

Contents

1	Introduction	1
1.1	Motivation	1
1.2	Mechanical Energy Harvesting	3
1.3	Scope and Organization of Thesis	4
	References	6
2	Overview of Energy Harvesting Technologies	9
2.1	Mechanical Energy Harvesting Mechanisms	9
2.1.1	Piezoelectric Energy Harvesters	9
2.1.2	Electromagnetic Energy Harvesters	13
2.1.3	Electrostatic Energy Harvesters	15
2.2	Triboelectric Energy Harvesting	17
2.2.1	Out-of-Plane Contact-Separation Mechanism	18
2.2.2	In-Plane Sliding Mechanism	19
2.3	Materials and Fabrication of Triboelectric Nanogenerators	21
2.4	Triboelectric Energy Harvesters and Self-powered Sensors	21
2.4.1	Biomechanical Energy Harvesters	23
2.4.2	Wind Based Energy Harvesters	24
2.4.3	Water Based Energy Harvesters	26
2.4.4	Wearable Energy Harvesters	27
2.4.5	Self-powered Sensors	29
2.5	Summary	33
	References	34
3	Study of Effect of Topography on Triboelectric Nanogenerator Performance Using Patterned Arrays	39
3.1	Motivation	39
3.2	Cantilever Based TENG—I	40
3.2.1	Device Design	40
3.2.2	Working Mechanism	40

3.2.3	Theory	42
3.2.4	Fabrication Process	46
3.2.5	Broadening of Operating Bandwidth Using Mechanical Stopper	47
3.2.6	Output Voltage and Power	49
3.2.7	Design of Experiment	50
3.2.8	Experimental Setup	51
3.2.9	Results and Discussion	52
3.3	Cantilever Based TENG—II	57
3.3.1	Device Design and Fabrication	57
3.3.2	Deformation in the PDMS Micropad Patterns	58
3.3.3	Results and Discussion	61
3.4	Summary	65
	References	65
4	Skin Based Self-powered Wearable Sensors and Nanogenerators	67
4.1	Motivation	67
4.2	Skin Used as a Triboelectric Material	67
4.2.1	Device Design	68
4.2.2	Device Fabrication	68
4.2.3	Working Mechanism	70
4.2.4	Harvesting Energy Using Skin Based Triboelectric Nanogenerator from Various Human Activities	71
4.2.5	Testing as a Motion Sensor	74
4.3	Integration of Skin Based Nanogenerator with a Capacitance Based Sensor to Realize Human Finger Motion Tracking	75
4.3.1	Fabrication	76
4.3.2	Operating Principle of Sensor	76
4.3.3	Working of Triboelectric Nanogenerator	79
4.3.4	Finger Motion Sensor Testing	80
4.3.5	Energy Harvesting Testing	84
4.4	Summary	85
	References	85
5	Large Scale Fabrication of Triboelectric Energy Harvesting and Sensing Applications	87
5.1	Motivation	87
5.2	Large Scale Energy Harvesting Using Roll-to-Roll Fabrication Process	88
5.2.1	Fabrication Process	88
5.2.2	Working Mechanism	93
5.2.3	Effect of Different Embossed Patterns	94
5.2.4	Applications in Energy Harvesting	95

5.3	Triboelectric Pressure Sensor Arrays Using Roll-to-Roll	
	UV Embossed Films	97
5.3.1	Fabrication and Assembly	97
5.3.2	Sensor Array Characterization	99
5.3.3	Motion Tracking and Security Applications	101
5.3.4	Applications in Posture Tracking	104
5.4	Summary	105
	References	105
6	Triboelectric Mechanism for Bidirectional Tactile Sensing	
	and Energy Harvesting	107
6.1	Motivation	107
6.2	Design and Fabrication	107
6.2.1	Device Configuration	107
6.2.2	Working Principle	108
6.2.3	Fabrication	110
6.3	Experiments and Discussion.	113
6.3.1	Tactile Sensing.	113
6.3.2	Energy Harvesting Applications	115
6.4	Summary	117
	References	118
7	Conclusion and Recommendations for Future Work	119
7.1	Conclusions	119
7.2	Future Work	120
7.2.1	High Current Output Triboelectric Nanogenerator	120
7.2.2	Power Management Electronics	120
7.2.3	Contributions	120
	References	121
Appendix: Modeling Equations for Finger Movement		
	Using Joint Angle and Length Between Joint	123

**Triboelectric Devices for Power Generation and
Self-Powered Sensing Applications**

Dhakar, L.

2017, XXXII, 123 p. 101 illus., 93 illus. in color.,

Hardcover

ISBN: 978-981-10-3814-3