

Acid-base properties of Al₂O₃: effects of morphology, crystalline phase, and additives

Jaekyoung Lee, Eun Jeong Jang, and Ja Hun Kwak*

Department of Chemical Engineering, School of Energy and Chemical Engineering, UNIST, Ulsan, Korea

*E-mail: jhkwak@unist.ac.kr

γ -Al₂O₃ is one of the most important heterogeneous catalyst materials [1-3], and is mainly used as a support for catalytically active phases (metal and oxide) owing to its textural properties, such as high surface area and thermal stability. Al₂O₃-based catalysts have wide applications, ranging from petroleum chemistry to automobile emission control. In addition, γ -Al₂O₃ itself is a well-known acidic catalyst for alcohol dehydration reactions.

In this presentation, I would like to show the strong correlation between the desorption temperature (T_d) of dissociative ethanol and the catalytic behaviors of Al₂O₃ surfaces with various modification origins (morphologies, phases, and additives) using an acid-catalyzed model reaction (ethanol dehydration). For general insight into the effect of each factor on surface modification, we prepared Al₂O₃ with different morphologies (platelet and rod), transition aluminas, and Al₂O₃ supported by metal oxides.

Based on a combined ethanol TPD/dehydration study, we could demonstrate that ethylene productivity was inversely proportional to the T_d of dissociative ethanol irrespective of modification origins. Interestingly, the apparent activation barrier for ethylene formation showed a volcano-type relationship with T_d where the maximum E_a was observed on pure γ -Al₂O₃ (159–165 kJ/mol). However, ether showed similar apparent activation barrier (84–106 kJ/mol), suggesting potentially different active sites for ethylene and ether formation. This empirically correlated trend suggests that T_d can be used as

a descriptor for the acid-base properties of Al₂O₃ with various modification origins.

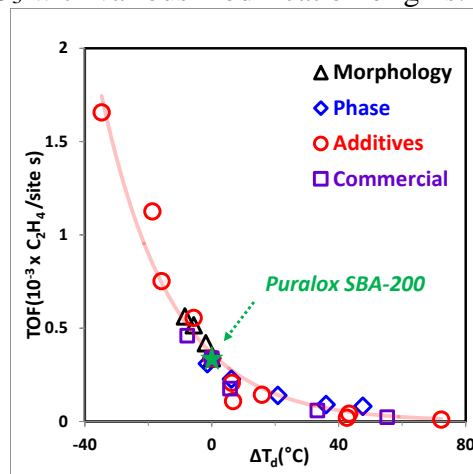


Fig. 1 Ethylene formation rate vs desorption maximum temperature of dissociative ethanol.

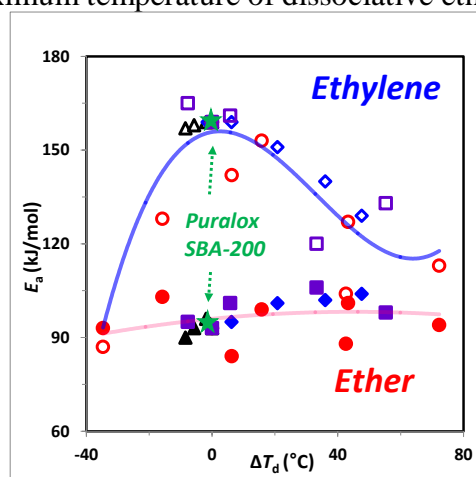


Fig. 2 Variation of apparent activation barrier of ethylene and ether with ethoxide desorption temperature.

REFERENCES

- [1] J. Lee, E. J. Jang and J.H. Kwak, J. Catal. 345 (2017) 135.