Study on Nano Fibrous Catalysts Prepared by Electrospinning Method for Control of Diesel Exhaust Emissions

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論 文 名　：　Study on Nano Fibrous Catalysts Prepared by Electrospinning Method for
Control of Diesel Exhaust Emissions
（エレクトロスピニング法で調製したナノファイバー触媒のディーゼル排ガス処理特性
に関する研究）

Title

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Category

論 文 内 容 の 要 旨
Thesis Summary

In chapter 1, the history and characteristics of diesel particulate matter (PM) and catalysts for diesel soot oxidation were summarized and introduced.

In Chapter 2, Ceria oxide (CeO_2) nanofibers with diameters of about 250 nm were produced via the electrospinning method. They were then applied as new support materials for silver nanoparticles and their effectiveness as diesel soot oxidation catalysts was examined. The crystal structure of the Ag was confirmed by X-ray diffraction (XRD), X-ray photoelectron spectroscopy (XPS), high-resolution transmission electron microscopy (HR-TEM), and energy dispersive spectroscopy (EDS). The diesel soot oxidation experiment was performed using a mixture of carbon black and the fabricated catalyst. In the tight contact and loose contact modes, the highest temperatures of both the CeO_2-fiber-supported Ag catalysts (Ag/CeO_2) calcined at 500 ◦C and the CeO_2 fibers calcined at 500 ◦C were shifted to a lower temperature range, compared with JRC-CEO-3 (a commercial catalyst). In addition, the activation energy also showed similar behavior.

In Chapter 3, we report $La_{1-x}Sr_xCo_{0.2}Fe_{0.8}O_{3-\delta}$ perovskite oxide catalysts with a unique three-dimensional (3D) fiber web structure that increases the large contact area by trapping soot in the unique pore structure for effective catalytic activity. This feature was carefully analyzed using scanning transmission electron microscopy (STEM) tomography to investigate the location of the soot on the web. The structure of the web, with a thickness of approximately 55 μm, indicated that the soot particles were caught by the 3D pores between the fibers. The relationship between the Sr amount and activate oxygen was also characterized by means of XPS. The results show that the Sr amount of 0.4 produced the highest amount of active oxygen

species (O^-) that are essential for soot oxidation reaction. The developed catalyst exhibited a good catalytic performances due to the optimized perovskite chemical structure and the greatly increased number of the contact points owing to the 3D inter-fiber spaces.

In Chapter 4, Ag and/or Mn particles loaded mesoporous zirconia oxide (ZrO_2) nanofibers were prepared by the electrospinning method followed by calcination at 600 ◦C for catalytic oxidation of diesel soot particles and benzene. The presence and crystal structure of loaded Ag and Mn particles were confirmed by X-ray diffraction (XRD), high-resolution transmission electron microscopy (HR-TEM), energy dispersive spectroscopy (EDS) and X-ray photoelectron spectroscopy (XPS). The prepared catalysts were evaluated for their soot and benzene oxidation performance. Although ZrO_2 nanofibers with loaded Ag species exhibited better soot oxidation catalytic activity than the Mn loaded ZrO_2 fiber and pristine ZrO_2 nanofiber, Mn loaded ZrO_2 fibers also showed the high catalytic activity of benzene oxidation.