

# **Importance of Exsolution in Transition Metal (Co, Rh, and Ir)-doped LaCrO<sub>3</sub> Perovskite Catalysts for Boosting Dry Reforming of CH<sub>4</sub> Using CO<sub>2</sub> for Hydrogen Production**

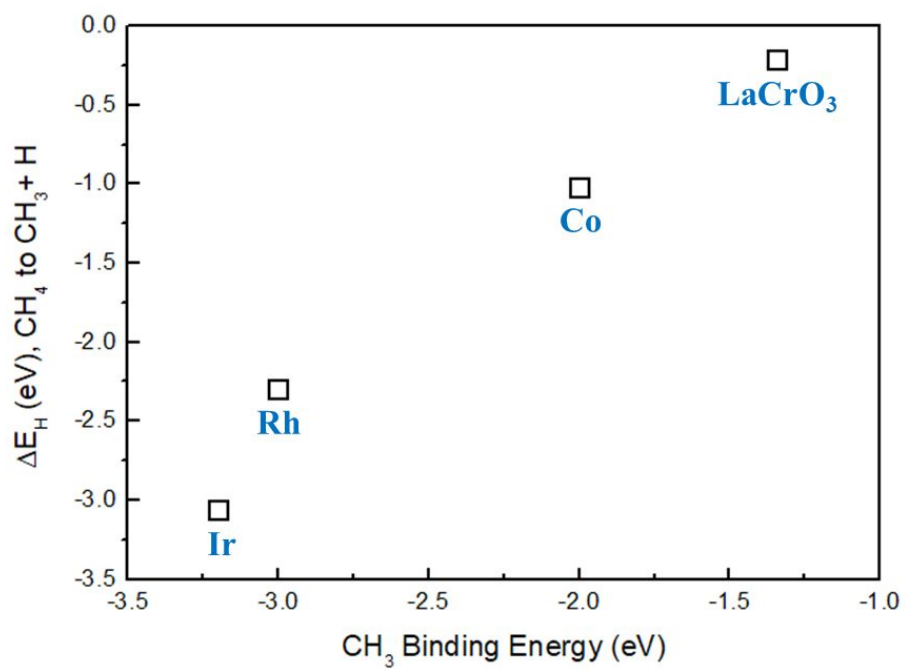
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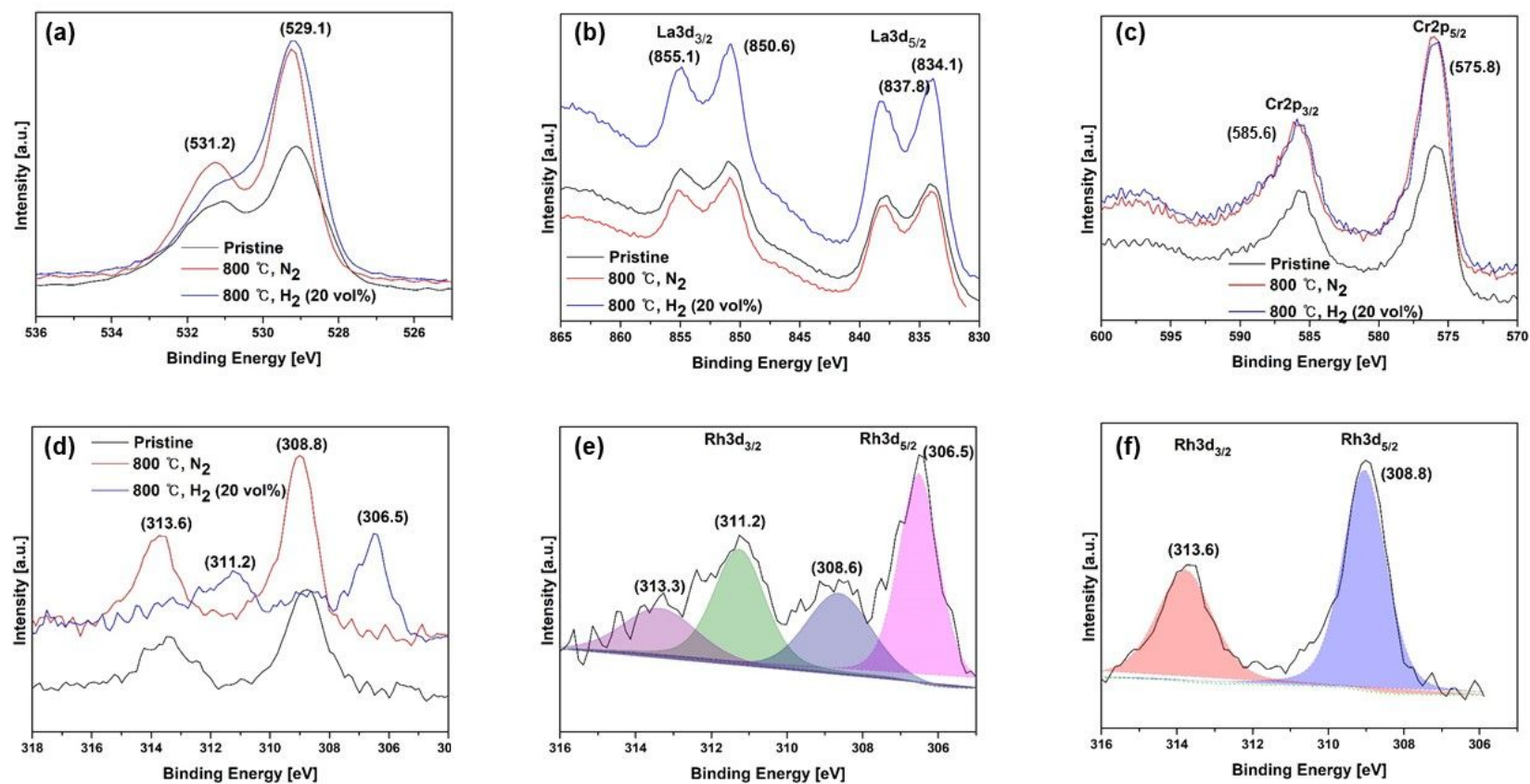
