Catalyst Technologies for Advanced Engine Emission Controls

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April 28, 2015

EMISSION CONTROL TECHNOLOGIES

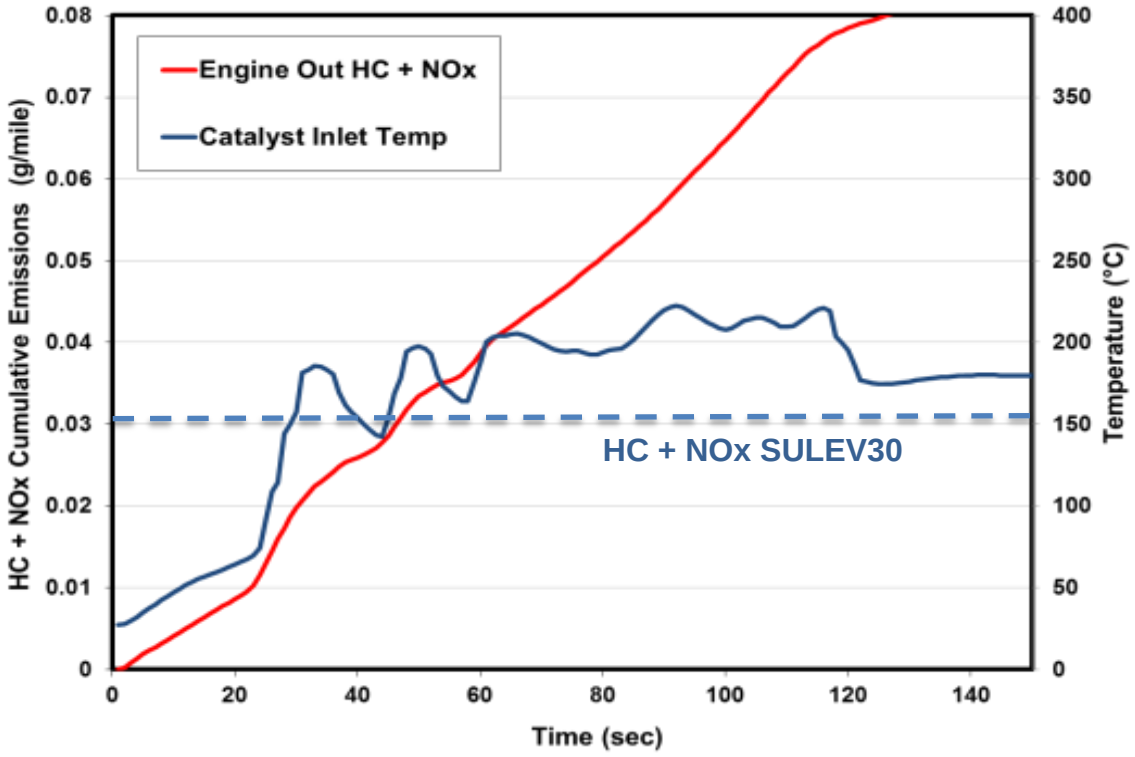
Cold start emission control is one of the major challenges

- Control of cold-start emissions is crucial to meet the future tighter emission regulations

- e.g. SULEV30

  (HC +NOx = 30 mg/mile)

  - Current TWC, DOC, SCR, NAC catalysts function at temp >~200°C
  - ~100-200s is needed for these components to reach the operating temperature
  - Engine-out HC/NOx emissions exceed SULEV30 during the cold start

