(Form6)

論　文　要　旨

Thesis Abstract

(yyyy/mm/dd)　2019 年　03 月　12 日

※報告番号	乙 第　88　号	氏　名 (Name)	Witold Prendota *Witold Prendota*

主論文題名　(Title)

Properties of Fe-Mn-Si and Ni-Ti shape memory alloys prepared by pulsed-current sintering

内容の要旨　(Abstract)

This Thesis presents results of a study of Fe-Mn-Si alloys and Ni-Ti intermetallics which exhibit shape memory effect. Such materials are commonly used in a broad area of applications, such as: engineering or medicine. In particular, Fe-Mn-Si can be used e.g. for constructions, and Ni-Ti - in medicine or micro-electro mechanical devices (MEMS). Within this work, materials prepared with pulsed-current sintering method were studied. Main focus was put on the thorough characterization and description of physical properties of the materials and phases involved as well as on the interplay between them and dependence on the composition and preparation conditions.

As the technological novelty a single-step route for preparation of Ni-Ti shape memory micro foil alloys from pure element foils has been designed. Three starting configurations of elemental foils of properly adjusted thicknesses were used: a simple Ni/Ti as well as sandwich-like Ni/Ti/Ni and Ti/Ni/Ti. A good shape memory recovery effect. reaching 100 %. was obtained for Ni/Ti/Ni configuration derived alloy. A complex characterization of the materials obtained included X-Ray Diffraction, Scanning Electron Microscope with EDS elemental mapping, Differential Scanning Calorimetry, magnetometry, electrical resistivity and magnetoresistance. The results revealed the phases occurring in the material at different preparation conditions with respect to the completeness of the diffusion process leading to the formation of the Ni-Ti shape memory alloy. A comparison was made to the materials prepared from the cold-rolled foils, subsequently annealed which shows a much higher effectiveness of the pulsed-sintering method.

For the Fe-Mn-Si system the materials obtained with mechanical alloying of elemental powders and subsequent pulsed-current sintering process were studied. The same characterization methods as for Ni-Ti system were also used here. Except for them, Mössbauer spectroscopy and the specific heat measurements were carried out. The as annealed and thermally processed samples were studied and the properties of the phases involved were characterized. The study showed that the austenitic fcc phase is ferro or ferri magnetic and exhibits exchange bias behavior, depending on the heating temperature. A linear-like temperature dependencies of the inversed magnetic susceptibility reveal a Curie-Weiss character corresponding to localized moments. A very small magnetic splitting derived from iron Mössbauer spectra indicates that the magnetism is governed by manganese. For the material with 0.1 wt.% carbon added for improvement of shape memory effect a peak at 250 K in the specific heat is observed. It is almost insensitive to the applied magnetic field up to 9 T was observed, indicating transition to antiferromagnetic-like state of the martensite hcp phase. The exchanged bias effect observed for the fcc phase at some thermal treatment conditions samples and a nucleation of reversed domain character of their virgin magnetization curves reveals a nanometric size of the austenitic fcc phase precipitation, not detectable with XRD, in the martensite matrix.

※official use only

論　文　要　旨
Thesis Abstract

(yyyy/mm/dd)　2019 年　03 月　12 日

※ 報告番号	第　　　号	氏　名 (Name)	Witold Prendota

内容の要旨(Abstract)

This Thesis presents results of a study of Fe-Mn-Si alloys and Ni-Ti intermetallics which exhibit shape memory effect. Such materials are commonly used in a broad area of applications, such as: engineering or medicine. In particular, Fe-Mn-Si can be used e.g. for constructions, and Ni-Ti - in medicine or micro-electro mechanical devices (MEMS). Within this work, materials prepared with pulsed-current sintering method were studied. Main focus was put on the thorough characterization and description of physical properties of the materials and phases involved as well as on the interplay between them and dependence on the composition and preparation conditions.

As the technological novelty a single-step route for preparation of Ni-Ti shape memory micro foil alloys from pure element foils has been designed. Three starting configurations of elemental foils of properly adjusted thicknesses were used: a simple Ni/Ti as well as sandwich-like Ni/Ti/Ni and Ti/Ni/Ti. A good shape memory recovery effect. reaching 100 %. was obtained for Ni/Ti/Ni configuration derived alloy. A complex characterization of the materials obtained included X-Ray Diffraction, Scanning Electron Microscope with EDS elemental mapping, Differential Scanning Calorimetry, magnetometry, electrical resistivity and magnetoresistance. The results revealed the phases occurring in the material at different preparation conditions with respect to the completeness of the diffusion process leading to the formation of the Ni-Ti shape memory alloy. A comparison was made to the materials prepared from the cold-rolled foils, subsequently annealed which shows a much higher effectiveness of the pulsed-sintering method.

For the Fe-Mn-Si system the materials obtained with mechanical alloying of elemental powders and subsequent pulsed-current sintering process were studied. The same characterization methods as for Ni-Ti system were also used here. Except for them, Mössbauer spectroscopy and the specific heat measurements were carried out. The as annealed and thermally processed samples were studied and the properties of the phases involved were characterized. The study showed that the austenitic fcc phase is ferro or ferri magnetic and exhibits exchange bias behavior, depending on the heating temperature. A linear-like temperature dependencies of the inversed magnetic susceptibility reveal a Curie-Weiss character corresponding to localized moments. A very small magnetic splitting derived from iron Mössbauer spectra indicates that the magnetism is governed by manganese. For the material with 0.1 wt.% carbon added for improvement of shape memory effect a peak at 250 K in the specific heat is observed. It is almost insensitive to the applied magnetic field up to 9 T was observed, indicating transition to antiferromagnetic-like state of the martensite hcp phase. The exchanged bias effect observed for the fcc phase at some thermal treatment conditions samples and a nucleation of reversed domain character of their virgin magnetization curves reveals a nanometric size of the austenitic fcc phase precipitation, not detectable with XRD, in the martensite matrix.

※official use only