# 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 supperlattice 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 (LIGA) 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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- 1. Understanding the eBook Microsystems Technology For Multimedia Applications An Introduction
  - The Rise of Digital Reading Microsystems Technology For Multimedia Applications An Introduction
  - Advantages of eBooks Over Traditional Books
- 2. Identifying Microsystems Technology For Multimedia Applications An Introduction
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
- 3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Microsystems Technology For Multimedia Applications An Introduction
  - User-Friendly Interface
- 4. Exploring eBook Recommendations from Microsystems Technology For Multimedia Applications An Introduction
  - Personalized Recommendations
  - Microsystems Technology For Multimedia Applications An Introduction User Reviews and Ratings
  - Microsystems Technology For Multimedia Applications An Introduction and Bestseller Lists
- 5. Accessing Microsystems Technology For Multimedia Applications An Introduction Free and Paid eBooks
  - Microsystems Technology For Multimedia Applications An Introduction Public Domain eBooks
  - Microsystems Technology For Multimedia Applications An Introduction eBook Subscription Services
  - Microsystems Technology For Multimedia Applications An Introduction Budget-Friendly Options

#### Microsystems Technology For Multimedia Applications An Introduction

- 6. Navigating Microsystems Technology For Multimedia Applications An Introduction eBook Formats
  - o ePub, PDF, MOBI, and More
  - Microsystems Technology For Multimedia Applications An Introduction Compatibility with Devices
  - Microsystems Technology For Multimedia Applications An Introduction Enhanced eBook Features
- 7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Microsystems Technology For Multimedia Applications An Introduction
  - Highlighting and Note-Taking Microsystems Technology For Multimedia Applications An Introduction
  - Interactive Elements Microsystems Technology For Multimedia Applications An Introduction
- 8. Staying Engaged with Microsystems Technology For Multimedia Applications An Introduction
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Microsystems Technology For Multimedia Applications An Introduction
- 9. Balancing eBooks and Physical Books Microsystems Technology For Multimedia Applications An Introduction
  - Benefits of a Digital Library
  - o Creating a Diverse Reading Collection Microsystems Technology For Multimedia Applications An Introduction
- 10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
- 11. Cultivating a Reading Routine Microsystems Technology For Multimedia Applications An Introduction
  - Setting Reading Goals Microsystems Technology For Multimedia Applications An Introduction
  - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Microsystems Technology For Multimedia Applications An Introduction
  - Fact-Checking eBook Content of Microsystems Technology For Multimedia Applications An Introduction
  - Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
- 14. Embracing eBook Trends
  - Integration of Multimedia Elements

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