Contents

Preface —— v

1 General introduction —— 1

2 General classification of surfactants —— 5
2.1 Anionic surfactants —— 5
2.1.1 Carboxylates —— 6
2.1.2 Sulfates —— 6
2.1.3 Sulfonates —— 7
2.1.4 Isethionates —— 8
2.1.5 Taurates —— 9
2.1.6 Phosphate-containing anionic surfactants —— 9
2.2 Cationic surfactants —— 9
2.3 Amphoteric (zwitterionic) surfactants —— 11
2.4 Nonionic surfactants —— 12
2.4.1 Alcohol ethoxylates —— 12
2.4.2 Alkyl phenol ethoxylates —— 13
2.4.3 Fatty acid ethoxylates —— 13
2.4.4 Sorbitan esters and their ethoxylated derivatives (Spans and Tweens) —— 13
2.4.5 Ethoxylated fats and oils —— 15
2.4.6 Amine ethoxylates —— 15
2.4.7 Amine oxides —— 15
2.5 Speciality surfactants —— 16
2.5.1 Fluorocarbon and silicone surfactants —— 16
2.5.2 Gemini surfactants —— 17
2.5.3 Surfactants derived from mono- and polysaccharides —— 17
2.5.4 Naturally occurring surfactants —— 18
2.5.5 Biosurfactants —— 22
2.5.6 Polymeric surfactants —— 24

3 Aggregation of surfactants, self-assembly structures, liquid crystalline phases —— 29
3.1 Thermodynamics of micellization —— 36
3.1.1 Kinetic aspects —— 36
3.1.2 Equilibrium aspects: Thermodynamics of micellization —— 37
3.2 Enthalpy and entropy of micellization —— 39
3.3 Driving force for micelle formation —— 40
3.4 Micellization in surfactant mixtures (mixed micelles) —— 42

Bibliografische Informationen
http://d-nb.info/1045093505

digitalisiert durch DEUTSCHE NATIONAL BIBLIOTHEK

3.5 Surfactant self-assembly — 45
3.5.1 Structure of liquid crystalline phases — 45
3.5.2 Hexagonal phase — 46
3.5.3 Micellar cubic phase — 47
3.5.4 Lamellar phase — 47
3.5.5 Bicontinuous cubic phases — 47
3.5.6 Reversed structures — 47
3.6 Experimental studies of the phase behavior of surfactants — 48

4 Surfactant adsorption at interfaces — 51
4.1 Introduction — 51
4.2 Adsorption of surfactants at the air/liquid (A/L) and liquid/liquid (L/L) interfaces — 52
4.2.1 The Gibbs adsorption isotherm — 53
4.2.2 Equation of state approach — 57
4.2.3 The Langmuir, Szyszkowski and Frumkin equations — 58
4.3 Interfacial tension measurements — 59
4.3.1 The Wilhelmy plate method — 59
4.3.2 The pendent drop method — 60
4.3.3 The Du Nouy's ring method — 61
4.3.4 The drop volume (weight) method — 61
4.3.5 The spinning drop method — 61
4.4 Adsorption of surfactants at the solid/liquid interface — 62
4.4.1 Adsorption of ionic surfactants on hydrophobic surfaces — 64
4.4.2 Adsorption of ionic surfactants on polar surfaces — 67
4.4.3 Adsorption of nonionic surfactants — 69

5 Surfactants as emulsifiers — 73
5.1 Introduction — 73
5.1.1 Nature of the emulsifier — 73
5.1.2 Structure of the system — 74
5.1.3 Breakdown processes in emulsions — 74
5.2 Physical chemistry of emulsion systems — 77
5.2.1 The interface (Gibbs dividing line) — 77
5.2.2 Thermodynamics of emulsion formation and breakdown — 78
5.2.3 Interaction energies (forces) between emulsion droplets and their combinations — 80
5.3 Mechanism of emulsification — 85
5.3.1 Methods of emulsification — 86
5.3.2 Role of surfactants in emulsion formation — 88
5.3.3 Role of surfactants in droplet deformation — 89
5.4 Selection of emulsifiers — 92

5.4.1 The Hydrophilic-Lipophile Balance (HLB) concept — 92
5.4.2 The Phase Inversion Temperature (PIT) concept — 95
5.5 Stabilization of emulsions — 97
5.5.1 Creaming or sedimentation and its prevention — 97
5.5.2 Flocculation of emulsions and its prevention — 98
5.5.3 Ostwald ripening and its reduction — 99
5.5.4 Emulsion coalescence and its prevention — 100

