Rapid hydrocarbon pulsing on a dual-layer LNT-SCR catalyst for low-temperature NOx reduction

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Motivation
- Fuel economy and emission trade-off for light-duty vehicles.
- Low-T lean NOx reduction: an easy enabler of clean and fuel-efficient passenger cars
- Exhaust conditions towards net-lean (oxygen excess) and low temperatures

Di-Air System for lean NOx reduction
-Diesel NOx aftertreatment by Adsorbed intermediate reductants

Fuel injector
HC
NSR or LNT
Hydrocarbon (HC)
(Nox Storage & Reduction or Lean NOx Trap)

Our conjecture
Addition of Cu-CHA SCR catalyst under rapid HC injection may capture and utilize much of products via HC-SCR pathway for incremental NOx conversion

Effects of cycling frequency and SCR addition

Catalytic test (GHSV=80,000 h⁻¹)
- Gas: Lean
- Rich
- NO: 300 ppm
- C3H8: 10% 5%
- CO2: 5% 3.5%
- H2O: 3.5% 3.5%
- TAD
  - Lean: 1.81
  - Rich: 0.8

SCR top-layer impact
- LNT assisted HC-SCR pathway
- Catalytic barrier
- Likely thermal effect due to increased thermal mass and reduced heat loss

Cycle frequency impact on NH3 yield
Surface intermediates identified by DRIFTS

Working principle of fast HC pulsing on dual-layer catalysts

Impact of catalyst design
- Top-layer impact
- PGM load impact
- Ceria load impact

Cycle frequency and SCR addition impact on N₂O selectivity
- Increased selectivity by fast cycling due to higher O₂ partial pressure
- Decreased selectivity by SCR addition likely due to lower N₂O selectivity for NOx reduction by SCR

Cycle frequency impact on NH3 yield
Surface intermediates identified by DRIFTS

Summary and Conclusions
- Combination of fast propane pulsing and SCR addition enable low-T NOx conversion, compared to conventional NSR operation over LNT alone
- Under fast cycling partially oxidized HC intermediates instead of NH3 are the primary NOx reductants for SCR
- Layered catalyst of half reactor volume out-performs sequential one in terms of low-T NOx conversion
- Potential for future improvements
- HC-SCR catalysts (Ag-based), PGM zoning, reduced BaO loading; Different HC species (heavy HC, light/lean HC mixture), optimal cycling frequency;