Contents

Preface to the second edition — VII Preface to the first edition — IX Symbol Index — XI

1	What is surface tension? —— 1						
1.1	Surface tension and its definition — 1						
1.2	Physical origin of the surface tension of liquids —— 2						
1.3	Temperature dependence of the surface tension —— 5						
1.4	Surfactants — 5						
1.5	The Laplace pressure —— 6						
1.6 Surface tension of solids — 8							
1.7	Values of surface tensions of solids —— 8						
	Additional Reading —— 9						
	Appendix 1A. The short-range nature of intermolecular forces — 9						
	Appendix 1B. The Laplace pressure from simple reasoning —— 10						
	Bullets —— 11						
	References —— 11						
2	Wetting of ideal surfaces —— 13						
2.1	What is wetting? The spreading parameter —— 13						
2.2	The Young equation —— 14						
2.3	Wetting of flat, homogeneous, curved surfaces —— 17						
2.4	Line tension —— 19						
2.5	Disjoining pressure —— 20						
2.6	Wetting of an ideal surface: influence of absorbed liquid layers and the liquid vapor —— 22						
2.7	Gravity and wetting of ideal surfaces: a droplet shape						
	and liquid puddles —— 24						
2.8	The shape of the droplet and the disjoining pressure —— 26						
2.9	Distortion of droplets by an electric field —— 27						
2.10	Capillary rise —— 29						
2.11	The shape of a droplet wetting a fiber —— 31						
2.12	Wetting and adhesion: the Young-Dupré equation —— 33						
2.13	Wetting transitions on ideal surfaces —— 33						
2.14	How is the surface tension measured? —— 35						
2.14.1	The Du Noüy ring and the Wilhelmy plate methods —— 35						
2.14.2	The pendant drop method —— 36						
2.14.3	Maximum bubble pressure method —— 37						
2.14.4	Dynamic methods of the measurement of surface tension — 38						

2.15	Measurement of the surface tension of solids —— 40				
	Additional Reading —— 41				
	Appendix 2A. Transversality conditions —— 41				
	Appendix 2B. Zisman plot —— 42				
	Appendix 2C. Antonoff's rule —— 43				
	Bullets —— 43				
	References — 44				
	Additional Reading —— 46				
3	Contact angle hysteresis — 47				
3.1	Contact angle hysteresis: its sources and manifestations — 47				
3.2	Contact angle hysteresis on smooth homogeneous substrates — 49				
3.3	Strongly and weakly pinning surfaces — 50				
3.4	Qualitative characterization of the pinning of the triple line —— 53				
3.5	The zero eventual contact angle of evaporated droplets				
	and its explanation —— 55				
3.6	Contact angle hysteresis and line tension —— 55				
3.7	More physical reasons for contact angle hysteresis on smooth				
	ideal surfaces — 56				
3.8	Contact angle hysteresis on chemically heterogeneous smooth surfaces:				
	the phenomenological approach. Acquaintance with the apparent				
	contact angle —— 57				
3.9	The phenomenological approach to the hysteresis of the contact angle				
	developed by Vedantam and Panchagnula —— 59				
3.10	The macroscopic approach to contact angle hysteresis, the model				
	of Joanny and de Gennes —— 60				
3.10.1	Elasticity of the triple line —— 60				
3.10.2	Contact angle hysteresis in the case of a dilute system of defects —— 61				
3.10.3	Surfaces with dense defects and the fine structure				
	of the triple line —— 62				
3.11	Deformation of the substrate as an additional source				
	of contact angle hysteresis —— 63				
3.12	How contact angle hysteresis can be measured —— 65				
3.13	Roughness of the substrate and contact angle hysteresis —— 66				
3.14	Use of macroscopic contact angles for characterization				
	of solid surfaces —— 67				
	Additional Reading —— 68				
	Appendix 3A. A droplet on an inclined plane —— 68				
	Bullets — 70				
	References — 71				
	Additional Reading —— 73				

