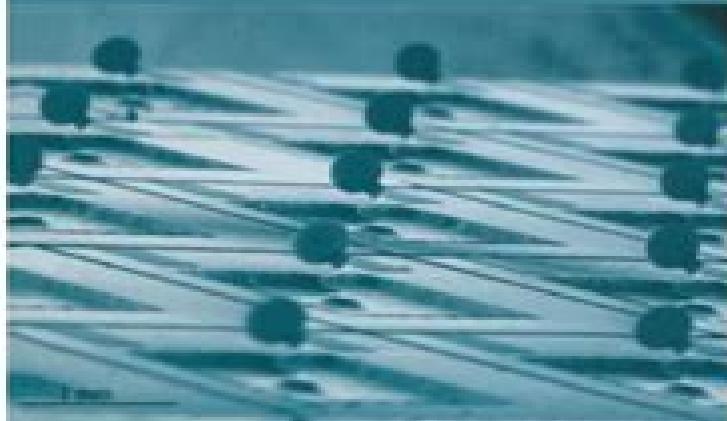


# Optical Microscanners and Microspectrometers using Thermal Bimorph Actuators



*Gerhard Lammel  
Sandra Schweizer  
Philippe Renaud*

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# Optical Microscanners And Microspectrometers Using Thermal Bimorph Actuators Microsystems

**AW Chickering**

## **Optical Microscanners And Microspectrometers Using Thermal Bimorph Actuators Microsystems:**

*Optical Microscanners and Microspectrometers using Thermal Bimorph Actuators* Gerhard Lammel, Sandra Schweizer, Philippe Renaud, 2002-01-31 Optical Microscanners and Microspectrometers using Thermal Bimorph Actuators shows how to design and fabricate optical microsystems using innovative technologies and original architectures A barcode scanner laser projection mirror and a microspectrometer are explained in detail starting from the system conception discussing simulations choice of cleanroom technologies design fabrication device test packaging all the way to the system assembly An advanced microscanning device capable of one and two dimensional scanning can be integrated in a compact barcode scanning system composed of a laser diode and adapted optics The original design of the microscanner combines efficiently the miniaturized thermal mechanical actuator and the reflecting mirror providing a one dimensional scanning or an unique combination of two movements depending on the geometry The simplicity of the device makes it a competitive component The authors rethink the design of a miniaturized optical device and find a compact solution for a microspectrometer based on a tunable filter and a single pixel detector A porous silicon technology combines efficiently the optical filter function with a thermal mechanical actuator on chip The methodology for design and process calibration are discussed in detail The device is the core component of an infrared gas spectrometer

### **BioMEMS**

Gerald Urban, 2007-02-01 Explosive growth in the field of microsystem technology MST has introduced a variety of promising products in major disciplines from microelectronics to life sciences Especially the life sciences and health care business was and is expected to be a major market for MST products Undoubtedly the merging of biological sciences with micro and nanoscience will create a scientific and technological revolution in future Microminiaturization of devices down to the nanoscale approaching the size of biological structures will be a prerequisite for the future success of life sciences Bioanalytical and therapeutic micro and nanosystems will be mandatory for system biologists in the long run to obtain insight into morphology the function and the interactive processes of the living system With such a deeper understanding new and personalized drugs could be developed leading to a revolution in life sciences Today microanalytical devices are used in clinical analytics or molecular biology as gene chips In parallel standard microbiomedical products are employed in the intensive care and surgical theatre mainly for monitoring and implantation purposes The gap between these two different scientific fields will be closed however as soon as functional micro devices can be produced allowing a deeper view into the function of cells and whole organisms Here a new discipline evolved which focuses on microsystems for living systems called BIOMEMS In this review at a glance the exciting field of bio microsystems from their beginnings to indicators of future successes are presented It will also show that a broad penetration of micro and nano technologies into biology and medicine will be mandatory for future scientific and new product development progress in life science

### **Heat Convection in Micro Ducts**

Yitshak Zohar, 2013-03-09 As the field of Microsystems expands into more disciplines and new applications such as RF

MEMS Optical MEMS and Bio MEMS thermal management is becoming a critical issue in the operation of many microdevices including microelectronic chips Heat Convection in Micro Ducts focuses on the fundamental physics of convective heat transfer in microscale and specific applications such as microchannel heat sinks micro heat pipes microcoolers and micro capillary pumped loops This book will be of interest to the professional engineer and graduate student interested in learning about heat removal and temperature control in advanced integrated circuits and microelectromechanical systems

**Principles and Applications of NanoMEMS Physics** Hector Santos,2006-07-02

Principles and Applications of NanoMEMS Physics presents the first unified exposition of the physical principles at the heart of NanoMEMS based devices and applications In particular after beginning with a comprehensive presentation of the fundamentals and limitations of nanotechnology and MEMS fabrication techniques the book addresses the physics germane to this dimensional regime namely quantum wave particle phenomena including the manifestation of charge discreteness quantized electrostatic actuation and the Casimir effect and quantum wave phenomena including quantized electrical conductance quantum interference Luttinger liquids quantum entanglement superconductivity and cavity quantum electrodynamics Potential building blocks are also addressed for NanoMEMS applications including nanoelectromechanical quantum circuits and systems such as charge detectors the which path electron interferometer and the Casimir oscillator as well as a number of quantum computing implementation paradigms Finally NanoMEMS applications in photonics are addressed including nanophotonic light sources and plasmonic devices

