TECHNISCHE UNIVERSITÄT
BERGAKADEMIE FREIBERG
Die Ressourcenuniversität. Seit 1765.

CHAIR OF REACTION ENGINEERING

Soot oxidation on manganese oxide catalysts in diesel and gasoline exhaust gas

Steffen Wagloehner, Maria Nitzer-Noski, Sven Kureti

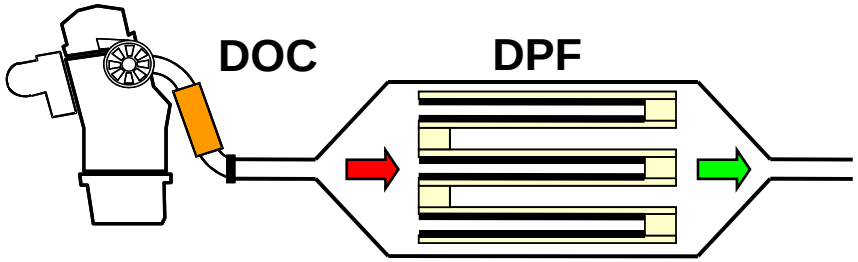
TU Bergakademie Freiberg · Institute of Energy Process Engineering and Chemical Engineering · Chair of Reaction Engineering
Reiche Zeche · Fuchsmuehlenweg 9 · 09599 Freiberg · Phone: +49 3731 394551 · Fax: +49 3731 394555 · www.iec.tu-freiberg.de

Strategies of DPF regeneration

- Passive regeneration (T=200…450°C)

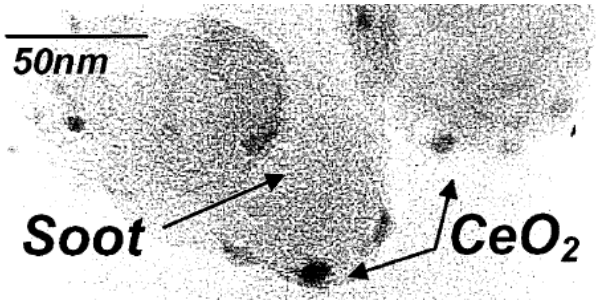
  $2\ NO + O_2 \rightarrow 2\ NO_2$

  $2\ NO_2 + \text{“C”} \rightarrow CO_2 + 2\ NO$



- Active regeneration (fuel post-injection)

  “C” + $O_2 \rightarrow CO_2$ T > 600°C



K. Ohno, Ph.D. thesis 2005

- Fuel Borne Catalyst: metal-organic compounds

  “C” + $O_2 \rightarrow CO_2$ T > 300°C

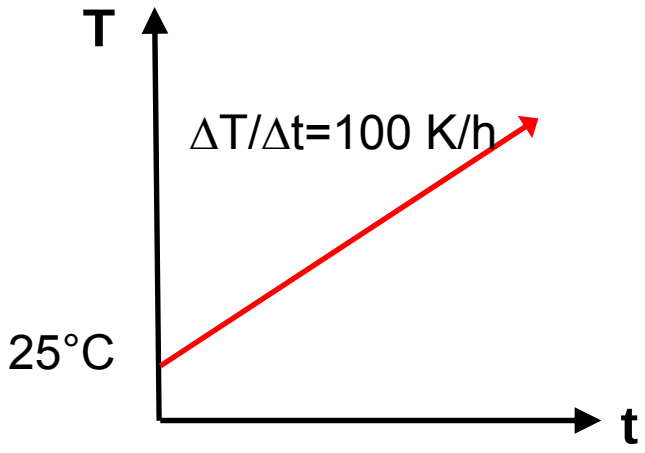
- Catalytic DPF (CDPF): CeO_2 and Fe_2O_3 based catalysts

