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Molecular Catalysis for the Steam Reforming of Ethanol

By

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Abstract

In this talk the application of molecular catalysis for the steam reforming of ethanol (SRE) is reviewed. Bio-ethanol is a promising liquid fuel to provide clean energy for future transportation and power plants via SRE to produce H_2. However SRE is kinetic controlled under normal conditions and need good catalysts to achieve high ethanol conversion, high H_2 selectivity, low cost and long catalyst life span. Among the 8 metals (Ni, Co, Cu, Pt, Rh, Pd, Ir and Ru) which have shown high catalytic activity, Ni and Rh are the best two because they possess high d character in the metal bond and low metal-oxygen binding (vs. metal-carbon) and hence can effectively promote C-C bond cleavage in the rate-determining process during SRE. However Rh is weak in water-gas-shift so that CH_4 and CO become the main by-products at low reaction temperatures. Iron-oxide in Rh-Fe/Ca-Al_2O_3 can assist Rh catalysts to promote water-gas-shift reaction and significantly improve the SRE performance. Ni is strong in activation of C-C and C-H bonds. Ni/Al_2O_3 is an economic and

excellent catalyst for SRE. However rapid deactivation of the Ni catalysts inhibits its wide application. The addition of 3wt%CaO to Al_2O_3 is found to solve the problems because the Ca modification increases Ni concentration on the surface and 3d electron density near the Fermi level, promoting the C-C bond cleavage of adsorbed C2 intermediates. It also facilitates the water adsorption and availability of abundant surface OH groups which helps the formation and conversion (to H_2 and CO_2) of adsorbed formate. Hence, ethanol reaction on Ca-Al_2O_3-supported Ni, Pt, Pd and Rh catalysts follows formate-intermidated pathway, a new reaction pathway alternative to traditional acetate-intermediated one as that on Pt/Al_2O_3.

Biography

Prof. Jianyi Lin is the Principal Scientist in Energy Research Institute at Nanyang Technological University (Singapore). He got his PhD in Chemistry at Stanford University in1991. He had been the Principal Scientist at the Institute of Chemical and Engineering Science (Singapore) from 2004 to 2012 and associate professor in Physics Department at the National University of Singapore from 1999 to 2004. His research interests include: Surface science, Heterogeneous catalysis, and Nanomaterials, which include hydrogen production and storage, H_2 PEM fuel cell, supercapacitor, and Li-ion battery studies. Prof. Lin had supervised 41 postgraduates (24 PhD and 17 MSc) and 23 research fellows and published 275 SCI papers in international-renowned journals, such as Nature and PRL.

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