

LECTURE # 22

Note Title

11/28/2007

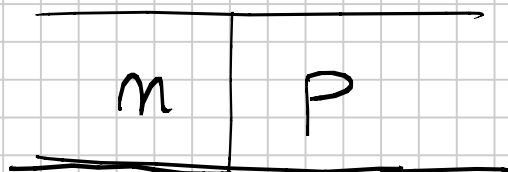
NANOSYSTEMS

ARTIFICIAL STRUCTURE

1mm ~ 10¹⁰ Å

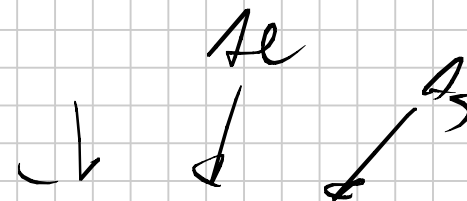
(Si)

Si DONORS Si ACCEPTORS



HOMOJUNCTION

→ HETEROSTRUCTURES



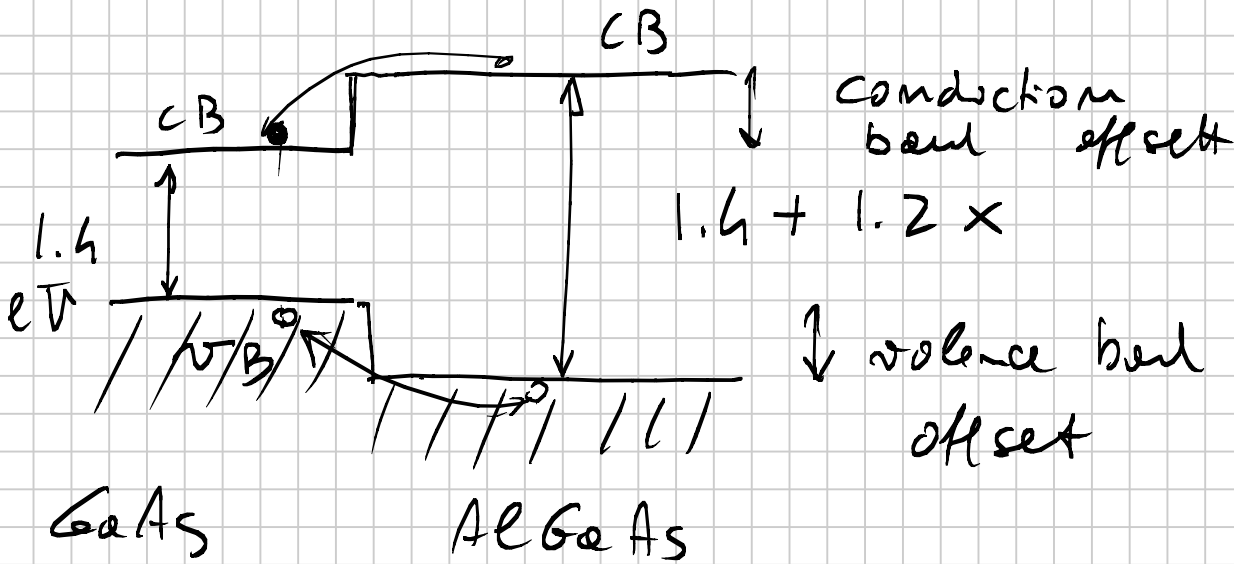
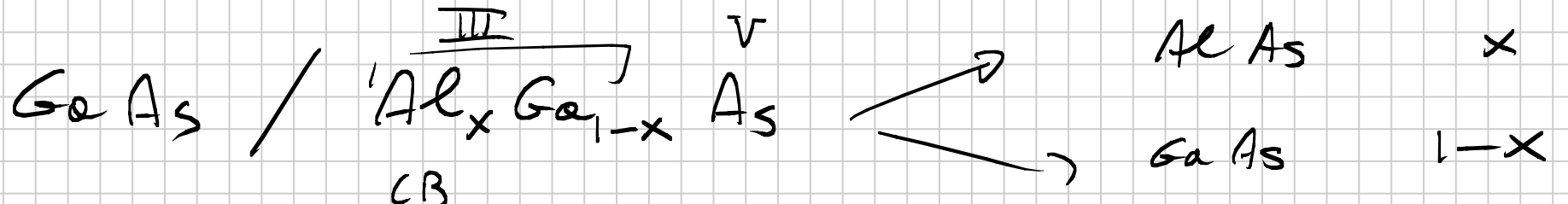
MOLECULAR

