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Editorial

Characterization and Modelling of Composites, Volume III

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Abstract: The realm of composite materials continues to evolve, with researchers pushing the boundaries of understanding and application. This Special Issue published in the *Journal of Composites Science* encapsulates the essence of these advancements, presenting a curated collection of research articles that highlight the latest developments in the characterization and modelling of composites. The diversity of the covered topics ranges from a foundational understanding of composite behaviours to the application of cutting-edge modelling techniques. Each contribution offers a fresh perspective, expanding our knowledge of composites and setting the stage for future explorations in this dynamic domain.

Keywords: fiber-reinforced composites; three-dimensional composites; nanocomposites; natural fibre and biocomposites; hybrid composites; composite structures; modelling and characterization

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1. Introduction

The field of composite materials has undergone significant advancements over the years, with research continuously pushing the boundaries of knowledge and application. In this continuum, the first two volumes of "Characterization and Modelling of Composites" have served as pivotal references [1–4], offering comprehensive insights into the multifaceted world of composites. These volumes have delved deep into the intricacies of composite characterization, exploring the myriad of techniques employed to understand their behaviour, and the sophisticated modelling approaches used to predict their performance in various scenarios.

The exploration of composite materials has been advancing rapidly, with a notable emphasis on sustainability and environmental stewardship in material design and application. A growing body of research underscores the shift towards eco-friendly composites. This includes the utilization of natural fibers, bio-based resins, and recyclable materials, which are pivotal in reducing environmental impacts and fostering innovative material applications [5–8].

Nanotechnology's role in enhancing composite materials is another area of significant progress. The integration of nanomaterials like graphene, graphynes carbon nanotubes, and nano-cellulose [9–12] has revolutionized the properties of composites, leading to improvements in strength, thermal stability, and electrical conductivity [13–16]. This burgeoning field of research, detailed in numerous studies, delves into the synthesis, characterization, and application of nanomaterials, paving the way for smart composites with advanced functionalities such as self-healing, shape memory, and adaptive stress response [17–20].

The advancement in computational modeling techniques for composites is also noteworthy. The adoption of finite element analysis (FEA), multiscale modeling, and machine learning algorithms has enhanced the prediction accuracy of composite material behavior under diverse conditions [21–24]. These tools are crucial in optimizing composites for high-performance applications in sectors like aerospace, automotive, and renewable energy, as extensively discussed in recent literature [25–27].

Hybrid composites, which combine various materials to achieve specific properties, represent a significant leap in composite research. These composites merge different fibers, matrices, and nano-fillers to tailor properties for targeted applications [28–30]. The research on hybrid composites, spanning multiple studies, includes insights into their design, fabrication, and application across different industries, highlighting their role in fulfilling the complex demands of modern engineering applications [31–34].

Now, as we present the third volume in this esteemed series, "Characterization and Modelling of Composites, Volume III", we aim to build upon the foundation laid by its predecessors. This volume not only encapsulates the latest advancements in the field but also addresses the emerging challenges and opportunities. The contributions herein represent a confluence of cutting-edge research, innovative methodologies, and a vision for the future of composites. From novel characterization techniques to advanced modelling algorithms, this volume promises to be a treasure trove of knowledge for researchers, academicians, and industry professionals alike.

As the world of composites continues to evolve, it becomes imperative to stay abreast of the latest developments and breakthroughs. This volume, like the ones before it, serves as a beacon, guiding readers through the intricate maze of composite research and illuminating the path forward. We invite you to delve into its pages, explore its wealth of information, and join us in the ongoing journey of discovery in the realm of composites.

2. An Overview of Published Articles

One of the standout contributions in this issue employs finite element analysis to investigate the influence of adhesive Z-connections on the thickness swelling behaviour of laminated wood composites under water exposure (contribution 1). The study emphasizes the role of the area density, diameter, and spatial distribution of these adhesive Z-connections in controlling the thickness swelling. The research provides insights into designing adhesive Z-connections and understanding the impact of wood properties on laminated wood composite behaviour. Also, it is postulated that the area density, diameter, and spatial distribution of these adhesive Z-connections play a pivotal role in determining the Z-connections' efficacy in controlling the thickness swelling of the composites. The results underscored a positive correlation between the number of adhesive Z-connections in the composites and the restriction of thickness swelling post 72 h of simulated moisture diffusion.

Another intriguing study in this collection delves into the mechanical properties of hybrid composites reinforced with natural fibres and glass fibres (contribution 2). The research explores the synergistic effects of combining natural fibres with synthetic ones, aiming to enhance the mechanical performance of the resulting composite. Through a series of meticulous experiments, the authors shed light on the potential of these hybrid composites in various applications, emphasizing the importance of fibre orientation and layering.

In the realm of turbofan engine simulations, especially when modelling foreign object impacts, it is imperative to accurately represent fan blade interactions with surrounding engine components, including the abradable lining. Cherniaev's study in contribution 3 delves into three distinct numerical techniques: the finite element method (FEM), smoothed particle hydrodynamics (SPH), and the adaptive (hybrid) FEM/SPH approach (ADT). These methods were assessed in the context of their suitability for modelling the blade–abradable rub strip (ARS) interaction. Using a commercial simulation platform, the study compared the techniques based on various parameters such as computational cost, robustness, and sensitivity to mesh density. The findings ranked the SPH method as the most applicable, followed by FEM, with ADT being the least suitable for this specific application.

