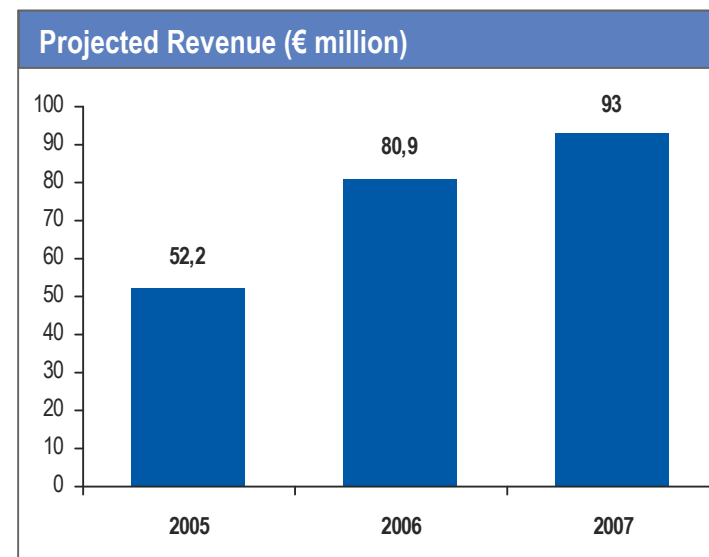


Catalytic Solutions for Emission Control of Natural Gas Vehicles

Dr. Toni Kinnunen
Osmo Jahkola
Sergio Del Re
Dr. Andreina Moreno

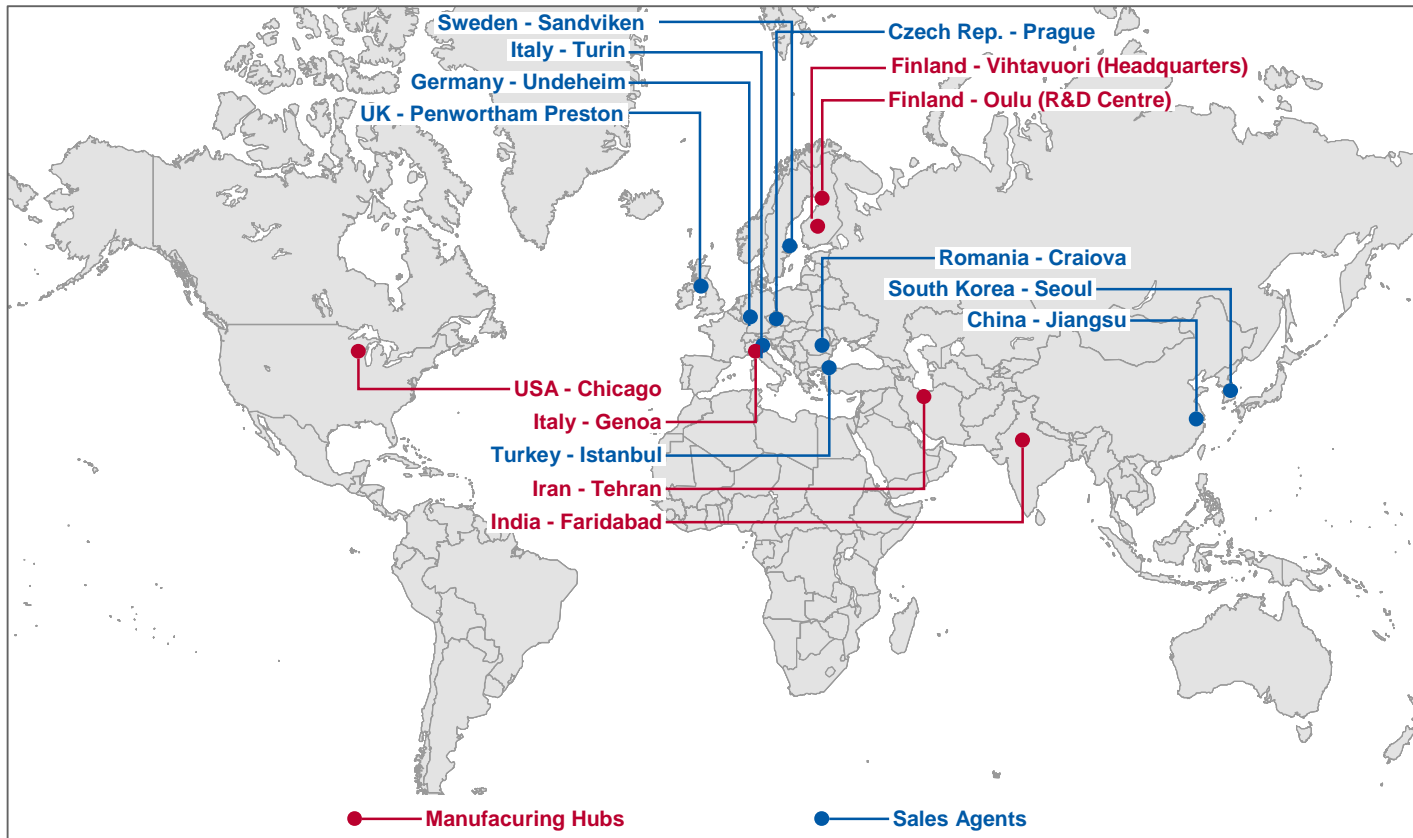
Ecocat Group

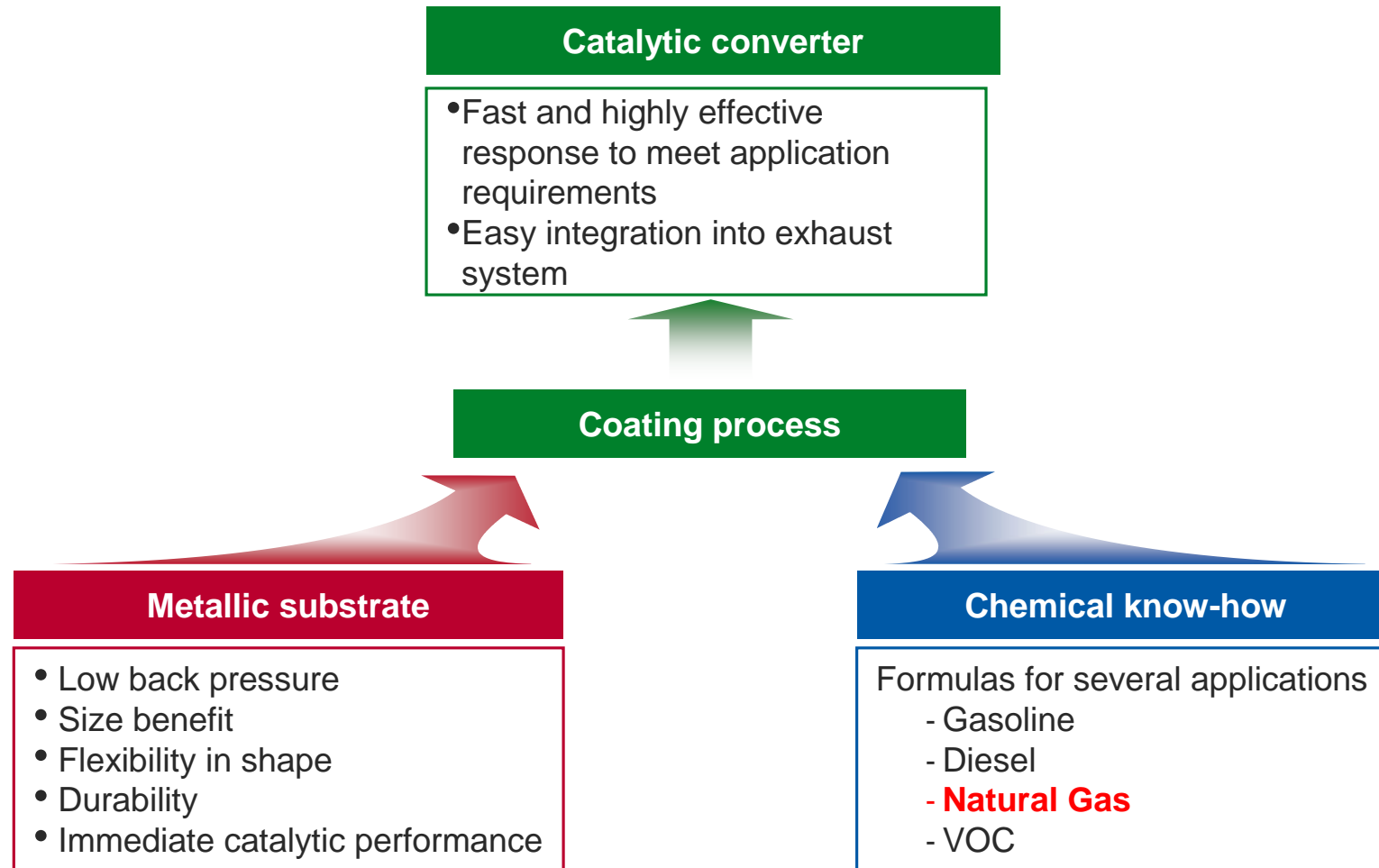
- Ecocat is an international and fast growing clean air technology company headquartered in Finland.
- Ecocat develops and manufactures catalytic converters, in other words mechanical substrates with chemical coatings for automotive industry, small engines and industrial applications.
- Ecocat's global market share is close to 20% of metallic substrates and 3% of all substrates.
- The company has manufacturing plants in Finland, India, Italy, Middle-East and the U.S.



