Catalytic soot oxidation studied by Environmental Transmission Electron Microscopy

Simonsen, Søren Bredmose; Dahl, S.; Johnson, E.; Helveg, S.

Publication date:
2008

Document Version
Peer reviewed version

Catalytic soot oxidation studied by Environmental Transmission Electron Microscopy

S.B. Simonsen[1], S. Dahl[1], E. Johnson and S. Helveg[1]

1. Haldor Topsøe A/S, Nymøllevej 55, DK-2800 Kgs. Lyngby, Denmark
2. Nano-Science Center, Niels Bohr Institute, University of Copenhagen, Denmark

sth@topsoe.dk
Keywords: ETEM, catalysis, soot oxidation, diesel engine, emission control

At present, the awareness of soot abatement in the exhaust from diesel engines is increasing due to new environmental legislation for exhaust specifications. An attractive approach for effective soot removal includes the introduction of filters on the diesel-driven vehicles and the functionalization of the filters for catalytic soot oxidation by ceria-based materials. Although it is generally accepted that the redox properties of ceria are crucial to the catalytic effect, the detailed reaction mechanism and the location of the catalytic active sites are still matters of debate.

In this contribution we present an Environmental Transmission Electron Microscopy (ETEM) study of ceria-catalyzed soot oxidation related to diesel engine emission control [1]. ETEM has become a powerful tool in heterogeneous catalysis due to its ability to directly monitor catalysts *in situ* during exposure to reactive gases at elevated temperatures [2]. From time-lapsed ETEM image series of soot particles in contact with a CeO_2 catalyst, as illustrated in fig. 1, direct observations at the soot-catalyst interface were obtained during exposure to oxidation conditions and provided mechanistic and kinetic insight into the catalytic oxidation reaction. The results show that the catalytic oxidation reaction involved processes, which were confined to the soot-CeO_2 interface region, and that the catalytic reaction surprisingly resulted in motion of soot agglomerates toward the catalyst surface, which acted to re-establish the soot-CeO_2 interface in the course of the oxidation process. The observed reaction dynamics was found to be consistent with observations from *ex situ* oxidation experiments and quantitatively in good agreement with previous kinetic measurements.

1. S.B. Simonsen, S. Dahl, E. Johnson and S. Helveg, J. Catal. **255** (2008), p. 1.
2. P.L. Hansen, S. Helveg and A.K. Datye, Adv. Catal. **50** (2006), p. 77.

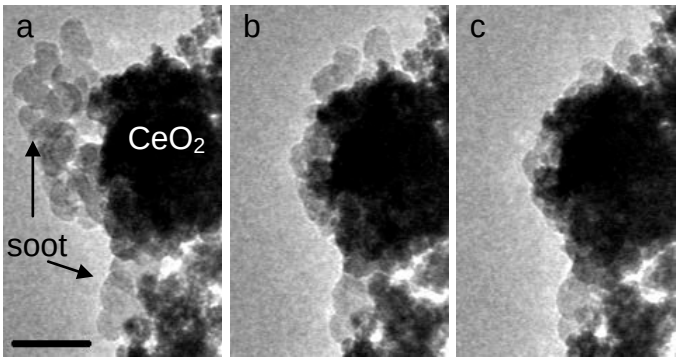

Figure 1. Time-lapsed ETEM images of soot in contact with a CeO_2 catalyst during the exposure to 2mbar O_2 at 550ºC. The time interval between the images is ~2min. Scale bar , 90nm. The figure adapted from [1].