The effect of the replacement of La by Sr in $La_{1-x}S_xMnO_3$ perovskite on the catalytic oxidation of light hydrocarbons

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Perovskites, with general formula ABO_3, are highly promising materials in catalysis due to their excellent redox properties, high lattice oxygen ion mobility, and exceptional thermal stability. Their flexibility in replacing the A-site and/or B-site cations with other elements of the same or different valence (i.e., $A_{1-x}A'_xB_{1-x}B'_xO_{3\pm\delta}$) allows them to create oxygen defects (vacancies) and modify the valence state of the transition metals in the B-site. This, in turn, alters (a) the mobility of O_{2-} ions within the lattice and (b) their surface redox properties, thereby enhancing their catalytic performance.

In the present study, the catalytic activity of the perovskite $La_{1-x}Sr_xMnO_3$ (LSxM), was comparatively examined for deep oxidation of light hydrocarbons, LHCs, namely CH_4, C_3H_8 and C_3H_6, under excess O_2 conditions. The effect of the gradual partial substitution of the A-site of $La_{1-x}A'_xMnO_3$ perovskite, (where A′ = Sr and x = 0, 0.3, 0.5, and 0.7) on the activity and stability of the materials in deep LHCs oxidation. Various characterization techniques such as BET, XRD, and H_2-TPR were employed to assess their physicochemical properties, correlating them with their catalytic activity. Additionally, different pre-treatment protocols were applied, including (a) pre-reduction, (b) pre-oxidation, and (c) oxidative aging at high temperatures. It turns out that the primary factor affecting the performance of LSxM was the degree of La substitution by strontium (Sr). The catalytic performance of the materials followed an inverted volcano pattern based on the variable x, with the most efficient catalyst being for x=0 while the least efficient for x=0.5. This observation strongly highlights the impact of x on the total surface area and the reducibility of the materials. Furthermore, complex hysteresis phenomena were recorded for the first time in the catalytic system during heating/cooling cycles, revealing new phenomena and findings that may be of interest to the catalysis under consideration.

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