New Sugar Conversion Mechanisms Identified On Zeolite-based Catalysts

Scientific Achievement

Lewis acid Sn sites in zeolites selectively catalyze glucose epimerization to mannose in methanol and glucose isomerization to fructose in water. Extraframework SnO$_2$ contains base sites that catalyze isomerization via enolization.

Significance and Impact

- The first demonstration of glucose epimerization via an intramolecular C1-C2 carbon shift (Bilik reaction) on a solid Lewis acid.
- Opportunities to tailor catalyst structure during or after synthesis to influence selectivity in biomass and sugar conversion by exploiting different reactions prevalent on different Sn site structures.

Research Details

- Framework and extraframework Sn sites identified unambiguously by $^{119}$Sn MAS NMR.
- Base-catalyzed enolate mechanism for isomerization on extraframework SnO$_2$ confirmed by isotopic labeling studies.
- Bilik mechanism for glucose epimerization (intramolecular C1-C2 carbon shift) determined from reactions of isotopically-labeled glucose ($^2$H at C-2, $^{13}$C at C-1); product analysis by $^1$H and $^{13}$C liquid NMR.

Work was performed by the group of Mark Davis at the California Institute of Technology.