



## Catalysis for sustainable development

Ganapati D. Yadav<sup>1</sup> · Bhalchandra M. Bhanage<sup>2</sup>

Published online: 5 April 2018

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This issue is devoted to theme of catalysis for sustainable development covering a few papers presented in the APCAT-7 (Asia Pacific Conference on Catalysis) conference held in Mumbai during January 2017. More than 500 delegates had participated including 135 foreign delegates, and oral and poster presentations totalling 350 were presented.

Omid Mowla et al. discuss in their article on “Hydroesterification of bio-oils over HZSM-5, BETA and Y zeolites” the influence of various experimental parameters on the reaction in order to establish the optimum conditions for which the highest conversion level of zeolite-catalysed oil hydroesterification (two-step reaction/oil hydrolysis and fatty acid esterification) can be achieved. Exceeding stoichiometric values during hydrolysis (excess H<sub>2</sub>O) or esterification (excess CH<sub>3</sub>OH) does not enhance the conversion level of the oil and can act adversely on the extent of hydroesterification. In excess of 95% of the original zeolite activity was recovered via calcination in air during studies of catalyst deactivation.

“Pd Nanoparticles Embedded Carbon Nanotube Interface for Electrocatalytic Oxidation of Methanol towards DMFC Applications” authored by Sunil Kumar et al. deals with synthesis and characterization of different catalysts based on multi-walled carbon nanotubes (MWCNT) among which effect of two different dispersing agents, such as chitosan (CS, 0.1% w/v) and Nafion (Nf, 0.05% w/v), was studied. Dramatic increases in the electrocatalytic activity of Pd-MWCNT-CS catalysts compared to Pd-MWCNT-Nf catalysts towards methanol oxidation were revealed. The steady-state current density for methanol oxidation at

Pd-MWCNT-CS electrode is nearly five times higher than that of Pd-MWCNT-Nf electrode.

Sharma and co-workers have dealt with “Application of BICOVOX Catalyst for Hydrogen Production from Ethanol”. Catalytic activity of cobalt-doped bismuth vanadate [Bi<sub>4</sub>(V<sub>0.90</sub>Co<sub>0.10</sub>)<sub>2</sub>O<sub>11</sub>·BICOVOX] powder, prepared by a solution combustion synthesis method and calcined at 800 °C (BICOVOX-800), for hydrogen production using low-temperature steam reforming of ethanol. It is observed that with increase in reaction temperature and H<sub>2</sub>O:EtOH mole ratio, H<sub>2</sub> and CO<sub>2</sub> selectivities increase whereas CO and CH<sub>4</sub> selectivities decrease. The maximum H<sub>2</sub> selectivity and ethanol conversion are observed to be 63 and 88%, respectively, for H<sub>2</sub>O:EtOH = 23:1 mol ratio at 400 °C.

Heterogeneous cycloaddition of styrene oxide with carbon dioxide for synthesis of styrene carbonate using reusable lanthanum–zirconium mixed oxide as catalyst is an article by Tambe and Yadav. Various solid catalysts such as 0.1% Li/MgO, calcined hydrotalcite (CHT), La–Zr mixed oxide (1:3 La/Zr), 0.1% La/MgO and ZrO<sub>2</sub> were employed for cycloaddition of carbon dioxide to styrene oxide. Carboxylation of styrene oxide with carbon dioxide is enhanced by catalysts having both strong basic sites and weak acidic sites. Patankar et al. have discussed a biobased process intensification in selective synthesis of  $\gamma$ -butyrolactone from succinic acid via synergistic palladium–copper bimetallic catalyst supported on alumina xerogel. The synergistic effect of palladium–copper supported on alumina xerogel is demonstrated to obtain higher yield of  $\gamma$ -butyrolactone during successive dehydration and hydrogenation of succinic acid. The catalytic performance studies were carried out in a slurry batch reactor, and 2.5% Pd–2.5% Cu on alumina xerogel was found to be an active, selective and reusable catalyst.

