

17

Monday

August 2009

Week 34

Day 229 • 136

Date 17 • 08 • 2009

	S	M	T	W	T	F	S	M
AUG 09	30	31					6	7
	2	3	4	5	6	7	13	14
	9	10	11	12	13	14	20	21
	16	17	18	19	20	21	27	28
	23	24	25	26	27	28		

Satur

NanoScienceNanotechnology

NanoScience is the study of fundamental principles of particles and structures not greater than 100nm in size. These structures are called nanostructures.

In NanoScience, properties differ significantly from those at large scale.

Nanotechnology

Nanotechnology is the technology of design, synthesis, characterisation and application of particles in nanoscale. When we go to nanoscale physics and interaction between the atoms displaying properties is different from those at large scale.

We know that there are three states of matter i.e. Solid, liquid and gas. In nanoscience we are more interested in solid particles like wires which have dimension (at least one) in

Notes

Birthday / Anniversary

the nanorange (1nm - 100nm). The density of gas is very low i.e. 10^{25} atoms/ m^3 and density of solid and liquid is 10^{29} atoms/ m^3 . The distance between the atoms/molecules in gas is 3-4 nm and in solid and liquid it is .2 - .3 nm.

However, if the distance and density of solid liquid and that of gases is compatible then also properties will be different.

Quantum well, dot and wire.

When the dimension of a material is continuously reduced from the macroscopic size then initially the properties will not change but if the dimensions are reduced below 100 nm (nanorange) then there will be drastic change in the properties. This is because of the quantum mechanics of physics in domain of nanoscale.

Reduction in dimension of nanostructure takes place as:

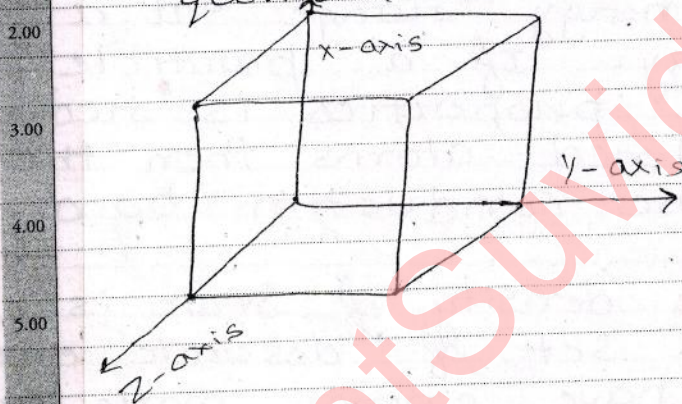
- 1) If one of the dimension (say x, y or z axis) is reduced to the nanorange while other two dimensions

	S	M	T	W	T	F	S
	30	31					1
AUG 09	2	3	4	5	6	7	8
	9	10	11	12	13	14	15
	16	17	18	19	20	21	22
	23	24	25	26	27	28	29

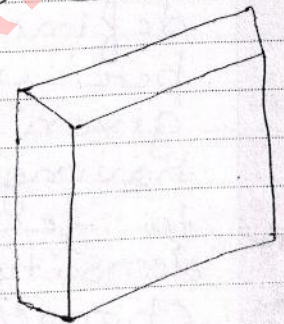
remains same then structure so formed is called quantum well.

2) If two dimensions are reduced to nano size while one dimension remains same, structure so formed is called quantum wire.

3) If three dimensions are reduced to nano size while structure formed in this case is called quantum dot.



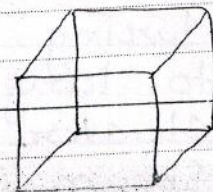
(a) Macroscopic material.



(b) Quantum well



(c) Quantum wire



(d) Quantum dot

Electronic Structure & Quantum Size Effect

The electronic structure of nano particles depends upon the size of the particles.

A space lattice is the combination of atoms at regular intervals in three dimensions. When an atom forms a lattice, set of discrete energy levels mix up into energy band gap.