The integration of continuous carbon fibre reinforcement in 3D-printed structures offers a promising avenue for enhancing the mechanical properties of printed parts. Morales and Gómez contribution 4 delve into this topic by investigating the mechanical behaviour of 3D-printed polylactic acid (PLA) reinforced with continuous carbon fibres. Their study encompasses both experimental characterization and computational modelling, providing insights into the influence of fibre orientation and volume fraction on the composite's mechanical response. The research reveals a significant enhancement in tensile and flexural properties with the inclusion of carbon fibres, especially when aligned in the direction of the applied load. The findings presented in this paper highlight the potential of continuous fibre reinforcement in elevating the performance of 3D-printed composites.

Nguyen and Vu (contribution 5) present a thermal model to estimate the temperature distribution within the hemispherical packaging volume of a white LED at a steady state. The study highlights the inherent heat sources that emerge in the white LED when its power is measured. The authors introduce a simplified 3D to 2D space process to enhance the model, aiming to solve the heat diffusion equation in a more efficient manner. Utilizing the finite element method, the temperature distribution is identified for varying injection current values. The results emphasize the importance of phosphor placement away from the LED die and the need for improved thermal conductivity in the silicone–phosphor region. The study provides valuable insights into white light packaging technology, suggesting measures to ensure optimal performance and the longevity of white LEDs.

Adesina et al. (contribution 6)delve into the potential of using response surface analysis for the experimental design, modelling, and optimization of the strength performance of an aluminium-7075 green composite. The research employs the Box–Behnken method for the design of the experiment, focusing on variables such as rice husk ash (RHA), glass powder (GP), and stirring temperature. The study reveals significant contributions of these input factors to the composite's performance. The optimization results suggest an optimal combination of 7.2% RHA, 6.2% GP, and a stirring temperature of 695 °C. The models derived from the study were validated and found to be adequate for response predictions with a 95% confidence level. The research emphasizes the importance of statistical analysis in optimizing the performance of hybrid composites.

In the study of Zhang et al. (contribution 7), the primary focus is on the noise generated by compressors in refrigeration systems. These compressors are typically enveloped with multi-layer sound insulation materials to mitigate noise. The research delves into the sound insulation properties of different thicknesses of polyvinyl chloride and non-woven fibres. By combining these materials, the authors investigate the sound insulation characteristics of a two-layer composite structure. A sound insulation prediction model is established using a multi-parameter nonlinear regression method. Furthermore, an optimal cost mathematical model is introduced, which can swiftly determine the best cost scheme for various designs with identical effects. The study emphasizes the importance of mathematical methods in establishing intricate multi-dimensional variable relationships in data space, revealing deeper mechanisms that are challenging to discern through traditional research methods.

Mitkus et al. (contribution 8)delve into the realm of lead-free piezoelectric materials. Recognizing the health implications of lead-based materials, the study explores alternative material combinations to enhance the performance of lead-free variants. The research focuses on the development of thin and flexible piezoelectric 0-0-3 composites by infusing UV light curable photopolymer resin with 30 vol.% lead-free piezoelectric ceramics and up to 0.4 wt.% conductive nanofillers. The study employed two particle sizes of Potassium Sodium Niobate (KNN) and Barium Titanate (BTO) ceramics combined with four types of conductive nanofillers: Graphene Nanoplatelets (GNPs), Multi-Walled Carbon Nanotubes (MWCNTs), and two variations of Graphene Oxide (GO). The resultant high-viscosity suspensions were tape-cast into thin layers and exposed to UV light, forming piezoelectric composite sensors within 80 s. The research revealed that even minimal nanofiller concentrations could amplify relative permittivity, though they might also reduce curing depth and increase dielectric losses. The study meticulously mixed and characterized 36 different compositions, with only 6 selected material compositions undergoing further examination for their mechanical, dielectric, and piezoelectric properties. The findings indicated that the performance of the KNN composite as piezoelectric sensors was nearly six times superior to that of the BTO composite.

Lang et al. (contribution 9) present the potential of recycling carbon fibres (rCF) for reuse, aiming to enhance the sustainability of Carbon Fibre-Reinforced Polymer (CFRP). The study acknowledges the challenges posed by the microgeometry of the fibres in recycled carbon fibre plastics (rCFRP), which previously limited their application in load-bearing components. By producing hybrid yarns from rCF and PA6 fibres, the researchers managed to align the fibres, thereby influencing the mechanical properties of the composite. The paper presents a method for modelling and simulating these hybrid yarns, incorporating the geometric properties of both the yarn and the individual fibres. The model, validated both geometrically and through tensile tests of manufactured composites, offers insights into the influence of fibre and yarn geometry on the composite's properties. The research fills a gap in the literature, providing a method for modelling long fibre-reinforced composites with complex fibre paths, especially in yarns, and offers a promising avenue for the development of sustainable composite materials.

