



**Title of Project : High Entropy Alloys: Science of New Class of Materials Based on Elemental Multiplicity and Heterogeneity**

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Research Project Number : 18H05450 Researcher Number : 30213135

**【Purpose of the Research Project】**

This project aims at establishing a new science concerning high-entropy alloys that exhibit new and peculiar materials properties by elucidating nonlinear interactions among various constituent elements through intensive and interdisciplinary cooperative research among research groups of various research fields within the project. ‘High-entropy alloys’ is defined in a narrow sense as equiatomic solid-solution alloys formed with constituent elements more than five kinds, the subjects of research have recently been expanded to include concentrated alloys with chemical compositions in the middle of multi-component phase diagrams, even they are deviated from the equiatomic compositions and contain precipitates of the secondary phase. Many of these high-entropy alloys of broader sense exhibit peculiar mechanical properties, such as abnormally high strength and high toughness at low temperatures, high strength retention at high temperatures, which are not observed in conventional alloys. These peculiar materials properties are considered to arise from the so-called ‘cocktail’ effects (nonlinear interactions among various constituent elements), and the identification of materials property expression behind the cocktail effects is one of the most challenging topics in materials science. Through establishing new scientific principle for controlling variety and inhomogeneity of elements, we aims at creating a new scientific area, in which the basis is established for developing new peculiar materials beyond conventional ones.

**【Content of the Research Project】**

In this research area, the following three research items are promoted cooperatively to establish a new scientific area with the concept of High-Entropy Alloys.

- Research Item A01: Identification of Materials Property Expression and Materials Development
- Research Item A02: Modelling and Designing of Materials Property
- Research Item A03: Controlling of Phase Stability and Microstructures

For all three items, several experimental and theoretical research groups will collaborate closely together to promote the understanding of cocktail

effects of high-entropy alloys.

**【Expected Research Achievements and Scientific Significance】**

Unlike conventional alloys (such as Ni- and Al-based alloys) that are developed with a particular principal element at a corner of the phase diagram, high-entropy alloys are to be developed in the middle of multi-component phase diagrams, which have been undiscovered. Many unknown alloys with excellent properties are therefore expected to be discovered. Some particular combinations of elements may generate a cocktail effect that is not predictable only from the combination, and we expect a paradigm shift to occur in materials development, so that a best combination of elements and their fractions is searched, , departing from conventional ways with one particular principal element and some minor alloying elements.

**【Key Words】**

High-entropy alloy, Multi-component equiatomic alloy, high-order solid-solution, cocktail effect, materials strength, fracture toughness, solid-solution strengthening, phase stability, trap effect, variety of elements, inhomogeneity of elements

**【Term of Project】** FY2018-2022

**【Budget Allocation】** 1,169,100 Thousand Yen

**【Homepage Address and Other Contact Information】**

<http://www.hightentropy.mtl.kyoto-u.ac.jp>