The term 'density of state' is defined as no. of energy levels per unit energy range at a given energy. If a particle having bulk properties is reduced to a few hundred atoms then the density of the conduction band changes.

The continuous density of state is replaced by set of discrete energy levels which have energy more than thermal energy $k_B T$ (k_B - Boltzmann Constant) and energy gap open.

The change in electronic structure during the transition of bulk metal to large cluster and then to small cluster is less than 15 atoms as shown in the figure. The smaller cluster is analogous to set of discrete energy levels.

Notes

Birthday / Anniversary

21

Friday

August 2009

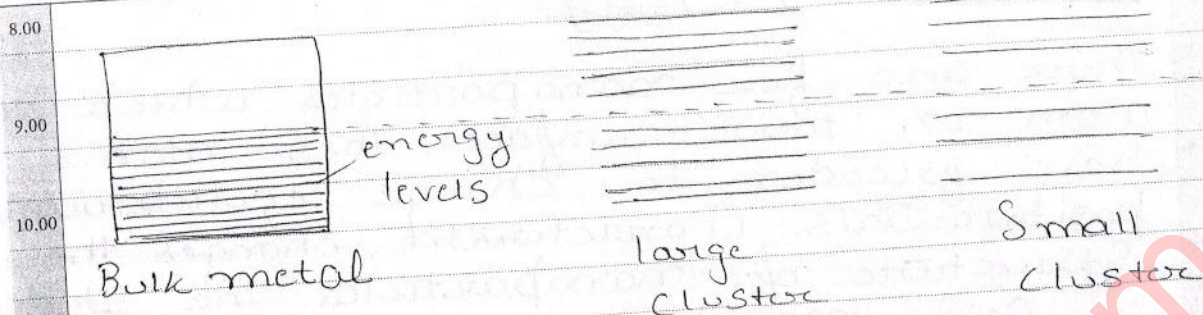
Week 34

Day 233 • 132

Date 21 • 08 • 2009

	S	M	T	W	T	F	S
	30	31					1
AUG 09	2	3	4	5	6	7	8
	9	10	11	12	13	14	15
	16	17	18	19	20	21	22
	23	24	25	26	27	28	29

	S	M
SEP 09	6	7
	13	14
	20	21
	27	28



(Change in Valence energy level with size)

Eventually a size is reached when the surface of particles is separated by distance in order of wavelength of the electron.

Energy is given by: $E_n = \frac{n^2 h^2}{8mL^2}$

where $n = 0, 1, 2, \dots$

The splitting up of energy levels is called Quantum Size effect.

PROPERTIES OF NANOPARTICLES

- 1) Mechanical
- 2) optical
- 3) Magnetic
- 4) Electronic

Birthday / Anniversary

8.00

Mechanical property

9.00

10.00

11.00

12.00

1.00

2.00

3.00

4.00

5.00

6.00

7.00

8.00

There are few nanoparticles which have atom on their surface. These atoms have freedom to change equilibrium position. This characteristic changes the structure of nanoparticles. The study of gold nanoparticle reveals that gold nanoparticle continue to attain the different structural arrangement. This property is known as fluctuations.

At high temperature, fluctuation can cause the breakdown of structural arrangement of nanoparticles, which leads to the formation of liquid droplet of atom.

Particle in a nanophase with exceptionally small grain size are more strong. That means, particles in nanophase are capable of high strength and super hardness. Graph is plotted between hardness vs decreasing grain size.

Notes

The melting point of the cluster inc. with increase in number of atoms. Large increase in number of atoms means large melting point.