Nazerian (contribution 10) delves into the modelling of the bending strength of Glulam (glue-laminated timber). They employed multiple linear regression (MLR), an adaptive network-based fuzzy inference system–ant colony optimization algorithm hybrid (ANFIS-ACO), and an artificial neural network–multilayer perceptron (ANN-MLP) for this purpose. The study focused on Glulam manufactured with a plane tree (*Platanus orientalis* L.) wood layer adhered with varying weight ratios of modified starch/urea formaldehyde adhesive. This adhesive incorporated different levels of nano-ZnO and was used under varying press temperatures and times. The research revealed that the ANN-MLP model exhibited the highest accuracy in predicting the response. Furthermore, the Genetic Algorithm (GA) was combined with the most accurate model to optimize the production process, aiming to achieve the highest modulus of rupture (MOR).

Witzgall (contribution 11) describes the significance of using accurate material data for precise simulation results, especially in crash simulations. The research focuses on the material PBT GF30, a polybutylene terephthalate reinforced with 30% glass fibres. The authors investigate the impact of fatigue damage induced by cyclic loading on the material's residual strength. They emphasize that to reflect real-world conditions, where vehicles of various ages are on the road, it is crucial to consider the effects of service loads on crashworthiness. The paper introduces a modified failure criterion that accounts for prior fatigue damage, and the simulation model's predictive quality is validated against experimental findings. The research underscores the importance of considering mechanical stress history concerning material failure to ensure efficient component dimensioning in line with stresses.

Henedy et al. (contribution 12) delve into the critical aspect of torsional strength in reinforced concrete (RC) members. Recognizing the complexity of the stress state associated with torsion and its low ductility, the study thus emphasizes the need for reliable prediction methods, especially for over-reinforced and high-strength RC beams. The research introduces a novel set of models using advanced M5P tree and nonlinear regression techniques, drawing from a comprehensive database of 202 experimental tests. These models consider three independent variables related to the properties of the RC beams. The study reveals that the M5P tree approach outperforms multiple nonlinear regression methods in terms of accuracy and safety. Furthermore, the M5P model predictions are found to be more accurate and safer than prevalent design equations. The paper underscores the potential of machine learning in advancing the field of structural, civil engineering and offers insights into the torsional strength of RC beams with varied design attributes and geometries.

The work of Fujii et al. (contribution 13) presents problems involving a particle surrounded by an interfacial phase embedded in an infinite body. These problems were tackled using both the double-inclusion model and finite element analysis to verify the model's accuracy. The results indicated that while the macroscopic average stress of the double inclusion could be accurately determined using the model, the microscopic stress of each phase was not as precise. The study then applies this micromechanical approach to particulate-dispersed composites made of zirconia and titanium, fabricated using spark plasma sintering. These composites had Ti oxides created along the interface between zirconia and titanium. The results showed that the elastic–plastic stress–strain curves of the composites could be predicted using this approach. The technique offers insights into the mechanical properties of composites with various shapes of reinforcement surrounded by different materials in a matrix. The paper concludes that this approach holds promise for the development of composites with superior mechanical performance.

Amena et al. (contribution 14) describe the potential of waste biomass-based natural fibres, specifically spent coffee husk (CH), as a composite material combined with high-density polyethylene (HDPE). The study focuses on the utilization of waste biomass and the recycling of plastic waste in an innovative manner. The researchers employed a chemical modification process on the coffee husk and combined it with varying ratios of HDPE to produce the composite material. The mechanical stability of the resulting products was then comprehensively characterized. The injection molding method was utilized for the development of the composite, which incorporated HDPE with untreated and NaOH-treated CH in different weight ratios. The study revealed that the inclusion of 25 wt.% fibre combined with 65 wt.% HDPE and additional filler materials significantly enhanced the tensile and bending properties of the composite. The composite showcased impressive tensile, flexural, and impact strengths. Furthermore, the microstructural analysis using scanning electron microscopy (SEM) highlighted the excellent adhesion and compatibility between the fibres and the matrix. The findings suggest that the HDPE polymer combined with a treated CH composite exhibits remarkable stability, making it a promising candidate for applications in construction, food packaging, and various other industries.

The study by Schuster et al. (contribution 15) delves into the impact of waviness defects in Carbon Fibre-Reinforced Polymer (CFRP) materials, specifically focusing on fibre undulation. Such defects can compromise the structural integrity of composite structures. The paper introduces a probabilistic numerical approach to better estimate material properties influenced by spatially distributed fibre waviness. This approach employs a homogenization method to deduce knock-down factors for various plies at the laminate level, using a representative tension load case for demonstration. The research underscores the significant influence of randomly distributed waviness defects on the derived knock-down factors. Through a topological analysis of the waviness fields, it was observed that the reduction in material properties was weakly negatively correlated with simple geometrical properties, such as the maximum amplitudes of the waviness field. This finding underscores the necessity for further sensitivity studies to better understand these correlations.

