ORNL/TM-2022/2608
NFE-ORNL97-0489

NO_x Control and Measurement Technology for Heavy-Duty Diesel Engines

W. P. Partridge
S. Joshi
T. Lutz

December 2022

CRADA final report for
CRADA number NFE-ORNL97-0489

Approved for public release.
Distribution is unlimited.

OAK RIDGE National Laboratory

ORNL IS MANAGED BY UT-BATTELLE LLC FOR THE US DEPARTMENT OF ENERGY

ORNL/TM-2022/2608
NFE-ORNL97-0489

Buildings and Transportation Science Division

NO_X CONTROL AND MEASUREMENT TECHNOLOGY FOR HEAVY-DUTY DIESEL ENGINES

W. P. Partridge*
S. Joshi†
T. Lutz‡

*ORNL principal investigator (PI), both Catalyst and Combustion sections
†Cummins PI for Catalyst section
‡Cummins PI for Combustion section

December 2022

COOPERATIVE RESEARCH AND DEVELOPMENT AGREEMENT
(hereinafter "CRADA") NO. ORNL97-0489

Between

UT-Battelle LLC
under its US Department of Energy Contract No. DE-AC05-00OR22725
(hereinafter "Contractor")
and
Cummins Inc.
(hereinafter "Participant")
both being hereinafter jointly referred to as the "Parties."

Prepared by
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, TN 37831
managed by
UT-BATTELLE LLC
for the
US DEPARTMENT OF ENERGY
under contract DE-AC05-00OR22725

The Cooperative Research and Development Agreement (CRADA) No. ORNL97-0489 project between the US Department of Energy's (DOE's) Oak Ridge National Laboratory (ORNL) and Cummins Inc. was originally signed in September 1997 and ran through September 2022. During this project, 13 amendments, nominally on 3-year cycles, updated the technical focus to remain relevant to the DOE and industry technical objectives and barriers. DOE funded ORNL's participation in the CRADA with technology managers Gurpreet Singh, Ken Howden, Siddiq Khan, and Mike Weismiller. Cummins provided 1:1 DOE-matching funding via their participation and other in-kind contributions. The CRADA had a $34,100,100 (1:1 split between DOE and Cummins) agreement level and a $22,021,000 actual funding level. The CRADA started with a focus on catalysis and added a combustion-focused task in later years. Although these foci were formally part of the same CRADA agreement, they are referred to as the Catalyst CRADA and Combustion CRADA in this report.

The Catalyst CRADA focused on lean-NO_x trap (LNT) and selective catalytic reduction (SCR) automotive emission control catalyst technology. It particularly had the goal of developing and applying advanced diagnostics capable of elucidating the network and sequence of catalyst reactions, as well as how they are affected by real-world operation and aging. Another overarching goal and action of this CRADA section was to develop methods to quantify and monitor catalyst states and support the development of full and reduced models for design and in-use control applications. William Partridge was the ORNL principal investigator (PI) throughout the Catalyst CRADA; Neal Currier was the Cummins PI through circa 2017, and Saurabh Joshi was the subsequent Cummins PI.

The Catalyst CRADA is most notable for its development of the spatially resolved capillary inlet mass spectrometer (SpaciMS) and associated applications and industry/community effects. The SpaciMS allowed for resolving the spatiotemporal evolution of reactions within and along a catalyst channel, which was a significant advancement over the previous analytical state, which provided measurements only at the catalyst inlet and outlet. SpaciMS enabled the new capability of spatially and temporally resolved intracatalyst measurements. The SpaciMS provided many new insights, including how different catalyst functions interact and are affected by aging, resolution of intermediate species that are formed and consumed within the catalyst, and identification of phenomena that exist only within the catalyst, which are indicative of important catalysis details. The development of SpaciMS involved not only hardware and instrumentation development but also analysis and visualization methodologies, as well as teaching the community how to think about and understand these spatiotemporal intracatalyst distributions and interactions. This difficult process revolutionized the automotive catalyst community by enabling a shift to an intracatalyst focus and understanding, which is now standard. The SpaciMS was commercialized by Hidden Analytical.

The Catalyst CRADA involved many field campaigns in which ORNL took equipment and jointly worked with the Cummins partners at their development facilities in Columbus, Indiana. There were also campaigns where Cummins brought vehicles, engines, and catalyst samples to ORNL facilities for work performed under the CRADA. The CRADA spawned many projects funded and performed outside the CRADA and affected numerous other DOE projects via its diagnostics and insights. In addition to catalyst applications, SpaciMS was also used by Cummins to investigate exhaust gas recirculation (EGR) and intake uniformity as part of the 2007 ISB and 5 L V8 engine development. Outside the CRADA, SpaciMS was applied to measure the first engine-managed H_2 generation process and understand spatiotemporal distributions within an operating fuel cell for nonthermal plasma and fuel reformer reactors.

The Combustion CRADA formally started in fiscal year (FY) 2003, was separately funded starting in FY 2010, and focused on understanding the origins of and developing mitigation strategies for cylinder- and cycle-specific combustion variations. The Combustion CRADA primarily focused on developing and applying advanced diagnostics to understand processes and develop design models. William Partridge

was the ORNL PI throughout the project; Mike Ruth, Ray Shute, and Sam Geckler served as Cummins PIs through circa 2016, and Tim Lutz was the subsequent Cummins PI. The Combustion CRADA grew out of a successful campaign at Cummins's Olympia facility, where SpaciMS was used to assess EGR–air mixer designs as part of the early 5 L V8 engine development. The Combustion CRADA is most notable for its development and implementation of the fuel-in-oil (FiO) and EGR probe diagnostics. The FiO was developed in response to needing a faster analytical method for resolving the fuel dilution of oil than the offline ASTM International Standard method (D3524-04), which had practical, week-scale feedback times. Dynamic catalyst management can affect oil dilution and create durability issues, and increasingly complex catalyst systems require fast oil dilution feedback to develop system calibration. The FiO provides on-engine oil dilution measurements with minutes-scale feedback times; it resulted in two patents and was commercialized by Da Vinci Emissions Services (as DAFIO). Although the SpaciMS was used for early EGR uniformity measurements, it did not have the capability of providing cycle-, cylinder-, and valve-event–resolved measurements necessary for more advanced engine and engine model development.

The EGR probe was developed in response to the need for more advanced engine and engine model development. It provides fast, 5 kHz measurement of H_2O and CO_2 concentrations, temperatures, and pressures using a 3/8 in. outer diameter probe that can be inserted into a minimally invasive port at the appropriate location (i.e., unlike typical optical diagnostics, it can be applied to base metal engines with minimal modifications to accommodate EGR probe application). The probe is based on tunable diode laser absorption spectroscopy and provides for calibration-free measurements based on spectroscopic modeling. It was developed starting in the CRADA and completed in collaboration with the Cummins SuperTruck-II project (W. P. Partridge, ORNL PI; Dave Koeberlein, Cummins PI). The EGR probe was applied to quantify EGR waves in different engine intake architectures, cylinder scavenging, and combustion-residual backflow into the intake manifold and external EGR air breathing dynamics, all for engine development in the CRADA and SuperTruck projects. In further developments and applications, the EGR probe instrument was combined with a separate multipass probe to measure fast exhaust O_2 transients. The EGR probe resulted in nine ORNL patents and was applied to advance DOE programs outside the CRADA. Other Combustion CRADA instruments include the optical backscatter probe (one patent) for fast exhaust particulate measurements, and the gated bagger to integrate multiple temporally discrete samples into a bag sample to enable the use of highly accurate, steady-state analytical methods in transient applications.

The CRADA investigated a wide range of technical issues, contributed to the development of numerous students and postdoctoral research associates, and was critical to many Cummins commercial products. The spatiotemporal intracatalyst nature and interplay of various LNT functions were studied, including NO_x storage and reduction, reductant generation and utilization, oxygen storage capacity and water–gas shift, as well as how these functions were individually affected by sulfur aging. Spatiotemporal NH_3 storage and utilization related to NO_x conversion in an SCR catalyst was studied and motivated further excellent work in the CLEERS (Crosscut Lean Exhaust Emissions Reduction Simulations) project. Through SpaciMS use, a transient SCR onset conversion inflection that was most dominant just inside the catalyst front was discovered and found to be indicative of rate imbalances in the reduction half cycle (RHC) and oxidation half cycle (OHC) of the Cu redox cycle, which governs the SCR process. This inflection was a new discovery and was published along with the first transient kinetic model of the SCR Cu redox process. This discovery was expanded into a new transient response methodology for determining RHC and OHC kinetic parameters, and the method was published along with the first studies of how field aging affects the half-cycle kinetics. Other new insights included partitioning, use, and redistribution of stored NH_3 between the Lewis and Bronsted sites, as well as details of various RHC and OHC pathways. CRADA investigations related to engine development focused on hardware design, control strategy development, validation of computational fluid dynamics models, and the origin of cylinder- and cycle-specific combustion variations. The related publications primarily focused on

diagnostic development and demonstration because the applications were largely proprietary and/or CRADA protected.

The CRADA supported development of 11 postdoctoral research associates (54% women or underrepresented minorities) and 9 US and international students spanning undergraduate, masters, and doctoral levels. Through these ORNL CRADA mentoring activities, W. P. Partridge was awarded the 2010 Outstanding Mentor Award from the DOE Office of Science. The CRADA resulted in at least 8 US patents, 38 archival journal publications, 9 nonarchival publications, 26 reports, 25 international invited and keynote lectures, 145 presentations, and many other similar documents and events through separate CRADA-influenced and enabled projects at ORNL and Cummins. The broader effect and number of publications and presentations enabled by the CRADA (e.g., SpaciMS) is international and significant but not quantifiable.

