

# CONTENTS

<i>Contributors</i>	xiii
<i>Foreword</i>	xv
<i>Preface</i>	xix
<b>Part 1 History and State of the Art of the “Direct Synthesis” Methods</b>	<b>1</b>
<b>1. Educational and Historical Aspects of Direct Synthesis of Metal Complexes</b>	<b>3</b>
Miguel Angel Méndez-Rojas, Luis Arturo García de la Rosa	
1. Introduction	3
2. Historical Development of Direct Synthesis	4
3. Pedagogical Value: Why Incorporate Direct Synthesis in the Undergraduate Laboratory?	10
4. Ultrasonic and Microwave Mediated Direct Synthesis	19
5. Conclusion	21
References	22
<b>2. Recent Advances in Direct Synthesis of Organometallic and Coordination Compounds</b>	<b>25</b>
Vidyasagar C. Chandrashekhar, Blanca M. Muñoz Flores, Víctor M. Jiménez-Pérez	
1. Indirect Synthesis	25
2. Direct Synthesis	27
3. Group I	31
4. Group 7	39
5. Group 8	42
6. Group 9	42
7. Group 10	55
8. Group 11	55
9. Group 12	61
10. Group 13	65
11. Group 14	70
12. Group 15	74
13. Group 16	75
14. Summary and Outlook	80
Acknowledgment	81
References	81
Further Reading	85

<b>3. Direct Electrochemical Synthesis of Metal Complexes</b>	<b>87</b>
Carlos Puente, Israel López	
1. Basic Concepts	89
2. Electrochemical Thermodynamics	91
3. Electrochemical Kinetics	96
4. Reaction Mechanisms	102
5. Electrochemical Cells	105
6. Solvents and Supporting Electrolytes	107
7. Metals	110
8. Ligands	117
9. Conclusions and Further Outlook	133
References	134
Further Reading	141
<b>4. Cryochemical Co-condensation of Metal Vapors and Organic Compounds</b>	<b>143</b>
Andrei Yu. Olenin, Ilia A. Leenson, George V. Lisichkin	
1. Introduction	143
2. Formation of Metal Organosols Under the Low-temperature Vapor Co-condensation	145
3. Preparation of Metal-Organic Compounds via the Metal-Vapor Cryosynthesis	154
4. Synthesis of Catalysts by Low-temperature Co-condensation of Metal Vapors and Organic Compounds	162
5. Conclusions	175
References	175
<b>Part 2 "Direct" Methods in the Preparation of Distinct Types of Complexes</b>	<b>181</b>
<b>5. Direct Synthesis of Heterometallic Complexes</b>	<b>183</b>
Vladimir N. Kozozay, Olga Yu. Vassilyeva, Valeriya G. Makhankova	
1. Introduction	183
2. Salt Route	184
3. Ammonium Salt Route	197
4. Conclusions	230
References	231
<b>6. New Trends in the Direct Synthesis of Phthalocyanine/Porphyrin Complexes</b>	<b>239</b>
Tatyana N. Lomova, Elena Y. Tyulyaeva	
1. Introduction	239
2. Classical Approach of Phthalocyanine/Porphyrin Complexes Direct Synthesis	240

3. New Methods of Phthalocyanine/Porphyrin Complexes Direct Synthesis	259
Acknowledgments	268
References	268
Further Reading	278
<b>7. Increasing the Rate of the Direct Synthesis Complex Compounds</b>	<b>279</b>
Victor Khentov, Vladimir V. Semchenko, Hussein Hanaa Hassan Hussein	
1. The Accumulation of Metallic Elements in the Technological Waste	280
2. The Use of Direct Synthesis of Complex Compounds for Extraction of Metallic Elements from Industrial Waste	288
3. Effect on the Rate, Selectivity, and Yield of the Donor–Acceptor Interaction Product of a Number of Physical and Chemical Factors	292
4. Accelerate the Direct Synthesis of Complex Compounds When Moving and Delivery of the Ligand Molecule in the Surfactant Micelles	298
5. Effect of Porous Silica on Coordinating the Interaction	302
6. Contact the Kinetic Characteristics of the Direct Synthesis of Complex Connections with the Debye Temperature of the Metal and Coefficient Grüneisen	302
References	308
Further Reading	313
<b>Part 3 “Direct Synthesis” and Nanotechnology</b>	<b>315</b>
<b>8. Direct Synthesis of Nanomaterials: Building Bridges Between Metal Complexes and Nanomaterials</b>	<b>317</b>
Luis Arturo García de la Rosa, Miguel Angel Méndez-Rojas	
1. Introduction	317
2. Analogies Among Metal Complexes and Nanomaterials	319
3. Direct Synthesis of Nanomaterials	321
4. Novel Strategies for the Direct Synthesis of Nanomaterials	331
5. Perspectives	333
References	334
<b>Part 4 Practical Applications of “Direct” Methods</b>	<b>339</b>
<b>9. Direct Synthesis of Air-Stable Metal Complexes for Desalination (and Water Treatment)</b>	<b>341</b>
David D.J. Antia	
1. Introduction	342
2. Direct Synthesis of Metal Complexes (ASMC)	343

