THE ROLE OF POLYMERS IN THE STABILIZATION OF DISPERSE SYSTEMS

D.H. Napper

Department of Physical Chemistry
University of Sydney, NSW 2006
Australia

INTRODUCTION

Nonionic polymers can impart stability to a colloidal dispersion in at least two different ways:

(i) if attached to the colloidal particles, they can generate steric stabilization;
(ii) if free in solution, they may generate depletion stabilization.

Steric stabilization has been exploited continuously for some five millennia since the production in Ancient Egypt of 'instant' inks for writing on papyrus. Nowadays, it is exploited in paints, inks, foods, pharmaceuticals, etc., and is evident in biological systems (e.g. milk, blood, etc.). There are at least three advantages that steric stabilisation possesses over electrostatic stabilization:

(i) its relative insensitivity to high concentrations of electrolytes;
(ii) the fact that high solids dispersions display relatively low viscosities;
(iii) it is equally effective in both aqueous and nonaqueous dispersion media.

THE ATTRACTIVE INTERACTION

It is a matter of common observation that a dispersion of naked uncharged colloidal particles undergo very rapid coagulation.
This is a consequence of the strong long-range London dispersion attraction between the particles. London dispersion forces have a quantum mechanical origin and are responsible for the liquefaction of rare gases at low temperatures.

GENERAL METHODS FOR IMPARTING COLLOID STABILITY

In order to generate stable dispersions, it is necessary to provide repulsive interactions which outweigh the London interaction. Currently, there really exist only the general methods by which colloid stability can be usefully imparted:

(i) electrostatic stabilization;
(ii) polymeric stabilization.

At the present time, stabilization by what are termed 'solvation forces' does not seem to be sufficiently long range or sufficiently well-understood to be exploited.

STERIC STABILIZATION

The best steric stabilizers which have been prepared to date are amphiphatic block or graft copolymers. These are composed of a nominally insoluble 'anchor' polymer, and soluble stabilizing moieties. Whilst homopolymers can impart stability, they are comparatively ineffectual. Homopolymers impose conflicting requirements on the dispersion medium: on the one hand, it must be a good solvent for effective stabilization, whereas on the other, it must be a poor solvent for effective adsorption.

Optimum stability is usually achieved if (i) the 'anchor' polymer is about one-third by weight of the amphiphatic copolymer, and (ii) the particles are fully coated. Condition (i) ensures that the stabilizing chains do not desorb under the stress generated by a Brownian collision, whilst condition (ii) ensures that the chains cannot undergo lateral motion away from the stress zone. Colloidal dispersions stabilised by homopolymers, or poorly anchored stabilizers, often exhibit instability arising from the lateral movement and/or desorption of the stabilizing chains.

A third criterion for optimum stability is the need for reasonably high molecular weight stabilizing moieties to ensure that the van der Waals' forces of attraction between the core particles is rendered negligible.