

Appendix A. Supplementary Information

Constructing Tri-coordinated Al (Al_{III}) Sites to Boost Complete Propane Oxidation of Pt/Al₂O₃ Catalyst

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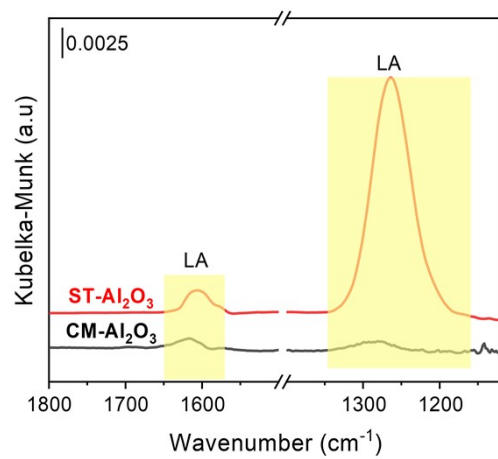


Fig. S1. NH₃-FTIR spectra of CM-Al₂O₃ and ST-Al₂O₃ collected at 200 °C. LA: Lewis acid.

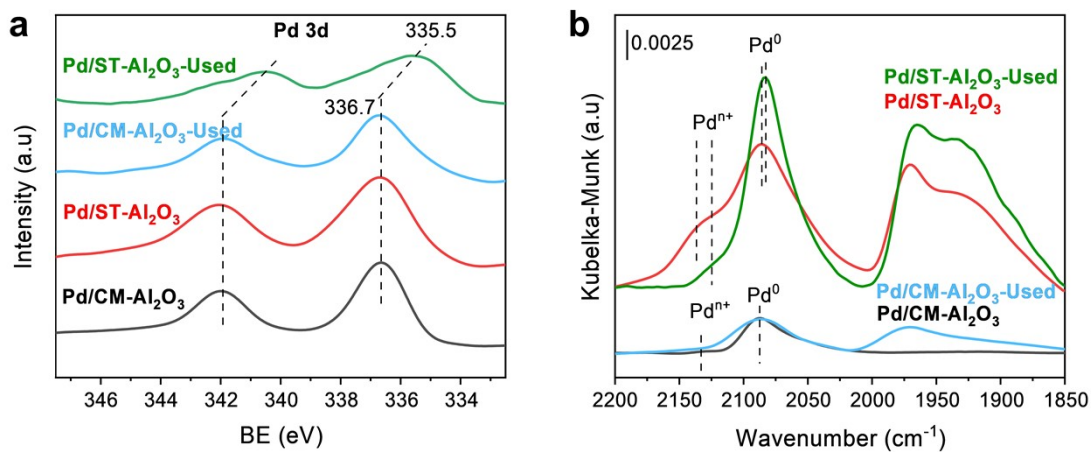


Fig. S2. (a) Pd 3d XPS, and (b) CO-FTIR of Pd/CM-Al₂O₃, Pd/ST-Al₂O₃, Pd/CM-Al₂O₃-Used, and Pd/ST-Al₂O₃-Used. BE: binding energy.

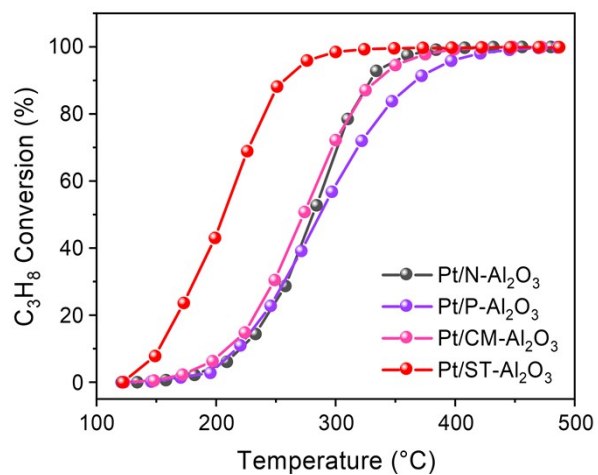


Fig. S3. The complete propane oxidation activity comparison with other Pt/Al₂O₃ catalysts. All the curves were obtained after three reaction cycles. (The complete propane oxidation activity test condition: 0.2 vol.% C₃H₈ + 1 vol.% O₂ + N₂ balance, 50 mL/min total flow, 0.1 g catalyst, WHSV = 30,000 mL·g⁻¹·h⁻¹.)