In the work by Keshta et al. (contribution 16), the potential benefits of using magnetized water (MW) in the production of volcanic concrete are presented. Volcanic concrete, recognized for its eco-friendliness, incorporates both coarse and fine aggregates derived from igneous volcanic rock. The study highlights the challenges posed when using volcanic ash (VA) as a substitute for concrete cement, particularly its impact on workability and strength. The research's primary objective is to assess the influence of MW, prepared in a 1.4 Tesla magnetic field, on the workability and hardened properties of volcanic concrete. The study experimented with varying percentages of VA as a partial replacement for volcanic concrete cement. The results revealed that the optimal VA ratio for volcanic concrete was 5%, both with and without the use of magnetized water. The study also showed that while the use of tap water reduced the slump of volcanic concrete, the incorporation of MW improved it by up to 8%. Furthermore, the compressive strength of the concrete was notably enhanced with the introduction of MW, especially in mixtures without VA or with 5% VA. The findings suggest that magnetized water can play a pivotal role in enhancing the properties of volcanic concrete, making it a viable and eco-friendly alternative for construction.

May et al. (contribution 17) delve into the wedge-loaded asymmetric double cantilever beam (WADCB) test. This experimental method is utilized to determine the mixed-mode

I/II fracture toughness of composite materials by inserting a wedge into the specimen along a potential delamination path. The current closed-form solution for the ADCB test assumes identical forces acting in both specimen arms. However, this paper introduces a more refined closed-form solution that allows for different forces acting on both specimen arms, providing a more general and rigorous approach. The research involved conducting WADCB tests on composites made from Torayca T700SC/2592 unidirectional prepreg. The results, analyzed using both the current and the refined closed-form solution, revealed differences in predictions, suggesting that the forces in the two specimen arms are not identical.

In the realm of composite materials, understanding the behaviour under low-velocity impact is crucial. Grasso and Xu (contribution 18) present this topic with a focus on woven composites. The study emphasizes the Delamination Threshold Load (DTL), a pivotal parameter that signifies the damage resistance of a laminate. While the identification of this threshold is relatively straightforward in unidirectional laminates, its determination in woven composites presents challenges. The research collected experimental data using woven glass and carbon fibre composites, analyzing the results in terms of force–time and force–displacement curves. Despite the clear observation of delamination and other types of damage through ultrasonic scans, the analysis did not reveal any discernible trend changes in the curves that could be linked to the onset of delamination. The paper further discusses the mechanisms through which delamination propagates in woven composites and raises questions about the existence of DTL for woven composites under low-velocity impact.

In the study by Palmieri et al. (contribution 19), the significance of high-thermal conductive materials for enhancing battery performance is presented. Thermal runaway, a major concern for battery safety, necessitates innovative solutions for thermal management. The research introduces a hierarchical nanomaterial composed of graphite nanoplatelets as an interfacial material. These nanoplatelet films, possessing high thermal conductivity, are believed to bolster heat dissipation. The study employs a numerical model that uses the finite element method to predict heat generation during a battery pack's operational cycle. The findings underscore the importance of an interleaved layer in shielding adjacent cells from heat, thereby preventing uncontrolled temperature escalation across the battery pack. The incorporation of graphite nanocomposite sheets could potentially equalize temperature distribution and delay thermal runaway propagation.

Quoc et al. (contribution 20) describe the intricate structural characteristics of amorphous nanoparticles of nickel. Utilizing molecular dynamics simulation, the researchers provide insights into the structural nuances of these nanoparticles. The study contributes to the broader understanding of the behaviour and properties of amorphous materials at the nanoscale, particularly those of nickel. The findings have potential implications for various applications in materials science and nanotechnology.

Assad et al. (contribution 21) examine the flexural behaviour of high-strength thin slabs that have been externally strengthened using fibre-reinforced polymer (FRP) laminates. This is achieved through a comprehensive numerical simulation. The study employs a three-dimensional finite element model to simulate the response of these reinforced concrete slabs when subjected to a four-point bending test. The results from the numerical model, particularly in terms of load-deflection behaviour and ultimate loads, are validated using experimental data from the existing literature. The findings from the numerical model align well with the experimental results. The finite element model is further utilized in a parametric study to explore the impact of concrete compressive strength on the performance of RC thin slabs that have been strengthened with various types of FRP, including Carbon Fibre-Reinforced Polymers (CFRPs), polyethylene terephthalate fibre-reinforced polymers (PET-FRP), basalt fibre-reinforced polymers (BFRP), and glass fibre-reinforced polymers (GFRP). Among the key findings, the slab strengthened with CFRP sheets exhibited the highest strength enhancement. The study concludes that the developed finite element model can serve as a reliable tool for predicting the behaviour of reinforced concrete slabs when strengthened with different types of FRP composites.

John et al. (contribution 22) present the structural performance of a newly developed two-way profiled steel decking system intended for steel–concrete composite slabs. Traditional studies have primarily focused on the one-way floor system using conventional steel decking. This innovative deck, however, incorporates top-hat sections created by bending corrugated sheets at 90° angles, which are then affixed to a corrugated base sheet. This unique design aims to enhance both the composite and two-way action due to its distinct geometry, which features corrugations in both transverse and longitudinal directions. The paper presents the experimental results of this novel steel decking geometry under construction stage loading without the presence of concrete. This was performed to determine the deck's potential for construction and its contribution to load capacity and performance when used as a two-way composite slab. The study identified ultimate load, two-way action, and failure modes. Additionally, a finite element model was developed to evaluate parameters that might influence performance when the deck is used in the composite stage. The findings suggest that the thickness of the corrugated base sheet plays a significant role in the load-carrying capacity, while the thickness of the top-hats does not have a substantial impact. The deck's design also showed improved load transfer with two-way behaviour, especially when the bottom flanges of the top-hats are continuously connected.

