## **Supporting Information**

## CoO<sub>x</sub>-decorated CeO<sub>2</sub> Heterostructures: How the Morphology Affects Catalytic Properties in Diesel Soot Combustion

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Figure S1.  $N_2$  adsorption-desorption isotherm for a series of CoCeO<sub>2</sub> catalysts with different morphologies.



**Figure S2**. (A) UV-vis adsorption spectra and (B) the estimated band gap energies determined from the  $(ahv)^{1/2}$  versus photon-energy plot of of a series of CeO<sub>2</sub> catalysts with different morphologies.



Figure S3. (a) TEM image, (b) HR-TEM images, and (c) SEAD of CeO<sub>2</sub>-NR.



Figure S4. (a) TEM image, (b,c) HR-TEM image, and (d) SEAD of CeO<sub>2</sub>-NC.



Figure S5. TEM image of CeO<sub>2</sub>-NP.



Figure S6. NO-temperature programed oxidation (TPO).



Figure S7. Comparison of NO-TPD spectra of CoCeO<sub>2</sub> samples.



**Figure S8.** Comparison of O<sub>2</sub>-TPD spectra of CoCeO<sub>2</sub> samples and desorption temperature.



**Figure S9.** Repeated change in the Ce  $L_{III}$ -edge XANES spectra of the series of CoCeO<sub>2</sub> catalysts with different morphologies measured at 340 °C under oxidative (10% O<sub>2</sub>/He; blue lines) or reductive (20% H<sub>2</sub>/He; blue lines) atmospheres.



Figure S10. TEM images of a series of recovered  $CoCeO_2$  with different morphologies after the carbon soot combustion under tight contact mode with 20%  $O_2$  atmosphere.



Figure S11. XRD pattern of a series of  $CoCeO_2$  catalysts with different morphologies before and after the catalytic reaction.

Catalyst	$a_0$ / Å	
	Before reaction	After reaction
CoCeO <sub>2</sub> -NR	5.420	5.421
CoCeO <sub>2</sub> -NC	5.416	5.407
CoCeO <sub>2</sub> -NP	5.418	5.409

Table S1. Lattice constant of a series of  $CoCeO_2$  before and after the carbon combustion.