Automotive Catalysts at ECT

November 9th and 10th 2016

Speaker

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BS VI 2 and 3 Wheeler Challenges

- **Key Challenges for the Transition form BS IV and BS VI**
- **Key Parameter for Catalyst Performance**
  - Noble Metal
  - Technology
  - Substrate
- **Catalyst characterization**
  - Light off
  - OSC
  - Lambda-sweep
  - OBD II
- **Durability and aging stability**
  - Synthetic aging
  - Correlation synthetic and street aging
  - OBD II limit samples

Impact of BS VI and Strategies for 2 / 3 Wheelers Development

The Key Challenges to Move from BS IV to BSVI

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Legislation Requirements	BS4	BS6	Comment
CO and HC Oxidation	60-70%	90%	Impact on PGM, Support Material and System layout?
NMHC	Not required	68mg/km	
NOx Reduction	Not required	90-95%	Impact on PGM, Support Material and System layout?
Engine Operating Conditions	Lean	Stoichiometric	Which Engine Operating Conditions are required?
Durability	(30,000 Km)	30,000 km	How to Proof / Display Field Durability?
OBD II (2023)	Not required	OSC/ Detection/ Limit Samples	Transfer from Pass-car to MC?

Key Parameter for Catalyst Performance

Key Parameter for Catalyst Performance

Noble Metal and Functionality

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Oxidation of HC • CxHy + (x+y/4) O2 → x CO2 + (y/2) H2O	**Pd, Pt, Rh**
Oxidation of CO • 2 CO + O2 → 2 CO2	**Pt, Rh, Pd, OSC**
Reduction of NOx • 2 NO + 2 CO → 2 CO2 + N2 • CxHy + (2x+y/2) NO → x CO2 + (y/2) H2O + (x+y/4) N2 • 2 H2 + 2 NO → 2 H2O + N2	**Rh, OSC, Pd, Pt,**

Key Parameter for Catalyst Performance

Technology and Performance

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- A wide range of technologies are available in Market.
- One, Two or Three metal technologies → Cost and Performance
- High, Medium and Low OSC technologies → Performance and OBD
- Backpressure optimized technologies → Power and Fuel Consumption
- High, Medium and Low Aging Stable Technologies → Durability

Key Parameter for Catalyst Performance

Substrates

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- Material, metal or ceramic → Thermal behavior
- Volume (Space velocity) → Performance, Construction Space
- Cell density → Performance, Back pressure
- Substrate Structure → Performance, Durability

Catalyst Characterization

Characterise Catalyst Performance

- Light Off Test
  - One of the most important aspects of TWC performance in the WMTC is light off and cold start.
  - The engine bench test is aimed at benchmarking catalyst regarding their light off temperature.
  - This test does however not fully represent the extremely fast temperature transients in a real application. But it allows a quite good characterization of a catalyst (relative comparison)

Characterise Catalyst Performance

- Lambda Sweep Test
  - The lambda sweep test examines the TWC performance under varying somehow stationary lambda conditions.
  - Lambda is varied from rich to lean and lean to rich step by step. At each lambda plateau conversions of HC, CO and NOx is recorded.
  - 1Hz Lambda frequency: Temperature: 450°C, Lambda amplitude:
    - 3,4% lambda (0,5 AF)
    - 6,8% lambda (1,0 AF)

Characterise Catalyst Performance

- OSC Testing – Lambda Step Test
  - The lambda step test aims at quantifying total available OSC amount after a “static” step change in lambda.
  - A correct integration of the lambda signals requires oxygen sensors both upstream and downstream catalyst and an integration between these signals.

Catalyst Aging

Catalyst Aging

Selection criteria for catalyst aging mode

- Correlation to field aging (severity, profile, …)
- Realistic temperature / gas conditions
- Reliability and reproducibility
- Cost
- Philosophy

materials for a better life

Catalyst Aging

- Most aging mechanisms caused by thermal exposure are irreversible
    - Sintering of PGM and oxides
- Reversible deactivation is mostly related to some poisons. In such cases moderate heat treatment can restore the initial activity and reverse the deactivation process.
    - Sulfur poisoning or generally precious metal is oxidized or poisoned.