BEAM

EPITAXY



Ge As



QUANTUM

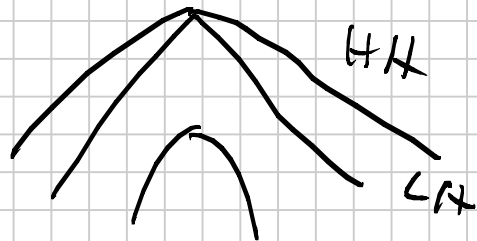
HETEROSTRUCON

IS

A

QUANTUM

WELL

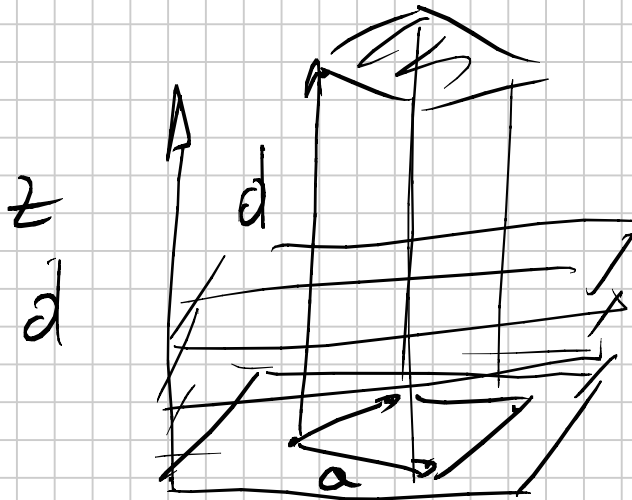
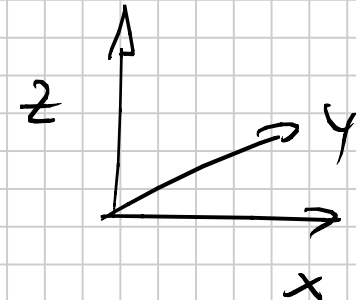
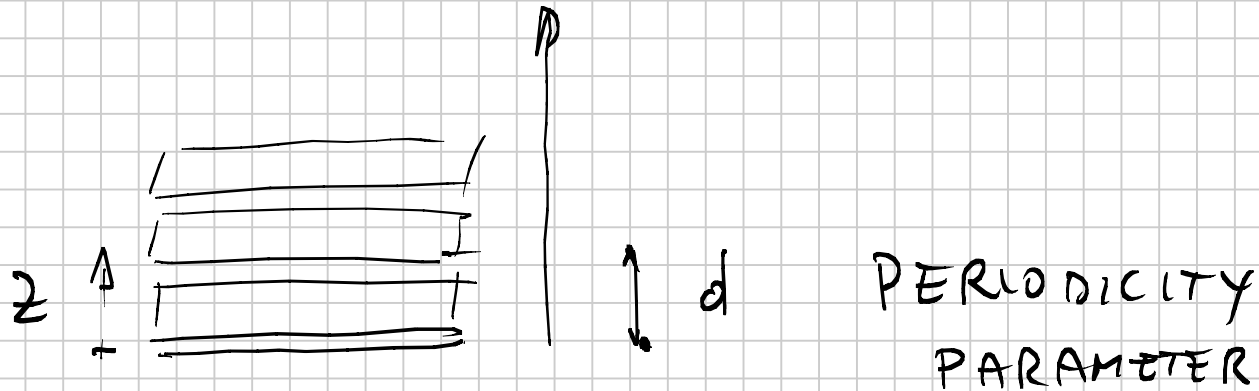