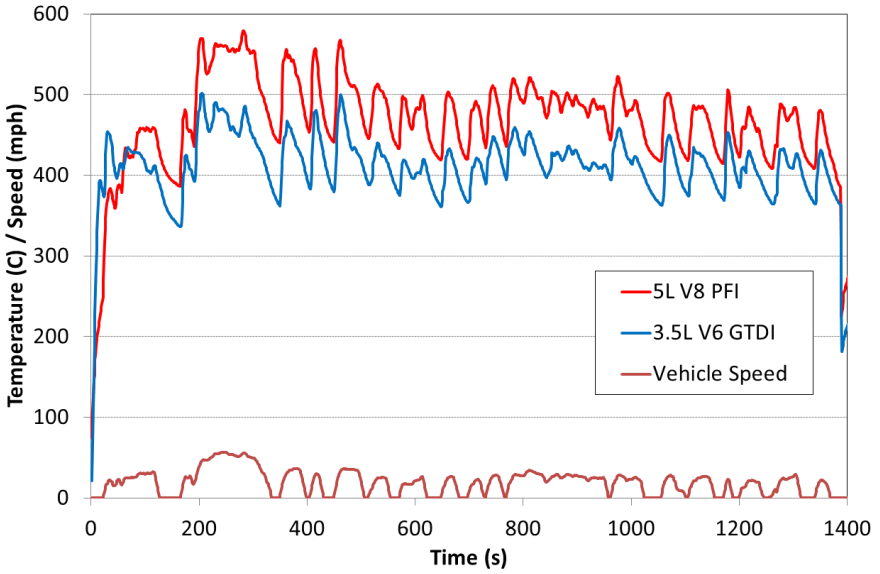


- Passive Adsorber Devices (Traps) can help, but…

Catalysts with low operation temperature is still the major hurdle

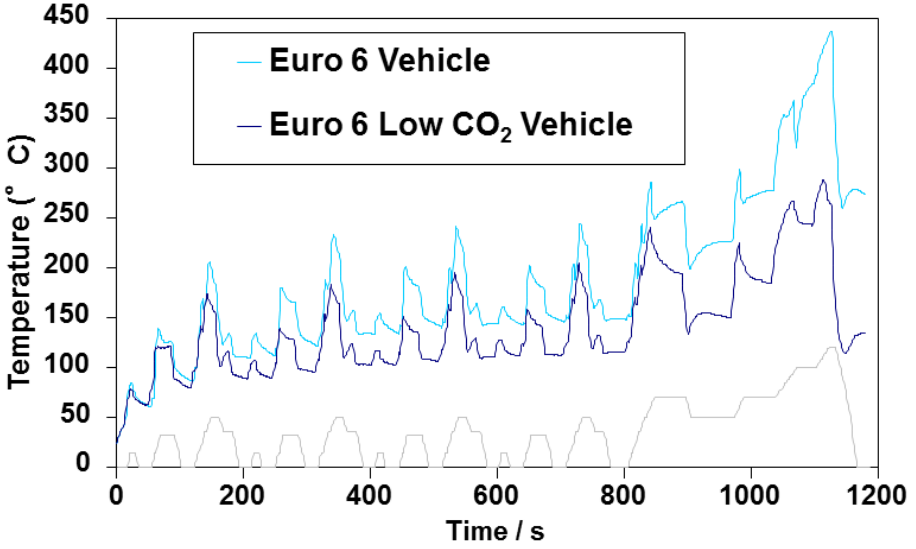
- Advanced combustion, downsizing of engine, turbocharging,

  all result in lower exhaust temperature



Gasoline vehicles

- Diesel CO_2 reduction leads to even lower exhaust temperature



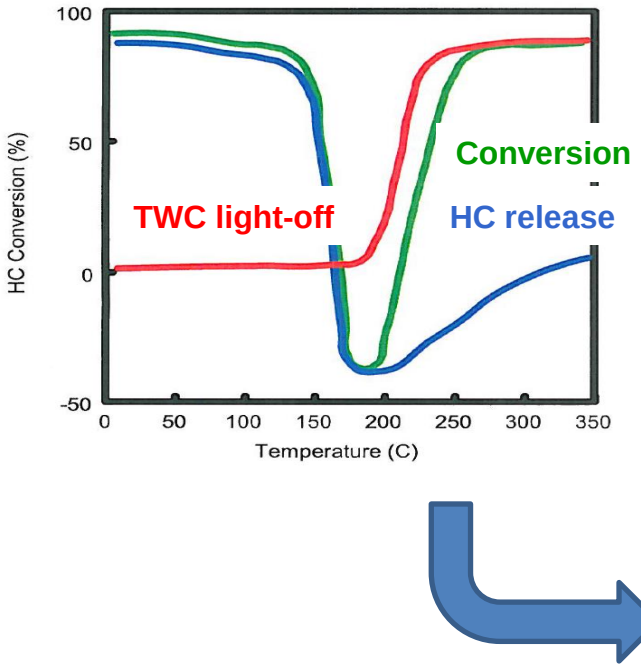
Diesel vehicles

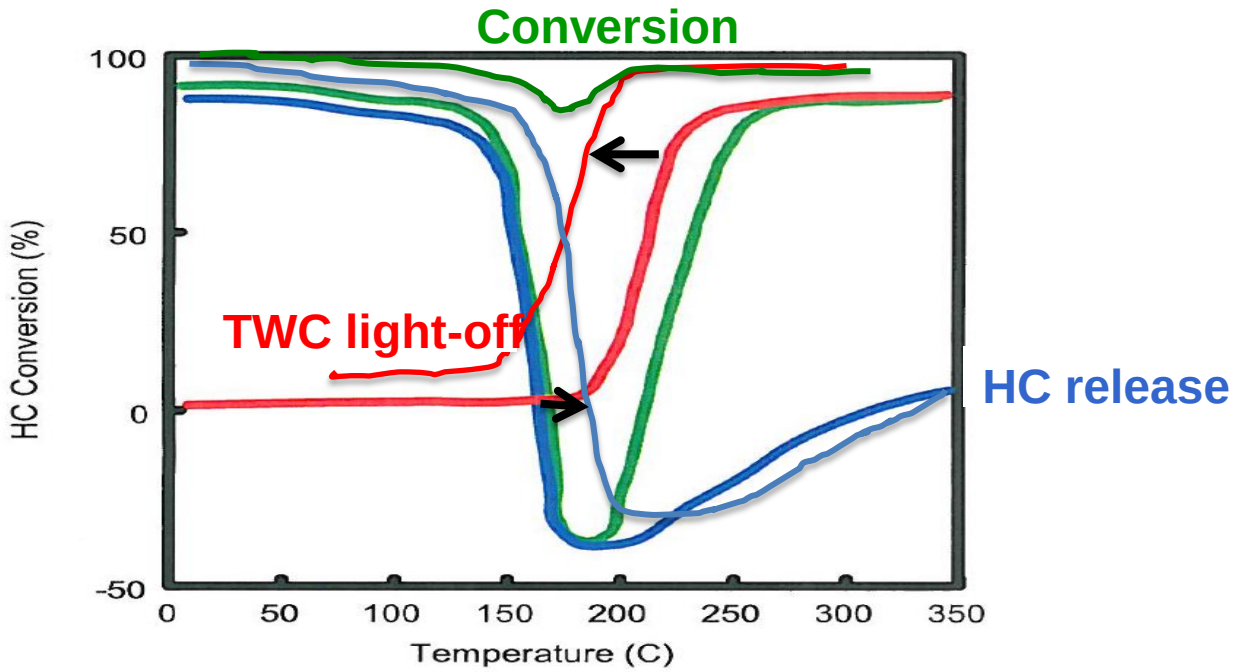
Cold Start Concept (CSC™) technology is an integrated approach