Birthday / Anniversary

23

Sunday

August 2009

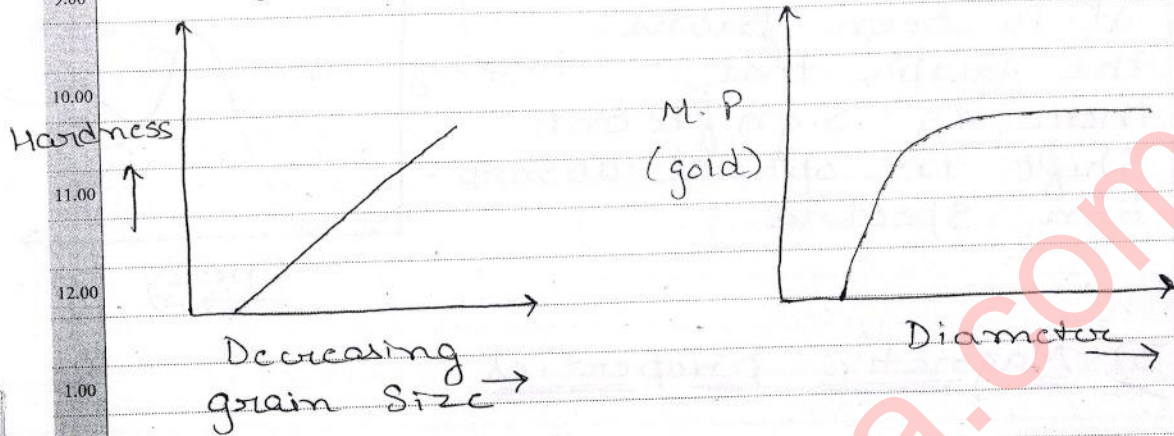
Week 34

Day 235 • 130

Date 23 • 08 • 2009

	S	M	T	W	T	F	S
AUG 09	30	31					1
	2	3	4	5	6	7	8
	9	10	11	12	13	14	15
	16	17	18	19	20	21	22
	23	24	25	26	27	28	29

Graph is plotted between melting point of gold and Diameter of particles



2) optical properties

The colour of the particles can be determined on the basis of the photon absorbed by it. Absorption of photons occurs because electrons migrate from low energy state to high energy state level. It has been found that different clusters have different absorption spectrum. Diff. clusters possess different colours.

In semiconductor nanoparticles, there is large changes in optical properties as compared to bulk material. For example, consider a shift in optical absorption spectra of CdSe

Notes

Birthday / Anniversary

S	F	S
1		
6	7	8
13	14	15
20	21	22
27	28	29

S	M	T	W	T	F	S
	1	2	3	4	5	
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

August 2009

Week 35

Day 236 • 129

Date 24 • 08 • 2009

24

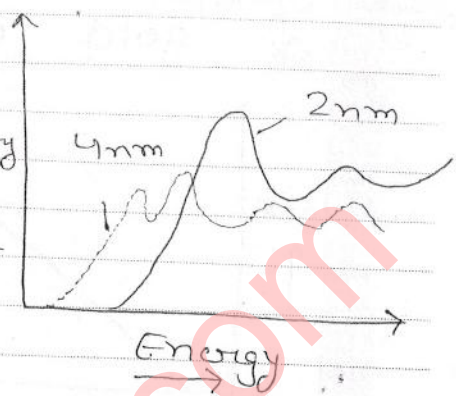
Monday

nt

at different Size (2nm and 4nm) at 10k.

8.00
9.00
10.00
11.00
12.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00

It is seen from the graph that there is significant shift in optical absorption spectra.



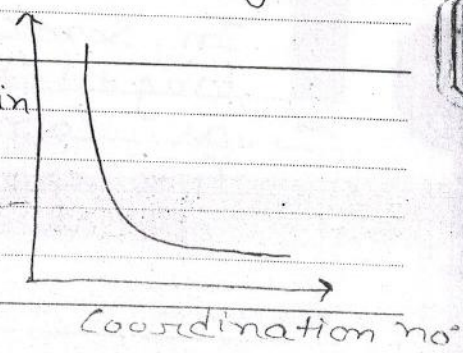
3). Magnetic properties

The nanoparticles of magnetic solid possesses a new class of magnetic properties. It is important to explain here that small particles differ from bulk material in the sense that they have low coordination number. Graph is plotted between change in intensity of magnetisation versus coordination number.