6 Surfactants as dispersants and stabilization of suspensions — 103
6.1 Introduction — 103
6.2 Role of surfactants in preparation of solid/liquid dispersions (suspensions) — 103
6.2.1 Role of surfactants in condensation methods. Nucleation and growth — 104
6.2.2 Emulsion polymerization — 105
6.2.3 Dispersion polymerization — 107
6.2.4 Role of surfactants in dispersion methods — 109
6.3 Assessment of wettability of powders — 115
6.3.1 Sinking time, submersion or immersion test — 115
6.3.2 Measurement of contact angles of liquids and surfactant solutions on powders — 116
6.3.3 List of wetting agents for hydrophobic solids in water — 116
6.3.4 Stabilization of suspensions using surfactants — 118

7 Surfactants for foam stabilization — 121
7.1 Introduction — 121
7.2 Foam preparation — 121
7.3 Foam structure — 122
7.4 Classification of foam stability — 123
7.4.1 Drainage and thinning of foam films — 124
7.4.2 Theories of foam stability — 125
7.5 Foam inhibitors — 129
7.5.1 Chemical inhibitors that lower viscosity and increase drainage — 130
7.5.2 Solubilized chemicals which cause antifoaming — 130
7.5.3 Droplets and oil lenses which cause antifoaming and defoaming — 130
7.5.4 Surface tension gradients (induced by antifoamers) — 131
7.5.5 Hydrophobic particles as antifoamers — 131
7.5.6 Mixtures of hydrophobic particles and oils as antifoamers — 132
7.6 Assessment of foam formation and stability — 132
7.6.1 Efficiency and effectiveness of a foaming surfactant — 133

8 Surfactants in nanoemulsions — 135
8.1 Introduction — **135**
8.2 Fundamental principles of emulsification — **137**
8.2.1 Methods of emulsification and the role of surfactants — **138**
8.3 Preparation of nanoemulsions — **139**
8.3.1 Use of high pressure homogenizers — **139**
8.3.2 Phase inversion principle methods (low energy emulsification) — **140**
8.4 Steric stabilization and the role of the adsorbed layer thickness — **141**
8.5 Ostwald Ripening — **144**
8.6 Examples of nanoemulsions — **145**

9 Surfactants in microemulsions — 153
9.1 Introduction — **153**
9.2 Thermodynamic definition of microemulsions — **154**
9.3 Description of microemulsions using phase diagrams — **155**
9.4 Thermodynamic theory of microemulsion formation — **157**
9.5 Characterization of microemulsions using scattering techniques — **159**
9.5.1 Time average (static) light scattering — **159**
9.5.2 Dynamic light scattering (photon correlation spectroscopy, PCS) — **162**
9.6 Characterization of microemulsions using conductivity — **163**
9.7 NMR measurements — **165**
9.8 Formulation of microemulsions — **165**

10 Surfactants as wetting agents — 169
10.1 Introduction — **169**
10.2 The concept of contact angle — **170**
10.3 Adhesion tension — **172**
10.4 Work of adhesion W_a — **172**
10.5 Work of cohesion — **172**
10.6 The spreading coefficient S — **173**
10.7 Contact angle hysteresis — **173**
10.8 Critical surface tension of wetting — **174**
10.9 Effect of surfactant adsorption — **175**
10.10 Measurement of contact angles — **176**

11 Industrial applications of surfactants — 179
11.1 Surfactants in the home, personal care and cosmetics — **179**
11.1.1 Shaving formulations — **184**
11.1.2 Bar soaps — **185**
11.1.3 Liquid hand soaps — **185**

11.1.4 Bath oils — **186**
11.1.5 Foam (or bubble) baths — **186**
11.1.6 After bath preparations — **186**
11.1.7 Skin care products — **186**
11.1.8 Hair care formulations — **188**
11.1.9 Sunscreens — **191**
11.1.10 Make-up products — **193**
11.2 Surfactants in pharmacy — **196**
11.2.1 Surface active drugs — **197**
11.2.2 Naturally occurring micelle-forming systems — **198**
11.2.3 Biological implications of the presence of surfactants in pharmaceutical formulations — **200**
11.2.4 Solubilized systems — **201**
11.2.5 Pharmaceutical aspects of solubilization — **202**
11.3 Surfactants in agrochemicals — **202**
11.4 Surfactants in paints and coatings — **212**
11.5 Surfactants in detergents — **217**

Index — 221