

The Summer Undergraduate Research Fellowship (SURF) Symposium  
6 August 2015  
Purdue University, West Lafayette, Indiana, USA

## Determining Glucose Isomerization Mechanisms on Lewis Acidic Beta Zeolites Using Isotopic Tracer Studies and $^1\text{H}$ NMR

Jacklyn Hall, Michael Cordon, and Rajamani Gounder  
Department of Chemical Engineering, Purdue University

### ABSTRACT

Biofuels synthesized from biomass sources are becoming necessary for sustainable production due to their significantly lower net  $\text{CO}_2$  production than fuels synthesized from fossil-based carbon sources such as petroleum. Catalytic pathways for the primary biomass-to-biofuels reaction pathway include the isomerization of glucose to fructose, which can be catalyzed by either Lewis acids or bases. Isolated metal atoms and metal oxide particles on Beta zeolites serve as active sites that catalyze this reaction through a Lewis acid 1,2-intramolecular hydride shift or by a Lewis base proton transfer mechanism, respectively. The Lewis acid mechanism has proven to have higher fructose selectivity than the Lewis base mechanism. Determining the glucose-fructose isomerization mechanism provides critical information about the active site placement in catalysts prepared by different methods, making it an ideal test of quality control for new material syntheses. Using glucose reactants deuterated at the second carbon, catalytic reaction mechanisms could be determined by tracing the location of the deuterium atom in the sugar products using  $^1\text{H}$  NMR spectroscopy. Comparison of fructose product spectra with an unlabeled fructose standard was used to show that glucose isomerization to fructose followed the Lewis acidic pathway on the samples in this study. The outcomes of these isotopic labeling studies provide insight into the placement of Lewis acid metals in zeolite frameworks and help to further understand this important step in biomass conversion to biofuels.

### KEYWORDS

Beta zeolites, proton NMR, Lewis acid, isomerization, fructose, glucose