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EDITORIAL

Special Issue on Innovations Using High-Entropy Materials

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High entropy materials (HEMs) have been conceived in the last part of the twentieth century and realized at the beginning of the twenty-first century as a breakthrough in material design involving multiple components in equimolar or near equimolar ratio in alloy making. They are relatively new (20 years old) and therefore, research and development activities for industrial applications have recently been started and notably few practical applications have been achieved. Nonetheless, it needs to be vigorously followed to develop many novel chemistry and types as well as manufacturing routes to make them more useful, showcasing their distinct properties and applicability for various structural and functional applications. Ever since the discovery of HEMs in 2004, multitude of materials systems were developed using this concept comprising not only of metals, but also oxides, carbides, nitrides, composites and polymers. In this way of materials manufacturing, all the participating entities will have equal or near-equal compositional presence. This has been a major revolution in the last two decades as it drastically differs from the conventional way of materials development, which has been in practice for several thousands of years. These exciting materials have been developed using conventional melting and casting, powder processing methods on bulk scale, thin films, nanopowders as well as laboratory scale production (low volume) was carried out using solution-based chemistry methods. While these novel and varied classes of materials have been offering fascinating mechanical, magnetic, optical, catalytic, sensing properties, it is highly imperative to take the development to the next level towards finding practical applications. With any new material, the opportunities for innovation are extremely large, but any useful attempt for innovation is only possible by rational choice. A typical material development cycle starting from an idea to product takes about 25 years of sustained activity. Hence, next decade in the life of HEMs is the most crucial period, requiring new and sustainable innovation to keep the field moving.

In this regard, this special issue is aimed at bringing all the efforts in this direction. This collection will act as a nucleating point for cultivating and nurturing novel ideas in exploring further applications. Various academicians/scientists/industry personnel, working in this field, were invited by the editors to contribute to this special volume. All the submissions were subjected to rigorous peer review, as per the procedures laid down by the Transactions of the Indian National Academy of Engineering, and a final decision was taken. This special issue, in total, contains 16 accepted papers. This collection highlights the potential of various HEAs for future generation applications in different fields. Various state-of-the-art methods are discussed to manufacture these materials. Thermodynamic assessment on phase formation and phase stability was performed and comprehensively discussed. Combinatorial alloy design methods, considering thermodynamics, diffusion pathways and kinetics were explored and presented. Novel strategies for realizing single-phase HEAs are reported. Role of HEAs in effectively reducing sintering temperatures is discussed. Effect of alloying elements on phase formation and phase stability in eutectic high-entropy alloys (EHEAs) is also presented; furthermore, artificial neural networks were considered to predict the hot deformation behaviour of EHEAs. While understanding the scientific aspects of these fascinating class of materials, efforts on adapting these materials for functional applications such as in gas sensing and catalysis are discussed in detail. In addition, the potential of various HEAs for applications as bond coats in high-temperature structures and for cryogenic engineering applications are investigated. Considering the wide spectrum of applications presented in this special issue, HEAs hold a huge promise for future functional as well as structural engineering applications with enhanced performance. A close collaboration of professionals working in multi-physics-based theory at

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different length scales and time scales, experiments with deep domain knowledge will accelerate the “directed basic research leading to product development”.

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