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Biocomposites from waste-derived polyhydroxyalkanote (PHA): Mixed culture generation of polyhydroxybuturate-co-valerate (PHBV) copolymers and their inclusion in wood plastic composites

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Polyhydroxyalkanote (PHA) bioplastics have properties similar to polypropylene and PET, and are therefore outstanding candidates to replace some fossil fuelderived materials. Moreover, being both bio-based and biodegradable, PHAs allow for a closed loop carbon cycle and, unlike many other biomaterials on the market, they are both water resistant and UV stable. However, PHA is relatively expensive. This can be somewhat addressed by (i) producing PHA in open mixed microbial cultures using waste organic carbon as the feedstock, and (ii) compounding the polymer with fillers like wood flour; the use of wood flour in plastics is attractive for many reasons: it is abundantly available, biodegradable and low cost. This work lays a foundation for the development of high performance PHA-based wood plastic composites. The paper presents the compounding of commercial poly-(hydroxybutyrate-co-valerate) (PHBV) with low HV content (5%), with pine flour (300 μm and 550 μm). A range of PHA to wood flour ratios was considered. The mechanical properties (toughness and elongation to break), thermal behaviour and morphology of the produced materials were analysed, as was the water permeability. A preliminary analysis of the effect of surface modification on these properties was undertaken. The results are a benchmark for new Biocomposites from HV-rich, waste-derived PHA. Our recent research shows that industrially relevant PHA can be readily synthesised in mixed cultures, which can utilise cheap and renewable carbon sources such as waste streams from the pulp and paper industry. This, coupled with the innovative approach of making direct use of PHA-rich intact cells in wood fibre composites, thereby avoiding PHA extraction, means the PHA based materials could be cost-competitive with alternatives. Further, it is suspected that HV-rich mixed culture PHA will lead to good melt flow and hence effective contact between wood fibre and the biopolymer, as well as enable lower processing temperatures than are necessary for PHB based materials, thereby reducing thermal degradation and energy costs. Also, the concept overcomes a perceived limitation of PHA since the wood fibres act as nucleating agents for rapid crystallisation thereby circumventing the material stability issues associated with secondary crystallisation.

Biography

Steven Pratt is a senior lecturer in the School of Chemical Engineering at the University of Queensland. The theme of Steven Pratt research activities broadly encompasses Biorefining and the development of sustainable biomaterials. Steven Pratt currently lead Australian Research Council (ARC) funded projects on developing novel PHA wood composites, generating PHA from methane, and managing algae harvested from coal seam gas water. Steven Pratt major contribution to the field of environmental biotechnology is the invention of the TOGA Sensor for examination and control of biotech/bioprocess systems; The TOGA Sensor is a platform for world-class research and it has been a key tool for many PhD projects.

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