- Gasoline Cold Start Concept (gCSC™) technology
  - SAE 2014-01-1509
- Diesel Cold Start Concept (dCSC™) technology
  - SAE 2013-01-0535
  - SAE 2015-01-0992

Gasoline Cold Start Concept (gCSC™)Technology combines low temperature TWC and HC trap

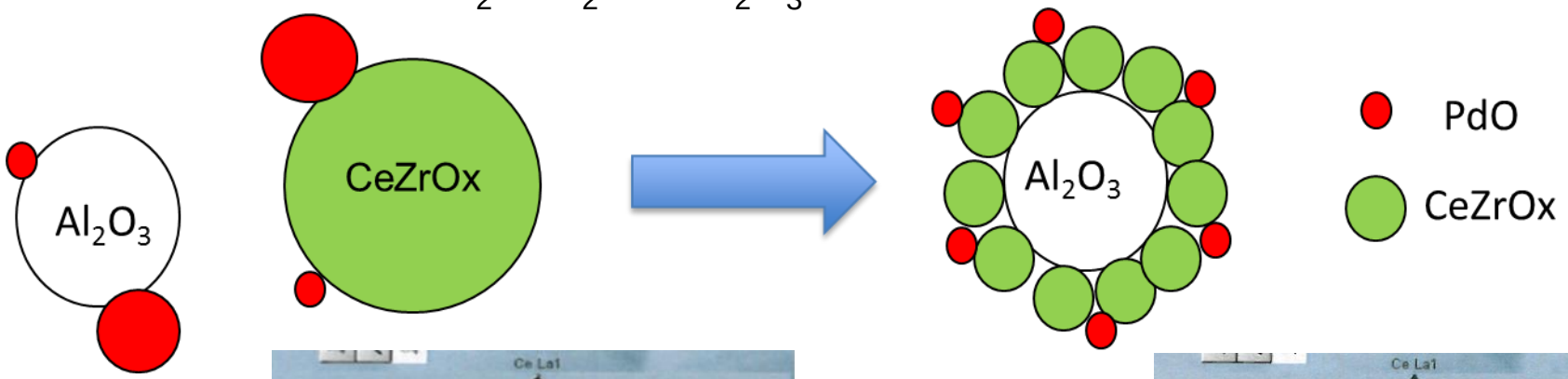
- Improving oxygen storage components to lower the light-off temperature of TWCs
- Utilizing extruded zeolite substrates to increase HC trapping capacity/efficiency and HC release temperature



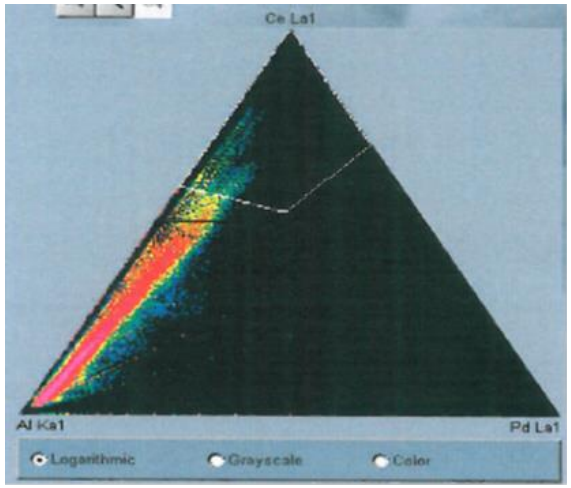


Oxygen storage components strongly influence the low temperature performance of a TWC

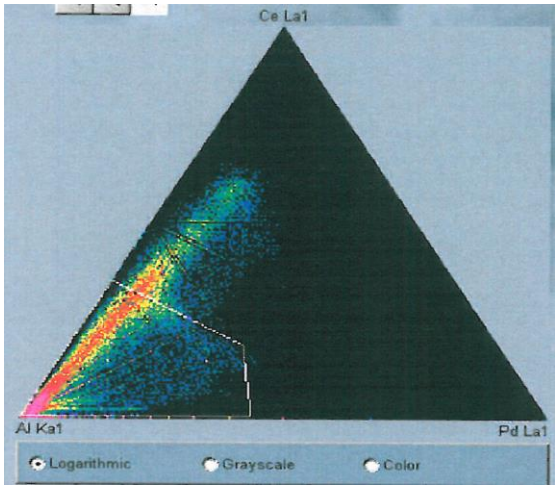
- **Depositing CeO_2/ZrO_2 mixed oxides directly on Al_2O_3 supports significantly improves the thermal stability of the materials**
  - The new $Al_2O_3/CeO_2/ZrO_2$ mixed oxide was compared to a mixture of conventional CeO_2/ZrO_2 and Al_2O_3



Conventional TWC with Pd supported on a mixture of Al_2O_3 + CeO_2/ZrO_2 supports

