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Micro and Nanotechnology Applied to Optical Devices and Systems
MEMS Reference Shelf

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Photonic Microsystems
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Springer
To Terri, Jenni, and Nikolai
Like many other engineers and inventors, I believe that the boundaries between traditional fields offer unique and exciting opportunities for innovation and new developments. This is almost self-evident when one considers complex systems that integrate functions from several domains. It is also natural that the boundaries between fields are less understood, simply because their study requires expertise in two or more fields.

From this last observation, it follows that interdisciplinary research is hard. It requires dedicated individuals who are willing to make the heavy investments necessary to master several fields of inquiry, or, something even more extraordinary, teams that are able to smoothly communicate across disciplinary boundaries. This is the defining problem of the book. It is written to encourage and facilitate interdisciplinary research on optical microsystems, by which we mean optics created using microfabrication technology, i.e. the tools and techniques developed to fabricate Integrated Circuits (ICs) and MicroElectroMechanical (MEMS).

Innovation and design of modern optical systems requires input from many fields, as well as specific application knowledge. Examples include optical interconnects, optical-fiber communication networks, digital projectors, and imagers for photography and microscopy. The design of these systems depends on seamless integration of optics with electronics and mechanics. The best solutions are optimized over all these domains to meet application demands. In the case of micro-optics, the interdisciplinary requirements are even stricter; these systems must be optimized for the Integrated Circuit (IC) and MicroElectroMechanical (MEMS) fabrication environment. A large part of that optimization is to reduce the dimensions of the optical-systems designs so that they can be practically and economically fabricated using IC and MEMS techniques.

This book gives students, researchers, and developers the tools they need to analyze and design micro-optical devices systems. Design is the ultimate “inverse” problem, so the emphasis is on analytical models that can be turned into design equations. The point is to enable interdisciplinary research, so very little background in optics, MEMS, or fabrication is assumed. The first part on optics fundamentals is accessible to readers with an understanding of first-year, university-level physics. The book is self-contained in that the concepts developed in the first part give the necessary background for understanding the detailed descriptions of the second and third parts.
Acknowledgements

This book would not be possible if it were not for my collaborators at Stanford, UC Berkeley, UC Davis, the University of Oslo, and at SINTEF in Oslo. Their brilliant insights and stimulating discussions have been a constant source of inspiration, and I am forever grateful for being able to work in the exciting environment that they create. For as much as I have learned from my colleagues, I believe my students taught me more. Working with such a talented group has been a true privilege and I thank all of them for the time and effort they invested and for their many contributions. A special thanks also goes to the reviewers of this text. They made it better in many ways and therefore more enjoyable for the reader.

Being a teacher, I believe in the power of good mentors, and I have been lucky to learn from some of the best. During my years as a post doc at Berkeley, I worked with Professors Kam Lau and Richard Muller. Between these two leading experts, the fields of semiconductor lasers and MEMS were opened to me. In addition to their technical advice, I owe them both for creating an inspiring and demanding environment and for encouraging me to following my own ideas. But my biggest debt of gratitude goes to my PhD advisor, Professor David Bloom. He, more than anyone else, taught me that it is always possible to improve the status quo, that even crazy ideas can be harnessed, and that the best solutions are often found in unlikely places.
6.2.7 Coupling from Spatially Incoherent Sources to Single Mode Fibers
6.2.8 Prism Coupling
6.2.9 Grating Coupling
6.3 Coupled Optical Modes
6.4 Directional Couplers
6.4.1 Coupled Mode Description of Directional Couplers
6.4.2 Eigenmodes of the Coupled System
6.4.3 Conceptual Description of Directional Couplers based on Eigen Modes
6.5 Optical Devices Based on Directional Couplers
6.5.1 Modulators and Switches based on Directional Couplers
6.5.2 Power Combiners and Filters based on Directional Couplers
6.6 Periodic Waveguides – Bragg Filters
6.6.1 Energy Conservation in Counter Propagating Waves
6.6.2 Modes of the Bragg Grating
6.6.3 One-Dimensional Photonic Bandgaps
6.6.4 Bragg Filters
6.7 Waveguide Modulators
6.7.1 Mach-Zender modulators
6.7.2 Figures of Merit for Optical Modulators
6.7.3 Phase Modulation
6.7.4 Acoustooptic Modulators
6.7.5 Modified Mach-Zender Modulators
6.7.6 Directional Coupler Switches
6.7.7 Fabry-Perot Modulator
6.7.8 Resonant Waveguide Coupling
6.8 Summary of Fiber and Waveguide Devices
Exercises
References:

