Progress in Composite Materials
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Editorial

Progress in Composite Materials

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1. Introduction

Composite materials are the most unique and versatile tools for many practical plications. Before humans, and not surprisingly, mother nature gets the first credit for creating composite materials to support its creations such as humans, plants, pearls and shells to name a few [1]. Humans started to develop and use composite materials from prehistoric times. Plywood was created in 3400 BCE by Mesopotamians while Egyptians made death masks using Cartonnage and layers of linen and papyrus soaked in plaster [2]. The development and use of composite materials have been expanding more rapidly in the last 100 years. Practically all the sectors including engineering, infrastructural and biomedical sectors use composite materials to enhance the performance and reliability of the components/systems and stretch the working limits in the context of, but not limited to, load bearing, temperature, sliding, fatigue and impact resistance [3,4].

Composite materials are made through a judicious combination of matrix and one or multiple reinforcements. The matrix can be a polymer, metal/alloy or ceramic. Composites are most broadly defined based on the type of matrix i.e., Polymer Matrix Composite, Metal Matrix Composite and Ceramic Matrix Composite. Besides them, there are other minor variations of composites such as Intermetallic Matrix Composites. The selection and integration of matrix and reinforcement are perhaps the most crucial factors for developing a high-performance composite and the former is dependent on the requirements of end application. The integration and distribution of the reinforcement in the matrix are keys to realizing the best properties from the unified combination. A bad interface (partial or full debonding) and non-uniform distribution can compromise the enhancement in properties. Excellent distribution and well-bonded matrix and reinforcement can be realized through an intelligent selection of primary and secondary processing techniques to fabricate composites. This selection depends primarily on the shape complexity and size of the end part/component. It should be further noted that, for the same type of matrix and reinforcement, the end properties of composites can vary significantly depending on the length scale, amount and morphology of the reinforcement. Most recently, it was established that the use of nanolength scale reinforcement can significantly vary and enhance the properties of specific polymers and metals/alloys in a very different way than micron-length scale reinforcements. Among the types of reinforcements, amorphous reinforcements [5] and hollow reinforcements [6] have opened new avenues for enhancing certain targeted properties that are not possible using conventional reinforcements. Further, the properties of composites can be optimized using controlled thermal and cryogenic treatments such as for Metal Matrix Composites.

To process composite materials, conventional and new techniques can be modified to allow for the incorporation and uniform distribution of reinforcement in matrix. Like conventional materials, composites are subjected to forming, joining and surface treatments (where applicable) such as for corrosion mitigation, reducing friction coefficient, and increasing wear resistance.

Given the fascinating potential and relevance of composite materials, the present journal is launched to provide a platform for researchers to share new findings, innovative ideas, and new applications for taking composite materials to new heights and most importantly, to improve the quality of life of the humans through robust, comfortable and long-lasting end products. The present journal is unique in that it brings together all types of composite materials under a common platform and encourages interdisciplinary learning between metals, polymers, and ceramic experts.

2. Aim and Scope

The primary aim of this journal is to increase awareness of the remarkable potential of composite materials and to enhance the level of composite science and technology so that its application spectrum can be expanded. The translation of research from lab to industry is perhaps the most challenging part and encompasses the simultaneous development of science and technology in the interrelated fields. For example, development of composites should also be accompanied by methods to scale up primary processing techniques, forming, joining and corrosion mitigation, to name a few. In view of the requirements of both research labs and industry, this journal aims to cover (but not limited to) the topics listed below along with their importance and relevance.

