Metal-Organic Frameworks (MOFs)-Driven Carbon Neutral Society: Heterogeneous Catalysis of Waste Biomass and Plastics Conversion

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ABSTRACT

Scientific innovation in various fields is surely necessary to achieve carbon neutrality by 2050. To reduce carbon dioxide (CO2), seven approaches including de-fossil resources, switch to renewable energy, etc. have been proposed. Meanwhile, nanoporous metal-organic frameworks (MOFs) have been well known and have shown great potential in catalysis and energy applications owing to their high surface areas, controllable composition, and tunable surface functionalities. In this talk, I will focus on MOFs-driven carbon neutral society by introducing MOFs in waste biomass and plastics conversion. (1) For heterogeneous catalysis, we synthesize a heterogeneous Bi-BTC catalyst for the conversion of bio-based 2,5-dimethylfuran and acrylic acid to para-xylene with a promising yield (92%), under relatively mild conditions (160 ºC, 10 bar) with low reaction energy barrier (47.3 kJ/mol). The proposed reaction strategy also demonstrated remarkable versatility for furan derivatives such as furan and 2-methylfuran. (2) For plastics conversion, polyethylene terephthalate (PET) has been extensively used for fabrication of various packaging materials, creating million tons of waste per year. Degrading and recycling PET waste has been identified as a prominent issue. Herein, we demonstrate an effective process to chemically convert PET to bis(2-hydroxyethylterephthalate) (BHET) through the use of metal azolate framework-6 (MAF-6) as a catalyst in the presence of ethylene glycol. A high 92.4% conversion of PET and 81.7% yield of BHET at 180 °C for 4 h was achieved. We have also hypothesized a mechanism for the high conversion and yield of PET glycolysis reaction catalyzed by MAF-6.

References:

- Engineering a Homogeneous Alloy-Oxide Interface Derived from Metal-Organic Frameworks for Selective Oxidation of 5-Hydroxymethylfurfural to 2,5-Furandicarboxylic Acid. *Applied Catalysis B: Environmental.* 2020, 270, 118805.
- Metal-organic framework (MOF)-derived catalysts for fine chemical production. *Coordination Chemistry Reviews*. 2020, 416, 213319.
- Diels-Alder Conversion of Acrylic Acid and 2,5-Dimethylfuran to para-Xylene over Heterogeneous Bi-BTC Metal-Organic Framework (MOF) Catalysts under Mild Conditions. *Angewandte Chemie International Edition.* 2021, 60, 624-629. Very Important Paper. Selected as Front Cover.
- Highly Selective and High-Performance Osmotic Power Generators in Subnanochannel Membranes Enabled by Metal-Organic Frameworks. *Science Advances.* 2021, 7, eabe9924.
- Highly Efficient One-pot Conversion of Saccharides to 2,5-Dimethylfuran using P-UiO-66 and Ni-Co@NC Noble Metal-Free Catalysts. *Green Chemistry.* 2022, 24, 5070-5076.
- Yu-Wen Chiao, Weisheng Liao, Philip Anggo Krisbiantoro, Bor-Yih Yu*, Kevin C.-W. Wu.* Waste-Battery-Derived Multifunctional Zinc Catalysts for Glycolysis and Decolorization of Polyethylene Terephthalate. *Applied Catalysis B: Environmental.* 2023, 325, 122302.