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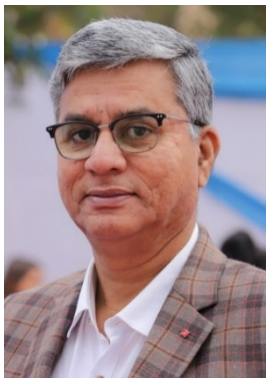
FAMU-FSU College of Engineering

Biorefining in Electrochemical Reactors: Conversion of Biomass-Derived Compounds to Various Platform Chemicals



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EVENTS

June 9	11 am – 12:30 pm	**Seminar** in AME 106 (2003 Levy Ave)
June 10	9 am – 6 pm	**Individual Meetings*** with Dr. Basu
June 11	9 am – 12 pm	**Individual Meetings*** with Dr. Basu
	1:30 – 2:30 pm	**Fulbright Roundtable Discussion** in Beth Moore Lounge, Longmire (FSU)

**Sign up for an individual meeting with Dr. Basu in Engineering B-202: Basu_Itinerary_mtgs.xlsx*

ABSTRACT The bio-electro-refinery refers to the bio-refinery integrated with the electrochemical and photo-electrochemical conversion of intermediate biomass-derived compounds to value-added chemicals.[1,2] The thermochemical treatment of paddy stubble was done using fast pyrolysis obtained a mixture of organic compounds, termed as bio-oil. Bio-oil comprises organics such as phenol, catechol, p-cresol, furfural (FF), acetic acid, 2-methoxyphenol, and hydroquinone.[3] As a component of bio-electro-refinery, the electrocatalytic conversion of biomass-derived FF provides platform chemicals such as furfuryl alcohol (FA), hydrofuroin and furoic acid (FU) used in pharmaceuticals, and bio-fuel industries. The electrocatalytic hydrogenation (ECH) of FF was dependent upon the availability of adsorbed hydrogen and FF, type of electrocatalyst and applied potential. Cu-NPNi/NF was developed through the etching of Cu from a co-electrodeposited Ni-Cu electrode on a Ni-foam substrate followed by a re-electrodeposition of Cu. Cu-NPNi/NF exhibited a porous, and bimetallic form of Ni-Cu, which yielded a high FA (118.7 ± 8 µmol h^{-1} cm^{-2}) and HF (176.3 ± 3.4 µmol h^{-1} cm^{-2}) generation rates determined at −1.45 V vs. Ag/AgCl/sat KCl after 1 h of electrolysis in an alkaline electrolyte. 100% conversion of furfural was observed after 2 h of electrolysis with the same catalyst. The high rate of FA and HF formation was ascribed to enhanced adsorbed FF because of the formation of Cu-nanoplates and bimetallic Ni–Cu.[4] The utilization of solar energy was further utilized to reduce the electrical energy requirement in the photoelectrochemical conversion of FF. Herein, the FF ECH was paired with photoelectrochemical oxidation of FF to generate FA at cathode and FU at non-noble TiO_2 photoanode in a batch photoelectrochemical cell. A 50% electrical energy saving efficiency was obtained due to the use of solar illumination. To further increase the cell capacity (5 times) and overcome mass transfer limitations, a flow photoelectrochemical cell was employed yielding an increase in FA and FU generation rates.[5-7] I shall further discuss electrochemical conversion of biomass based HMF (5-(Hydroxymethyl) furan-2-carbaldehyde) into FDCA (2, 5-Furandicarboxylic acid) and hydrogen gas simultaneously. The conversion process occurs within a 3D-printed flow electrolyzer operating under alkaline conditions (pH 13) at room temperature and pressure. At room

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temperature and pressure, a single pass through an electrochemical cell, yields 287.5 µmol/h of FDCA, an industrially significant precursor of bioplastic. Upto 80 % conversion of HMF is seen at flowrate of 0.5 ml/min in a single pass. These results are achieved with a potential bias of 3.5 V. This technological advancement in electrochemical flow reactors facilitates the uninterrupted production of value-added chemicals and fuels from biomass derived chemicals under ambient environment[8,9].

References

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