Ecocat cleans the air for the world

Global Presence

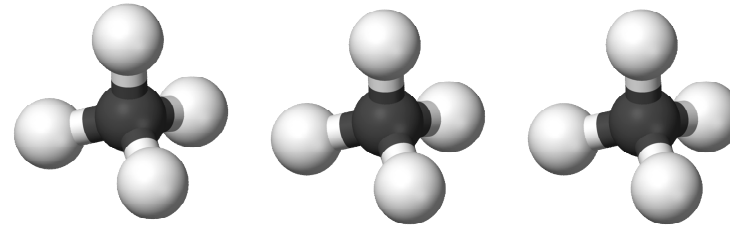




- Ecocat has been active in the catalyst market since the early stages of the regulation of exhaust emission controls internationally and has over 20 years of know-how in all three processes

Introduction

CNG: **C**ompressed **N**atural **G**as
Composition: 95-98% Methane (CH_4)



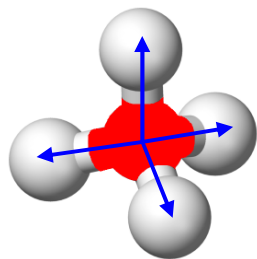
- CNG is a very economic fuel since there is no need to refine it
- There are around **6.182 trillion ft³** proven reserves of natural gas in the world when compared to **1.317 billion barrels** of oil
- CNG is gaining territory as a fuel of choice for mobile and stationary combustion engines:
- By 2020 there will be around **25 million cars** running on CNG in Europe alone!!

Ecocat has both the technical and logistical ability to provide substrate, coating and canning as an integrated one-piece solution

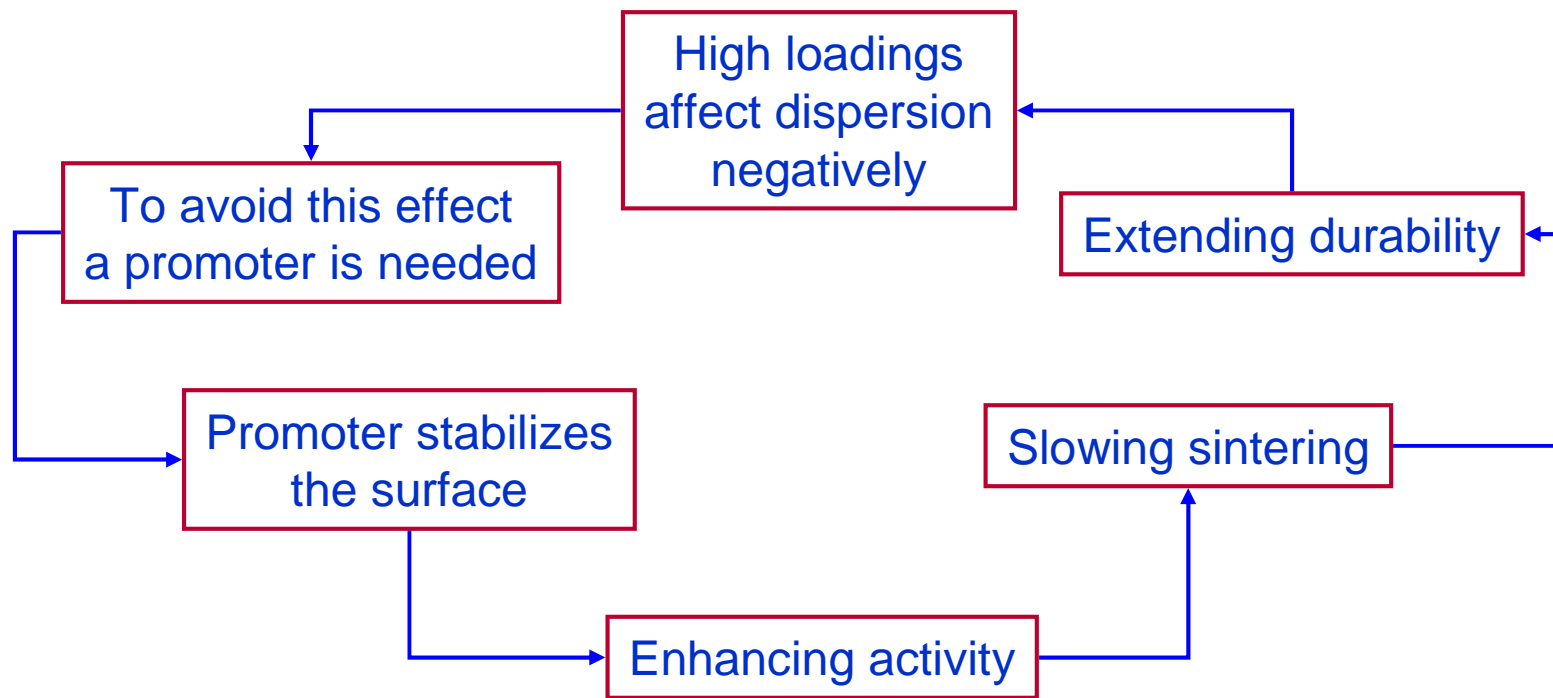


Hence Ecocat's strategy of focusing on CNG

Introduction



To tackle the high energy barrier is common to use high loaded catalysts



Introduction

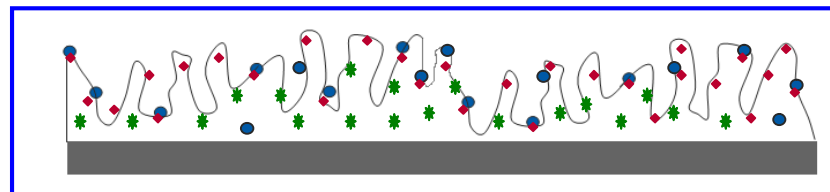
Trough intensive research, Ecocat has developed an advance formulation designed to cope with the demanding conditions CNG catalysts must endure

Our range of products covers:
CNG only applications
Bi-fuel applications
LD & HD, Stationary



Particular emphasis has been put on:
Increasing durability
Reducing light-off

Advanced Coating



Metal substrates enable reduced emissions

- **Thinner walls mean:**
 - Lower pressure drop
 - More geometric surface area
 - Higher CPSI possible
- **Higher thermal conductivity and lower heat capacity mean:**
 - Faster, more uniform heat up
 - No “hot spots”
- **Air gap between substrate and canning means:**
 - “Air” insulation
 - Higher operating temperatures
- **Speed bumps improves mass and heat transfer**

Introduction

- Features groove system for substrate locking and improved flow dynamics.
- 100 % stainless steel (1.4767/1.4725 substrate, FeCrAl).
- Easy to integrate into the exhaust system.
- Improved heat and mass transfer rate, low thermal inertia.
- High resistance against thermal and mechanical shocks.



