

Low-dimensional semiconductors. Optical properties. (Opto)electronic applications.

PH 673

Nanoscience and nanotechnology

October 13, 2025

QW lasers: history

1958 - Arthur L. Schawlow and Charles H. Townes invent the laser and publish a paper title "Infrared and Optical Masers"

1961 - First continuous operation of an optically pumped solid state laser

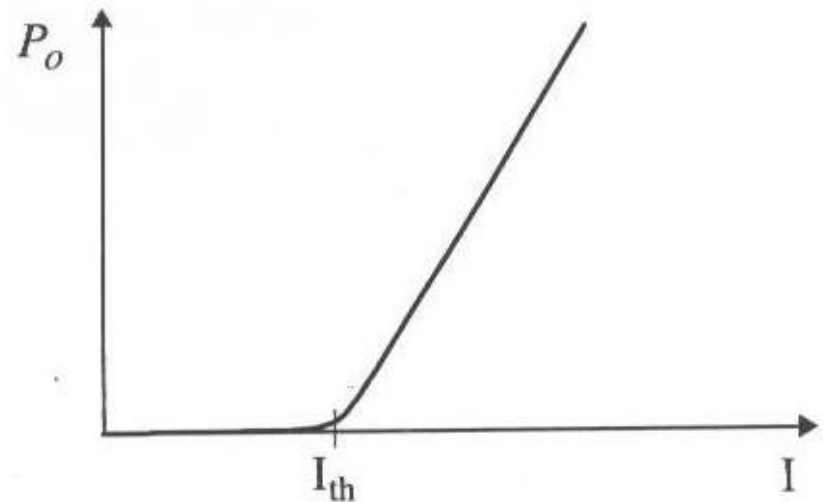
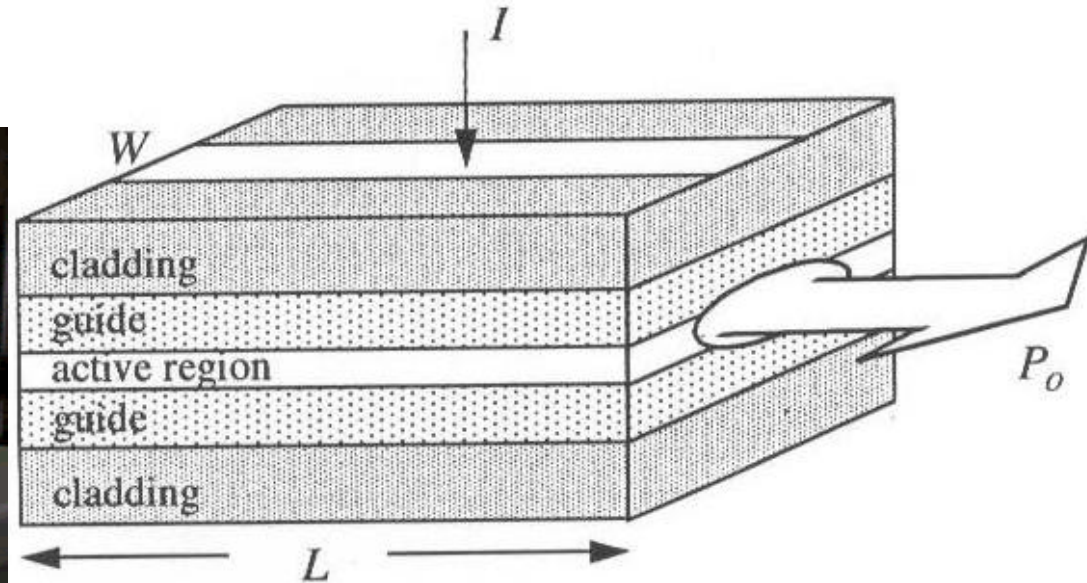
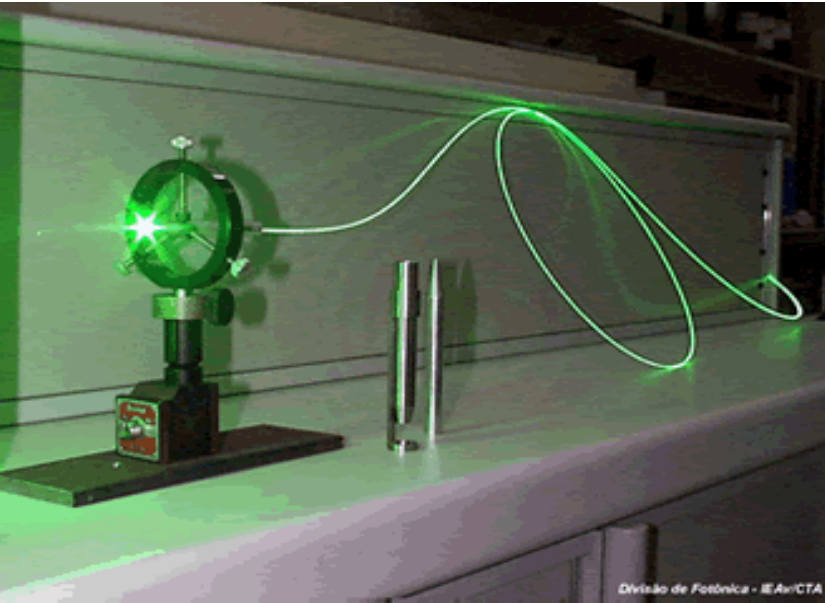
1963 - Quantum well laser first suggested by H.Kroemer from the U.S. and Kazrinov and Alferov from the Soviet Union.

