

Contents

1	Introduction	1
1.1	Micro-/Nanohierarchical Structures in Nature	2
1.2	Artificial Micro-/Nanohierarchical Structures	3
1.2.1	The Progress of Bottom-Up Method	3
1.2.2	The Progress of Top-Down Method	6
1.3	The Development Progress of Microenergy Field	10
1.3.1	Microenergy Technology	10
1.3.2	Nanogenerator	12
1.3.3	Triboelectric Nanogenerator	13
1.4	Research Purpose and Content	15
1.4.1	Research Purpose	15
1.4.2	Research Content	16
	References	18
2	Micro-/Nanointegrated Fabrication Technique for Silicon	23
2.1	Nanoforest Fabrication Based on an Improved DRIE Process	23
2.1.1	Deep Reactive-Ion Etching (DRIE) Process	23
2.1.2	Nanostructuring by an Improved DRIE Process	26
2.1.3	Mechanism of Controllable Formation of Nanostructures	27
2.2	Fabrication of Si-based Micro-/NanoHierarchical Structures	30
2.2.1	Structural Design	30
2.2.2	Fabrication Process	31
2.2.3	Characterization and Analysis of Micro-/NanoHierarchical Structures	33
2.3	Interaction of Multiscale Structures Based on Silicon	35
2.4	Properties of Si-Based Micro-/NanoHierarchical Structures	38
2.4.1	Anti-reflective Property	39
2.4.2	Super-hydrophobic Property	41
2.5	Conclusions	46
	References	47

3	Micro-/Nanointegrated Fabrication Technique for Flexible Materials . . .	49
3.1	Replication Process and Surface-Energy Control	50
3.1.1	Replication Process Based on Silicon Mold	50
3.1.2	Controllable Fabrication of Ultra-Low-Surface-Energy Silicon Mold.	51
3.2	Micro-/Nanohierarchical Structures Based on PDMS	52
3.2.1	Brief Introduction of PDMS.	52
3.2.2	Single-Step Fabrication of Micro-/Nanohierarchical Structures on PDMS.	54
3.2.3	Key Factors of Single-Step Replication Process	56
3.2.4	Effect of Process Parameters on Surface Properties of PDMS.	57
3.3	Micro-/Nanohierarchical Structures Based on Parylene-C	61
3.3.1	Fabrication and Method	62
3.3.2	The Properties of Fabricated MNHS Parylene-C Films.	65
3.4	The Interaction of Multiscale Structures on Flexible Materials.	67
3.5	The Surface Modification Based on Post-DRIE Process	69
3.5.1	Fluorocarbon Plasma Treatment Based on Post-DRIE Process	69
3.5.2	The Mechanism of Enhancing Hydrophobicity by Using Post-DRIE Process	70
3.6	Conclusions	72
	References.	73
4	Flexible Triboelectric Nanogenerators: Principle and Fabrication . . .	75
4.1	Working Principle of TENG.	76
4.2	Design of Flexible Sandwich-Shaped TENG.	80
4.2.1	Structural Geometry and Surface Profile	80
4.2.2	Theoretical Analysis.	81
4.2.3	Finite Element Simulation	83
4.3	Fabrication of the Sandwich-Shaped TENG	84
4.4	Electric Properties Test and Analysis of the Sandwich-Shaped TENG	85
4.4.1	Test System and Brief Results	85
4.4.2	Frequency Effect of External Force on TENG.	87
4.4.3	Structural Effect on TENG.	89
4.4.4	Powering Ability for Practical Applications.	90
4.5	Conclusions	90
	References.	91
5	Flexible Triboelectric Nanogenerators: Enhancement and Applications	93
5.1	Enhancement of TENG Based on Single-Step Fluorocarbon Plasma Treatment.	93
5.1.1	Structural Design and Fabrication	94
5.1.2	Triboelectric Mechanism Analysis Based on DFT Calculations	95

5.1.3	Effect of Fluorocarbon Plasma Treatment on Output Performance of TENG	98
5.1.4	Reliability of Fluorocarbon Plasma Treatment for Enhancing TENG	99
5.1.5	The Performance Enhancement Analysis.	101
5.2	Enhancement of TENG Based on Hierarchical Structures	103
5.2.1	Enhancement of TENG Based on Micro-/Nanohierarchical Structures	103
5.2.2	Enhancement of TENG Based on Hybrid Mechanisms.	105
5.3	Applications of TENG for Biomedical Microsystems.	108
5.3.1	Application of TENG for Driving Neural Prosthesis In Vitro	108
5.3.2	Application of TENG for Driving Neural Prosthesis In Vivo	110
5.4	Applications of TENG in the Other Fields.	113
5.4.1	Self-Powered Humidity Monitoring Sensor.	113
5.4.2	Application for Portable Electronics	114
5.5	Conclusions	115
	References.	116
6	Summary and Perspectives	119
6.1	Summary	119
6.2	Main Contribution	120
6.3	Perspectives	121
	Reference.	122

Micro/Nano Integrated Fabrication Technology and Its
Applications in Microenergy Harvesting

Zhang, X.-S.

2016, XX, 122 p. 95 illus., 76 illus. in color., Hardcover

ISBN: 978-3-662-48814-0