The CRADA directly contributed to the development of the 6.7 L ISB engine and related new-to-class catalyst system, the 5 L V8 engine, the Cummins SuperTruck engine system, which demonstrated an 80+% tractor trailer freight efficiency gain, and other not-yet-commercialized engine systems. The CRADA received R&D 100 awards for the SpaciMS and FiO diagnostics, and Dr. David Danielson, DOE assistant secretary for the Office of Energy Efficiency and Renewable Energy, acknowledged in a 2015 award the CRADA's contribution to enabling clean and efficient engines for current and future vehicles. William Partridge received a letter of accommodation from Cummins vice president (VP) and chief technical officer (CTO) John C. Wall in 2007 acknowledging the critical role of the CRADA partnership in the development of their new 6.7 L ISB engine catalyst system, which was the first in its class to meet 2010 emissions regulations—3 years early. In 2022, W. P. Partridge received another letter from Cummins VP and CTO Jim Fier celebrating the 24-year-long CRADA. Fier acknowledged the supreme value of the partnership and how it broadly and uniquely affected and enabled Cummins's advanced development efforts.

Further details are provided in the following sections:

- Diagnostics Developed
- Affected Cummins Products
- Campaigns
- Partner Universities
- Patents
- Publications
  - Journal Articles
  - Conference Papers
  - Reports
  - SuperTruck Cummins
- Presentations

Diagnostics Developed

1. SpaciMS: spatiotemporal species distributions, minimally invasive probes for intracatalyst and engine applications. 2008 R&D 100 Award and commercialized by Hidden Analytical
2. FiO: fuel-in-oil, provides minutes-scale measurement resolution of oil dilution rates. 2 US patents (7,839,492 B2 and 8,653,830), 2013 R&D 100 Award, and commercialized as DAFIO by Da Vici Emissions Services Ltd.
3. EGR probe: 4 US patents (9,000,374 B2; 9,068,933 B2; 9,541,498 B1; and 9,851,296 B2)
4. Oxygen sensor: 1 US patent (8,248,612 B2)
5. Optical backscatter probe: 1 US patent (8,451,444 B2)

6. Optical fiber–based phosphor thermography for intracatalyst spatiotemporal temperature mapping
7. Gated bagger for temporally resolved bag sampling and resolution of transient response using steady-state analyzers

Affected Cummins Products

1. 2007 6.7 L ISB diesel engine and catalyst system
   a. Available in the Dodge Ram pickup truck, met 2010 emissions regulations 3 years early, first in its class to deploy an advanced catalyst system
   b. SpaciMS applied in campaign at Cummins Technical Center to acquire data and insights for driving design point
   c. SpaciMS applied extensively as part of knowledge development leading to first-in-class development and deployment of advanced emissions control catalyst system
2. 5 L V8 diesel engine
   a. Available in Nissan Titan
   b. SpaciMS used to quantify performance of different EGR air mixer designs in early development
   c. FiO applied to quantify fuel dilution of oil during standard diesel particulate filter de-soot processes as part of satisfying a Nissan-defined gate for getting the system in the Titan
3. SuperTruck-II engine system and platform
   a. Demonstrated an 80%+ tractor trailer freight efficiency gain
   b. EGR probe measurements applied to develop, tune, and validate EGR-mixing computational fluid dynamics models, assess and develop control strategies, and assess alternative fuel combustion strategies
4. Other confidential development products

Campaigns

Capabilities, personnel, and diagnostics developed in the CRADA were applied in 20 joint measurement campaigns focused on engine and catalyst studies between 1999 and 2019. Sixteen of these were in Cummins's or Cummins contractor facilities in Columbus, Indiana; two were at Cummins partner facilities in Knoxville, Tennessee; and two were at ORNL. Fourteen of these were in the CRADA, two supported the related SuperTruck-II project, and four were funds-in campaigns targeting specific commercialization topics. The work spanned applications using bench reactors, single-cylinder research engines, multicylinder engines, and full vehicle systems on a chassis dynamometer; they used diagnostics such as SpaciMS, phosphor thermometry, a Fourier domain mode-locked (FDML) line-of-sight transient H_2O instrument, fuel-in-oil, a midinfrared light-emitting diode (MIR LED) transient CO_2 instrument, an EGR probe (CO_2, CO_2 + H_2O + temperature + pressure, cross-flow and end-on-flow probes, and a line-of-sight probe), and a multipass exhaust O_2 instrument.

Partner Universities

1. Queen's University Belfast; Prof. Alex Goguet
2. University of Chemistry and Technology, Prague; Prof. Petr Kočí
3. Chalmers University of Technology; Prof. Louise Olsson
4. Polytechnic University of Milan; Prof. Enrico Tronconi and Prof. Isabella Nova
5. University of Central Florida; Prof. Subith Vasu
6. University of Waterloo; Prof. William Epling

Patents (8)

1. J. E. Parks, W. P. Partridge, "Laser-Induced Fluorescence Fiber Optic Probe Measurement of Oil Dilution by Fuel," US Patent No. 7,839,492 B2, November 23, 2010.
2. J. E. Parks, W. P. Partridge, "Oxygen Concentration Sensors and Methods of Rapidly Measuring the Concentration of Oxygen in Fluids," US Patent No. 8,248,612 B2, August 21, 2012.
3. J. E. Parks, W. P. Partridge, "Optical Backscatter Probe for Sensing Particulate in a Combustion Gas Stream," US Patent No. 8,451,444 B2, May 28, 2013.
4. L. C. Maxey, W. P. Partridge, S. A. Lewis, J. E. Parks, "Optically Stimulated Differential Impedance Spectroscopy," US Patent No. 8,653,830, February 18, 2014.
5. J. E. Parks, W. P. Partridge, J. H. Yoo, "EGR Distribution and Fluctuation Probe Based on CO_2 Measurements," US Patent No. 9,000,374 B2, April 7, 2015. *(Original MIR LED-based EGR probe)*
6. J. E. Parks, W. P. Partridge, J. H. Yoo, "EGR Distribution and Fluctuation Probe Based on CO_2 Measurements," US Patent No. 9,068,933 B2, June 30, 2015. *(Addition to US Patent 9,000,374 B2, adding laser-based and multiplexed capabilities)*
7. W. P. Partridge, G. S. Jatana, J. H. Yoo, J. E. Parks, "Diagnostic System for Measuring Temperature, Pressure, CO_2 Concentration and H_2O Concentration in a Fluid Stream," US Patent No. 9,541,498 B1, January 10, 2017. *(Adding multispecies CO_2, H_2O, temperature, and pressure capabilities)*
8. W. P. Partridge, G. S. Jatana, J. H. Yoo, J. E. Parks, "Diagnostic System for Measuring Temperature, Pressure, CO_2 Concentration and H_2O Concentration in a Fluid Stream," US Patent No. 9,851,296 B2, December 26, 2017. *(System patent)*

Publications

Journal Articles (38)

1. W. P. Partridge, J. M. E. Storey, S. A. Lewis, R. W. Smithwick, G. L. DeVault, M. J. Cunningham, N. W. Currier, T. M. Yonushonis (2000). "Time-Resolved Measurements of Emission Transients by Mass Spectrometry," *SAE Transactions—Journal of Fuels and Lubricants* ***109***, 2992–2999.
2. W. P. Partridge, S. A. Lewis, M. J. Ruth, G. G. Muntean, R. C. Smith, J. H. Stang (2002). "Resolving EGR Distribution and Mixing," *SAE Transactions—Journal of Engines* ***111***, 2699–2704.
3. T. J. Toops, D. B. Smith, W. P. Partridge (2005). "Quantification of the In-Situ DRIFT Spectra of Pt/K/Gamma-Al_2O_3 NO_x Adsorber Catalysts," *Applied Catalysis B* ***58***, 245–254, doi: 10.1016/j.apcatb.2004.10.021.
4. T. J. Toops, D. B. Smith, W. S. Epling, J. E. Parks, W. P. Partridge (2005). "Quantified NO_x Adsorption on Pt/K/Gamma-Al_2O_3 and the Effects of CO_2 and H_2O," *Applied Catalysis B* ***58***, 255–264, doi: 10.1016/j.apcatb.2004.10.022.
5. T. J. Toops, D. B. Smith, W. P. Partridge (2006). "NO_x Adsorption on Pt/K/Al_2O_3," *Catalysis Today* ***114***, 112–124, doi:10.1016/j.cattod.2006.02.006.
6. J.-S. Choi, W. P. Partridge, C. S. Daw (2005). "Spatially-Resolved In Situ Measurements of Transient Species Breakthrough During Cyclic, Low-Temperature Regeneration of a Monolithic Pt/K/Al_2O_3 NO_x storage-reduction catalyst," *Applied Catalysis A* ***293***, 24–40, doi: 10.1016/j.apcata.2005.06.025.
7. J.-S. Choi, W. P. Partridge, W. S. Epling, N. W. Currier, T. M. Yonushonis (2006). "Intra-channel Evolution of Carbon Monoxide and its Implication for the Regeneration of Monolithic Pt/K/Al_2O_3

NO_x Storage-Reduction Catalyst," *Catalysis Today* ***114***, 102–111; doi: 10.1016/j.cattod.2006.02.011. ***Invited.***

8. T. J. Toops, D. B. Smith, W. P. Partridge (2006). "NO_x Adsorption on $Pt/K/Al_2O_3$," *Catalysis Today* ***114***, 112–124, doi: 10.1016/j.cattod.2006.02.006.