1975 - First quantum well laser operation made by J.P. Van der Ziel, R. Dingle, R.C Miller, W. Wiegmann, and W.A. Nordland, Jr.

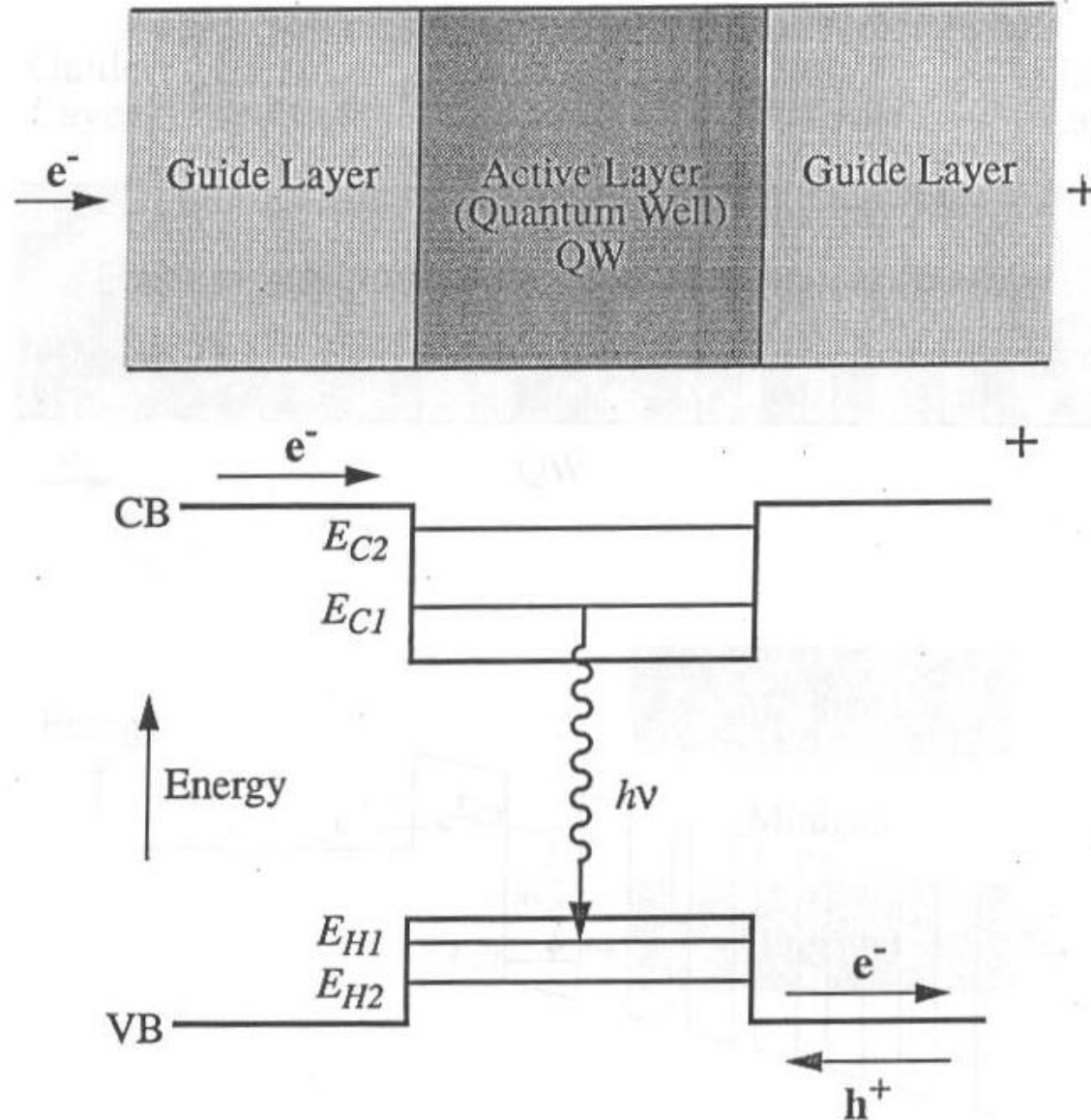
1977 - R.D. Dupuis, P.D. Dapkus, N. Holonyak submitted paper demonstrating first quantum well injection laser

