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Special Issue “Natural Fiber Based Composites II”

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In the last twenty years, the use of cellulosic and lignocellulosic agricultural by-products for composite applications has been of great interest, especially for reinforcing matrices. Fibers of renewable origin have many advantages. They are abundant and cheap, have a reduced impact on the environment, and are independent from fossil resources. Their ability to mechanically reinforce thermoplastic matrices is well known, as is their natural heat-insulation ability. The matrices can themselves be of renewable origin (e.g., proteins, thermoplastic starch, poly(lactic acid), polyhydroxyalkanoates, etc.), thus contributing to the development of 100% bio-based composites with a controlled end of life.

Continuing the Special Issue, “*Natural Fiber Based Composites*” [1], this Special Issue provides an inventory of the latest research in the area of composites reinforced with natural and wood fibers, focusing particularly on the preparation and molding processes of such materials (e.g., extrusion, injection-molding, hot pressing, 3D printing, etc.) and their characterizations. It contains one review and ten research reports authored by researchers from three continents and eleven countries, namely, China, Egypt, France, Germany, Italy, Malaysia, Poland, Russia, Saudi Arabia, Tunisia, and Yemen.

An overview of the hybridization of MMT/lignocellulosic fiber-reinforced polymer nanocomposites for structural applications is provided in a comprehensive review paper [2]. The use of montmorillonite nanoparticles (MMTs) improves the mechanical properties of composites while ensuring their thermal stability. The dispersion of MMTs, particularly in water-soluble polymers, is facilitated by its intrinsic properties. This review article provides an exhaustive list of the latest advances in the field, from methods of obtaining these innovative materials to their mechanical, thermal, and fire-retardant properties. Such materials can now be used as reinforcing agents in a variety of high-end industrial applications.

Some of the research articles in this Special Issue suggest using very different raw materials to obtain bio-based composite materials from different molding techniques, which may have future applications in many fields, e.g., automotive, packaging, load-bearing composites, tissue engineering and biomedicine, filtering, agriculture, and fabrics.

- Non-woven preforms made from natural and thermoplastic fibers are frequently used as vehicle interior parts. Lightweight and recyclable, they can nevertheless release volatile organic compounds (VOCs) and odors into the vehicle interior. In [3], VOCs and odors released by flax/PP non-woven composites were quantified using headspace solid-phase microextraction (HS-SPME) coupled with gas chromatography–mass spectrometry (GC-MS). The composition of VOCs changes according to the compression-molding temperature. It is, therefore, possible to optimize this temperature to obtain materials that are less odorous and more suitable for use in the automotive sector.
- *Neosinocalamus affinis* is a clumping bamboo. Cellulose is extractable from its powder through bio-enzymatic digestion [4]. Cellulose is the most abundant polysaccharide on Earth. Once extracted, it can be transformed into nanocellulose (CNM). The amount of extracted cellulose, purity, crystallinity, and thermal stability depend on the initial



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particle size of the powder and the bio-enzyme used. The result is cellulose nanofibrils (CNFs), which, as a hardening component, can be mixed with other materials to improve their toughness. The use of bamboo as an ingredient in composites could therefore expand in the years to come.

- Cellulose is also abundant in wood. Along with hemicelluloses and lignin, it can be used in tissue engineering and biomedicine because of their good properties. Wood fiber gel can be prepared as a 3D-printing material using a hybrid 3D printer with three nozzles and five degrees of freedom [5]. The printer is capable of multi-material and multi-degree-of-freedom printing, making the wood fiber gel suitable for multiple biomedical applications.
- Depending on the three-dimensional printing technology used, the structure of the composites produced can differ markedly. This technique can even be combined with another unconventional technology, electrospinning (ES), to produce composites with improved qualities. These could be used in future for the construction of filtering devices and in medical applications [6].
- In [1], one research article presented the use of sunflower proteins to produce controlled release fertilizers (CRFs) through injection-molding, with urea and/or new biopolymers (BPs) obtained via the hydrolysis of municipal biowastes acting as additional sources of nutrients for plants [7]. In the present Special Issue, these innovative CRFs were tested for spinach cultivation [8]. In the presence of BP, the work highlighted that composites yield the safest crop coupled with high biomass production, thus contributing to the development of a bio-based chemical industry exploiting biological wastes as a raw material for eco-friendly agriculture.
- Widely available, sugar cane bagasse fiber can be used to make polyvinyl alcohol (PVA)-based foamed composites [9]. Their static cushioning performance is comparable to that of expanded polystyrene (EPS), commonly used in the packaging industry. The foamed composites developed mainly have an open cell structure. Bagasse fiber is also compatible with PVA foam. Depending on their mechanical properties and static cushioning performance, some of these new materials could be suitable for the cushioned packaging of light, fragile products.

In the textile industry, agricultural by-products can also be used as dyes for environmentally friendly fabric finishing. In [10], for example, pomegranate peel extract was used to produce a natural dye. This new, bio-based dye is particularly recommended for dyeing polyamide fabrics. Despite their fair light fastness, finished samples are resistant to rubbing and washing, and have good antibacterial properties. Such an extract could soon be used in the textile industry.

At the frontier between the textile industry and the medical field, the development of antimicrobial textiles is playing an increasingly important, protective role. Schiff bases and nanometric complexes have been in situ synthesized on bio-based conventional cotton fabrics to give highly effective and durable antibacterial and UV protection properties [11].

