# One-pot conversion of furfural to γ-valerolactone with bifunctional Sn/Al Beta zeolites

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Bifunctional Sn/Al Beta zeolite catalysts were prepared via post-synthesis procedure and utilized for the one-pot synthesis of γ-valerolactone (GVL), a renewable platform chemical, from biomass-derived furfural. Several partially-dealuminated H-Al-Beta were prepared through acid treatment and the degree of dealumination was adjusted by varying the acid concentration. This step allows us to tune the concentration of Brønsted acid sites within the Beta zeolites and create the vacant tetrahedral sites for tin species. Incorporation of tin into the Beta zeolite for Lewis acid sites was accomplished by solid state ion exchange with organometallic precursors. The synthesized Sn/Al Beta zeolites can selectivity convert furfural into GVL (~70% selectivity) in alcoholic solvents (e.g. 2-propanol) via transfer hydrogenation catalyzed by Lewis acid sites and hydrolytic ring-opening reaction catalyzed by Brønsted acid sites. The detailed kinetic analysis of furfural reactions combined with structure and acidity characterizations of the catalysts using solid-state NMR, $NH_3$-TPD, pyridine-FTIR, UV-VIS spectroscopy revealed the presence of bifunctional sites, isolated Lewis and Brønsted acid sites, within the Sn/Al Beta zeolites.