Ultra-high yield production of para-xylene from biomass-derived DMF

The production of renewable chemicals from biomass has been spurred by the increasing demands for sustainable products and economy. Aromatics, including benzene, toluene and xylenes (BTX), are one of the five major products dominating the current chemical production in terms of volume and energy consumption. P-xylene, an essential commodity chemical for the production of terephthalic acid (TPA), is an important BTX compound requiring a low-cost, thermochemical process for renewable production. TPA is used as a monomer to produce polyethylene terephthalate (PET), which has been widely used to manufacture plastic bottles, clothing, automobiles and food packaging. Because of the rapid growth in PET global market (6-8% per year), there exist numerous ongoing research and development efforts to produce renewable PET and its monomer precursors from renewable biomass feedstocks.

Description of the Invention

A new series of phosphorous-containing solid catalysts for ultra-high yield production of p-xylene has been developed by suppressing competing side reactions. Among them, phosphorous-containing BEA zeolite (P-BEA) with 12 membered-ring (12 MR) structures and phosphorous-containing self-pillared pentasil (P-SPP) zeolite nanosheets with 10 MR exhibit exceptional activities up to 97% yield of p-xylene at 99% conversion of DMF. The Diels–Alder cycloaddition of 2,5-dimethylfuran (DMF) and ethylene and the subsequent dehydration of the cycloadduct intermediate is an attractive reaction pathway to produce renewable p-xylene from biomass feedstocks. Passing the Diels-Alder cycloaddition product of ethylene and DMF over this catalyst technology, a conversion rate of 97% can be achieved. The renewable p-xylene produced is an important precursor for production of PET and other related plastic materials. Using ethylene (the most highly produced petrochemical) with DMF (which can be derived from fructose) may provide a more economical method of para-xylene production. This unique aspect establishes a commercially attractive process for renewable p-xylene production.

Features and Benefits

- Cost effective phosphorous-containing solid catalysts
- Ultra-high yield production of p-xylene
- No competing side reactions
- Renewable p-xylene

Potential Applications

- Precursor for terephthalic acid used in the production of PET and other related plastic materials
- Beverage bottles, automotive, fibers for clothing and carpeting