4	Dynamics of wetting —— 75					
4.1	The dynamic contact angle —— 75					
4.2	The dynamics of wetting: the approach of Voinov —— 75					
4.3	The dynamic contact angle in a situation of complete wetting — 77					
4.4	Dissipation of energy in the vicinity of the triple line — 78					
4.5	Dissipation of energy and the microscopic contact angle — 79					
4.6	A microscopic approach to the displacement of the triple line — 80					
4.7	Spreading of droplets: Tanner's law —— 81					
4.8	Superspreading — 81					
4.9	Dynamics of the filling of capillary tubes —— 82					
4.10	The drag-out problem —— 83					
4.11	Dynamic wetting of heterogeneous surfaces — 85					
	Additional Reading —— 86					
	Bullets —— 86					
	References — 86					
	Additional Reading —— 87					
5	Wetting of rough and chemically heterogeneous surfaces:					
	the Wenzel and Cassie Models —— 89					
5.1	General remarks —— 89					
5.2	The Wenzel model —— 89					
5.3	Wenzel wetting of chemically homogeneous curved					
	rough surfaces —— 91					
5.4	The Cassie–Baxter wetting model —— 93					
5.5	The Israelachvili and Gee criticism of the Cassie–Baxter model —— 94					
5.6	Cassie-Baxter wetting in a situation where a droplet partially sits on air —— 95					
5.7	The Cassie–Baxter wetting of curved surfaces — 97					
5.8	Cassie-Baxter impregnating wetting — 98					
5.9	The importance of the area adjacent to the triple line in the wetting					
3.9	of rough and chemically heterogeneous surfaces —— 99					
5.10	Wetting of gradient surfaces — 103					
5.11	The mixed wetting state —— 104					
5.12	Considering the line tension —— 105					
J.12	Appendix 5A. Alternative derivation of the Young, Cassie, and Wenzel					
	equations — 107					
	Bullets — 109					
	References —— 110					
	Additional Reading —— 111					
	Additional Reading —— III					

6	Superhydrophobicity, superhydrophilicity, and the rose petal effect — 113						
6.1	Superhydrophobicity —— 113						
6.2	Superhydrophobicity and the Cassie–Baxter wetting regime —— 114						
6.3	Wetting of hierarchical reliefs: approach of Herminghaus —— 115						
6.4	Wetting of hierarchical structures: a simple example —— 116						
6.5	Superoleophobicity —— 118						
6.6	The rose petal effect —— 119						
6.7	Superhydrophilicity — 121						
	Additional Reading —— 122						
	Bullets — 122						
	References —— 122						
	Additional Reading —— 124						
7	Wetting transitions on rough surfaces —— 125						
7.1	General remarks —— 125						
7.2	Wetting transitions on rough surfaces: experimental data —— 126						
7.3	Time-scaling of wetting transitions —— 127						
7.4	Origin of the barrier separating the Cassie and Wenzel wetting states:						
	the case of hydrophobic surfaces —— 128						
7.4.1	The composite wetting state —— 128						
7.4.2	Energy barriers and Cassie, Wenzel, and Young contact angles —— 130						
7.5	Critical pressure necessary for wetting transition —— 132						
7.6	Wetting transitions and de-pinning of the triple line; the dimension						
	of a wetting transition —— 133						
7.7	The experimental evidence for the 1D scenario						
	of wetting transitions —— 136						
7.8	Wetting transitions on hydrophilic surfaces —— 137						
7.8.1	Cassie wetting of inherently hydrophilic surfaces:						
	criteria for gas entrapping —— 137						
7.8.2	Origin of the energetic barrier separating Cassie and Wenzel wetting						
	regimes on hydrophilic surfaces —— 138						
7.8.3	Surfaces built of ensembles of balls —— 140						
7.9	Mechanisms of wetting transitions: the dynamics —— 142						
	Additional Reading —— 143						
	Bullets —— 143						
	References —— 144						
	Additional Reading —— 146						
8	Electrowetting and wetting in the presence of external fields —— 147						
8.1	General remarks —— 147						
8.2	Electrowetting —— 147						
8.3	Wetting in the presence of external fields: a general case —— 148						
	Additional Reading —— 150						

	References —— 150				
	Additional Reading —— 151				
9	Nonstick droplets —— 153				
9.1	General remarks —— 153				
9.2	Leidenfrost droplets —— 153				
9.3	Liquid marbles —— 155				
9.3.1	What are liquid marbles? —— 155				
9.3.2	Liquid marble—support interface —— 157				
9.3.3	Liquid marble—vapor interface —— 157				
9.3.4	Effective surface tension of liquid marbles —— 158				
9.3.5	Scaling laws governing the shape of liquid marbles —— 159				
9.3.6	Properties of liquid marbles: the dynamics —— 160				
9.3.7	Actuation of liquid marbles with electric and magnetic fields —— 161				
9.3.8	Applications of liquid marbles —— 162				
9.4	Nonstick drops bouncing in a fluid bath —— 162				
	Additional Reading —— 163				
	Bullets —— 163				
	References —— 164				
	Additional Reading —— 165				
10	Wetting of lubricated surfaces — 167				
10.1	General remarks — 167				
10.2	Capillarity-inspired effects on wet (lubricated), flat,				
	solid surfaces — 167				
10.2.1	The effect of wettability on the tribology of ideal				
	lubricated surfaces — 167				
10.2.2	Impact of droplets: collision with wet, flat substrates —— 167				
10.3	Wetting of impregnated (infused), solid, rough substrates — 168				
10.4	Impact of water droplets on oil-infused surfaces —— 170				
10.5	Electrowetting of lubricated surfaces —— 170				
	Bullets —— 171				
	References —— 171				
11	Reactive wetting —— 173				
11.1	General remarks —— 173				
11.2	Kinetics of reactive wetting —— 173				
	Bullets —— 175				
	References —— 175				

Bullets — 150