9. J.-S. Choi, W. P. Partridge, C. S. Daw (2007). "Sulfur Impact on NO_x Storage, Oxygen Storage and Ammonia Breakthrough During Cyclic Lean/Rich Operation of a Commercial Lean NO_x Trap," *Applied Catalysis B: Environmental* ***77***, 145–156, doi: 10.1016/j.apcatb.2007.07.025.

10. J.-S. Choi, W. P. Partridge, J. A. Pihl, C. S. Daw (2008). "Sulfur and Temperature Effects on the Spatial Distribution of Reactions Inside a Lean NO_x Trap and Resulting Changes in Global Performance," *Catalysis Today* ***136***, 173–182, doi: 10.1016/j.cattod.2008.01.008.

11. W. P. Partridge, J.-S. Choi (2009). "NH_3 Formation and Utilization in Regeneration of $Pt/Ba/Al_2O_3$ NO_x Storage-Reduction Catalyst with H_2," *Applied Catalysis B: Environmental* ***91***, 144–151, doi: 10.1016/j.apcatb.2009.05.017.

12. Y. Ji, C. Fisk, V. Easterling, U. Graham, A. Poole, M. Crocker, J.-S. Choi, W. Partridge, K. Wilson (2009). "NO_x Storage-Reduction Characteristics of Ba-Based Lean NO_x Trap Catalysts Subjected to Simulated Road Aging," *Catalysis Today* ***151***, 362–375, doi: 10.1016/j.cattod.2009.12.009.

13. J.-S. Choi, W. P. Partridge, M. J. Lance, L. R. Walker, J. A. Pihl, T. J. Toops, C. E. A. Finney, C. S. Daw (2010). "Nature and Spatial Distribution of Sulfur Species in a Sulfated Barium-Based Commercial Lean NO_x Trap Catalyst," *Catalysis Today* ***151***, 354–361, doi: 10.1016/j.cattod.2010.01.016.

14. J. Sá, D. L. A. Fernandes, F. Aiouache, A. Goguet, C. Hardacre, D. Lundie, W. Naeem, W. P. Partridge, C. Stere (2010). "SpaciMS: Spatial and Temporal Operando Resolution of Reactions Within Catalytic Monoliths," *Analyst* ***135***, 2260–2272, doi: 10.1039/C0AN00303D.

15. N. A. Ottinger, T. J. Toops, J. A. Pihl, J. T. Roop, J.-S. Choi, W. P. Partridge (2010). "Sulfate Storage and Stability on Representative Commercial Lean NO_x Trap Components," *Applied Catalysis B: Environmental* ***117–118***, 167–176, doi: 10.1016/j.apcatb.2011.12.044.

16. J.-S. Choi, W. P. Partridge, J. A. Pihl, M.-Y. Kim, P. Kočí, C. S. Daw (2012). "Spatiotemporal Distribution of NO_x Storage and Impact on NH_3 and N_2O Selectivities During Lean/Rich Cycling of a Ba-Based Lean NO_x Trap Catalyst," *Catalysis Today* ***184***, 20–26, doi: 10.1016/j.cattod.2011.11.007.

17. X. Auvray, W. P. Partridge, J.-S. Choi, J. A. Pihl, A. Yezerets, K. Kamasamudram, N. W. Currier, L. Olsson (2012). "Local Ammonia Storage and Ammonia Inhibition in a Monolithic Copper-Beta Zeolite SCR Catalyst," *Applied Catalysis B: Environmental* ***126***, 144–152, doi: 10.1016/j.apcatb.2012.07.019.

18. P. Kočí, Š. Bártová, D. Mráček, M. Marek, J.-S. Choi, M.-Y. Kim, J. A. Pihl, W. P. Partridge (2013). "Effective Model for Prediction of N_2O and NH_3 Formation During the Regeneration of NO_x Storage Catalyst," *Topics in Catalysis* ***56***, 118–124, doi: 10.1007/s11244-013-9939-y.

19. S. Shwan, W. Partridge, J.-S. Choi, L. Olsson (2014). "Kinetic Modeling of NO_x Storage and Reduction Using Spatially Resolved MS Measurements," *Applied Catalysis B: Environmental* ***147,*** 1028–1041, doi: 10.1016/j.apcatb.2013.10.023.

20. Š. Bártová, P. Kočí, M. Marek, J. A. Pihl, J.-S. Choi, T. J. Toops, W. P. Partridge (2014). "New Insights on N_2O Formation Pathways during Lean/Rich Cycling of a Commercial Lean NO_x Trap Catalyst," *Catalysis Today (Special NAM2013 Edition)* ***231***, 145–154, doi: 10.1016/j.cattod.2013.11.050.

21. A. Goguet, W. P. Partridge, F. Aiouche, C. Hardacre, K. Morgan, C. Stere, J. Sá (2014). "Letter to the Editor, Comment on 'The Critical Evaluation of In Situ Probe Techniques for Catalytic Honeycomb Monoliths' by Hettel et al.," *Catalysis Today* ***236***, 206–208, doi: 10.1016/j.cattod.2014.02.034.

    a. Responding to: M. Hettel, C. Diehm, B. Torkashvand, O. Deutschmann (2013). "Critical Evaluation of In Situ Probe Techniques for Catalytic Honeycomb Monoliths," *Catalysis Today* ***213***, 2–10, doi: 10.1016/j.cattod.2013.05.005.

22. X. Auvray, W. Partridge, J.-S. Choi, J. Pihl, F. Coehlo, A. Yezerets, K. Kamasamudram, N. Currier, L. Olsson (2015). "Kinetic Modeling of NH_3-SCR Over a Supported Cu Zeolite Catalyst Using Axial Species Distribution Measurements," *Applied Catalysis B: Environmental* ***163,*** 393–403, doi: 10.1016/j.apcatb.2014.08.003.

23. D. Mráček, P. Kočí, M. Marek, J.-S. Choi, J. A. Pihl, W. P. Partridge (2015). "Dynamics of N_2 and N_2O Peaks During and After the Regeneration of Lean NO_x Trap," *Applied Catalysis B: Environmental* ***166-167***, 509–517, doi: 10.1016/j.apcatb.2014.12.002.

24. M. P. Ruggeri, I. Nova, E. Tronconi, J. A. Pihl, T. J. Toops, W. P. Partridge (2015). "In-situ DRIFTS Measurements for the Mechanistic Study of NO Oxidation Over a Commercial Cu-CHA Catalyst," *Applied Catalysis B: Environmental* ***166***, 181–192, doi: 10.1016/j.apcatb.2014.10.076.

25. J. Yoo, V. Prikhodko, J. E. Parks, A. Perfetto, S. Geckler, W. P. Partridge (2015). "Fast Spatially-Resolved EGR Distribution Measurements in an Internal Combustion Engine using Absorption Spectroscopy," *Applied Spectroscopy* ***69***, 1047–1058, doi: 10.1366/14-07796. ***Cover Feature***.

26. D. Mráček, P. Kočí, J.-S. Choi, W. P. Partridge (2015). "New Strategy for Driving the Selectivity of NO_x Reduction to N_2, NH_3 or N_2O During Lean/Rich Cycling of a Lean NO_x Trap Catalyst," *Applied Catalysis B: Environmental* ***182***, 109–114; doi: 10.1016/j.apcatb.2015.09.002.

27. K. Morgan et al. (2016). "Evolution and Enabling Capabilities of Spatially Resolved Techniques for the Characterization of Heterogeneously Catalyzed Reactions," *ACS Catalysis* ***6***, 1356–1381, doi: 10.1021/acscatal.5b02602. ***Invited***, ***Cover Feature***.

28. J. Yoo, V. Prikhodko, J. E. Parks, A. Perfetto, S. Geckler, W. P. Partridge (2016). "High-Speed Multiplexed Spatiotemporally Resolved Measurements of EGR Dynamics in a Multi-Cylinder Engine Using Laser Absorption Spectroscopy," *Applied Spectroscopy* ***70***, 572–584, doi: 10.1177/0003702816636802.

29. M. P. Ruggeri, T. Selleri, I. Nova, E. Tronconi, J. A. Pihl, T. J. Toops, W. P. Partridge (2016). "New Mechanistic Insights in the NH_3-SCR Reactions at Low Temperature," *Topics in Catalysis* ***59***, 907–912, doi: 10.1007/s11244-016-0567-1.

30. G. Jatana, S. Geckler, D. Koeberlein, W. Partridge (2017). "Design and Development of a Probe-Based Multiplexed Multi-Species Absorption Spectroscopy Sensor for Characterizing Transient Gas-Parameter Distributions in the Intake Systems of I. C. Engines," *Sensors and Actuators B: Chemical* ***240***, 1197–1204, doi: 10.1016/j.snb.2016.08.183.

31. W. P. Partridge, S. Y. Joshi, J. A. Pihl, N. W. Currier (2018). "New Operando Method for Quantifying the Relative Half-Cycle Rates of the NO SCR Redox Cycle Over Cu-Exchanged Zeolites," *Applied Catalysis B: Environmental* **236**, 195–204, doi: 10.1016/j.apcatb.2018.04.071.