Brazed Ecocat 500 cpsi

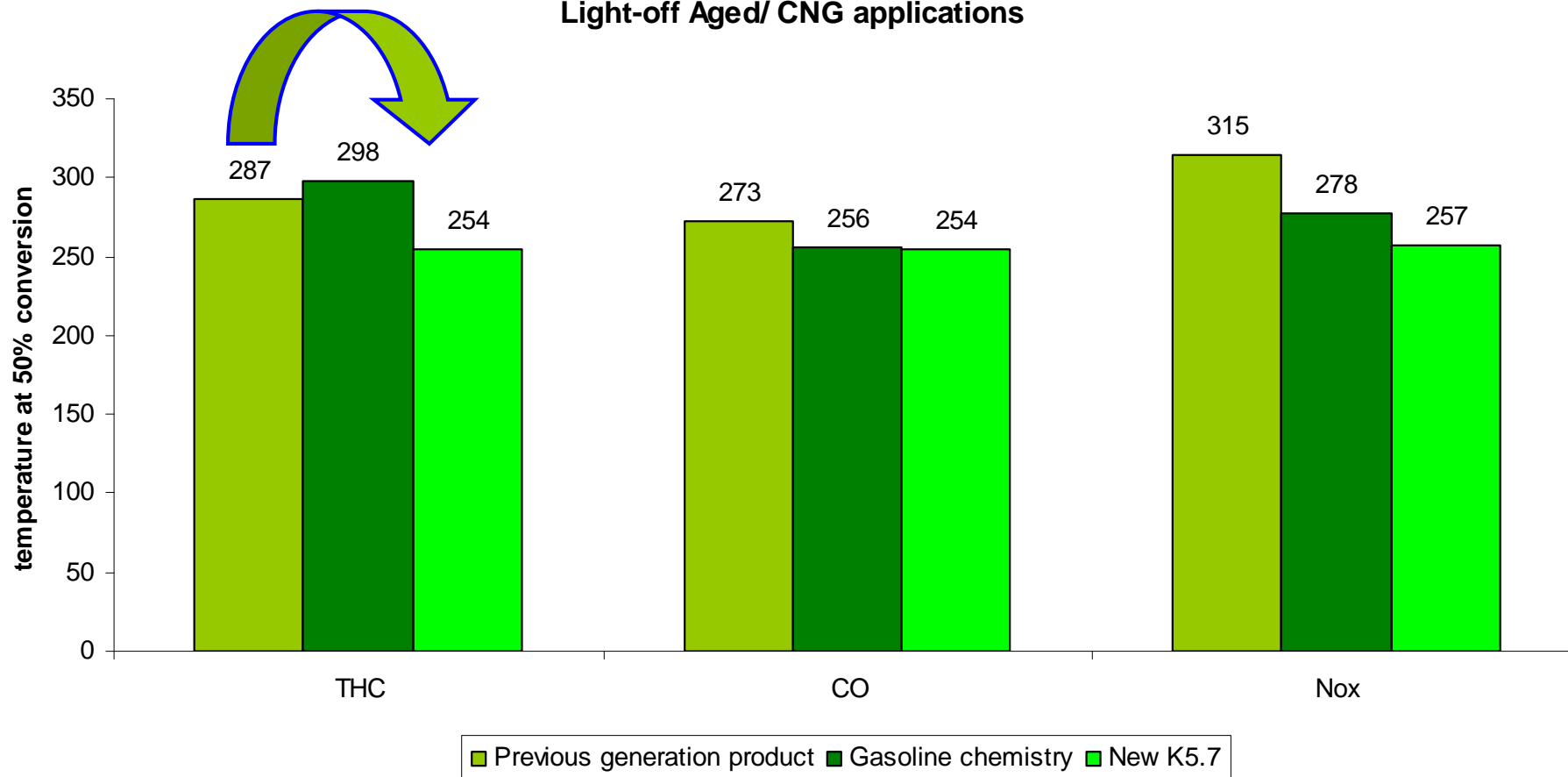


Lower bumps, decreased back pressure
Excellent mechanical durability by brazing

Solution for CNG Applications

New Washcoat for CNG-Only Applications

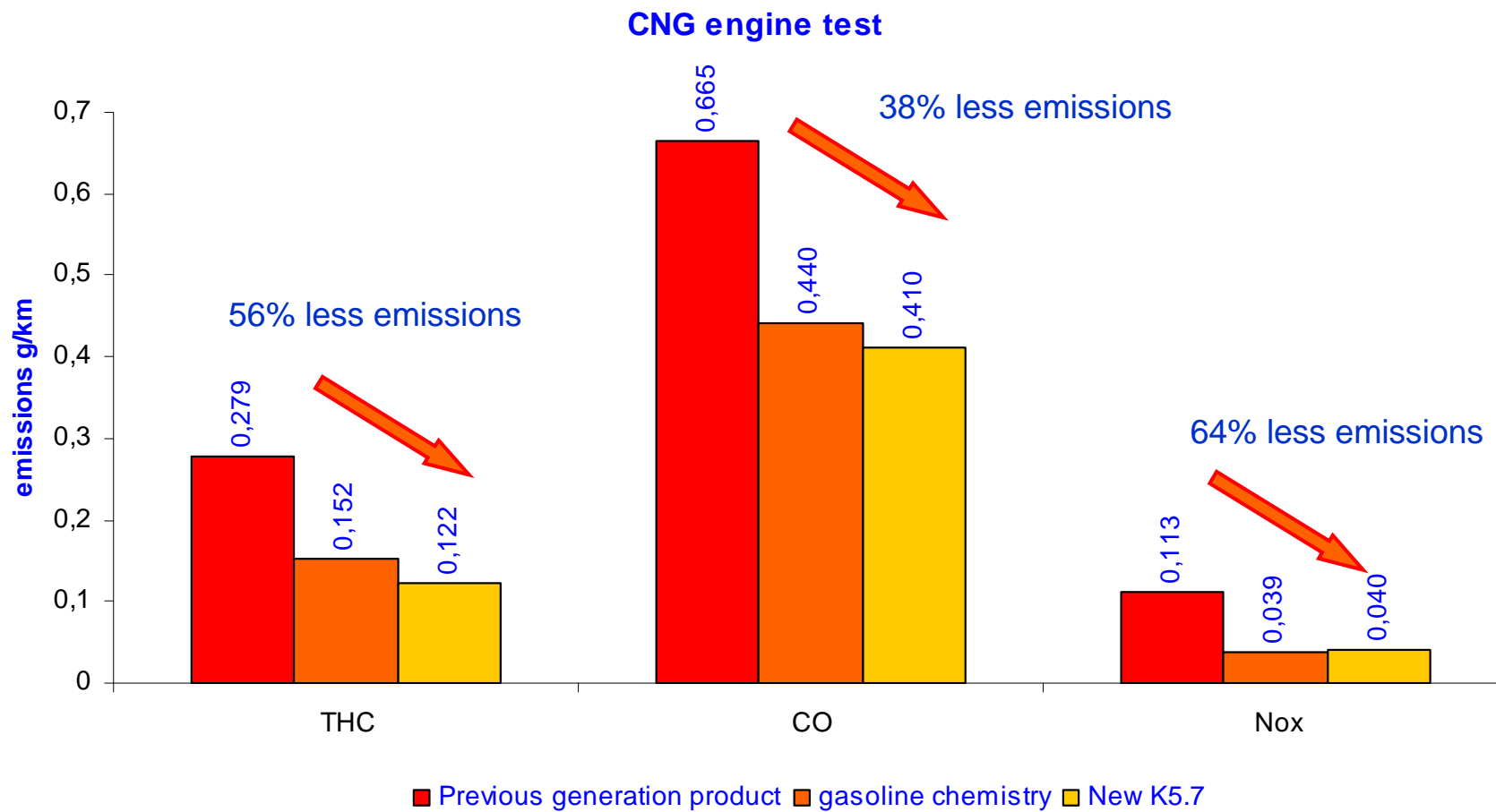
Light-off Aged/ CNG applications



