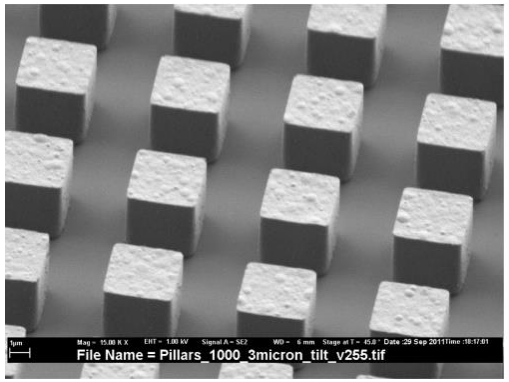
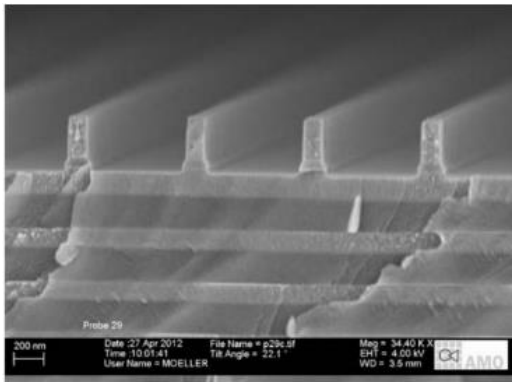
HCG-VCSEL Simulation Using PICS3D

High Contrast Grating (HCG)

Grating

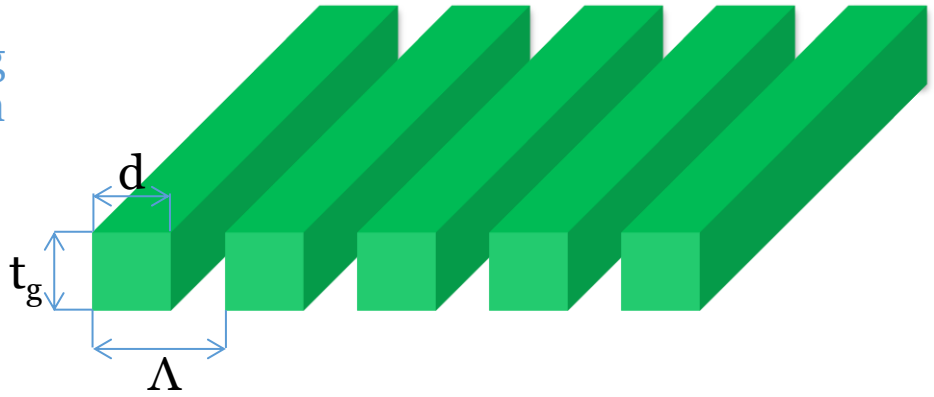
- Formed by periodically change material in one, two or three directions.
- Grating can be divided into three categories
  - Diffraction Grating
  - Effective medium grating
  - Sub-wavelength (Resonance) Grating





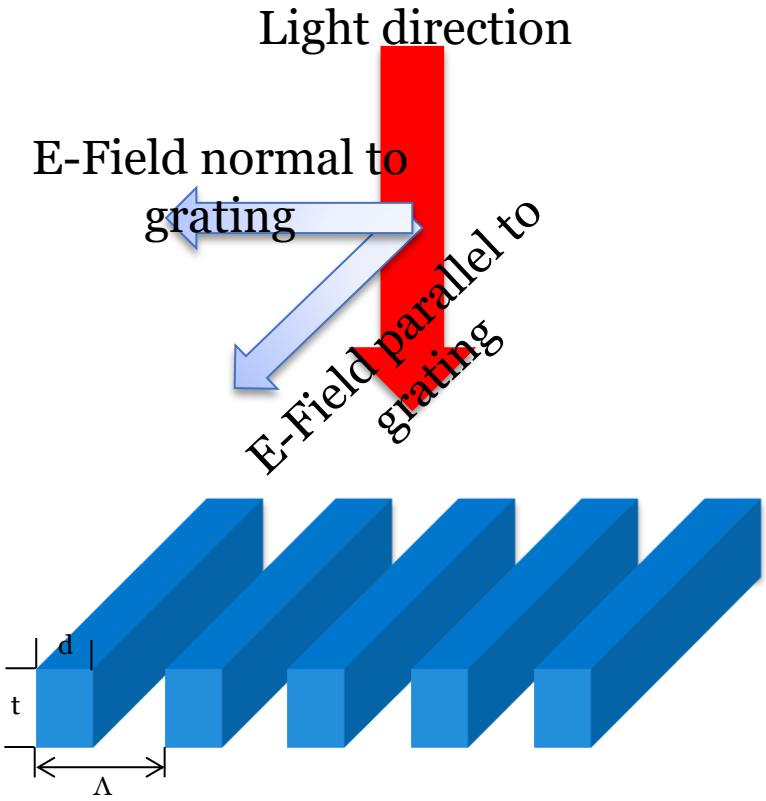
High Contrast Grating (HCG)

