

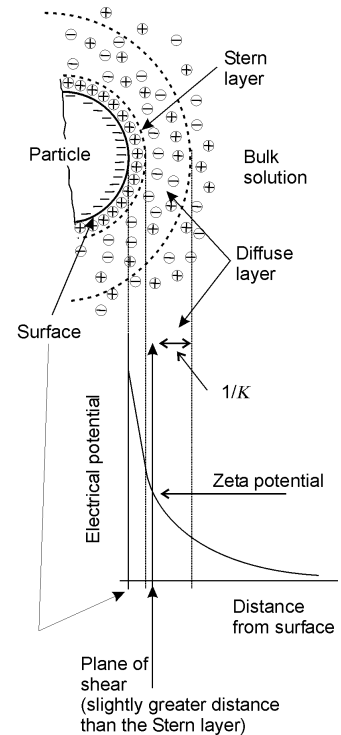
# 13 Colloids and agglomeration

The processing of fine particulate materials is becoming increasingly important and the term *nanotechnology* is typically used to describe any system with particle diameters less than 1 micron. In liquid systems, colloidal forces become significant when particle diameters are less than 40 microns and very significant below 10 microns. At higher particle sizes the liquid drag and particle weight forces are normally dominant. These thresholds are, of course, material dependent and the equations covered in this chapter should help in determining the relative importance of the various forces. In gas based systems, some of the forces appropriate to liquid systems may still be applied, such as van der Waal's attraction, but others will not: e.g. electrical double layer repulsion. Thus, this chapter covers the forces on fine particles (other than drag and inertia) in both systems separately.

In a gaseous continuous phase *agglomeration* may be performed, which is the process of sticking particles together, either relying on natural adherence forces to bring the particles together or by adding binding agents. Granulation is the process of forming particle granules that are usually large enough to flow readily and are easy to process. Industrial granulation relies upon the formation of strong agglomerates which are, usually, compressed or heated (or otherwise treated) to give granules that do not easily subsequently break. Hence, within a process it may be necessary to grind a powder to a small size, to intimately mix the small grain sizes with another powder, and then to agglomerate the resulting mixture into granules for the purpose of storage and further powder processing. The granules may, eventually, be made into tablets or a similar compressed compact. Another process worth mentioning is the formation of engineering components from very small particles, which after pressing form strong solid objects. Complex shaped objects with tailored physical properties, and composites, can be made by this technique. Hence, an understanding of fine particle processing, and forces, is important to many modern processing industries.

## 13.1 Forces on small particles – in liquid medium

Figure 13.1 illustrates a particle in water and the associated electric field around it. Most mineral particle surfaces are negatively charged, due to defects in the solid crystal lattice, chemical reactions at the surface, slightly soluble ions dissolving from the crystal and adsorption (and exchange) of ions from the surrounding solution. Some biological particles may be positively charged. The charge on the particle surface gives rise to ions of counter charge strongly bound to the surface. The total depth of strongly bound ions to the particle is called the *Stern layer*. At some distance further away from the particle there is the shear plane, which marks the start of the *diffuse layer*. It is



**Fig. 13.1** Electrical charge around a particle in an electrolyte solution