  “C” + $O_2 \rightarrow CO_2$ T > 500°C

Evaluation of Mn_xO_y catalysts

Evaluation of soot oxidation activity

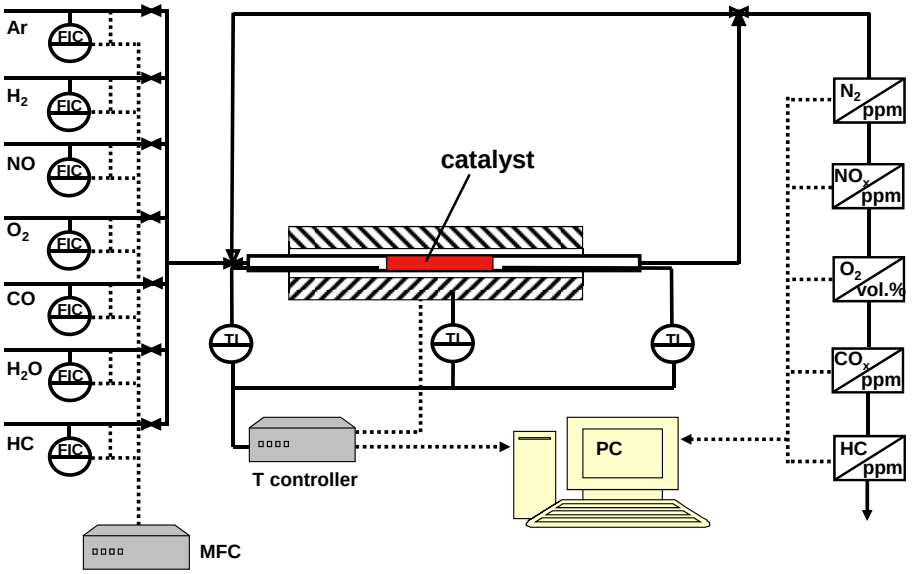
Temperature Programmed Oxidation (TPO)



Plug flow reactor with packed bed

TPO conditions

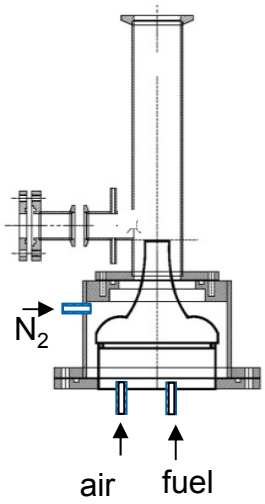
- $y(O_2)$=10%, $y(N_2)$= 90%
- F=500 mL/min
- Intimate catalyst/soot blend
- C_3H_6-soot
- m_{blend}=0.9 g (n_{cat}/n_{soot}=2)



Laboratory test bench

Preparation and characterisation of the soot

- C_3H_6/O_2 diffusion flame



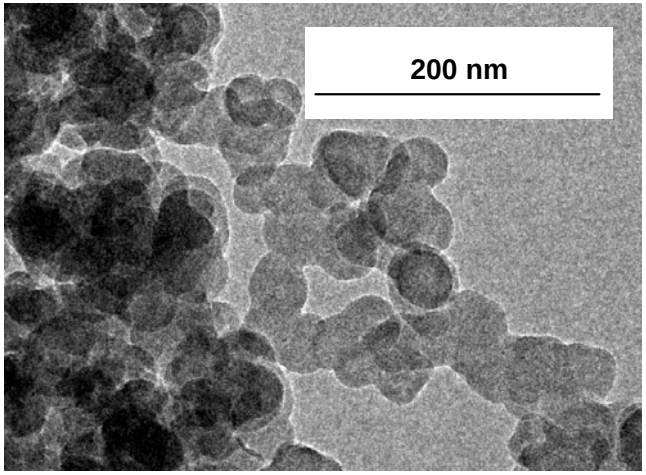
- Adsorbed species: 2.5 wt.%
- Chemical composition