- Grating
  - Grating parameters
    - Grating period (pitch size) (Λ)
    - Fill factor (f)
      - Ratio between grating material width and pitch size (d/Λ)
    - Grating thickness (t_g).
  - Grating type
    - Diffraction Grating
    - Effective medium grating
    - Sub-wavelength (Resonance) Grating



High Contrast Grating (HCG)

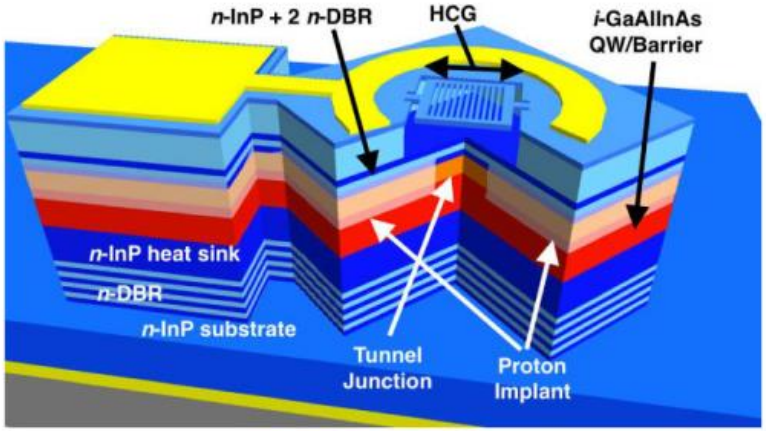
- HCG is a sub wavelength grating
  - It has a high index contrast between the low / high refractive material
- Optical properties
  - Resonance behavior at a certain band, therefore a perfect reflection within a certain band can be achieved.
  - HCG is a polarization sensitive
    - Mode with E-Field parallel to grating.
    - Mode with E-Field normal to grating.



High Contrast Grating (HCG)

Application

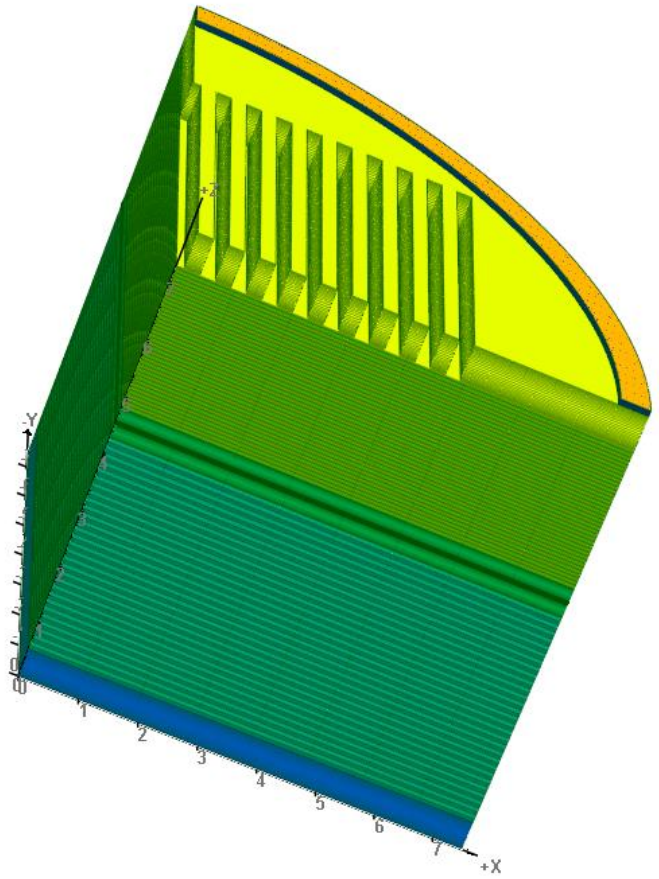
- Compact VCSEL design
  - In order to reduce the size of the VCSEL, the top DBR layer can be replaced with HCG
  - Tunable VCSEL can be realized by using MEMS based HCG



