Preface

The aim of this book is to provide a comprehensive, well-structured insight into the physical chemistry of liquid foams which can be used by both academics and industrialists. Liquid foams may occur naturally or by design and may be desirable or undesirable. Generally, there is a multitude of complex causes of foaming and antifoaming and the text is structured to give clarity to the field by providing an up-to-date, state-of-the-art guide explaining the chemistry of real foam systems. It is hoped that the reader will achieve a reasonably clear understanding of why foaming occurs, how it can be measured and how it can be prevented. As the use of foams spans different disciplines, some introductory aspects of physics, chemical engineering and material science of foams are included but this is relatively easy to follow. This book is orientated toward the descriptive rather than the theoretical and contains many diagrams. It is also a rich source of information and references, arranged in a way which the reader should find useful and also provides an historical prospect to the area of foams and foaming.

The most popular academic books dealing solely with foams include the classics *Foams* by J. J. Bikerman (1973), published by Springer-Verlag, Berlin and *The Physics of Foams* by D. Weaire and S. Hutzler (1999), published by Clarendon Press, Oxford. Both of these books ran into several updated editions but considerable advancements in the field have been made since their publication. Other early texts are *Foams and Biliquid Foams-Aphrons* by F. Sebba (1987), published by Wiley and the two books – *Antifoaming* (edited by P. Garrett, 1993) and *Foams* (edited by R. K. Prud'homme and S. A. Kahn, 1996) – published in the *Surfactant Science Series* (Marcel Dekker). These are fairly well-read books but are essentially a collection of viewpoints which describe many varied aspects of foaming and antifoaming science. *Foam and Foam Films* by D. Exerowa and P. M. Kriglyako (1997), published by Elsevier in the *Studies in Interfacial Science Series*, has been well received but presents a strongly fundamental text with the main emphasis on thin films. More recently is the book *Foam Engineering*, edited by P. Stevenson (2012) and published by Wiley, covers rheology, flow and foam processing and is aimed toward the chemical engineering community. Another recent book, *Foams Structure and Dynamics* (2013) edited by a group of French scientists and published by Oxford University Press, was directed toward the Physics community.

There are many other books available but they are multi-authored, specialist texts edited by engineers, chemists, chemical engineers or physicists. They usually include an ad hoc assortment of specialist research or review papers focused on foams or foaming within specific areas. For example, an early book by Schraum (1994) covered the oil industry and E. Dickenson and coworkers edited several books on the food industry which included chapters on food foams. Another multi-authored book, *Foamspex*, came out as a European Union project and covers the large-scale applications and modeling of foam spreads and extinguishment aspects of firefighting foams. This was published by SP Sweden (the Swedish National Testing and Research and Fire Technology Institutes) in 2001. Other texts on polymer foam systems are more specialized, for example, *Polymer Foam Handbook*, edited by N. J. Mills and published by Elsevier (2007) and *Handbook of Polymeric Foams and Foam Technology*, edited by D. Klemper and coworkers and published by Hanser (2004).

This book is a single-authored, comprehensive text which gives a current and coherent picture of foam chemistry. The book will probably be of most interest to senior undergraduate and graduate students of physical chemistry, chemical engineering, surface and colloid chemistry, life sciences and applied physics. It is also aimed at scientists and engineers in industry who frequently encounter foams under practical conditions. In these cases, the presence, absence and nature of foam can determine the economic and technical success of the process. Although some prerequisite scientific knowledge is expected from the reader, only the bachelor's level in sciences is needed to adequately understand the principles presented. In fact, the book could prove to be of interest to less academic amateur scientists, for example, with interests in the brewing of beer.

The book contains twelve chapters. Chapter 1 outlines the most important properties of foams and their uses in everyday situations. The physical and chemical aspects of foams and foaming are reviewed and the main features of wet and dry foams are described. Surface active agents and the relevant basic thermodynamics are also introduced. Chapter 2 describes the nature and properties of chemical foaming surfactants together with their role in stabilizing bubbles. Chapter 3 is an important chapter from a fundamental viewpoint since it covers soap films, which are the basic structural elements in foams, and it reviews the role of the intermolecular forces which define the stability of thin films. Techniques for measurement of the stability and draining of foam films are also discussed. In Chapter 4, an overview of the different types of processes in foaming is presented. These include the ascent of bubbles in liquids, the drainage of liquids through foams and the diffusion of gas through the foam, humidity and evaporation. Chapter 5 covers the generation of foams and includes a range of methods used both in laboratory and in industry. In Chapter 6, the coalescence of bubbles and techniques for measuring the coalescence process are described. Coalescence of bubbles in solutions of different types of inorganic electrolytes is reviewed in light of recent experiments in which the bubble approach speed is taken into consideration. Chapter 7 discusses the classification of bubble and foam stability and the different types of stabilization mechanisms which can operate. In addition, the various types of additives which can be used in stabilization of foam systems are summarized.

In Chapter 8, the historic background of particle stabilized foams is presented together with their use in established processes such as deinking and flotation. The role of contact angle, particle shape, charge, detachment forces, capillary pressure and the influence of the formation of different types of particle networks is discussed. Chapter 9 covers foaming in non-aqueous liquids, which is less commonly encountered in non-aqueous fluids than in water-based media, but it is an important topic to consider. It occurs in a wide range of industrial processes – for example, during the processing of crude oils, drilling fluids, lubricants, solvent (base cleaners), etc. Chapter 10 covers defoaming and antifoaming. Problems are caused by foaming throughout a range of industrial processes – for example, in the production and processing of paper, pharmaceuticals, materials, textiles, coatings, crude oils, washing, leather, paints, adhesives, lubrication, fuels, heat transfer fluids, etc. and in the processing of food and beverages such as sugar beet, orange and tomato juice, beer, wine and mashed potatoes. The different types of antifoaming additives used to prevent formation and destruction of foams are classified and also the physical chemical mechanisms involved. Foam test methods are described in Chapter 11, including both laboratory and industrially developed techniques. Finally, in Chapter 12, several new developments in the area of foam research are reviewed. This includes the growth and stability of foams in microgravity and mechanisms involved in the production of metal foams at high temperature, which have the potential to be used in the automobile and aircraft industries. In addition, foaming in the environment is documented (natural waters, sea waters and polluted waters). Insects, mammals and reptiles produce stable foams from bio-surfactants or surface active proteins which have complex structures.