

Feature Papers in Metal Matrix Composites

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Metal matrix composites (MMCs) are dynamic and fascinating materials as they can be designed to suit the end property requirements for any present and futuristic application. Accordingly, they constantly challenge materials engineers and will continue to do so as new applications with different requirements continue to emerge and at times enhancements in the properties of existing materials are required due to an increase in functionality of devices, such as in the electronics and transportation industries. MMCs, in the past, have assisted in performance enhancement through increasing the elastic modulus, strength, and wear and erosion resistance of components. This has assisted in reducing failures and increasing the lifetime of components and systems, leading to increased reliability and a reduced cost burden. Further efforts are continuously being undertaken to improve other properties of components, such as their physical, thermal, and electrical properties. With an awareness of the significance of the nanolength scale, particularly over the last two decades, in modifying properties differently, a simultaneous enhancement in strength and ductility, for example, has been established for a number of magnesium alloys. The nanolength scale still intrigues scientists and researchers and there is tremendous scope for harnessing the advantages of the nanolength scale of microstructural features.

Fundamentally, the variables that are important for enhancing performance of MMCs include (a) the judicious selection of the matrix and reinforcement, primarily to ensure their compatibility, (b) the choice and development of processing routes (both primary and secondary), and (c) the heat treatment, including cryogenic treatment.

In the present book, 10 interesting papers are compiled. They address the development of aluminium- [contributions 1–3], magnesium- [contributions 4 and 5], titanium- [contributions 6 and 7], copper- [contribution 8] and nickel [contribution 9]-based materials. Among these metals, aluminium and magnesium are lightweight materials that are targeted principally by the transportation sector to mitigate fuel consumption and carbon dioxide emissions. Titanium is also classified as a lightweight material, but due to its cost, it is primarily used in critical applications such as in defence applications and also as a permanent implant material in the biomedical sector. Copper-based materials are highly sought after in the electrical/electronics industry due to their superior electrical/thermal conductivity and natural resistance to corrosion. These materials have been further explored principally to enhance their thermal and electrical conductivities. Nickel-based materials are targeted primarily for high-temperature applications and are subject to interest from metallurgical engineers in relation to further increasing their high-temperature performance. It can thus be seen that from a materials perspective, the choice of matrix material is clear in the research endeavours covered in this book, indicating where the research in MMCs is heading.

Traditionally, MMCs are fabricated via liquid-based methods, which include all casting methods [contribution 1], and solid-based methods, which include all variations of powder metallurgy, including mechanical alloying [contribution 2]. Additive manufacturing, which is capable of creating complex shapes with a high resolution reaching the micron scale, is rapidly attracting interest and is covered in three of the papers in this book [contributions 7, 9 and 10]. Similarly, the friction stir processing technique, another promising technique, is



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rapidly emerging due to its ability to refine matrix microstructures and to realize a uniform distribution of reinforcement [contribution 3].

Heat treatment, including cryogenic treatment [contribution 4], has the ability, subjected to its proper design, to enhance microstructural characteristics and related properties of interest. In the present book, three papers [contributions 4, 8, and 9] demonstrate the ability of heat/cryogenic treatment to influence the properties of a matrix.

Among the properties of interest, the strength and ductility at both ambient and elevated temperatures [contributions 2–4, 8, and 9], the dry sliding response [contribution 1], and the coefficient of friction [contributions 1] are covered in this book. A total of five papers addresses the evolution of these properties under the influence of three important variables (materials selection, processing, and heat treatment) that decide the end performance of MMCs, as mentioned earlier.

Overall, the present book compiles an interesting combination of papers of current relevance and will be a wonderful resource for students and researchers (both academia and industry) from a broad spectrum of engineering backgrounds to enhance their knowledge and awareness related to metal matrix composites.

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