Raw materials of non-plant origin can also be used to produce innovative composite materials. For example, in the medical sector, hydroxyapatite (HAP) has great potential for wound healing. Mineral in origin, it is a calcium phosphate belonging to the apatite family. This wound-healing property can be explained by its high biocompatibility and angiogenic capacity. While traditional HAP-based materials are often fragile and not very mechanically resistant, it is possible to obtain dressings based on HAP nanowires, in the form of a flexible and superhydrophilic biopaper, which, due to the continuous release of Ca^{2+} ions, will promote the healing of skin lesions [12]. Safe and effective, this biocompatible material opens new prospects for clinical applications.

The final research article in this Special Issue presents the preparation of graphene oxide composites and evaluates their adsorption properties for lanthanum (III), a metallic element contained in low proportions in the earth, but widely used in optical glasses, alloys, catalysts, and ceramics [13]. Graphene occurs naturally in graphite crystals (defined as a stack of graphene sheets). The adsorption capacity of lanthanum was studied under differ-

ent conditions; the results show that the carboxylated graphene oxide/diatomite/magnetic chitosan (GOH/DMCS) composite could be used in future as an adsorbent that is effective and reusable.

This Special Issue presents a wide range of topics. It provides an update on the current research in the field of natural-fiber-based composite materials, and more. These contributions will be a source of inspiration for the development of new composites. These new materials are environmentally friendly and will undoubtedly find numerous applications in the years to come in many sectors.

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References

1. Evon, P. Special Issue “Natural Fiber Based Composites”. *Coatings* **2021**, *11*, 1031. [[CrossRef](#)]
2. Alias, A.H.; Norizan, M.N.; Sabaruddin, F.A.; Asyraf, M.R.M.; Norrahim, M.N.F.; Ilyas, A.R.; Kuzmin, A.M.; Rayung, M.; Shazleen, S.S.; Nazrin, A.; et al. Hybridization of MMT/Lignocellulosic Fiber Reinforced Polymer Nanocomposites for Structural Applications: A Review. *Coatings* **2021**, *11*, 1355. [[CrossRef](#)]
3. Barthod-Malat, B.; Hauguel, M.; Behlouli, K.; Grisel, M.; Savary, G. Influence of the Compression Molding Temperature on VOCs and Odors Produced from Natural Fiber Composite Materials. *Coatings* **2023**, *13*, 371. [[CrossRef](#)]
4. Zhao, J.; Wu, X.; Yuan, X.; Yang, X.; Guo, H.; Yao, W.; Ji, D.; Li, X.; Zhang, L. Nanocellulose and Cellulose Making with Bio-Enzymes from Different Particle Sizes of Neosinocalamus Affinis. *Coatings* **2022**, *12*, 1734. [[CrossRef](#)]
5. Chen, J.; Zhao, Q.; Wu, G.; Su, X.; Chen, W.; Du, G. Design and Analysis of a 5-Degree of Freedom (DOF) Hybrid Three-Nozzle 3D Printer for Wood Fiber Gel Material. *Coatings* **2022**, *12*, 1061. [[CrossRef](#)]
6. Kozior, T.; Mamun, A.; Trabelsi, M.; Sabantina, L. Comparative Analysis of Polymer Composites Produced by FFF and PJM 3D Printing and Electrospinning Technologies for Possible Filter Applications. *Coatings* **2022**, *12*, 48. [[CrossRef](#)]
7. Evon, P.; Labonne, L.; Padoan, E.; Vaca-Garcia, C.; Montoneri, E.; Boero, V.; Negre, M. A New Composite Biomaterial Made from Sunflower Proteins, Urea, and Soluble Polymers Obtained from Industrial and Municipal Biowastes to Perform as Slow Release Fertiliser. *Coatings* **2021**, *11*, 43. [[CrossRef](#)]
8. Padoan, E.; Montoneri, E.; Bordiglia, G.; Boero, V.; Ginepro, M.; Evon, P.; Vaca-Garcia, C.; Fascella, G.; Negre, M. Waste Biopolymers for Eco-Friendly Agriculture and Safe Food Production. *Coatings* **2022**, *12*, 239. [[CrossRef](#)]
9. Liu, B.; Huang, X.; Wang, S.; Wang, D.; Guo, H. Performance of Polyvinyl Alcohol/Bagasse Fibre Foamed Composites as Cushion Packaging Materials. *Coatings* **2021**, *11*, 1094. [[CrossRef](#)]
10. Bouaziz, A.; Dridi, D.; Gargoubi, S.; Chelbi, S.; Boudokhane, C.; Kenani, A.; Aroui, S. Analysis of the Coloring and Antibacterial Effects of Natural Dye: Pomegranate Peel. *Coatings* **2021**, *11*, 1277. [[CrossRef](#)]
11. Saeed, S.E.-S.; Al-Harbi, T.M.; Alhakimi, A.N.; Abd El-Hady, M.M. Synthesis and Characterization of Metal Complexes Based on Aniline Derivative Schiff Base for Antimicrobial Applications and UV Protection of a Modified Cotton Fabric. *Coatings* **2022**, *12*, 1181. [[CrossRef](#)]
12. Gao, J.; Hao, L.-S.; Ning, B.-B.; Zhu, Y.-K.; Guan, J.-B.; Ren, H.-W.; Yu, H.-P.; Zhu, Y.-J.; Duan, J.-L. Biopaper Based on Ultralong Hydroxyapatite Nanowires and Cellulose Fibers Promotes Skin Wound Healing by Inducing Angiogenesis. *Coatings* **2022**, *12*, 479. [[CrossRef](#)]
13. Zhou, J.; Song, X.; Shui, B.; Wang, S. Preparation of Graphene Oxide Composites and Assessment of Their Adsorption Properties for Lanthanum (III). *Coatings* **2021**, *11*, 1040. [[CrossRef](#)]

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