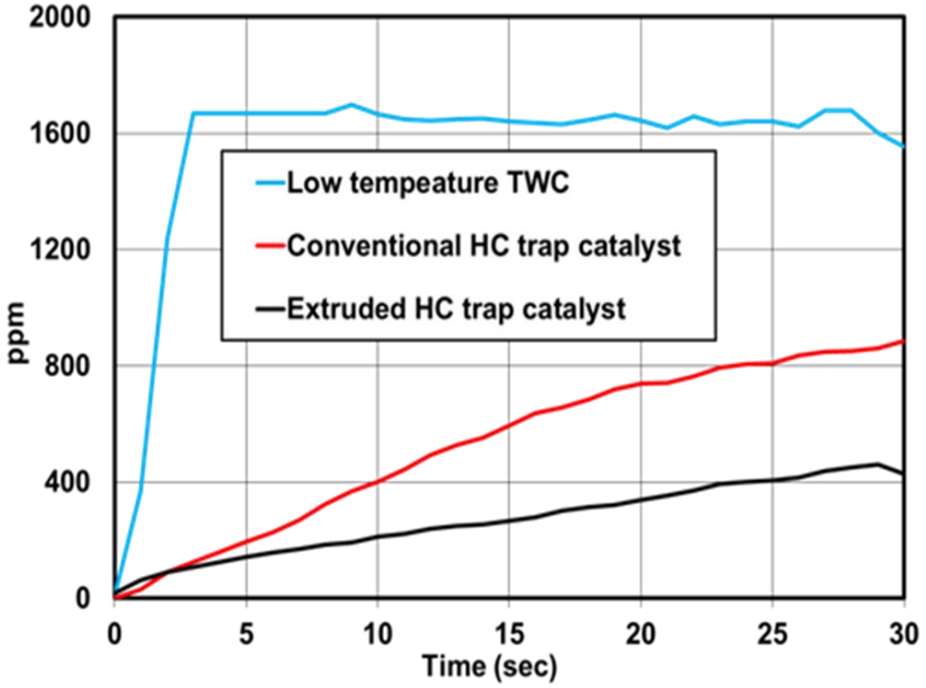


LT TWC with Pd supported on a novel $Al_2O_3/CeO_2/ZrO_2$ support

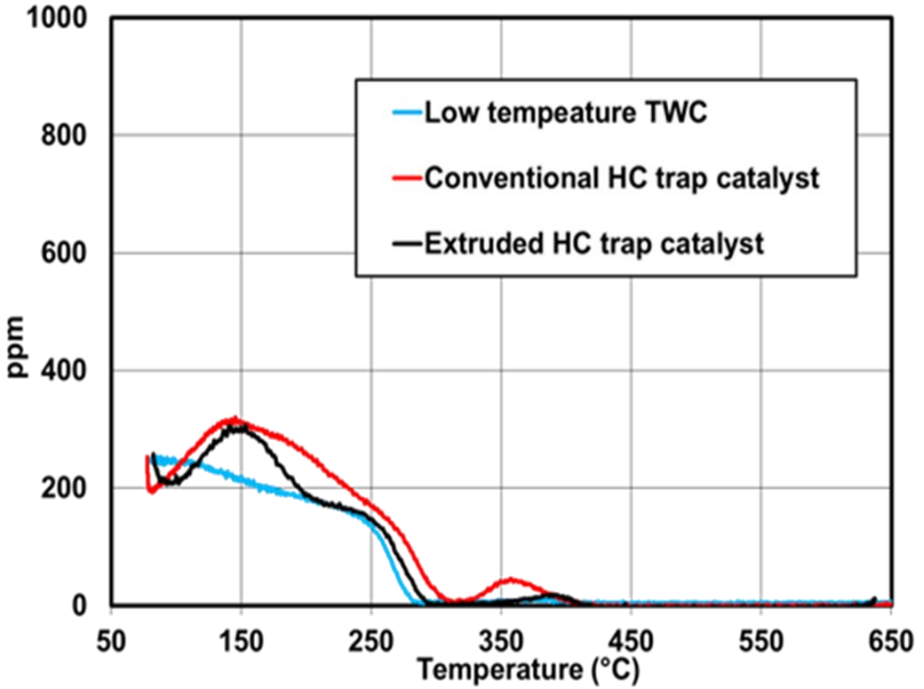


Extruded zeolite substrates improve HC storage capacity/efficiency and increase HC release temperature

Storage at 80 ˚C
1500 ppm C1 mixture of propylene, iso-pentane and toluene
Pd = 3.4 g/L, Rh = 0.7 g/L

