PROGRAM

APCAT 4

6 to 8 December 2006

Singapore

Organized by

NANYANG TECHNOLOGICAL UNIVERSITY School of Chemical & Biomedical Engineering

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A6-O16	11:25 to 11:45	**Photophysical and photocatalytic properties of $AgSbO_3$** T. Kako, J.H. Ye, *NIMS (Japan)*
A6-O17	11:45 to 12:05	**Photocatalytic preferential oxidation of CO in the presence of H_2 on Mo-oxide catalysts at 293K** M. Matsuoka, T. Kamegawa, R. Takeuchi, M. Anpo, *Osaka Prefecture University (Japan)*
A6-O18	12:05 to 12:25	**Photomineralisation study of non-volatile organic acids by doped TiO_2 photocatalysts under UV and visible light irradiation** T. Hudaya, T. Safinski, A.S. Qazaq, A.A. Adesina, *University of New South Wales (Australia)*
A6-O19	12:25 to 12:45	**Steam photo reforming of methane over metal doped titanium oxide photocatalysts** Y. Ichihashi, M. Yamaguchi, S. Tsuruya, S. Nishiyama, *Kobe University (Japan)*

Catalysis for Environment
Oral Session 3
8 December 2006, Friday
LT 2

A7-O12	10:35 to 10:55	**Catalytic reduction of NO by CO over Pd/Al_2O_3 and $Pd/TiO_2/Al_2O_3$ catalyst in the passive $DeNO_x$ system** Y.C. Ko, Y.H. Li, *Korea University (Korea)*; Y.S. Yoo, H.S. Han, *Heesung Engelhard (Korea)*; K.Y. Lee, *Korea University (Korea)*
A7-O13	10:55 to 11:15	**$Pt/Ba/Al_2O_3$ NO_x storage reduction catalysts made by flame synthesis** R. Strobel, S.E. Pratsinis, M. Piacentini, M. Maciejewski, A. Baiker, *ETH Zurich (Switzerland)*
A7-O14	11:15 to 11:35	**Evidences for the necessity of nitrates in HC-SCR** R. Ke, J.H. Li, L.X. Fu, J.M. Hao, *Tsinghua University (China)*
A7-O15	11:35 to 11:55	**Investigation of Ag/Al_2O_3 reductant system in the selective catalytic reduction of NO_x** H. He, Q. Wu, *Research Centre for Eco-Environmental Sciences (China)*
A7-O16	11:55 to 12:15	**The various roles of water in the Pt-Ba/Alumina lean NO_x trap catalyst system** C.H.F. Peden, J. Szanyi, D.H. Kim, J.H. Kwak, X.Q. Wang, *Pacific Northwest National Laboratory (U.S.)*; W.S. Epling, *University of Waterloo (Canada)*; J.C. Hanson, *Brookhaven National Laboratory (U.S.)*
A7-O17	12:15 to 12:35	**CeO_2-Mn_2O_3 catalyst: a potential Pt replacement for NO_x assisted soot oxidation** A. Setiabudi, *Universitas Pendidikan Indonesia (Indonesia)*; A. Hanafi, S.R. Wuryaningsih, *Kawasan Puspiptek (Indonesia)*; M. Makkee, J.A. Moulijn, *Delft University of Technology (The Netherlands)*

Nanotechnology in Catalysis
Oral Session 8
8 December 2006, Friday
LT 1

A1-O37	14:00 to 14:20	**Template-synthesis of hierarchical porous zeolites** L.F. Wang, C.Y. Yin, F.S. Xiao, *Jilin University (China)*
A1-O38	14:20 to 14:40	**Ordered mesoporous supports as model systems for studying catalyst preparation** J.R.A. Sietsma, P.E. de Jongh, A.J. van Dillen, K.P. de Jong, *Utrecht University (The Netherlands)*
A1-O39	14:40 to 15:00	**Nanosized gold on Ti-mesocellular silica foams (Ti-MCF) as stable and efficient catalysts for gas-phase epoxidation of propylene** D.L. Tang, H.W. Yang, X.N. Lu, Z.J. Lin, Y.Z. Yuan, *Xiamen University (China)*
A1-O40	15:00 to 15:20	**Preparation and characterization of nanodispersed early transition metal oxide catalysts on mesoporous silica** Y. Wang, J.E. Herrera, J.H. Kwak, J.Z. Hu, Charles H.F. Peden, *Pacific Northwest National Laboratory (U.S.)*
A1-O41	15:20 to 15:40	**Synthesis and characterization of mesoporous ceria-zerconia mixed oxide** C.L. Li, X. Gu, Y.Q. Wang, G.Z. Lu, *East China University of Science & Technology (China)*

Catalytic Reaction Engineering
Oral Session 6
8 December 2006, Friday
LT 6

A2-O28	14:00 to 14:20	**Effect of Ni-modified Al_2O_3 on the properties of Pd/α-Al_2O_3 catalysts in selective hydrogenation of acetylene** N. Wongwaranon, J. Panpranot, P. Praserthdam, *Chulalongkorn University (Thailand)*
A2-O29	14:20 to 14:40	**Tuning of activity and induction period of double metal cyanide catalyzed ring-opening polymerization of propylene oxide by ionic liquids** S.T. Baek, Anas K, D.W. Park, C.S. Ha, I. Kim, *Pusan National University (Korea)*