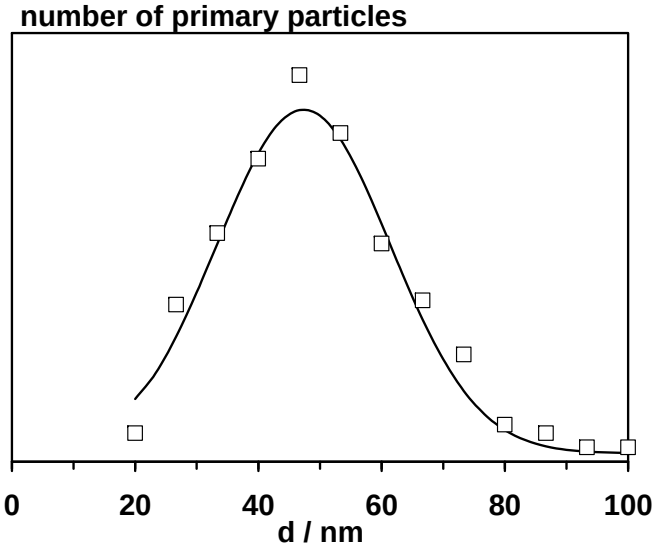
  98.8 wt.% C

  0.7 wt.% O

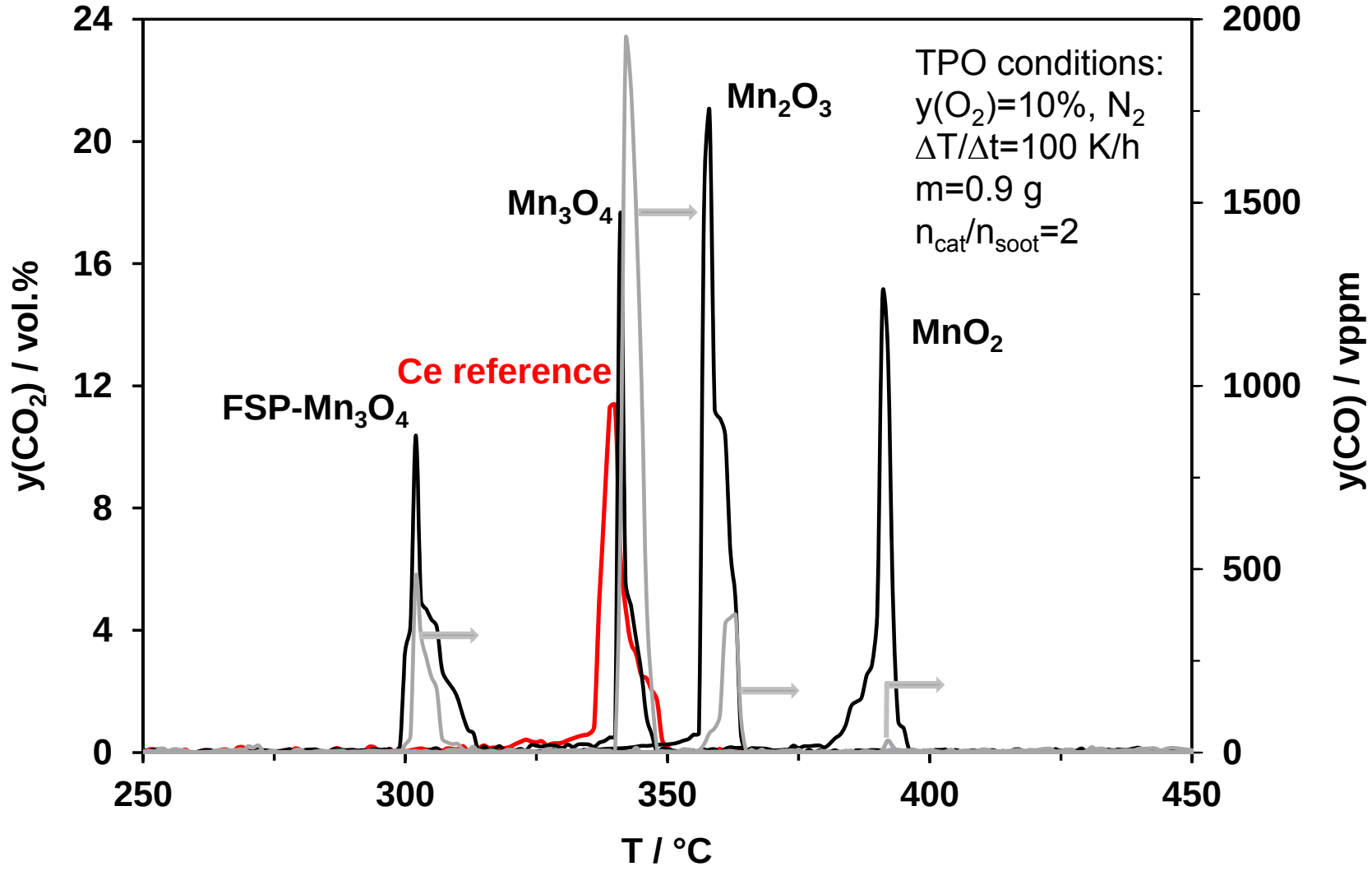
  0.5 wt.% H

  <0.1 wt.% N
- S_{BET} = 65 m^2/g
- d = 45 nm (most frequent diameter)

