Special Issue on Materials Science on High-Entropy Alloys

PREFACE

In 2004, the concept of ‘high-entropy alloy’ was proposed by J.W. Yeh and was experimentally proved by B. Cantor independently. The concept is based on thermodynamic arguments that the configurational entropy should be very high when the alloy is in a solid-solution in a multicomponent alloy system so that such high entropy promotes a tendency to form a simple solid-solution without forming secondary/tertiary intermetallic phases. Since then, the concept of high-entropy alloys has caught significant attention of a tremendous number of materials scientists in the world and the research of high-entropy alloys has become one of the most active areas in materials science today.

‘High-entropy alloys’ are defined originally in a narrow sense as equiatomic solid-solution alloys formed with constituent elements more than five kinds. However, the subjects of research have recently been expanded to include concentrated alloys with chemical compositions in the vicinity of the center of multi-component phase diagrams, even they are deviated from the equiatomic compositions and contain precipitates of the secondary phase. These alloys are sometimes termed ‘MPE (multi-principle element) alloys’ or ‘CC (compositionally complex) alloys’. These alloys formed based on the above concept is in sharp contrast to traditional alloys that are based on one or two principal elements at the corner or edge of phase diagrams. Many of these high-entropy (MPE and CC) 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. For this purpose, Grant-in Aid for Scientific Research on Innovative Areas ‘High-Entropy Alloys: New Scientific Principle for Controlling Variety and Inhomogeneity of Elements’ has been launched in 2018 as a 5-year research project supported by MEXT (Ministry of Education, Culture, Sports, Science and Technology) of Japan.

This special issue is intended to provide some preliminary outcomes of the above-mentioned project. I sincerely and strongly hope that this special issue would make an opportunity to attract potential contributors to this research field and to ignite the activity of this research field, in particular in Japan.

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