Chemical Engineering Doctoral Defense

Synthetic biology for enhanced protein secretion to valorisebiological and synthetic polymers

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Abstract

Polymers have played a pivotal role in building our modern society. Polymers are present in almost every equipment, gadget, textile, household product, pharmaceutical, food, etc. Polymers can be classified as synthetic and natural polymers. Synthetic polymers are artificially made by carrying polymerization reactions. Synthetic polymers are non-biodegradable and synthetic polymers like polyethylene terephthalate constitute a significant part of non-biodegradable waste.

Similarly, lignocellulosic biomass waste is an untapped resource of natural polymers like cellulose, hemicellulose, and lignin. Depolymerization of polymers can be used for waste reduction and utilization of polymer components in a bioprocess to produce valuable chemicals. Different thermochemical methods have been used to depolymerize synthetic and natural polymers. However, thermochemical methods have harsh conditions and produce inhibitory by-products, because of which they are not preferable to be used in a bioprocess. Enzymatic hydrolysis can depolymerize different polymers before being fed to a bioprocess. Enzymatic hydrolysis is high specificity and high conversion reaction, but the high cost of the enzyme is a roadblock to bioprocess commercialization. Developing consolidated bioprocess, which involves one-pot enzymatic hydrolysis and fermentation, can help build low economically viable bioprocess. The efficient secretion of hydrolytic enzymes is an essential part of the consolidated bioprocess. Optimization and screening of unique signal peptide and enzyme combinations can improve secretion efficiency in host organisms. Also, coculture consortia can help reduce metabolic stress on host organisms in consolidated bioprocess. The development of consolidated bioprocess, which can process renewable feedstocks and produce a vast range of chemicals, can be a promising

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alternative to present unsustainable industrial processes. The present work demonstrates consolidated bioprocess for cellulose and hemicellulose substrates and one pot deconstruction process for synthetic polymer PET. A Consolidated bioprocess for hemicellulose to xylose showed a xylose titer of 7.1 g/L. Products like succinate, ethanol, and lactate were produced from hemicellulose in one pot process. A 72% reduction of avicel cellulose was achieved in a cellulose bioprocess. Furthermore, the first bis (2-hydroxyethyl) terephthalate (BHET) consolidated bioprocess was developed, which produced a terephthalic acid titer of 7.4 g/L. Consolidated bioprocesses can be an invaluable approach to waste utilization and making cost-effective processes.

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Zoom Link: https://asu.zoom.us/j/3943670126