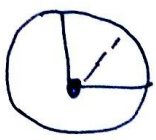
Quantum Dot

Nano Materials ? < 100 nm

If size < 10 nm Quantum Dot

(a)  : spherical (3D)

If l, b and Thickness < 10nm

called Q. Dots

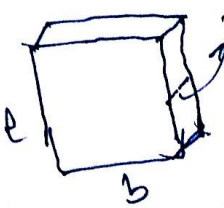
(b) 

l = bigger

Tubular type material

Cross sectional area  Two Dimensions

x and $y < 10$ nm → Q. wire

(c) 

Film Type Material

(Thin Film)

l and b bigger

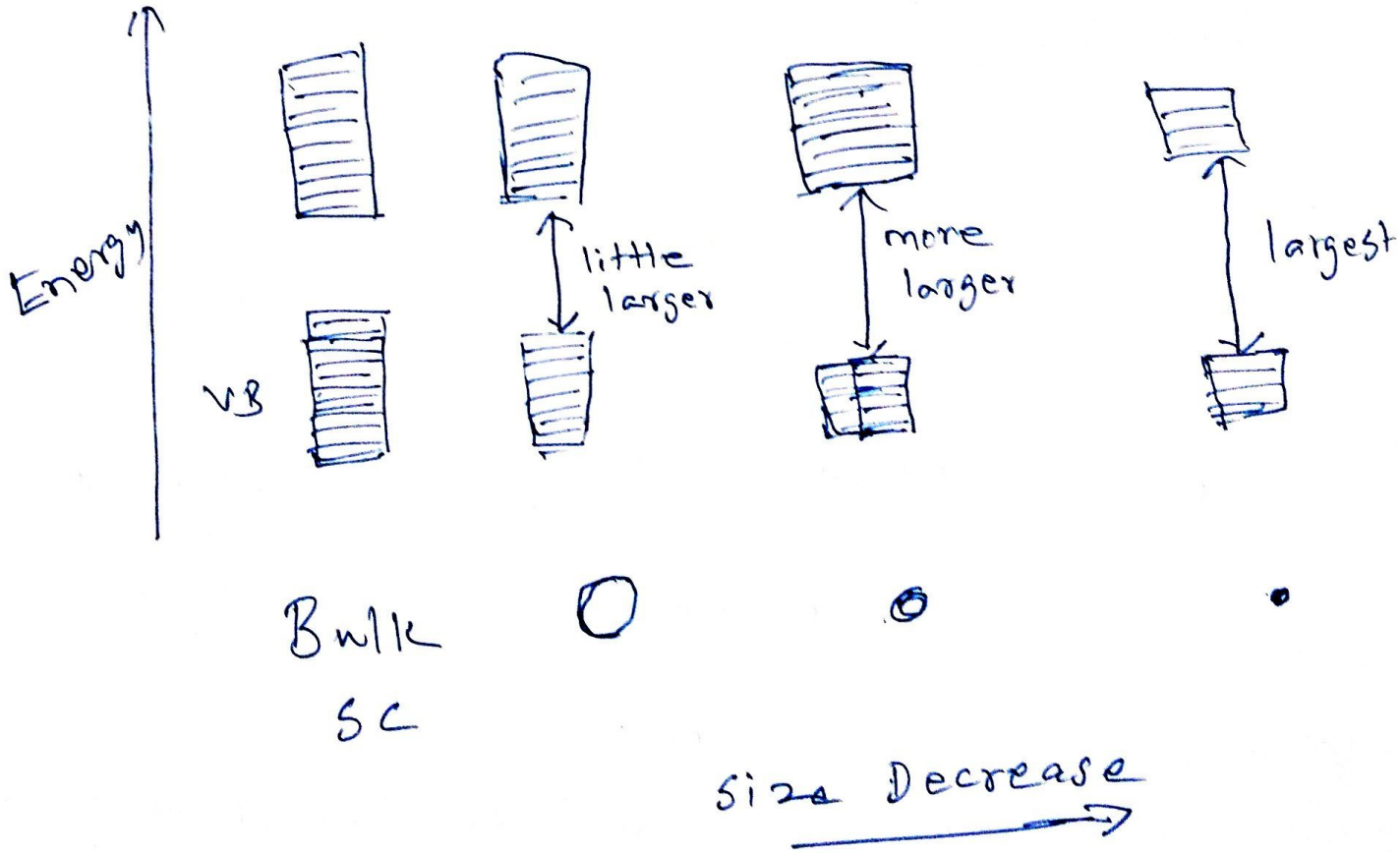
Thickness < 10 nm, single Dimension, Q. well

Nano particles → $10^2 - 10^4$ atoms

[100 → 1000]

larger but ~~[illegible]~~ not large enough for continuous solid

Band structure differ w.r.t size



Density changes. (MO - decreased)

