Supporting Information

Enhancing the Low-temperature Performance of Pt-based Three-way Catalysts Using CeO₂(core)@ZrO₂(shell) Supports

Chih-Han Liu¹, Junjie Chen^{1,a*}, Patrick R. Raffaelle², Michael J. Lance³, Jacob Concolino¹, Prateek Khatri¹, Tala Mon¹, Todd J. Toops³, Alexander A. Shestopalov², and Eleni A. Kyriakidou^{1,*}

 ¹ Department of Chemical and Biological Engineering, University at Buffalo, The State University of New York, Buffalo, NY 14260, USA
 ² Hajim School of Engineering and Applied Sciences, University of Rochester, Rochester, New York 14627, USA
 ³ Oak Ridge National Laboratory, Oak Ridge, TN 37831, USA
 ^a Current address: SUNCAT Center for Interface Science and Catalysis, Department of Chemical Engineering, Stanford University, Stanford, CA 94305, USA

*Corresponding authors at:

jchen@buffalo.edu (J. Chen)

elenikyr@buffalo.edu (E.A. Kyriakidou)

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Sample	Surface area (m ² /g)
CeO ₂ sphere	83.6
0.9CeO ₂ @0.1ZrO ₂	93.5
$0.8 \text{CeO}_2 @ 0.2 \text{ZrO}_2$	87.2
$0.7 \text{CeO}_2 @ 0.3 \text{ZrO}_2$	95.0
0.5CeO ₂ @ 0.5 ZrO ₂	69.3
$Ce_{0.9}Zr_{0.1}O_2$	77.2

 Table S1. BET surface area of all studied supports (calcined at 500 °C for 2 h in static air).



Fig. S1. N₂ adsorption (solid) – desorption (open) isotherms of $(1-x)CeO_2@xZrO_2$ (where x = 0, 0.1, 0.2, 0.3, and 0.5) and $Ce_{0.9}Zr_{0.1}O_2$ supports.



Fig. S2. HRTEM images of CeO₂ spheres.



Fig. S3. (a) HRTEM images of $0.5 \text{CeO}_2 @ 0.5 \text{ZrO}_2$ support. (b) HRTEM and (c) EDS elemental maps of Pt/ $0.5 \text{CeO}_2 @ 0.5 \text{ZrO}_2$ showing non-uniform coverage of ZrO₂ on the surface of CeO₂.



Fig. S4. XPS survey scan of 0.9CeO₂@0.1ZrO₂.



Fig. S5. Light off curves of (a) CO, (b) THCs, and (c) NO_x over DG 1.8 wt.% Pt/(1-x)CeO₂@xZrO₂ (DG) (x = 0, 0.1, 0.2, 0.3, 0.5) catalysts.



Fig. S6. Comparison of $T_{50,90}$'s of CO (black), THC (blue), and NO_x (red) for (a) DG and (b) HTA 1.8 wt.% Pt/0.9CeO₂@0.1ZrO₂ (c@s) and 1.8 wt.% Pt/Ce_{0.9}Zr_{0.1}O₂ (s-s) catalysts.



Fig. S7. (a) Effluent CO concentration and (b) CO concentration subtracted from the empty reactor (blank) effluent CO over $Pt/(1-x)CeO_2@xZrO_2$ (x = 0, 0.1, 0.2, 0.3, 0.5) catalysts.



Fig. S8. Oxygen releasing rate of CeO₂ sphere, 0.7CeO₂@0.3ZrO₂, and Ce_{0.7}Zr_{0.3}O₂ solid solution at 150, 350, and 550 °C.



Fig. S9. Light off curves of (a) CO, (b) THCs, and (c) NO_x over HTA 1.8 wt.% Pt/(1-x)CeO₂@xZrO₂ (HTA) (x = 0, 0.1, 0.2, 0.3, 0.5) catalysts.



Fig. S10. TEM images of $Pt/0.9CeO_2@0.1ZrO_2$ after redox HTA.



Fig. S11. ΔT_{50} (= $T_{50,HTA} - T_{50,DG}$) of CO, THC, and NO_x over 1.8 wt.% Pt/(1-x)CeO₂@xZrO₂ (x = 0, 0.1, 0.2, 0.3, 0.5) catalysts.