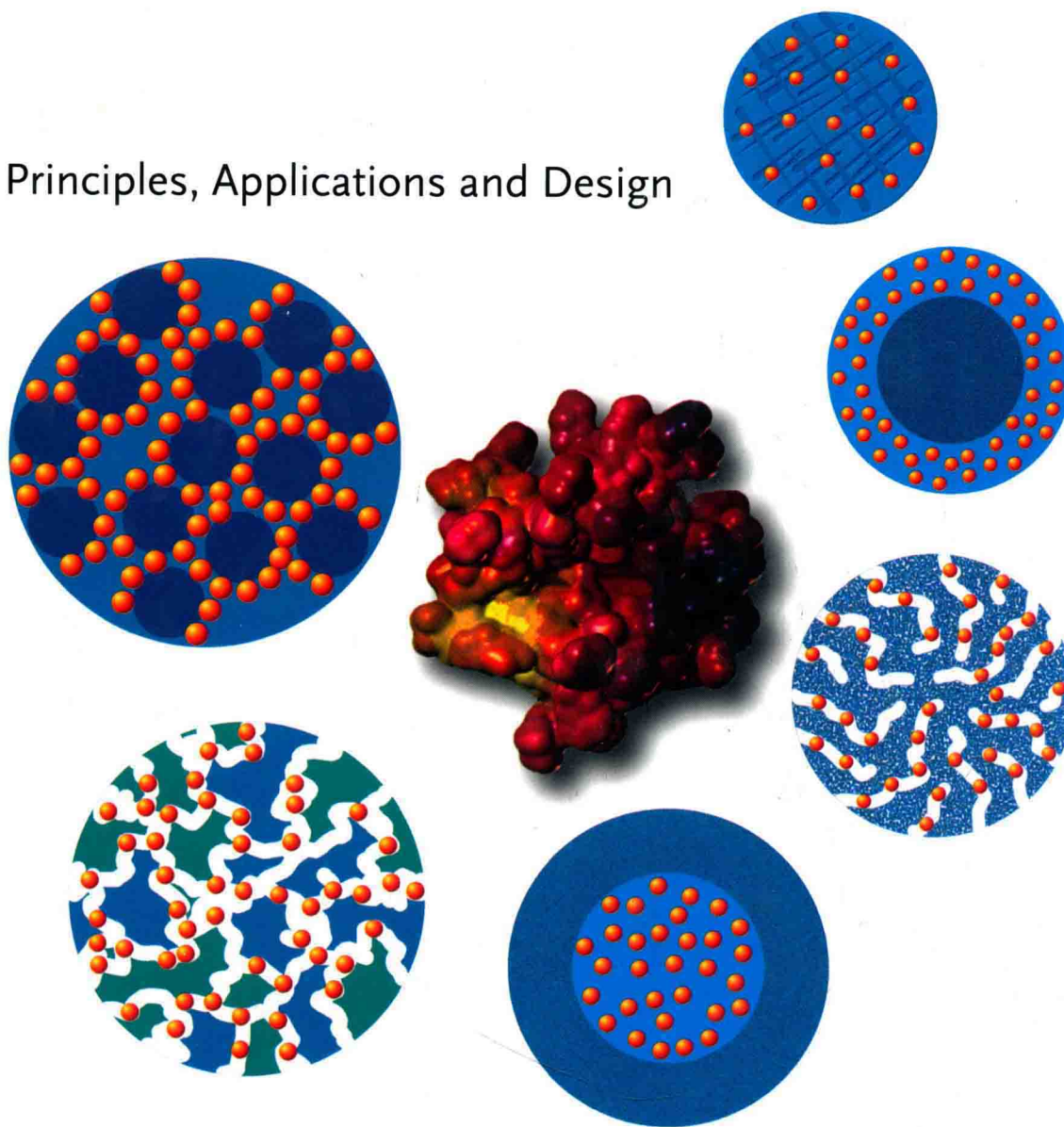


Linqiu Cao

 WILEY-VCH

Carrier-bound Immobilized Enzymes

Principles, Applications and Design



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Foreword

Enzymes are the biocatalysts of the living cell. Their excellent performance in cellular metabolism is due to their intrinsic catalytic properties. In addition, their activity may be further enhanced by functioning in distinct cellular compartments, e.g., within or attached to cellular membranes, or as multifunctional enzyme complexes such as a cellulose-degrading cellulosome.

