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Recent Progress on the catalytic routes for the Fabrication of 2,5-Furandicarboxylic Acid (FDCA) from 5-Hydroxmethyl Furfural (HMF)

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Abstract
The use or generation of furandicarboxylic acid (FDCA) has been considered as a good precursor instead of petroleum-derived phthalate acid (TPA) for producing green polymers. Such as polyethyles 2,5-furandicarboxylic (PEF) the oxidative production of FDCA from bio-based 5-hydroxymethyl furfural (HMF) has attracted the most attention it can be carried out by electrochemical catalytic and non-catalytic process and the most of frequently used catalyst for the chemical catalytic methods are oxides of noble metal but their high cost poor hindrances to their commercial acceptances the history of green chemistry in 1990. The concepts of green chemistry is the design of chemical products and processes that reduces or eliminate the use and generation of hazardous substance the global recognition of green chemistry are some in major countries like Australia, Canada, Italy, USA and Japan. The progress of green chemistry it has demonstrated now fundamental scientific methodologies can be devised and applied to protect human health and the environment in an economically beneficial manner in this review. Agriculture has indicated that there will be an increase in the commodities of biochemical and bio-material to 25% in 2030 this goal has settled on the case of Lcb as a renewable and sustainable resource of petroleum carbon for the production of commodity chemicals. Lcb is primarily composed of cellulose (40-50%), lignin (20-30%) and others such as protein, silica and waxes. Irrespective of its robust structure, cellulose preferably needs to be depolymerized to glucose, which is in turn converted to platform bio-chemicals such as 5-hydroxymethylfurfural (HMF).

Keywords: HMF, FDCA, Cellulose, Sustainable, Environment

Introduction

The scale of global economy has expanded many-fold to meet the continuously growing demands of energy, chemical and materials The chemical industry has also seen tremendous growth in the use of chemical intermediates, polymeric materials and. integrated derivatives fuel And these features of foster have forced humans to search for more renewable and sustainable feedstocks. Agriculture have indicated that there will be an increase in the commodities of biochemicals and bio-chemicals to 25% in 2030. This goal has settled on the use of LCB as a renewable and sustainable resource of petroleum carbon for the production of commodity chemicals. Polymeric material such as Polyethylene terephthalate, polyamides, and polyurethanes have played vital roles in the modern economy. FDCA synthesis is considered as a precursor for the production of these green polymers especially polyethylene 2,5-furandicarboxylate (PEE).

PEF is a real alternate to fossil based terephalate (PET). Despite all the and scientific research the worldwide production of bio plastic) is only a fraction of the total market supply the objective of this work is to comprehensively review and discuss the catalytic conversion HMF to produce mechanism which in turn are utilized is film and fiber production packing materials and soft drink bottle PEF has excellent thermochemical properties with biodegradability that maker it is better choice in comparsion to PET.

FDCA as a chemical building block

FDCA is one of the most important and promising candidates of the furan family due to its multi-functionality based on the cyclic structure and di-acidic side chains. FDCA is found naturally in human urine and blood plasma, and has been utilized for the production of a variety of biochemicals such as succinic acid. The combination of these alcoholic components with FDCA would leads to a new family of completely biomass-derived products. The extension of these concepts to the products of new nylons, either through reaction of FDCA with diamines or through the conversion of FDCA to 2,5-bis (aminomethyl) tetrahydrofuran, could leads to future markets bio-derivation with multiple applications.

Chemical Oxidative Production of 2,5-FDCA from HMF

HMF came out as a promising feedstock for the production of FDCA in the 19^{th} century. Different reaction system have been used for the oxidation of HMF with air, oxygen and other oxidizing agents (H_2O_2, $KMnO_4$). In the process, cellulose is usually firstly separated from hemicellulose and lignin by followed by isomerization of the obtained glucose to form fructose. Direct utilization of glucose as feed-stock proceeds via the in situ isomerization of glucose to fructose followed by dehydration to produce HMF, and oxidation of HMF further yields. Direct utilization of glucose as feed-stock proceed via the in situ isomerization of glucose to fructose followed by dehydration to production and oxidation of HMF further yields FDCA. In contrast, heterogeneous catalysis demonstrates several merits, with the facile separation and recycling due to the heterogeneous nature.

Homogenous catalytic methods

Catalytic oxidation of HMF either by a homogeneous or heterogeneous catalytic, is still the most promising and extensively researched FDCA production pathway. High-pressure air oxidation of HMF with CO $(OAC)_2$, Mn (OAC), and HBr could produce FDCA with yield of 60.9% and HMF oxidation to over Pt supported catalysts supported platinum (Pt) catalysts are dynamic for the aerobic oxidation of HMF as compared to other nobles metal catalysts. The detection of HFCA as an intermediate proves the preferred oxidation of the formyl group over the hydroxymethyl group with the lead-doped Pt catalyst. Following this, the bismuth (Pt-Bi/C) having a Pt-Bi molar ratio of 0.2 was developed and applied in FDCA synthesis. A 29% increase in FDCA yield by Bi addition proved the improvement in the activity of the bimetallic catalyst with identical parameters. Pressure reduction negatively affected the yield and an increase in pressure did not exhibit appreciable effects. The effects of the supports have been investigated by production Pt-Bi/TiO_2. The TiO_2 effectively and selectively increased the FDCA yield. Relatively cheap metal oxide-supported Pt catalysts. Reaction kinetics have shown that HMF oxidation proceeds through the Pt-Nanoparticles yields Pt-alkoxides by reacting with hydroxyl groups presents in HMF, substituting with hydroxide ions (OH). Bi containing ceria accelerates the oxygen reduction due to the availability of more oxygen vacancies and the breakup of transitional peroxide. This smooth catalytic cycle continues to consume surface electrons in oxygen reduction which safeguards the catalytic efficiently and the Pt/$Ce0._8Bi0._2$ catalyst can work efficiency even in the fifth cycle which was appreciably close to the recorded yield in the batch (98%).

Conclusion

Biomass-derived FDCA is a promising feedstock for the production of a variety of downstream chemicals its most important application is the production of polymer replacing fossil-derived terephthalic acid (TPA). Therefore, the economical manufacturing of FDCA and its commercialization will not only play a vital role in the production of biodegradable polymers but also reward enormous financial and advantage. Fructose is mostly used for the direct conversion of carbohydrates to FDCA in a one -pot two-step process, but the one-pot step process just gives a low FDCA yield, is not yet competitive. The one-pot process is more encouraging for FDCA synthesis due to HMF instability, poor availability and potential economics improvement in technology can make this process more cost-effective and feasible by excluding the barrier of HMF extraction and purification.

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