TYPE I

e AND h IN THE
SAME LOCATION

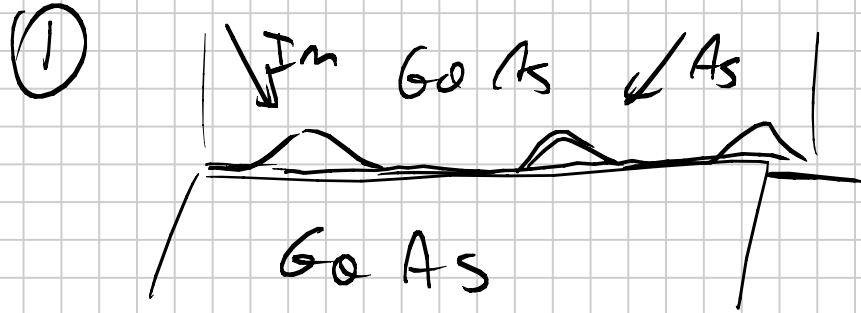
IMPORTANT FOR OPTICAL SYSTEMS

→ SUPERLATTICE



QUANTUM DOTS

→ SELF-ASSEMBLE QD NIBE

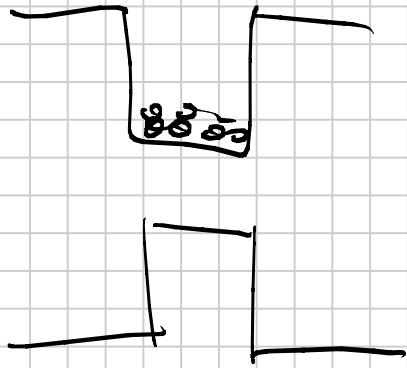


STRAIN
LATTICE MISMATCH
⇓
SPONTANEOUS FORMATION
OF DOTS

② LATERAL QUANTUM DOTS

2 DIMENSIONAL ELECTRON GAS

QUANTUM WELL



GeAs GeAs

③ COLLOIDAL QUANTUM DOTS

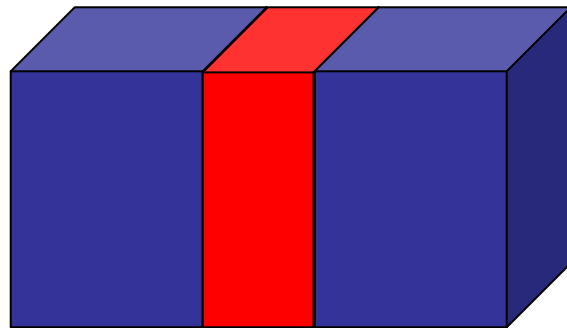
III - IV

CdS



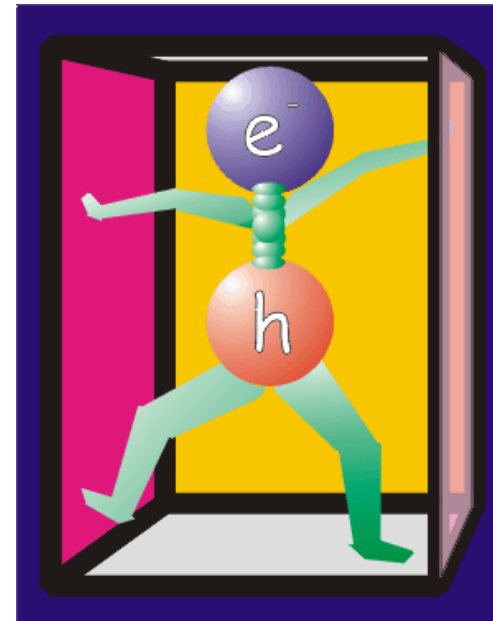
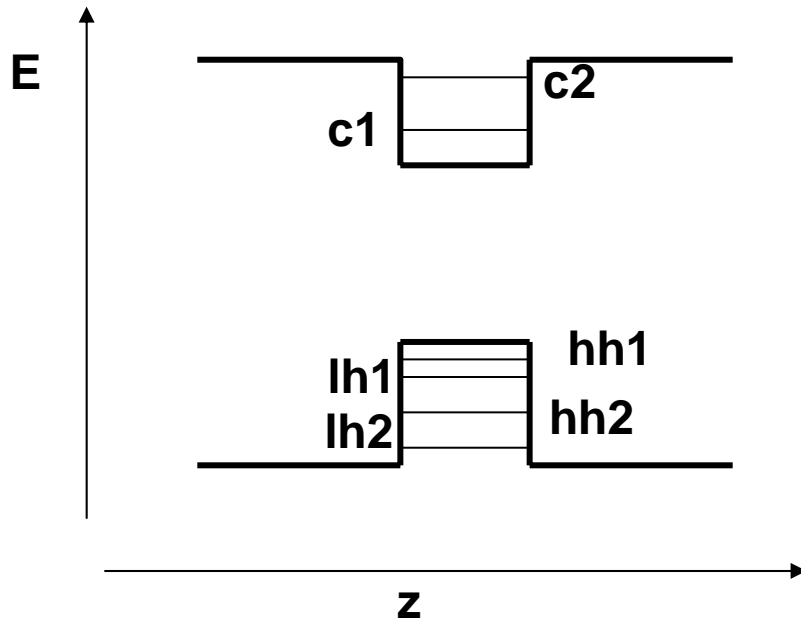
Excitons confined in a quantum well