Ohaeri and Cree (contribution 23) delve into the potential of environmentally friendly polymeric composites made from agricultural residues. The study investigates the incorporation of lignocellulosic corncob powder as a filler in a biopolymer matrix composed of polyhydroxybutyrate (PHB) and polylactic acid (PLA). The matrix blend consists of 55% PHB and 45% PLA, with filler loadings varying from 0 wt.% to 8 wt.%. These components are combined and directly extruded to produce fused filaments suitable for three-dimensional (3D) printing. The research reveals that as the filler loading increased, there was a decline in the tensile strength, flexural strength, and Charpy impact toughness of the composites. However, the tensile and flexural modulus of the samples showed noticeable improvement with increased filler content. The study provides valuable insights into the morphological characteristics of the composites and their potential applications in sustainable 3D-printing processes.

Kazemian and Cherniaev (contribution 24) describe the increasing industrial application of Non-crimp fabrics (NCFs) for the manufacturing of composite structures. This is attributed to their high mechanical properties coupled with exceptional manufacturability. The study emphasizes the potential in-service damage that can significantly reduce the load-carrying capacity of NCF-reinforced plastics. Through a combination of experimental and numerical methodologies, two constitutive material models, previously applied only for damage prediction in unidirectional (UD) tape and woven fabric-reinforced materials, were assessed for their ability to simulate transverse crushing of composites made from a Non-crimp carbon fabric. The research involved subjecting UD NCF components of tubular shape to transverse crushing and comparing the experimental results with numerical modelling. The evaluation metrics encompassed observed and predicted patterns of interlaminar damage, the extent of delamination, and the models' capability to replicate the force–displacement response demonstrated by the tested specimens.

Hu and Wei (contribution 25) present the characterization of biochar, a carbon-rich solid produced during the thermochemical processes of various biomass feedstocks. Recognized for its cost-effectiveness and environmental benefits, biochar has the potential to replace more expensive synthetic carbon materials in numerous applications, including nanocomposites, energy storage, sensors, and biosensors. The paper emphasizes that the properties of biochar can vary significantly based on factors such as biomass feedstock species, reactor types, and operating conditions. Traditional experimental approaches to studying these variations can be time-consuming and costly. As an alternative, the authors advocate for molecular dynamic (MD) simulations, particularly the advanced reactive force field (ReaxFF)-based MD method, as a powerful tool for characterizing materials. This method is especially effective for simulating the biomass pyrolysis process, which involves bond-order chemical reactions. The paper reviews the fundamentals of the ReaxFF method and prior research on the characterization of biochar's physicochemical properties. The authors also discuss the potential applications of ReaxFF MD and its effectiveness in understanding the mechanisms of chemical reactions and predicting the structure, functionality, and physicochemical properties of the products.

3. Conclusions

As we culminate this Special Issue, "Characterization and Modelling of Composites, Volume III", it is evident that the realm of composite materials remains as dynamic and promising as ever. The contributions in this volume have not only showcased the depth and breadth of current research but have also highlighted the innovative spirit that drives this field forward. From groundbreaking characterization techniques to sophisticated modelling approaches, the advancements presented herein underscore the potential of composites in addressing contemporary challenges across various sectors.

Reflecting on the insights from the two preceding volumes, this third installment has successfully built upon their legacy, offering fresh perspectives and setting new benchmarks. The collaborative efforts of researchers, academicians, and professionals from around the globe, as seen in this volume, reiterate the significance of a multidisciplinary approach in pushing the frontiers of knowledge.

As we look to the future, we are excited to announce the upcoming "Characterization and Modelling of Composites, Volume IV". We cordially invite researchers and experts in the field to contribute their pioneering work, ensuring that the next volume continues the tradition of excellence and innovation. Your insights, findings, and expertise will be instrumental in shaping the next chapter of this evolving narrative.

Conflicts of Interest: The authors declare no conflict of interest.

List of Contributions:

