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Abstract

Biofuels and Biomaterials: the Road Ahead

The development of a sustainable energy portfolio to mitigate climate change is one of the great challenges we are facing today. The United States has set goals to develop a bio-based industry for fuel, power, and other products. These goals have engendered a growing interest in the production of biomass and its conversion to fuels, chemicals, and materials.
The challenge of converting cellulosic biomass to sugars is the dominant obstacle to cost-effective production of biofuels and biomaterials in sustained quantities, capable of impacting U.S. consumption of fossil transportation fuels. Several large research programs such as the BioEnergy Science Center (BESC) will address this challenge in an unprecedented interdisciplinary effort.

A deeper understanding of how to modify plant cell wall synthesis to increase accessibility of sugars coupled with novel deconstruction methods focusing on enzymatic catalysis will overcome biomass recalcitrance and enable targeted access to cheap sugars derived from cellulose and hemicellulose, in addition to permitting the exploration of other plant cell wall components such as lignin. The sugars can be used to produce ethanol through a fermentative process. Several technologies are under development to convert accessible sugars economically into biofuels for diesel and jet fuel. ORNL developed a novel technology using an inexpensive zeolite catalyst to transform ethanol into a hydrocarbon blend-stock. The resulting liquid can be blended at various concentrations into gasoline, diesel, and jet fuel without affecting engine performance or can be used to purify desirable chemicals.
Lignin, among other applications, is evaluated as precursor for carbon fiber production. Traditional carbon fiber, derived from fossil fuel precursors, is currently used in many high-end applications such as light weighing of high-end sports cars to increase performance. The production of carbon fiber at a lower cost will allow the use in conventional vehicles leading to substantial weight saving. Weight reduction has a direct impact on fuel economy and is a targeted goal to achieve future fuel standards. Lignin carbon fiber researchers at ORNL developed a novel process for lignin carbon fiber spinning which reduces the carbon fiber cost significantly, opening the door for use in conventional vehicles. In addition, the combination of biofuel production with higher value products such as carbon fiber will lead to novel economic models and will further help in advancing the commercial development of a integrated biofuel industry in the U.S.