

Contents

SERIES EDITOR'S PREFACE	xi
PREFACE	xiii

Part 1 Technology Basics

CHAPTER 1 What is Nanotechnology?	3
1.1 Nanotechnology as Process	4
1.2 Nanotechnology as Materials	7
1.3 Nanotechnology as Materials, Devices and Systems	8
1.4 Direct, Indirect and Conceptual Nanotechnology	9
1.5 Nanobiotechnology and Bionanotechnology	10
1.6 Nanotechnology—Toward a Definition	10
1.7 The Nanoscale	11
1.8 Nanoscience	11
Further Reading	12
CHAPTER 2 Science, Technology and Wealth	13
2.1 Nanotechnology is Different	18
2.2 The Evolution of Technology	20
2.3 The Nature of Wealth and Value	22
2.4 The Social Value of Science	24
Further Reading	26
CHAPTER 3 Innovation	27
3.1 The Time Course of Innovation	31
3.2 Creative Destruction	34
3.3 What Drives Development?	37
3.4 Can Innovation be Managed?	37
3.5 The Effect of Maturity	38
Further Reading	39
CHAPTER 4 Why Nanotechnology?	41
4.1 Fabrication	44
4.2 Performance	45
4.3 Agile Manufacturing	45
Further Reading	46

Part 2 Nanotechnology Products

CHAPTER 5	The Nanotechnology Business	49
5.1	Nanotechnology Statistics	50
5.2	The Total Market.....	51
5.3	The Current Situation.....	53
5.4	Consumer Products	55
5.5	The Safety of Nanoproducts	58
5.6	Geographical Distribution	60
5.6.1	The fiscal environment for nanotechnology.....	61
5.6.2	Nanotechnology in the developing world	63
CHAPTER 6	Miscellaneous Applications	65
6.1	Noncarbon Materials	66
6.1.1	Composites	66
6.1.2	Coatings	67
6.2	Carbon-Based Materials	68
6.3	Ultraprecision Engineering	69
6.4	Aerospace and Automotive Industries	70
6.5	Catalysis	70
6.6	Construction	70
6.7	Energy	71
6.7.1	Production.....	71
6.7.2	Storage	72
6.7.3	Lighting.....	72
6.8	Environment	72
6.9	Food	73
6.10	Metrology	80
6.11	Paper	81
6.12	Security.....	81
6.13	Textiles	82
CHAPTER 7	Information Technologies.....	83
7.1	Silicon Microelectronics	84
7.2	Data Storage Technologies.....	85
7.3	Display Technologies	86
7.4	Sensing Technologies.....	86
CHAPTER 8	Applications to Health	89
8.1	Principal Applications	90
8.2	Implanted Devices.....	91
8.3	Nanoparticle Applications	92
8.4	Tissue Scaffolds	93
8.5	Paramedicine.....	94

8.6	Nanobots	94
8.7	Toxicology Aspects.....	95
	Further Reading	95

Part 3 Organizing Nanotechnology Business

CHAPTER 9	The Business Environment.....	99
9.1	The Universality of Nanotechnology	100
9.2	The Radical Nature of Nanotechnology.....	103
9.3	Financing Nanotechnology	104
9.4	Government Funding	108
9.5	Intellectual Needs	110
	9.5.1 Company–University Collaboration	113
	9.5.2 Clusters.....	114
9.6	The Cost of Nanotechnology.....	114
9.7	Companies.....	114
	9.7.1 Hyperion.....	114
	9.7.2 CDT.....	116
	9.7.3 Q-Flo	116
	9.7.4 Owlstone.....	117
	9.7.5 Analysis.....	117
9.8	Temporal Evolution	119
9.9	Patents and Standards	120
CHAPTER 10	Assessing Demand for Nanotechnology.....	121
10.1	Products of Substitution.....	122
10.2	Incrementally Improved Products	123
10.3	Radically New Products	123
10.4	Modeling	123
10.5	Judging Innovation Value.....	124
10.6	Anticipating Benefit	124
CHAPTER 11	Design of Nanotechnology Products.....	127
11.1	The Challenge of Vastification	127
11.2	Enhancing Traditional Design Routes.....	128
11.3	Materials Selection	130
	Further Reading	130

Part 4 Wider and Long-Term Issues

CHAPTER 12	The Future of Nanotechnology.....	133
12.1	Productive Nanosystems.....	135
12.2	Social Impacts.....	136
12.3	Timescales.....	138

Part 2 Nano	12.4 Self-Assembly	139
CHAPTER 5	12.5 Molecular Electronics	140
	12.6 Quantum Computing	141
	Further Reading	141
CHAPTER 13	Grand Challenges	143
	13.1 Material Crises.....	144
	13.2 Social Crises.....	146
	13.3 Is Science Itself in Crisis?	146
	13.4 Nanotechnology-Specific Challenges	148
	13.5 Globalization	149
	13.6 An Integrated Approach	149
CHAPTER 14	Ethics and Nanotechnology	151
	14.1 Risk, Hazard and Uncertainty	152
	14.2 Regulation	154
	14.3 A Rational Basis for Safety Measures	155
	14.4 Should We Proceed?.....	156
	14.5 What About Nanoethics?	157
	Further Reading	159
INDEX		161