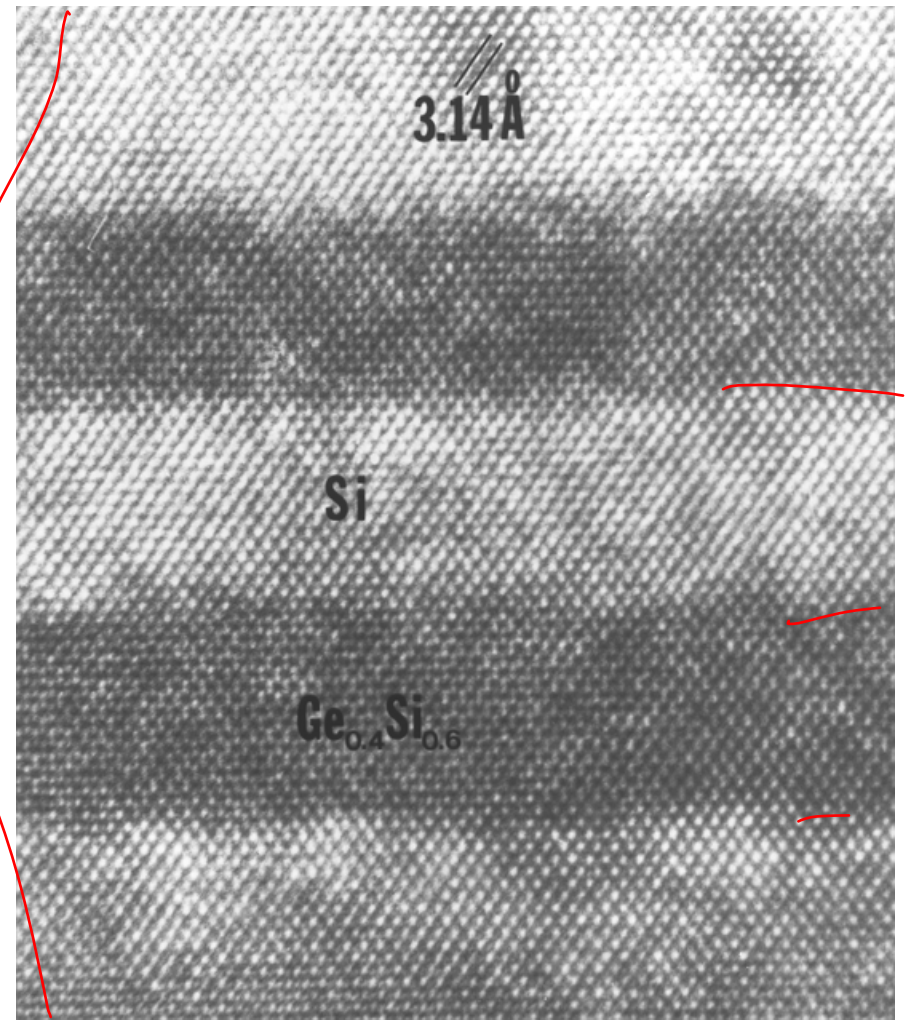
AlGaAs GaAs AlGaAs



Growth direction [001]

Propagation allowed only in the in-plane direction





BULK

QW

Q
WIRE

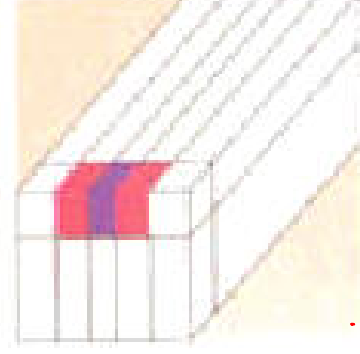
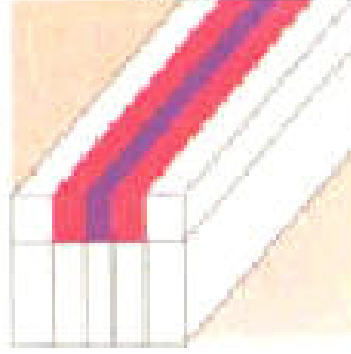
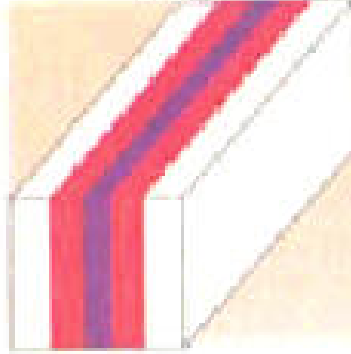
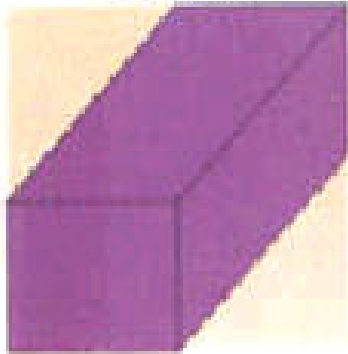
Q
DOT

