

Application of Microsystems Technology in the Fabrication of Thermoelectric Micro-Converters

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1. Introduction

The use of thin-film deposition techniques with microsystems technologies renewed the interest in the thermoelectricity in the last years. Integration of efficient solid-state thermoelectric (TE) microdevices with microelectronics is desirable for local cooling and, since they can be used to stabilise the temperature of devices, decrease noise levels and increase operation speed. Their use in thermoelectric microgeneration (energy harvesting) can also supply energy to low power consumption electronic devices. In this chapter, the fabrication of thermoelectric microconverters is compared, both on materials from thin-film composites to superlattice structures, and on its fabrication techniques.

Various materials can be used for this type of converters. However, for room temperature application, Bi/Sb/Te compounds are still the most efficient thermoelectric materials. Recently, efforts were made to apply quantum confinement to thermoelectric materials, and the results are thin-film superlattice structures and nanowires and even more recently, bulk nanocomposites. Some of these materials proved the ability to double efficiency of current thermoelectric devices. Several deposition techniques can be used for the fabrication of Bi/Sb/Te thin-films: co-sputtering, electrochemical deposition, metal-organic chemical vapor deposition or flash evaporation are some examples compared here.

The patterning process must use photolithography techniques to create the small dimensions of these devices. Despite these techniques are commonly used in microelectronic devices, mainly with silicon based substrates, its application in other thermoelectric alloys is still under development.

The patterning of thermoelectric structures for the fabrication of thermoelectric microconverters can be done using common microsystems technologies. Techniques used in MEMS fabrication, namely wet-etching, lift-off (with SU-8 photoresist), Reactive Ion Etching (RIE) and Lithography-Electroplating-Molding (LEIGA) are here compared for the fabrication of thermoelectric microsystems.

2. Theory behind thermoelectric devices

There are two groups of applications for thermoelectric materials based on Seebeck and Peltier effects respectively. In the Seebeck effect, a temperature difference between the junctions of two different materials produces an electric voltage (figure 1), and an electric

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**Kamisetty Ramamohan Rao,Z. S.
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Microsystems Technology for Multimedia Applications Bing Jay Sheu, 1995 Current interest in NAD Nicotinamide adenine dinucleotide in biological systems focuses on its role in ADP ribose transfer reactions These appear to be fundamentally involved in the regulation of many physiological processes The contributions in this monograph thus represent the range of research in the very active investigation of niacin metabolism The major topics covered are Enzymology of ADP Ribosylation ADP Ribosylation and Chromatin Function Carcinogenesis and Differentiation NAD Metabolism and Chemotherapy ADP Ribosylation and Signal Transduction Molecular Genetic Approaches to **Smart Adaptive Systems on Silicon** Maurizio Valle, 2004-10-18 Intelligent smart systems have become common practice in many engineering applications On the other hand current low cost standard CMOS technology and future foreseeable developments makes available enormous potentialities The next breakthrough will be the design and development of smart adaptive systems on silicon i e very power and highly size efficient complete systems i e sensing computing and actuating actions with intelligence on board on a single silicon die Smart adaptive systems on silicon will be able to adapt autonomously to the changing environment and will be able to implement intelligent behaviour and both perceptual and cognitive tasks At last they will communicate through wireless channels they will be battery supplied or remote powered via inductive coupling and they will be ubiquitous in our every day life Although many books deal with research and engineering topics i e algorithms technology implementations etc few of them try to bridge the gap between them and to address the issues related to feasibility reliability and applications Smart Adaptive Systems on Silicon though not exhaustive tries to fill this gap and to give answers mainly to the feasibility and reliability issues Smart Adaptive Systems on Silicon mainly focuses on the analog and mixed mode implementation on silicon because this approach is amenable of achieving impressive energy and size efficiency Moreover analog systems can be more easily interfaced with sensing and actuating devices **Circuits and Systems Tutorials** Chris Toumazou, Nick Battersby, Sonia Porta, 1995-12-11 Available for the first time in paperback this ground breaking industry textbook is heralded as a first in its state of the art coverage of the most important areas emerging in circuits and systems It is compiled from course material used in a suite of one day tutorials on circuits and systems designed expressly for engineers and research scientists who want to explore subjects outside but related to their immediate fields Authored by 50 circuits and systems experts this volume fosters a fundamental and authoritative understanding of each subject **Neuromorphic Systems** Leslie S. Smith, Alister Hamilton, 1998 Neuromorphic systems are implementations in silicon of sensory and neural systems whose architecture and design are based on neurobiology This growing area proffers exciting possibilities such as sensory systems that can compete with human senses and pattern recognition systems that can run in real time The area is at the intersection of neurophysiology computer science and electrical engineering This book brings together recent developments in Europe and the US so that researchers in both academia and industry can find out about the state of the art As well as elementary

material on what neuromorphic systems are and why they are growing in importance the book contains details of current work There are articles on aspects of implementing sensory neuromorphic systems as well as articles on neuromorphic hardware

Multimedia Communication Systems Kamisetty Ramamohan Rao, Z. S. Bojkovic, Dragorad A. Milovanovic, 2002 With extensive coverage of multimedia communications standards and processing techniques this guide presents new approaches to traffic management services deployment and QoS for networked multimedia systems It contains many practical examples more than 200 figures and over 400 references

