Solid Base Catalysts: Opportunities for Renewable Fuels

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Abstract

A sustainable biomass economy requires the development of different integrated steps for the conversion of biomass-derived feedstocks into a range of fuels and chemicals. Many of these steps involve basic catalysts. One key step in biorefinery concept to produce diesel and jet fuel range alkanes involves C-C bond forming reactions by aldol condensation. In this research, we present two types of novel solid base catalysts for both the liquid and gas phase aldol condensation reactions: the nitrogen-substituted zeolites and silica supported CeZrO$_x$. Furaldehydes condensation with acetone or propanal was studied in liquid phase over the nitrogen-substituted NaY (Nit-NaY) and MgO-ZrO$_2$, a mixed metal oxide. Nit-NaY showed comparable catalytic activity to MgO-ZrO$_2$, but higher selectivity to furadhyde acetone monomer product, indicating the shape selective significance of Nit-NaY. In the gas phase aldol condensation reaction, butanal was selected as model compound to generate C8 to C12 hydrocarbon compounds. CeZrO$_x$/SiO$_2$ lowers the reaction temperature about 100°C and is very stable towards acid poisoning compared to MgO/SiO$_2$. The nature of the basic sites, the reaction chemistries and reaction mechanisms were also investigated.

Keywords: Aldol condensation, solid base catalysts, biorefinery, nitrogen-substituted zeolites, silica supported CeZrO$_x$ catalyst