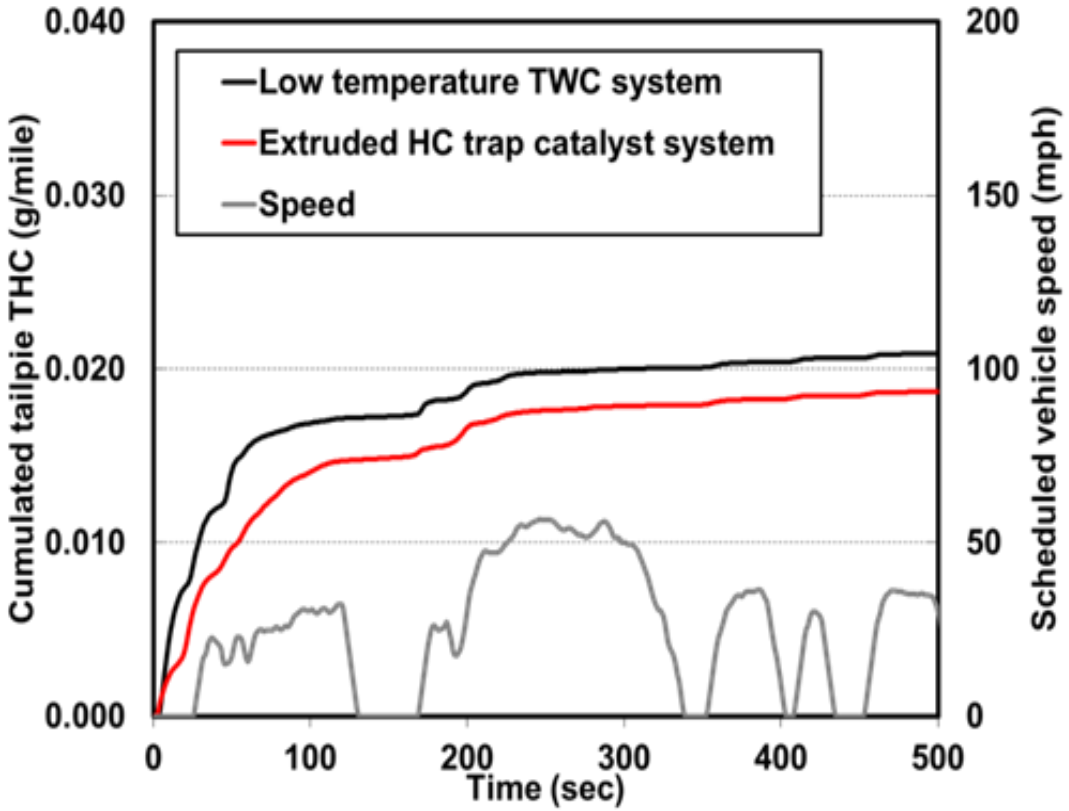


Temperature ramp after storage at 80 ˚C
200 ppm C1 in feed
40 ˚C/min ramp
Pd = 3.4 g/L, Rh = 0.7 g/L



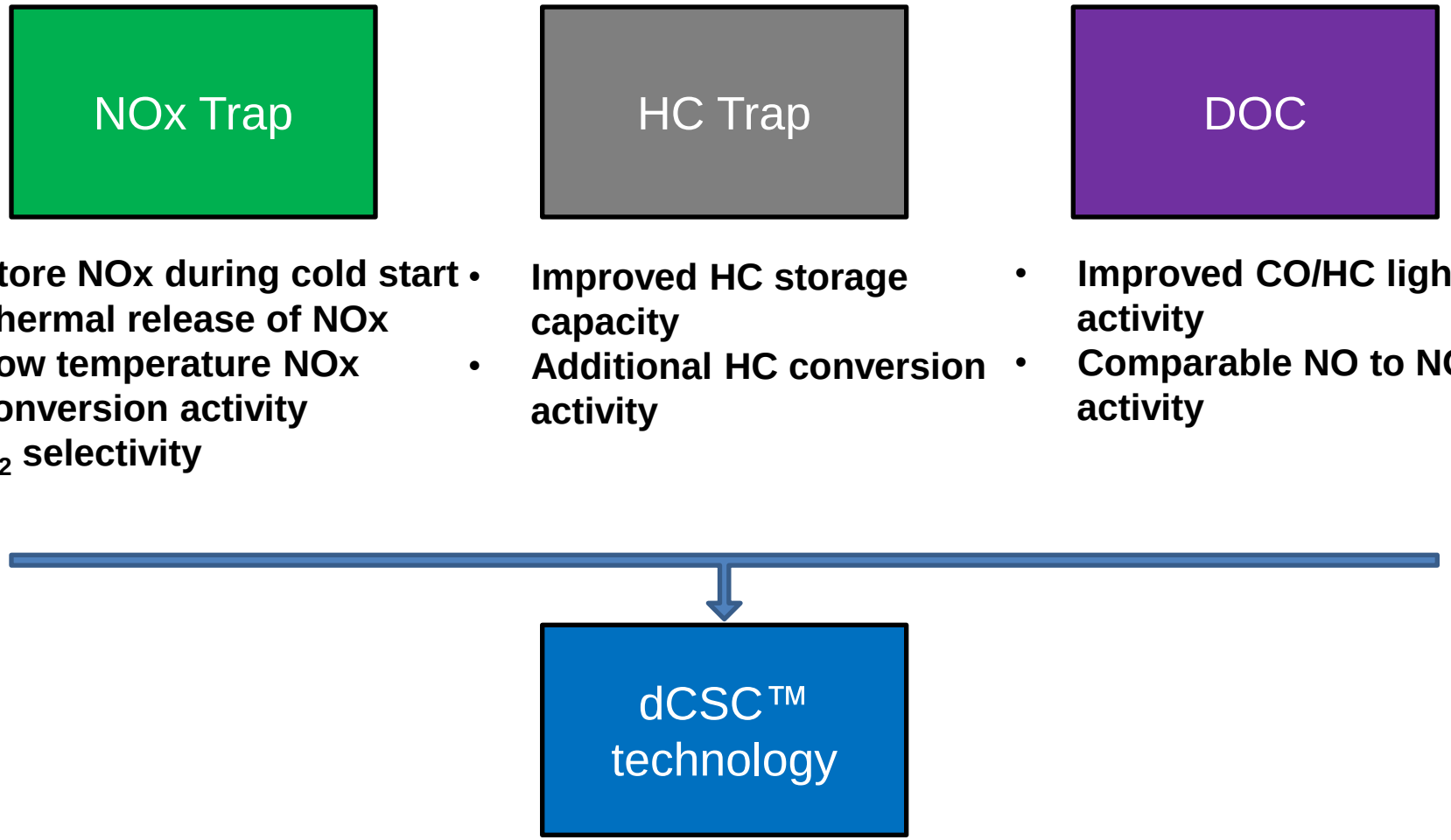
Combination of LT TWC and extruded zeolite substrate further improves HC conversion

