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Plastics from Renewable Sources

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With increasing global warming, declining fossil fuel reserves, and increasing population worldwide, there has been an intense effort to expand our energy portfolio from renewable sources, like wind, hydro, solar, and biomass. Among these, biomass is the only carbon based renewable energy source and as such, is ideal for production of fuels and chemicals. With the Department of Energy (DOE) projecting replacement of 1/3 of fuels and ¼ of all organic chemicals in the next few years from biomass, intense efforts have been devoted to converting lignocellulosic biomass, such as trees, switchgrass, and waste into intermediate platforms that can be fed to the refinery and chemicals industry.

Could bioplastics replace crude-oil-based soda, water and shampoo bottles, packaging, etc.? Production of bioplastics is a challenging undertaking as lignocellulose is a multiscale composite biopolymer consisting of three main components, cellulose, hemicellulose, and lignin. These polymers are architecturally 'glued' together by numerous hydrogen bonds providing structural integrity to living trees and grass. It is this structural integrity that makes biomass recalcitrant to breakdown. Yet, the pulp and paper industry has developed technology to enable the breakdown of biomass.

Upon breaking biomass down to its building blocks, the next challenge emerges. The majority of biomass polymers consist of sugars of 5 or 6 carbon atoms or aromatics building blocks. The large number of oxygen atoms in these building blocks and in their linkages renders the building blocks unsuitable for fuels and chemicals. As a result, one needs to learn how to 'upgrade' the resulting products resulting from the fragmentation of biomass. Heterogeneous catalysts can be employed for achieving this goal. They are solid materials that are often superior over enzymes due to their ability to withstand high temperatures, possess low cost, and exhibit high rates in converting building blocks. Their high stability and activity compared to enzymes often comes at the cost of low selectivity, i.e., the inability of solid materials to produce the right molecules without undesirable molecules. Improving the selectivity of heterogeneous catalysts has been a long standing goal and major inroads have been made toward this goal over the past century. But applying this knowledge to biomass processing for green plastics has proven far from trivial [1,2]. As a result, efforts to convert biomass building blocks to molecules for green polymers have been met with moderate success only.

Now starting from an intermediate platform, dimethyl furan, produced from six-carbon sugar, zeolite catalysts have been shown to give high yield to para-xylene [3]. Para-xylene is key aromatic for producing terephthalic acid, which in turn is the basis of a large market of plastics. Two deliberately chosen functionalities in the heterogeneous zeolite catalyst, namely Lewis and Brønsted, along with careful reaction engineering have proven crucial to achieve high yield of para-xylene. This is the first time that such a high yield to a precursor to bioplastics is attained. This discovery has very promising economic prospects and opens up the horizons for commercial production of additional monomers and plastics from renewable biomass sources.

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References

1. Cortright RD, Blommel PG (2011) Synthesis of liquid fuels and chemicals from oxygenated hydrocarbons, US patent. Virent Energy Systems Inc 8: 53-615.
2. Peters MW, Taylor JD, Taylor TJ, Manzer LE (2012) Renewable xylenes produced from biological C4 and C5 Molecules, US. USPTO Applicaton: 20120171741 GEVO, Inc.
3. Williams CL, Chang CC, Do P, Nikbin N, Caratzoulas S, et al. (2012) Cycloaddition of Biomass-Derived Furans for Catalytic Production of Renewable p-Xylene. ACS Catal 2: 935-939.

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