Enzyme technologists have reinvented such natural forms of “enzyme immobilization”. They have looked for their own bionic solutions to arrive at immobilized biocatalysts which can be used in analytical devices such as a glucose biosensor or in an industrial plant producing, e. g., chiral amines from racemic precursor material. These initial steps towards a benign “green technology” are presently gaining momentum. In fact, the emerging concept of “white biotechnology” (sustainable chemical processes built on renewable resources and biocatalysts, carried out in “biorefineries”) builds not only on fermentation using metabolically engineered microorganisms, but as much on enzymes improved by protein engineering techniques which are used, attached to carrier material, as heterogeneous catalysts in an enzyme reactor. Quite often, the skill to stabilize and re-use an enzyme catalyst through immobilization has proven one of the key steps to render an enzymatic process economically viable.

With this book on “Carrier-bound immobilized enzymes”, Linqiu Cao provides a comprehensive survey of this important field, covering both the history and the present state of immobilization procedures used in enzyme technology. After a short introduction to 100 years of enzyme immobilization, he discusses in great detail not only the methods by which enzymes can be adsorbed, covalently bound or entrapped, but also the laws governing their behaviour in these artificial environments. In the concluding chapter of his book, he also adds an authoritative survey of most recent developments such as enzyme immobilization using genetically engineered attachment points, artificial tags or enzymes whose properties have been changed through reversible binding to synthetic polymers. He thus provides both the industrial enzymologist and the researcher in an academic environment with a well-structured, easily accessible choice of options and protocols to solve their individual needs.

My compliments go to the author for the thorough collection and structuring of a plethora of data, and my wishes to the readers for continuing success in their research on and application of immobilized biocatalysts.

Stuttgart, May 2005

Rolf D. Schmid

Contents

Foreword V

1	Introduction: Immobilized Enzymes: Past, Present and Prospects	1
1.1	Introduction	1
1.2	The Past	4
1.2.1	The Early Days (1916–1940s)	5
1.2.2	The Underdeveloped Phase (1950s)	5
1.2.3	The Developing Phase (1960s)	7
1.2.4	The Developed Phase (1970s)	9
1.2.5	The Post-developed Phase (1980s)	14
1.2.6	Rational Design of Immobilized Enzymes (1990s–date)	16
1.3	Immobilized Enzymes: Implications from the Past	20
1.3.1	Methods of Immobilization	20
1.3.2	Diversity versus Versatility	21
1.3.3	Complimentary versus Alternative	23
1.3.4	Modification versus Immobilization	25
1.3.4.1	Enhanced Stability	25
1.3.4.2	Enhanced Activity	26
1.3.4.3	Improved Selectivity	29
1.4	Prospective and Future Development	34
1.4.1	The Room for Further Development	34
1.4.2	An Integration Approach	36
1.5	References	37
2	Adsorption-based Immobilization	53
2.1	Introduction	53
2.2	Classification of Adsorption	54
2.3	Principles Involved in Absorptive Enzyme Immobilization	55
2.3.1	Monolayer Principle	56
2.3.2	Stabilization Principle	57
2.3.3	Enzyme Distribution	60
2.4	Requirement of the Carriers	61
2.4.1	Physical Requirements	61

