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SUPPORTING INFORMATION

Influence of support on the catalytic properties of Pt-Sn-K/θ-Al_2O_3 for propane dehydrogenation

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Fig. S1 shows the conversion and selectivity of the main by-products of catalysts supported on different θ-Al_2O_3 supports.

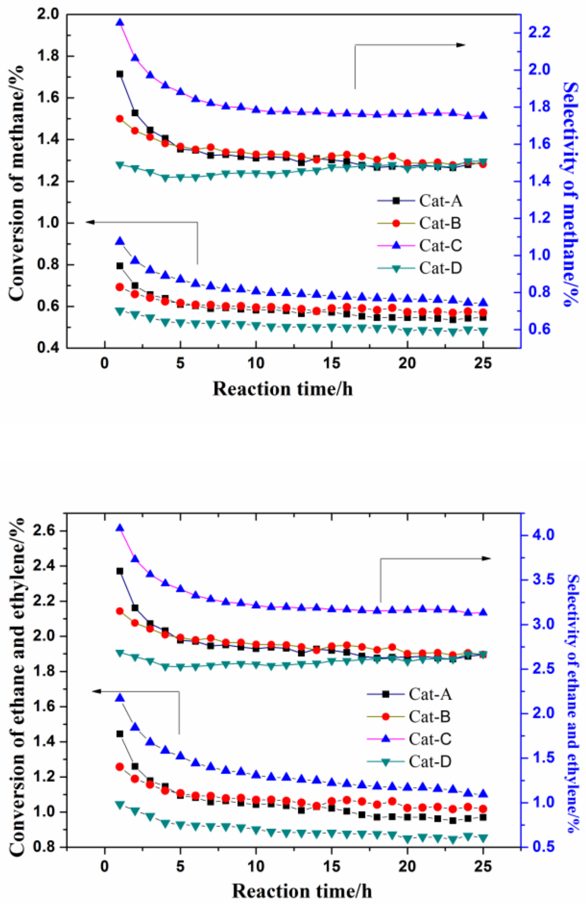

Fig. S1 Conversion and selectivity of the main by-products (methane, ethane and ethylene) of catalysts supported on different θ-Al_2O_3 supports (reaction conditions: T=600 °C, H_2:C_3H_8=0.5:1,WHSV=4 h^{-1}, mcat=0.25g).

The analysis of side-products (methane, ethane and ethylene) produced during the propane dehydrogenation process was conducted, and the conversion and selectivity are depicted in Fig. S1. As can be seen, the byproducts with 4 carbon atoms or more are not observed. The conversion and selectivity of those byproducts are lower compared with propane. The conversion and selectivity of methane show a similar trend to that of ethane and ethylene, both different from propane.

Fig. S2 shows the relationship between the total pore volume of different supports and the deactivation parameter of four catalysts.

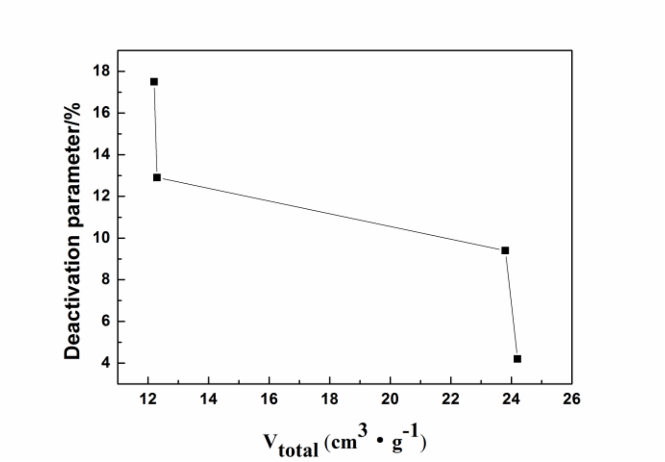

Fig. S2 Relationship between the total pore volume of different supports and the deactivation parameter of four catalysts.

It can be seen from Fig. S2 that with the increase of the total pore volume, the decrease trend was observed for the deactivation parameter of different catalysts. It indicates that large pore volume can improve the stability of catalysts. The reasons are that coke can deposit on the external surface of the support and didn't cover the active metal surface, which is benefit to keep the catalysts' activity. And large pore volume can accommodate more carbon deposites too.

Fig. S3 shows the DTA curves of the deactivated catalysts

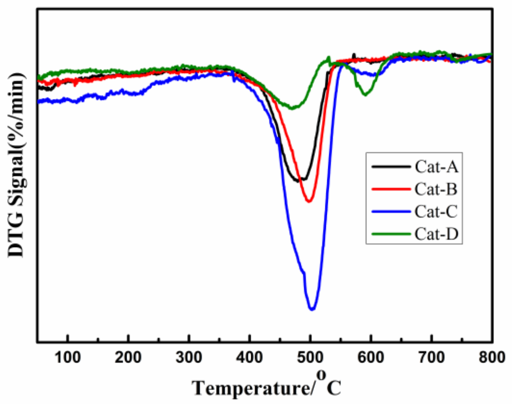

Fig. S3. The DTA profiles of deactivated catalysts

The DTA curves of different deactivated catalysts are plotted in Fig. S3. The coke oxidation zone at lower temperature (350–450 °C) was attributed to the coke deposited on or around the Pt particles, while the one at higher temperature (>450 °C) was related to the coke located on the external surface of the support, which was composed of polymerized carbon species with high graphitization degree.[1] In Fig. S3, all the deactivated catalysts display a broad combustion peak between 350 and 600°C. The combustion peak of coke deposited on the Pt particles is obvious, as the Pt centers may be covered by some coke deposits that is not on the catalyst surface and the catalytic combustion of coke occurs before the coke layered on the support. On the other hand, the amounts and properties of the coke deposited on the catalysts are related to their total acid content, acidic strength distribution and the textural properties. Part of coke was deposited on the active centers, which can decrease the catalytic activity and the rest of coke is located on the acidic centers, which improves the selectivity to propene. The amount of coke deposited on the catalysts is gradually increased with the prolongation of the reaction time.

References

1 Afonso, J. C., M. Schmal and R. Frety (1994) The chemistry of coke deposits formed on a Pt-Sn catalyst during dehydrogenation of N-alkanes to mono-olefins. Fuel Processing Technology 41(1): 13-25.