32. G. Jatana, L. Kocher, S.-M. Moon, S. Popuri, K. Augustin, J. Helt, F. Tao, Y. Wu, R. Booth, S. Geckler, D. Koeberlein, W. Partridge (2018). "Mapping of EGR and Combustion Residual Backflow in the Intake Ports of a Heavy Duty Diesel Engine using a Multiplexed Multi-species Absorption Spectroscopy Sensor," *International Journal of Engine Research* ***19***, 542–552, doi: 10.1177/1468087417720588.

33. G. S. Jatana, A. K. Perfetto, S. C. Geckler, W. P. Partridge (2019). "Absorption Spectroscopy Based High-Speed Oxygen Concentration Measurements at Elevated Gas Temperatures," *Sensors and Actuators B: Chemical* ***293***, 173–182; doi: 10.1016/j.snb.2019.04.143.

34. S. Neupane, V. B. Colomer, D. Splitter, W. P. Partridge (2021). "An Improved Method for Determining Transient Fuel Dilution of Oil in an Internal-Combustion Engine Using Laser-Induced Florescence and Multivariate Least Square Calibration," *Applied Spectroscopy* ***75,*** 1237–1250, doi: 10.1177/0003702821996455.

35. D. J. Deka, R. Daya, A. Ladshaw, S. Y. Joshi, W. P. Partridge (2022). "A Transient-Response Methodology based on Experiments and Modeling for Cu-Redox Half-Cycle Kinetic Analysis on a Cu-SSZ-13 SCR Catalyst," *Chemical Engineering Journal* ***435***, 134219, doi: 10.1016/j.cej.2021.134219.

36. D. J. Deka, R. Daya, A. Ladshaw, D. Trandal, S. Y. Joshi, W. P. Partridge (2022). "Assessing Impact of Real-World Aging on Cu-Redox Half Cycles of a Cu-SSZ-13 SCR Catalyst via Transient Response Measurements and Kinetic Modeling," *Applied Catalysis B: Environmental* ***309***, 121233, doi: 10.1016/j.apcatb.2022.121233.

37. R. Daya, D. Trandal, U. Menon, D. J. Deka, W. P. Partridge, S. Y. Joshi (2022). "Kinetic Model for Reduction of Cu^{II} Sites by NO + NH_3 and Re-oxidation of NH_3-Solvated Cu^{I} Sites by O_2 and NO in Cu-SSZ-13," *ACS Catalysis* ***12***, 6418−6433, doi: 10.1021/acscatal.2c01076.

38. D. J. Deka, R. Daya, S. Y. Joshi, W. P. Partridge, "On the Various Cu-Redox Pathways and O_2-Mediated Bronsted-to-Lewis Adsorbed-NH_3 Redistribution Under SCR Half-Cycle Conditions," *Applied Catalysis A: General* ***640***, 118656, doi: 10.1016/j.apcata.2022.118656.

Conference Papers (9)

1. R. L. Graves et al., "Exhaust Aftertreatment Research for Heavy Vehicles," Society of Automotive Engineers (SAE), May 2001, paper 2001-01-2064.

2. G. Singh, DOE; R. Graves et al., ORNL; B. Penetrante et al., Lawrence Livermore National Laboratory; Christopher Aardahl et al., Pacific Northwest National Laboratory, "Emission Control Research to Enable Fuel Efficiency DOE Heavy Vehicle Technologies," SAE, June 2000, paper 2000-01-2198.

3. W. P. Partridge, J. M. E. Storey, S. A. Lewis, R. W. Smithwick, G. L. DeVault, M. J. Cunningham, N. W. Currier, T. M. Yonushonis, "Time-Resolved Measurements of Emission Transients by Mass Spectrometry," SAE, 2000, paper 2000-01-2952.

   This manuscript also appears in the following:

   - *Diesel Nitrogen Oxide Emissions—Landmark Research 1995–2001*, John H. Johnson ed., SAE, 79–88, 2002.
   - *Emissions: Measurement, Test Methods, and Controls*, SAE, 2002.

4. W. P. Partridge, S. A. Lewis, M. J. Ruth, G. G. Muntean, R. C. Smith, J. H. Stang, "Resolving EGR Distribution and Mixing," SAE, 2002, paper 2002-01-2882.

   This manuscript also appears in the following:

   - *Diesel Particulate Systems and Gaseous Emissions*, SAE, 2002.

5. J. Parks, B. Partridge, S. Whitacre, "Rapid In Situ Measurement of Fuel Dilution of Oil in a Diesel Engine Using Laser-Induced Fluorescence Spectroscopy," SAE, 2007, paper 2007-01-4108, doi: 10.4271/2007-01-4108.

6. J. Parks, B. Partridge, V. Prikhodko, "An Optical Backscatter Sensor for Particulate Matter Measurement," SAE, 2009, paper 2009-01-0687, doi: 10.4271/2009-01-0687.

7. L. A. Kranendonk, J. E. Parks II, V. Prikhodko, W. Partridge, "High Speed H_2O Concentration Measurements Using Absorption Spectroscopy to Monitor Exhaust Gas," SAE, 2009, paper 2009-01-0239, doi: 10.4271/2009-01-0239.

8. G. Jatana et al., "Development and Application of a Multiplexed Two-Color Sensor for Mapping of EGR and Back-Flowing Combustion Residual into the Intake Manifold of a Heavy Duty Diesel Engine," Proceedings of the 9th US National Combustion Meeting, Cincinnati, Ohio, May 17–20, 2015.

9. G. Jatana, A. Perfetto, S. Geckler, W. Partridge, "Development of an Absorption Spectroscopy Sensor for High-Speed Oxygen Concentration Measurements in the Exhaust of I. C. Engines," 2016 Spring Technical Meeting of the Central States Section of the Combustion Institute, Knoxville, Tennessee, May 15–17, 2016.

Reports (20)

1. B. Partridge, N. Currier, R. Shute, J.-S. Choi, J. Parks, M. Cunningham, A. Yezerets, M. Ruth (2009). "NO_x Control and Measurement Technology for Heavy-Duty Diesel Engines," US DOE Vehicle Technologies Program, Gurpreet Singh and Ken Howden (program managers), DOE FY 2009 Advanced Combustion Technologies Annual Report.

2. B. Partridge, N. Currier, S. Geckler, R. Shute, J.-S. Choi, J. Parks, M. Cunningham, M. Ruth, A. Yezerets (2010). "NO_x Control and Measurement Technology for Heavy-Duty Diesel Engines," US DOE Vehicle Technologies Program, Gurpreet Singh and Ken Howden (program managers), DOE FY 2010 Advanced Combustion Technologies Annual Report.

3. B. Partridge, N. Currier, J.-S. Choi, M. Connatser, J. Parks, X. Auvray, L. Olsson, K. Kamasamudram, A. Yezerets (2011). "Cummins-ORNL SmartCatalyst CRADA: NO_x Control and Measurement Technology for Heavy-Duty Diesel Engines," US DOE Vehicle Technologies Program, Gurpreet Singh and Ken Howden (program managers), DOE FY 2011 Advanced Combustion Technologies Annual Report.

4. B. Partridge, S. Geckler, M. Connatser, J. Yoo, J. Parks, C. Hetisimer, P. Helman (2011). "Cummins-ORNL Combustion CRADA: Characterization and Reduction of Combustion Variations," US DOE Vehicle Technologies Program, Gurpreet Singh and Ken Howden (program managers), DOE FY 2011 Advanced Combustion Technologies Annual Report.

5. B. Partridge, N. Currier, J.-S. Choi, J. Pihl, J. Parks, X. Auvray, L. Olsson, K. Kamasamudram, A. Yezerets (2012). "Fiscal Year 2012 Annual Report, Cummins-ORNL SmartCatalyst CRADA: NO_x Control and Measurement Technology for Heavy-Duty Diesel Engines," US DOE Vehicle Technologies Program, Gurpreet Singh and Ken Howden (program managers), DOE FY 2012 Advanced Combustion Technologies Annual Report.

6. B. Partridge, S. Geckler, J. Yoo, A. Perfetto, J. Parks, M. Connatser, V. Prikhodko, R. Sanchez-Gonzalez (2012). "Fiscal Year 2012 Annual Report, Cummins-ORNL Combustion CRADA: Characterization and Reduction of Combustion Variations," US DOE Vehicle Technologies Program, Gurpreet Singh and Ken Howden (program managers), DOE FY 2012 Advanced Combustion Technologies Annual Report.

7. B. Partridge, S. Geckler, J. Yoo, A. Perfetto, R. Sanchez-Gonzalez, J. Parks, M. Connatser, V. Prikhodko (2013). "Fiscal Year 2013 Annual Report: Cummins-ORNL Combustion CRADA: Characterization and Reduction of Combustion Variations," US DOE Vehicle Technologies

Program, Gurpreet Singh and Ken Howden (program managers), DOE FY 2013 Advanced Combustion Technologies Annual Report.