CeO_2-Mn_2O_3 Catalyst:
A Potential Pt Replacement for NOx-assisted Soot Oxidation

Agus Setiabudi,
Univ. Pendidikan Indonesia
Research Center for Chemistry;
LIPI Indonesia

Achmad Hanafi S, Wuryaningsih S.R.,
Research Centre for Chemistry; LIPI Indonesia

M. Makkee, and J.A. Moulijn
Delft university of Technology The Netherlands

In this presentation

A catalytic system as a replacement for Pt catalyzed NOx-assisted soot oxidation is proposed

A catalytic system to improve available NOx-assisted soot oxidation system is proposed

In This Presentation

1. Introduction

- Diesel PM and Diesel Emission Regulation
- NOx-Assisted Soot Oxidation

2. Experiment

3. Results

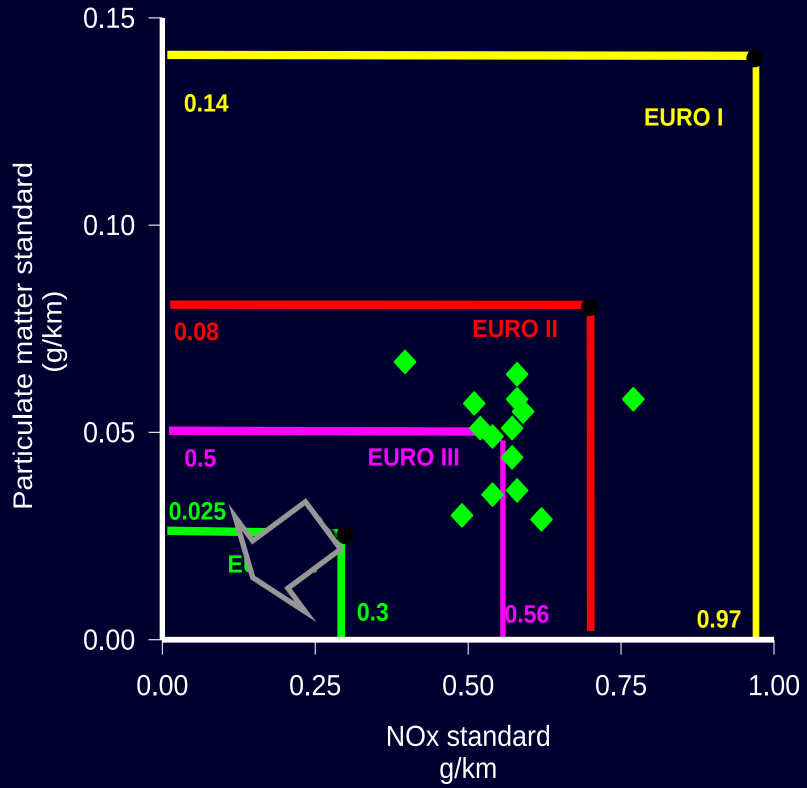
Catalyst activity in NO and Soot Oxidation by CeO_2-Mn_2O_3

4. Conclusions

Introduction

Emission Regulation

NO_x and soot (PM) emission are harmful and regulated



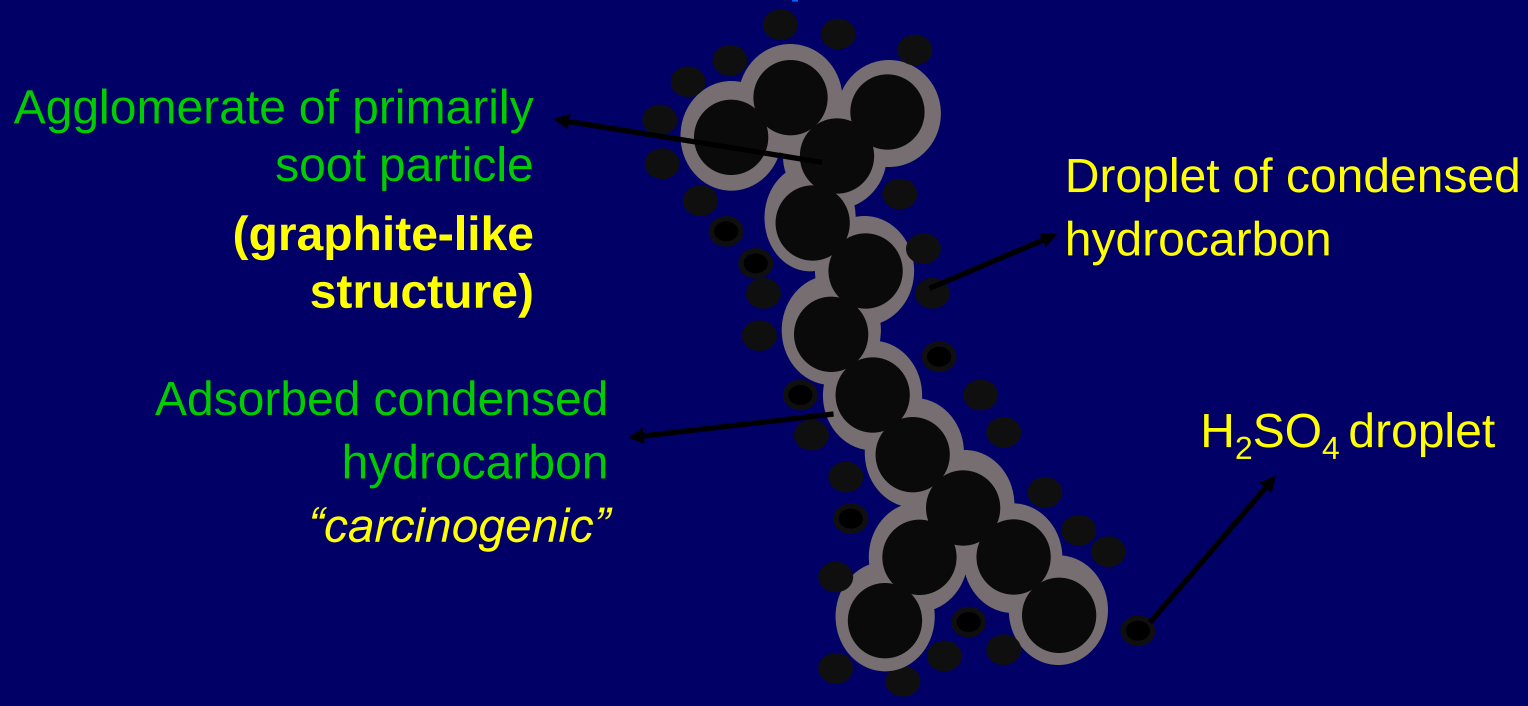
Asia-:

