【Grant-in-Aid for Scientific Research (S)】

Science and Engineering (Engineering)

Title of Project : Ferrous Structural Superelastic Alloys - New Stage of Shape Memory Materials -

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Research Project Number : 15H05766 Researcher Number : 20202004
Research Area : Engineering
Keyword : Martensitic transformation, Coherent precipitation, Abnormal grain growth

【Purpose and Background of the Research】

The conventional shape memory alloys (SMAs), such as NiTi, are widely used as a typical functional material in many practical fields. On the other hand, there was no ferrous alloy showing enough superelastic (SE) properties. Recently, we have found excellent SE properties in the FeNiCoAlTaB and FeMnAlNi alloys.(Fig. 1) The most important points in these alloy systems are: 1) coherent precipitates play an important role to obtain SE, 2) the change in crystal structure by martensitic transformation (MT) is just opposite to each other, and 3) material costs of the alloys are relatively low. In both the alloys, however, brittleness caused by grain boundary precipitation (GBP) is one of the most serious problems.

In the present project, alloy design and microstructural control will be performed to solve the above problem against practical use.

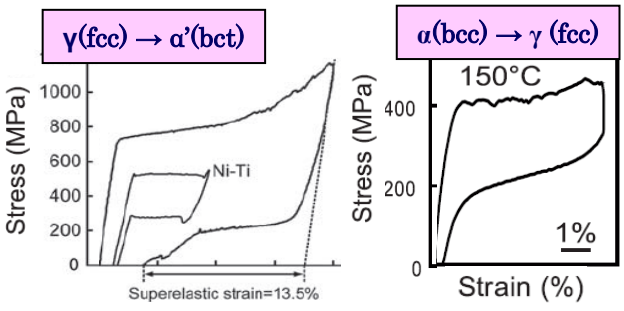

Fig. 1 SE properties in FeNiCoAlTaB and FeMnAlNi

【Research Methods】

1. Prevention of GBP

By using phase diagram calculation (CALPHAD), it will be tried to estimate the alloy compositions, in which the stability of the harmful grain boundary phases effectively decreases.

2. Control of coherent precipitates

It will be systematically investigated how the lattice coherency and misfit between matrix and precipitates influence SE properties.

3. Control of grain size and texture

It will be tried that the huge and textured grain structure, where excellent SE properties are expected, is realized by using abnormal grain growth and recrystallization texture techniques.

4. Evaluation to possibility of practical use

After evaluation of basic properties of the present alloys, some applications in machine and architecture fields will be considered.

【Expected Research Achievements and Scientific Significance】

Both the present alloys have a disordered matrix structure with coherent ordered precipitates, which is different from the conventional SMAs with an ordered single-phase structure. It is interesting that the precipitates can significantly be deformed by MT as shown in Fig. 2. The success of this project will open a possibility making the SMA a structural material.

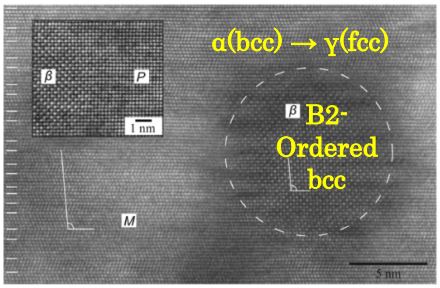

Fig.2 Particle deformed by MT in FeMnAlNi

【Publications Relevant to the Project】

・ Tanaka et al., Ferrous Polycrystalline Shape-Memory Alloy Showing Huge Superelasticity, **Science** 327 (2010) 1488
・ Omori et al., Superelastic Effect in Polycrystalline Ferrous Alloys, **Science** 333 (2011) 68

【Term of Project】

FY2015-2019

【Budget Allocation】

154,100 Thousand Yen

【Homepage Address and Other Contact Information】

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