Catalytic Oligomerization of Furfuryl Alcohol over Homogeneous and Heterogeneous Catalysts

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Abstract

The conversion of lignocellulosic biomass into fuels has been investigated as results of increasing demand for petroleum oil and environmental concern. Furfuryl alcohol (FA), which is produced from furfural derived from a selective dehydration of xylose, is an attractive intermediate chemical for the production of template chemicals, such as levulinic acid and alkyl levulinate. During the formation of template chemicals, FA can be also converted to oligomer / polymer via dehydration under acidic conditions. To minimize the yield of oligomer/polymer and maximize the yield of LA, fundamental understanding of undesired side reactions is required. The acid-catalyzed FA oligomer/polymerization has been studied in the liquid phase to identify the intermediate species and investigate the reaction mechanism. At room temperature, with a mineral acid (H_2SO_4) and Amberlyst 15 polymeric resin, FA monomer was vigorously converted into oligomer/polymers. A strong C=C and C=O bands observed in the Raman and IR spectra, respectively, provided the formation of a conjugated diene and diketone structure during the reaction. Based on the mass spectrometer data, FA monomer converted into a broad range of carbon number oligomers and three different dimer structures were observed; terminal CH_2OH, ether bridged and methylene bridged dimer. In the case of metal oxide catalysts (Al_2O_3, ZrO_2, TiO_2, and Nb_2O_5), even at 100 ^oC, FA oligomerization was not observed, while WO_3 can change the FA monomer color from yellow to red. It is suggested that small amount of FA monomer converted into oligomer over WO_3 catalyst and the number of carbon can possibly be controlled.