- Australia : EURO III in 2005
- Singapore: EURO III 2007
- Indonesia : EURO II 2005-?
- Philippines: EURO II 2007

Introduction

The Particulate Matter

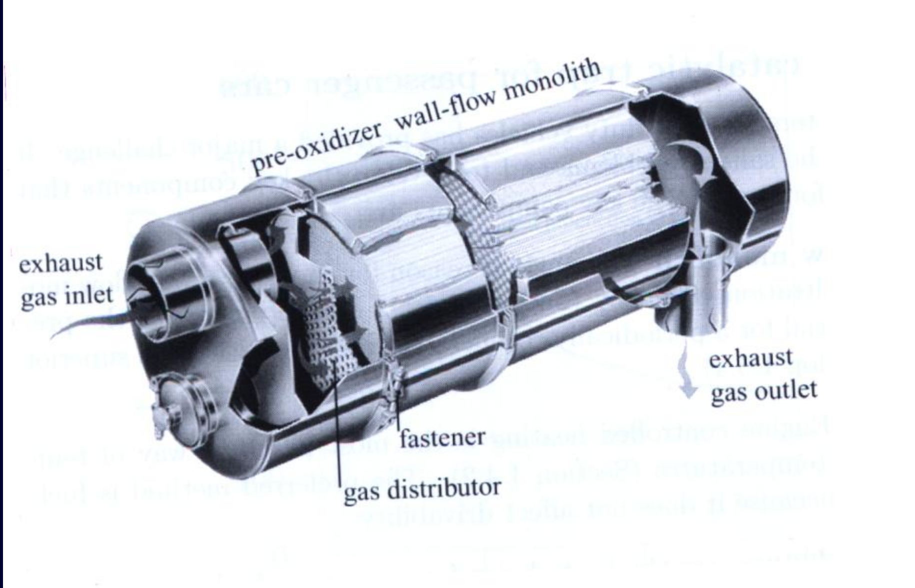
- Soot structure and components:



Diesel Emissions Abatement Technology

Existing Tech

CRT™ Technology



Allanson et .al SAE 2000-01-0480.

Reaction:

Other option?

$$NO + O_2 \xrightarrow{Pt} NO_2$$

$$NO_2 + C \rightarrow CO + NO$$

Depends on engine-out NO_x;

Recycle reaction ?

$$NO + O_2 \xrightarrow{Pt} NO_2$$

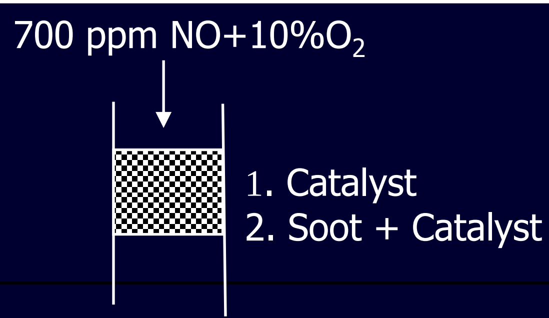
$$NO_2 + C \xrightarrow{Pt/Ce} CO + NO$$

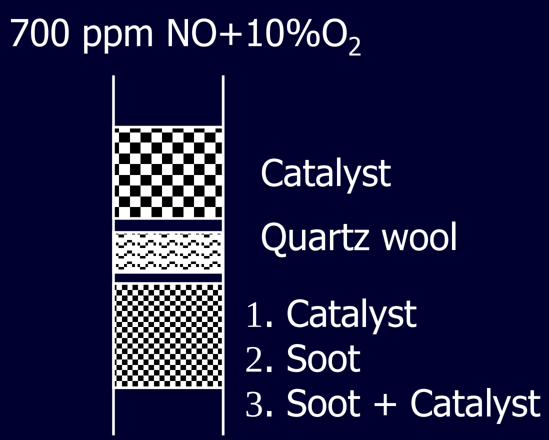
How To proceed?