Bands are no longer continuum

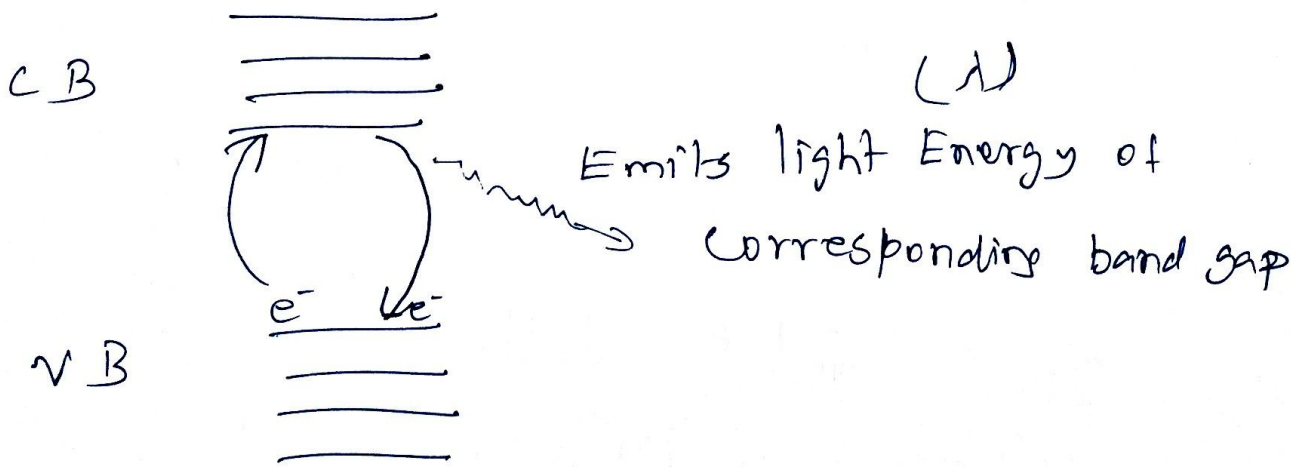
Individual quantised orbital
Energy level exist (Discrete)

Size DECREASES → Number of Energy level Decreases → BAND GAP INCREASE

Ex:

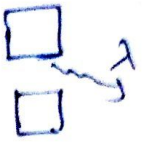
CdSe	Size	Gap
	11.5 nm	1.8 ev
	1.2 nm	3 ev

Optical Response



$$E = h\gamma = h \cdot \frac{1}{\lambda}$$

$E \propto \frac{1}{\lambda}$ inversely Proportional



Larger B.D. → Smaller Band Gap → Lesser the Light Energy → Longer λ

Smaller B.D → Larger Band Gap → Higher the Energy → Shorter λ

Ex:

Cd Se

5.5 nm Dia → Orange light

2.3 nm Dia → Bluish Green

Bulk Gold - Yellow

Thin Film Au - blue

Chalcogens

- Ore Forming

- S / Se / Te with Transition metals
  Zn, Pb, Cd

Applications

S - based → opto electronic

Se - based → sensors, Biomedical
Solar cells

Te - based → Memory Devices

Ex.

ZnS, ZnSe, ZnTe

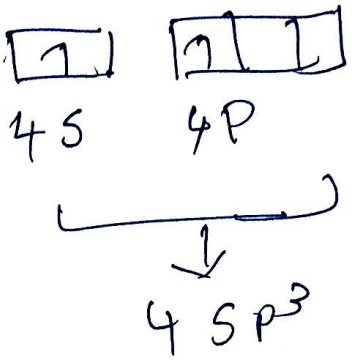
PbS, PbSe, PbTe Semiconductors.

CdS, CdSe, CdTe

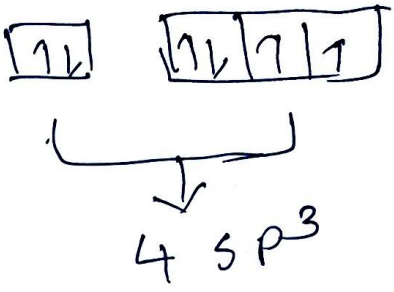
Zn Se

$Zn \rightarrow [Ar]\ 3d^{10}\ 4s^2$

Excited



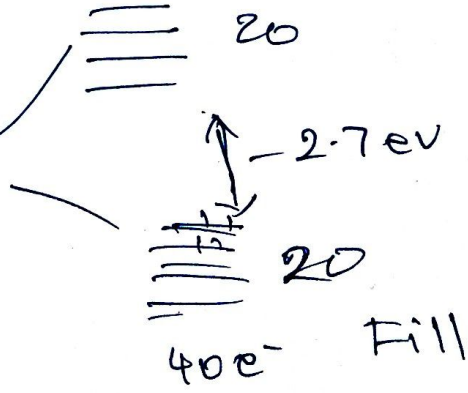
$Se \rightarrow [Ar]\ 3d^{10}\ 4s^2\ 4p^4$



5 Atoms each

5 Zn + 5 Se

$10 \times 4 = 40\ sp^3$



$5 \times 2 = 10\ e^-$

$5 \times 6 = 30\ e^-$

$40\ e^-$