MANUFACTURING OF NICKEL-TITANIUM SHAPE MEMORY ALLOY AND SHAPE MEMORY TRAINING

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ABSTRACT

Shape memory alloys (SMA) are successfully used for their potential use as functional material in many engineering and medical applications. The technological importance of shape memory alloys is coming from their shape memory effect (SME) and superelastic (SE) capability. SME and SE capability are due to martensitic phase transformation, that is triggered by changing temperature and applied stress.

In this study, in order to manufacture nickel-titanium shape memory alloy, commercially pure Ni and Ti are measured and cast in vacuum arc and vacuum induction furnace, to produce equiatomic structure. After successful manufacturing, DSC and microscopical analysis was applied to alloys NiTi 12-3, NiTi 7-3, NiTi 4-3 and NiTi 3-2 for material characterization, to determine their transformation temperature and phase structure. Additionally, Vickers hardness and X-Ray diffraction phase analysis were performed and the shape memory capabilities of the alloys were studied with shape memory training experiments.

Among the produced nickel-titanium alloys, the one with highest shape memory capability is determined to be the one cast in zirconia crucible in three remelting castings, in 4mm.x4mm.x65mm dimensions, namely NiTi 12-3. EDS analysis showed the atomic percentage to be 50.10 % Ti and 49.90 % Ni. DSC analysis was done to find out the phase transformation temperatures.

Among the heat treatment that were applied to the produced alloys, the one resulting the highest shape memory ability is found to be, holding at 550°C for 10 minutes in mould and than quenching in water. During shape memory training experiments, if the alloy, that has undergone permanent deformation in martensitic phase, is prevented from returning to the original shape during heating, it has been observed that the shape memory recovery of the alloy diminishes significantly. Shape memory training experiments revealed that the produced NiTi 12-3 alloy loses all of its shape memory, if it is prevented from returning to the previous shape at temperatures above 500°C.

Keywords: Shape memory alloys, Ni-Ti alloy, Shape memory training

DEVELOPMENT OF NICKEL-TITANIUM SHAPE MEMORY ALLOYS ACTUATED ITU ROBOT HAND (ITUHAND) AND ITS PERFORMANCE ANALYSIS

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ABSTRACT

The technological importance of shape memory alloys is coming from their shape memory effect (SME) and superelastic (SE) capability. SME and SE capability are related with temperature variation and applied stress which effect the crystal structure by martensitic and austenitic phase transformation.

Shape memory alloys (SMA) classified as a technological material for 20 years by its fabrication development. They are used now from sensor systems to medical artery calcification stent, from automotive radiator to robotic multi-legged robot system.

In this study, NiTi shape memory alloy internal structure and mechanical properties are examined. NiTi SMA is produced in vacuum induction furnace under argon gas atmosphere. Produced NiTi is used as an actuator in attached arm of ITUHand that has been developed to carry, remove and destroy explosives. In ITUHand‘s fingers NiTi sheet that had been imported from USA was used. Furthermore, a set of experiments were performed regarding gripping/releasing time according to applied powers and gripped object dimension.

Keywords: Shape memory alloys, Ni-Ti alloy, Robot hand, Nitinol