Conversion of methane starts at lower temperatures

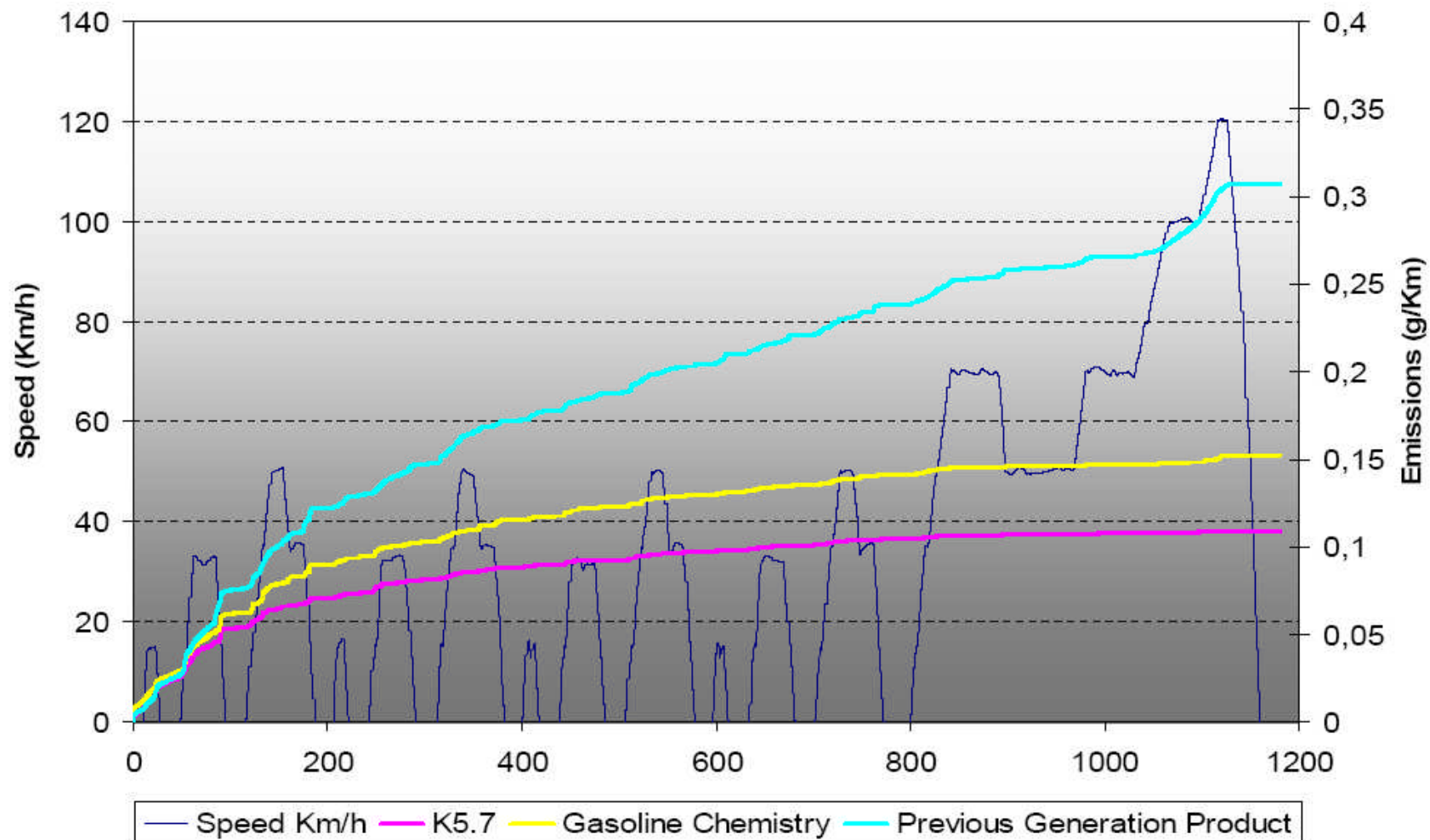
New Washcoat for CNG-Only Applications: K5.7

Results Correspond to Aged Samples



Cumulative THC Emissions During Engine Test

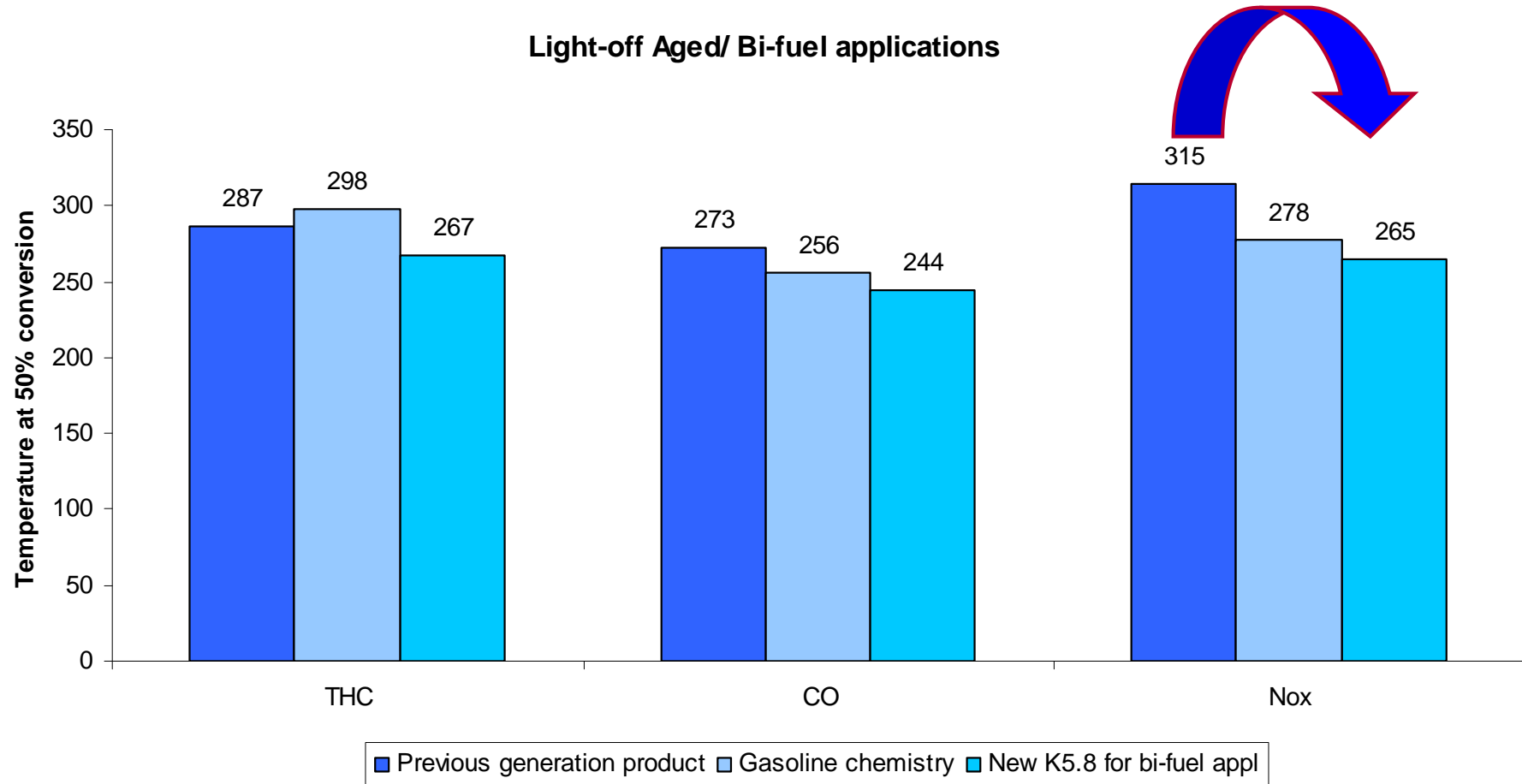
Results Correspond to Aged Samples- CNG Test