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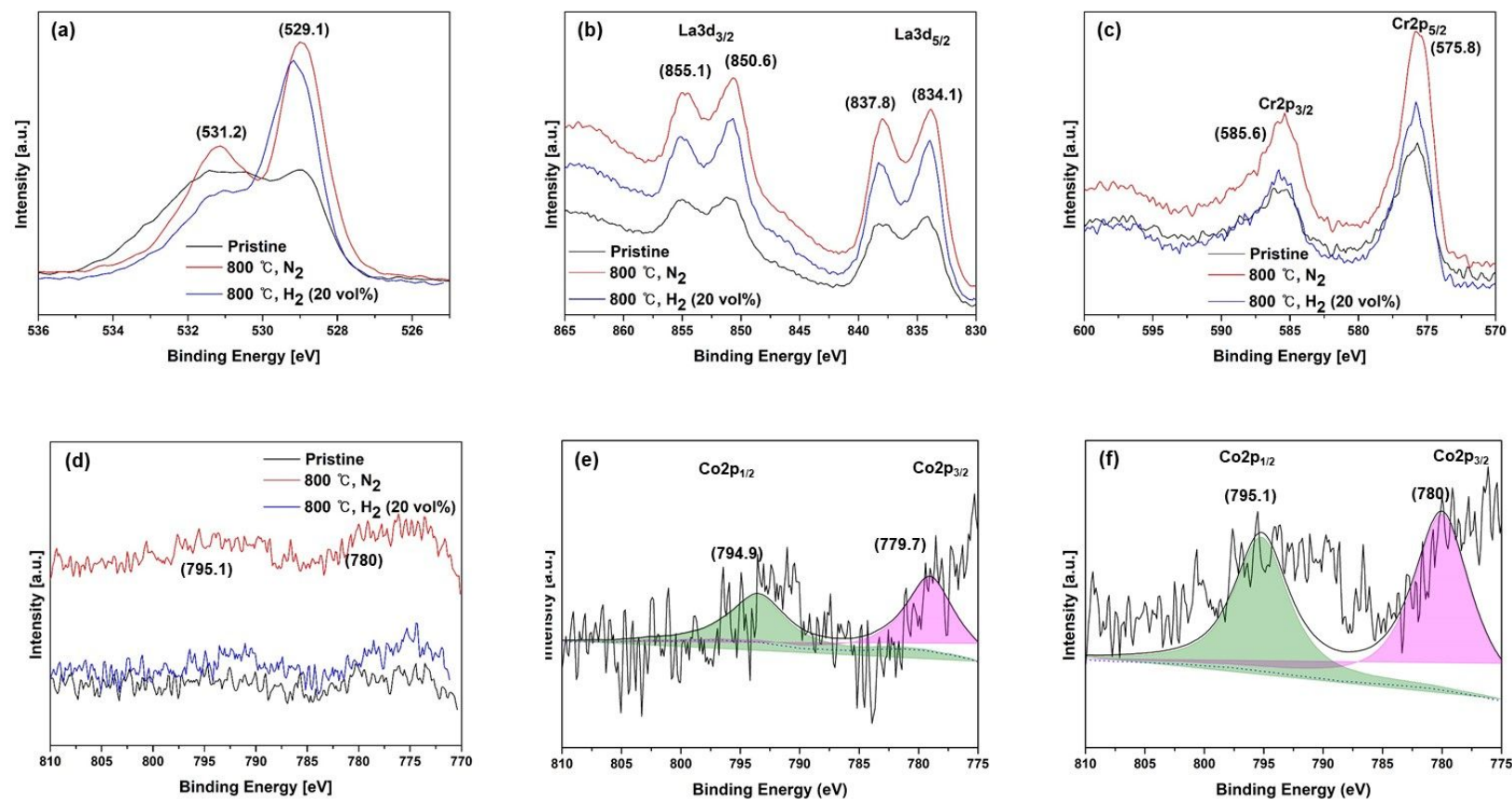
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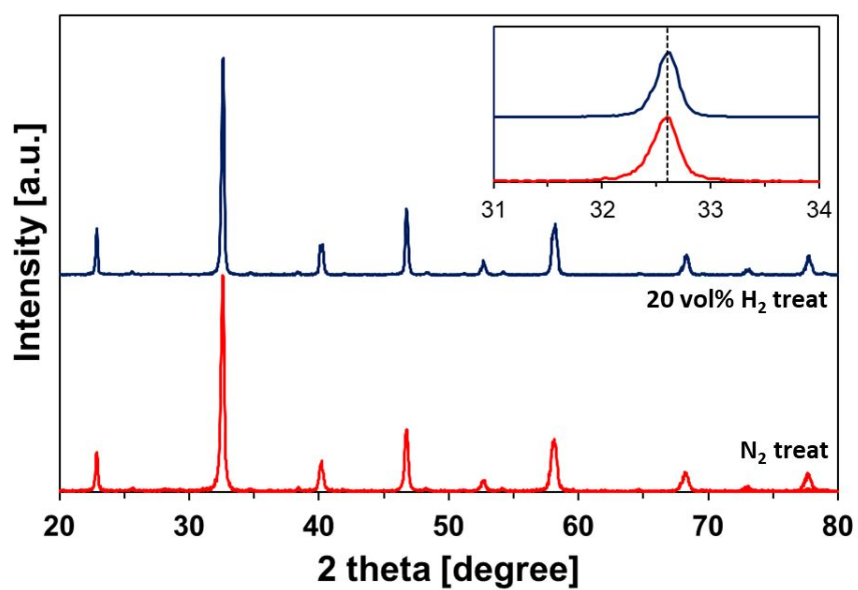
**Figure S1.** Reaction energies of the dehydrogenation of CH<sub>4</sub> versus CH<sub>3</sub> binding energies.