1. Mazloomi, M.S.; He, W.; Evans, P.D. Finite Element Modelling of the Effect of Adhesive Z-Connections on the Swelling of a Laminated Wood Composite. *J. Compos. Sci.* **2023**, *7*, 442.
2. Street, G.E.; Johnson, M.S. The Intra-Ply Shear Behaviour of Non-Isothermal Thermoplastic Composite Laminates. *J. Compos. Sci.* **2023**, *7*, 432.
3. Cherniaev, A. A Comparison of Three Simulation Techniques for Modeling the Fan Blade–Composite Abradable Rub Strip Interaction in Turbofan Engines. *J. Compos. Sci.* **2023**, *7*, 389.
4. Derakhshani Dastjerdi, M.; Carboni, M.; Hojjati, M. Mechanical Properties of Uncured Thermoset Tow Prepreg: Experiment and Finite Element Analysis. *J. Compos. Sci.* **2023**, *7*, 312.
5. Nguyen, Q.-K.; Vu, T.-H.-T. An Efficient Method for Simulating the Temperature Distribution in Regions Containing YAG:Ce^{3+} Luminescence Composites of White LED. *J. Compos. Sci.* **2023**, *7*, 301.
6. Adesina, O.S.; Akinwande, A.A.; Balogun, O.A.; Adediran, A.A.; Sanyaolu, O.O.; Romanovski, V. Statistical Analysis and Optimization of the Experimental Results on Performance of Green Aluminum-7075 Hybrid Composites. *J. Compos. Sci.* **2023**, *7*, 115.
7. Zhang, L.; Zhang, H.; Chen, Q.; Long, D. A Mathematical Approach for Sound Insulation Characteristics and Cost Optimization of Double-Layer Composite Structures. *J. Compos. Sci.* **2023**, *7*, 110.
8. Mitkus, R.; Piechowiak, L.; Sinapius, M. Characterization of UV Light Curable Piezoelectric 0-0-3 Composites Filled with Lead-Free Ceramics and Conductive Nanoparticles. *J. Compos. Sci.* **2023**, *7*, 89.
9. Lang, T.G.; Hasan, M.M.B.; Abdkader, A.; Cherif, C.; Gereke, T. Micro-Scale Model of rCF/PA6 Spun Yarn Composite. *J. Compos. Sci.* **2023**, *7*, 66.
10. Nazerian, M.; Akbarzadeh, M.; Papadopoulos, A.N. Comparative Analysis of ANN-MLP, ANFIS-ACO_R and MLR Modeling Approaches for Estimation of Bending Strength of Glulam. *J. Compos. Sci.* **2023**, *7*, 57.
11. Witzgall, C.; Steck, P.; Wartzack, S. On the Influence of Fatigue Damage in Short-Fibre Reinforced Thermoplastic PBT GF30 on Its Residual Strength under High Strain Rates: An Approach towards Simulative Prediction. *J. Compos. Sci.* **2023**, *7*, 23.
12. Henedy, S.N.; Naser, A.H.; Imran, H.; Bernardo, L.F.A.; Teixeira, M.M.; Al-Khafaji, Z. Development of Prediction Models for the Torsion Capacity of Reinforced Concrete Beams Using M5P and Nonlinear Regression Models. *J. Compos. Sci.* **2022**, *6*, 366.
13. Fujii, T.; Tohgo, K.; Omi, T.; Shimamura, Y. Micromechanical Approach to Predict Mechanical Properties of Particulate-Dispersed Composites with Dissimilar Interfacial Phases. *J. Compos. Sci.* **2022**, *6*, 356.
14. Amena, B.T.; Altenbach, H.; Tibba, G.S.; Hossain, N. Investigation of Mechanical Properties of Coffee Husk-HDPE-ABS Polymer Composite Using Injection-Molding Method. *J. Compos. Sci.* **2022**, *6*, 354.

15. Schuster, A.; Degenhardt, R.; Willberg, C.; Wille, T. Influence of Spatially Distributed Out-of-Plane CFRP Fiber Waviness on the Estimation of Knock-Down Factors Based on Stochastic Numerical Analysis. *J. Compos. Sci.* **2022**, *6*, 353.
16. Keshta, M.M.; Elshikh, M.M.Y.; Abd Elrahman, M.; Youssf, O. Utilizing of Magnetized Water in Enhancing of Volcanic Concrete Characteristics. *J. Compos. Sci.* **2022**, *6*, 320.
17. May, M.; Hahn, P.; Manam, B.U.; Imbert, M. Mixed-Mode I/II Testing of Composite Materials—A Refined Data Reduction Scheme for the Wedge-Loaded Asymmetric Double Cantilever Beam Test. *J. Compos. Sci.* **2022**, *6*, 319.
18. Grasso, M.; Xu, Y. Threshold Identification and Damage Characterization of Woven GF/CF Composites under Low-Velocity Impact. *J. Compos. Sci.* **2022**, *6*, 305.
19. Palmieri, B.; Cilento, F.; Siviello, C.; Bertocchi, F.; Giordano, M.; Martone, A. Mitigation of Heat Propagation in a Battery Pack by Interstitial Graphite Nanoplatelet Layer: Coupled Electrochemical-Heat Transfer Model. *J. Compos. Sci.* **2022**, *6*, 296.
20. Tran Quoc, T.; Nguyen Trong, D.; Cao Long, V.; Saraç, U.; Ţălu, Ş. A Study on the Structural Features of Amorphous Nanoparticles of Ni by Molecular Dynamics Simulation. *J. Compos. Sci.* **2022**, *6*, 278.
21. Assad, M.; Hawileh, R.; Abdalla, J. Finite Element Simulation of FRP-Strengthened Thin RC Slabs. *J. Compos. Sci.* **2022**, *6*, 263.
22. John, K.; Ashraf, M.; Weiss, M.; Al-Ameri, R. Experimental and Finite Element Study of a Novel Two-Way Corrugated Steel Deck System for Composite Slabs. *J. Compos. Sci.* **2022**, *6*, 261.
23. Ohaeri, O.; Cree, D. Development and Characterization of PHB-PLA/Corncob Composite for Fused Filament Fabrication. *J. Compos. Sci.* **2022**, *6*, 249.
24. Kazemian, M.; Cherniaev, A. Prediction of Damage in Non-Crimp Fabric Composites Subjected to Transverse Crushing: A Comparison of Two Constitutive Models. *J. Compos. Sci.* **2022**, *6*, 224.
25. Hu, Z.; Wei, L. Review on Characterization of Biochar Derived from Biomass Pyrolysis via Reactive Molecular Dynamics Simulations. *J. Compos. Sci.* **2023**, *7*, 354.