Experiments

Catalysts bed Configuration

Bed configurations

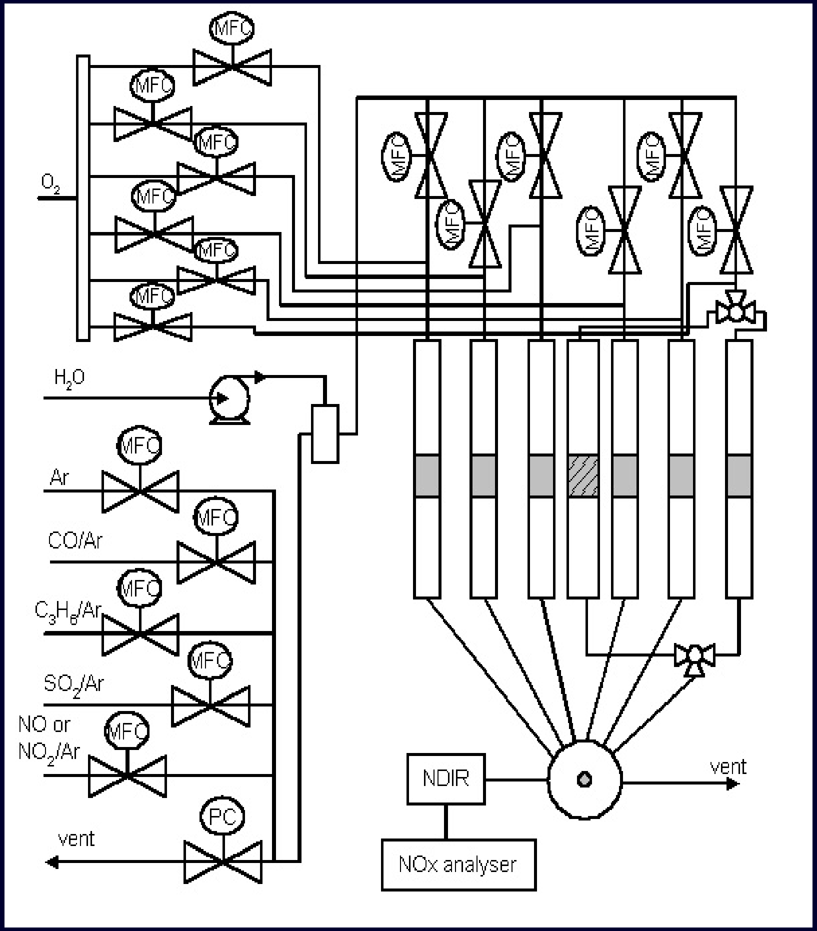




Aspects to observe:

- **Catalyst activity in the oxidation of NO to NO_2**
- **Catalyst activity in the NOx-assisted PM oxidation**
- **Catalyst activity in NOx-assisted soot oxidation (two separate beds)**

Experiment:
Reactor Set-Up



Feed:	700 ppm NO, 10% O2 Argon as gas balance GHSV 54000 l/lh
Reactor:	Heating programme: TPO ond Isothermal
NDIR:	Analyze CO, NO, CO2, SO2 Argon as gas balance
NOx analyzer	NO and NO2

