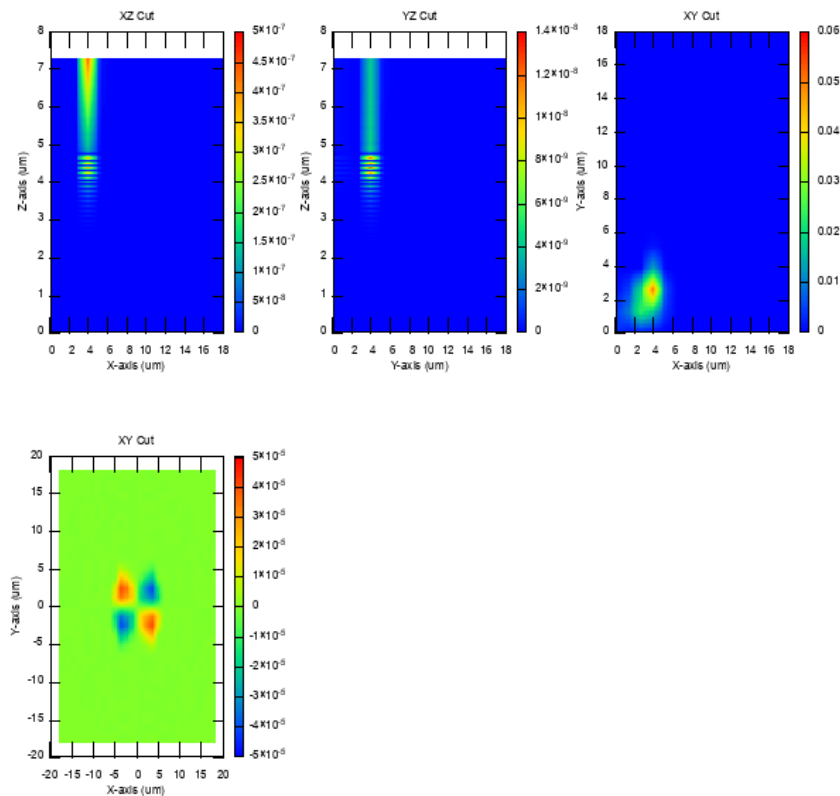


Photonic Crystal Vertical Cavity Surface Emitting Laser PC-VCSEL



PCSEL

- Structure
- Optical Modes
 - Mode #10
 - $\text{Res-Lambda}_0 = 0.8413890 \text{ } \mu\text{m}$