Solution for Bi-fuel (gasoline and CNG) Applications

New Washcoat for Bi-fuel Applications

Light-off Aged/ Bi-fuel applications

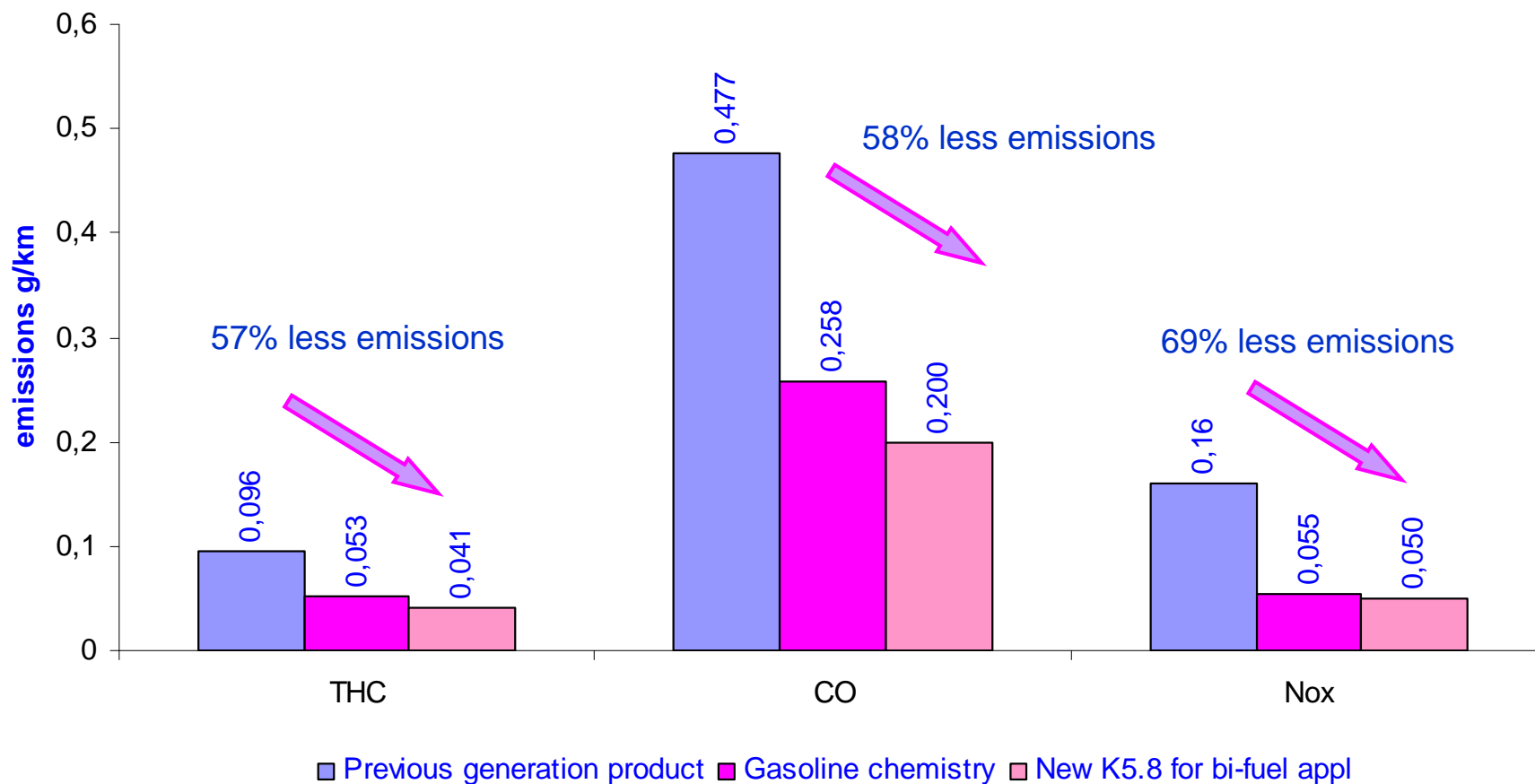


High efficiency due to lower light-off!