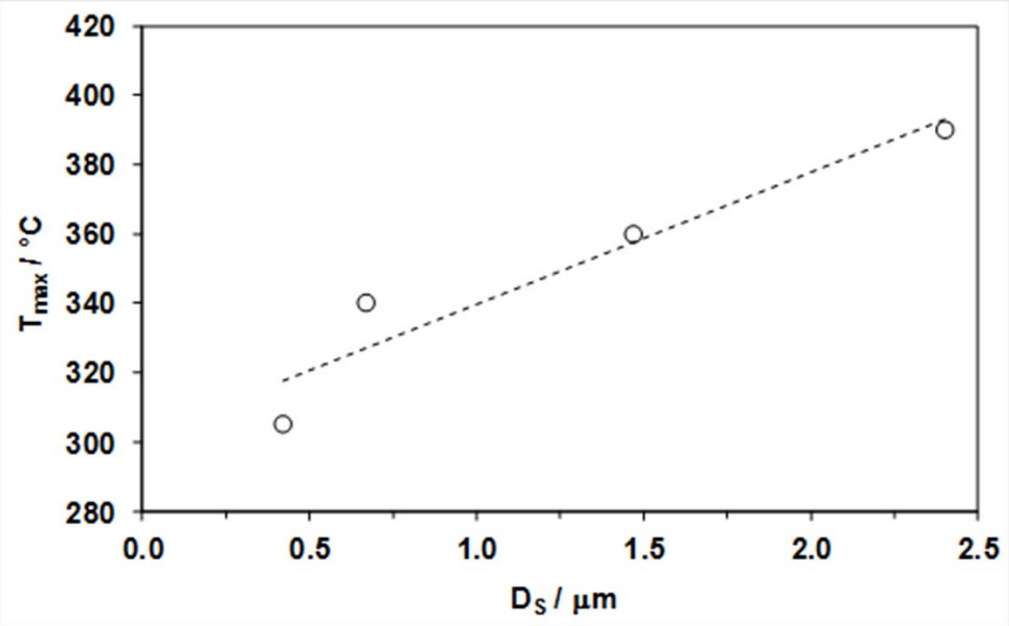




Activity of manganese oxide catalysts in TPO

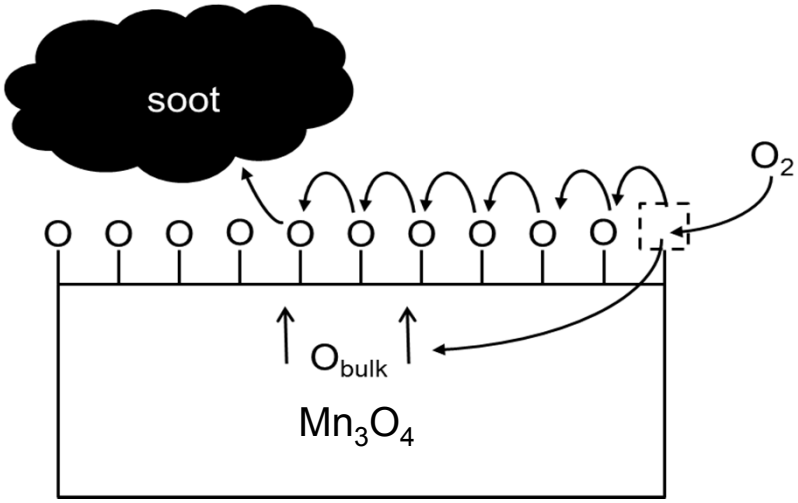


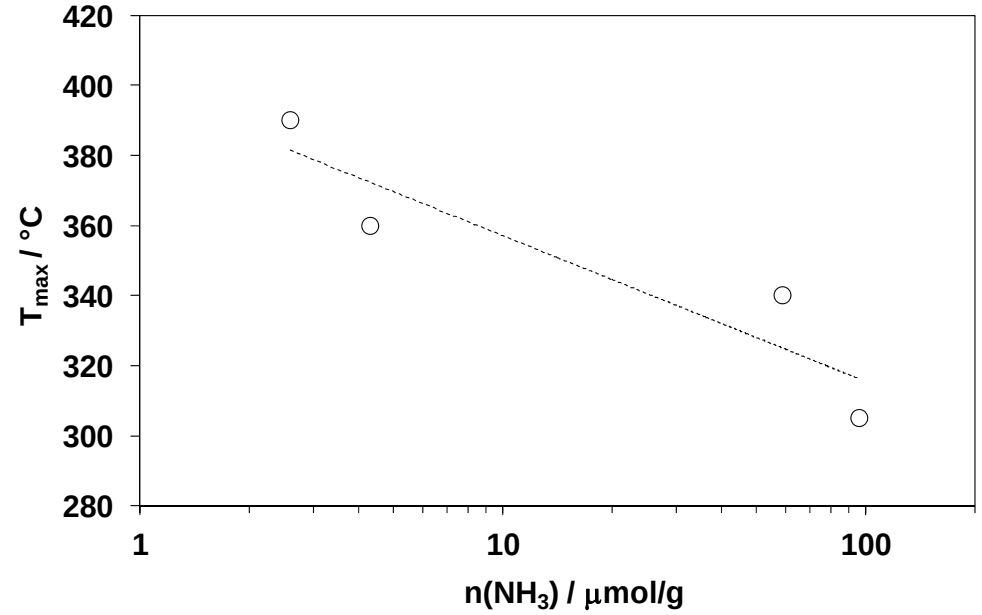
Determining characteristics of the catalysts