2.4.1.1	Pore-size and Available Surface	61
2.4.1.2	Internal Structure	63
2.4.1.3	Density of Binding Functionality	63
2.4.1.4	Particle Size	64
2.4.2	Chemical Nature of the Carriers	65
2.4.2.1	Nature of Binding Functionality	65
2.4.2.2	The Role of the Spacer	66
2.4.2.3	The Nature of the Backbone	66
2.5	Factors Which Dictate Enzyme Catalytic Performance	67
2.5.1	Activity	67
2.5.1.1	Diffusion-controlled Activity	67
2.5.1.2	Conformation-controlled Activity	68
2.5.1.3	Substrate-controlled Activity	70
2.5.1.4	Loading-controlled Activity	70
2.5.1.5	Medium-dependent Activity	72
2.5.1.6	Microenvironment-dependent Activity	73
2.5.1.7	Carrier Nature-dependent Activity	74
2.5.1.8	Enzyme Nature-dependent Activity	75
2.5.1.9	Additive-dependent Activity	75
2.5.1.10	Hydrophilicity-dependent Activity	76
2.5.1.11	Orientation-determined Activity	78
2.5.1.12	Binding Nature-controlled Enzyme Activity	78
2.5.1.13	Binding Density-controlled Enzyme Activity	80
2.5.1.14	Reactor-dependent Activity	81
2.5.1.15	Pore-size-dependent Activity	82
2.5.1.16	Water-activity-dependent Activity	82
2.5.2	Stability	83
2.5.2.1	Conformation-controlled Stability	84
2.5.2.2	Confinement-controlled Stability	85
2.5.2.3	Enzyme Loading-dependent Stability	85
2.5.2.4	Diffusion-controlled Stability	86
2.5.2.5	Cross-linking-dependent Stability	86
2.5.2.6	Carrier Nature-controlled Stability	86
2.5.2.7	Aquaphilicity-controlled Stability	87
2.5.2.8	Medium-controlled Stability	88
2.5.2.9	Temperature-dependent Stability	88
2.5.2.10	Microenvironment-controlled Stability	89
2.5.2.11	Binding Nature-controlled Enzyme Stability	90
2.5.2.12	Binding Density-controlled Enzyme Stability	91
2.5.2.13	Additive-dependent Stability	91
2.5.2.14	Enzyme Orientation-dependent Stability	91
2.5.2.15	Enzyme-dependent Stability	91
2.5.3	Selectivity	92
2.5.3.1	Conformation-controlled Selectivity	93
2.5.3.2	Diffusion-controlled Selectivity	94

2.5.3.3	Binding Functionality-controlled Selectivity	94
2.5.3.4	Additive-controlled Selectivity	95
2.5.3.5	Orientation-controlled Selectivity	96
2.5.3.6	Medium-controlled Enantioselectivity	96
2.5.3.7	Water Activity-controlled Enantioselectivity	97
2.6	Preparation of Immobilized Enzymes by Adsorption	97
2.6.1	Conventional Adsorption	97
2.6.1.1	Non-specific Physical Adsorption	99
2.6.1.2	Ionic Adsorption	100
2.6.1.3	Hydrophobic Adsorption	108
2.6.1.4	Biospecific Adsorption	113
2.6.1.5	Affinity Adsorption	116
2.6.2	Unconventional Adsorption	121
2.6.2.1	Immobilization via Reversible Denaturation	123
2.6.2.2	Pseudo-covalent Immobilization	123
2.6.2.3	Mediated Adsorption	124
2.6.3	Adsorption-based Double Immobilization	128
2.6.3.1	Modification-Adsorption	128
2.6.3.2	Adsorption and Entrapment	131
2.6.3.3	Adsorption-Cross-linking	134
2.6.3.4	Adsorption-Covalent Attachment	142
2.7	References	145

3 Covalent Enzyme Immobilization 169

3.1	Introduction	169
3.2	Physical Nature of Carriers	171
3.2.1	The Surface of the Carriers	172
3.2.1.1	Internal and External Surface	173
3.2.1.2	Accessible Surface/Efficient Surface	173
3.2.1.3	A Theoretical Simulation	175
3.2.2	Density of Binding Sites	176
3.2.3	Pore Related Properties	177
3.2.3.1	The Porosity	177
3.2.3.2	Pore Size and Distribution	178
3.2.4	Particle Size	180
3.2.5	Shape of the Carriers	182
3.3	Chemical Nature of Carriers	183
3.3.1	Carrier-bound Active Groups (CAG)	185
3.3.2	Carrier-bound Inert Groups (CIG)	187
3.3.3	Spacer-Arm	188
3.4	Enzyme: Amino Acid Residues for Covalent Binding	190
3.4.1	Reactivity of Amino Acid Residues (AAR)	191
3.4.2	Position of Active Amino Acids	192
3.5	Factors Affecting Enzyme Performance	193
3.5.1	Activity Retention	194