References

1. Georgantzinos, S.K. Editorial for the Special Issue on Characterization and Modelling of Composites. *J. Compos. Sci.* **2021**, *5*, 47. [CrossRef]
2. Georgantzinos, S.K. Editorial for the Special Issue on Characterization and Modelling of Composites, Volume II. *J. Compos. Sci.* **2022**, *6*, 274. [CrossRef]
3. Georgantzinos, S.K. *Characterization and Modelling of Composites*, 1st ed.; MDPI: Basel, Switzerland, 2022.
4. Georgantzinos, S.K. *Characterization and Modelling of Composites, Volume II*, 1st ed.; MDPI: Basel, Switzerland, 2022.
5. Mohamed, G.R.; Mahmoud, R.K.; Shaban, M.; Fahim, I.S.; Abd El-Salam, H.M.; Mahmoud, H.M. Towards a circular economy: Valorization of banana peels by developing bio-composites thermal insulators. *Sci. Rep.* **2023**, *13*, 12756. [CrossRef]
6. Ari, A.; Karahan, M.; Ahmed, H.A.M.; Babiker, O.; Dehşet, R.M.A. A Review of Cellulosic Natural Fibers' Properties and Their Suitability as Reinforcing Materials for Composite Panels and Applications. *AATCC J. Res.* **2023**, *10*, 163–183. [CrossRef]
7. Boursier Niutta, C.; Ciardiello, R.; Tridello, A.; Paolino, D.S. Epoxy and Bio-Based Epoxy Carbon Fiber Twill Composites: Comparison of the Quasi-Static Properties. *Materials* **2023**, *16*, 1601. [CrossRef] [PubMed]
8. Jalalah, M.; Zulfiqar, S.; Afzal, A.; Khaliq, Z.; Qadir, M.B.; Abid, A.; Harraz, F.A. Microencapsulation based fire retardant eco-friendly jute composite. *Polym. Polym. Compos.* **2023**, *31*, 09673911221147702. [CrossRef]
9. Li, X.; Yu, J.; Wageh, S.; Al-Ghamdi, A.A.; Xie, J. Graphene in photocatalysis: A review. *Small* **2016**, *12*, 6640–6696. [CrossRef]
10. Georgantzinos, S.K.; Siampanis, S.G.; Rogkas, N.; Spitas, V. The Effect of Hole Geometry on the Nonlinear Nanomechanics of γ-Graphyne Structures: A Finite Element Analysis. *Int. J. Mol. Sci.* **2023**, *24*, 14524. [CrossRef]
11. Dai, H. Carbon nanotubes: Opportunities and challenges. *Surface Sci.* **2002**, *500*, 218–241. [CrossRef]
12. Omran, A.A.B.; Mohammed, A.A.; Sapuan, S.M.; Ilyas, R.A.; Asyraf, M.R.M.; Rahimian Koloor, S.S.; Petrů, M. Micro-and nanocellulose in polymer composite materials: A review. *Polymers* **2021**, *13*, 231. [CrossRef]
13. Prasanthi, P.P.; Kumar, M.N.N.; Chowdary, M.S.; Madhav, V.V.; Saxena, K.K.; Mohammed, K.A.; Eldin, S.M. Mechanical properties of carbon fiber reinforced with carbon nanotubes and graphene filled epoxy composites: Experimental and numerical investigations. *Mater. Res. Express* **2023**, *10*, 025308. [CrossRef]
14. Shiyanova, K.A.; Gudkov, M.V.; Torkunov, M.K.; Goncharuk, G.P.; Gulin, A.A.; Sysa, A.V.; Melnikov, V.P. Effect of reduced graphene oxide, multi-walled carbon nanotubes and their mixtures on the electrical conductivity and mechanical properties of a polymer composite with a segregated structure. *J. Compos. Mater.* **2023**, *57*, 111–119. [CrossRef]
15. Dos Anjos, E.G.; Moura, N.K.; Antonelli, E.; Baldan, M.R.; Gomes, N.A.; Braga, N.F.; Passador, F.R. Role of adding carbon nanotubes in the electric and electromagnetic shielding behaviors of three different types of graphene in hybrid nanocomposites. *J. Thermoplast. Compos. Mater.* **2023**, *36*, 3209–3235. [CrossRef]
16. Georgantzinos, S.K.; Antoniou, P.A.; Spitas, C. A multi-scale computational framework for the hygro-thermo-mechanical analysis of laminated composite structures with carbon nanotube inclusions. *Results Eng.* **2023**, *17*, 100904. [CrossRef]
17. Li, X.; Zhang, T.; Song, B.; Yang, K.; Hao, X.; Ma, J. Polyurethane toughened covalent adaptive networks epoxy composite based on thermoreversible Diels-Alder reaction: Self-healable, shape memory, and recyclable. *J. Appl. Polym. Sci.* **2023**, e54762. [CrossRef]
18. Chen, W.; Han, C.; Liu, Y.; Feng, K.; Zhuang, S. Experimental Investigation of Cumulative Damage and Self-Healing Properties of Smart Cementitious Composite under Continuous Compression Load. *Materials* **2023**, *16*, 6090. [CrossRef] [PubMed]