THREE

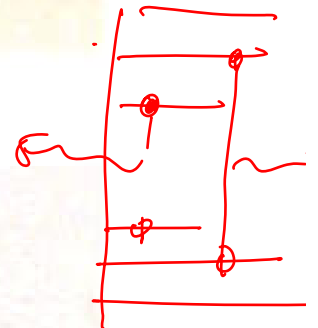
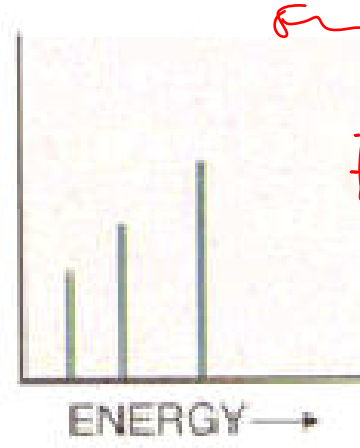
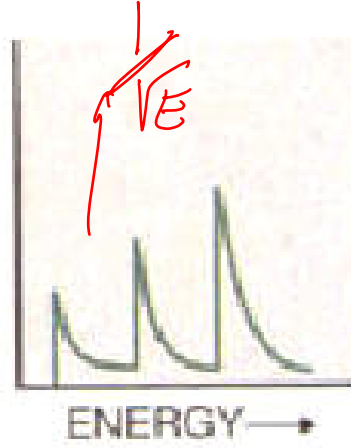
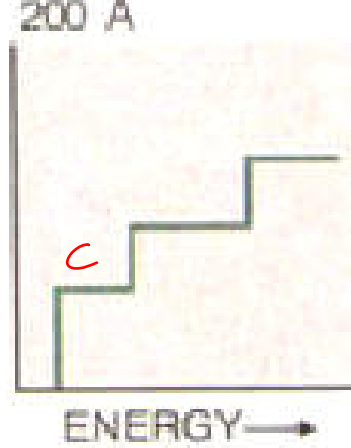
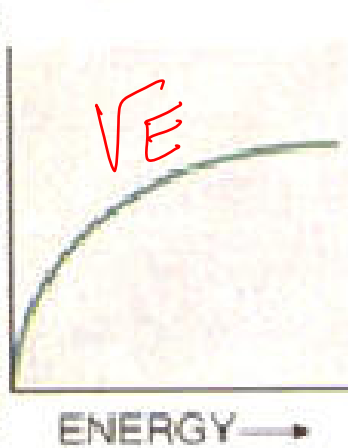
TWO