3.5.1.1	Pore-size-dependent Activity	194
3.5.1.2	CAG-controlled Activity	196
3.5.1.3	CIG-controlled Retention of Activity	200
3.5.1.4	Spacer-controlled Activity	205
3.5.1.5	Enzyme Orientation-controlled Activity	210
3.5.1.6	Binding Density-controlled Activity	210
3.5.1.7	Diffusion-controlled Enzyme Activity	211
3.5.1.8	Reactive Amino Acid Residues (RAAR)-controlled Activity	212
3.5.1.9	Loading-dependent Activity	213
3.5.1.10	Other Factors Controlling Activity	213
3.5.2	Stability of Immobilized Enzymes	214
3.5.2.1	Multipoint Attachment/binding density	215
3.5.2.2	CAG-controlled Stability	217
3.5.2.3	CIG-controlled Enzyme Stability	221
3.5.2.4	Spacer-dependent Stability	224
3.5.2.5	Molecular Confinement-controlled Stability	225
3.5.2.6	Microenvironment-controlled Stability	227
3.5.3	Selectivity of Immobilized Enzymes	228
3.5.3.1	CAG-controlled Selectivity	228
3.5.3.2	CIG-controlled Selectivity	230
3.5.3.3	Spacer-controlled Enzyme Selectivity	232
3.5.3.4	Diffusion-controlled Selectivity	233
3.5.3.5	Aquaphilicity-controlled Selectivity	233
3.5.3.6	Conformation-controlled Enantioselectivity	233
3.5.3.7	Selectivity and Particle Size	234
3.6	Preparation of Active Carriers	235
3.6.1	Synthetic Active Carriers	237
3.6.1.1	Polymers Bearing Acyl Azide	237
3.6.1.2	Polymers Bearing Anhydrides	238
3.6.1.3	Polymers Bearing Halogen Atoms	240
3.6.1.4	Oxirane Functional Polymers	241
3.6.1.5	Isocyanate/Thioisocyanate Functional Polymers	244
3.6.1.6	Polycarbonate	245
3.6.1.7	Activated Carbonyl Polymers	247
3.6.1.8	Polyphenolic Polymers	248
3.6.1.9	Polymeric Carriers Bearing Aldehyde Groups	249
3.6.1.10	Polymers Bearing Activated Ester	251
3.6.1.11	Polymers Bearing Active Azalactone	252
3.6.2	Inactive Pre-carriers	253
3.6.2.1	Hydroxyl Functionality	253
3.6.2.2	Polyacrylamide	254
3.6.2.3	Insoluble Polyacrylic Acid or Derivatives	255
3.6.2.4	Polymers Bearing Nitrile Groups	257
3.6.2.5	Semi-synthetic Polysaccharides	258
3.6.2.6	Synthetic Polypeptide	259

3.6.2.7	Polymers Bearing Amino Groups	260
3.6.3	Interconversion of Inert Carriers	260
3.6.3.1	Polymers Containing Hydroxyl Groups	261
3.6.3.2	Activation of Separate Hydroxyl Groups	268
3.6.3.3	Polymers Containing Carboxylic or Ester Groups	272
3.6.3.4	Polymers Containing Amino Groups	277
3.6.3.5	Polymers Containing Amide Groups	283
3.6.3.6	Polymers Containing Nitrile Groups	286
3.6.3.7	Polymers Bearing Isonitrile Functional Groups	287
3.6.4	Interconversion of Active Functionality	288
3.6.4.1	Converting Epoxy Groups	289
3.6.4.2	Converting Anhydride to New Functionality	290
3.6.4.3	Aldehyde	292
3.7	References	293