8. B. Partridge, N. Currier, M. Connatser, J. Pihl, J.-S. Choi, X. Auvray, S. Shwan, L. Olsson, K. Kamasamudram, A. Yezerets (2013). "Fiscal Year 2013 Annual Report: Cummins-ORNL SmartCatalyst CRADA: NO_x Control and Measurement Technology for Heavy-Duty Diesel Engines," US DOE Vehicle Technologies Program, Gurpreet Singh and Ken Howden (program managers), DOE FY 2013 Advanced Combustion Technologies Annual Report.
9. Bill Partridge et al. (2014). "Fiscal Year 2014 Annual Report: Cummins-ORNL Combustion CRADA: Characterization and Reduction of Combustion Variations," US DOE Vehicle Technologies Program, Gurpreet Singh and Ken Howden (program managers), DOE FY 2014 Advanced Combustion Technologies Annual Report.
10. B. Partridge, N. Currier, M.-Y. Kim, J. Pihl, J.-S. Choi, K. Kamasamudram, A. Yezerets (2014). "Fiscal Year 2014 Annual Report, Cummins-ORNL SmartCatalyst CRADA: NO_x Control and Measurement Technology for Heavy-Duty Diesel Engines," US DOE Vehicle Technologies Program, Gurpreet Singh and Ken Howden (program managers), DOE FY 2014 Advanced Combustion Technologies Annual Report.
11. B. Partridge, N. Currier, M.-Y. Kim, J. Pihl, J.-S. Choi, M. Salazar, K. Kamasamudram, A. Yezerets (2015). "Fiscal Year 2015 Annual Report, Cummins-ORNL SmartCatalyst CRADA: NO_x Control and Measurement Technology for Heavy-Duty Diesel Engines," US DOE Vehicle Technologies Program, Gurpreet Singh and Ken Howden (program managers), DOE FY 2015 Advanced Combustion Technologies Annual Report.
12. B. Partridge et al. (2015). "Fiscal Year 2015 Annual Report, Cummins-ORNL Combustion CRADA: Characterization and Reduction of Combustion Variations," US DOE Vehicle Technologies Program, Gurpreet Singh and Ken Howden (program managers), DOE FY 2015 Advanced Combustion Technologies Annual Report.
13. B. Partridge, N. Currier, M. Salazar, K. Kamasamudram, A. Yezerets (2016). "Fiscal Year 2016 Annual Report, Cummins-ORNL SmartCatalyst CRADA: NO_x Control and Measurement Technology for Heavy-Duty Diesel Engines," US DOE Vehicle Technologies Program, Gurpreet Singh, Ken Howden, and Leo Breton (program managers), DOE FY 2016 Advanced Combustion Technologies Annual Report.
14. B. Partridge, S. Geckler, G. Jatana, A. Perfetto (2016). "Fiscal Year 2016 Annual Report, Cummins-ORNL Combustion CRADA: Characterization and Reduction of Combustion Variations," US DOE Vehicle Technologies Program, Gurpreet Singh, Ken Howden, and Leo Breton (program managers), DOE FY 2016 Advanced Combustion Technologies Annual Report.
15. B. Partridge, S. Joshi, N. Currier, J. Pihl, K. Kamasamudram, A. Yezerets (2017). "Fiscal Year 2017 Annual Report, Cummins-ORNL SmartCatalyst CRADA: NO_x Control and Measurement Technology for Heavy-Duty Diesel Engines," US DOE Vehicle Technologies Program, Gurpreet Singh and Ken Howden (program managers), DOE FY 2017 Advanced Combustion Technologies Annual Report, https://www.energy.gov/sites/prod/files/2018/05/f51/AdvCombSysAndFuels_FY2017_APR_Final.pdf.
16. B. Partridge, S. Joshi, N. Currier, J. Pihl, K. Kamasamudram, R. Daya, A. Yezerets (2018). "Fiscal Year 2018 Annual Report, Cummins-ORNL Catalyst CRADA: NO_x Control and Measurement Technology for Heavy-Duty Diesel Engines," US DOE Vehicle Technologies Program, Gurpreet Singh and Ken Howden (program managers), DOE FY 2018 Advanced Combustion Technologies

Annual Report, https://www.energy.gov/sites/prod/files/2019/04/f62/fy2018_adv-comb-sys_and_fuelsb.pdf.

17. B. Partridge, S. Joshi, R. Daya, N. Currier, J. Pihl, K. Kamasamudram, A. Yezerets (2019). "Fiscal Year 2019 Annual Report, Cummins-ORNL Catalyst CRADA: NO_x Control and Measurement Technology for Heavy-Duty Diesel Engines," US DOE Vehicle Technologies Program, Gurpreet Singh and Ken Howden (program managers), DOE FY 2019 Advanced Combustion Technologies Annual Report, https://www.energy.gov/sites/prod/files/2020/06/f75/VTO_2019_APR_ADV_FUEL_COMPILED_REPORT_compliant%20052020_0.pdf.
18. B. Partridge, S. Joshi, D. Deka, R. Daya, A. Kumar, J. Pihl, A. Ladshaw, K. Kamasamudram, A. Yezerets (2020). "Fiscal Year 2020 Emissions Control R&D Annual Report, Cummins-ORNL Catalyst CRADA: NO_x Control and Measurement Technology for Heavy-Duty Diesel Engines," US DOE Vehicle Technologies Program, Ken Howden and Siddiq Khan (program managers), DOE FY 2020 Advanced Combustion Technologies Annual Report, https://www.energy.gov/sites/default/files/2021-07/VTO_2020_APR_ADV_FUEL_COMPILED_REPORT_JUL_7_2021_compliant_.pdf
19. B. Partridge et al. (2021). "Fiscal Year 2021 Emissions Control R&D Annual Report, Cummins-ORNL Catalyst CRADA: NO_x Control and Measurement Technology for Heavy-Duty Diesel Engines," US DOE Vehicle Technologies Program, Siddiq Khan and Ken Howden (program managers), DOE FY 2021 Advanced Combustion Technologies Annual Report, https://www.energy.gov/sites/.....pdf
20. S. Curran, B. Partridge, M. Moses-DeBusk, M. Wissink, T. Lutz (2021). "Fiscal Year 2021 Emissions Control R&D Annual Report, Next-Generation Heavy-Duty Powertrains (Oak Ridge National Laboratory)," US DOE Vehicle Technologies Program, Michael Weismiller (program manager), DOE FY 2021 Advanced Combustion Technologies Annual Report, https://www.energy.gov/sites/.....pdf

SuperTruck Cummins Technical Reports Using EGR Probe Developed in Partnership with CRADA (6)

1. W. P. Partridge, Jr., I. Choi, R. Booth, "N-Species Diagnostic: Transient Exhaust $NO/NO_2/NH_3$ Measurements Utilizing Absorption Spectroscopy," Cummins Inc. Technical Report # 00046090.
2. W. P. Partridge, Jr., R. Sanchez-Gonzalez, I. Choi, R. Booth, "High-Speed Intake and Exhaust O_2 Measurement by Optical Absorption Spectroscopy," Cummins Inc. Technical Report # 00046069.
3. W. P. Partridge, Jr., R. Sanchez-Gonzalez, J. Yoo, R. Booth, "Multiplex EGR Probe: Theory, Design, Operation, Analysis & Performance," Cummins Inc. Technical Report # 00046088.
4. W. P. Partridge, Jr., J. Yoo, K. Smith, D. Splitter, J. Szybist, L. Kocher, K. Augustin, R. Booth, D. Koeberlein, "EGR Probe Modifications and Application to Measure Cylinder-Residual Backflow," Cummins Inc. Technical Report # 00046089.
5. W. P. Partridge, Jr., R. Sanchez-Gonzalez, J. Yoo, R. Booth, "Evaluation of EGR Mixing Uniformity Utilizing a Laser-Based Multiplex EGR Probe," Cummins Inc. Technical Report # 00044747.
6. G. S. Jatana et al., "Development and Application of a Two-Color EGR Probe for Spatiotemporal Mapping and Quantification of Combustion Residual Backflow," Cummins Inc. Technical Report # 00055180.

Presentations (145)

1. W. P. Partridge, J. M. E. Storey, S. A. Lewis, R. W. Smithwick, G. L. DeVault, S. A. Lewis, M. J. Cunningham, N. W. Currier, T. M. Yonushonis, "Resolving NO_x-Adsorber Emission Transients," Diesel Engine Emissions Reduction (DEER) workshop, San Diego, California, August 20–24, 2000.
2. W. P. Partridge, J. M. E. Storey, S. A. Lewis, R. W. Smithwick, G. L. DeVault, S. A. Lewis, M. J. Cunningham, N. W. Currier, T. M. Yonushonis, "Time-Resolved Measurements of Emission Transients By Mass Spectrometry," SAE International Fall Fuels and Lubricants Meeting and Exposition, Baltimore, Maryland, October 16–19, 2000.
3. W. P. Partridge, S. A. Lewis, M. J. Ruth, G. G. Muntean, R. C. Smith, J. H. Stang, "Resolving EGR Distribution and Mixing," presented at the following:
   a. Oak Ridge National Laboratory 2002 Seminar Series, Oak Ridge, Tennessee, March 6, 2002.
   b. The Combustion Institute, Central States Section, 2002 Spring Technical Meeting, Knoxville, Tennessee, April 7–9, 2002.
   c. SAE Powertrain and Fluid Systems Conference and Exposition, San Diego, California, October 21–24, 2002.
4. T. J. Toops, D. B. Smith, W. S. Epling, J. E. Parks, W. P. Partridge, "Quantified In-Situ DRIFTS Analysis of NO_x Adsorption on $Pt/K/Al_2O_3$ in the Presence of CO_2 and H_2O," 18th North American Catalysis Society Meeting, Cancun, Mexico, June 2003.
5. J.-S. Choi, T. Miller, W. S. Epling, S. P. Huff, K. Chakravarthy, K. E. Lenox, W. P. Partridge, C. S. Daw, "Regeneration Behavior of NO_x Storage-Reduction Catalysts Under Simulated or Realistic Diesel Exhaust," 4th Department of Energy National Laboratory Catalysis Conference, Oak Ridge, Tennessee, October 2003.
6. T. J. Toops, D. B. Smith, W. P. Partridge, "Lean NO_x Trap Chemical Behavior and Thermal Deactivation Effects," DOE National Laboratory Advanced Combustion Engine R&D Merit Review and Peer Evaluation, Argonne, Illinois, May 19, 2004.
7. B. Partridge, J.-S. Choi, S. Allison, "Minimally Invasive Diagnostics for Intra-Reactor Measurements of Species and Temperature," 51st International Instrumentation Symposium of The Instrumentation, Systems, and Automation Society, Knoxville, Tennessee, May 10, 2005.
8. J.-S. Choi, W. P. Partridge, W. S. Epling, N. W. Currier, T. Yonushonis, "A Technical Highlight from the ORNL/Cummins CRADA: Intra-channel Evolution of Carbon Monoxide and its Implication on the Regeneration of Lean NO_x Traps," DOE National Laboratory Advanced Combustion Engine R&D Merit Review and Peer Evaluation, Argonne, Illinois, April 19–21, 2005.
9. T. J. Toops, D. B. Smith, W. P. Partridge, "Fundamental Study of Lean NO_x Trap Deactivation," DOE National Laboratory Advanced Combustion Engine R&D Merit Review and Peer Evaluation, Argonne, Illinois, April 19–21, 2005.
10. B. Partridge, J.-S. Choi, S. Allison, "Minimally Invasive Diagnostics for Intra-Reactor Measurements of Species and Temperature," 51st International Instrumentation Symposium of The Instrumentation, Systems, and Automation Society, Knoxville, Tennessee, May 10, 2005.
11. J.-S. Choi, W. P. Partridge, W. S. Epling, N. W. Currier, T. Yonushonis, "Intra-Channel Evolution of CO and its Implication on the Regeneration of $Pt/K/Al_2O_3$ Monolithic NO_x Storage-Reduction Catalyst," 19th Meeting of the North American Catalysis Society, Philadelphia, Pennsylvania, May 25, 2005.
12. T. J. Toops, D. B. Smith, J. E. Parks, W. P. Partridge, "Lean NO_x Trap Adsorption on $Pt/K/Al_2O_3$," 19th Meeting of the North American Catalysis Society, Philadelphia, Pennsylvania, May 25, 2005.