Catalyst size

→ number of contact points

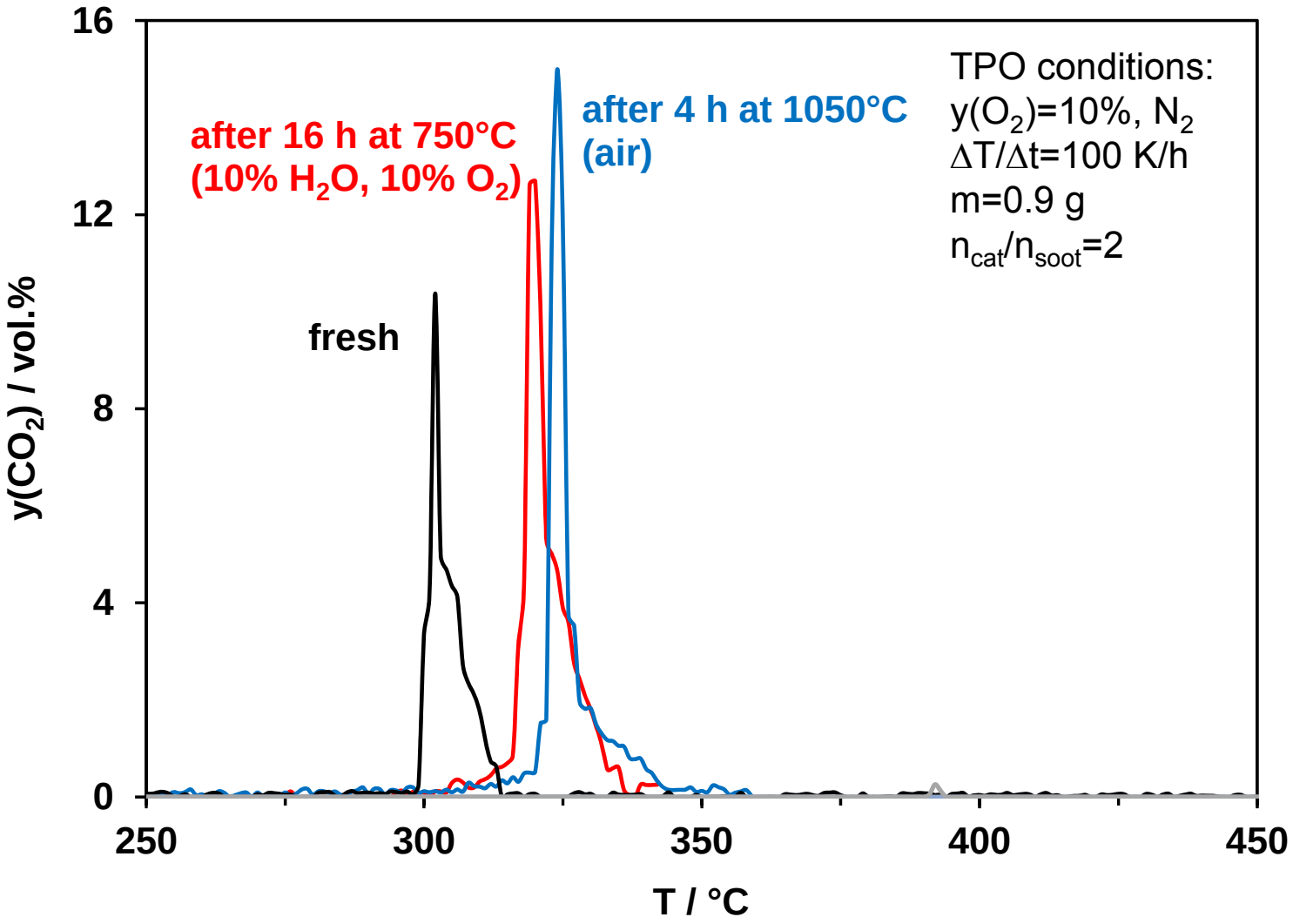




Number of acid sites of catalyst

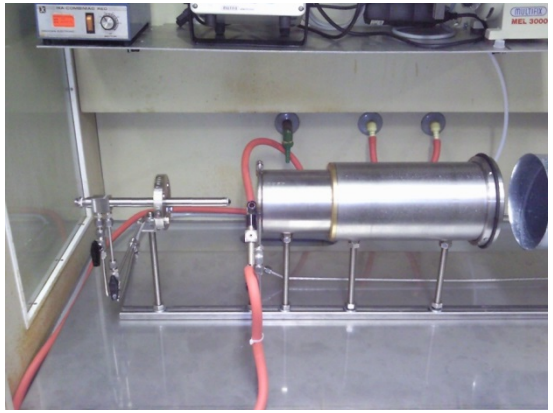
→ transport of surface oxygen