Ref:Christopher Chase, Yi Rao, Werner Hofmann, and Connie J. Chang-Hasnain, "1550 nm high contrast grating VCSEL," Opt. Express **18**, 15461-15466 (2010)

HCG VCSEL

- VCSEL
  - Bottom DBR
    - 29 layer
  - Cavity
    - Spacer
    - 7 MQW
    - spacer
  - Top DBR
    - 18layer
  - HCG



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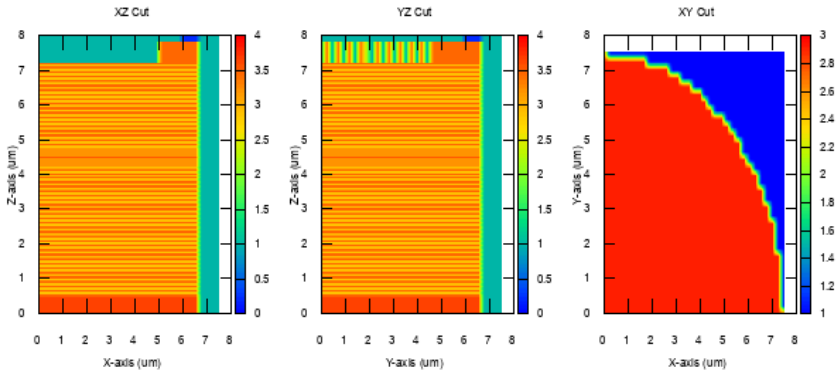
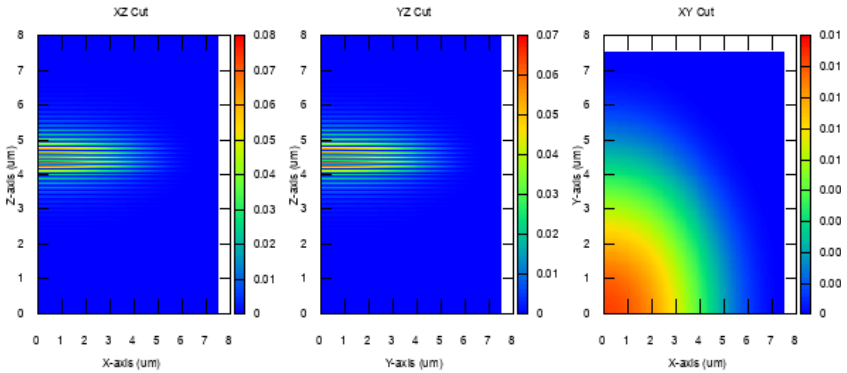


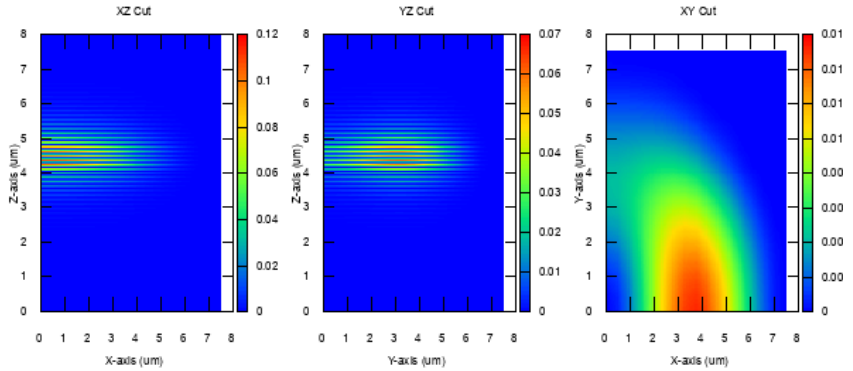
HCG VCSEL

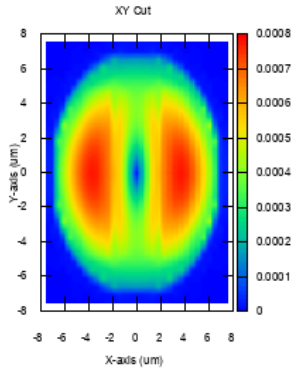
- Simulation Result
  - Optical Modes
    - Mode 01