Setiabudi et .al Appl. Catal. B; 50 (2004) 185-194

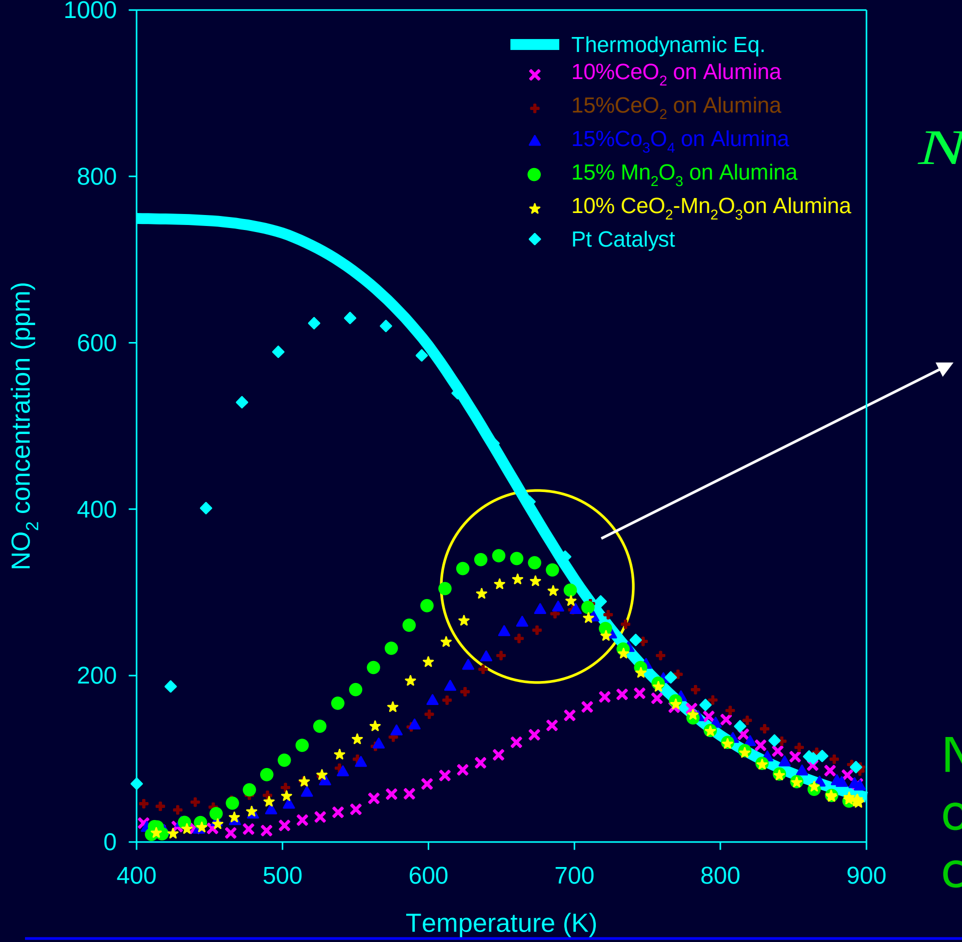
Experiment:
The (RUTI) Catalysts

Support	Active Metal	Metal loading (%w/w)	BET Surface Area
Al_2O_3 (Alumina)	Ce_2O_3	5, 10, 15	96 ± 2
	Co_2O_3	5, 10, 15	111 ± 3
	Mn_2O_3	5, 10, 15	103 ± 2
	Ce_2O_3-Mn_2O_3	5-5	107 ± 2
	Ce_2O_3-Mn_2O_3	7.5-7.5	107 ± 2

- Preparation Methods: Incipient wetness impregnation from its Nitrate precursor
- Characterizations: BET, XRD, TPR

Results:

NO oxidation



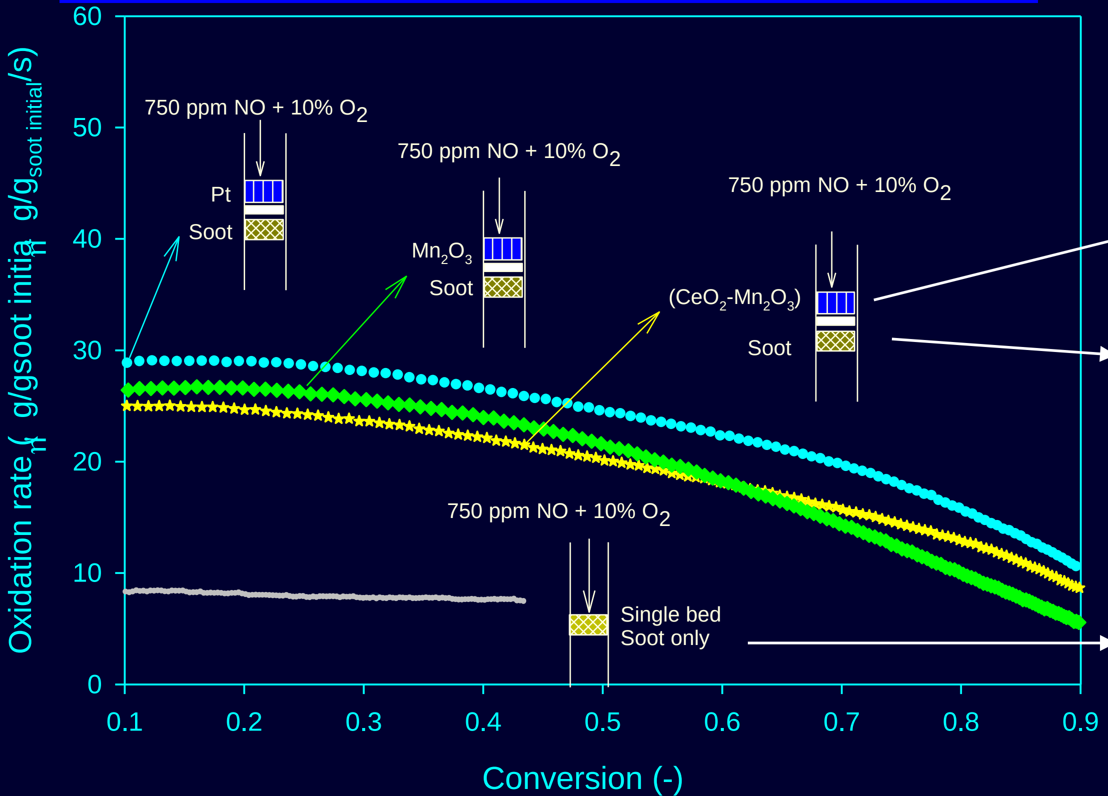
$NO + O_2 \xrightarrow{Catalyst} NO_2$

580-680 K

NO oxidation as a function of temperature by various catalysts

Results:

Soot Oxidation ‘one step reaction type’