Thermal stability of FSP-Mn_3O_4 catalyst



Test of catalytic particulate filters

Catalytic coating of DPF



FSP bench

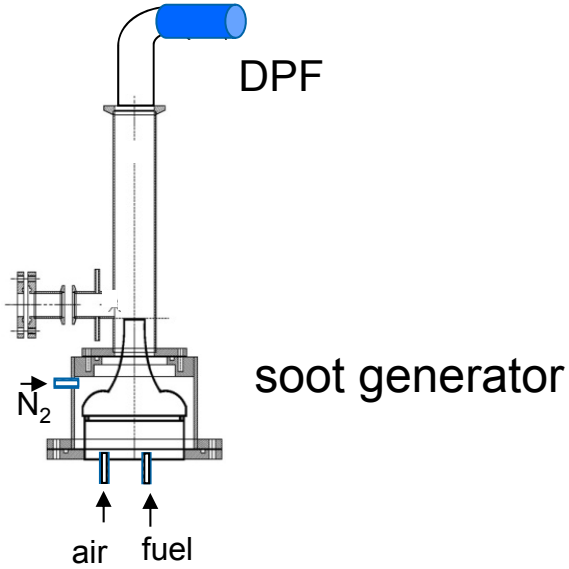
Lab-DPF

300 cpsi, 1''x 2''