7 Optical MEMS Scanners
7.1 Introduction to MEMS Scanners
7.2 Scanner Resolution
7.2.1 Resolution of an Ideal Scanner
7.2.2 Optimum Resolution of a Scanned Gaussian Beam
7.2.3 Scanner Aperture
7.2.4 Surface Roughness, Curvature, and Bending of Micro Mirrors
7.3 Reflectivity of Metal Coated Micromirrors
7.4 Lens Scanners
7.5 Mechanical Scanner Design – One Dimensional Scanners
7.5.1 Transformation from Linear Motion to Rotation
7.5.2 Torsional Spring Design
7.5.3 Mechanical Resonances ............................................................ 275
7.5.4 Higher-Order Mechanical Resonances ........................................ 278
7.6 Two Dimensional Scanners .......................................................... 281
7.7 High Resolution 2-D Scanners – Design Examples ......................... 284
  7.7.1 Gimbaled Scanner ...................................................................... 284
  7.7.2 Universal Joint Microscanner with “Terraced-Plate”
       Actuators .................................................................................. 287
  7.7.3 Universal Joint Microscanner with Combdrive Actuators .......... 288
7.8 Summary of MEMS scanners .......................................................... 289
Exercises ............................................................................................. 291
References ........................................................................................... 293

8 Optical MEMS Fiber Switches .......................................................... 296
  8.1 Introduction to MEMS Fiber Switches ............................................ 296
  8.2 Fiber Optical Switches and Cross Connects .................................... 297
  8.3 MEMS Switch Architectures ........................................................ 299
  8.4 2 by 2 Matrix Switch ...................................................................... 304
      8.4.1 Fiber Separation in 2 by 2 MEMS Switches .......................... 304
      8.4.2 Mirror Thickness in 2 by 2 Matrix Switches ....................... 306
      8.4.3 Low-loss 2 by 2 Matrix Switches ....................................... 308
      8.4.4 MEMS Implementation of 2 by 2 Fiber Switch ................. 309
  8.5 N by N Matrix Switches ................................................................. 311
      8.5.1 Scaling of N by N Matrix Switch ....................................... 313
      8.5.2 MEMS Implementations of N by N Matrix Switch ......... 316
  8.6 N by N Beam Steering Switches ..................................................... 317
      8.6.1 Scaling of the Beam Steering Switch ................................. 318
      8.6.2 MEMS Implementations of the N by N Beam Steering
           Switch .................................................................................. 325
  8.7 Summary of MEMS Fiber Switches ............................................... 327
Exercises ............................................................................................. 329
References ........................................................................................... 331

9 Micromirror Arrays – Amplitude and Phase Modulation ..................... 332
  9.1 Introduction to Micromirror Arrays .............................................. 332
  9.2 Amplitude Modulating Mirror Arrays ........................................... 333
      9.2.1 Projection Display ............................................................... 334
  9.3 Projection of Micromirror Arrays .................................................. 338
      9.3.1 The Point Spread Function ................................................ 339
      9.3.2 Image formation with finite Point Spread Functions .......... 344
      9.3.3 Projection of a Gaussian Source ......... ............................... 345
      9.3.4 Projection of a Gaussian Micromirror ............................... 347
      9.3.5 Projection of a 1-D Gaussian Source .................................. 349
  9.4 Micromirrors with Phase Modulation ........................................... 349
      9.4.1 Projection of a Phase Step .................................................. 350
9.4.2 Projection of a Phase Modulated Line..............................................................353
9.4.3 Sub-Pixel Shifts in Phase-Modulated Micromirror arrays........................356
9.5 Projection of Micromirrors through Hard Apertures ....................................356
9.6 Adaptive Optics ..........................................................................................358
  9.6.1 Micromirror Arrays for Adaptive Optics.................................................360
9.7 Phase vs. Amplitude Modulation ....................................................................362
  9.7.1 Diffractive Optical MEMS ......................................................................364
9.8 Summary of Micromirror Arrays ....................................................................368
Exercises .............................................................................................................369
References ..........................................................................................................371

