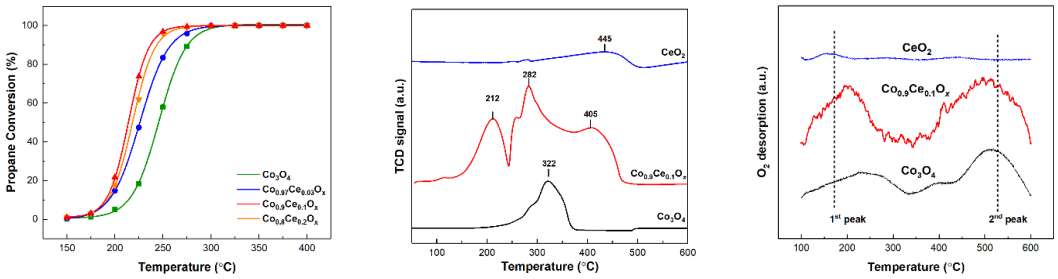
Supporting Information

Co-based catalyst had good redox performance under low-temperature range but with low selectivity in high-temperature, while vanadium-based catalyst had good acidity with low activity in low-temperature condition. In order to obtain the superb activity of single layer, we optimized the $CoCeO_x$ catalyst series with oxidation ability and acidity. The characteristic results of $CoCeO_x$ series were shown in Fig. S1(a). With the increase of Ce doping, the catalytic propane oxidation activity decreased slightly. The overall catalytic activity was in order as followed: $Co_{0.9}Ce_{0.1}O_x > Co_{0.8}Ce_{0.2}O_x > CoO_x > CeO_x$. Moreover, we surveyed all samples to confirm the property including oxidation ability from H_2-TPR and O_2 adsorption ability from O_2-TPD, which was generally seen as the origin for catalytic oxidation. It could be found that all results indicated that $Co_{0.9}Ce_{0.1}Ox$ performed the most suitable property with highest peak in low temperature H_2 reduction and top peak area in O_2 desorption.



(a) (b) (c)

Fig. S1 (a) Catalytic activity of $CoCeO_x$ series catalysts for propane oxidation (Zhang et al., 2019). (b) H_2-TPR of $CoCeO_x$ series catalysts, (c) O_2-TPD of $CoCeO_x$ series catalysts

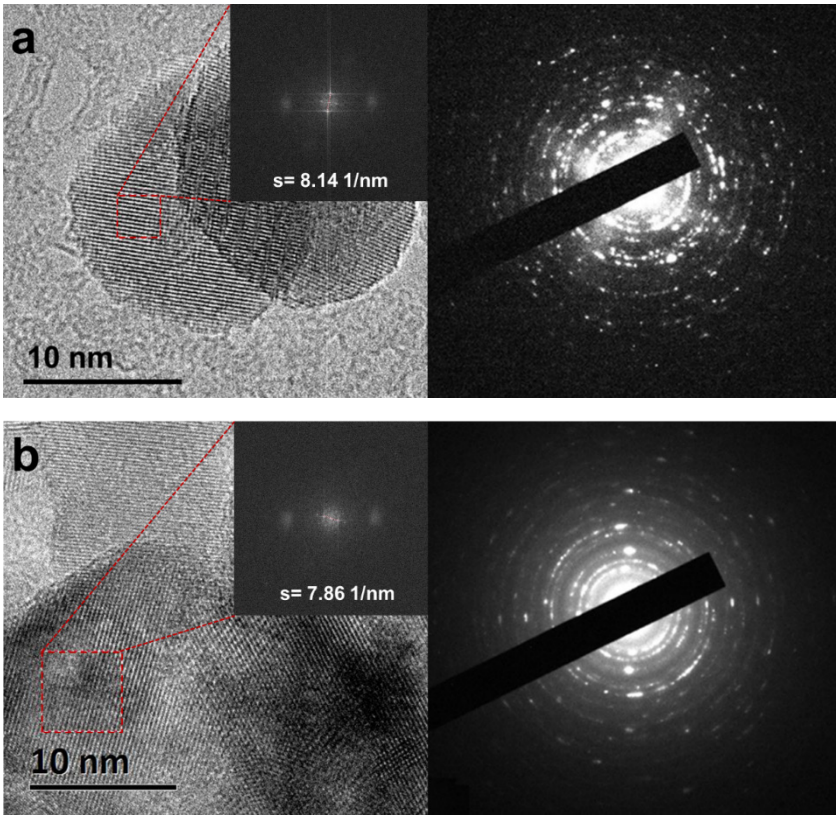


Fig. S2 (a) TEM image of Co_3O_4; (b) TEM image of $Co_{0.9}Ce_{0.1}Ox$;
The electron diffraction image (SAED) and fast Fourier transform image (FFT) of the selected area are on the right and upper right corners of (a) and (b), respectively.

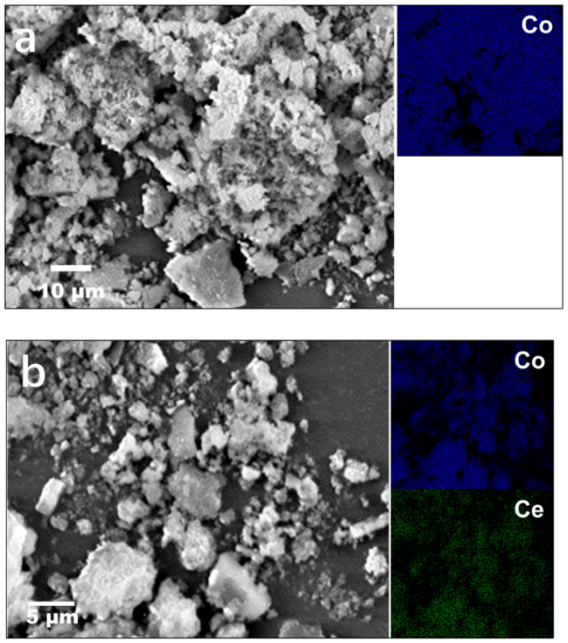


Fig. S3 (a) SEM image of Co_3O_4; (b) SEM image of $Co_{0.9}Ce_{0.1}Ox$;