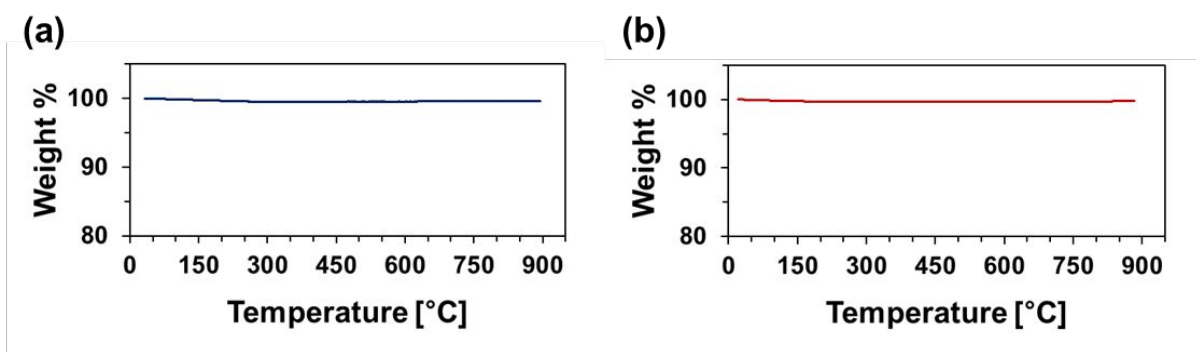
**Figure S2.** XPS spectra of  $\text{LaCr}_{0.95}\text{Rh}_{0.05}\text{O}_{3-\delta}$  perovskite-based catalyst: (a) O1s, (b) La3d, (c) Cr2p, (d) Rh3d core-line spectra and curved-fitted Rh3d spectra after treated at 800 °C under (e)  $\text{N}_2$  and (f)  $\text{H}_2$  (20 vol%) conditions.