3.	ASMC Desalination	344
4.	Simplified ASMC Desalination Process	345
5.	Dubinín-Astakhov Adsorption-Desorption Model	345
6.	Equilibrium Desalination Level	346
7.	Manipulation of Desalination Rates by Altering Eh and pH	347
8.	Redox Oscillation	348
9.	Desalination Rate Constant	349
10.	Catalyst Types	349
11.	Statistical Evaluation	353
12.	Commercial Applications	355
13.	Production of Irrigation Water	355
14.	Processing of Reject Brine Associated With Conventional Desalination Plants	360
15.	Principal ASMC Desalination Technical Advances (2010–2017)	362
16.	Future Commercial Applications	363
	References	364
	Further Reading	367
<b>10.</b>	<b>Applications of Heterometallic Complexes in Catalysis</b>	<b>369</b>
	Carolina Solís Maldonado, Javier Rivera de la Rosa, Carlos J. Lucio-Ortiz, Ladislao Sandoval-Rangel, Daniela Xulú Martínez-Vargas, Raúl Alejandro Luna Sánchez	
1.	Heterometallic Complexes in Catalysis of Cycloalkane Oxidation	369
2.	Alternative Catalytic Applications of Metallic Complexes Obtained by Direct Synthesis	373
3.	Metallic Complexes From Direct Synthesis as Potential Catalysts	374
4.	Conclusions	375
	References	375
<b>11.</b>	<b>Recent Advances in Corrosion Science: A Critical Overview and a Deep Comprehension</b>	<b>379</b>
	Sukanchan Palit	
1.	Introduction	380
2.	The Aim and the Objective of This Chapter	381
3.	The Need and the Rationale Behind This Chapter	381
4.	What Is Corrosion?	382
5.	Technological Advancements in Corrosion Science	383
6.	The Challenge of Science, Scientific Introspection, and the Present Status of Corrosion Science	383
7.	Corrosion Chemistry, the Challenges, and the Visionary Road Toward the Future	384
8.	The Vision of Corrosion Processes and the Scientific Progress Ahead	386
9.	Technological Vision in Corrosion Processes and the Wide Scientific Endeavor	386
10.	Recent Scientific Endeavor in the Field of Corrosion Science and Engineering	389

11. The Vision of Material Science, the Wide World of Chemical Process Engineering and the Vision for the Future	392
12. The Cost of Corrosion and Its Challenge and Vision	393
13. Environmental Corrosion, Atmospheric Corrosion, and the Road Ahead	393
14. Scientific Doctrine of Corrosion Science and Its Scientific Vision	396
15. Scientific Cognizance and the Progress in Nanoscience and Nanotechnology	397
16. Nanotechnology, Corrosion Science and the Vision for the Future	398
17. Nanotechnology and Sustainability: The Visionary Domains of Science	401
18. Chemistry of Corrosion Science and the Widening Vision Today	404
19. Corrosion Science and Environment	405
20. Environmental Sustainability, the Environment and the Success of Nanotechnology	405
21. Recent Research Endeavor in the Field of Environmental Sustainability	406
22. Recent Scientific Endeavor in the Field of Nanoscience and Nanotechnology	407
23. Recent Scientific Endeavor in the Field of Application of Nanomaterials for Environmental Protection	407
24. Recent Scientific Advances in the Field of Corrosion Control	408
25. The Challenge of Science, the Technological Vision and the Path Forward	408
26. Future Trends in Corrosion Science Research and the Futuristic Vision	408
27. Conclusion and Future Perspectives	409
Acknowledgments	410
References	410
<b>Part 5 Forgotten "Direct" Methods of XX Century</b>	<b>413</b>
<b>12. Less-Common Methods of the "Direct Synthesis" Area</b>	<b>415</b>
<b>Boris I. Kharisov, Oxana V. Kharissova, Idalia Gómez de la Fuente</b>	
1. Introduction	415
2. Ultrasonic Treatment	416
3. Use of <i>Rieke</i> Metals	420
4. Laser Ablation	424
5. Sputtering	424
6. Intercalation	425
7. Reactions in Liquid NH <sub>3</sub> and Ammonothermal Synthesis	426
8. Oxidative Dissolution of Elemental Metals	426
9. Concluding Remarks	428
References	429
Further Reading	433
<i>Concluding Remarks</i>	435
<i>Index</i>	437