60% porosity

Coating device

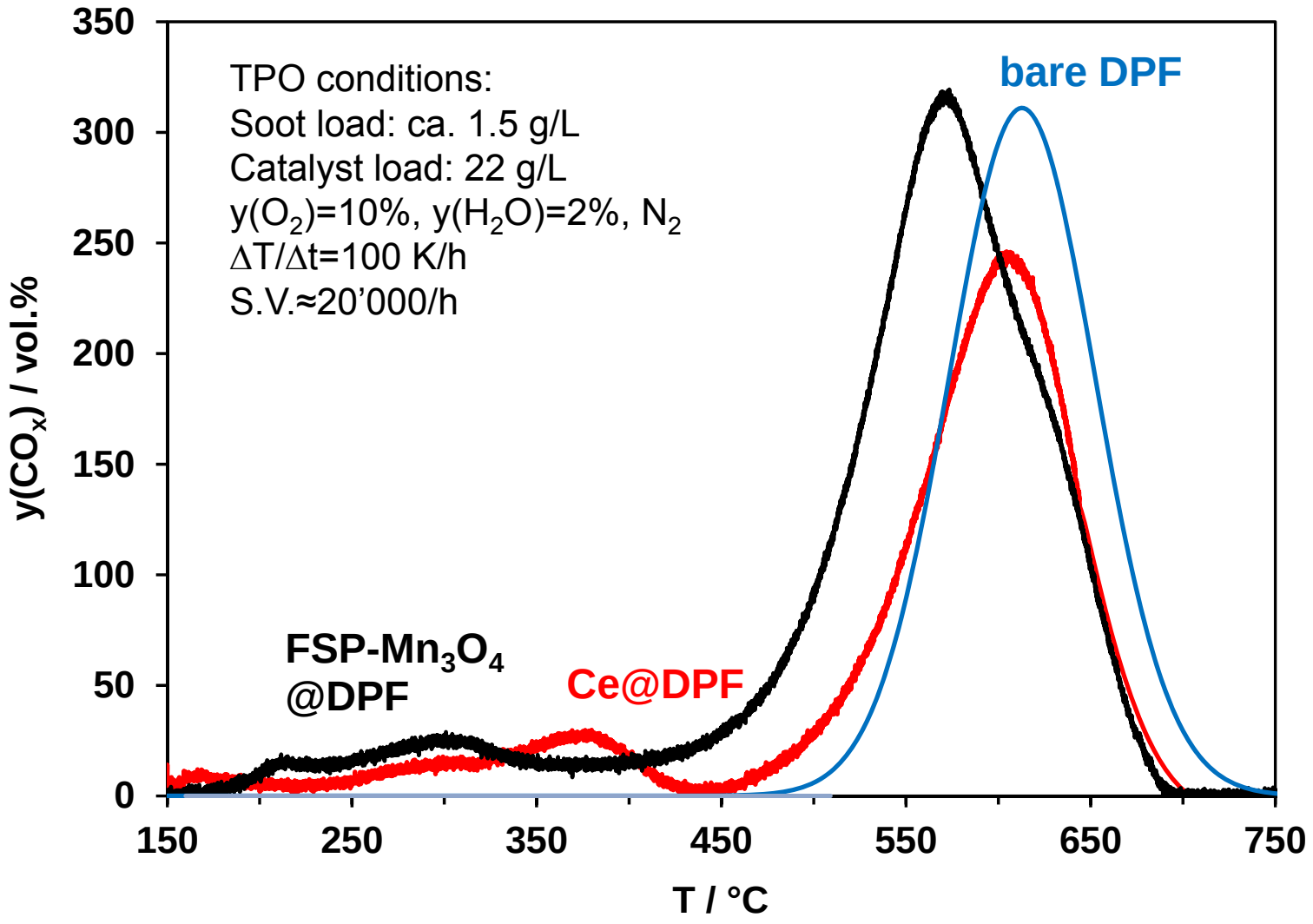
Soot deposition on catalytic DPF



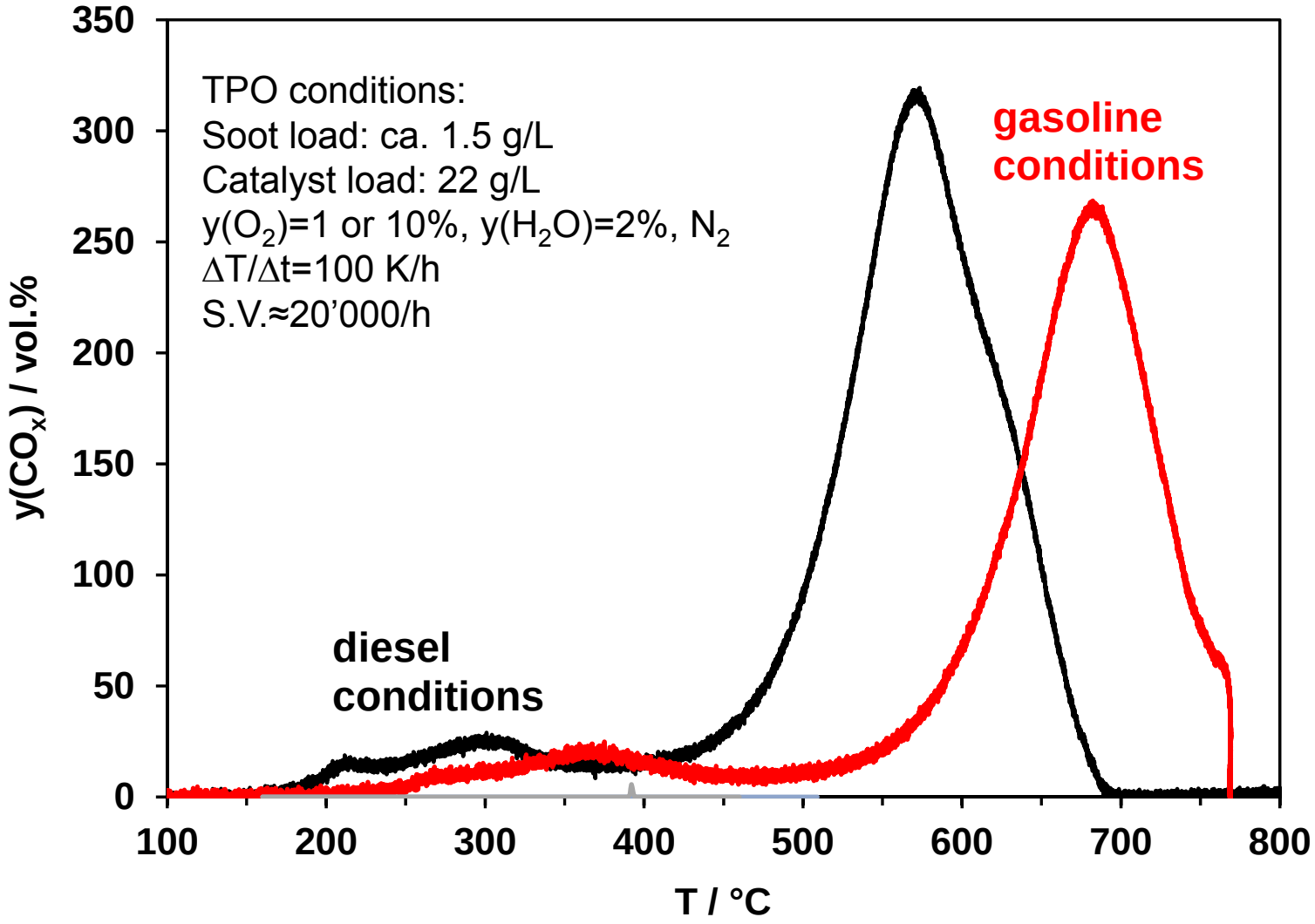
TPO conditions

- Catalyst loading: 22 g/L
- Soot loading: ca. 1.5 g/L
- $y(O_2)$=10%, $y(H_2O)$=2%, N_2 balance
- F=6500 mL/min (S.V.≈20'000/h)

Performance of lab-DPF coated with FSP-Mn_3O_4 under diesel conditions



Performance of lab-DPF coated with FSP-Mn_3O_4 under diesel and lean gasoline conditions