New Washcoat for Bi-fuel Applications: K5.8

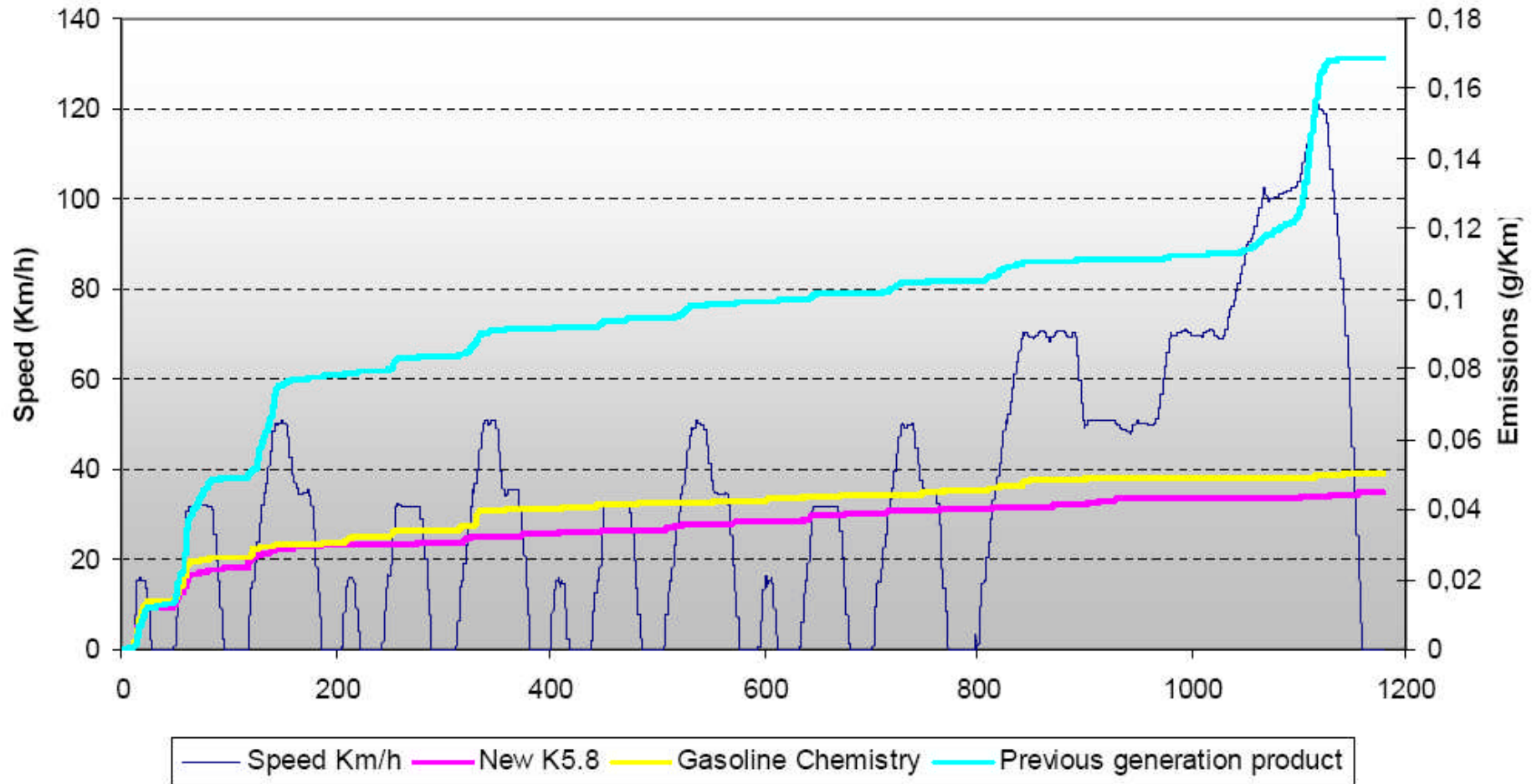
Results Correspond to Aged Samples

Gasoline engine test



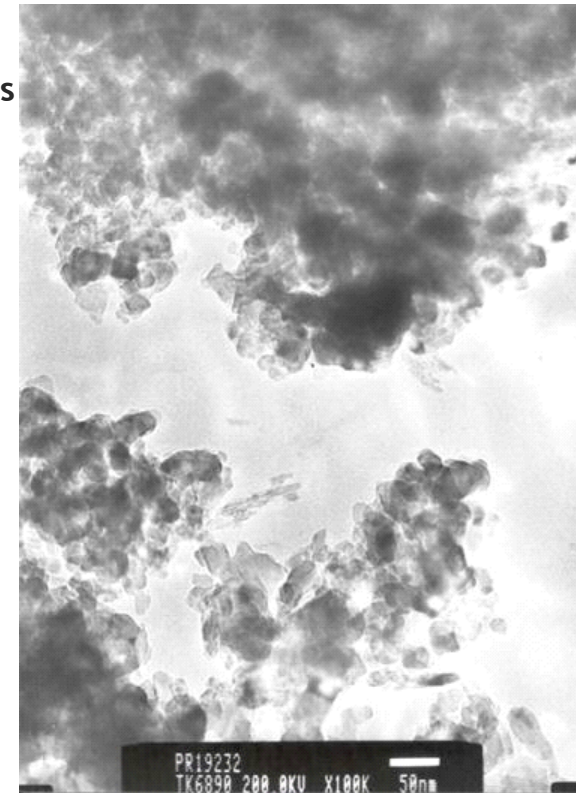
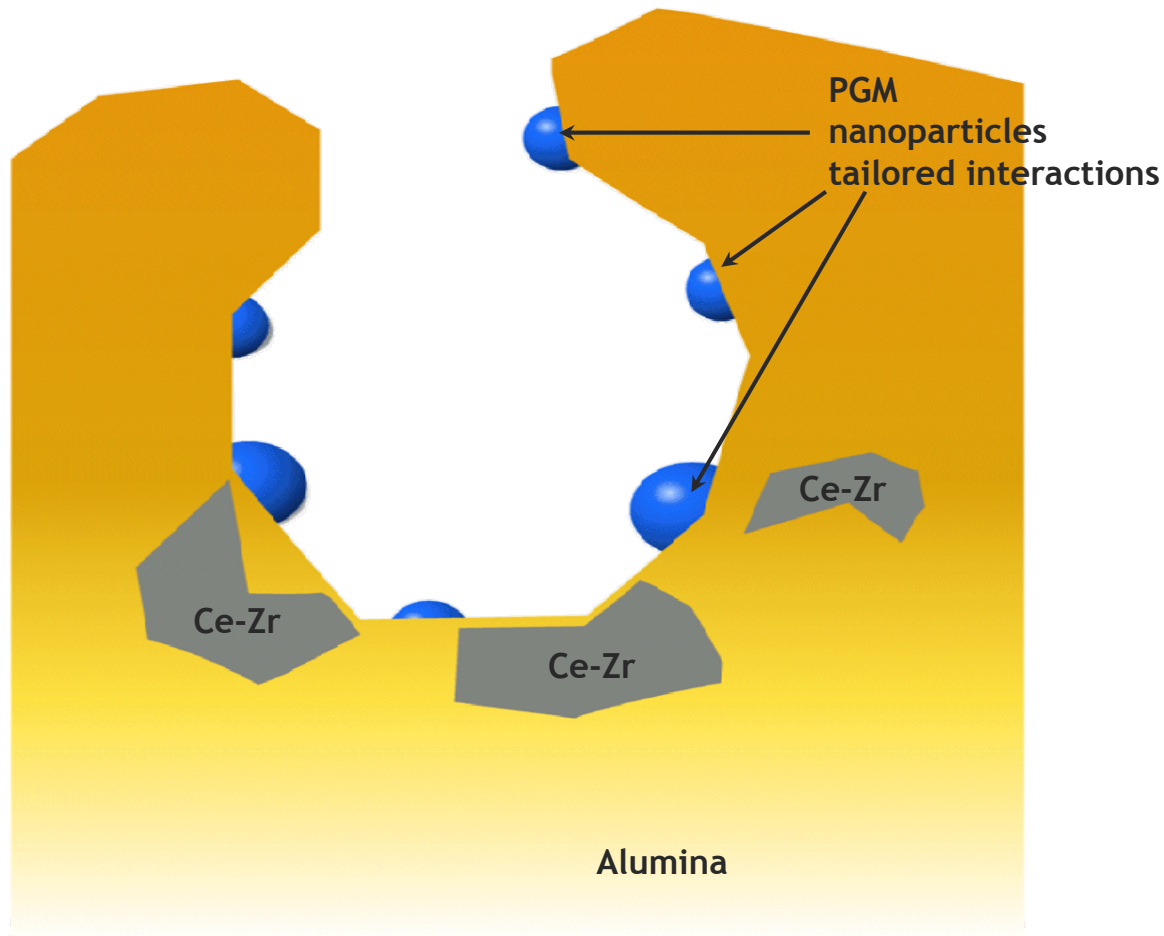
Cumulative NOx Emissions During Engine Test