ONE

ZERO



DENSITY OF STATES

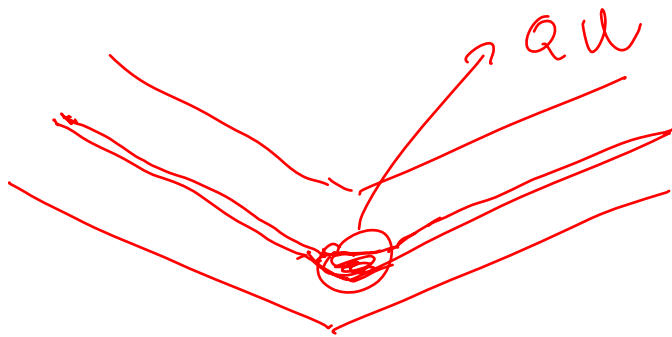
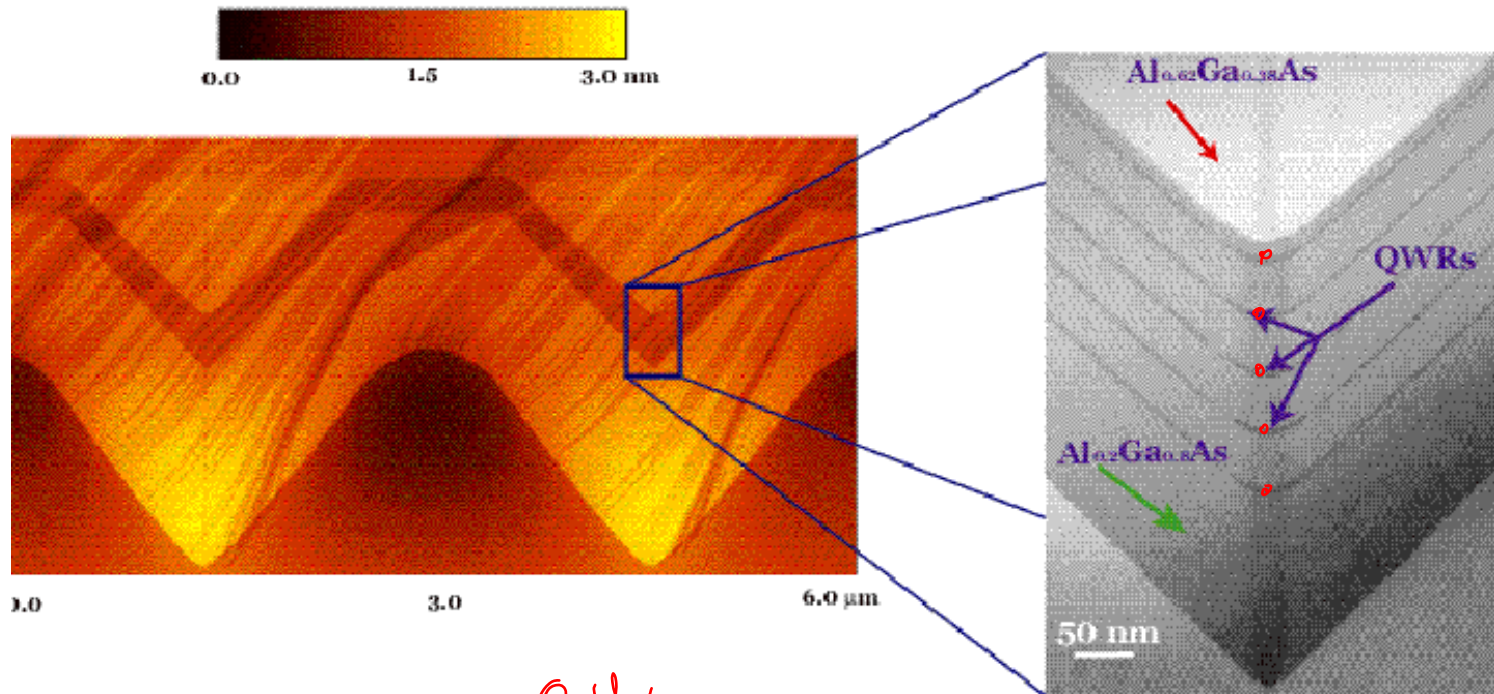