1994 - Quantum cascade lasers first developed

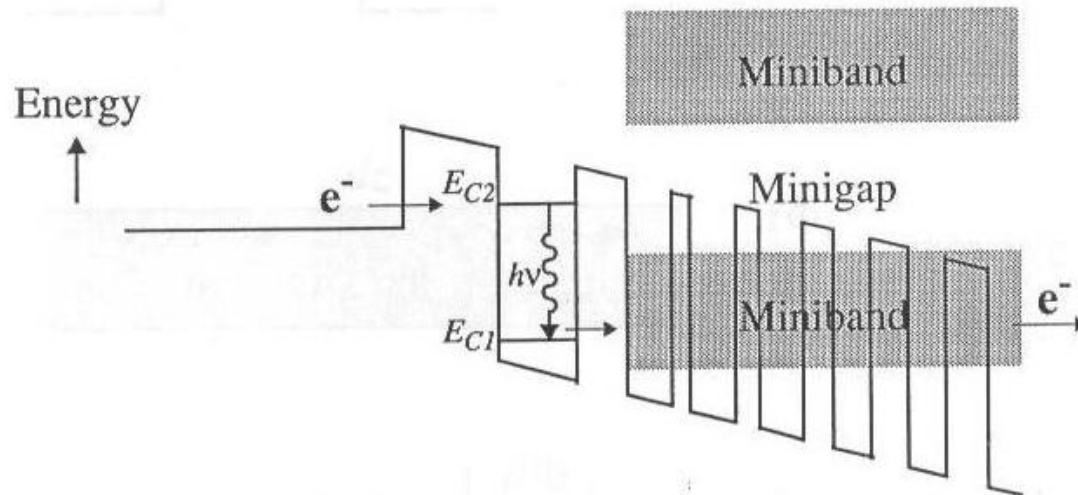
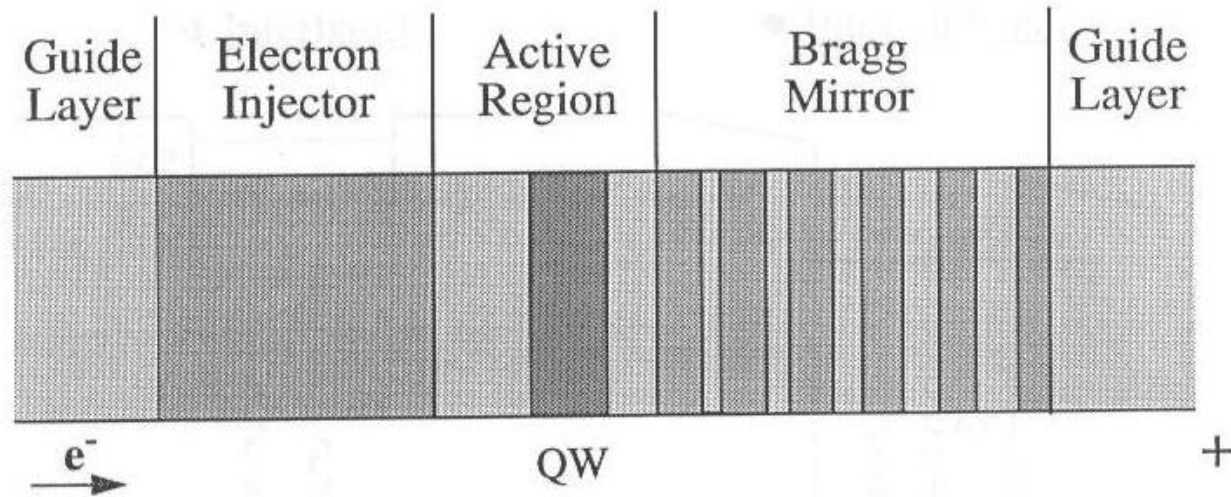
Semiconductor Laser