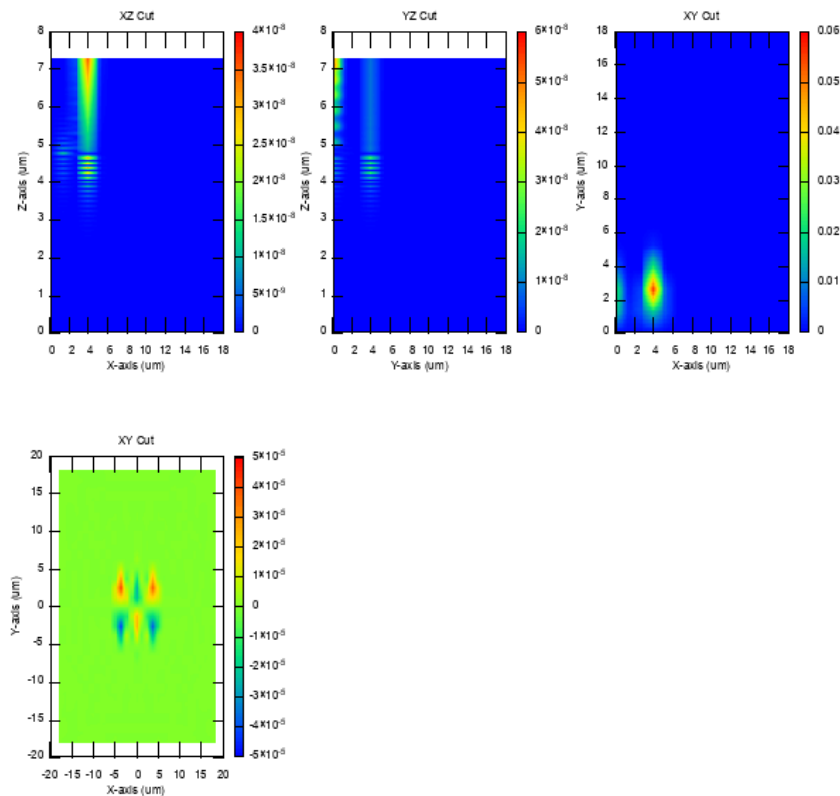


Photonic Crystal Vertical Cavity Surface Emitting Laser PC-VCSEL



PCSEL

- Structure
- Optical Modes
 - Mode #11
 - Res-Lambda0 = 0.8412996 um

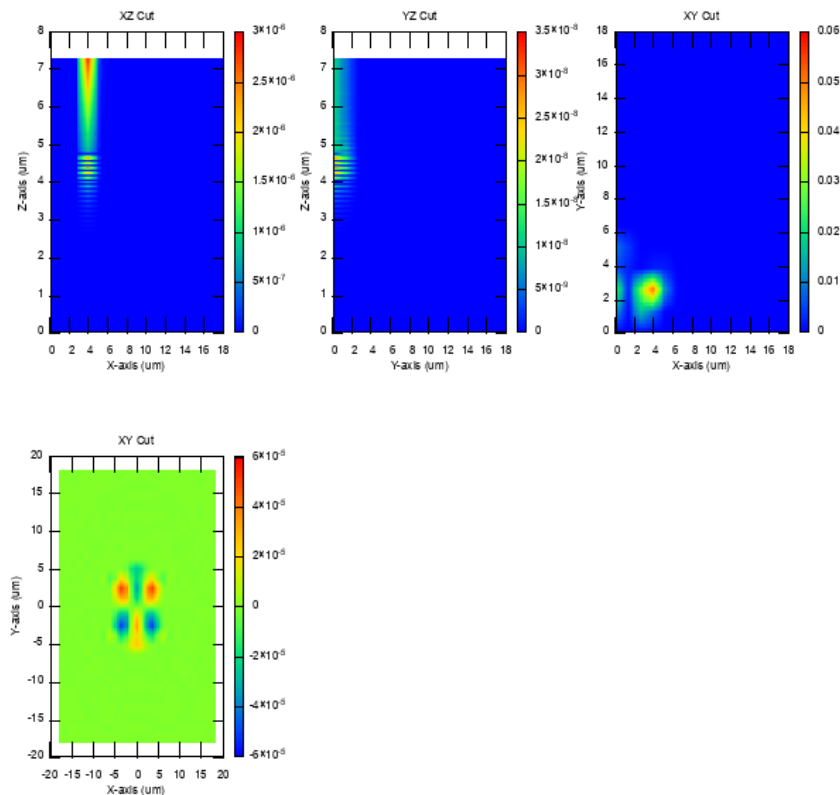


Photonic Crystal Vertical Cavity Surface Emitting Laser PC-VCSEL



PCSEL

- Structure
- Optical Modes
 - Mode #12
 - Res-Lambda0 = 0.8412917 um

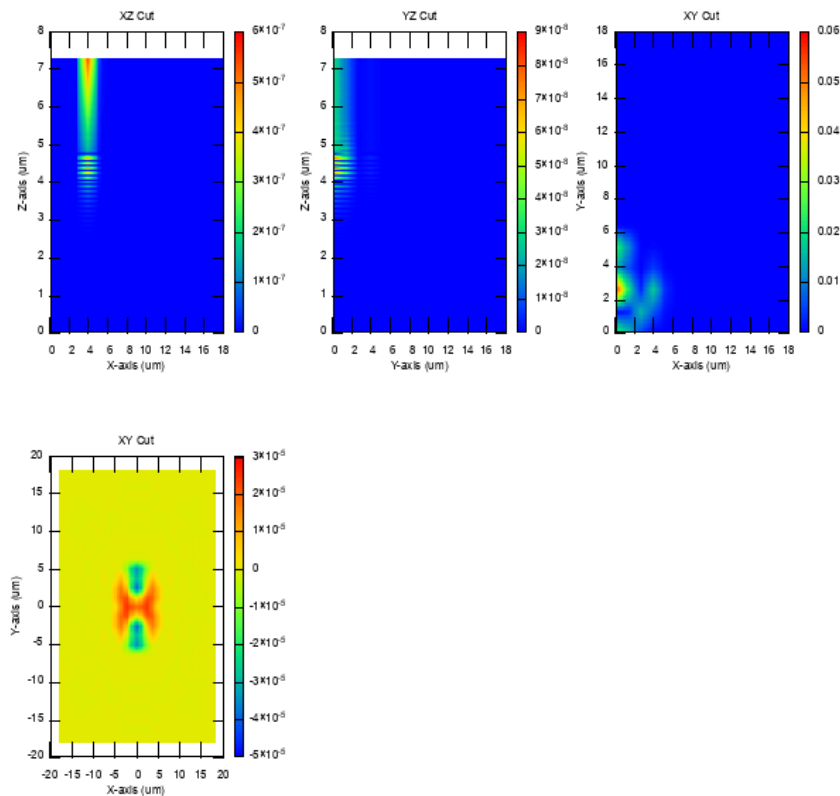


Photonic Crystal Vertical Cavity Surface Emitting Laser PC-VCSEL



PCSEL

- Structure