$$NO + O_2 \xrightarrow{RUTI\ Cat} NO_2$$

$$NO_2 + C \rightarrow CO + NO$$

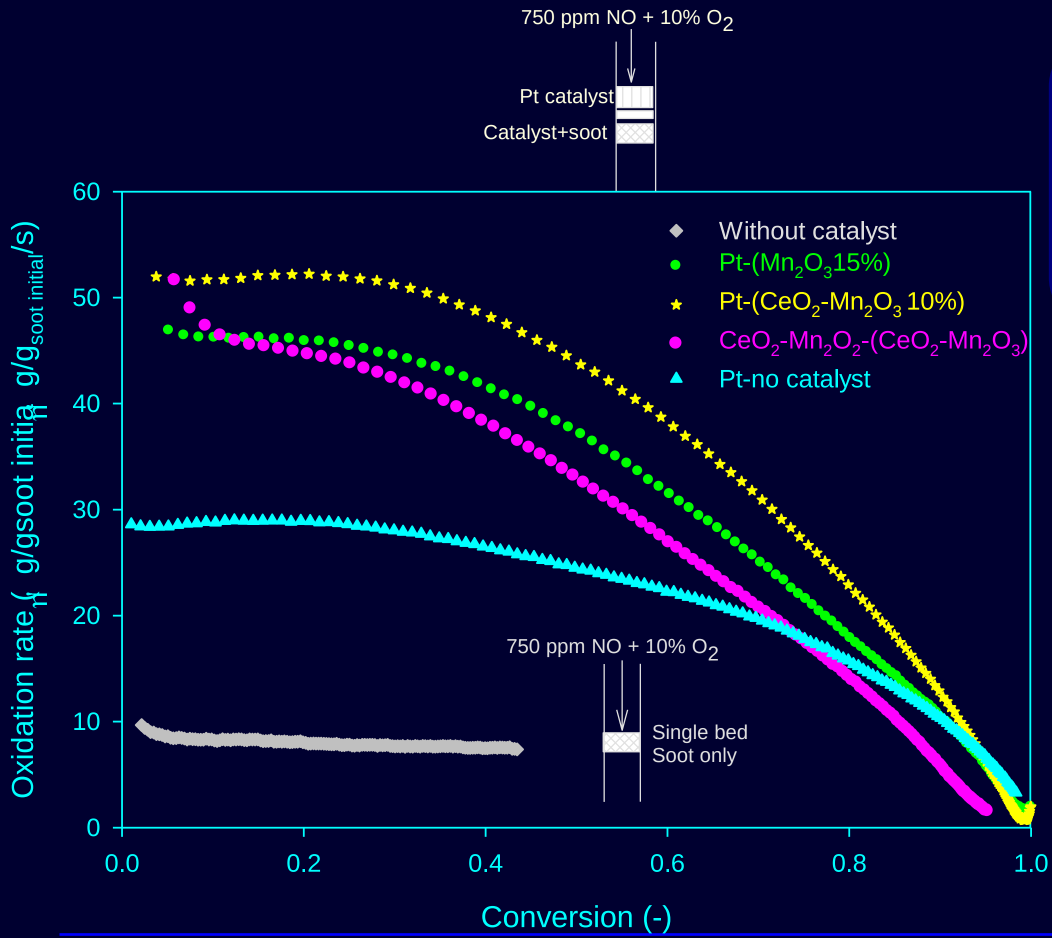
$$CO + \tfrac{1}{2}O_2 \xrightarrow{Pt} CO_2$$

$$C + O_2 \rightarrow CO_2 + NO$$

Isothermal NOx-assisted soot oxidation rate at 625 K, one step reaction

Results:

Soot Oxidation 'recycle reaction type'



Oxidation rates increase dramatically

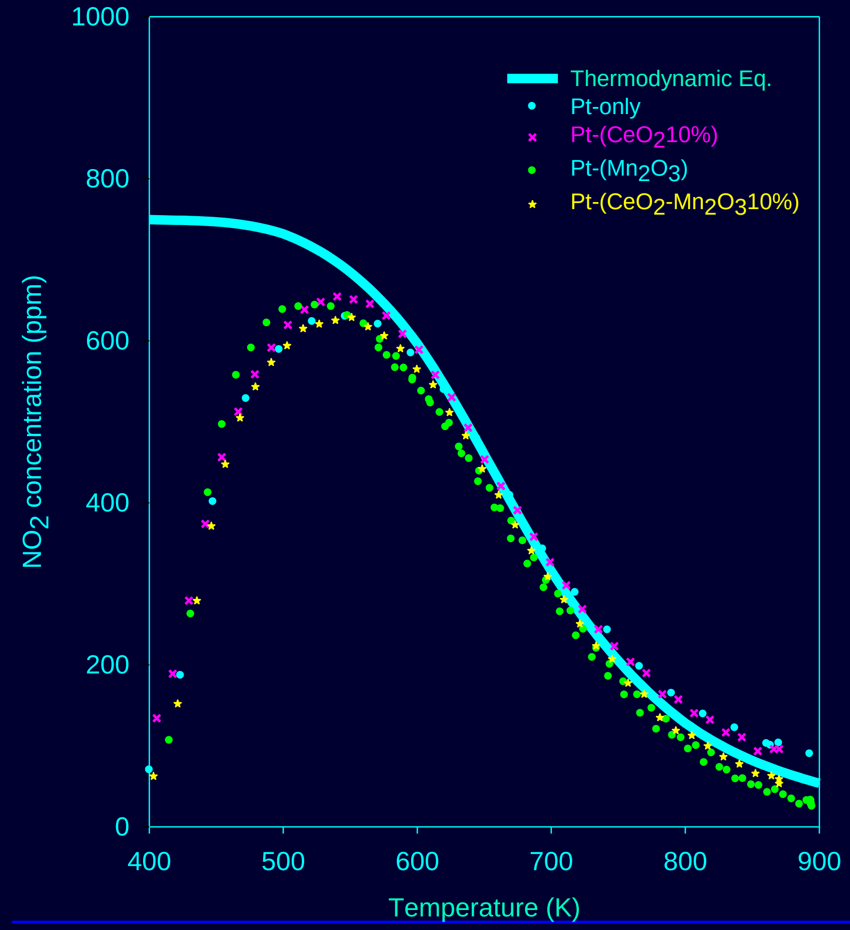
- Nr of NO_2 increase ?