13. J. Parks, T. Toops, J.-S. Choi, B. Partridge, S. Daw, K. Chakravarthy, J. Pihl, B. Bunting, S. Huff, B. West, "NO_x Adsorber Catalysis for Diesel Emission Control," keynote lecture, Environmental: Diesel Engines Session, 19th Meeting of the North American Catalysis Society, Philadelphia, Pennsylvania, May 25, 2005. ***Invited.***
14. J.-S. Choi, W. P. Partridge, C. S. Daw. "Spatially-Resolved In Situ Measurements of Transient Species Breakthrough During Low-Temperature Regeneration of a $Pt/K/Al_2O_3$ Lean NO_x Trap," 8th CLEERS Workshop, Dearborn, Michigan, May 17–19, 2005.
15. W. P. Partridge, "Spatially Resolved Capillary-Inlet Mass Spectrometry: Instrument Details and Applications," Centre for the Theory and Application of Catalysis (CenTACat), Queen's University Belfast, Belfast, Ireland, June 7, 2006. ***Invited***
16. B. Partridge, J.-S. Choi, W. S. Epling, N. W. Currier, T. Yonushonis, "Intra-Reactor Measurements of Transient Species Distributions," The Instrumentation, Systems, and Automation Society 2006 Technical Conference, Houston, Texas, October 17, 2006. ***Invited***
17. B. Partridge, J.-S. Choi, S. Daw "Distributed Impact of Sulfation on LNT Catalyst Reactions," 10th DOE Crosscut Workshop on Lean Emissions Reduction Simulation, University of Michigan, Dearborn, Michigan, May 2, 2007.
18. J.-S. Choi, B. Partridge, S. Daw, "Assessing a Commercial Lean NO_x Trap Performance via Spatiotemporal Species Profile Measurements: Sulfation and Its Impacts," North American Catalysis Society, 20th North American Meeting, Houston, Texas, June 22, 2007.
19. J. Parks, B. Partridge, S. Whitacre, "Rapid In Situ Measurement of Fuel Dilution of Oil in a Diesel Engine Using Laser-Induced Fluorescence Spectroscopy," SAE Powertrain and Fluid Systems Conference, Chicago, Illinois, October 29–31, 2007.
20. J.-S. Choi, W. P. Partridge, J. A. Pihl, C. S. Daw, "Sulfur Effects on Spatiotemporal Distribution of Reactions in a Commercial Lean NO_x Trap," American Institute of Chemical Engineers (AIChE) National Meeting, Salt Lake City, Utah, November 7, 2007.
21. W. P. Partridge, J.-S. Choi, J. Parks, N. Currier, A. Yezerets, M. Ruth, S. Whitacre, M. Cunningham, K. Kamasamudram, "Cummins/ORNL-FEERC CRADA: NO_x Control and Measurement Technology for Heavy-Duty Diesel Engines," DOE Vehicle Technologies Program Annual Merit Review, Bethesda, Maryland, February 26, 2008. http://info.ornl.gov/sites/publications/Files/Pub10341.pdf.
22. B. Partridge, J.-S. Choi, "Ammonia Formation and Utilization in Lean NO_x Trap Catalysts: Experimental Determination of Reaction Pathways," 11th DOE Crosscut Workshop on Lean Emissions Reduction Simulation, University of Michigan, Dearborn, Michigan, May 13, 2008. http://cleers.org/workshops/workshop11/index.php.
23. J.-S. Choi, B. Partridge, J. Pihl, T. Toops, M. Lance, C. Finney, K. Chakravarthy, S. Daw, "Sulfation Impact on LNT Performance: Experimental Studies with Umicore CLEERS Reference Catalyst," 11th DOE Crosscut Workshop on Lean Emissions Reduction Simulation, University of Michigan, Dearborn, Michigan, May 13, 2008. http://cleers.org/workshops/workshop11/index.php.
24. J.-S. Choi, W. P. Partridge, J. A. Pihl, T. J. Toops, V. K. Chakravarthy, C. S. Daw, "Correlation Between Spatiotemporal Distribution of Reactions and Global Performance of Lean NO_x Trap Catalysts," 14th International Congress on Catalysis, Seoul, Korea, July 14, 2008.
25. B. Partridge, J.-S. Choi, "Ammonia Formation and Utilization in Lean NO_x Trap Catalysts: Experimental Determination of Reaction Pathways," Hanseo University, Seosan, Korea, July 21, 2008. ***Invited.***

26. J.-S. Choi, W. P. Partridge, J. A. Pihl, T. J. Toops, V. K. Chakravarthy, C. S. Daw, "Correlation Between Spatiotemporal Distribution of Reactions and Global Performance of Lean NO_x Trap Catalysts," Hyosung Corporation, Anyang, Korea, July 22, 2008.

27. W. Partridge, J.-S. Choi, J. Pihl, T. Toops, S. Daw, "Intermediate NH_3 Generation and Utilization Inside a Lean NO_x Trap Catalyst," 5th International Conference on Environmental Catalysis, Belfast, United Kingdom, September 2, 2008.

28. J.-S. Choi, W. Partridge, J. Pihl, T. Toops, M. Lance, C. Finney, K. Chakravarthy, S. Daw, "Correlation Between Spatiotemporal Distribution of Reactions and Global Performance of a Commercial LNT Catalyst at Varying Sulfation Stages," 5th International Conference on Environmental Catalysis, Belfast, United Kingdom, September 3, 2008.

29. J. Parks, B. Partridge, V. Prikhodko, "An Optical Backscatter Sensor for Particulate Matter Measurement," SAE 2009 World Conference, Detroit, Michigan, April 20–23, 2009.

30. L. A. Kranendonk, J. E. Parks II, V. Prikhodko, W. Partridge, "High Speed H_2O Concentration Measurements Using Absorption Spectroscopy to Monitor Exhaust Gas," SAE 2009 World Conference, Detroit, Michigan, April 20–23, 2009.

31. B. Partridge, J.-S. Choi, J. Pihl, T. Toops, N. Ottinger, J. Parks, A. Yezerets, N. Currier, "Understanding the Distributed Intra-Catalyst Impact of Sulfation on Water Gas Shift in a Lean NO_x Trap Catalyst," 12th DOE Crosscut Workshop on Lean Emissions Reduction Simulation, University of Michigan, Dearborn, Michigan, April 30, 2009. http://cleers.org/workshops/workshop12/index.php.

32. W. P. Partridge, J.-S. Choi, J. E. Parks, T. J. Toops, J. A. Pihl, N. A. Ottinger, N. Currier, A. Yezerets, M. Cunningham, M. Ruth, "Cummins/ORNL-FEERC CRADA: NO_x Control and Measurement Technology for Heavy-Duty Diesel Engines," 2009 DOE Vehicle Technologies Program Annual Merit Review, Arlington, Virginia, May 21, 2009.

