Promoting effect of strontium on lanthanum oxide catalysts for the oxidative coupling of methane

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Oxidative coupling of methane (OCM) is a promising one-step reaction for the direct conversion of natural gas to C_2 hydrocarbons according to the following reactions.[1]

$$2\ CH_4 + O_2 \rightarrow C_2H_4 + 2H_2O \qquad \Delta H_r^0 = -282\ kJ\ mol^{-1} \qquad (1)$$
$$2\ CH_4 + 0.5\ O_2 \rightarrow C_2H_6 + H_2O \qquad \Delta H_r^0 = -177\ kJ\ mol^{-1} \qquad (2)$$

The presence of oxygen and the high reaction temperature limit C_2 hydrocarbon yields to below 30% for most catalysts.[2] Among OCM catalysts, strontium promoted lanthanum oxide has been shown to be highly active for OCM.[3] In this work, we examine the promoting role of strontium on lanthanum oxide catalysts for oxidative coupling of methane. A series of strontium promoted lanthanum oxide catalysts with varying strontium loadings (1 to 11 wt%) were prepared. The synthesized catalysts were tested in a fixed bed reactor operating under intrinsic kinetic conditions. Promotion of lanthanum oxide with strontium enhances the activity of the catalysts (Figure 1a). Additionally, the selectivity towards C_2 hydrocarbons is improved when the strontium loading is more than 1 wt% (Figure 1b). For all the catalysts C_2 selectivity increases with temperature and stabilizes.
To understand the promoting effect of strontium on lanthanum oxide, the catalysts were fully characterized using XRD, CO_2-DRIFTS, CO_2-TPD and XPS.

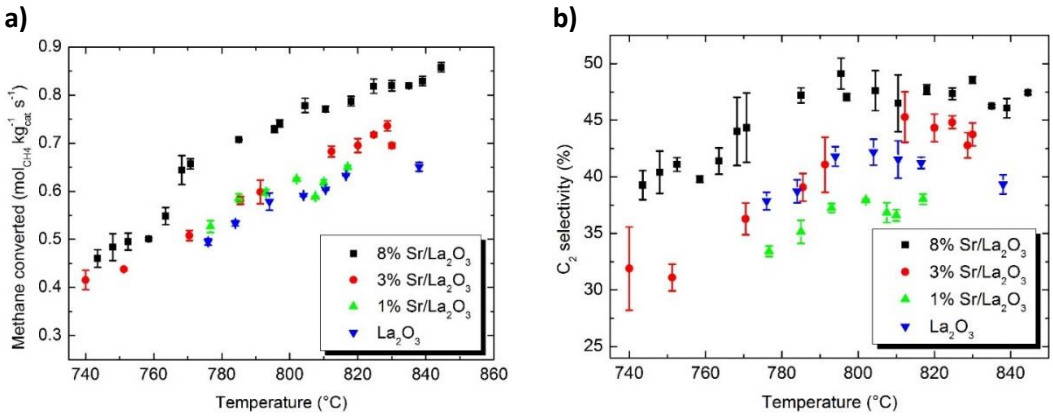

Figure 1: a) Activity and b) C_2 selectivity of unsupported Sr/La_2O_3 catalysts vs. temperature. Other experimental conditions: P_{total} =1.8 bar (50% He), inlet CH_4:O_2 ratio =4:1, space time = 0.2-0.25 kg_{cat} s $mol^{-1}_{CH4,0.}$

References

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