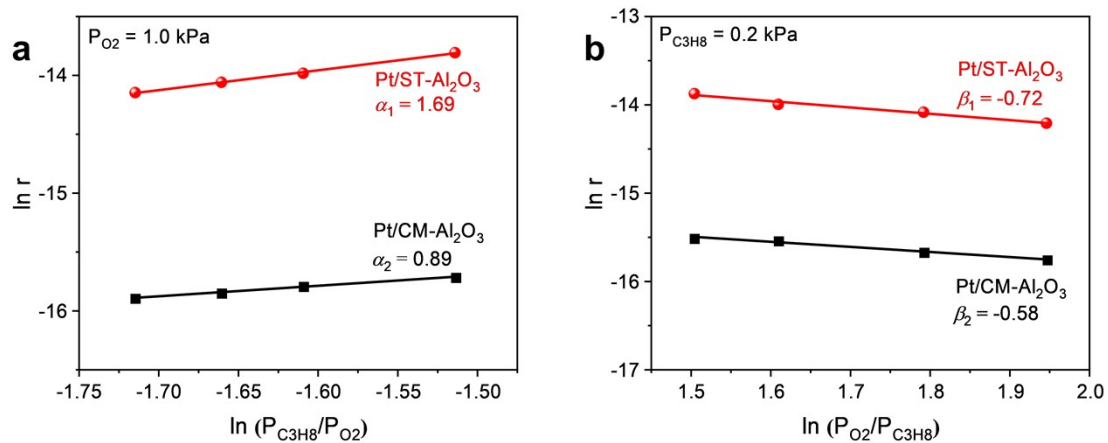


Fig. S4. The (a) propane and (b) oxygen orders of Pt/CM- Al_2O_3 and Pt/ST- Al_2O_3 . Test temperature: 220 °C.

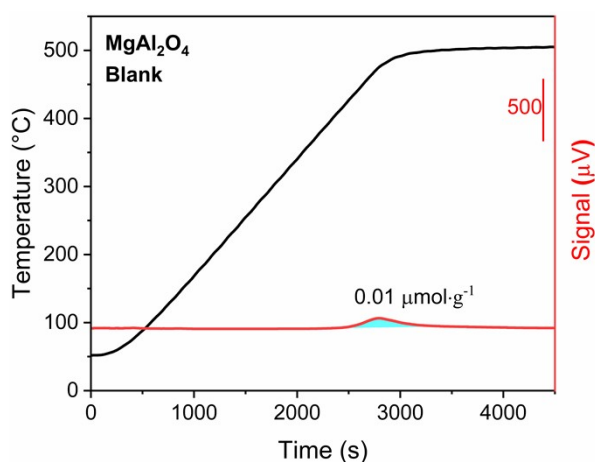


Fig. S5. The blank experiment profile of C₃H₈-TPD.

To evaluate the possible effect induced by residual carbonates of sample, we prepared a more basic sample MgAl₂O₄ by the reported method¹, to perform a blank experiment. The blank experiment procedure was identical to the original C₃H₈-TPD, except that the propane adsorption step was absent. As shown in Fig. S5, the residual carbonates contributed a desorption signal equivalent to only 0.01 µmol·g⁻¹ propane, much lower than the desorption propane amounts of CM-Al₂O₃ (0.19 µmol·g⁻¹), proving the reliability of C₃H₈-TPD experiment.

