

H. J. Kreuzer
Z. W. Gortel

Physisorption Kinetics

With 133 Figures



Spr 9 / 1



Springer-Verlag
Berlin Heidelberg New York Tokyo

Inventar Nr. M 226 / PC 3

Contents

1. Introduction	1
1.1 Adsorption Phenomena: a Brief Survey	1
1.2 Survey of Experimental Methods	17
2. Gas-Solid Interaction	23
2.1 The Static Surface Potential $V_S(r)$	23
2.2 Mean-Field Surface Potential at Finite Coverage	43
2.3 The Dynamic Atom-Solid Interaction	55
2.4 Phonon Dynamics of a Solid	64
2.5 The Gas-Solid Hamiltonian	86
3. The Master Equation	89
3.1 The Mesoscopic Approach to the Master Equation	89
3.2 The Master Equation for Physisorption Kinetics	96
3.3 The Microscopic Approach to the Master Equation	103
3.4 The Master Equation at Finite Coverage	107
4. Transition Probabilities in the Master Equation	112
4.1 One-phonon Processes at Low Coverage	112
4.2 Multi-phonon Processes and Correlation Functions	122
4.3 Soft Cube Model and Phenomenological Models at Low Coverage	133
4.4 Mean-Field Theory at Finite Coverage	141
5. Desorption Times	142
5.1 Model System with Two Bound States	143
5.2 Systems with a Few Shallow Bound States	146
5.3 Perturbation Theory of the Master Equation	150
5.4 Desorption Kinetics Mediated by Surface Phonons	157
5.5 Inclusion of Parallel Phonon Momentum for Mobile Desorption	159
5.6 Desorption from a Localized Adsorbate	164

5.7	Cole-Tolgo Corrections	173
5.8	Multiphonon Contributions	176
5.9	Multilayer Desorption	181
5.10	Adsorbent Cooling in Thermal Desorption	186
5.11	Flash Desorption and Thermalization	190
6.	Time of Flight Spectra	198
6.1	Experiments	198
6.2	Flux of Desorbed Particles	207
6.3	One-phonon Processes	213
6.4	Classical Models	220
7.	Sticking and Accommodation	223
7.1	Experimental Results	223
7.1.1	Sticking Coefficient	223
7.1.2	Accommodation Coefficient	227
7.2	Theory	229
7.2.1	Sticking	229
7.2.1(a)	Quantum Theories of Sticking	229
7.2.1(b)	Classical Theories of Sticking	242
7.2.2	Energy Accommodation	251
7.2.2(a)	Quantum Theories of Accommodation	251
7.2.2(b)	Classical Theories of Accommodation	256
8.	Kramers Equation	259
8.1	Derivation from the Master Equation	261
8.2	Macroscopic Laws	269
8.3	Friction Coefficient	276
8.4	Hydrodynamics of Adsorption	277
9.	Summary and Outlook	282
9.1	Progress and Problems	282
9.2	Related Topics I: Photodesorption	283
9.3	Related Topics II: Electron-Stimulated Desorption	285
9.4	Approaches to Chemisorption Kinetics	286
	References	293
	Subject Index	317