CHAPTER I
INTRODUCTION

Polymer and surfactants are often used together in industrial formulations to take advantage of their idiosyncratic characteristics. When present together polymer and surfactant can interact to either provide beneficial properties or cause unwanted problems. Interactions between polymers and surfactants in aqueous solution can be classified into three broad categories; uncharged polymer-ionic surfactant interactions, oppositely charged polymer-surfactant interactions and hydrophobically-modified polymer-surfactant interactions.

Industry employs mixtures of charged polymer and oppositely charged-surfactants in a multitude of applications. For instance in water treatment, paints, paper making, oil recovery, detergency, cosmetic and protein purification. Strong dominating electrostatic interactions coupled with the wide number of industrial applications made the category of oppositely charged polymer-surfactant interactions an interesting and widely applicable subject area. In this study we will only be concerned with oppositely charged polymer-surfactant interactions.

It is widely known that a mixture of charged polymer and an oppositely charged surfactant will interact strongly before potentially separating into a dilute phase and a phase concentrated in both the polymer and the surfactant. This phase separation can be either a liquid-liquid separation called coacervation or liquid-solid phase separation called precipitation. These phase separation phenomena have received increasing interest for both theoretical and technological investigations. The phase separation process is the consequence of flocculation processes followed by sedimentation or gravimetric effects. The surfactant and the polyelectrolyte interact to form complexes. These complexes are typically single phase at both low and high surfactant concentrations while at intermediate concentrations the complexes aggregate to form a polymer-rich phase precipitates.

There are a number of commercial applications of such behaviour. This study will be focussed on one such commercial application of polymer-surfactant flocculation; 2 in 1 hair shampoos.

From the consumer perspective a 2 in 1 shampoo has to perform a number of functions. Firstly, the shampoo has to clean (removing pollutants, sebum and sweat): the consumer believes that this can only be achieved through the generation of lather. Secondly, the shampoo has to detangle the hair during the rinsing process. This is typically achieved through the use of cationic polymers. These polymers are substantive to hair due to charge attraction, however, due to their highly hydrophilic nature they are able to create a structured layer which acts as a hydrodynamic lubricant to reduce detangling forces. In the past, cationic polymers that did not undergo flocculation at any dilution were used to create this effect.

Thirdly, the shampoo has to deliver conditioning after the hair has dried, in order to provide smooth/soft feeling hair. The primary route to achieving this conditioning benefit is through delivery of silicone lubricants to the hair. However, this creates an obvious paradox: how to deliver a lubricant oil to hair when the system has been designed to remove oils? Different organisations have found different routes to overcoming this paradox. One approach is to use silicone microemulsion particles (which are essentially too small to deposit onto hair fibres) during the washing/cleaning process, as the consumer starts to rinse their hair the system passes from the single phase polymer-surfactant complex to the two-phase flocculated polymer-surfactant region. During this flocculation process, the silicone microemulsion particles are trapped into the forming flocs. The flocs that are formed will be considerably larger (several 100's microns); large enough to be filtered by the hair fibre array, hence improving deposition of the silicone, without having significant impact on the cleaning process.

Whilst the above deposition process is extremely effective, it is not selective. In that the flocs that are formed may contain materials other than silicone, such as other hydrophobic materials that are added to change the appearance of the shampoo, or, alternatively, may not contain any additional materials. Whilst the conditioning benefits of the silicone are clear and well established, the impact on hair feel/conditioning of the other materials that are deposited, such as the polymer-surfactant flocs are relatively unknown. Furthermore, the impact of these deposits on the performance of post-shampoo hair care products, such as rinse-off conditioners are unknown.