

## Supporting Information

### High Field 1D and 2D $^{27}\text{Al}$ MAS NMR Study of $\theta$ -, $\delta$ -, and $\gamma$ - $\text{Al}_2\text{O}_3$ Dominated Aluminum Oxides: Toward Understanding the Al Sites in $\gamma$ - $\text{Al}_2\text{O}_3$

Suochang Xu,<sup>a,b</sup> Nicholas R. Jaegers,<sup>a,c</sup> Wenda Hu,<sup>a,c</sup> Ja Hun Kwak,<sup>a,d</sup> Xinhe Bao,<sup>b</sup> Junming Sun,<sup>c</sup> Yong Wang,<sup>a,c,\*</sup> and Jian Zhi Hu<sup>a,\*</sup>

<sup>a</sup>Institute for Integrated Catalysis, and Environmental Molecular Sciences Laboratory, Pacific Northwest National Laboratory Richland, Washington 99354, USA.

<sup>b</sup>Dalian Institute of Chemical Physics, the Chinese Academy of Sciences, Dalian, P.R. China.

<sup>c</sup>Gene and Linda Voiland School of Chemical Engineering, Washington State University, Pullman, WA 90015, USA.

<sup>d</sup>Ulsan National Institute of Science and Technology (UNIST), Ulsan 689-798, Korea.

To whom the correspondence should be addressed:

Supporting Information

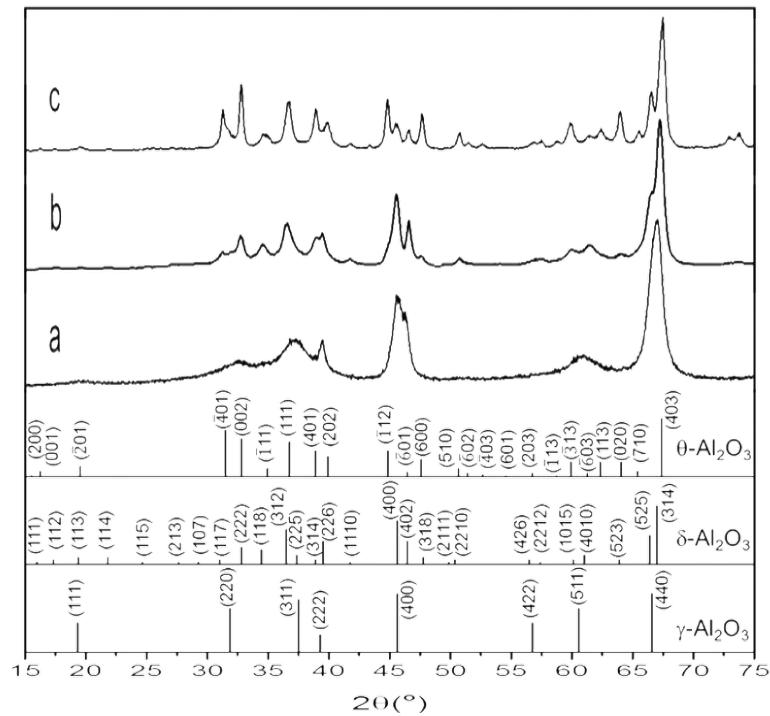


Figure S1. XRD patterns of the as-prepared alumina samples, (a)  $\gamma\text{-Al}_2\text{O}_3$ , (b)  $\delta\text{-Al}_2\text{O}_3$ , (c)  $\theta\text{-Al}_2\text{O}_3$ , the vertical lines correspond to the peak positions and intensities of  $\gamma\text{-Al}_2\text{O}_3$  (PDF file no.50-0741),  $\delta\text{-Al}_2\text{O}_3$  (PDF file no.16-394),  $\theta\text{-Al}_2\text{O}_3$  (PDF file no.23-1009), respectively. In trace C, there is a group of four features just above  $45^\circ$ . The outside 2 are indicative of theta while the inside 2 suggest delta. The small feature just to left  $\sim 43^\circ$  is alpha at 0.6%.

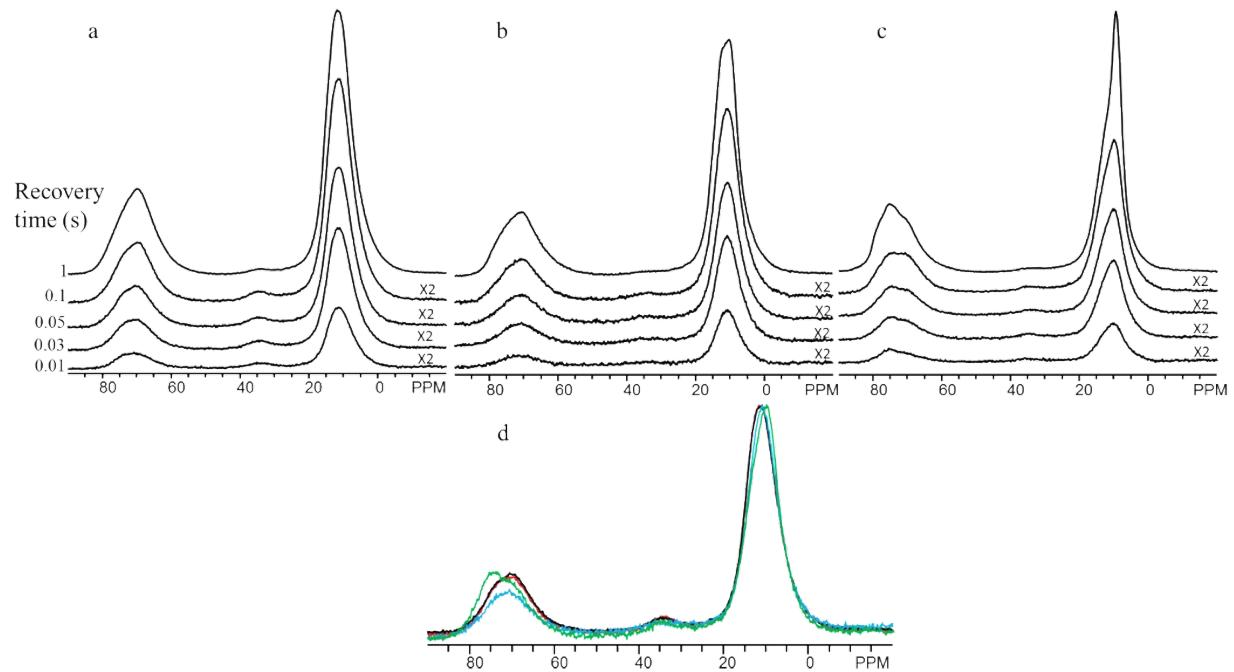


Figure S2. Spin-lattice relaxation NMR spectra. (a-c)  $^{27}\text{Al}$  MAS NMR spectra of the prepared alumina samples as a function of several selected recovery times. (a) sample A, (b) sample B, (c) sample C, (d) overplayed spectra of the three samples, the black and red lines are sample A acquired with recovery time 0.05 and 0.03 s, respectively. The blue and green lines are sample B and C acquired with recovery time 0.03 s.