TWC systems	NMHC (g/mile)	NOx (g/mile)
CCC - low temperature TWC Under floor – low temperature TWC	0.022	0.038
CCC - low temperature TWC Under floor - extruded HC trap	0.017	0.037



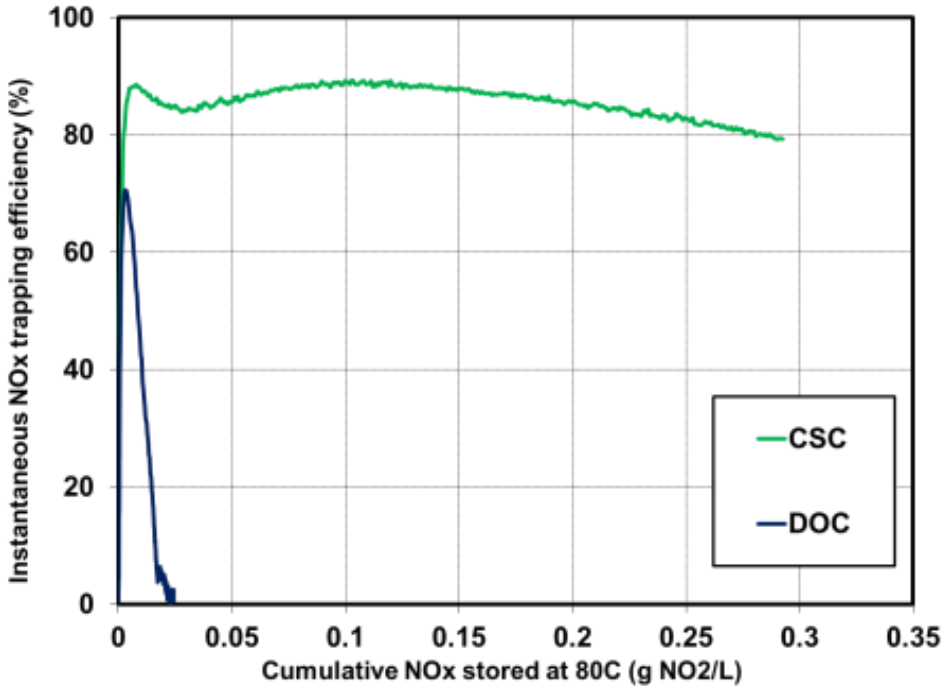
- Same CCC for both systems
- Low temperature TWC: coated on cordierite substrate (400cpsi/6.5mil)
- Extruded HC trap: low temperature TWC coated on zeolite extruded (300cpsi/11mil)
- PGM of UFC: 3.46 g/L Pd, 0.07 g/L Rh

dCSC™ technology combines and improves the functions of NOx trap, HC trap, and DOC

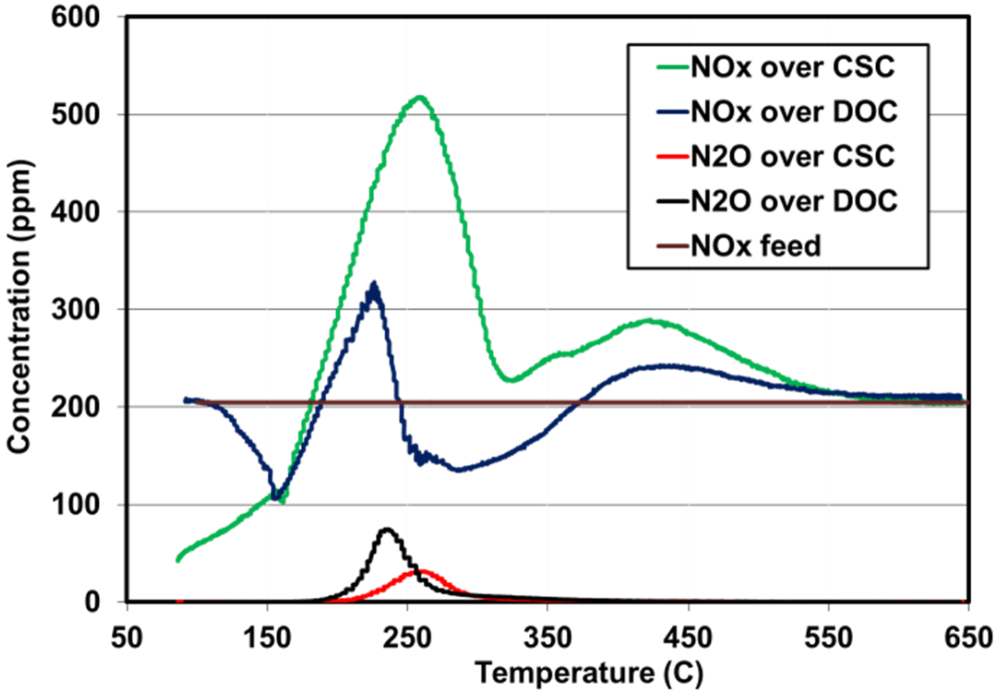


dCSC™ catalysts exhibit high NOx storage capacity/efficiency, NOx thermally release at ~200-350°C