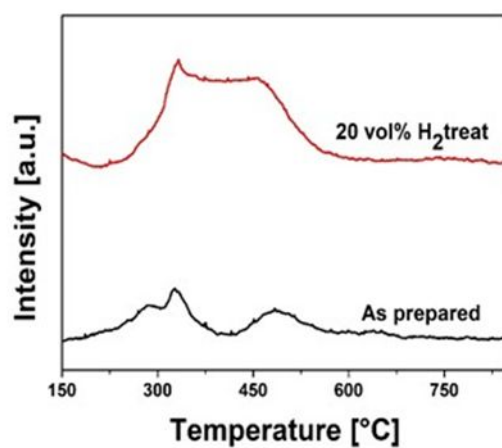
**Figure S3.** XPS spectra of LaCr<sub>0.95</sub>Co<sub>0.05</sub>O<sub>3-δ</sub> perovskite-based catalyst: (a) O 1s, (b) La 3d, (c) Cr 2p, (d) Co 2p core-line spectra after the heat treatment at 800 °C under (e) N<sub>2</sub> and (f) H<sub>2</sub> (20 vol%) conditions.



**Figure S4.** X-ray diffraction spectra of  $\text{LaCr}_{0.95}\text{Ir}_{0.05}\text{O}_{3-\delta}$  after  $\text{N}_2$  or 20 vol%  $\text{H}_2$  (balanced with  $\text{N}_2$ ) treatment. Inset: Detailed XRD spectrum between  $31^\circ$  and  $34^\circ$ .



**Figure S5.** Thermogravimetric analysis of  $\text{H}_2$  treated  $\text{LaCr}_{0.95}\text{Ir}_{0.05}\text{O}_{3-\delta}$  perovskite-based catalyst at (a) before and (b) after the dry reforming reaction of  $\text{CH}_4$  using  $\text{CO}_2$  at 750 °C.



**Figure S6.** H<sub>2</sub>-TPR profile of LaCr<sub>0.95</sub>Ir<sub>0.05</sub>O<sub>3-δ</sub> at before/after activation under 20 vol% H<sub>2</sub> (balanced with N<sub>2</sub>) treatment.