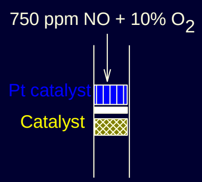
- Other factor ?

Isothermal NOx-assisted soot oxidation rate at 625 K, one step reaction

Results:

NO Oxidation ‘double cat. bed’





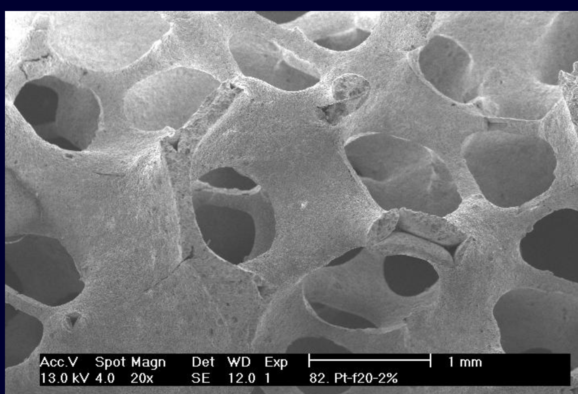
No additional NO_2 !!!

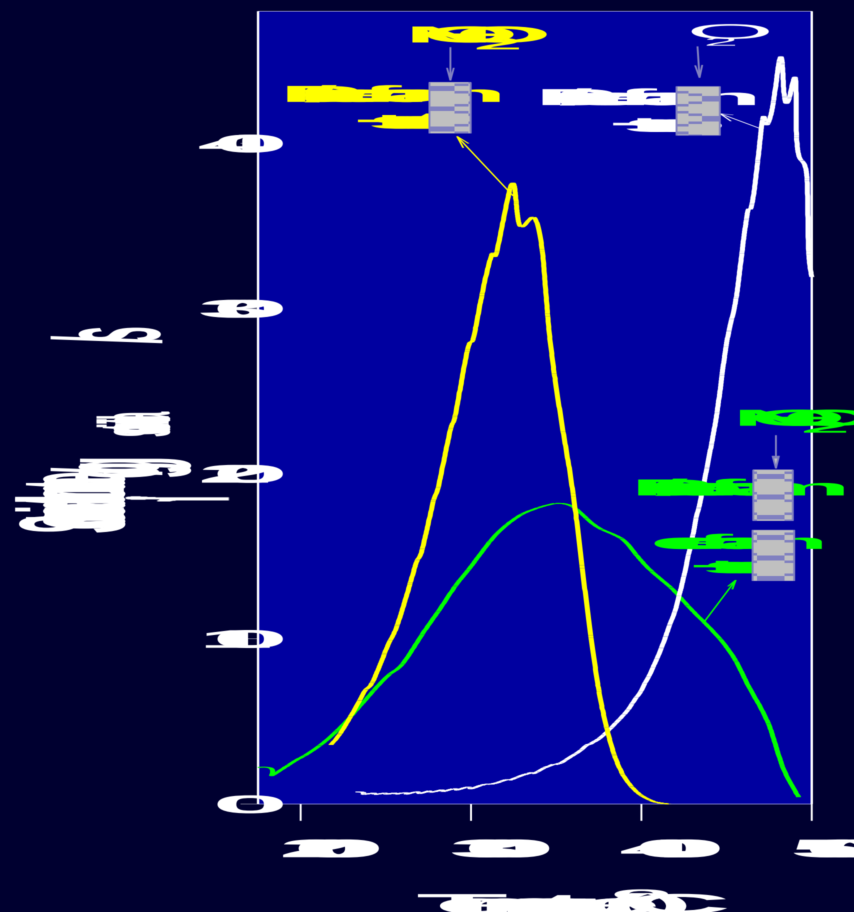
Oxidation rate with Pt/ceramic foam

$$NO + \tfrac{1}{2}O_2 \xrightarrow{Pt} NO_2$$

$$NO_2 + C \longrightarrow CO + NO$$

$$CO + \tfrac{1}{2}O_2 \xrightarrow{Pt} CO_2$$





Setiabudi et. al Appl. Catal. B; 42, 2003, 35-45

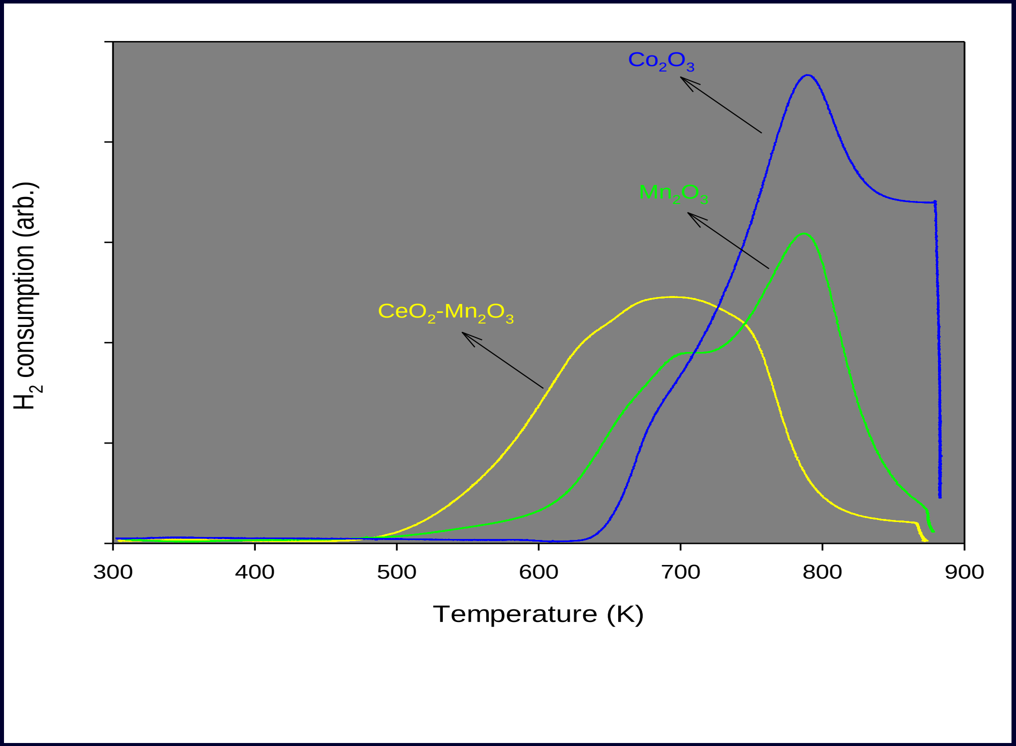
Conclusions

- Mn_2O_3, CeO_2-Mn_2O_3 catalysts are active in the oxidation of NO to NO_2