NOx storage at 80°C

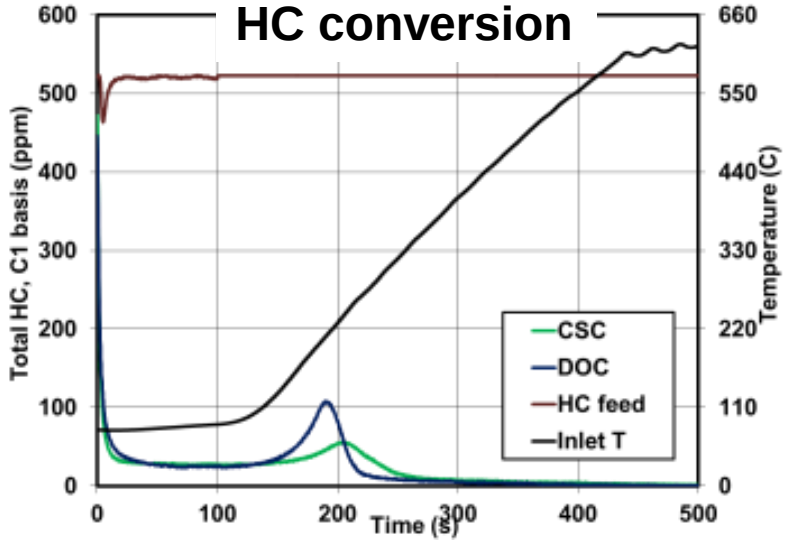


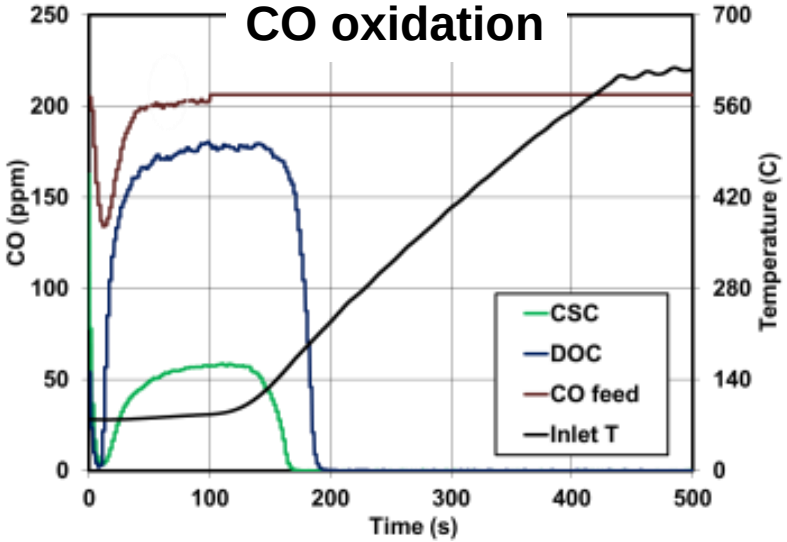
NOx release in the subsequent temperature ramp

