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

Science and Engineering (Engineering Ⅱ)

Title of Project : Basic Research to Develop Dual Multi-phase Intermetallic Alloys as Next-generation Type Heat Resistant Materials

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Research Area : Materials Science and Engineering

Keyword : High temperature materials

【Purpose and Background of the Research】

To reduce CO_2 gas causing global warning, the improvement of energy efficiency in thermal exchange system and high-temperature fabricating instruments are required. The present authors have created fundamental alloy composition and microstructure which display excellent high-temperature strength and tensile ductility, based on Ni base multi-phase intermetallic alloys consisting of geometrically close packed (GCP) Ni_3X type structures.

In the present study, we study $L1_2(Ni_3Al)$-$D0_{22}(Ni_3V)$ pseudo-binary alloy system with high crystallographic coherency and fine microstructure (Fig.1). Firstly, alloy design, formation mechanism of fine microstructure, phase and microstructural stability, and high-temperature deformation property are studied. Next, environmental nature (such as oxidation and corrosion) is investigated. Furthermore, next-generation type of heat resistant materials or parts are developed in collaboration with some industries.

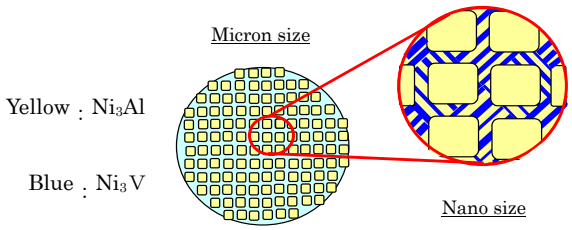

Fig.1 Schematic illustration of dual multi-phase microstructure.

【Research Methods】

○Alloy design and microstructural control : Phase diagrams are constructed from identifying the constituent phases, determining the phase relation and solid solubility in each phases. Based on this information, alloy design and microstructural control are proposed with helps of computational phase diagram.

○Understanding of high-temperature deformation and environmental properties : High-temperature mechanical properties such as strength, elongation, fracture, wear, and creep are investigated, and their mechanisms are discussed. From this experimental survey, alloys with superior mechanical and environmental properties are suggested.

○Development of applications : In collaboration with some industries, fabrication procedure and secondary processing are developed. Also, turbine blade for jet-engine, friction stir welding tool for high hardness and high melting point metals and alloys, bolt and nut, and ball bearing are actually developed.

【Expected Research Achievements and Scientific Significance】

Succeeding in the preset study, intermetallic alloy called as 'third' materials in the field of heat resistant materials will get the status of citizenship, preceded by metals and alloys, and ceramics. Also, the importance of studying alloys with microstructural hierarchy will be understood worldwide. On the other hand, industries associated with high temperature materials, instruments and plant makers will be innovated once Ni base multi-phase intermetallic alloys are successfully developed.

【Publications Relevant to the Project】

・S. Shibuya, Y. Kaneno, M. Yoshida and T. Takasugi, Dual multi-phase intermetallic alloys composed of geometrically close-packed Ni_3X (X:Al, Ti and V) type structures – II. Mechanical properties, Acta Materialia, 54, 861-870 (2006).

・S. Shibuya, Y. Kaneno, M. Yoshida, T. Shishido and T. Takasugi, Mechanical Properties of *dual* multi-phase single-crystal intermetallic alloy composed of geometrically close packed Ni_3X (X: Al and V) type structures, Intermetallics, 15, 119-127 (2007).

【Term of Project】 FY2009-2012

【Budget Allocation】 79,500 Thousand Yen

【Homepage Address and Other Contact Information】

http://www.eng.osakafu-u.ac.jp/Japanese/02senko/materi_group/group05.htm