Sun Grant Western Regional Center
Oregon State University

Development of a Bio-based Industry Utilizing Organic Waste Streams:

Production of Biological Thermoplastics and Natural Fiber-Thermoplastic Composites

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Overview

Biologically-derived polyesters known as polyhydroxyalkanoates (PHAs) represent a potentially sustainable replacement to fossil-fuel based thermoplastics. However, current commercial production of PHAs exhibits higher fossil fuel demands and generates more carbon emissions, and is therefore not environmentally benign. Dr. Coats, and his co-PI seek to develop new biobased products and processes that utilize waste streams, improve waste management practices, enhance rural economic development opportunities, and ultimately, lead toward reduction in the dependence of petroleum-based feedstocks and products. The principle goal of their research will be to implement a PHA production and composting process utilizing biodiesel and manure waste streams.

PI and assistants studying bioreactor converting crude glycerol to PHB, a bioplastic.

Progress to Date

The research team is making significant progress toward the goal of producing PHA on dairy-based waste streams. They are producing large quantities of high quality PHA precursors, such as acetic acid, via fermentation of dairy manure and continue to maximize PHA yield by modulating bioreactor parameters. Results have confirmed that success is predicated on establishing conditions in the first stage of the process to maximize the enrichment for a microbial consortium capable of performing feast-famine PHA synthesis. A second waste stream of interest to Dr. Coat's team is biodiesel wastewater, or crude glycerol (CG). While the results of producing PHB, a co-polymer, from CG have been promising, this process is not economically feasible. Based on this conclusion, CG investigations will be expanded to include a fermentation process to produce better PHA precursors rather than direct bioconversion of CG to PHB. This will ultimately yield to better long term success of producing valuable commodities from thjs waste stream.

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Progress (cont.)

The second research objective is to test the quality of the PHA produced in the bioreactors. The team is evaluating how the properties of the PHA co-polymers PHB and PHBV change as temperature is increased using Differential Scanning Calorimetry (DSC). The results will help the team develop PHAs with improved material properties, such as flexibility, and processing (lower processing temperature). Dynamic mechanical analysis (DMA) was also used on films of PHB and PHBV. Dynamic testing can provide important information on glass transition point and viscoelastic properties.

Finally, the team will manufacture Natural Fiber Plastic Composites with PHB-rich biomass. The goal for this task is to produce and evaluate the material properties of a range of composites. Testing will commence once a sufficient amount of PHB has been recovered to make the composites.

Presentations

- Dr. Coats presented on this research at the 2009 Sun Grant Initiative Energy conference in Washington, DC on March 12, 2009.
- Dr. McDonald and two of his graduate students gave three talks on this research at the annual Forest Products Society meeting held in Boise Idaho June 22-24, 2009.

Collaborators

Co-PI: Armando McDonald, University of Idaho

Industry Partner: Simplot, Idaho

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