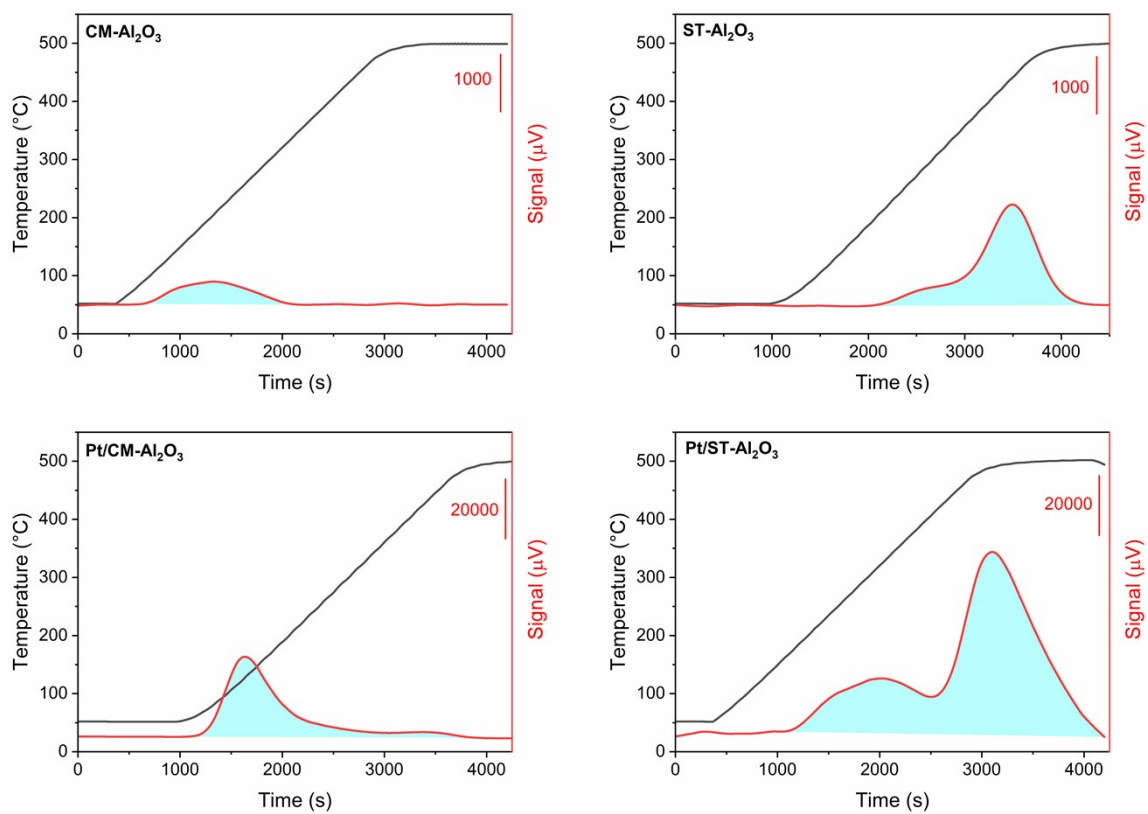


Fig. S6. C_3H_8 -TPD profiles of (a) CM- Al_2O_3 , (b) ST- Al_2O_3 , (c) Pt/CM- Al_2O_3 , and (d) Pt/ST- Al_2O_3 .

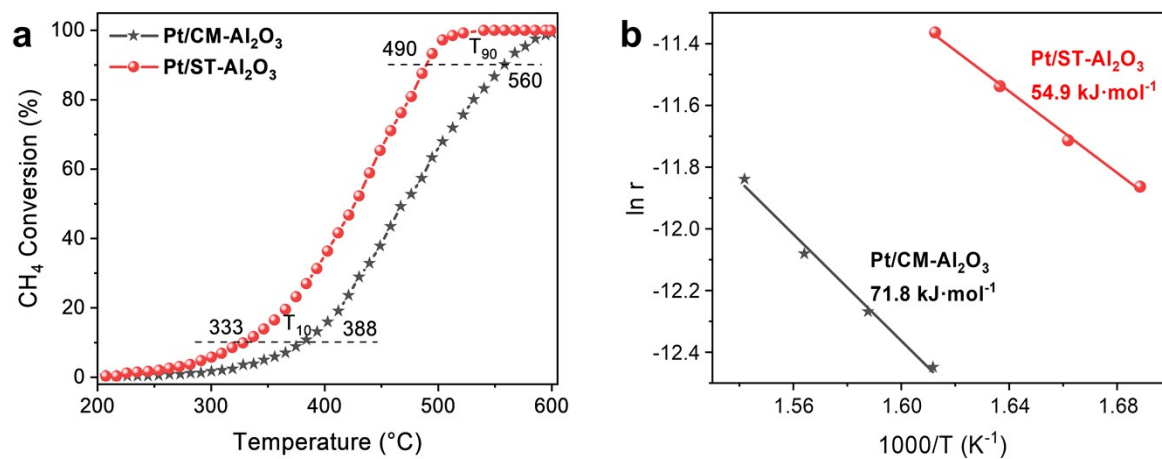


Fig. S7. (a) The complete methane oxidation activity curves, and (b) apparent activation energies. (The complete methane oxidation activity test condition: 0.2 vol.% CH₄ + 1 vol.% O₂ + N₂ balance, 50 mL/min total flow, 0.1 g catalyst, WHSV = 30,000 mL·g⁻¹·h⁻¹.)