33. B. Partridge, J.-S. Choi, J. Parks, J. Pihl, T. Toops, N. Ottinger, A. Yezerets, N. Currier, "Elucidating Lean NO_x Trap Catalyst Regeneration and Degradation Chemistry: Insights from Intra-Catalyst, Spatiotemporally Resolved Measurements," Keynote Lecture, Catalysis for Environmental Protection topical area, North American Catalysis Society, 21st North American Meeting, San Francisco, California, June 9, 2009. ***Invited.***

34. B. Partridge, J.-S. Choi, J. Parks, S. Lewis, N. Currier, M. Ruth, R. Smith, G. Muntean, J. Stang, A. Yezerets, "Measuring Transient Chemistry Distributions Inside Automotive Catalyst and Engine Systems," General Electric Global Research Center's Symposium on Emissions and After Treatment, Niskayuna, New York, September 17, 2009. ***Invited.***

35. B. Partridge, J.-S. Choi, J. Pihl, T. Toops, J. Parks, N. Ottinger, A. Yezerets, N. Currier, "Understanding the Distributed Intra-Catalyst Impact of Sulfation on Water Gas Shift in a Lean NO_x Trap Catalyst," AIChE National Meeting, Nashville, Tennessee, November 13, 2009.

36. J.-S. Choi, B. Partridge, N. Ottinger, T. Toops, J. Pihl, M. Lance, C. Finney, S. Daw, "Types, Spatial Distribution, Stability, and Performance Impact of Sulfur on a Lean NO_x Trap Catalyst," AIChE National Meeting, Nashville, Tennessee, November 12, 2009.

37. J. Parks, B. Partridge, "Laser-Induced Fluorescence Diagnostic for Fuel Dilution of Oil in Advanced Combusiton," ACE/HCCI (Advanced Combustion Engine/Homogenous Charge Compression Ignition) Working Group Meeting, Sandia National Laboratories, February 25, 2010.

38. J.-S. Choi, J. Pihl, B. Partridge, K. Chakravarthy, T. Toops, S. Daw, "Factors Affecting LNT NH_3 Selectivity," 2010 DOE Crosscut Workshop on Lean Emissions Reduction Simulation, University of Michigan, Dearborn, Michigan, April 22, 2010.

39. W. P. Partridge, J.-S. Choi, J. E. Parks, L. A. Kranendonk, N. Currier, R. Shute, A. Yezerets, M. Cunningham, M. Ruth, K. Kamasamudram, "Cummins/ORNL-FEERC CRADA: NO_x Control and Measurement Technology for Heavy-Duty Diesel Engines," 2010 DOE Vehicle Technologies Program Annual Merit Review, Washington, DC, June 10, 2010.

40. J.-S. Choi, B. Partridge, J. Pihl, K. Chakravarthy, T. Toops, S. Daw, "Spatial Distribution of Reactions: A Key to Understanding the Performance of Lean NO_x Trap Catalysts," Pohang University of Science and Technology, Pohang, Korea, June 22, 2010. ***Invited.***

41. J.-S. Choi, B. Partridge, J. Pihl, K. Chakravarthy, T. Toops, S. Daw, "Spatial Distribution of Reactions: A Key to Understanding the Performance of Lean NO_x Trap Catalysts," Keynote Lecture, Discussions on Catalysis Research, Korean Institute of Chemical Engineers, Busan, Korea, June 23, 2010. ***Invited.***

42. J.-S. Choi, B. Partridge, J. Pihl, K. Chakravarthy, T. Toops, S. Daw, "Spatial Distribution of Reactions: A Key to Understanding the Performance of Lean NO_x Trap Catalysts," Korea Institute of Science and Technology, Seoul, Korea, July 1, 2010. ***Invited.***

43. J.-S. Choi, W. P. Partridge, J. A. Pihl, K. Chakravarthy, C. S. Daw, "Factors Affecting the NH_3 Selectivity of Lean NO_x Traps—Insights from Spatiotemporal Distribution of Reactions," Keynote Lecture, 2nd International Symposium on Air Pollution Abatement Catalysis (APAC 2010), Cracow, Poland, September 8, 2010. ***Invited.***

44. W. P. Partridge, X. Auvray, N. Currier, L. Olsson, J.-S. Choi, A. Yezerets, K. Kamasamudram, "Ammonia Storage and Reaction Distributions Within an Operating SCR Catalyst," 9th Annual Symposium of the Southeastern Catalysis Society, Asheville, North Carolina, September 27, 2010.

45. B. Partridge, J.-S. Choi, J. Pihl, T. Toops, J. Parks, N. Ottinger, A. Yezerets, N. Currier, "Advanced LNT DeSulfation Control via Understanding the Distributed Intra-Catalyst Impacts of Sulfation on Water Gas Shift, NO_x Storage, and Reduction Reactions," DEER 2010 Conference, Emissions Control Technologies, Detroit, Michigan, September 28, 2010.

46. B. Partridge, X. Auvray, L. Olsson, J.-S. Choi, K. Kamasamudarm, A. Yezerets, N. Currier, "Distributed Transient Performance of a Model Cu-Beta SCR Catalyst: For Development of Self-Diagnosing Catalyst Systems," 2011 DOE Crosscut Workshop on Lean Emissions Reduction Simulation, University of Michigan, Dearborn, Michigan, April 19, 2011.

47. P. Koci, M. Marek, W. Partridge, J. Pihl, J.-S. Choi, "N_2O Formation During the Regeneration of Lean NO_x Traps," 2011 DOE Crosscut Workshop on Lean Emissions Reduction Simulation, University of Michigan, Dearborn, Michigan, April 21, 2011.

48. J.-S. Choi, J. Pihl, M. Kim, B. Partridge, S. Daw, P. Koci, "Correlation between LNT NH_3 and N_2O Selectivities Under Fast Cycling Conditions," 2011 DOE Crosscut Workshop on Lean Emissions Reduction Simulation, University of Michigan, Dearborn, Michigan, April 21, 2011.

49. W. P. Partridge, J.-S. Choi, J. E. Parks, R. M. Connatser, N. Currier, S. Geckler, A. Yezerets, K. Kamasamudram, "Cummins/ORNL-FEERC CRADA: NO_x Control and Measurement Technology for Heavy-Duty Diesel Engines," 2011 DOE Vehicle Technologies Program Annual Merit Review, Arlington, Virginia, May 12, 2011. https://www.energy.gov/sites/default/files/2014/03/f11/ace032_partridge_2011_o.pdf.

50. S. Shwan, B. Partridge, J.-S. Choi, L. Olsson, "Kinetic Modeling of NO_x Storage and Reduction Using Spatially Resolved MS Measurements," Mobile/Stationary Emissions Control topical area, North American Catalysis Society, 22nd North American Meeting, Detroit, Michigan, June 6, 2011.

51. J.-S. Choi, J. Pihl, B. Partridge, M. Kim, S. Daw, "Axial Redistribution of NO_x Storage and Impact on LNT Performance under Fast Cycling Conditions," Mobile/Stationary Emissions Control topical

area, North American Catalysis Society, 22nd North American Meeting, Detroit, Michigan, June 7, 2011.

52. P. Koci, M. Marek, J. Pihl, J.-S. Choi, W. Partridge, "N_2O Formation During the Regeneration of Lean NO_x Traps," Mobile/Stationary Emissions Control topical area, North American Catalysis Society, 22nd North American Meeting, Detroit, Michigan, June 7, 2011.

53. B. Partridge, X. Auvray, L. Olsson, J.-S. Choi, K. Kamasamudarm, A. Yezerets, N. Currier, "Temperature and Hydrothermal Ageing Impacts on Intra-Catalyst SCR-Reaction Distribution," Mobile/Stationary Emissions Control topical area, North American Catalysis Society, 22nd North American Meeting, Detroit, Michigan, June 8, 2011.

54. S. Shwan, W. Partridge, J.-S. Choi, L. Olsson, "Kinetic Modeling of NO_x Storage and Reduction Using Spatially Resolved MS Measurements," AVL Advanced Simulation Technologies International User Conference, Graz, Austria, June 28, 2011.

55. B. Partridge, X. Auvray, L. Olsson, J.-S. Choi, J. Pihl, K. Kamasamudram, A. Yezerets, N. Currier, "Temperature and Hydrothermal Ageing Impacts on Intra-Catalyst SCR-Reaction Distriubutions," Keynote Lecture, Environmental Catalysis Session, EuropaCat (European Congress on Catalysis) X, Glasgow, Scotland, United Kingdom, August 30, 2011. ***Invited.***

56. J.-S. Choi, J. Pihl, P. Koci, B. Partridge, M. Kim, S. Daw, "Axial Redistribution of NO_x Storage and Impact on LNT Performance under Fast Cycling Conditions," Environmental Catalysis Session, EuropaCat X, Glasgow, Scotland, United Kingdom, August 30, 2011.

57. P. Koci, M. Marek, J. Pihl, J.-S. Choi, W. Partridge, "Modelling of N_2O Formation During the Regeneration of NO_x Storage Catalysts," Environmental Catalysis Session, EuropaCat X, Glasgow, Scotland, United Kingdom, August 30, 2011.

58. A. Goguet, C. Stere, J. Sá, D. L. A. Fernandes, F. Aiouache, C. Hardacre, D. Lundie, W. Naeem, W. P. Partridge, "SPACIMS—Spatial and Temporal Operando Resolution of Structured Catalysts," Catalyst Characterization Session, EuropaCat X, Glasgow, Scotland, United Kingdom, September 2, 2011.

59. P. Koci, S. Bartova, M. Marek, J. Pihl, J.-S. Choi, W. Partridge, "Modelling of N_2O Formation During the Regeneration of NO_x Storage Catalysts," MODEGAT II (2nd International Symposium on Modeling of Exhaust-Gas After-Treatment), Bad Herrenalb/Kalrsruhe, Germany, September 19, 2011.

