Physicochemical Stabilization of Pt against Sintering for a Dehydrogenation Catalyst with Exceptionally High Activity, Selectivity, and Durability

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Suppressing irreversible catalyst deactivation is critical in heterogeneous catalysis. In particular, deactivation via sintering of active sites is a significant issue for reactions involving harsh reaction/regeneration conditions. Here, we developed a PtGa/γ-Al_2O_3 alkane dehydrogenation catalyst with exceptionally high activity, selectivity, and long-term stability by markedly suppressing Pt sintering under harsh conditions (reaction/regeneration at >823 K). To stabilize Pt, physical and chemical stabilization strategies were synergistically combined. For the former, Pt was introduced during the synthesis of γ-Al_2O_3 via sol-gel chemistry, which can increase the interfacial contact between Pt and γ-Al_2O_3 due to the partial entrapment of Pt in γ-Al_2O_3. For the latter, Ce was doped on γ-Al_2O_3, which can stabilize Pt via strong Pt-O-Ce interactions. Because of effective Pt stabilization, the catalyst showed remarkably steady activity and selectivity over the repeated reaction cycles, although the catalyst is regenerated via simple oxidation rather than industrially used oxychlorination.