Results Correspond to Aged Samples- Gasoline Test



Nanotechnology behind

Active sites in optimum usage



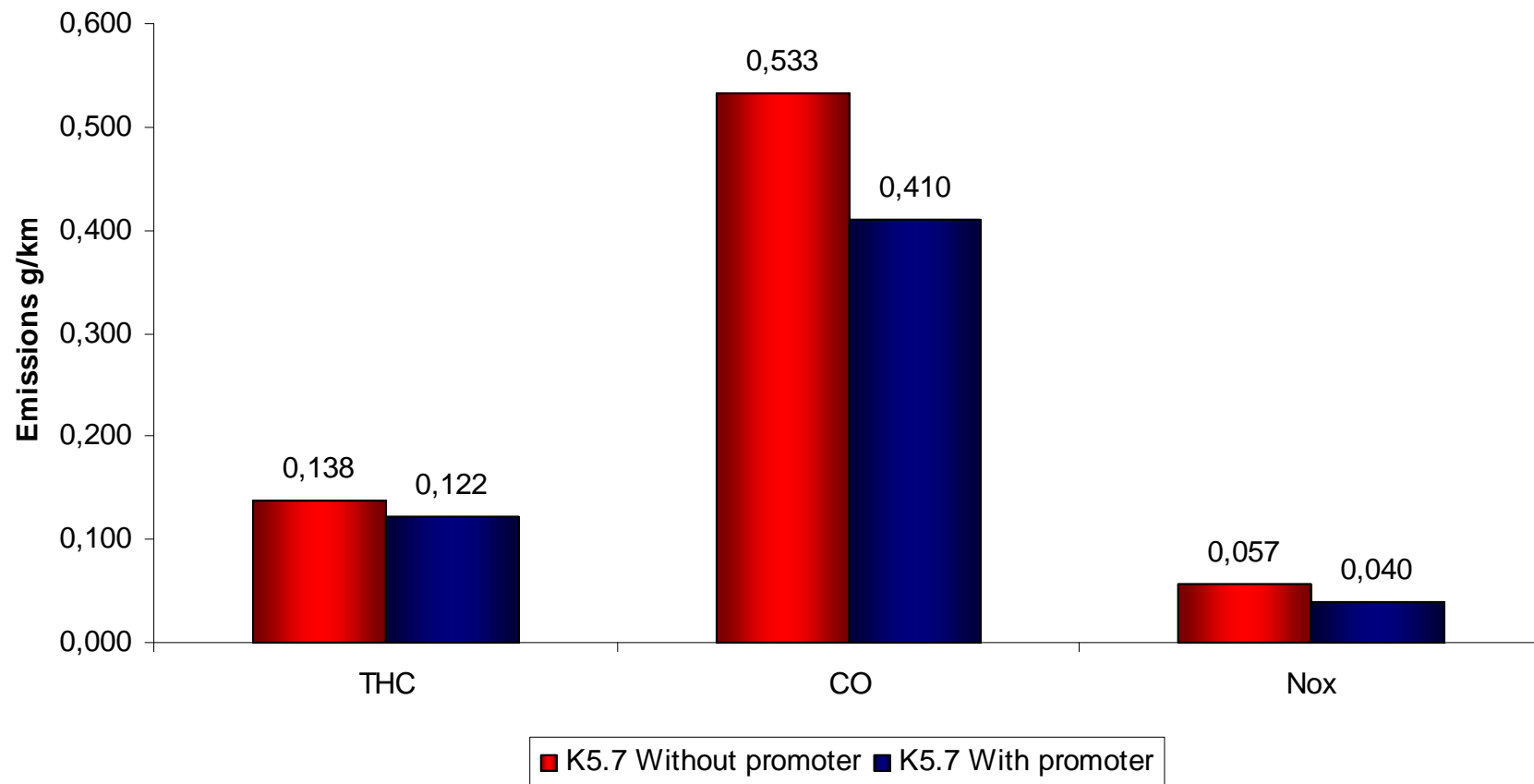
Constant need for enhanced activity without significant increase in cost
→ Optimised usage of precious metals needs improvements in catalytic chemistry

Promoter Effect on Emissions: K5.7 for CNG only applications

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Results Correspond to Aged Samples

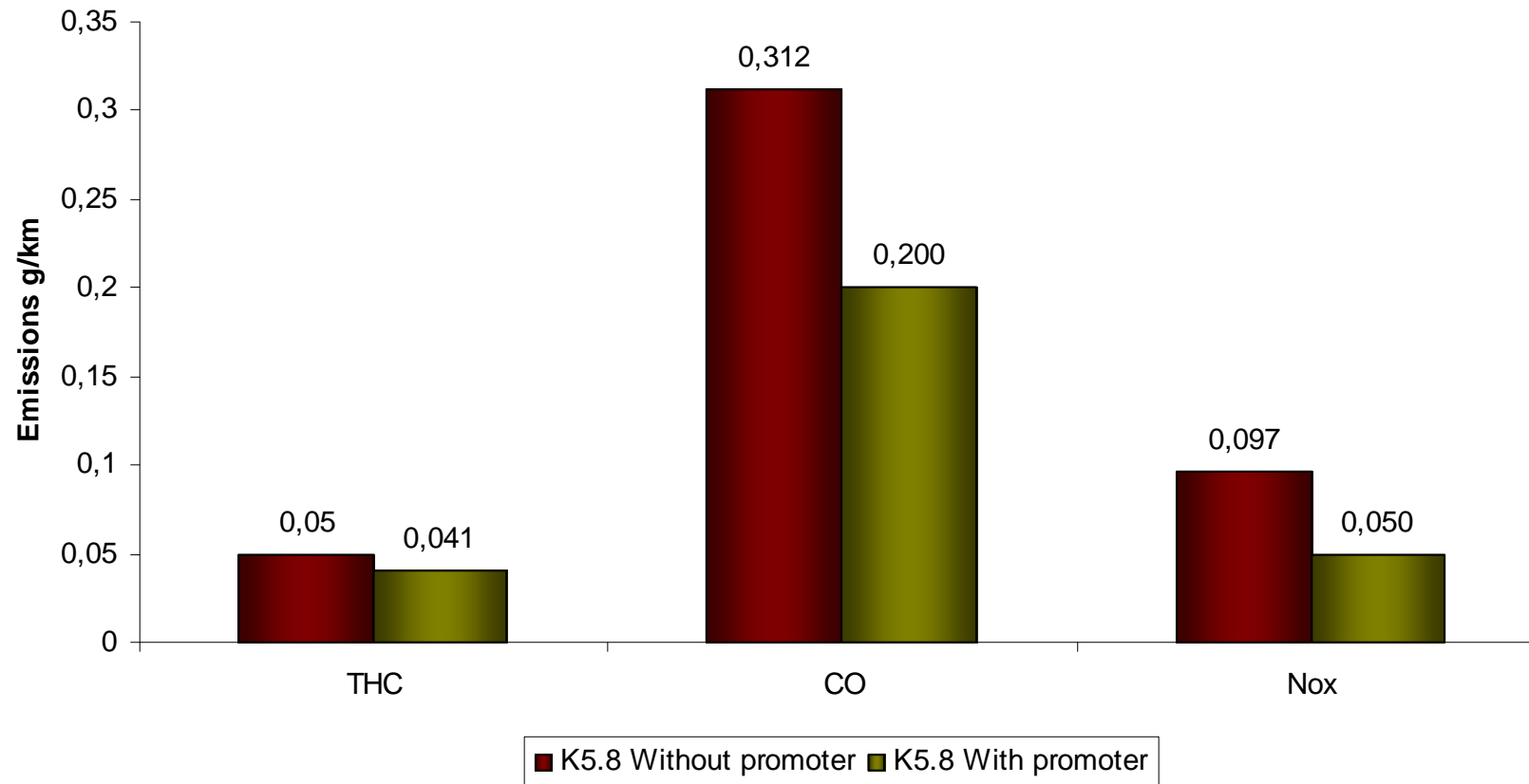
Effect of promoter on Activity/ CNG engine test