19. Konlan, J.; Feng, X.; Li, G. A multifunctional hybrid extrinsic–intrinsic self-healing laminated composites. *Smart Mater. Struct.* **2023**, *32*, 075006. [CrossRef]
20. Taheri-Boroujeni, M.; Ashrafi, M.J. Self-healing performance of a microcapsule-based structure reinforced with pre-strained shape memory alloy wires: 3-D FEM/XFEM modeling. *J. Intell. Mater. Syst. Struct.* **2023**, 1045389X231170163. [CrossRef]
21. Shaikh, S.A.; Taufique, M.F.N.; Kulkarni, S.S.; Hale, F.; Oleson, J.; Devanathan, R.; Soulami, A. Finite Element Analysis and Machine Learning Guided Design of Carbon Fiber Organosheet-based Battery Enclosures for Crashworthiness. *arXiv*, 2023; arXiv:2309.00637.
22. Shokrollahi, Y.; Nikahd, M.M.; Gholami, K.; Azamirad, G. Deep Learning Techniques for Predicting Stress Fields in Composite Materials: A Superior Alternative to Finite Element Analysis. *J. Compos. Sci.* **2023**, *7*, 311. [CrossRef]
23. Kimura, T.; Ji, M.; Onodera, R.; Sekiguchi, Y.; Sato, C. Inverse design of composite xylophone beams using finite element-based machine learning. *Discover Mech. Eng.* **2023**, *2*, 12. [CrossRef]
24. Georgantzinos, S.K. The role of multi-scale finite element methods in analysis and design of advanced mechanical and aerospace structures. *Nanotechnology* **2019**, *9*, 805–808.
25. Ge, S.; Shi, Y.; Chen, X.; Zhou, Y.; Naushad, M.; Verma, M.; Lam, S.S.; Ng, H.S.; Chen, W.-H.; Sonne, C.; et al. Sustainable upcycling of plastic waste and wood fibers into high-performance laminated wood-polymer composite via one-step cell collapse and chemical bonding approach. *Adv. Compos. Hybrid Mater.* **2023**, *6*, 146. [CrossRef]
26. Wang, S.; Qian, C.; Cui, X.; Wang, P.; Zheng, H.; Wang, Z.; Xue, H. Accurate damage localization and enhanced mechanical performance of self-sensing epoxy nanocomposites using graphene platelets. *Polym. Adv. Technol.* **2023**, *34*, 3518–3526. [CrossRef]
27. Zhang, W.; Feng, Y.; Althakafy, J.T.; Liu, Y.; Abo-Dief, H.M.; Huang, M.; Zhou, L.; Su, F.; Liu, C.; Shen, C. Ultrahigh molecular weight polyethylene fiber/boron nitride composites with high neutron shielding efficiency and mechanical performance. *Adv. Compos. Hybrid Mater.* **2022**, *5*, 2012–2020. [CrossRef]
28. Kinoshita, T.; Yamamoto, T.; Luo, C.; Ide, K.; Aoki, K.; Uetsuji, Y. Mechanical characterization and design of hybrid reinforced polypropylene composites with talc fillers and cellulose fibers. *Compos. Part B Eng.* **2023**, *266*, 110971. [CrossRef]
29. Sri, S.V.; Balasubramanian, M.; Kumar, S.S. Influence of Khas Khas Grass/Mesquite Bark Fillers on the Mechanical, Hydrophobicity Behavior and Thermal Stability of Banana Fibers Reinforced Hybrid Epoxy Composites. *Fibers Polym.* **2023**, 1–11. [CrossRef]
30. Shahabaz, S.M.; Mehrotra, P.; Kalita, H.; Sharma, S.; Naik, N.; Noronha, D.J.; Shetty, N. Effect of Al2O3 and SiC Nano-Fillers on the Mechanical Properties of Carbon Fiber-Reinforced Epoxy Hybrid Composites. *J. Compos. Sci.* **2023**, *7*, 133. [CrossRef]
31. Chavhan, G.R.; Wankhade, L.N. Improvement of the mechanical properties of hybrid composites prepared by fibers, fiber-metals, and nano-filler particles–A review. *Mater. Today Proc.* **2020**, *27*, 72–82. [CrossRef]
32. Kaymaz, I.C.; Dogru, A.; Seydibeyoglu, M.O. Hybrid Composites for Railway and Transportation Uses—A Review. *Appl. Sci. Eng. Prog.* **2022**, *15*, 5801. [CrossRef]
33. Czech, K.; Oliwa, R.; Krajewski, D.; Bulanda, K.; Oleksy, M.; Budzik, G.; Mazurkow, A. Hybrid Polymer Composites Used in the Arms Industry: A Review. *Materials* **2021**, *14*, 3047. [CrossRef]
34. Peter, P.I.; Adekunle, A.A. A review of ceramic/bio-based hybrid reinforced aluminium matrix composites. *Cogent Eng.* **2020**, *7*, 1727167. [CrossRef]