- Optical Modes
 - Mode #13
 - Res-Lambda₀ = 0.8412740 μm

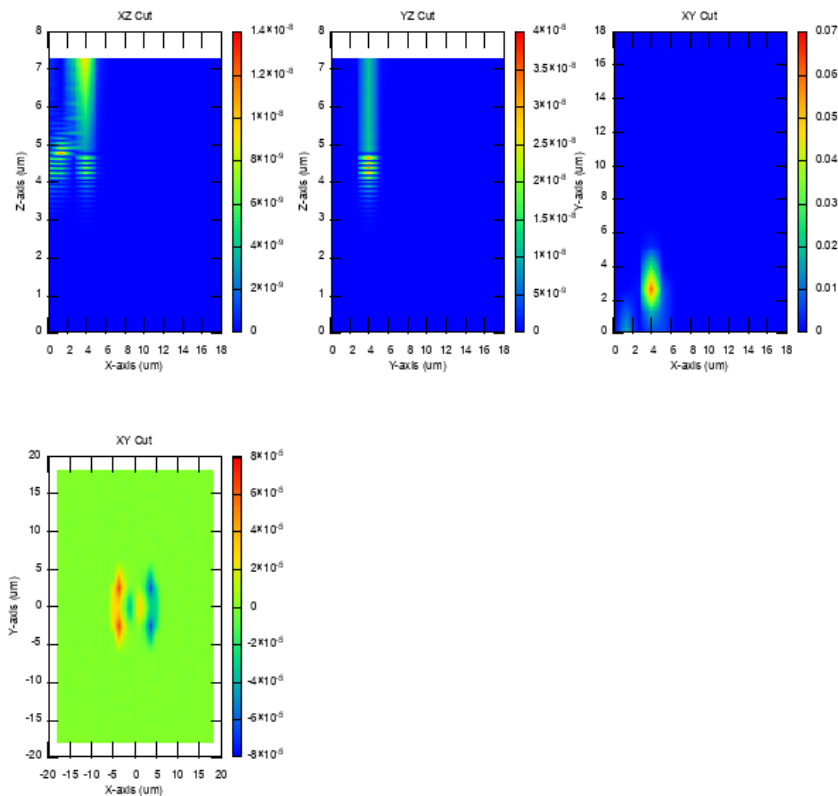


Photonic Crystal Vertical Cavity Surface Emitting Laser PC-VCSEL



PCSEL

- Structure
- Optical Modes
 - Mode #14
 - Res-Lambda₀ = 0.8412678 um

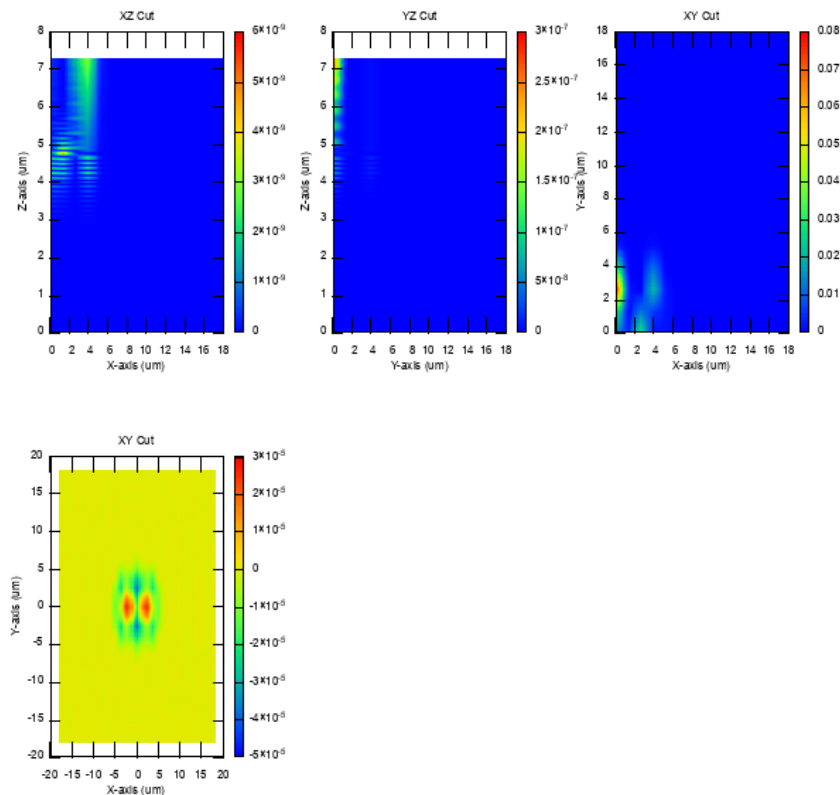


Photonic Crystal Vertical Cavity Surface Emitting Laser PC-VCSEL



PCSEL

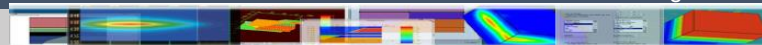
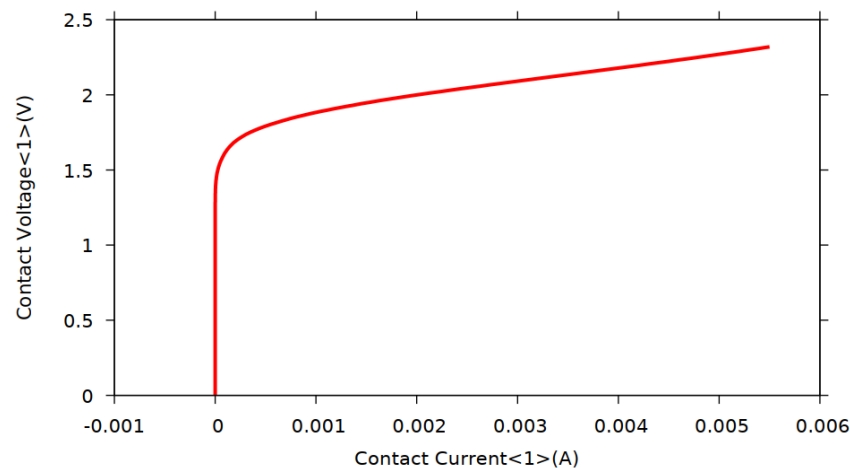
- Structure
- Optical Modes
 - Mode #15
 - Res-Lambda₀ = 0.8412109 μm