Promoter Effect on Emissions: K5.8 for Bifuel applications

Results Correspond to Aged Samples

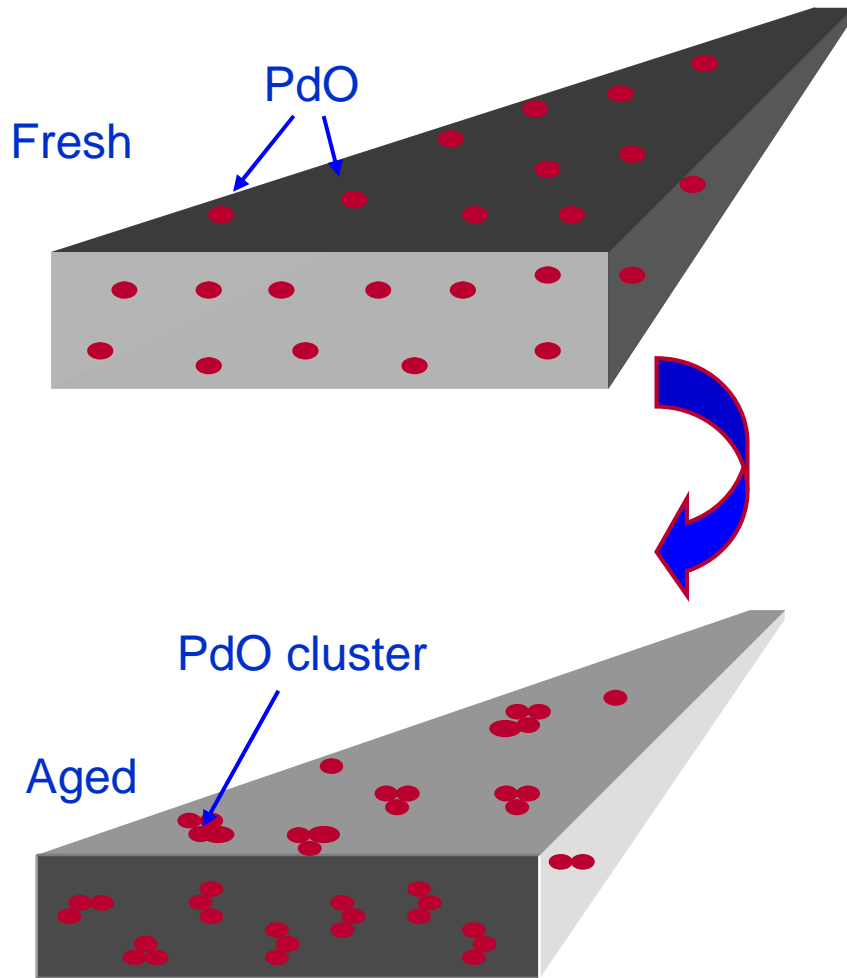
Effect of promoter on activity / Gasoline engine test



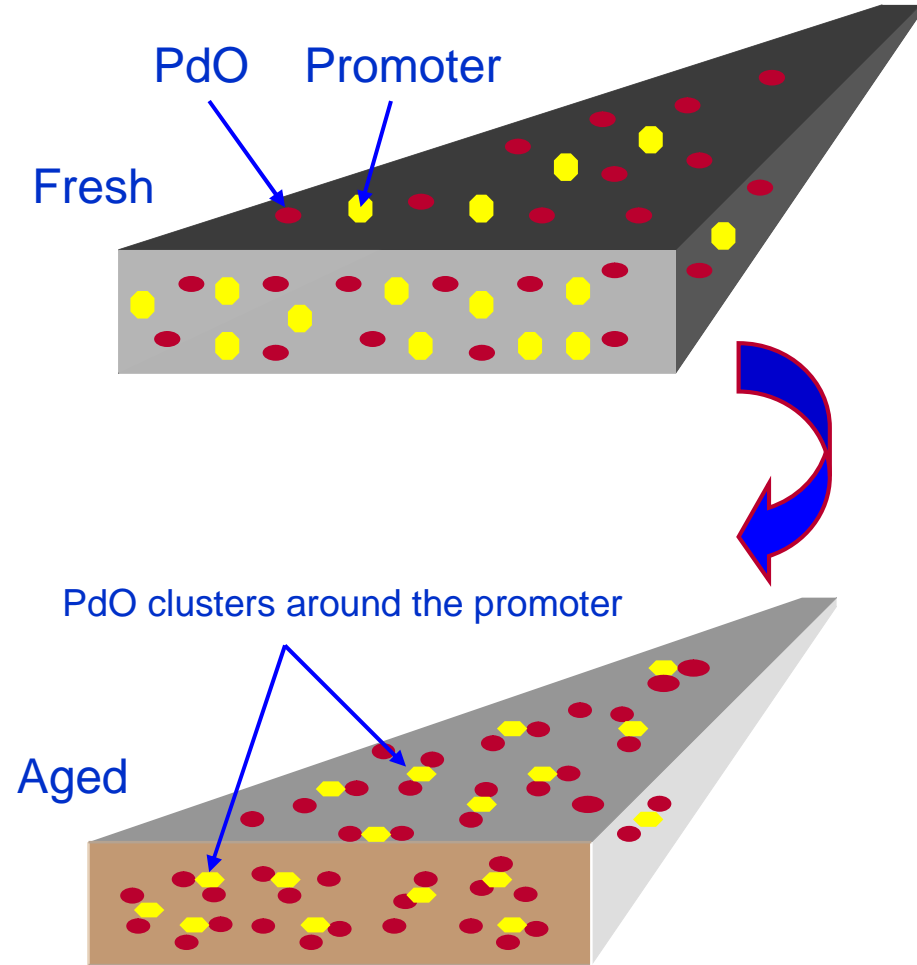
The promoter effect is particularly significant on NOx emissions from gasoline

Addition of promoter hinders the sintering of PGM

Unpromoted Surface



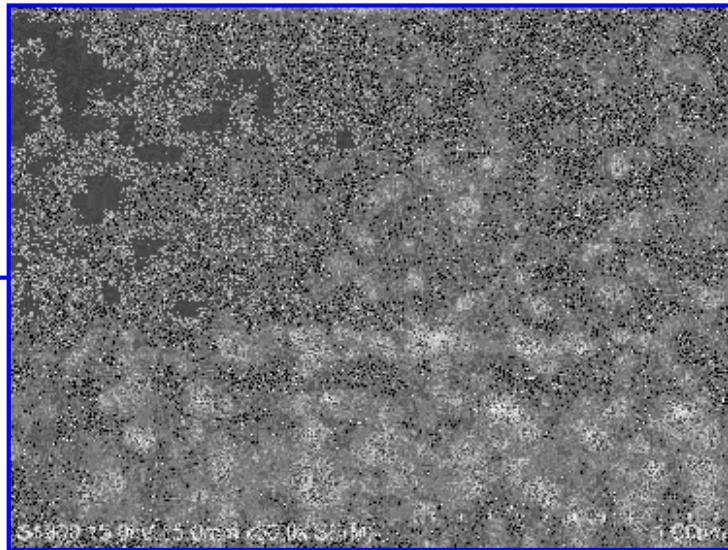
Promoted Surface



Dispersion is kept at good levels

Addition of promoter hinders the sintering of PGM

Aged Sample with promoter

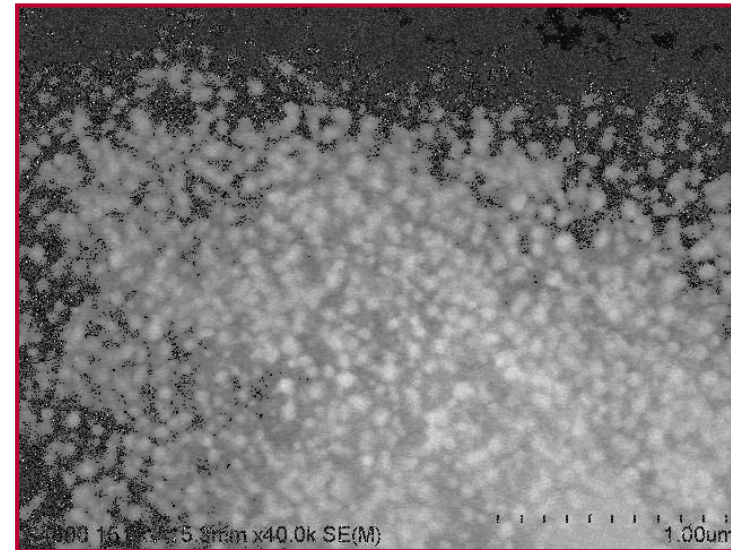


Low density of Pd clusters on the surface

Promoter stabilizes the surface

Less sintering after aging

Aged Sample **without** promoter



High density of Pd clusters on the surface

Ustabilized surface

More sintering after aging

Ecocat technology = Optimised combination of appropriate substrate and efficient chemistry

Ecocat is unique in the world by providing the whole product for catalytic aftertreatment

Competitive solutions for CNG and Bi-fuel

- ✓ **Low-Dp durable metallic substrate**
- ✓ **Enhanced promotion effect**
- ✓ **Low light-off, high activity**
- ✓ **Excellent thermal durability**
- ✓ **Pd-rich = cost effective**