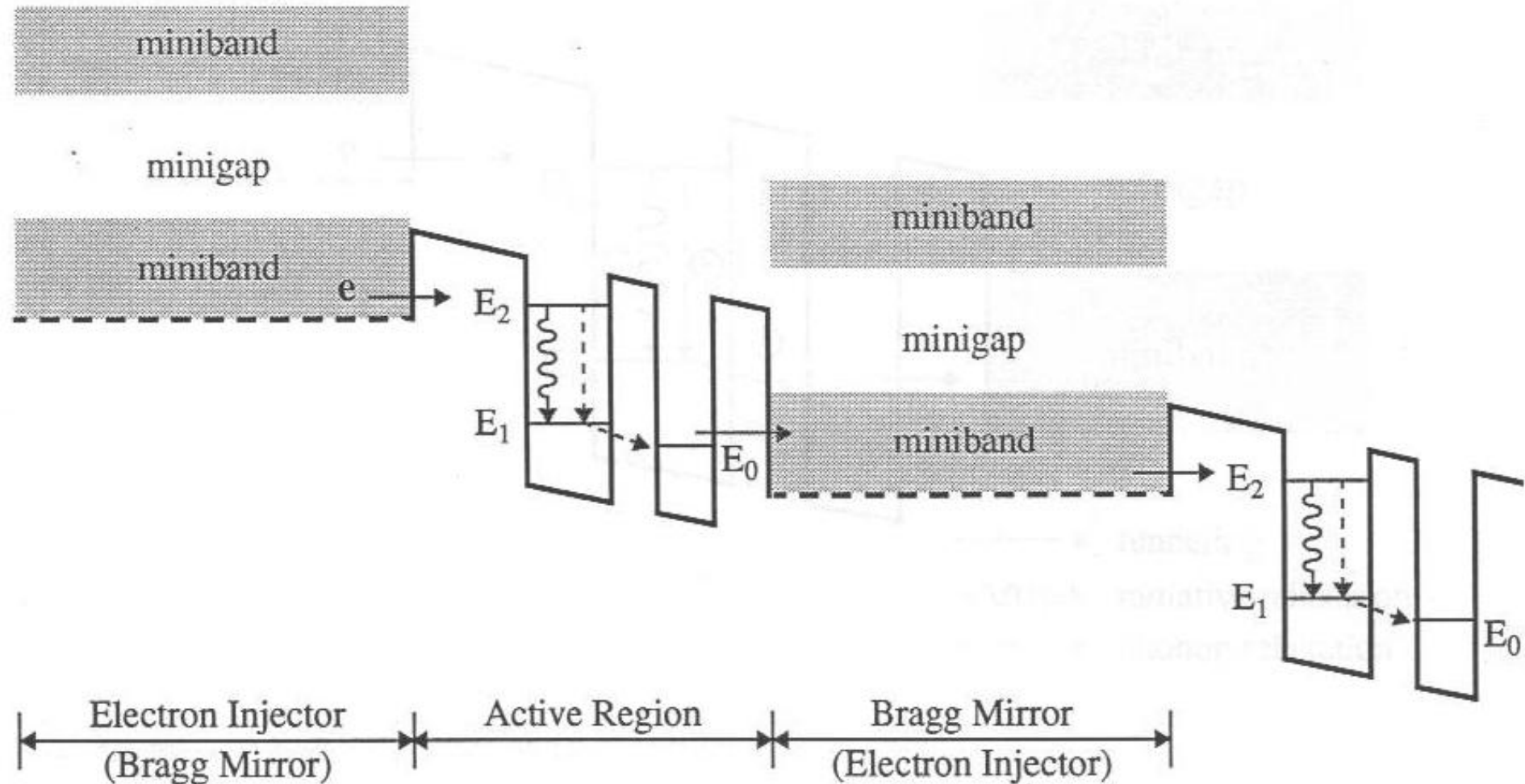
Interband Lasing Concept



Intersubband Lasing Concept

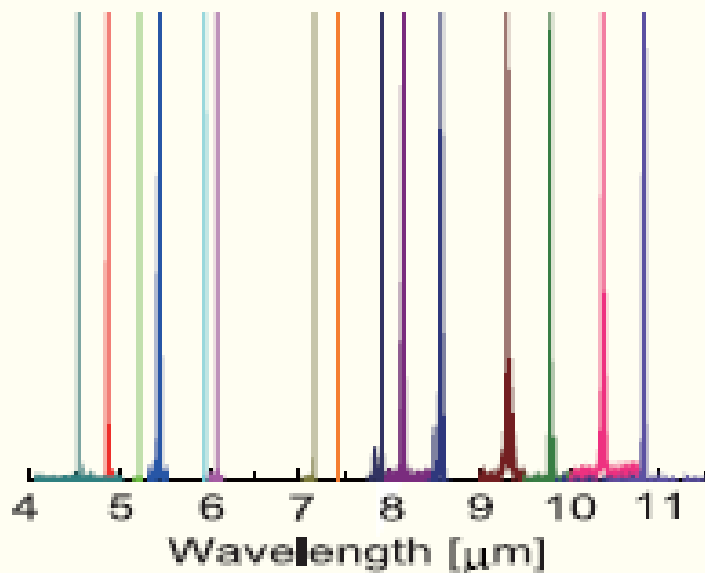


Quantum Cascade Laser (QCL)



Commercially available QCLs

The wavelength range of CW-QCL



●DFB-CW Laser (Top(qcl) * = 20 °C)

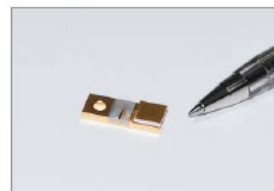
Type	Wavelength (nm)			Output Power (mW)			Heatsink, Package
	Min.	Typ.	Max.	Min.	Typ.	Max.	
L10195-4573H	4545	4565	4585	30	80	—	HHL-Package
L10195-7253H	7240	7260	7280	10	40	—	HHL-Package
L10195-7743A	7720	7740	7760	20	40	—	Open Heatsink
L10195-7743H	7720	7740	7760	20	40	—	HHL-Package
L10195-9673A	9650	9670	9690	10	15	—	Open Heatsink
L10195-9673C	9650	9670	9690	10	15	—	C-mount
L10195-9673H	9650	9670	9690	10	15	—	HHL-Package