- At 625 K, NOx-assisted soot oxidation rates by the catalysts are comparable to that of Pt catalyst both in both single step and recycle reaction type.
- The catalysts are potential as Pt replacement in the NOx-assisted soot oxidation.

Acknowledgments

- Indonesian Ministry of Research and Technology
- Netherlands Academy of Science (KNAW)

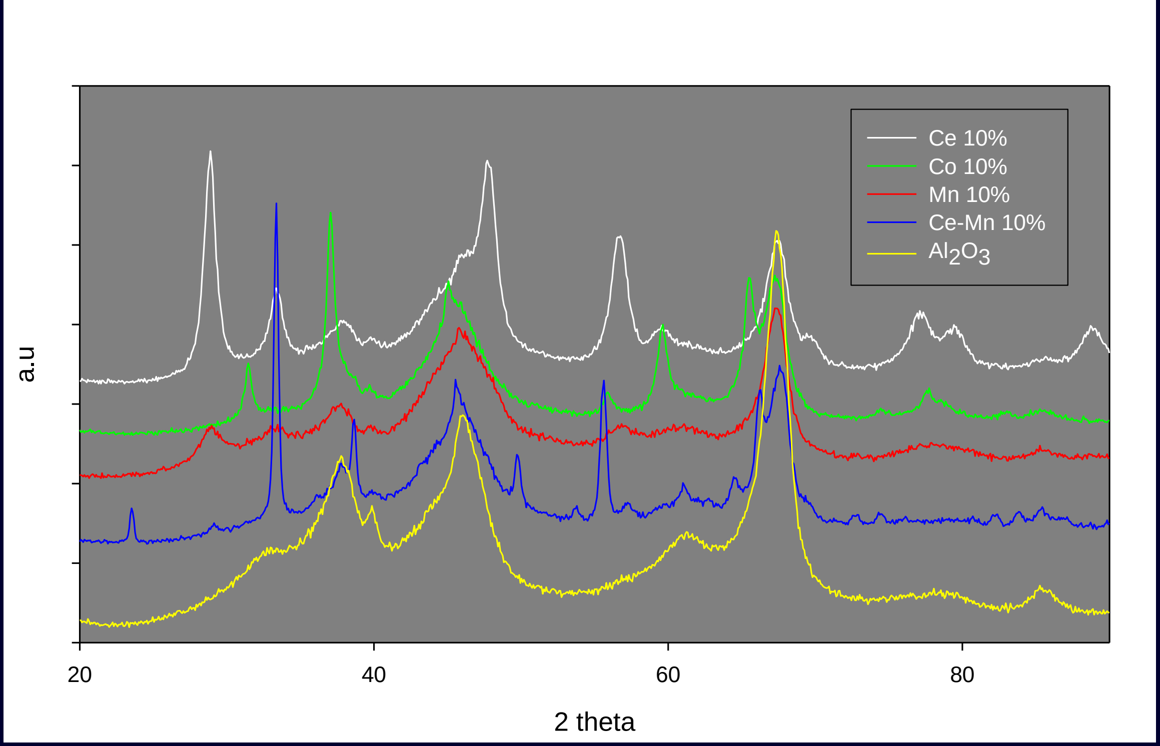
Results
Chatalyst Caracterisation: TPR



CeO_2-Mn_2O_3 has the lowest reduction temperature, might be the most active one

Temperature Programmed Reduction (TPR) profile of catalysts

Results
Catalysts characterisation XRD (2)



Best Calcinations
Temperature:

Mn : 500 °C

Ce : 500 °C

Ce-Mn10%: 600 °C

X-Ray Diffraction (XRD) spectra of 10% w/w catalysts supported on Alumina calcined at 600 °C