frontiers | Frontiers in Materials

TYPE Editorial
PUBLISHED 21 February 2023
DOI 10.3389/fmats.2023.1162346

OPEN ACCESS

EDITED AND REVIEWED BY
Nicola Maria Pugno,
University of Trento, Italy

*CORRESPONDENCE
Praveen Sathiyamoorthi,
praveen.met@iitbhu.ac.in
Niraj Chawake,
nchawake@iitk.ac.in
Alireza Zargaran,
alireza@postech.ac.kr
Ravi Sankar Kottada,
ravi.sankar@iitm.ac.in

SPECIALTY SECTION
This article was submitted to Mechanics of Materials, a section of the journal Frontiers in Materials

RECEIVED 09 February 2023
ACCEPTED 14 February 2023
PUBLISHED 21 February 2023

CITATION
Sathiyamoorthi P, Chawake N, Zargaran A and Kottada RS (2023), Editorial: High entropy alloy design concept enabled emerging novel materials with enhanced mechanical properties.
Front. Mater. 10:1162346.
doi: 10.3389/fmats.2023.1162346

Editorial: High entropy alloy design concept enabled emerging novel materials with enhanced mechanical properties

Praveen Sathiyamoorthi[1]*, Niraj Chawake[2]*, Alireza Zargaran[3]* and Ravi Sankar Kottada[4]*

[1]Department of Metallurgical Engineering, Indian Institute of Technology (BHU) Varanasi, Varanasi, India, [2]Department of Materials Science and Engineering, Indian Institute of Technology Kanpur, Kanpur, India, [3]Graduate Institute of Ferrous & Energy Materials Technology, Pohang University of Science and Technology, Pohang, Republic of Korea, [4]Department of Metallurgical and Materials Engineering, Indian Institute of Technology Madras, Chennai, India

KEYWORDS

high entropy alloys (HEA), mechanical properties, CALPHAD, atomistic Simulations, corrosion, alloy design, multicomponent alloy

Editorial on the Research Topic
High entropy alloy design concept enabled emerging novel materials with enhanced mechanical properties

The search for new alloys with enhanced properties than existing ones is a never-ending demand in industries to keep up with the advancement in science and technology. For instance, alloys with a superior combination of high strength and toughness have the potential to decrease the critical structural component's thickness in the aerospace/automobile industries, thereby decreasing the component weight and increasing fuel efficiency. The current high-strength alloys in structural applications are mostly based on steel. The advent of a new alloy design concept based on multi-component has opened a flurry of research interest from all over the world. The alloys developed based on this concept are termed "high entropy alloys" and "medium entropy alloys" depending on their configurational entropy. Other terms such as "complex concentrated alloys" and "compositionally complex alloys" are also widely used to represent multi-component alloys. The first work on multi-component alloys is reported by two independent groups in 2004 (Yeh et al., 2004) and (Cantor et al., 2004). Yeh et al., proposed the term "high entropy alloys" as they hypothesized that the increase in configurational entropy due to a large number of elements taken in equiatomic proportion helped in achieving a simple structure. The term "high entropy alloy" has become debatable as many research groups demonstrated that entropy is not the sole factor in determining the structure. Later, to achieve superior properties, the research took a detour from fixating on single-phase equiatomic alloys to multi-phase alloys, and then to non-equiatomic alloys. Recently, ferrous medium entropy alloys, a subset of non-equi atomic alloys, have been gaining a lot of research interest due to their superior properties and being more economical than other equiatomic and non-equi atomic alloys. Pickering and Jones and Miracle and Senkov, in their critical assessment of high entropy alloys rightly pointed out that the multi-

component design concept holds great potential in the development of new alloys for structural components and the focus should be on achieving desired properties.

Since its first publication in 2004, the alloy design concept based on multi-component has been constantly evolving in search of better properties. The goal of this Research Topic is to explore research activities focused on the unique strategies in utilizing the multi-component design concept to develop novel alloys with superior mechanical properties. In this topic, six articles were published including two perspective articles, one mini-review article, and three original research articles.

Kumar et al., provided a perspective on the alloy design concepts enabling enhanced mechanical properties of high entropy alloys. In this perspective article, the authors reviewed the various multi-component alloy design strategies for achieving desired mechanical properties, discussed the mechanical properties of crystalline and amorphous multi-component alloys, and provided future prospects of this novel design approach in developing new alloys with enhanced properties. Nene provided a perspective on transformative high entropy alloys with an emphasis on design approach, unexpected strength-ductility synergy, damage tolerance, and its potential for metal additive manufacturing. Ehsan Ghassemali and Conway authored a brief review, highlighting the use of high-throughput computational screening methods combined with the calculation of phase diagrams technique to address the challenge of selecting compositions from the vast array of options available due to the multi-component alloy design concept.

Yoosefan et al., investigated the microstructure and corrosion properties of high entropy alloy coating synthesized by the electrochemical deposition method. They observed that the coating morphology varies with different coating potentials. They also demonstrated an improved corrosion resistance of the substrate and excellent performance of coating with an efficiency of over 80% in 3.5 wt% NaCl solution. Mohanty et al. investigated the effect of thermomechanical treatment on the microstructure and mechanical properties of carbon-containing high entropy alloy. They concluded that an unfavorable crystallographic texture could account for the limited strengthening after heat treatment of cold rolled samples. Esfandiarpour et al. studied the impact of lattice distortion and short-range order in a medium entropy alloy through atomic simulations. They investigated the depinning stress and discussed the effect of chemical short-range order on the magnitude of the depinning stress. Their findings show that increasing Ni and decreasing Co in VCoNi alloy leads to a higher depinning stress, making the alloy stronger. They also observed that annealing leads to a decrease in pinning stress, which they attribute to the decreasing bond fluctuations.

Author contributions

PS wrote the editorial, and NC, AZ, and RK revised the editorial. PS, NC, AZ, and RK served as editors for this Research Topic.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

References

Cantor, B., Chang, I. T. H., Knight, P., and Vincent, A. J. B. (2004). Microstructural development in equiatomic multicomponent alloys. *Mater. Sci. Eng.: A* 375, 213–218.

Yeh, J.-W., Chen, S.-K., Lin, S.-J., Gan, J.-Y., Chin, T.-S., Shun, T.-T., et al. (2004). Nanostructured high-entropy alloys with multiple principal elements: Novel alloy design concepts and outcomes. *Adv. Eng. Mater.* 6 (5), 299–303.