Mechanical Behavior of Sputter Deposited NiTi Shape Memory Alloy Thin Films

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1. Introduction

Shape memory alloys(SMAs) can be used in many fields because of their multifunctional properties. Two main mechanical properties of SMAs are superelasticity and shape memory effect. Superelasticity is a stress-induced phase transformation from austenite to martensite when loading and unloading exists at usually above austenite finish temperature. On the other hand, shape memory effect is a thermally activated phase transformation phenomenon under free or constant stress. Nitinol(NiTi) is one of the representative material of SMAs because of its large work output and broad applicability. Although there are a lot of research with Nitinol, studies on the mechanical behavior at small scale are still lacking. Because mechanical behavior in micron size is significantly different from its bulk, it is essential to understand the mechanism of mechanical behavior of Nitinol thin films under various environment condition for reliable application in various micro devices such as electrical or bio-medical sensors.

2. Body of abstract

Because nitinol has very narrow composition range, the superelasticity is largely affected by its composition. Small composition difference could cause precipitates to form such as Ni3Ti4, NiTi2 during annealing process, which can totally change its superelastic behavior. In this study, for the investigation of the micro-scale superelasticity of nitinol thin films, we report the mechanical testing of sub-micro scale nitinol thin films. The free-standing micro tensile specimens are fabricated by using MEMs process. the NiTi metallic thin films were deposited by magnetron sputter system using an equiatomic NiTi target. the composition of specimens become Ni-rich because the sputter yield of nickel is higher than titanium. After specimen fabrication, the samples are heated at various temperature to consider annealing effect. DSC(Differential Scanning Calorimetry) will be used to analyze the transformation temperatures of the thin film. SEM(Scanning Electron Microscope) and TEM(Transmission electron microscope) analysis will also be performed for observing the microstructure of thin films depending on the heat treatment conditions. The room temperature tensile test will be conducted using our customized in-situ SEM mechanical tester to get the stress-strain curve of the thin films.

3. Equations, figures, and tables

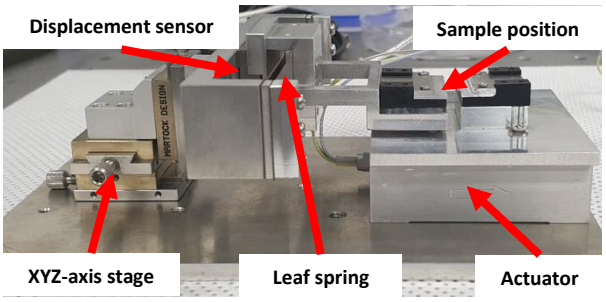

Fig.1 Customized in-situ SEM tensile tester

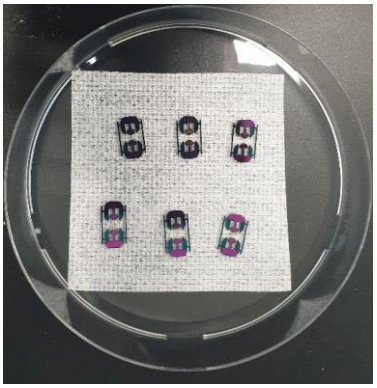

Fig.2 Micro tensile specimens

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