## Contents

1 Introduction .............................................. 1  
1.1 Implantable Biomedical Sensors ......................... 1  
1.2 Non-invasive Sensors and Application Areas ............... 2  
1.3 Importance of Blood Pressure and Radial Pulse Diagnosis .... 3  
1.4 Obesity as the 21st Century Plague ....................... 4  

2 Development of Microsystems Multi Physics Investigation Methods ................................................. 7  
2.1 Application of Time Averaged Holography for Micro-Electro-Mechanical System Performing Non-linear Oscillations .......... 7  
2.1.1 Phenomenological Model of MEMS Cantilever ............ 9  
2.1.2 FEM Analysis of MEMS Cantilever Performing Chaotic Oscillations ............................................. 15  
2.1.3 The Structure of Digital Data Processing ............... 16  
2.1.4 The Mathematical Model of the Optical Measurement .... 18  
2.1.6 Theoretical Substantiation of Possibilities for the Batcher Functioning ............................................. 23  
2.1.7 Experimental Analysis of the Spring .................... 25  
2.2.1 Concept of Indirect Method for Evaluation of Geometrical Parameters of Periodical Microstructure ........ 28  
2.2.2 Evaluation of Geometrical and Optical Parameters of Periodical Microstructure ............................ 29  
2.2.3 Evaluation of Geometrical Parameters with High Aspect Ratio ...................................................... 34  
2.2.4 Investigation of Microstructures of High Aspect Ratio .... 37  
2.3 Polycarbonate as an Elasto-Plastic Material Model for Simulation of the Microstructure Hot Imprint Process ..................... 40
4.1.3 Radial Pulse Diagnosis ........................................ 138
4.1.4 Radial Pulse Characteristics .................................. 139
4.2 Micro Membrane Design ........................................... 141
4.2.1 Evaluation of Residual Stresses ............................. 141
4.2.2 Three Dimensional Finite Element Model
of Micro-membrane ........................................ 143
4.2.3 Square Membrane Modeling .................................. 145
4.2.4 Circular Membrane Modeling ................................. 149
4.3 Micro Membrane Fabrication and Experimentation .......... 152
4.3.1 Determination of Primary Data for Analyzed Objects ..... 153
4.3.2 Deposition of Silicon Dioxide and Polysilicon ............ 154
4.3.3 Formation of Micro Membranes .............................. 156
4.3.4 Results of Fabrication, Micro Hardness and Surface
Morphology Tests ........................................ 164
4.3.5 Radial Pulse Analysis Through Application of Fabricated
Micro-objects ........................................ 170
4.4 Modeling and Simulation of Radial Artery Under Influence
of Pulse ................................................................ 189
4.4.1 Computational Fluid Dynamics (CFD) ...................... 190
4.4.2 Characteristics of Arteries .................................... 191
4.4.3 Characteristics of Blood ...................................... 191
4.4.4 Computational Fluid Structure Interaction (FSI) Modeling
for Blood Flow in Radial Artery ............................ 193
4.5 Moiré Method Application for Artery Surface Deformations
Analysis .......................................................... 198
4.5.1 Mathematical Representation of the Projected Image ..... 199
4.5.2 Double-Exposure Projection Moiré ......................... 201
4.5.3 Two Dimensional Example ................................. 202
4.5.4 Application of Whole-Field Projection Moiré for the
Registration of Radial Blood Flow Pulses ................... 203
4.6 Proposed Prototype of Wrist Watch-like Radial Pulse Analysis
Sensor ......................................................... 204
4.6.1 Prototype Design ........................................ 204
4.6.2 Proposed Prototype Geometry .............................. 205
References ................................................................ 208
5 Microsystems for the Effective Technological Processes .... 211
5.1 Periodical Microstructures Based on Novel Piezoelectric Material
for Biomedical Applications ...................................... 211
5.1.1 Synthesis and Formation of PZT Coating .................. 213
5.1.2 Characterization Methods .................................. 215
5.1.3 Dynamic Investigations of PZT Coatings ................ 215
5.1.4 Structure and Chemical Composition of PZT Composite
Material ...................................................... 218
5.1.5 Surface Morphology of Novel Cantilever Type Piezoelectric Elements ........................................ 220
5.1.6 Piezoelectric Properties ........................................ 222
5.1.7 Calculation of Module of Elasticity ...................... 225
5.1.8 Periodical Microstructure and SPR ...................... 227
5.2 Development of Complex 3D Microstructures Based on Computer Generated Hologram ...................... 230
5.2.1 The Creation and Formation of the Periodical Microstructure on the Basis of Computer Generated Hologram .............................................................. 236
5.2.2 Gerchberg-Saxton Algorithm for Design of Computer Generated Hologram ................................. 242
5.3 High-Frequency Excitation for Thermal Imprint of Microstructures into a Polymer ............................ 246
5.3.1 Methods of Microstructure Replication .................. 246
5.3.2 Materials, Experimental Setup and Methodology ...... 252
5.3.3 Investigation of Mechanical Hot Imprint Process .... 261
References .................................................................. 278
Biomechanical Microsystems
Design, Processing and Applications
Ostasevicius, V.; Janusas, G.; Palevicius, A.; Gaidys, R.; Jurenas, V.
2017, X, 282 p. 266 illus., 151 illus. in color., Hardcover
ISBN: 978-3-319-54848-7