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Soot oxidation on catalytic manganese oxide coatings in diesel and gasoline exhaust

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Soot particles emitted by combustion engines are cancerogenic and contribute to the greenhouse effect. Therefore, emission standards are being tightened, and currently discussed not only for diesel vehicles, but also for gasoline vehicles with direct fuel injection. For soot abatement particulate filters are widely employed requiring regeneration to remove the soot deposits. We present novel highly active manganese oxide catalysts for the regeneration of diesel and gasoline particulate filters using the CDPF technique. CDPF implies the combustion of soot deposits by a catalyst layer coated onto the filter. Manganese oxide based materials were recently shown to be highly effective in soot oxidation.

Manganese oxide was prepared by flame spray pyrolysis and was coated directly onto the laboratory-scaled particulate filter. This manganese oxide revealed high stability upon thermal (1050 °C) and hydrothermal (750 °C) exposure. The sample was characterised by powder XRD, N_2 physisorption, SEM, H_2-TPR and NH_3-TPD. The soot was coated onto the filter afterwards, using a C_3H_6 diffusion burner.

Tests of this filter coated with this FSP manganese oxide reveal oxidation activity below 350 °C indicating remarkable potential for soot conversion in real diesel and gasoline exhaust. Correlation of physical-chemical characteristics with soot oxidation kinetics showed that the number of surface oxygen vacancies and the particle size determine the performance of the catalysts.

For axial and radial investigation of the catalyst and the soot on the surface of the particulate filter, an optical microscope and SEM were used. The samples were prepared by cutting the filter, providing insights into different parts of the filter. Furthermore, kinetic experiments with a thermographic camera revealed the temperature distribution in the filter. These analyses are the basis for the optimization of the coating process for CDPF.

Keywords: manganese oxide, soot oxidation, particulate filter, catalytic layer