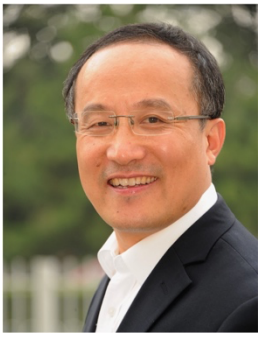
Catalytic valorization of lignocellulose to low-molecular oxygen- and nitrogen-containing compounds



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Biomass, consisting of hydrogen, oxygen, and carbon, is the most promising renewable resource for producing valuable chemicals. Transforming biomass into low-molecular oxygenates is highly important due to the relatively high oxygen content of biomass in comparison with fossil resource. Additionally, nitrogen-containing compounds are more valuable than oxygenates and widely applied in synthesis of agrochemicals and pharmaceuticals.

This study first introduces the catalytic conversion of cellulose/hemicellulose to low-molecular oxygenates including ethylene glycol and ethanol. In 2008, for the first time, my group developed this process using Ni-promoted tungsten carbides [1]. Cellulose/Hemicellulose could be converted to ethylene glycol on catalysts containing transition metal (Pt, Rh, Rh, or Ni) and W species [2-5]. We also developed a multifunctional catalyst Mo/Pt/WO_x, selectively producing ethanol from one-pot conversion of cellulose [6]. Then, recent progress in the catalytic transformation of biomass-based aldehydes into N-containing compounds in my group will be summarized. New synthesis pathways towards pyrimidine [7], benzylamines [8], quinolones [9], and carbazoles [10] have been developed, opening new avenues towards the transformation of cheap biomass into high-value N-containing compounds. Finally, the scale-up of DLEG (Direct Lignocellulose Ethylene Glycol) process will be introduced. A 1000 t/a pilot plant was established by us in Puyang, China, with an ethylene glycol yield of ~ 80% and purity of ≥99%. The commercialization of this technology is in progress.

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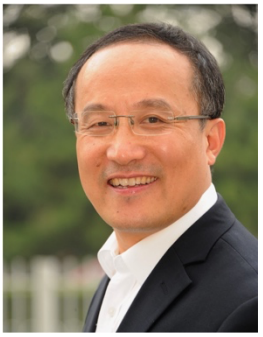

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Tao Zhang is a professor at Dalian Institute of Chemical Physics (DICP), Chinese Academy of Sciences (CAS). He is an academician of CAS, The World Academy of Sciences and the Canadian Academy of Engineering. He was the director of DICP (2007-2017) and vice president of CAS (2017-2023). Professor Zhang's main research interest lies in the catalysts and new materials for energy conversion. He coined the new concept of "Single-Atom Catalysis" in 2011 and invented a new catalytic process from cellulose to ethylene glycol in 2008. Over the past decade, Prof. Zhang has successfully designed a great number of nano, subnano and single-atom catalysts for the applications in energy conversion and environmental protection. Prof. Zhang is the members of Editorial Board or Advisory Board of Green Chemistry, Applied Catalysis B: Environmental, ACS Sustainable Chemistry & Engineering, Industrial & Engineering Chemistry Research, ChemPhyChem, and the co-editors-in-chief of Chinese Journal of Catalysis. He has also received many research awards, including National Award of Technology Invention (2008, 2006, 2005), Excellent Young Scientist Award of Chinese Catalysis Society (2008), Zhou Guang Zhao Foundation Award for Applied Science (2009), Distinguished Award of Chinese Academy of Sciences (2010), The Science and Technology Progress Award of HLHL Foundation (2016), Science China Materials Innovation Award (2018), ChinaNano Award (2019) and Advance of Catalysis Award of the Asian-Pacific Association of Catalysis Societies (2023).