Physical Properties of the Solid Materials

(Surface Physico-Chemistry)

The materials surfaces have their unique qualities. They differ from the bulk properties due to the difference in the chemical bond characteristics. These characteristics make the surface of each material behave differently.

Surface tension and surface energy:

Energy at the surface of a solid is greater than in its interior. For example, inside a lattice, all the atoms are equally attracted to each other. The interatomic distances are equal, and energy is minimal. However, at the surface of the lattice the energy is greater because there are no atoms on the outside. Hence there is only a force from the inside of the lattice pulling the outermost atoms inwards. This makes a tension on the outer surface and energy is needed to pull the outermost atoms away.

The increase in energy per unit area of surface is referred to as the surface energy or surface tension.

The surface atoms of a solid tend to form bonds to any atom that come close to the surface in order to reduce the surface energy of the solid. This attraction across the interface for unlike molecules is called adhesion.

In summary, the greater the surface energy, the greater will be the capacity for adhesion.

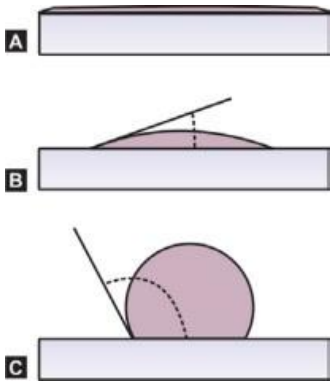
Wetting:

It is very difficult to force two solid surfaces to adhere. However smooth their surfaces may appear, they are likely to be very rough at the atomic or molecular level. When they are placed together, only the 'hills' or high spots are in contact. Since these areas form only a small percentage of the total surface, no adhesion takes place. One method of overcoming this difficulty is to **use a fluid** that will flow into these irregularities and thus provide contact over a great part of the surface of the solid. For example, **when two glass plates are placed one on top of the other, they do not usually adhere. However, if a film of water is placed in between them, it becomes difficult to separate the two plates.** To produce adhesion in this manner, the liquid must flow easily over the entire surface and adhere to the solid. This characteristic is referred to as "wetting".

Contact angle measurement:

The contact angle is the angle formed by the adhesive and the adherent at their interface. The extent to which an adhesive will wet the surface of an adherent may be determined by measuring the contact angle between the adhesive and the adherent. **If the forces of adhesion are stronger than the cohesive forces holding the molecules of the adhesive together, the**

liquid adhesive will spread completely over the surface of the solid and no angle will be formed. If the liquid remains as a drop without spreading, the contact angle will be high.



The physical properties of the solid materials (surface texture)

Understanding the surface texture of the material is quite important. It affects many kinds of industrial products ranging from optics to mechanical behaviors.

Surface texture is defined as the nature of the material surface in terms of waviness. It can be isotropic or anisotropic in orientation.

Surface texture analysis depends on the following features:

1- Primary texture (roughness)
2- Secondary texture (waviness)
3- Tertiary texture (error of form)\

Qualitative evaluation: The qualitative evaluation of surface texture can be achieved visually through direct observation for the glossy, matte finish, and surface imperfection, or by using the light microscope or the SEM the scanning electron microscopy.

Quantitative evaluation: The quantitative evaluation of surface texture can be achieved by using profilometer technique whether the stylus or the laser methods. Note: Surface roughness is not the average peak height or the number of peaks or their height, but it is the average distance from the center line.