colloids and interfaces

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Book Review

Surfactants—In Solution, at Interfaces and in Colloidal Dispersions. By Bob Aveyard. Oxford University Press: Oxford, UK, 2019; 576p, ISBN: 9780198828600

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Surfactants are not a recent invention required for new technologies, but people have been using them from the early stages of civilisation, for example, in ancient Egypt and Greece. There was no significant progress in the development of detergents for thousands of years until modern chemistry initiated the production of synthetic surfactants. Today, surfactants are present all around us and our daily life would not function as it does without them. This new book on surfactants will therefore be essential reading for those who work with surfactants.

Surfactants self-assemble in solution, adsorb at interfaces, and are able to act as stabilizing agents in various kinds of dispersions; the book covers all three areas of behaviour. It explains the basics of relevant colloid and surface science, and describes various experimental methods required to investigate the properties of systems containing surfactants. The reader gains interesting insights and an understanding of the connections between various aspects and areas of surfactant science.

The book consists of seven sections and starts with the scientific "Background". First (Chapter 1), the molecular structure and various categories of surfactants are discussed. This part is rather short, but references allow the reader to access further relevant information. Then, the amphiphilic nature of surfactants is introduced and the antipathy between hydrophobic surfactant groups and water (i.e., hydrophobic hydration, which drives much of surfactant behaviour in aqueous solution) is explored (Chapter 2). Various definitions and explanations of interfacial parameters and phenomena such as surface and interfacial tension (including its experimental determination), contact angle, wetting, adhesion and nucleation, are given in Chapter 3, which completes the background section.

The next two sections form the main parts of the book for those wanting to understand the behaviour of surfactants at interfaces (Section II) and in solution (Section III). The section on the "Adsorption of Surfactants" (covering more than 120 pages in Chapter 4 to Chapter 8) includes the key equations of the thermodynamics of adsorption, adsorption at liquid/vapour, and liquid/liquid interfaces, dynamic aspects of liquid interfaces (dynamic interfacial tension, interfacial rheology and adsorption kinetics) as well as adsorption at solid/liquid interfaces. Methods for characterising adsorbed films such as neutron reflection, scanning probe microscopy, and ellipsometry are also described. Section III (Chapters 9 and 10, covering 90 pages) deals with the "Aggregation of Surfactants in Solution". Aggregation in aqueous solution is covered in Chapter 9, where topics include models for micelle formation, the molecular thermodynamic treatment of micellisation, the shape and size of micelles, solubilisation, and interaction with polymers. In Chapter 10, surfactant systems containing roughly equal volumes of nonpolar oil and water (such as those used in emulsion formation) are considered. Included here is a discussion of ultralow oil/water interfacial tensions, microemulsion formation, and Winsor systems as well as a modern understanding of Bancroft's rule and the hydrophile–lipophile balance concept.

"Surface Forces and Thin Liquid Films" are dealt with in Section IV (Chapters 11 and 12), which covers background material relevant to the stability of thin liquid films such as those present between approaching particles/droplets in particulate dispersions, emulsions, and foams. The formation and stabilisation of emulsions and foams are considered in detail in Section V entitled "Dispersions Stabilized by Surfactants". Sections IV and V give an excellent insight into the behaviour of emulsions and foams, and also treat classical dispersions of solid particles in liquids. A short chapter (Chapter 15) on the bulk rheology of dispersions concludes Section V.

Section VI (Chapter 16) entitled "Wetting of Liquids and Solids" covers "equilibrium" wetting of liquids and solids as well as briefly describing some dynamic aspects of wetting. Included are discussions of the effects of surfactants on wetting, wetting and Hamaker constants, measurement of contact angles, "surface tension" of solids, and the super-hydrophobicity of solids.

Work on small solid particles adsorbed at fluid interfaces has been a topic of interest at the author's former University of Hull for some time. It is not surprising therefore, that Section VII is devoted to the description of systems with adsorbed particles at fluid interfaces. In Chapter 17, the energetics of particle adsorption is presented and the properties and structure of adsorbed particle monolayers at fluid interfaces explored. Particles can be used in the absence of surfactants to stabilize (Pickering) emulsions and the final chapter is devoted to a consideration of the role of adsorbed particle monolayers in emulsion stabilisation.

The final ten pages of the book are named "Themes and Connections". Starting from a keyword, the locations in the book linked to it are referred to. For example, the keyword "Contact Angle" (CA) is linked to its definition, to advancing/receding CA, to the impact of surfactants on CA, to surface roughness, to experimental methods to measure CA, etc. This is a great section and can serve as a tool for teachers in the preparation of lectures and examinations.

A special feature of the book are the text boxes, strategically placed throughout the book. These provide, for example, brief explanations of certain subjects and definitions and pose questions and provide answers. Several of these boxes also give brief biographies of famous scientists having set milestones in the field such as Thomas Young (contact angle, wetting), Benjamin Franklin (surfactant monolayers), Josiah Willard Gibbs (interfacial thermodynamics), William Thomson (Lord Kelvin, thermodynamics), Michael Faraday (colloid science), and Irving Langmuir (adsorption). Many of the boxes will provide useful material for teachers, covering the entire field of colloids and interfaces, with particular emphasis on surfactants.

The graphs and cartoons are of excellent quality, making it easy to understand various principles and trends caused by the action of surfactants. The system of referencing gives not only recent publications, but also classical papers and books, and the extensive list of symbols given at the beginning of the book is very useful for the reader.

The author of this book is Bob Aveyard, Professor Emeritus at the University of Hull. Over almost half a century, he has taught undergraduate and graduate students the fundamentals of surface chemistry and colloid science and has also provided many specialist courses at other universities and in industry. This experience provides an excellent basis for writing this didactic book on surfactants.

I recommend this book not only to undergraduates, graduates, and PhD students in colloid and interface science and related areas, but also to researchers in this field. Even established experts will find new insights into the various areas of surfactant science. I am sure readers will be inspired by the way the world of surfactants and their behaviour is presented here.