*Mems/Nems* Cornelius T. Leondes,2007-10-08

This significant and uniquely comprehensive five volume reference is a valuable source for research workers practitioners computer scientists students and technologists It covers all of the major topics within the subject and offers a comprehensive treatment of MEMS design fabrication techniques and manufacturing methods It also includes current medical applications of MEMS technology and provides applications of MEMS to opto electronic devices It is clearly written self contained and accessible with helpful standard features including an introduction summary extensive figures and design examples with comprehensive reference lists

**Micromachined Mirrors** Robert Conant,2013-04-17

Micromachined Mirrors provides an overview of the performance enhancements that will be realized by miniaturizing scanning mirrors like those used for laser printers and barcode scanners and the newly enabled applications including raster scanning projection video displays and compact high speed fiber optic components There are a wide variety of methods used to fabricate micromachined mirrors each with its advantages and disadvantages There are however performance criteria common to mirrors made from any of these fabrication processes For example optical resolution is related to the mirror aperture the mirror flatness and the scan angle Micromachined Mirrors provides a framework for the design of micromirrors and derives equations showing the fundamental limits for micromirror performance These limits provide the micromirror designer tools with which to determine the acceptable mirror geometries and to quickly and easily determine the range of possible mirror optical resolution and scan

speed    **Optimal Synthesis Methods for MEMS** S.G.K. Ananthasuresh,2012-12-06 The field of microelectromechanical systems or MEMS has gradually evolved from a discipline populated by a small group of researchers to an enabling technology supporting a variety of products in such diverse areas as mechanical and inertial sensors optical projection displays telecommunications equipment and biology and medicine Critical to the success of these products is the ability to design them and this invariably involves detailed modeling of proposed designs Over the past twenty years such modeling has become increasingly sophisticated with full suites of MEMS oriented computer aided design tools now available worldwide But there is another equally important side to the design process In my own book Microsystem figuring out what to build in the first place Design I chose to emphasize the modeling aspect of design The task of figuring out what to build was defined by a vague step called creative thinking I used practical product examples to illustrate the many subtle characteristics of successful designs but I made no attempt to systematize the generation of design proposals or optimized designs That systematization is called synthesis which is the subject of this book    **Mechanical Engineers' Handbook: Instrumentation, systems, controls, and MEMS** Myer Kutz,2006 A single source for mechanical engineers offering all the critical information they require

**The British National Bibliography** Arthur James Wells,2002    A MEMS-based Optical Scanner Using Aerosol Jet Printed PZT Thin-film Bimorph Actuators Ming-Yao Li,2020    *Optimization of a MEMS-based Optical Scanner Using Aerosol Jet Printed PZT Thin-film Bimorph Actuators* 2021    **Development of**

**SOI-based Thermally Actuated Micromirror** In Sik Cho,2019 Micromirror is a Micro Electro Mechanical Systems MEMS device used to steer light by tilting or displacing a reflective surface It is applied in numerous scanning applications and display technologies such as Light Detection And Ranging LiDAR and retinal scanning display To achieve rotational or translational motion in a compliant direction with applied voltage microactuators are implemented to a mirror Among four commonly known principles of MEMS actuation which are electrostatic thermal electromagnetic and piezoelectric actuations the proposed micromirror device operates based on thermal actuation more specifically using an Al SiO<sub>2</sub> bimorph structure In this thesis five different designs are proposed including some configurations capable of producing three degrees of freedom tip tilt and piston motion The proposed device also benefits from using Silicon On Insulator SOI wafer as a substrate as the buried oxide layer is used as an etch stop for Deep Reactive Ion Etch DRIE process and the device layer enhances the flatness of the mirror surface In the final design mirrors with a diameter of 500 μm consisting of silicon aluminum and silicon oxide with actuators made of aluminum and silicon oxide layers are developed fabricated and tested The selection of the dimensions and materials are justified through simulations in response to voltage in various scenarios Device dimensions are varied to investigate the effect of each parameter as well In addition the designs are simulated with other potential materials for the bimorph structure The fabrication process is optimized to circumvent the curvature of the mirror caused by residual stress For the final fabrication process the device Si layer is first patterned and etched for the

mirror structure Then Al is used as a hard mask for both frontside and backside while the frontside aluminum is also a part of the device The silicon oxide layer on the frontside and the handle layer on the backside are etched using Bosch process In this research some of the challenges are confronted and resolved during the fabrication and these include Al layer deposit and etch the DRIE process and residual stress after the release Finally Scanning Electron Microscope SEM images of the fabricated devices are taken and the tilt motion of the mirrors in response to actuation voltages is verified under an optical microscope The tilt angle of the micromirrors are further investigated with a surface profiler In conclusion the SOI based thermally actuated micromirror device is successfully developed with simple fabrication process while producing noticeable tilt motion with a very low actuation voltage

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