Ionic liquids have been extensively studied and reported in the literature. In the paper, “Application of ionic liquids in organic synthesis and catalysis” by Bhanage’s group, the authors showed that room-temperature ionic liquids (RTIL) have played multiple roles as catalyst, solvent and catalyst support. In some cases, it was observed that IL enables efficient catalytic reactions in comparison with conventional

✉ Ganapati D. Yadav  
gd.yadav@ictmumbai.edu.in

Bhalchandra M. Bhanage  
bm.bhanage@ictmumbai.edu.in

<sup>1</sup> Department of Chemical Engineering, Institute of Chemical Technology, Nathalal Parekh Marg, Matunga, Mumbai 400019, India

<sup>2</sup> Department of Chemistry, Institute of Chemical Technology, Nathalal Parekh Marg, Matunga, Mumbai 400019, India

molecular solvents. Several urgent questions regarding the fundamental aspects of ILs particularly toxicity, greener preparation methods need to be clarified. Several industrial applications of ionic liquids are also discussed.

Anil Kumar and Rai have reviewed literature on thermal properties of room-temperature ionic liquid (RTIL) solutions which are essential in developing chemical process design in addition to their use in understanding of ionic interactions at molecular level. RTILs are considered to be substitutes for volatile organic compounds. While some experimental thermal data on these systems are available in a random manner, the modelling efforts to correlate enthalpy-concentration profiles of RTIL solutions are very scanty. In this review, an effort has been made to discuss the experimental data available with respect to different quantities of enthalpy.

Palladium supported on silica gel confined ionic liquid as a reusable catalyst for carbon-carbon cross coupling reaction in water is an interesting paper by Ranu et al. which uses 1-decyl-3-methyl imidazolium fluoroborate ([dmim]BF<sub>4</sub>) in water at 80 °C. A variety of substituted aryl bromides underwent Suzuki and Heck coupling with various boronic acids and acrylates, respectively, to produce a series of functionalized biaryls and cinnamates in high yields.

Dhepe's group have two publications, one of them is concerned with effect of structural properties of organosolv lignins isolated from different rice husks on their liquefaction using acidic ionic liquids. When liquefaction was carried out at 120 °C for 1 h, 36% yield for EtOAc and DEE soluble products with high mass balance (97 ± 3%) was observed. The detailed characterizations of lignins and

organic solvent soluble products were done by a variety of techniques, and based on this, correlations between activity and properties of catalyst and lignin were established. In the second paper, biomass derived furfural (FAL) is converted into 2-methylfuran (2-MF) in the presence of PtCo/C bimetallic catalyst under 0.5–1 MPa H<sub>2</sub> pressure. 59% 2-MF yield was achieved at 180 °C and lower (0.5 MPa) H<sub>2</sub> pressure.

Glycerol, the co-product of biodiesel manufacture, is valorized into several chemicals. Dinesh Kumar et al. have explored the use of large pore size catalyst with high surface area in using KIT-6 silica-based mesoporous material for the conversion of glycerol to higher hydrocarbons. Palladium and alumina were incorporated on KIT-6 for providing Lewis acid sites and removal of oxygen. Maximum yield of 38.9% for gasoline range hydrocarbon fraction was obtained at 550 °C. Liquid product obtained in the presence of palladium has higher H/C ratio indicating the formation of paraffinic compounds and removal of oxygen.

Xie et al. investigated the influence of the presence of alkali compounds K and Na on the performance of a commercial Pt-Pd/Al<sub>2</sub>O<sub>3</sub> diesel oxidation catalyst (DOC), more particularly to show their influence on the reactions involving CO, hydrocarbons and NO. Promotion effect was found in the presence of K, whereas inhibiting effect was evidenced in the presence of Na or both Na/K on the DOC.

Ganapati D. Yadav  
Bhalchandra M. Bhanage  
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