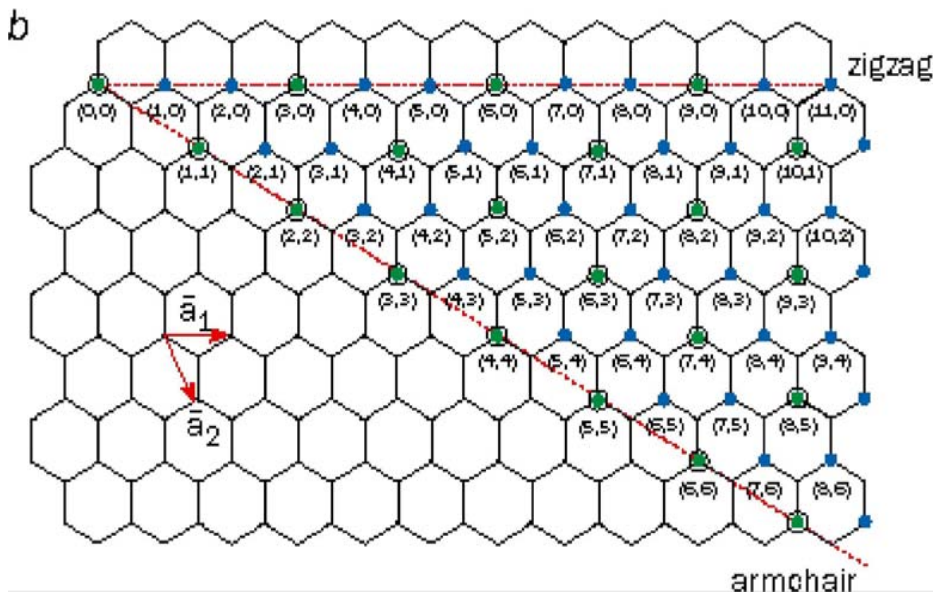
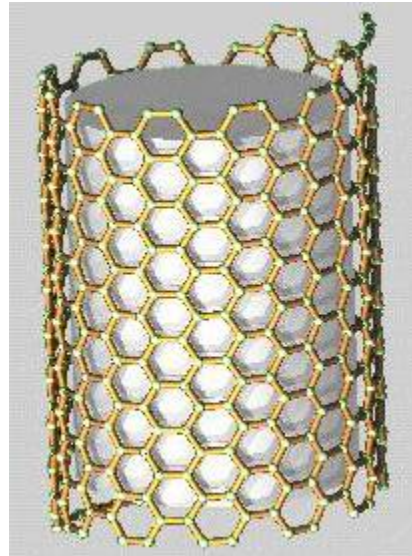
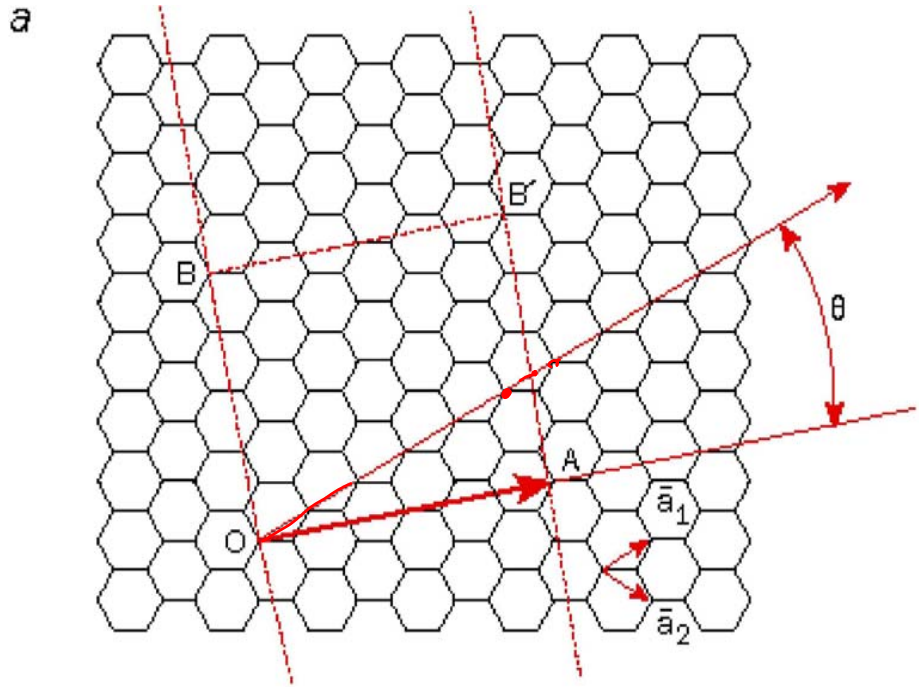
$$g(E) = \int \frac{d^3k}{(2\pi)^3} \delta(E - \frac{\hbar^2 k^2}{2m})$$