10 Grating Light Modulators ..............................................................................374
  10.1 Introduction to Grating Light Modulators ................................................374
  10.2 Phenomenological Description of MEMS Grating Modulators ...............374
    10.2.1 Mechanical design and actuation of Grating Light Modulators ..........374
    10.2.2 Optical Design and Operation of Grating Light Modulators ............377
    10.2.3 Schlieren Projection System .................................................................379
  10.3 Phasor Representation of Grating Modulator Operation ............................380
  10.4 High Contrast Grating Light Modulator ..................................................386
  10.5 Diffraction gratings ..................................................................................389
  10.6 Projection Displays Based on Grating Modulators ....................................393
    10.6.1 Actuator Design ..................................................................................403
    10.6.2 Ribbon Mechanics .............................................................................407
    10.6.3 Linear Display Architecture ...............................................................411
    10.6.4 1-D Modulator Array Fabrication ......................................................414
    10.6.5 Light Sources for swept-line projection displays ...............................418
  10.7 Summary of Grating Light Modulators .....................................................422
Exercises .............................................................................................................423
References ..........................................................................................................425

11 Grating Light Modulators for Fiber Optics ....................................................428
  11.1 Fiber Optic Modulators .............................................................................428
  11.2 Low Dispersion Grating Light Modulators ..............................................430
    11.2.1 Three-level Grating Light Modulator .................................................430
    11.2.2 Optimum Design of Three-Level Grating Modulator ............... 433
    11.2.3 Contrast in the Three-level Grating Modulator ............................. 435
    11.2.4 Wavelength Dependence of Attenuation ..............................................437
    11.2.5 Alternative Modulator Architectures .................................................439
  11.3 Polarization Independent Grating Light Modulators ..................................440
  11.4 Summary of GLMS for Fiber Optics .........................................................444
Further Reading ................................................................................................444
Exercises .............................................................................................................445
# 12 Optical Displacement Sensors

12.1 Introduction to Optical Displacement Sensors .................................................................................................................. 448
12.2 Interferometers as Displacement Sensors ............................................................................................................................... 451
   12.2.1 The Michelson Interferometer ........................................................................................................................................... 451
   12.2.2 Displacement Sensitivity ...................................................................................................................................................... 454
   12.2.3 Implementations of Interferometric Displacement Sensors ............................................................................................. 455
   12.2.4 Improved Sensitivity of High-Finesse Interferometers .................................................................................................. 460
   12.2.5 Effect of Apertures in Interferometers .............................................................................................................................. 466
12.3 Optical Lever .................................................................................................................................................................................. 469
   12.3.1 Displacement and Angle Sensitivity of the Optical Lever .............................................................................................. 471
   12.3.2 Grating Optical Lever ......................................................................................................................................................... 472
12.4 Sources of Noise in Displacement Measurements ...................................................................................................................... 473
   12.4.1 Thermal Noise ................................................................................................................................................................. 474
   12.4.2 Shot Noise ................................................................................................................................................................. 475
   12.4.3 Relative Intensity Noise .................................................................................................................................................... 475
12.5 Signal-to-Noise Ratio .............................................................................................................................................................. 476
   12.5.1 Noise Equivalent Power ................................................................................................................................................ 478
12.6 Detection Limits in displacement measurements ......................................................................................................................... 479
   12.6.1 Resolution of Optical Interferometers ............................................................................................................................. 479
   12.6.2 Resolution of Optical Levers ......................................................................................................................................... 481
   12.6.3 Resolution of Capacitive Sensors ..................................................................................................................................... 481
   12.6.4 Resolution of Piezoresistive Sensors ............................................................................................................................... 483
   12.6.5 Comparison of Displacement Sensors .......................................................................................................................... 485
12.7 Summary of Optical Displacement Sensors .................................................................................................................................. 486
Exercises ......................................................................................................................................................................................... 487
References: ....................................................................................................................................................................................... 489

