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Editorial

Editorial for the Special Issue on Multidisciplinary Composites

Swadesh Kumar Singh [1,2,*], Suresh Kumar Tummala [3], Satyanarayana Kosaraju [1] and Julfikar Haider [4,*]

[1] Gokaraju Rangaraju Institute of Engineering & Technology, Telangana 500090, India; satya.kosaraju@griet.ac.in
[2] Institute for Sustainable Industries & Livable Cities, Victoria University, P.O. Box 14428, Melbourne, VIC 8001, Australia
[3] Savan Green Energy Solutions Pvt. Ltd., Telangana 500051, India; suresh.t@savangreenenergy.com
[4] Department of Engineering, Manchester Metropolitan University, Manchester M12 5GN, UK
* Correspondence: swadeshsingh@griet.ac.in (S.K.S.); j.haider@mmu.ac.uk (J.H.)

The remarkable blend of features that advanced composites can provide, such as high stiffness, good strength-to-weight ratio, good corrosion resistance, design freedom, and product variety, has expanded their applicability. Continuously developing applications in the automotive, aerospace, electrical and electronic, building construction, and process industries have created a significant demand for material scientists, designers, and engineers with broad tasks in materials selection and the fabrication, design, and testing of composites. Even developing disciplines such as the biomedical field and sports rely heavily on composite materials to make technologically meaningful improvements.

This Special Issue consists of 10 research papers covering multidisciplinary composites, including an aluminum metal matrix, geopolymer, acrylic resin, and biobased polymer composites, in relation to their manufacturing, characterization, and functional property assessment.

Aljafery et al. [Contribution 1] evaluated the effects of adding an antimicrobial agent, Ag-Zn zeolite, on the surface roughness and hardness of denture base acrylic resins. The data analysis revealed that when 0.50 wt.% or 0.75 wt.% zeolite was added to the heat-cured acrylic resin specimens, the surface roughness decreased significantly compared to that of the control group. This reduction was not considerable for the cold-cured resin; however, the surface hardness was greatly improved after introducing 0.50 wt.% and 0.75 wt.% zeolite into both the resins.

Ikumapayi et al. [Contribution 2] investigated the effect of corrosion on various weight percentages of AgNp and $CaCO_3$ reinforcements in an aluminum metal matrix (AMC). They observed that an increase in the weight percentage of the reinforcement (AgNp + $CaCO_3$) reduced the AMC corrosion rate under corrosive conditions. The optimal composition was determined to be 4 wt.% for the hybrid reinforcement of AgNp + $CaCO_3$ and 6% for the $CaCO_3$ reinforcement in both the untreated and heat-treated samples.

Ononiwu et al. [Contribution 3] developed aluminum alloy (AA 6063)-based composites reinforced with eggshell and assessed the effect of the carbonization temperature on the physical, mechanical, wear, and corrosion properties of these composites. The distribution of eggshells improved with increasing carbonization temperature, and most of the properties increased at approximately 1200 °C; however, the corrosion and wear resistance were the lowest at this temperature. Therefore, an appropriate selection of processing temperature is important to tailor the properties for a specific application.

Langat et al. [Contribution 4] studied the effect of milling parameters on an unmodified Calotropis Procera fiber-reinforced PLA composite (UCPFRPC) and optimized the parameters of surface roughness, material removal rate (MRR), and temperature. Their results showed that to achieve the lowest surface roughness and average milling temperature, a rotational spindle speed of 400 rpm, a feed rate of 400 mm/min, and a depth of cut of 0.2 mm could be used. However, a larger MRR could be obtained by adjusting the

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parameters at a rotational speed of 400 rpm, a feed rate of 100 mm/min, and a depth of cut of 1.2 mm.

