Properties of Nanomaterials:—

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(1) Size – Very rough representation in terms of in terms atoms.

Now, we start from basic Unit — 1–100nm ✓

Atom (1) — Molecules (1 to 100 atoms) — Nanoparticles (10 –) — Bulk material (greater 10^6)

$10 - 10^6$ atoms

(2) Nanoparticles Exhibit Unique properties due to their surface area to volume ratio

Suppose, you have a spherical particle with its diameter of 100nm.

Volume of the sphere $= \frac{4}{3}\pi R^3$ R — Radius of sphere

$R = D/2$

$= \frac{4}{3}\pi \left(\frac{D}{2}\right)^3$

$$V = \frac{4}{3}\pi \frac{D^3}{8} = \frac{\pi D^3}{6}$$

Surface area of a sphere $= 4\pi R^2$

$$SA = \frac{4\pi D^2}{4} = \pi D^2$$

$D = 100\ nm = 100 \times 10^{-9}$ meter

$V =$ m^3 and $SA = 3.141 \times 10^{-14}\ m^2$

↳ $5.24 \times 10^{-22}\ m^3$

$$\frac{SA}{V} = \frac{3.141 \times 10^{-14}}{5.24 \times 10^{-22}} \approx 10^7$$

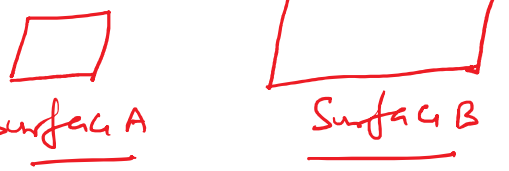
D = 10m

$V = \frac{\pi D^3}{6} = \frac{1000\pi}{6}$

$$\frac{SA}{V} = \frac{3.141 \times 10^{-17}}{5.24 \times 10^{-22}} \approx 10^{7}$$

↳ SA / 1

↳ This gives an approximate surface area to volume ration of $> 10^{7} : 1$ which is significantly lesser than macrosized particles.

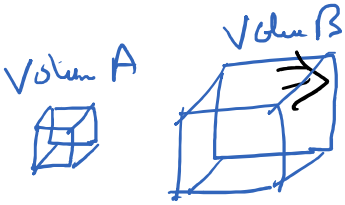


Matrical is same

That surface B is having higher No. of atoms compared to the surface A

N_S = total No. of atoms in surface.

$N_S \propto SA$ ✓



N_b = total No. of atoms in volume

$N_b \propto V$ ✓

$$\frac{SA}{V} = \frac{\pi D^2}{\frac{\pi D^3}{6}} = \frac{6}{D}$$

↳ $\frac{N_S}{N_b} = \frac{6}{D}$

D is the diameter

Total no. of atoms in surface are higher than the total no. of atoms in volume

↳ Surface forces are the dominent one in nano matricals

$$\frac{4}{3}\pi R^3 = \frac{4\pi R^2}{6} = \frac{100\pi}{6}$$

$SA = 100\pi$

$V = \frac{4}{3}\pi R^3$ $SA = 4\pi R^2$

$\frac{SA}{V} = \frac{4\pi R^2}{\frac{4}{3}\pi R^3}$

$\frac{3}{R}$

$R = 3$

$\frac{SA}{V} = \frac{R}{3}$

$\Rightarrow SA = V$

$R > 3$

$\frac{SA}{V} = 0.95$

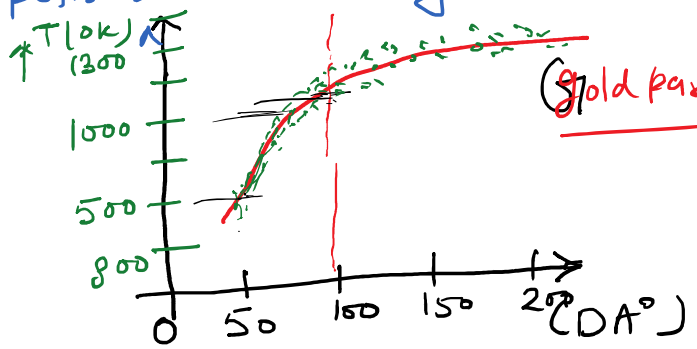
$SA = 0.95 \times V$

D is the diameter

materials

of nanomaterials

(3) Melting points are usually lower than their bulk Counterpart



(Gold particles)

As particles size decrease the melting point also decrease.