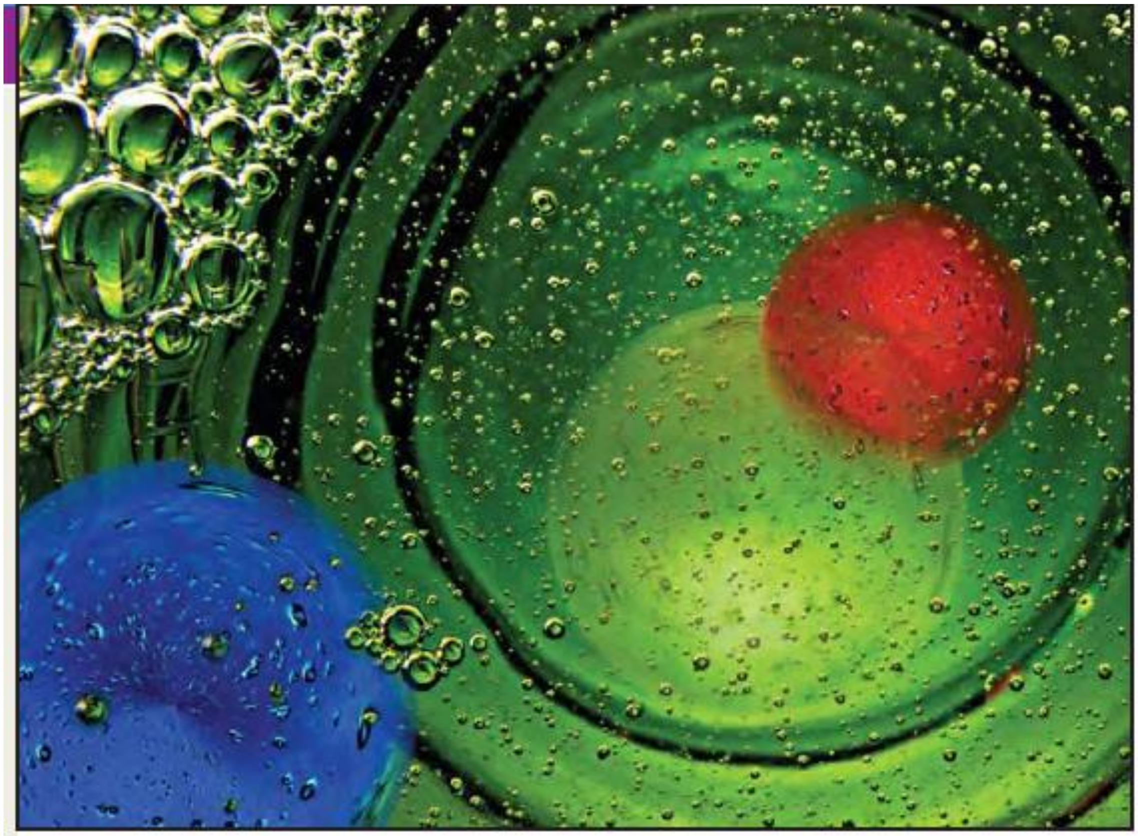
Course Title: Surface Phenomena

Course Code:Chem484/673



Thomas Graham (1861) studied the ability of dissolved substances to diffuse into water across a permeable membrane. He observed that crystalline substances such as sugar, urea, and sodium chloride passed through the membrane, while others like glue, gelatin and gum arabic did not. The former he called **crystalloids** and the latter **colloids** (Greek, *kolla* = glue ; *eidos* = like). Graham thought that the difference in the behavior of 'crystalloids' and 'colloids' was due to the particle size. Later it was realised that **any substance, regardless of its nature, could be converted into a colloid by subdividing it into particles of colloidal size.**

WHAT ARE COLLOIDS ?

In a **true solution** as sugar or salt in water, the solute particles are dispersed in the solvent as single molecules or ions. Thus the diameter of the dispersed particles ranges from 1Å to 10 Å.

On the other hand, in a **suspension** as sand stirred into water, the dispersed particles are aggregates of millions of molecules. The diameter of these particles is of the order 2,000 Å or more.

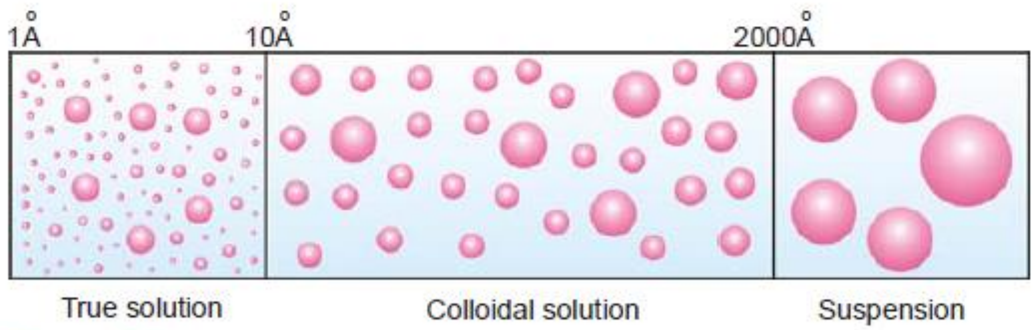


Figure 22.1
Particle size (indicated by diameter) range of true solution, colloidal dispersion, and suspension.