Emerging Multimedia Computer Communication Technologies Chwan-Hwa Wu, J. David Irwin, 1998 The most complete reference covering every type of emerging technology in multimedia computer communications

Multimedia Technologies: Concepts, Methodologies, Tools, and Applications Syed, Mahbubur Rahman, 2008-06-30 This book offers an in depth explanation of multimedia technologies within their many specific application areas as well as presenting developing trends for the future Provided by publisher

An Introduction to Microelectromechanical Systems Engineering Nadim Maluf, Kirt Williams, 2004 Bringing you up to date with the latest developments in MEMS technology this major revision of the best selling *An Introduction to Microelectromechanical Systems Engineering* offers you a current understanding of this cutting edge technology You gain practical knowledge of MEMS materials design and manufacturing and learn how it is being applied in industrial optical medical and electronic markets The second edition features brand new sections on RF MEMS photo MEMS micromachining on materials other than silicon reliability analysis plus an expanded reference list With an emphasis on commercialized products this unique resource helps you determine whether your application can benefit from a MEMS solution understand how other applications and companies have benefited from MEMS and select and define a manufacturable MEMS process for your application You discover how to use MEMS technology to enable new functionality improve performance and reduce size and cost The book teaches you the capabilities and limitations of MEMS devices and processes and helps you communicate the relative merits of MEMS to your company's management From critical discussions on design operation and process fabrication of devices and systems to a thorough explanation of MEMS packaging this easy to understand book clearly explains the basics of MEMS engineering making it an invaluable reference for your work in the field

Proceedings, 1998 *Proceedings of the IECON...International Conference on Industrial Electronics, Control, and Instrumentation*, 1997 *Proceedings of the ... International Symposium on Microelectronics*, 2000 *Microelectronics Education* Adrian M. Ionescu, Michel Declercq, Maher Kayal, Yusuf Leblebici, 2013-03-19 In this book key contributions on developments and challenges in research and education on microelectronics microsystems and related areas are published Topics of interest include but are not limited to emerging fields in design and technology new concepts in teaching multimedia in microelectronics industrial roadmaps and microelectronic education curricula nanoelectronics teaching long distance education The book is intended for academic education level and targets professors researchers and PhDs involved

in microelectronics and or more generally in electrical engineering microsystems and material sciences The 2004 edition of European Workshop on Microelectronics Education EWME is particularly focused on the interface between microelectronics and bio medical sciences **Design of Systems on a Chip: Design and Test** Ricardo Reis, Marcelo Soares

Lubaszewski, Jochen A.G. Jess, 2007-05-06 This book is the second of two volumes addressing the design challenges associated with new generations of semiconductor technology The various chapters are compiled from tutorials presented at workshops in recent years by prominent authors from all over the world Technology productivity and quality are the main aspects under consideration to establish the major requirements for the design and test of upcoming systems on a chip

QoS Guarantees in Wireless/mobile Networks Sunghyun Choi, 1999 *Low-Voltage/Low-Power Integrated Circuits and Systems* Edgar Sánchez-Sinencio, Andreas G. Andreou, 1999-01-13 Electrical Engineering Low Voltage Low Power Integrated Circuits and Systems Low Voltage Mixed Signal Circuits Leading experts in the field present this collection of original contributions as a practical approach to low power analog and digital circuit theory and design illustrated with important applications and examples Low Voltage Low Power Integrated Circuits and Systems features comprehensive coverage of the latest techniques for the design modeling and characterization of low power analog and digital circuits Low Voltage Low Power Integrated Circuits and Systems will help you improve your understanding of the trade offs between analog and digital circuits and systems It is an invaluable resource for enhancing your designs This book is intended for senior and graduate students It is also intended as a key reference for designers in the semiconductor and communication industries Highlighted applications include Low voltage analog filters Low power multiplierless YUV to RGB based on human vision perception Micropower systems for implantable defibrillators and pacemakers Neuromorphic systems Low power design in telecom circuits *Whitaker's Books in Print* , 1998 1995 International Symposium on Microelectronics , 1995 Fiber Optics Illustrated Dictionary J.K. Petersen, 2002-12-26 Within a few short years fiber optics has skyrocketed from an interesting laboratory experiment to a billion dollar industry But with such meteoric growth and recent exciting advances even references published less than five years ago are already out of date The Fiber Optics Illustrated Dictionary fills a gap in the literature by providing instructors hobbyists and top level engineers with an accessible current reference From the author of the best selling Telecommunications Illustrated Dictionary this comprehensive reference includes fundamental physics basic technical information for fiber splicing installation maintenance and repair and follow up information for communications and other professionals using fiber optic components Well balanced well researched and extensively cross referenced it also includes hundreds of photographs charts and diagrams that clarify the more complex ideas and put simpler ideas into their applications context Fiber optics is a vibrant field not just in terms of its growth and increasing sophistication but also in terms of the people places and details that make up this challenging and rewarding industry In addition to furnishing an authoritative up to date resource for relevant industry definitions this dictionary introduces many exciting recent applications

as well as hinting at emerging future technologies *Circuits and Systems in the Information Age* Yih-Fang Huang, 1997
1995 International Symposium on Microelectronics International Symposium on Microelectronics (28, 1995, Los Angeles, Calif.), 1995

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