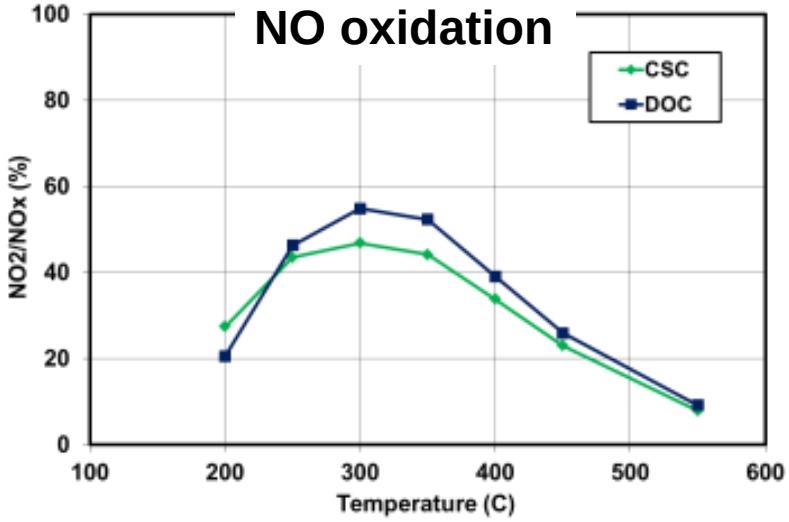


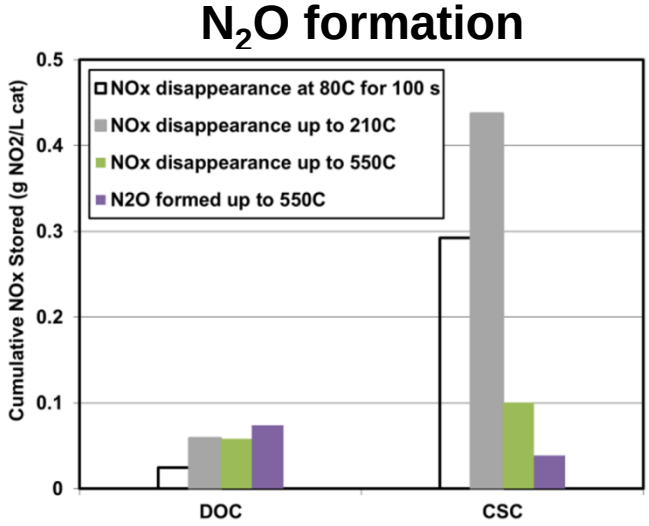
DOC @ Pt70:Pd35	= Diesel oxidation catalyst
CSC @ Pt50:Pd90	= New concept cold start catalyst

dCSC™ catalysts also show improved HC/CO conversion, less N_2O formation, and similar NO oxidation activity

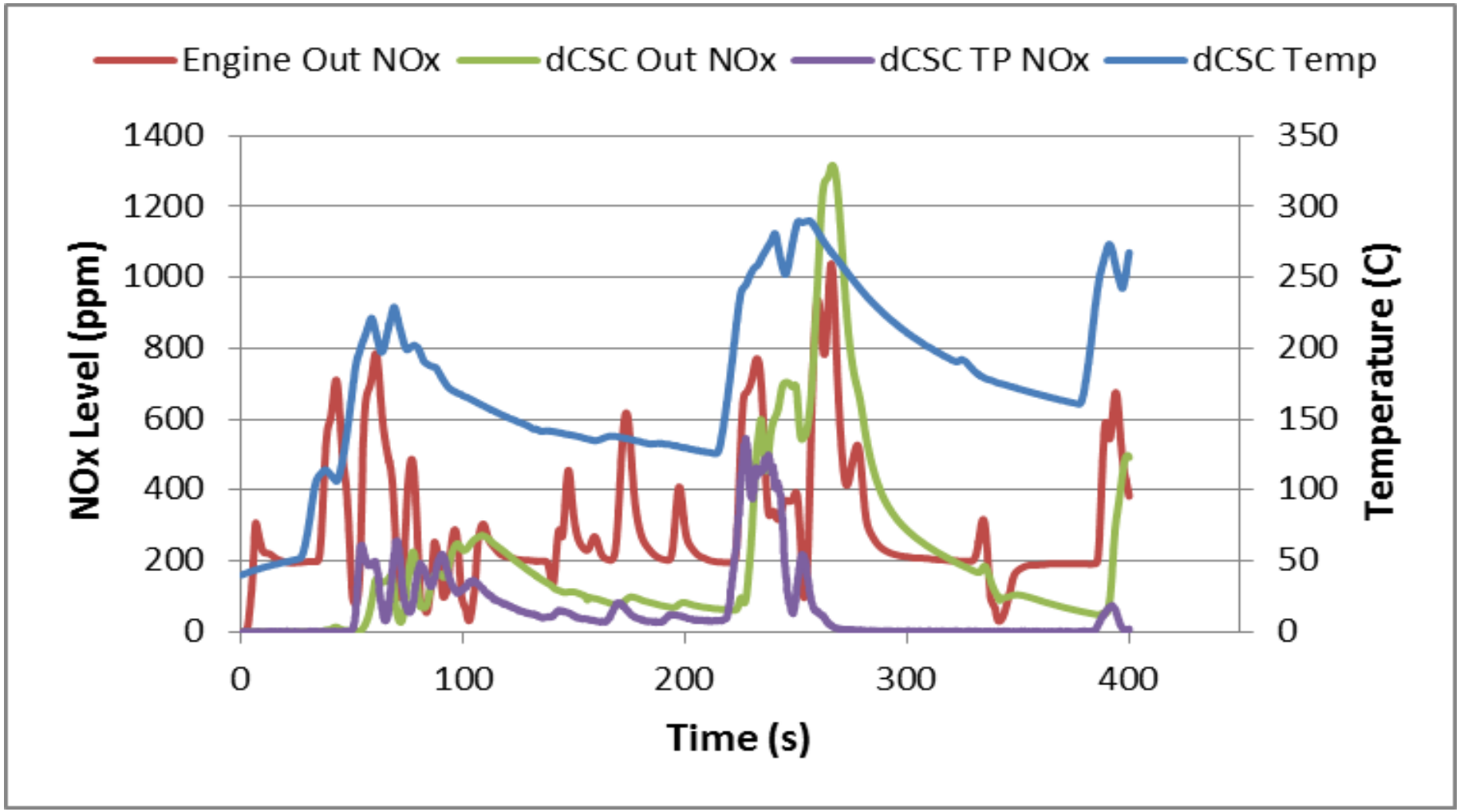








Systems with dCSC™ catalyst + SCR demonstrate high potential for advanced diesel engine emission control



11

Future perspective

- For gasoline engines
  - TWC technology with low operation temperature
  - HC trap with higher HC release temperature

- For diesel engines
  - dCSC™ technology shows high potential
  - NOx storage efficiency/capacity improvement
  - NOx release temperature optimization
  - Catalyst technologies with low operation temperature
    - NOx
    - HC
    - CO