4 Enzyme Entrapment 317

4.1	Introduction	317
4.2	Definition of Entrapment	319
4.3	Requirement of the Carriers	321
4.3.1	Physical Requirements	321
4.3.1.1	Pore Size	321
4.3.1.2	Porosity	322
4.3.1.3	Geometry	322
4.3.1.4	Particle Size	323
4.3.2	Chemical Requirements	323
4.3.2.1	Nature of the Active Functionality	323
4.3.2.2	Aquaphilicity of the Carriers	324
4.4	Effect of Entrapment	324
4.4.1	Activity of the Entrapped Enzyme	324
4.4.1.1	Loading-dependent Activity	325
4.4.1.2	Matrix-dependent Activity	325
4.4.1.3	Diffusion-controlled Enzyme Activity	326
4.4.1.4	Conformation-controlled Enzyme Activity	327
4.4.1.5	Additives-controlled Enzyme Activity	328
4.4.2	Stability	328
4.4.2.1	Confinement-determined Stability	329
4.4.2.2	Matrix-nature-dependent Stability	329
4.4.2.3	Enzyme-dependent Stability	330
4.4.2.4	Enzyme Structure-dependent Stability	331
4.4.3	Selectivity	331
4.4.3.1	Microenvironment-dependent Selectivity	331
4.4.3.2	Conformation-dependent Selectivity	332
4.4.3.3	Carrier Nature-dependent Selectivity	333
4.5	Preparation of Various Entrapped Enzymes	333
4.5.1	Conventional Entrapment Process	334

4.5.1.1	Formation of Entrapment Matrix by Chemical Cross-linking	334
4.5.1.2	Physical Entrapment	342
4.5.1.3	Covalent Entrapment	351
4.5.1.4	Sol–Gel Process	356
4.5.2	Non-conventional Entrapment	362
4.5.2.1	Post-loading Entrapment (PLE)	362
4.5.2.2	Entrapment-based Double-immobilization Technique	364
4.5.2.3	Modification and Entrapment	368
4.5.2.4	Supported Entrapment	371
4.6	References	379

5 Enzyme Encapsulation 397

5.1	Introduction	397
5.1.1	General Considerations	398
5.1.2	An Historical Overview	398
5.1.3	Pros and Cons of Micro-encapsulation	399
5.2	Classification of Encapsulation	399
5.2.1	Conventional Encapsulation	399
5.2.1.1	Encapsulation by an Interfacial Process	400
5.2.1.2	Encapsulation by Phase Inversion	401
5.2.2	Non-conventional Encapsulation	401
5.2.2.1	Encapsulation in Liquid Membrane	401
5.2.2.2	Encapsulation–Reticulation	401
5.2.3	Double Immobilization Based on Encapsulation	402
5.2.3.1	Encapsulation–Cross-linking	402
5.2.3.2	Encapsulation and Coating	402
5.2.3.3	Entrapment and Coating	403
5.2.3.4	Immobilization and Encapsulation	403
5.2.4	Post-loading Encapsulation	404
5.2.4.1	Encapsulation in Non-swellable Microcapsules	405
5.2.4.2	Encapsulation in Soft Microcapsules	405
5.3	Effect of Encapsulation	406
5.3.1	Activity of the Encapsulated Enzymes	406
5.3.2	Stability of the Encapsulated Enzymes	407
5.3.3	Enantioselectivity	407
5.4	Processes for Preparation of Encapsulated Enzymes	407
5.4.1	Interfacial Processes	407
5.4.1.1	Interfacial Cross-linking/Polymerization	408
5.4.1.2	Interfacial Physical Gelation	411
5.4.2	Surfactant-related Hollow Microsphere	412
5.4.2.1	Microemulsion-based Encapsulated Enzymes	412
5.4.2.2	Polymeric Micelles/Liposomes	416
5.4.2.3	Liposome capsules	416
5.4.2.4	Colloidal Liquid Aphrons (CLA)	421
5.4.3	Phase Inversion	423