●DFB-Pulsed Laser (Top(qcl) * = 20 °C)

Type	Wavelength (nm)			Peak Output Power (mW)			Heatsink, Package
	Min.	Typ.	Max.	Min.	Typ.	Max.	
L10195-5261A	5220	5260	5300	100	300	600	Open Heatsink
L10195-7441A	7400	7440	7480	50	100	—	Open Heatsink

●FP-CW Laser (Top(qcl) * = 20 °C)

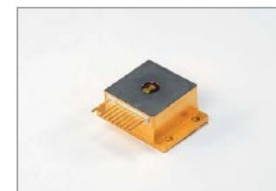
Type	Wavelength (nm)			Output Power (mW)			Heatsink, Package
	Min.	Typ.	Max.	Min.	Typ.	Max.	
5.2 μm FP-CW	—	5210	—	10	30	—	Open Heatsink C-mount HHL-Package , as requested
6.1 μm FP-CW	—	6130	—	10	30	—	
7.5 μm FP-CW	—	7450	—	10	50	—	
8.4 μm FP-CW	—	8350	—	10	50	—	HHL-Package , as requested
9.7 μm FP-CW	—	9650	—	10	50	—	



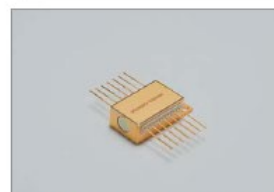
Open Heatsink



C-mount



HHL Package (Only CW-QCLs)

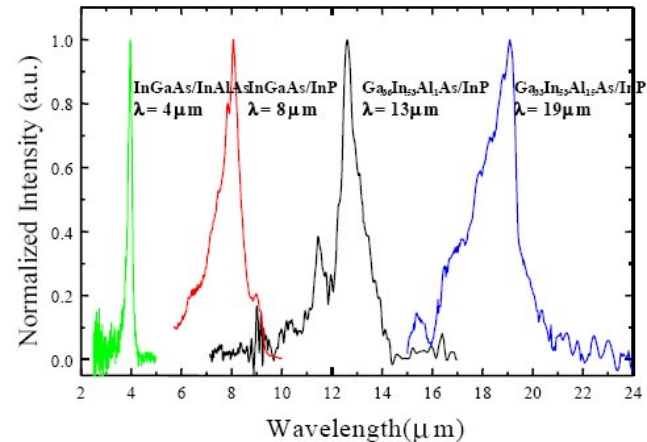


BTF Package (Only Pulsed-QCLs)



(available soon!!)
TO-8 Package (Only Pulsed-QCLs)

MQW IR photodetectors



MWIR InGaAs/InAlAs/InP QWIP 320x256
FPA camera (at 100 K)

<http://cqd.eecs.northwestern.edu/research/qwip.php>

Photoluminescence of quantum dots



Size increases (box is larger) -> Photoluminescence red-shifts (energy smaller)

Self-Assembled Quantum Dots

- Formed during epitaxial growth of lattice mismatched materials
 - e.g. InAs on GaAs (7% lattice mismatch)
 - Form due to kinetic and thermodynamic driving forces – energetically more favourable to form nanoscale clusters of InAs
- Some general properties
 - Perfect crystalline structures
 - High areal density ($10\text{-}500\mu\text{m}^{-2}$)
 - Strong confinement energies (100meV)
 - Already many applications
 - Lasers ($J^{\text{th}} < 6\text{Acm}^{-2}$) in visible and near infrared
 - Optical data storage
 - Optical detectors
 - Quantum Information and Cryptography