Catalyst Agings

Fuel Cut Aging

Mostly used for technologies with separated PGM

+ **Real engine exhaust**
+ **Real driving conditions**
+ **Flexible & dynamic cycle set up**

- **Limited max. temperature**
- **High to very high durations**

Secondary Air Aging

Mostly used for technologies with integrated PGM

+ **Real engine exhaust**
+ **High temperature possible**
+ **Flexible cycle set up**

- **No realistic driving conditions**
- **High to very high durations**
- **Challenging bench set up**

Oven Aging

+ **Cheap**
+ **Fast**
+ **High temperature possible**

- **No realistic exhaust condition**
- **No dynamic possible**
- **=> questionable correlation to field aging**

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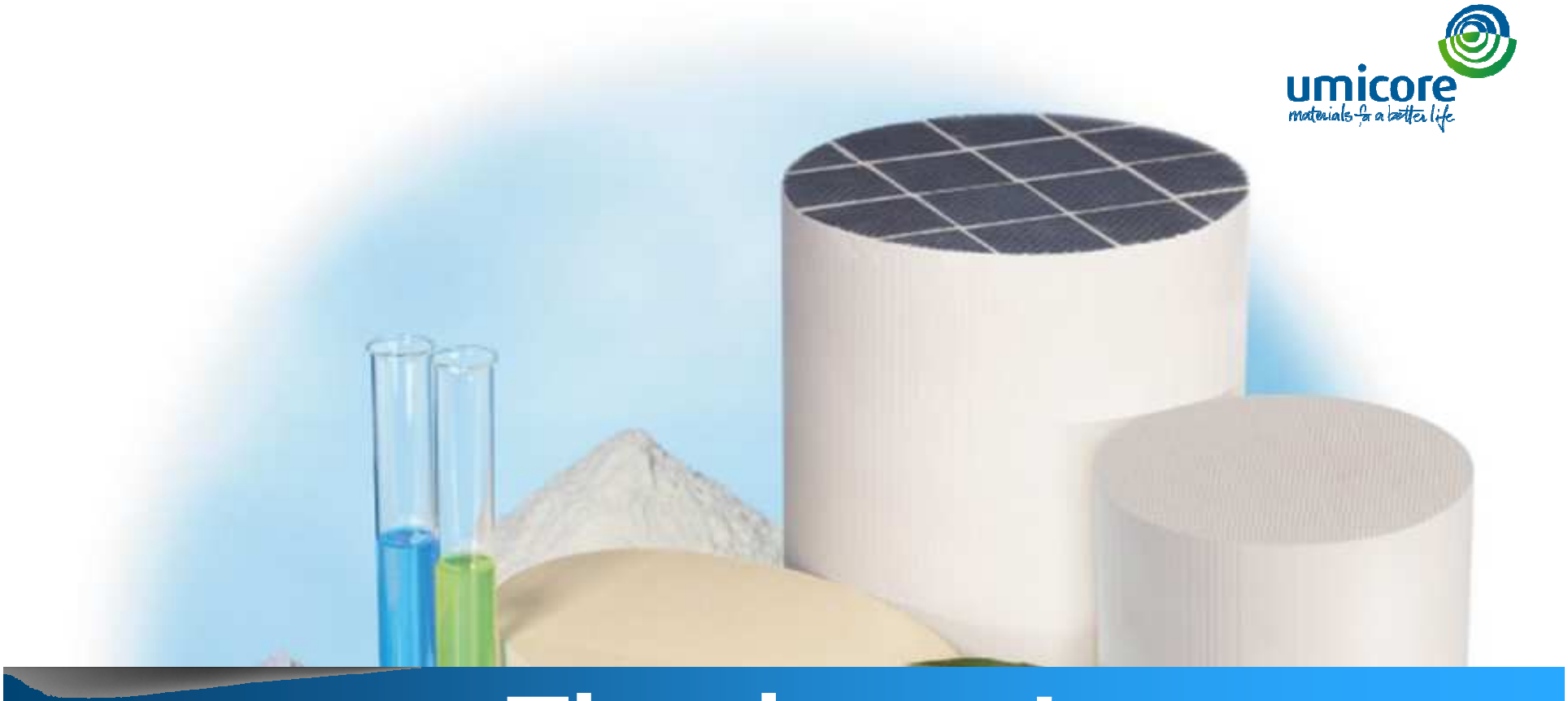

Thank you!

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“Clean air is our business”