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Role and reduction of NOx in the catalytic combustion of soot over iron–ceria mixed oxide catalyst

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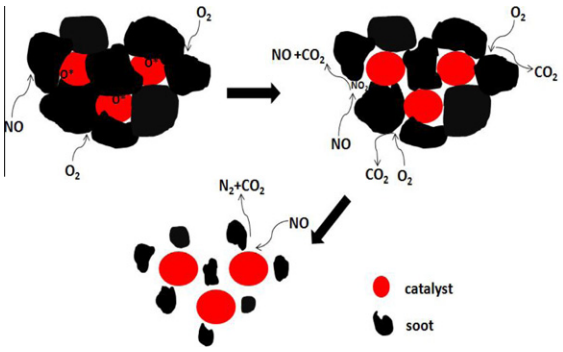
HIGHLIGHTS

- $FeCe_9$–O exhibits excellent catalytic activities for soot combustion.
- Fe^{3+} ions can be evenly doped in ceria lattice to increase the oxygen vacancy concentration.
- O vacancy amount in $FeCe_9$–O affect pivotally the catalytic (and NO_2-assistance) soot combustion.
- The NO_2-assistance for soot combustion is partly limited in "tight contact" condition.
- NOx reduction by soot can occur during the soot combustion over $FeCe_9$–O catalyst.

GRAPHICAL ABSTRACT



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ABSTRACT

The iron–ceria mixed oxide catalysts with different iron contents were prepared by a citrate acid sol–gel method, and were investigated by low-temperature nitrogen adsorption–desorption, XRD, H_2-TPR, Raman spectroscopy, etc. The performances of catalysts were evaluated for the soot combustion with O_2 or O_2/NO gases in "tight contact" condition. The results show that in the Fe–Ce–O catalyst Fe^{3+} can be doped into the ceria lattice and Fe–Ce–O solid solution is formed; the presence of Fe in CeO_2 can increase the oxygen vacancy concentration and decrease the crystallite sizes of the catalyst; the Fe–Ce–O catalyst (Fe/Ce = 1/9, mol) calcined at 600 °C possesses higher oxygen vacancy concentration on its surface, resulting in the maximal storage ability for nitrite/nitrate species on its surface and high catalytic activities for NO oxidation and the "NO_2-assistance" soot combustion. In "tight contact" condition, as the oxidation of NO is inhibited, the "NO_2-assistance" soot combustion is partly limited. With the soot particles gradually consumed, the contact between the soot and catalyst becomes loose, resulting in an improvement of the NO oxidation to NO_2 and "NO_2-assistance" soot combustion. We suppose that soot catalytic combustion by O_2 and NO_2 is simultaneously existed, in which the oxygen vacancy concentration on the Fe–CeO_2 catalysts is a key factor to influence the catalytic performance.

1. Introduction

In recent years, diesel-powered vehicles have attracted more and more interest from vehicles producer and public, due to their higher thermal efficiency, less CO and unburned hydrocarbons emission, lower cost and longer lifetime comparing with gasoline-fuelled vehicles [1]. However, the high emission of soot particulates and NOx are still the key problems to prevent their wide usage. Considering the deleterious effect of pollutions from diesel-powered vehicles on the global environment and human health, after-treatment technologies for the soot particulates and NOx have been developed. For the soot particulates in the diesel-powered vehicles, the diesel particulate filter (DPF) is designed and coated by an oxidation catalyst, and then it is applied to

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