Lecture-27-30 Intermolecular Forces between Particles and Surfaces

27.1. What is Hamaker's constant? What is its significance?

Ans: The Hamaker constant A can be defined for a Van der Waals (vdW) body-body interaction:

$$A = \pi^2 \times C \times \rho_1 \times \rho_2$$

where ρ_1 and ρ_2 are the number of atoms per unit volume in two interacting bodies and C is the coefficient in the particle-particle pair interaction.

The Hamaker constant provides the means to determine the interaction parameter C from the Van der Waals pair potential, $w(r) = -C/r^6$.

27.2. What are different types of Colloidal Stability?

Ans: Colloidal particles can either Electrostatically stabilized or Sterically stabilized. All similar particle tend to attach to each other in vacuum or air. The presence of electrical charge or (polymer molecules) attached to the surface of colloidal particles tend to screen this attraction, forming a stable dispersion. We may further want to add that while Coulombic repulsion is responsible for electrostatic stabilization, entropy hindrance is responsible for steric stabilization.

27.3. What is hard spehere approximation?

Ans: Hard spheres are widely used as model particles in the statistical mechanical theory of fluids and solids. In this theory the atoms are simply considered as impenetrable spheres that cannot overlap in space. They mimic the extremely strong repulsion that atoms and spherical molecules experience at very close distances. Hard sphere approximation suggests that the separation distance between two atoms or molecules is non zero, even when they are at contact, due to stiff born repulsion due to overlap of electronic orbital.

27.4. How can Effective Hamaker Constant be measured?

We have seen that when two blocks of materials 1 and 2 come in contact in air or vacuum, A12 can be written as:

$$\mathbf{A_{12} = -12\,\pi d_0^2 (\gamma_{12}^{LW} - \gamma_1^{LW} - \gamma_2^{LW})}$$

Now the individual LW components of surface and interfacial tension can be determined by Contact Angle Goniometry. Thus, if $\mathbf{d_0}$ is known, then A_{12} can be determined.

Further, by considering 1 and 2 are of the same material, $\gamma_{11}^{LW} = 0$, and therefore

$$\mathbf{A_{11} = 24\pi d_0^2 \gamma_1^{LW}}$$

Further one can also get $\mathbf{A_{12}} = \sqrt{(\mathbf{A_{11}}.\ \mathbf{A_{12}})}$

Thus, we observe that $\mathbf{A_{12}}$ can be expressed in terms of physically measurable quantities.

27.5. What is the physical significance of the lowest point in the Leonard-Jones potential curve?

Ans: It signifies that at that point, the separation distance is minimum for either two surfaces or molecules i.e they physically come into contact. Beyond this, a repulsive regime begins.