$$g(E) = c$$

$$g(E) = \sum \delta(E - E_n)$$

V-GROOVED QWIRES





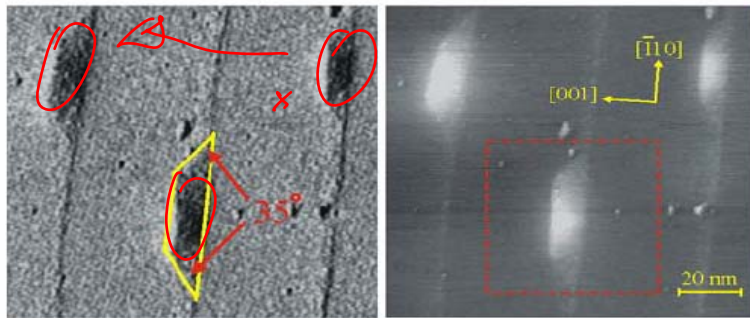
GRAPHITE
HCP

GRAPHENE
SINGLE 2D PLANE

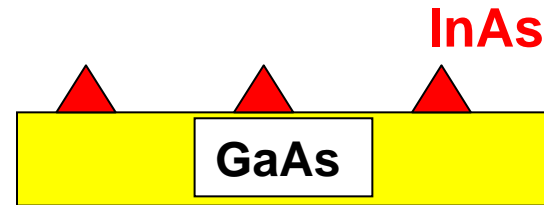
MOLECULAR
ELECTRONICS

Quantum Dots are artificial atoms made of semiconductor materials

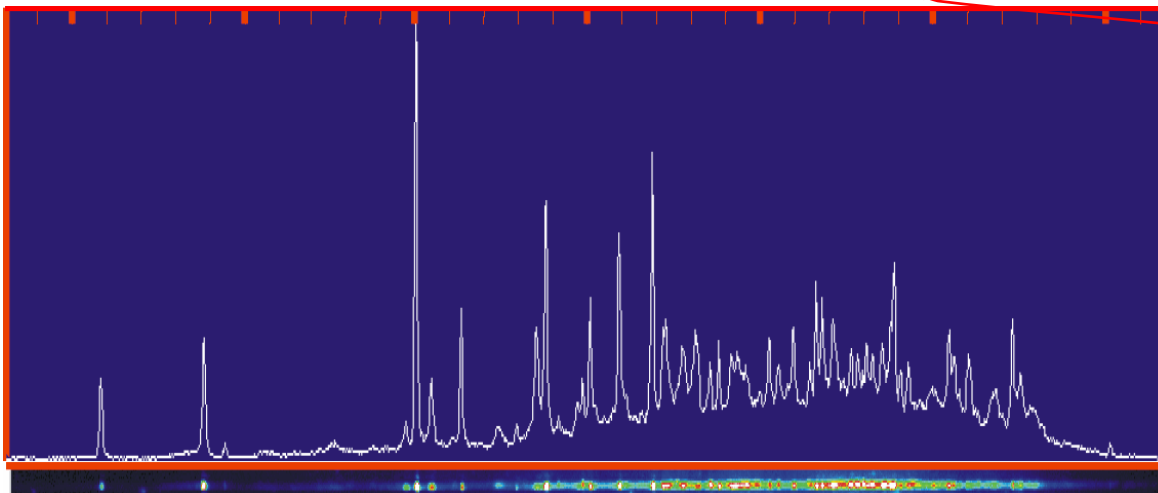
Self-assembled quantum dots



1 nm = 0.000000001 m

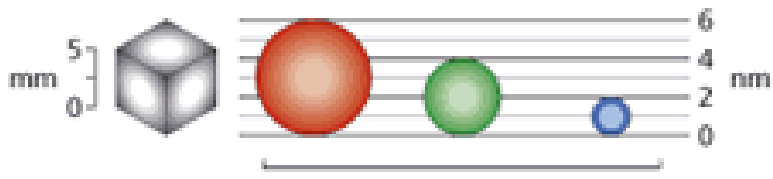
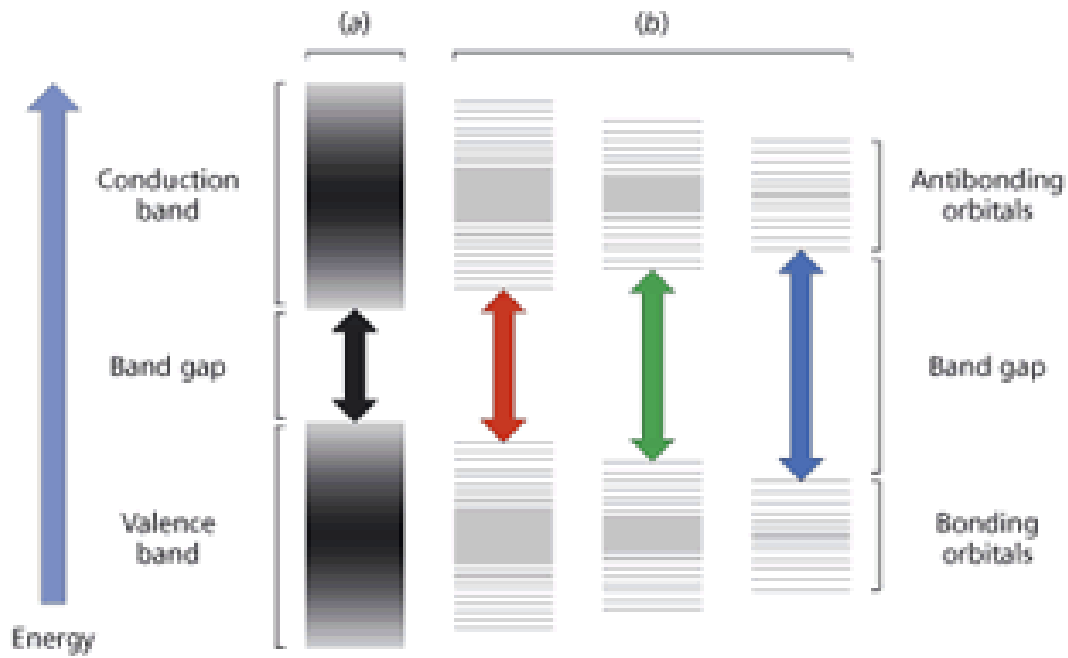


Atom Quantum Dot 1 inch



Emission spectrum like in atoms

Dr. Shih Lab, Phys. Dept. UT



Macroscopic crystal

Quantum dots

II-VI