From the graph it is clear that small particles are more magnetic than bulky material.

Notes

Table Shows the change in magnetic intensity behaviour of small particles of magnetisation



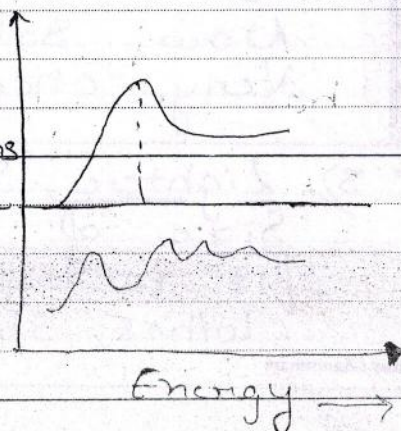
Birthday / Anniversary

8.00	of Various metal		
9.00	<u>Metal</u>	<u>Bulk</u>	<u>Cluster</u>
10.00	Na, K	Paramagnetic	Ferromagnetic
	Rb	Paramagnetic	Ferromagnetic
11.00	Fe, Co, Ni	Ferromagnetic	Super paramagnetic
12.00			

4) Electronic property

The Study of electronic property of nanoparticles can be done with the help of ultraviolet - photo electron spectroscopy. When an ultraviolet photon is incident on a electron in conduction band then electron is emitted. The electron emitted can be count with help of spectroscope. Graph is plotted between no. of electrons emitted Vs energy of copper cluster having 20 to 40 atoms.

It is seen from no. of the graph that electrons there is a emitted peak indicating that energy level of nanoparticles is discrete.



Notes

Birthday / Anniversary

Notes

Birthday

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

August 2009

Week 35

Day 238 • 127

Date 26 • 08 • 2009

26

Wednesday

8.00

9.00

10.00

11.00

12.00

1.00

2.00

3.00

4.00

5.00

6.00

7.00

8.00

- Various other properties are:
- 1) Nanoparticles are hard.
 - 2) They are exceptionally strong.
 - 3) They are ductile at high temperature.
 - 4) They are wear resistant.
 - 5) They are corrosion resistant.

Chemical activity of nanoparticles increases with increase in the surface area.

Applications:

- 1). Diagnostics: Nanotechnology is used in the field of medical diagnostics and provides cheaper, effective and portable diagnostic equipments.
- 2). Energy Sources: Nanotechnology provides an effective procedure method to conserve our energy sources. Now, Solar Cell will become very cheaper.

Notes

- 3). Lighter, Superior: The light weight / size of nanoparticles made them fit to used in tear resistant clothes, sport materials & body armour.

Birthday / Anniversary

27

Thursday

August 2009

Week 35

Day 239 • 126

Date 27 • 08 • 2009

	S	M	T	W	T	F	S
AUG 09	30	31					1
	2	3	4	5	6	7	8
	9	10	11	12	13	14	15
	16	17	18	19	20	21	22
	23	24	25	26	27	28	29

4) Computers: Nanotechnology helps in providing a small and a powerful computer.

5) Sensors: Sensors based on the nanotechnology are more sensitive and effective.

6) Water Source: Nanotechnology provides a very improved water purification techniques. Water from the oceans can be converted into safe drinking water.

XXXXXXXXXX

Notes

Birthday / Anniversary

	F	S
	1	
5	7	8
3	14	15
0	21	22
7	28	29

	S	M	T	W	T	F	S
			1	2	3	4	5
SEP 09	6	7	8	9	10	11	12
	13	14	15	16	17	18	19
	20	21	22	23	24	25	26
	27	28	29	30			

August 2009

Week 35

Day 240 • 125

Date 28 • 08 • 2009

28
Friday

n

ive

Piyush

Sakshi

8.00
9.00
10.00
11.00
12.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00

Notes

Birthday / Anniversary

Studentsuvidha.com