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Editorial

Special Issue "Renewable Polymers: Processing and Chemical Modifications"

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Received: 21 June 2019; Accepted: 21 June 2019; Published: 26 June 2019

The use of renewable resources for polymer production is receiving substantial and ever-growing interest. While only about 8% of the petroleum produced globally is used for the manufacture of polymers, there are alarming environmental and safety concerns associated with both the feedstock used to produce polymers and their end-of-life disposal. One possible solution to mitigate these negative environmental consequences is to develop more sustainable polymers via the use of renewable raw materials, or to recycle synthetic polymers. Feedstock such as proteins, cellulose, starch, lignin, chitosan, gums, vegetable oils, terpenes, and polyphenols can be used for the manufacture of a variety of sustainable materials and products, including elastomers, plastics, hydrogels, flexible electronics, sensors, engineering polymers, and composites. Various novel processing technologies and chemical modification strategies are also being implemented to make this feedstock more suitable for polymeric materials.

This Special Issue of *Processes* brings together several papers from leading scientists and researchers active in the area of "Sustainable and Renewable Polymers, Processing, and Chemical Modifications". The collected papers include both original research and two review articles related to renewable feedstock for polymer applications, processes for the fabrication of renewable polymer-based nanomaterials, the design and modification of renewable polymers, and applications of renewable polymers. The Special Issue is available online at the following link: https://www.mdpi.com/journal/processes/special_issues/renewable_polymers. The contributions are summarized below.

Khouri et al. [1] investigated the viscoelastic properties of treated chitosan films to elucidate the potential crosslinking of chitosan with citric acid. The study experimentally demonstrates that the thermal treatment of chitosan films in the presence of citric acid causes ionic crosslinking. The viscoelastic studies confirm that citric acid can be a safe alternative crosslinking agent to other crosslinkers, such as glutaraldehyde and epichlorohydrin of chitosan, by employing a heterogeneous film preparation method.

Adhikari et al. [2] developed a renewable wood-pellet binder from a short chain proteinaceous material co-reacted with polyamidoamine epichlorohydrin resin. The main contribution of this work is an experimental demonstration on the use of an otherwise waste protein material for wood binder applications. This proof-of-concept work, based on bench-scale continuous pelletization trials, clearly indicates the feasibility of using waste protein-derived peptides as a binder to improve the durability of torrefied wood pellets.

In an excellent example of enhancing the sustainability of plastics via recycling, Shin et al. [3] demonstrate the recovery of a useful organic material from recycled printed circuit boards that used brominated epoxy as a matrix. The depolymerization of the thermosetting epoxy was conducted via glycolysis using polyethylene glycol (PEG) under basic conditions. The recovered organic product (pre-polyol) obtained after glycolysis was converted into a recycled polyol via the Mannich reaction and the addition of the polymerization of propylene oxide to prepare rigid polyurethane foams for thermal insulation and other applications.

The use of soybean protein isolate as a biodegradable and environmentally-friendly alternative dust suppressing agent was investigated by Jin et al. [4]. They propose the use of an anionic surfactant to de-structure the complex tertiary and secondary structures of the protein, resulting in a relaxed protein–surfactant complex. Such modifications expose the hydrophobic functional groups of the protein, which provide an enhanced adsorption between the protein-based formulated dust suppressant and the hydrophobic dust (coal dust).

The potential of renewable ramie fibers with a range of treatments for fiber reinforced composite material applications was investigated by Kan et al [5]. Vacuum assisted resin infusion molding is used to fabricate composite materials with a target of producing lightweight, but high specific strength and modulus structural materials for the automotive and aerospace industry. Pretreatment along with the use of a coupling agent modification of the ramie fabrics results in composites with enhanced flexural modulus, tensile strength, and dynamic mechanical properties.

Kardan et al. [6] produced itaconic diacids via the fermentation of sugars; itaconic diacids are one of the most promising sustainable feedstocks for renewable polymeric material development. This work entailed nitroxide-mediated polymerization (NMP) of di-n-butyl itaconate using the BlocBuilder family of unimolecular initiators to obtain statistical copolymers with enhanced elastomeric properties. The polymerizations as a function of temperature and their initial compositions were presented.

The work by Mohamad Aini et al. [7] uses modified lignin as a renewable complementary filler of rubber composites. The modification of lignin employs hydroxymethylation inorder to enhance the compatibility of lignin with the hydrophobic polybutadiene rubber matrix. The results of the study indicate that the inclusion of hydroxymethylated lignin in rubber composites weakens the filler–filler interaction and improves processability. Furthermore, the compatibility and high interfacial adhesion between the modified lignin and the rubber matrix increase the cure rate of the rubber compound, and hence, increase the crosslink density compared to the unmodified lignin composites.

Panchal et al. [8] show that nanocellulose, in the form of cellulose nanocrystals and cellulose nanofibers, obtained by the deconstruction of fibers from wood or other cellulosic plants, are very appealing materials for functional material applications. This is because of their sustainability attributes, excellent mechanical properties owing to their crystalline assembly, and their abundant surface hydroxyl groups, which make them amenable to chemical modification. This article critically reviews the recent progress in the surface modification chemistries and processes of nanocellulose as functional nanomaterials, as well as carriers/substrates of other functional materials. Modifications that provide superhydrophobicity, barrier, electrical, and antimicrobial properties for coating, packaging, and electronics applications are reviewed in detail.

Finally, Cummings et al. [9] survey the use of starch in polymerizations, with a focus on sustainable emulsion polymerization processes. Some of the starch forms included in this review article are granular, native, functionalized, and nano-sized starch materials. One of the remarkable merits of this work was that it clearly presented future strategies of characterization methods and applications of starch grafted latexes and films.

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