

## Book Review on “Thin Film Shape Memory Alloys-Fundamentals and Device Applications”

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**Abstract:** Shape memory alloys (SMAs) are amazing materials that, after being severely deformed, can spontaneously return to their original shape upon heating. These materials possess a number of desirable properties, namely, high actuation power or force, large recovery strain, pseudoelasticity (or superelasticity), good chemical resistance and biocompatibility, etc. These unique features have attracted much attention toward the potential applications of SMAs for military, medical, safety, and robotics applications. More recently, thin film SMAs have been recognized as a new type of promising and high performance material for micro-electro-mechanical system (MEMS) and biological applications.

Among these SMA films, TiNi based films are the most promising ones, which are typically prepared by a sputtering method. Since TiNi films can provide a large force and displacement in actuation, most applications of TiNi films in microengineering and biomedical industries are focused on microactuators, for example, micropumps, microvalves, micro-grippers, micro-positioners, and microcages, etc. TiNi based micropumps and microvalves are attractive for many applications, for instance, implantable drug delivery, chemical analysis and analytical instruments, etc. Grasping and manipulating small or micro-objects with high accuracy is required for a wide range of important applications, such as the micro-assembly in microsystems, endoscopes for microsurgery, and drug injection micromanipulators for cells. At present, increasing attention has been paid to use TiNi thin film for minimally invasive surgery, microstents and bioMEMS applications. Microactuators made of TiNi thin films may be used to infuse drugs, or placed in strategic locations in the body to assist blood circulation. TiNi SMA thin films, in the superelastic state, are promising as compliant elements in the biological devices. The development of TiNi based SMA thin films and their microactuators witnessed a significant progress in recent years, driven by the high demand from MEMS and biomedical communities. As such, a timely review of the important issues pertaining to the preparation of high quality and high performance shape memory TiNi thin films and the technical applications of these films is necessary.

This book, the first dedicated to this exciting and rapidly growing field, enables readers to understand, prepare, and apply high-quality, high-performance thin film TiNi SMAs. It covers not only the state-of-the-art technologies for thin

film SMAs (preparation and characterization), but also their applications, in particular, in MEMS and biomedical devices. The book is naturally divided into two parts, namely, technologies and applications. The first part is focused on the fundamental issues of sputter deposited TiNi based SMA thin films, covering from general overview; the basics of martensitic transformation; deposition technologies, Ti/Ni multi-layer film, microstructure, crystallization, mechanical properties, and stress evolution in thin film SMA, as well as advanced post treatment of thin film SMA including ion implantation and laser annealing. The second part is devoted to the device applications based on TiNi based SMA thin film, focusing mainly on MEMS and biological applications. It covers from overview of applications; theory and simulation of shape memory microactuators; MEMS devices of microvalves, micropumps, microcages, micromirrors, superelastic thin film for medical applications, and thin film composite microactuators.

In this book, basic techniques and theory are covered to introduce new-comers to the subject, whilst various sub-topics, such as film deposition, characterization, post treatment, and applying thin films to practical situations, appeal to more informed readers. Each chapter is written by expert authors, providing an overview of each topic and summarizing all the latest developments, making this an ideal reference for practitioners and researchers. Hence, it is an essential reference book both for a better understanding of the fundamental issues in the technical aspect and for catching up the current development in technologies and applications in new frontiers.

In brief, this book has the following attributes:

- The first book dedicated to this exciting and rapidly growing field of thin film SMAs, written by leading experts;
- A complete introduction of the topic that enables readers to understand and prepare their own high-quality, high-performance TiNi thin film SMAs;

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• Focusing on the latest technologies and applications in MEMS and biomedical devices, providing up-to-date, practical information.

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