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Bio-based polymers based on fast pyrolysis bio-oil

Maria L Auad
Auburn University, USA

The use of biomass-based resources is currently a hot topic for both academic and industrial research as an alternative to mitigate the strong dependence on fossil carbon in the chemical and petrochemical industries. The US Department of Energy (DOE) and the US Department of Agriculture (USDA) have prioritized the development of bioenergy and bio-products; and they have the goal to produce 18% of the current US chemical commodities from biomass by 2020, and 25% by 2030. The macromolecular chemistry based on lignocellulosic feedstock represents one of the answers to the quest for polymeric materials capable of replacing their fossil-based counterparts. In particular, fast pyrolysis bio-oil is an excellent candidate for the bio-sourcing of polymeric resin. Their competitive cost, worldwide availability and built-in functionality have catapulted it use as a source of macromonomers for polymer applications. The development of this area has been carried out mainly through the reaction and functionalization of hydroxyl groups in the bio-oil to produce thermosetting resins such as: epoxy, phenolic, polyurethanes, etc. Thus, the main purpose of this project is to cover the major aspects related to the chemical synthesis, physical-chemical characterization and study of thermo-mechanical properties of bio-based resin, where highly functionalized components are synthetized by chemical modification. Results showed that this new bio-based polymeric systems display interesting properties that are close to their commercial counterparts.

auad@auburn.edu

Synthesis and characterization of bio-based telechelic polyesters

Marion Sanglard and Dawn A Smith
Scion, Rotorua, New Zealand

The production capacity of biopolymers is expected to grow from 5.1 to 17 million tons in the next five years, doubling biopolymers share of the total polymer production. In the European Union, the biobased plastics market is expected to reach 5.2 billion euro in 2030. Some of the key drivers to get more biobased content into products will be new legislation, and consumers, brand owners and manufacturers demanding products that are more than just green and renewable. Among biobased polymers, linear polyesters such as poly(butylene succinate) (PBS) have been extensively studied as they can be synthesized from renewable feedstock. But there is still a need for new biobased aliphatic polyesters with reactive groups which can be utilized for crosslinking, further functionalization or to obtain block copolymers. This would allow to tailor properties, such as the melting point, crystallinity, glass transition and molecular weight, extending the range of PBS applications. The goal of this study was to synthesize telechelic PBS, with all monomers now being available from renewable resources. The endgroups were functionalized using crotonic acid (2-butenoic acid). It was selected for this purpose because of its alkene functionality and the possibility to access it from bio-based feedstock. New grafted biopolymer structures were obtained using two synthesis methods. The resulting polymers with reactive endgroups were characterized to determine their chemical structure and respective thermal properties. This work was funded by the Ministry of Business, Innovation and Employment of New Zealand.

Marion.Sanglard@scionresearch.com