STRUCTURAL RELAXATION AND PHASE TRANSFORMATION OF NANOSTRUCTERED/AMORPHOUS NiTi DURING SINTERING

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Abstract

In this work the possibility of synthesis of amorphous phase in Ni-Ti binary system by mechanical alloying (MA) was investigated. Also, formation of B2-NiTi parent phase by crystallization of amorphous phase, and finally production of the nanostructured or fine grain parts during sintering step were examined. Phase transformation and amorphization were investigated by X-Ray diffraction, differential scanning calorimetry and scanning electron microscopy. Nanocrystaline B2- NiTi phase is formed in the early stage of the sintering due to crystallization of amorphous phase. However by increasing of the sintering temperature, the amount of B2-NiTi was decreased and almost replaced by Ni_3Ti and Ti_2Ni. So the reasons of this phase transformation were investigated.

Keyword: mechanical alloying, nanostructured NiTi, amorphous phase, sintering

1-Introduction

NiTi Shape memory alloy with near equiatomic composition has attracted much interest due to its potential as a functional and structural material in many engineering applications, such as active, adoptive or smart structures, as well as medical and dental implants. The alloy is well known for its unique properties of shape memory effect, superelasticity, high corrosion resistance and good biocompatibility [1,2]. NiTi alloy has been produced by several techniques such as casting as well as powder metallurgy (PM) methods likes conventional powder metallurgy, self propagating high temperature synthesis and explosive shock – wave compression using elemental Ni and Ti [1,3]. From view point of composition control, the techniques based on powder metallurgy methods are preferred.

Among the (PM) methods, mechanical alloying is able to form NiTi phase and reduce the crystallite size, simultaneously. In the Ni-Ti binary system, there are multiple intermetallics including Ni_3Ti-NiTi and Ti_2Ni [5]. Among them the only component that exhibit shape memory effect is NiTi with stoichiometric composition of Ni50 –Ti50 (at%).

Nanocrystalline NiTi exhibit variety of properties which are often considerably improved in comparison those of conventional coarse – grained polycrystalline materials [4]. Several investigations are dedicated to the synthesis of NiTi intermetallic in nanometric size by mechanical alloying. [3-16]. However, in the more cases the structural investigation are limited to the as-milled state and sintering behavior of the milled powders is less investigated. Fabrication of nanocrystalline NiTi parts is debatable in two pivots. One is the synthesis of nanocrystaline shape memory NiTi intermetallic by mechanical alloying without formation of other undesirable components, and the other is hindering of the grain grows during sintering. In our researches, we try to fabricate a nanostructured shape memory dental implant by mechanical alloying process. With respect to the other researcher's reports, the formation of crystallized products during mechanical allying is accompanied by formation of other undesirable components [9-16]. So we investigate the possibility of formation of amorphous phase during mechanical allying and its crystalization to NiTi(B2) parent

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