- New Composite Formulations: There are new developments in polymer, metal and ceramic-based materials. Further, new reinforcements have developed continuously over time. This provides additional opportunities to develop new composite materials. An interesting example is the development of multicomponent alloys that include high entropy alloys. They can be used both as matrix and as reinforcement.
- Synthesizing Techniques of Composites: These involve the conventional and new techniques based on liquid-state (casting, melt infiltration etc.), solid state (powder metallurgy, friction stir processing etc.) and two-phase methods (rheocasting, spray deposition etc.). The selection of processing technique(s) is crucial for fabricating an acceptable composite material.
- 3D printing of Composites: 3D printing technology has arrived and is already used to fabricate composite materials. 3D printing techniques are relatively new but can potentially create complex parts for many applications. They also complement the mass production techniques, and the journal will support the work related to them.
- Secondary Processing of Composites: Secondary processing methods such as extrusion, rolling, and forging are the most important among secondary processing techniques to give the final shape to the materials for subsequent use in applications. More targeted, new and innovative techniques will be similarly covered in this journal.
- Severe Plastic Deformation of Composites: Severe plastic deformation methods have emerged over the last 2 decades and their technology readiness level is slowly increasing. Their capability to refine the microstructure is captivating and holds promise to develop high-performance composites.
- Characterization of Composites: The capability of composites to perform well depends on their microstructure, thermal, physical, and mechanical properties. Accordingly, the journal will aim to support information and capabilities of new characterization methods and the advancement in the existing ones to better predict the characteristics of composites.
- Thermal Properties of Composites: Composites can be used at either ambient temperature or elevated temperatures, or both. Accordingly, thermal characteristics of the composites, including microstructural changes, ignition temperature, coefficient of thermal expansion and related properties will be in the scope of the journal.
- Mechanical Properties of Composites: Most of the components to be used in engineering and biomedical applications must conform to the minimal level of mechanical properties such as strength, elastic modulus and fatigue. Determination of such properties and the factors governing them is thus the most important and the related work will be covered in this journal.
- Tribological Properties of Composites: Many of the applications where composites are targeted include sliding conditions. Automotive sector, hydrothermal plants and oil and gas sector typically requires materials with high wear resistance. Composites are developed to enhance the life of components over the last 4 decades and there is further scope for enhancement. This journal will welcome new developments in this area.
- Modelling Aspects: Modelling is an important tool that has made rapid advancements to predict the mechanical behavior of materials. Besides, modelling can be used to understand solidification and correlate microstructure with mechanical properties to name a few. Any aspect and utilization of modelling tools to better understand microstructure and properties of composites will be encouraged and favored.
- Joining of Composites: Joining of composites is an important aspect to integrate them in an application. It presents challenges due to the presence of at least two distinct phases. New trends in solid and liquid state joining methods and their variations will be covered accordingly.
- Corrosion Response of Composites and Prevention Methods: All materials corrode. When in the application they need to be protected from corrosion, understanding corrosion mechanisms and mitigation of corrosion is a requirement for the material to be used in real-time applications.
- Machining of Composites: Both primary and secondary processing techniques can create either semi-finished or near-net shapes and that is where machining to the final shape becomes important. Machining of

composites can be tricky as in most cases, there is a soft phase and a hard phase. Thus, the development in machining alongside the development of composites is critical and all aspects of it will be covered.

- Failure Analysis of Composites: Materials fail and in different ways depending on the type of service conditions that include loading, temperature, impact, and corrosion, to name a few. All efforts are made to avoid failure of materials and composites are no exception. Understanding the failure mechanisms of composite materials is thus extremely important and we aim to cover failure investigations including mechanisms to assist in enhancing the reliability of composites in applications.
- Non-destructive Evaluation of Composites: To improve the robustness of the product and minimize the probability of failure, nondestructive methods are used and particularly for critical applications such as in aerospace sector. The journal will thus cover all aspects of non-destructive evaluation and the advancement in them to ensure the proper identification of defects that are a must for quality control.
- Engineering Application of Composites: Application of materials is always a dream of researchers as it reflects the validity of their research in practical outcome. The use of composites is currently not fully exploited given their potential. The journal will therefore welcome articles which are focused on applications of composites.
- Biomedical Applications of Composites: Composites are making inroads or being researched for cardiovascular applications, dentistry such as for dental prostheses, dental implants, restorative materials, cranial bone repair etc. and in orthopedic fixation devices [7]. New materials are evolving, and attempts are being made to widen the use of composites in bio-applications. Accordingly, bio applications of composites will be covered.

The aim and scope of the journal will be expanded with time to keep pace with developments in science and technology with time. All efforts will be made to publish papers through rigorous review in a short period of time. Both research and review papers will be equally favored by the journal.

3. Outlook

The outlook of composite materials is very positive as these materials can form a trillion-dollar market if properly researched and used in industry. Polymer-based composites are currently in fore forefront in applications and extensively used. A lot of research is conducted in metal matrix composites, and they have shown their capability clearly in sliding applications and where elastic modulus needs to be enhanced. Ceramic matrix composites have their market and need more research to widen their applications. Overall, progress in science and technology of composite materials provides an opportunity for researchers to create new science and to develop more unified combinations and for the industry to further expand and create brand names by promoting robust and reliable products. The journal therefore aims to publish high-quality papers from the authors which can be experiment-based, simulation-related, application oriented or of hybrid nature. Interdisciplinary work will be favored. Through these efforts, we intend to bring 'Progress in Composite Materials' as the best journal providing important insights and engineering (materials-related) solutions for conventional, complex, and emerging engineering applications.

Conflicts of Interest: The author declares no conflict of interest.

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