Department of Materials Science and Engineering Seminar Series 2025

Atomic-Level Engineering of Nanoalloy Catalysts

Xu Chaokai

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Venue: EA-02-14

Abstract

Nanoalloys with tunable morphology and composition have been found active in various thermocatalytic applications. While some simplified preparation methods like impregnation can produce nanoalloys, they are randomly distributed on support, which hampers the effective formation of desired configurations. The heterogeneity of metal species also results in the challenge of interpreting structure-property relationships. This thesis starts from the efforts to control Pt-Sn distribution in $PtSn/Al_2O_3$, an industrially important propane dehydrogenation catalyst, by constructing molecular complexes in the precursor solution. As-obtained Pt-Sn nanoparticles with uniform sizes (~ 1 nm) exhibit a higher initial propylene productivity than the counterpart prepared by conventional impregnation method. However, elaborate electron microscopy analysis reveals that compositional variation still exists among the particles. The overall catalytic activities turn out to correlate well with the Pt dispersity, indicating the structure-insensitive nature of reaction. The molecular complex strategy can be extended to Pt-Zn nanoparticles, which are reported to be highly selective in propane dehydrogenation reaction. The oxalate-bridged complex assists reduction of Zn and Pt-Zn alloy formation, leading to improved propylene productivity. In addition, the mobility of Zn under H_2 treatment is used to control the Pt-Zn alloy composition. Identical location electron microscopy studies track the gradual change and stabilization of alloy composition, and its relationship with catalytic performance is established. These results show the importance of atomic-level engineering for catalysis, and the strategies can be transferred to other nanoalloy catalysts.

Biography

Xu Chaokai received his Bachelor of Science degree from Peking University in 2020. He is currently a Ph.D. candidate in Department of Materials Science and Engineering under the supervision of Asst. Prof. He Qian. His research focuses on nanostructured thermocatalysts for energy and environmental applications.

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