# 13 Micro-Optical Filters

13.1 Introduction to Micro-Optical Filters ....................................................................................................................................... 490
13.2 Amplitude Filters .................................................................................................................................................................. 491
   13.2.1 Fabry-Perot Filters ......................................................................................................................................................... 491
   13.2.2 Bragg Filters ................................................................................................................................................................. 495
   13.2.3 Microresonator Filters .................................................................................................................................................... 495
13.3 Dispersion compensators .............................................................................................................................................................. 498
13.4 MEMS Spectrometers ............................................................................................................................................................. 500
   13.4.1 Swept Pass Band Spectrometers .................................................................................................................................. 501
   13.4.2 Generalized Transform Spectrometers .......................................................................................................................... 502
   13.4.3 Fourier Transform Spectrometers .................................................................................................................................. 503
   13.4.4 MEMS Implementations of Transform Spectrometers .................................................................................................. 507
13.5 Diffractive Spectrometers ......................................................................................................................................................... 511
   13.5.1 Spectral Synthesis ........................................................................................................................................................... 511
13.2 Diffractive MEMS Spectrometers........................................ 514
13.6 Tunable lasers ........................................................................ 517
  13.6.1 MEMS Vertical Cavity Surface Emitting Lasers ............... 518
  13.6.2 MEMS External Cavity Semiconductor Diode Lasers........ 519
  13.6.3 Tunable External Cavity Semiconductor Diode Lasers
      with Diffractive Filters ....................................................... 522
13.7 Summary of Microoptical Filters ......................................... 523
Exercises ...................................................................................... 524
References ................................................................................... 527

14 Photonic Crystal Fundamentals.............................................. 532
  14.1 Introduction to Photonic Crystals ........................................ 532
  14.2 Photonic Crystal Basics .................................................... 533
      14.2.1 1-D Photonic Crystals .............................................. 535
      14.2.2 Bloch States .............................................................. 538
      14.2.3 Band Structure of 2-D and 3-D Photonic Crystals ......... 539
  14.3 Guided Resonances ......................................................... 543
      14.3.1 Reflection and Transmission through 2-D Photonic
      Crystals............................................................................. 544
      14.3.2 Reflection and Transmission for a Mirror-Symmetric
      2-port with one Guided Resonance........................................ 546
      14.3.3 Reflection and Transmission for a Mirror-Symmetric
      2-port with two Guided Resonances ...................................... 549
      14.3.4 Coupling to Guided Resonances – Symmetry ............... 551
  14.4 Comparison of Photonic and Electronic Crystals ................. 553
  14.5 Summary of PC fundamentals ............................................ 555
Exercises ...................................................................................... 556
References ................................................................................... 557

15 Photonic Crystal Devices and Systems .................................. 560
  15.1 Introduction to PC devices and systems ............................. 560
  15.2 IC Compatible Photonic Crystals ....................................... 561
      15.2.1 Silicon Compatible 2-D Photonic Crystals .................. 561
      15.2.2 3-D Structuring of Photonic Crystals ........................ 566
  15.3 Photonic Crystal Optical Components ............................... 567
      15.3.1 Mirrors and Filters ...................................................... 568
      15.3.2 Photonic Crystal Fabry-Perot Resonators .................. 569
      15.3.3 PC Tunneling Sensors .............................................. 570
      15.3.4 PC Polarization Optics .............................................. 571
      15.3.5 PC Index Sensors ...................................................... 571
  15.4 Tunable Photonic Crystals .................................................. 573
      15.4.1 Photonic Crystal MEMS Scanners ........................... 574
      15.4.2 Photonic Crystal Displacement Sensors .................... 577
  15.5 Photonic Crystal Fiber Sensors ......................................... 579
## Appendix A  Geometrical Optics.................................................................588

A.1 Introduction to Geometrical Optics.....................................................588
A.2 Geometrical Optics Treatment of Lenses..........................................588
  A.2.1 Lens – Ray Picture ........................................................................ 588
  A.2.2 Lenses – Wave Picture ................................................................. 589
  A.2.3 Ray Tracing.................................................................................. 590
A.3 ABCD matrices..................................................................................591
  A.3.1 Free space.................................................................................. 592
  A.3.2 Slab of Index n ......................................................................... 592
  A.3.3 Thin Lens .................................................................................. 593
  A.3.4 Curved Mirror .......................................................................... 594
  A.3.5 Combinations of Elements ......................................................... 594
  A.3.6 Reverse transmission:.............................................................. 595

## Appendix B  Electrostatic Actuation..........................................................596

B.1 The parallel Plate Capacitor............................................................596
  B.1.1 Energy Storage in Parallel-Plate Capacitors............................ 597
B.2 The Parallel Plate Electrostatic Actuator ........................................ 599
  B.2.1 Charge Control........................................................................ 600
  B.2.2 Voltage Control........................................................................ 602
B.3 Energy Conservation in the Parallel Plate Electrostatic Actuator.... 606
B.4 Electrostatic Spring..........................................................................610
  B.4.1 Sensors Based on the Electrostatic Spring.............................. 613
B.5 Electrostatic Combdrives................................................................ 614
B.6 Summary of Electrostatic Actuation.............................................. 620
References............................................................................................ 624

Index........................................................................................................626