in-situ Mechanical Testing of Micro-scale NiTi SMA Tensile Bars

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1. Introduction

Shape memory alloy (SMA) thin films have gained attention as promising materials for micro applications such as energy and biomedical devices [1,2]. The shape memory effect and superelasticity are key behaviors that make SMA promising materials. SMAs are able to restore its originally defined profile when heated above a transformation temperature following the deformation. In addition, SMAs show superelasticity, which brings back large deformation upon unloading. These behaviors are important abilities to both bulk-scale and micro-scale SMAs, however, deformation behavior of SMA thin films are still not well understood. In order to better understand the mechanical behavior of thin films, precise fabrication and state-of-the-art measurement systems are required.

2. Body of abstract

In this presentation, we report our study about *in-situ* mechanical testing of Nickel-Titanium (NiTi) SMA tensile bars, fabricated by micro-fabrication. The aspect ratio of gauge parts ranges from 2.5:1 to 12.5:1. Grip part of the tensile bars were designed to be large compared to the gauge section in order to prevent deformation during loading. Compression bars are also included in the design to study tension-compression asymmetric behavior.

High-throughput microfabrication is carried out to produce silicon-based chips comprised of multiple tensile bars. Profiles of these tensile bars are defined by utilizing photoresist patterning. Sputter deposition is conducted to deposit micro-scale NiTi thin films. The presented microfabrication is exceptionally cost efficient in comparison with the micro-scale sample fabrication by means of focused ion beam (FIB) milling [3]. The mechanical properties of NiTi tensile bars are measured by utilizing a diamond micro-grip mounted *in-situ* SEM nanoindentation apparatus. Mechanical testing of micro-scale tensile bars is turned out to provide a great route for characterizing the mechanical properties of NiTi SMA thin films by exploiting sputter deposition and micro-fabrication.

3. Equations, figures, and tables

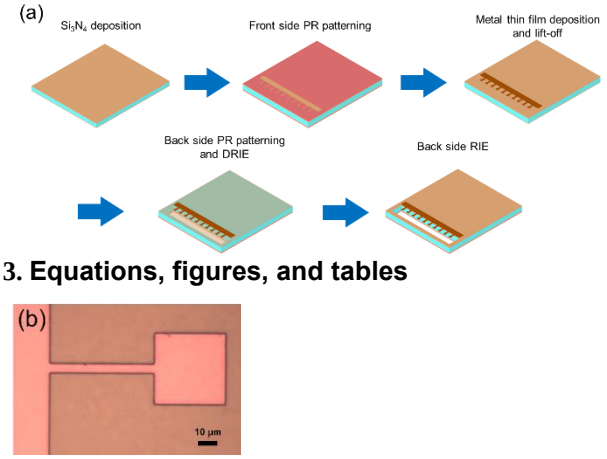

Fig.1. Image of (a) the fabrication process of NiTi tensile bars and (b) the profile of a single tensile bar defined by photoresist patterning.

Acknowledgment

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