

## Cost-Effective Synthesis of HMF from Fructose



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**WARF:** P06305US

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**The Wisconsin Alumni Research Foundation (WARF) is seeking commercial partners interested in developing a cost-effective and high-yield procedure to synthesize furan derivatives (e.g., 5-hydroxymethylfural (HMF), furfural, dimethylfuran, etc.) for use as monomers, diesel fuel precursors and fuel additives.**

### OVERVIEW

Increasing demand of petrochemical resources to produce the energy and chemical materials required by industrialized societies with growing populations combined with a diminishing supply has resulted in efforts to develop alternative, renewable ways to meet this need. Biomass could provide a means of obtaining both transportation fuels and valuable intermediate chemicals for production of drugs and polymeric materials if these substitute routes can be implemented in an economically feasible fashion.

The chemical 2,5-furandicarboxylic acid (FDCA) has potential as a replacement for terephthalic acid, which is used widely in synthetic polyesters such as those found in soft drink bottles. FDCA is formed electrochemically via oxidative dehydration of glucose or oxidation of 5-hydroxymethylfural (HMF). Currently, HMF is expensive to produce due to difficult separations of HMF from the organic solvents utilized in its creation, low product yield and low HMF concentrations in the product stream. A process to efficiently deliver HMF in high yields and high concentrations would provide a cost-effective route for the synthesis of di-substituted furan derivatives such as FDCA.

### THE INVENTION

UW-Madison researchers have developed a method for the selective dehydration of carbohydrates (preferably fructose) to produce furan derivatives (preferably HMF). This new process provides a cost-effective way for making these valuable chemical intermediates, which could replace key petroleum-based building blocks used in production of plastics, fine chemicals, diesel fuel and fuel additives.

The method is more commercially viable than those previously developed because it yields a higher concentration of HMF and produces HMF in a separation-friendly solvent which does not require difficult extraction processes. The dehydration process employs a

### THE WARF ADVANTAGE

Since its founding in 1925 as the patenting and licensing organization for the University of Wisconsin-Madison, WARF has been working with business and industry to transform university research into products that benefit society. WARF intellectual property managers and licensing staff members are leaders in the field of university-based technology transfer. They are familiar with the intricacies of patenting, have worked with researchers in relevant disciplines, understand industries and markets, and have negotiated innovative licensing strategies to meet the individual needs of business clients.



two-phase reactor system in which a reactive aqueous phase containing fructose and a chemically modified acid catalyst is contacted with an organic extracting phase modified with a C<sub>1</sub>-C<sub>12</sub> alcohol (preferably 2-butanol).

## BUSINESS OPPORTUNITY

- PET has a market size approaching 4 billion pounds per year.
- PBT has a market size of almost a billion pounds per year.
- Market value of PET polymers is in the range of \$1-3 per pound for uses as films and thermoplastic engineering polymers.
- Use of HMF in creating a new class of biomass derived polyesters could address a market of almost 9 billion pounds per year, with product values between \$0.85-2.20 per pound.

## APPLICATIONS

- Synthesizing renewable resources into a precursor for plastics that are usually petroleum-based (PET, PBT, Polyamide/Nylon, Polyester, Polyurethane)
- Biomass-derived precursors for diesel fuel, fuel additives and pharmacologically active compounds

## KEY BENEFITS

- Operates at concentrations of fructose between 10 and 50 percent by weight
- Achieves more than 80 percent concentration of HMF with more than 90 percent conversion
- Produces HMF in an easily separable solvent

## STAGE OF DEVELOPMENT

Experiments to identify key processing variables for HMF and furfural production using the new method were performed to improve the selectivity of the reaction when using less-reactive molecules. These reactants are desirable because they are inexpensive and abundantly available. Currently, the researchers are producing furfural from corn stover.

## ADDITIONAL INFORMATION

### Publications

Roman-Leshkov Y., Chheda J.N. and Dumesic J.A. 2006. Phase Modifiers Promote Efficient Production of Hydroxymethylfurfural from Fructose. *Science*. 5782, 1933-1937.

### Tech Fields

Clean Technology - Energy & resource efficiencies  
Materials & Chemicals - Polymers

## CONTACT INFORMATION

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