Ibitoye et al. [Contribution 5] examined the potential of corncob for green energy production. The raw corncob was collected, processed, and dried for seven days prior to the torrefaction experiment. Different torrefaction temperatures (200, 240, and 260 °C) and residence periods (20, 40, and 60 min) were investigated. The results showed that the torrefaction temperature and residence duration increased, which improved the thermal and combustion properties. The torrefied corncob had a greater heating value and energy density, ranging from 17.26 to 18.89 MJ/kg and 3.23 to 5.66 GJ/m^3, respectively. High torrefaction temperatures and residence times resulted in poor solid yields; nevertheless, the liquid and gas yields increased with the torrefaction temperature and residence time. The solid yields ranged from 27.57 to 52.23%, while the liquid and gas yields ranged from 31.56 to 44.78% and 16.21 to 27.65%, respectively.

Omoniyi et al. [Contribution 6] investigated the impact of the welding speed and laser power on the microhardness, microstructure, and tensile strength of Ti6Al4V alloy. The microhardness decreased toward the base metal from its maximum at the fusion zone, according to the results presented. The microstructure of the fusion zone exhibited a changed needle-shaped lamellar α phase, whereas the heat-affected zone displayed a martensitic α' phase. The impact of the welding speed and laser power on the microhardness, microstructure, and tensile strength of Ti6Al4V alloy was analyzed. The tensile test results also revealed that an improved tensile strength was obtained compared to that of the base metal.

Gupta et al. [Contribution 7] analyzed the mechanical and long-term performance of geopolymer composites based on granulated blast furnace slag (GGBS) at replacement proportions of 10%, 15%, 20%, 25%, and 30% of silica fume at 12 molarity of NaOH. The findings indicated that a high concentration of NaOH and silica fume in geopolymer composites (GPCs) was likely to increase the mechanical strength. The chloride ion penetration and water absorption values at 10% silica fume decreased to 23% and 26%, respectively. Strong correlations between compressive strength and tensile strength were detected via ultrasonic pulse velocity (UPV) tests and rapid chloride permeability tests (RCPs), with coefficients of determination of 0.9681, 0.9665, and 0.9208, respectively. There is little evidence of a relationship between the water absorption and compressive strength.

Bajpai et al. [Contribution 8] investigated Al nano TiCp composites (2.0, 4.0 and 6.0 wt.%) using a cold isostatic compaction (CIP) process in conjunction with a modified powder metallurgy (PM) procedure. The physical and mechanical properties of the Al metal matrix composites, including the density, porosity, microhardness, compressive strength, and indirect tensile strength, increased when nano TiCp particles were added, reaching up to 4% weight percentage.

Singh et al. [Contribution 9] focused on the current development of polymeric or organic membranes because they require less space for installation and have superior pore creation mechanisms, flexibility, and chemical and thermal durability. These authors highlighted the importance of continuing research and advancements in wastewater purification using nanocomposite membranes. As a result, this review offers a forum for increasing the awareness of recent findings and inspiring researchers to develop nanocomposite-based membranes for water purification.

Gupta et al. [Contribution 10] predicted the compressive strength and split tensile strength of geopolymer composites manufactured from waste fly ash and calcined clay using the random forest regression (RFR) approach. The RFR model based on supervised learning was successful in accurately predicting the compressive strength of geopolymer concrete at different temperatures ranging from room temperature to 100 °C. The efficacy of the model was assessed in terms of several performance metrics, such as the coefficient of determination (R^2), the mean squared error (MSE), the mean absolute error (MAE), and the root mean square error (RMSE). The model could be seen as an alternative feasible option to expensive destructive testing methods.

The editors would like to acknowledge the excellent contributions made by the authors to this Special Issue, as well as the dedicated reviewers for providing timely comments and feedback. We hope that this Special Issue showcases the cutting-edge research work being conducted on developing composite materials for solving real-life challenges and encourage further research in the abovementioned areas to create greater scientific impacts.

Conflicts of Interest: Author Suresh Kumar Tummala was employed by the company Savan Green Energy Solutions Pvt. Ltd. The remaining 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.

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