HCG VCSEL

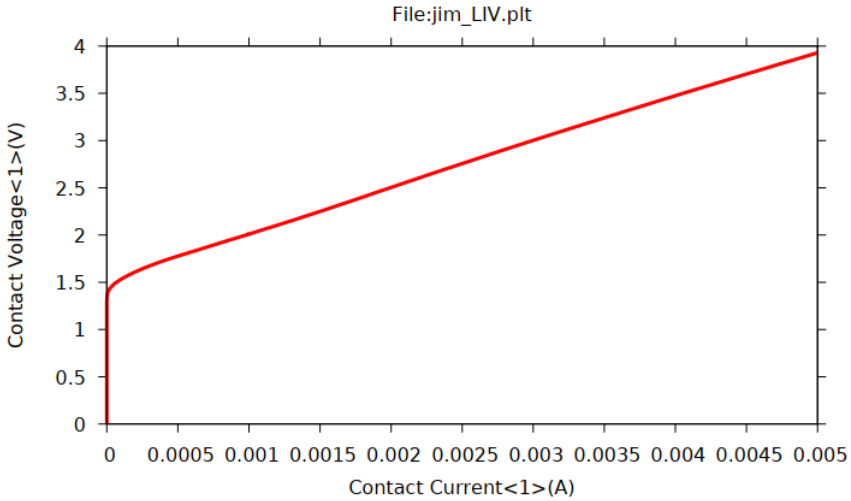
- Simulation Result
  - Optical Modes
    - Mode 03





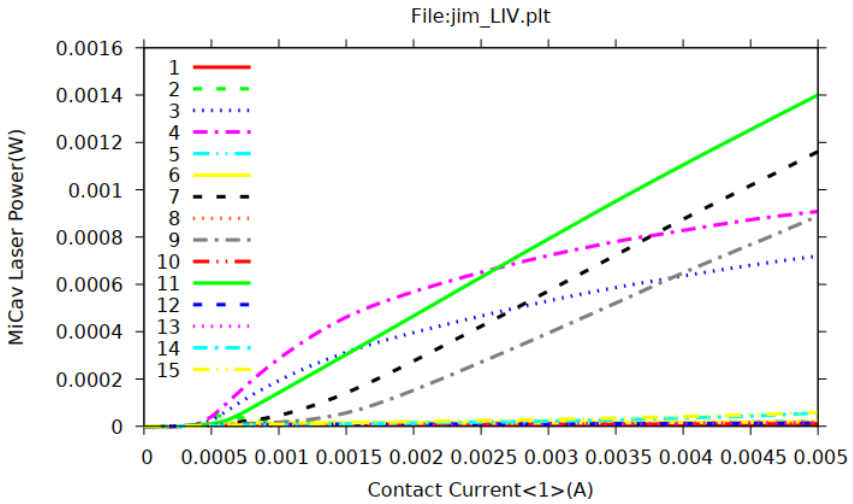
HCG VCSEL

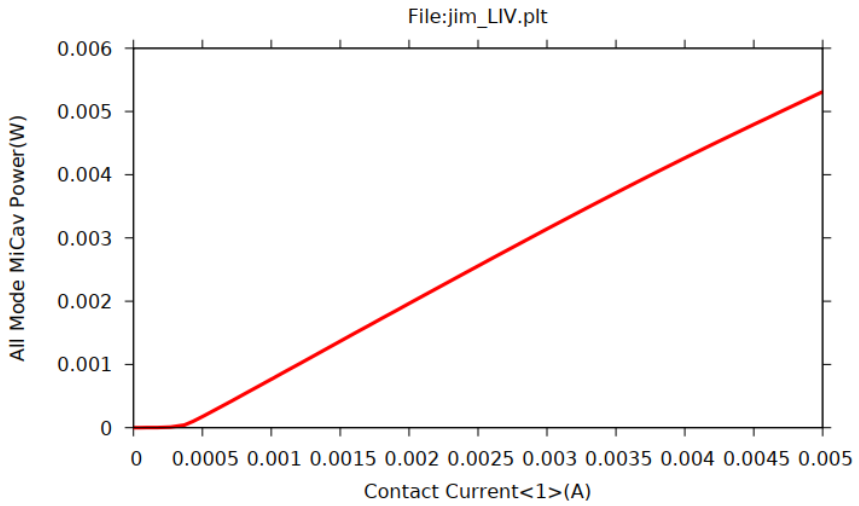
- Simulation Result
  - Optical Modes
  - VI



HCG VCSEL

- Simulation Result
  - Optical Modes
  - VI
  - LI



HCG VCSEL

- Simulation Result
  - Optical Modes
  - VI
  - LI