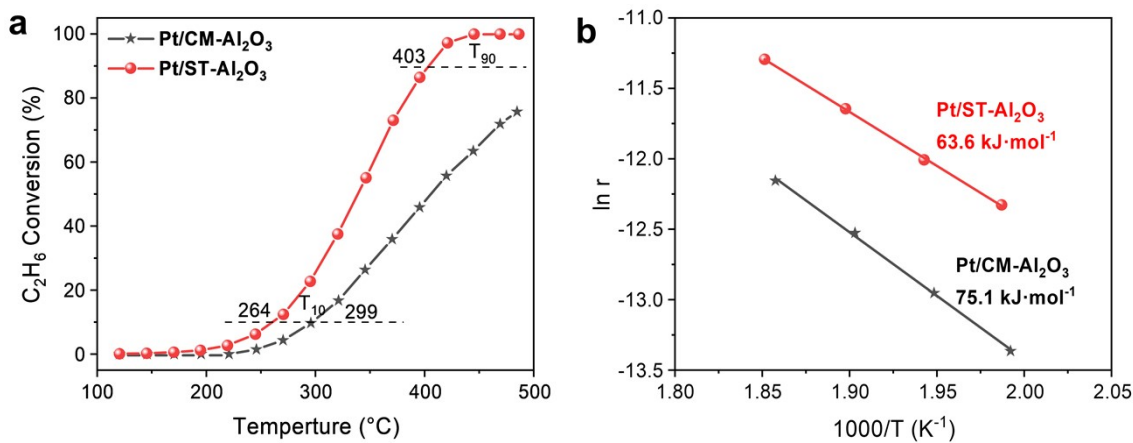


Fig. S8. (a) The complete ethane oxidation activity curves, and (b) apparent activation energies. (The complete ethane oxidation activity test condition: 0.2 vol.% C₂H₆ + 1 vol.% O₂ + N₂ balance, 50 mL/min total flow, 0.1 g catalyst, WHSV = 30,000 mL·g⁻¹·h⁻¹.)

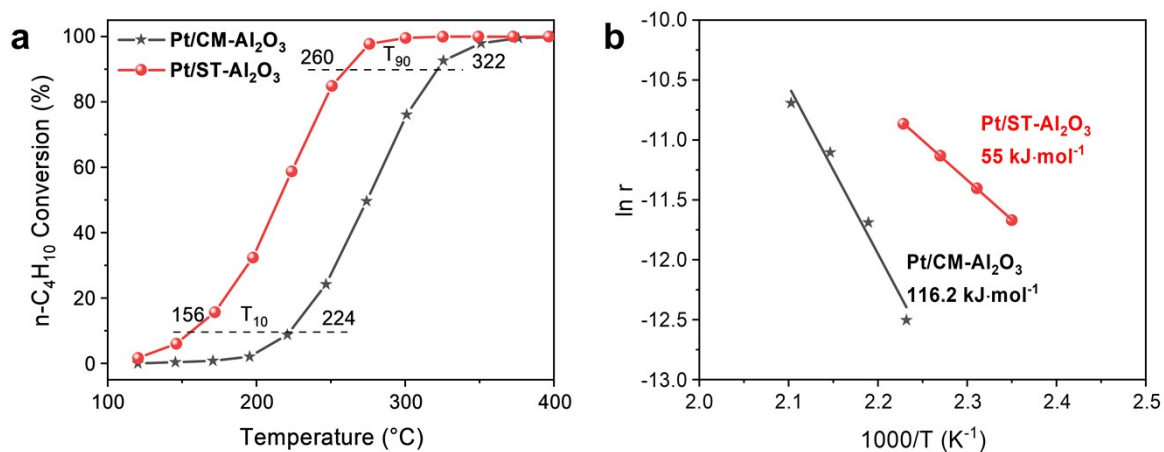


Fig. S9. (a) The complete n-butane oxidation activity curves, and (b) apparent activation energies. (The complete n-butane oxidation activity test condition: 0.2 vol.% n-C₄H₁₀ + 2 vol.% O₂ + N₂ balance, 50 mL/min total flow, 0.1 g catalyst, WHSV = 30,000 mL·g⁻¹·h⁻¹.)

Table. S1. The physical-chemical parameters of Pd/CM-Al₂O₃ and Pd/ST-Al₂O₃.

Catalyst	Pd Contents (wt%) ^a	Pd Dispersion D (%) ^b
Pd/CM-Al ₂ O ₃	0.82	17.6
Pd/ST-Al ₂ O ₃	0.82	58.0

^a Measured by ICP-OES.

^b Calculated by CO pulse chemisorption experiment.

Table. S2. Quantified data from C₃H₈-TPD (Fig. S6).

Sample	CM-Al ₂ O ₃	ST-Al ₂ O ₃	Pt/CM-Al ₂ O ₃	Pt/ST-Al ₂ O ₃
C ₃ H ₈ Desorbed Amounts (μmol·g ⁻¹)	0.19	0.73	10.5	40.1
Desorbed C ₃ H ₈ per Surface Pt atom	-	-	0.44	1.44

1. F. Wang, W.-Z. Li, J.-D. Lin, Z.-Q. Chen and Y. Wang, *Appl. Catal., B*, 2018, **231**, 292-298.