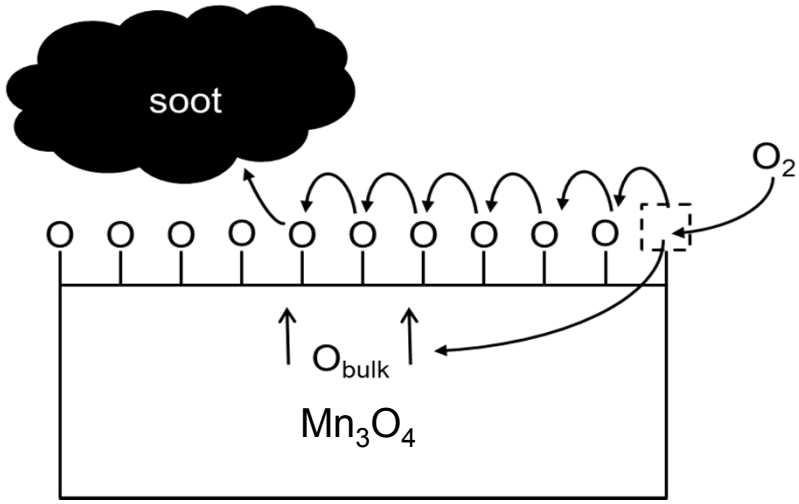


Summary

- Manganese oxides are effective in soot oxidation and show high resistance towards thermal and hydrothermal aging

- Manganese oxide catalysts require intimate contact to soot

- FSP-Mn_3O_4 strongly supplies bulk oxygen to soot



- Beneficial effect of FSP-Mn_3O_4 also occurs onto particulate filters under diesel and lean gasoline conditions

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