The colloidal solutions or colloidal dispersions are intermediate between true solutions and suspensions. In other words, the diameter of the dispersed particles in a colloidal dispersion is more than that of the solute particles in a true solution and smaller than that of a suspension.

When the diameter of the particles of a substance dispersed in a solvent ranges from about 10 Å to 2,000 Å, the system is termed a colloidal solution, colloidal dispersion, or simply a colloid.

The material with particle size in the colloidal range is said to be in the **colloidal state.**

Figure 22.2

Common examples of colloids.

The colloidal particles are not necessarily corpuscular in shape. In fact, these may be rod-like, disc-like, thin films, or long filaments. For matter in the form of corpuscles, the diameter gives a measure of the particle size. However, in other cases one of the dimensions (length, width and thickness) has to be in the colloidal range for the material to be classed as colloidal. Thus in a broader context we can say :

A system with at least one dimension (length, width, or thickness) of the dispersed particles in the range 10 Å to 2,000 Å, is classed as a colloidal dispersion.

TYPES OF COLLOIDAL SYSTEMS

As we have seen above, a colloidal system is made of two phases. The substance distributed as the colloidal particles is called the **Dispersed phase.** The second continuous phase in which the colloidal particles are dispersed is called the **Dispersion medium.** For example, for a colloidal solution of copper in water, copper particles constitute the dispersed phase and water the dispersion medium.

As stated above, a colloidal system is made of a dispersed phase and the dispersion medium. Because either the dispersed phase or the dispersion medium can be a gas, liquid or solid, there are eight types of colloidal systems possible. A colloidal dispersion of one gas in another is not possible since the two gases would give a homogeneous molecular mixture.

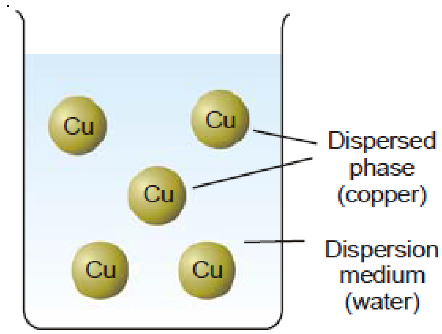


Figure 22.3
A colloidal system of copper in water

Sols or Colloidal system

The colloidal systems which consist of a solid substance dispersed in liquid.These are frequently referred to as sols or colloidal solutions.

Aqua sols or Hydrosols

colloidal solutions in water as the dispersion medium are termed **Hydrosols or Aquasols.**

Alcosols and Benzosols

When the dispersion medium is alcohol or Benzene, then the sols are referred to as alcosols and Benzosols, respectively.

TABLE 22.1. TYPES OF COLLOIDAL SYSTEMS			
Type Name	**Dispersed Phase**	**Dispersion medium**	**Examples**
Foam	gas	liquid	whipped cream, shaving cream, soda-water
Solid foam	gas	solid	froth cork, pumice stone, foam rubber
Aerosol	liquid	gas	for, mist, clouds
Emulsion	liquid	liquid	milk, hair cream
Solid emulsion (gel)	liquid	solid	butter, cheese
Smoke	solid	gas	dust, soot in air
Sol	solid	liquid	paint, ink, colloidal gold
Solid sol	solid	solid	ruby glass (gold dispersed in glass), alloys.

LYOPHILIC AND LYOPHOBIC SOLS OR COLLOIDS

Sols are colloidal systems in which a solid is dispersed in a liquid.

These can be subdivided into two classes :

(*a*) Lyophilic sols (solvent-loving)

(*b*) Lyophobic sols (solvent-hating)

Lyophilic sols are those in which the dispersed phase exhibits a definite affinity for the medium or the solvent.

The examples of lyophilic sols are dispersions of starch, gum, and protein in water.

Lyophobic sols are those in which the dispersed phase has no attraction for the medium or the solvent.

The examples of lyophobic sols are dispersion of gold, iron (III) hydroxide and sulphur in water. The affinity or attraction of the sol particles for the medium, in a lyophilic sol, is due to hydrogen bonding with water. If the dispersed phase is a protein (as in egg) hydrogen bonding takes place between water molecules and the amino groups (–NH–, $-NH_2$) of the protein molecule. In a dispersion of starch in water, hydrogen bonding occurs between water molecules and the – OH groups of the starch molecule. **There are no similar forces of attraction when sulphur or gold is dispersed in water.**