5.4.3.1	Coacervation	423
5.4.3.2	The Double-emulsion Method	423
5.4.3.3	Modified Double-emulsion Methods	426
5.4.3.4	Other Methods	429
5.4.4	Pre-designed Capsules for Post-loading Encapsulation	429
5.4.4.1	Introduction	429
5.4.4.2	Theoretical Considerations	430
5.4.5	Non-conventional Encapsulation Processes	430
5.4.5.1	Encapsulation/Coating	430
5.4.5.2	Encapsulation/Cross-linking	432
5.4.5.3	Immobilization and Encapsulation	434
5.4.5.4	Immobilization and Encagement	434
5.5	References	438
6	Unconventional Enzyme Immobilization	449
6.1	Introduction	449
6.2	Coating-based Enzyme Immobilization	450
6.2.1	Monolayer Enzymes	451
6.2.2	Phase-inversion Coating	451
6.2.3	Multiple Enzyme Coating by Physical Adsorption	452
6.2.4	Mediated Formation of Multiple Enzyme Layers	452
6.2.5	Affinity-ligand-mediated Formation of Enzyme Coatings	455
6.2.6	Coating of Soluble Enzyme–Polymer Complexes	456
6.2.7	Enzymatically Gelified Multienzyme Layer	456
6.2.8	Sol–Gel Coating and Covalent Attachment	457
6.2.9	Electrochemical Deposition	457
6.2.10	Enzyme Coating by Use of Small Pore-size Carriers	458
6.3	Site-specific Immobilization	458
6.3.1	Site-specific Immobilization via Biospecific Ligand–Enzyme Interaction	463
6.3.2	Introduction of Chemical Tags	464
6.3.2.1	Oxidation of the Sugar Moiety of Enzymes	466
6.3.2.2	Introduction of a Cofactor into the Enzyme	466
6.3.2.3	Orientation and Covalent Binding	466
6.3.3	Immobilized Ligand (Substrate Analogue) Enzyme-binding	468
6.3.3.1	Immobilized Substrate or Substrate Analogues	470
6.3.3.2	Immobilized Non-substrate Ligand	470
6.3.4	Genetically Engineered Tags	473
6.3.4.1	Non-covalent Oriented Enzyme Immobilization	473
6.3.4.2	Covalent Orientation in Enzyme Immobilization	477
6.4	Immobilization in Organic Solvents	477
6.4.1	Covalent Attachment in Organic Solvents	478
6.4.2	Entrapment of Enzyme in Organic Solvent	479
6.4.3	Immobilization of Organic-soluble Enzyme Derivatives	480
6.4.4	Adsorption of Enzyme on to the Carrier in Organic Solvents	480

6.5	Imprinting–Immobilization	481
6.5.1	Imprinting–Multipoint Attachment	481
6.5.2	Imprinting–Cross-linking	482
6.5.3	Entrapment–Imprinting	484
6.5.4	Crystallization and Cross-linking	484
6.5.5	Aggregation and Cross-linking	485
6.5.6	Intra-molecular Cross-linking – Imprinting	485
6.5.7	Post-immobilization Imprinting	486
6.5.8	Lyophilization Imprinting	486
6.6	Stabilization–Immobilization	487
6.6.1	Stabilization by Ligand Binding	488
6.6.2	Stabilization by Addition of Stabilizer as the Excipient of the Conformation	490
6.6.3	Stabilization by Pre-immobilization Modification	490
6.6.3.1	Stabilization by Pre-immobilization Modification with Soluble Polymer	490
6.6.3.2	Stabilization by Pre-immobilization Chemical Modification	492
6.6.3.3	Chemical Cross-linking/Covalent Immobilization	493
6.7	Modification-based Enzyme Immobilization	493
6.7.1	Immobilization then Modification	494
6.7.2	Modification then Polymerization	494
6.7.3	Pre-immobilization Improvement Techniques (PIT)	496
6.7.3.1	Introduction of Extra Charge	497
6.7.3.2	Alteration of Enzyme Hydrophobicity	498
6.7.3.3	Formation of Polymer–Enzyme Conjugate	498
6.7.3.4	Introduction of Active Functionality for Covalent Binding	503
6.7.3.5	Introduction of Mediators	505
6.7.3.6	Interconversion of Amino Acid Residues (AAR)	505
6.7.3.7	Cross-linking/Immobilization	506
6.8	Post-Immobilization Techniques	506
6.8.1	Introduction	506
6.8.2	Classification of Post-treatments	507
6.8.3	Physical Methods	507
6.8.3.1	Increasing the pH	509
6.8.3.2	Solvent Washing	510
6.8.3.3	Lyophilization/Drying/Addition of Additives	510
6.8.3.4	pH Imprinting	511
6.8.3.5	Physical Entrapment	512
6.8.3.6	Thermal Activation	512
6.8.3.7	Activation by Denaturants	513
6.8.3.8	Post-immobilization by Physical Coating	513
6.8.3.9	Rehydration/water Activity Adjustment	514
6.8.3.10	Sonication	515
6.8.3.11	Acid or Alkaline Treatment	515
6.8.4	Chemical Methods	515

