HEAT TREATMENT OF Ni-Ti ALLOY FOR IMPROVEMENT OF SHAPE MEMORY EFFECT

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ABSTRACT

Nickel-Titanium alloys with stoichiometric single phase and non-stoichiometric dual phase structures of NiTi and NiTi+Ni_3Ti are produced through high-speed induction melting and combustion synthesis of pure Ti/Ni elements. Both alloys are homogenized at 1273K for two hours, rolled into thin strips of 0.3 mm thickness, solution treated at 1273K for two hours under vacuum and finally quenched in water. Effect of ageing on austenite/martensite and intermediate phase transformation temperatures are investigated. Results show that transformation temperatures and reversible shape memory properties comparable with those required for bio-engineering applications such as manufacturing of artifitial hand prostheses can be obtained through careful control of the chemical composition and the heating processes.

1. INTRODUCTION

Shape Memory Effect (SME) is one of the most interesting behaviors associated with the martensitic transformation in Ni-Ti alloys. Ni-Ti alloys represent advantageous capabilities of memorizing both initial and final geometric shapes [1]. Numerous technological applications of great attraction to biomedical engineers have thus been raised during past few years [2]. Design and manufacturing of miniature type medical device, orthopedic surgical implant and artificial prosthesis are a few of the many possible examples.

Numerous investigations are underway throughout the world to find the important parameters that may influence the SME behavior [3,4,5]. Of the most important properties that must be controled during production, is the temperature that the alloy starts to remember its previous shape [6,7]. There is not much written, however, on the effects of the method of production, the chemical composition and the ageing time and temperature on the SMA transformation temperatures. Typical results obtained from our extensive studies on these effects are reported in this paper.

2. EXPERIMENTAL PROCEDURE

2.1. Method of Production Ni-Ti alloy may be produced via different routes. One way is to simultaneously melt the highly pure elements in a fast-melting unit such as High Frequency Induction system (HFI) [3]. Undesirable contaminations from refractory materials are, however, often inevitable in this method. "Self-Propagating High Temperature Synthesis (SHS)" also called "Combustion Synthesis (CS)" is also used as an alternative way to produce a highly desirable ultra-clean alloy [8,9,10]. This process consists of a self-sustaining ignition reaction that synthesizes the batch of uniformly mixed powders. Both methods are tried in this research. All specimens selected for this study show shape memory effect.

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