Photonic Crystal Vertical Cavity Surface Emitting Laser PC-VCSEL



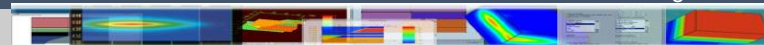
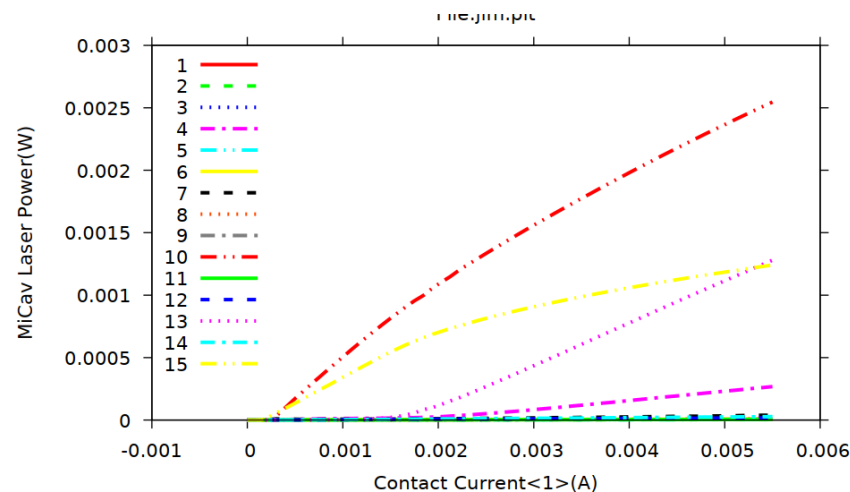
- Structure
- Optical Modes
- LIV Curve
 - VI Curve



Photonic Crystal Vertical Cavity Surface Emitting Laser PC-VCSEL



- Structure
- Optical Modes
- LIV Curve
 - VI Curve
 - LI Curve
 - Modal LI



Photonic Crystal Vertical Cavity Surface Emitting Laser PC-VCSEL



- Structure
- Optical Modes
- LIV Curve
 - VI Curve
 - LI Curve
 - Modal LI
 - All Modes LI

