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Cultivation and utilization of cyanobacterial exopolysaccharide for production of bio-based polymers

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Development of poly-cultures has been identified as a potential means for overcoming several challenges facing scale-up of algae-based commodities which can displace petroleum but do not compete with food production. In this presentation, we describe findings from our recent studies on cultivation of a marine cyanobacterial consortium in open algae raceways and downstream conversion to bio-plastic. In the consortium, three distinct cyanobacterial cultivars were combined to provide nitrogen fixation, photo-protection and high rates of secretion of extracellular polysaccharides in support of a long-term bio-product 'milking' strategy. Following lab-scale investigations of various combinations of the individual cultivars to identify optimal algae raceway inoculation and maintenance strategies, the best performing consortia were successfully cultivated in pilot-scale algae raceways for >120 days. The growth trials indicated bioproduct concentrations >2 g/L consisting primarily of a variety of C^5 and C^6 monosugars which were recovered using a low-cost semi-continuous harvesting strategy. In addition to the remarkable stability of the consortium in open cultivation, measurements of culture density time course indicated insignificantly different log-phase specific growth rates at different levels of nitrate or carbon dioxide addition, which should have significant techno-economic and sustainability impacts for commercialization. Following recovery of the biomass and exopolymer, generation of cyanobacterial-derived bioplastic was demonstrated and performance characteristics were found to be similar to common biobased plastics, such as PLA. Initial techno-economic analysis based on the product yield and corresponding biomass production, harvesting and conversion costs indicate an N^{th}-plant model finished product cost of $ 600/ton.

Biography

Ryan W Davis is the Principal Member of Technical Staff at Sandia National Laboratories. His research has focused on science and technology for production of bio-based commodities from renewable feedstocks using non-arable land and non-freshwater resources. He has obtained his PhD in Physical Chemistry from the University of New Mexico and completed Post-doctoral studies at Sandia Laboratories in New Mexico and California. He has published more than 25 articles in peer-reviewed journals and is Director of the Sandia Algae Raceway Testbed Facility.

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