6.8.4.1	Consecutive Cross-linking of the Immobilized Enzymes	516
6.8.4.2	Consecutive Chemical Modification of Immobilized Enzymes	518
6.8.4.3	Conversion	518
6.8.4.4	Consecutive Modification of the Carrier	519
6.8.4.5	Chemical Coating	521
6.8.5	Outlook	522
6.9	Reversibly Soluble Immobilized Enzymes	522
6.9.1	pH-responsive Smart Polymer	522
6.9.2	Temperature-sensitive Smart Polymers	526
6.9.3	Solvent-sensitive Enzyme–Polymer Conjugates	526
6.9.4	Reversibly Soluble Immobilized Enzyme Based on Ionic Strength-sensitive Polymers	528
6.9.5	Reversibly Soluble Immobilized Enzyme Based on Light-sensitive Polymers	528
6.10	References	531

Subject Index	551
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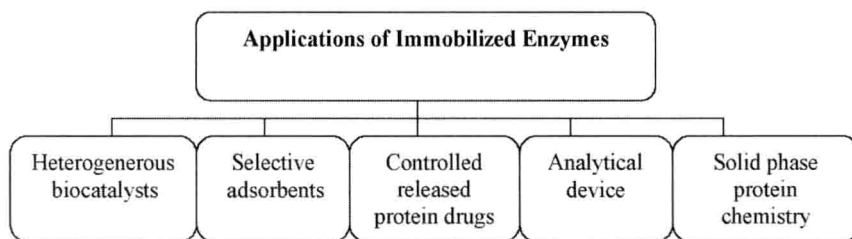
1

Introduction: Immobilized Enzymes: Past, Present and Prospects

1.1

Introduction

Since the second half of the last century, numerous efforts have been devoted to the development of insoluble immobilized enzymes for a variety of applications [2]; these applications can clearly benefit from use of the immobilized enzymes rather than the soluble counterparts, for instance as reusable heterogeneous biocatalysts, with the aim of reducing production costs by efficient recycling and control of the process [3, 4], as stable and reusable devices for analytical and medical applications [5–11], as selective adsorbents for purification of proteins and enzymes [12], as fundamental tools for solid-phase protein chemistry [13, 14] and as effective microdevices for controlled release of protein drugs [15] (Scheme 1.1).



Scheme 1.1 Range of application of immobilized enzymes.

However, whatever the nature of an immobilized enzyme and no matter how it is prepared, any immobilized enzyme, by definition, must comprise two essential functions, namely the non-catalytic functions (NCF) that are designed to aid separation (e.g. isolation of catalysts from the application environment, reuse of the catalysts and control of the process) and the catalytic functions (CF) that are designed to convert the target compounds (or substrates) within the time and space desired (Scheme 1.2).

NCF are strongly connected with the physical and chemical nature of the non-catalytic part of the immobilized enzymes, especially the geometric properties, e.g. the shape, size, thickness, and length of the selected carrier, whereas the CF are linked to the catalytic properties, for example activity, selectivity, and stability, pH