60. J.-S. Choi, B. Partridge, J. Pihl, P. Koci, M. Kim, S. Daw, "Spatiotemporal Distribution of NO_x Storage: A Factor Controlling NH_3 and N_2O Selectivities over a Commercial LNT Catalyst," Environmental Catalysis Session, 17th DEER Conference, Detroit, Michigan, October 5, 2011.

61. P. Kočí, Š. Bártová, M. Marek, J. A. Pihl, M.-Y. Kim, J.-S. Choi, W. P. Partridge. "N_2O Formation Pathways During the Regeneration of Lean NO_x Trap," SAE World Congress, Emissions/Environment/Sustainability Gaseous Engine Emissions Session, Detroit, Michigan, April 26, 2012.

62. W. P. Partridge, J.-S. Choi, J. A. Pihl, N. Currier, A. Yezerets, K. Kamasamudram, "Cummins/ORNL-FEERC Emissions CRADA: NO_x Control and Measurement Technology for Heavy-Duty Diesel Engines," 2012 DOE Vehicle Technologies Program Annual Merit Review, Arlington, Virginia, May 17, 2012.

63. W. P. Partridge et al., "Cummins/ORNL-FEERC Combustion CRADA: Characterization and Reduction of Combustion Variations," 2012 DOE Vehicle Technologies Program Annual Merit Review, Arlington, Virginia, May 17, 2012.

64. R. M. Connatser, B. Partridge, J. Parks. "Facilitating More Precise Control of Selective Catalytic Reduction for Automotive Aftertreatment: Toward Intra-Catalyst Ammonia Detection Using Materials-Modified Optical Fiber Sensors," 58th International Instrumentation Symposium, La Jolla, California, June 5, 2012.

65. J. Yoo, W. Partridge. "Spatiotemporal Distribution of EGR in an Intake Manifold Using HWG," 58th International Instrumentation Symposium, La Jolla, California, June 6, 2012.

66. J. Yoo, J. E. Parks, V. Prikhodko, W. P. Partridge, S. Geckler. "An Absorption Spectroscopy Probe for Diagnosing EGR Spatial Uniformity and Cylinder-Resolved Exhaust Transients," CLEERS Teleconference (intra- and international attendance via teleconference), Oak Ridge National Laboratory, June 19, 2012. ***Invited.***

67. P. Kočí, Š. Bártová, D. Mráček, M. Marek, J.-S. Choi, J. A. Pihl, C. S. Daw, W. P. Partridge. "Effective Model for Prediction of N_2O Formation during the NO_x Storage Catalyst Regeneration with H_2, CO, and Hydrocarbons," CAPoC9 (9th International Conference on Catalysis and Automotive Pollution Control), Brussel, Belgium, August 29–31, 2012.

68. W. Partridge, J. Pihl, X. Auvray, L. Olsson, T. Toops, J.-S. Choi, S. Daw, K. Kamasamudram, A. Yezerets, N. Currier. "Local Ammonia Storage in a Monolithic SCR Catalyst: Comparing Commercial and Model Catalyst Performance," CAPoC9, Brussels, Belgium, August 29–31, 2012.

69. W. Partridge, J. Pihl, X. Auvray, L. Olsson, T. Toops, J.-S. Choi, S. Daw, K. Kamasamudram, A. Yezerets, N. Currier, "Local Ammonia Storage in a Monolithic SCR Catalyst: Comparing Commercial and Model Catalyst Performance," 7th International Conference on Environmental Catalysis (ICEC 2012), Lyon, France, September 2–6, 2012.

70. B. Partridge, J.-S. Choi, "Understanding Ammonia Formation and Utilization and Sulfation of Lean NO_x Trap Catalysts via Intra-Reactor Spatiotemporal Diagnostics," IFP (French Institute of Petroleum) Énergies nouvelles, Lyon, France, September 7, 2012. ***Invited.***

71. R. M. Connatser, W. P. Partridge, Jr., J. E. Parks, II, "State Assessment of SCR Catalyst: Copper Zeolite/Sol-Gel-Tipped Optical Fiber Probes," Southeastern Catalyst Society, 11th Annual Symposium, Asheville, North Carolina, October 1, 2012.

72. R. M. Connatser, J. E. Parks, V. Prikhodko, W. P. Partridge, S. Geckler, N. Currier. "Ammonia Sensors Based on Doped-Sol-Gel-Tipped Optical Fibers for Catalyst System Diagnostics," Emission Control Technologies, 18th Directions in Engine-Efficiency and Emissions Research (DEER) Conference, Detroit, Michigan, October 17, 2012. http://energy.gov/sites/prod/files/2014/03/f8/p-04_connatser.pdf.

73. Š. Bártová, P. Kočí, D. Mráček, M. Marek, J.-S. Choi, J. A. Pihl, C. S. Daw, W. P. Partridge. "Lean NO_x Trap Regeneration Selectivity Towards N_2O—Similarities and Differences Between H_2, CO, and C_3H_6 Reductants," Emission Control Technologies, 18th Directions in Engine-Efficiency and Emissions Research (DEER) Conference, Detroit, Michigan, October 19, 2012. http://energy.gov/sites/prod/files/2014/03/f8/deer12_bartova.pdf.

74. J. Yoo, J. E. Parks, V. Prikhodko, A. Perfetto, S. Geckler, R. Booth, D. Koeberlein, W. P. Partridge. "Single-Cylinder Information from Multi-Cylinder Engines: Measuring EGR Uniformity with Crank-Angle Resolution using a Practical and Minimally Invasive EGR Probe," US DOE Advanced Engine (ACEC and Diesel) Crosscut Team meeting; US Council for Automotive Research (USCAR) headquarters, Detroit, Michigan and participation by phone/web; presentation via teleconference from Oak Ridge National Laboratory, January 10, 2013. ***Invited.***

75. B. Partridge et al., "Diagnostics Development and Applications for Enabling Advanced Efficiency Automotive Systems," International Society of Automation Oak Ridge Section, January Meeting, Knoxville, Tennessee, January 22, 2013. ***Invited.***

76. M. P. Ruggeri, I. Nova, E. Tronconi, J. A. Pihl, J. S. Choi, T. J. Toops, W. P. Partridge, "Role of NO Oxidation to NO_2 in SCR Reactions," Catalyst Technology Group, Corporate Research and Technology, Cummins Inc., Cummins Technical Center, Columbus, Indiana, February 8, 2013. ***Invited.***

77. B. Partridge et al., "Advanced Diagnostics for Automotive Catalysts, Exhaust Gas Recirculation and Oil Dilution," Department of Mechanical Engineering, Czech Technical University, Prague, Czech Republic, February 25, 2013. ***Invited.***

78. B. Partridge et al., "Advanced Diagnostics for Automotive Catalysts, Exhaust Gas Recirculation, and Oil Dilution," Monolith Research Group, Department of Chemical Engineering, Institute of Chemical Technology, Prague, Prague, Czech Republic, February 27, 2013. ***Invited.***

79. R. M. Connatser, W. P. Partridge, Jr., J. A. Pihl, J. E. Parks, II, "Ammonia and Oxidation State Sensing Based on Catalyst-Tipped Optical Fibers," 2013 DOE CLEERS Workshop, University of Michigan, Dearborn, Michigan, April 11, 2013.

80. W. P. Partridge, J. A. Pihl, J.-S. Choi, L. Olsson, F. Coelho, X. Auvray, N. Currier, A. Yezerets, K. Kamasamudram, "Cummins/ORNL-FEERC Emissions CRADA: NO_x Control and Measurement Technology for Heavy-Duty Diesel Engines," 2013 DOE Vehicle Technologies Program Annual Merit Review, Arlington, Virginia, May 16, 2013. http://energy.gov/sites/prod/files/2014/03/f13/ace032_partridge_2013_o.pdf.

81. W. P. Partridge et al., "Cummins/ORNL-FEERC Combustion CRADA: Characterization and Reduction of Combustion Variations," 2013 DOE Vehicle Technologies Program Annual Merit Review, Arlington, Virginia, May 16, 2013. http://energy.gov/sites/prod/files/2014/03/f13/ace077_partridge_2013_o.pdf.

82. Š. Bártová, P. Kočí, M. Marek, J. A. Pihl, J.-S. Choi, T. J. Toops, W. P. Partridge, "New Insights on N_2O Formation Pathways during Lean/Rich Cycling of a Commercial Lean NO_x Trap Catalyst," 23rd North American Catalysis Society Meeting, Louisville, Kentucky, June 5, 2013.

83. W. Partridge, J. Pihl, M.-Y. Kim, S. Daw, X. Auvray, L. Olsson, J.-S. Choi, K. Kamasamudram, A. Yezerets, N. Currier, "Understanding NH_3 Coverage Distributions based on the Common Intra-Catalyst Nature of Model and Commercial SCR Catalysts," 9th World Congress of Chemical Engineering, Seoul, Korea, August 20, 2013. ***Invited.***

84. J.-S. Choi, J. A. Pihl, T. J. Toops, W. P. Partridge, Š. Bártová, P. Kočí, M. Marek, "Factors Controlling N_2O Formation during Lean/Rich Cycling of Lean NO_x Trap Catalysts," 9th World Congress of Chemical Engineering, Seoul, Korea, August 20, 2013.

85. W. Partridge, J. Pihl, M.-Y. Kim, S. Daw, X. Auvray, L. Olsson, J.-S. Choi, K. Kamasamudram, A. Yezerets, N. Currier, "Understanding NH_3 Coverage Distributions Based on the Common Intra-Catalyst Nature of Model and Commercial SCR Catalysts," Pohang University of Science and Technology, Chemical Engineering Department (Professor In-Sik Nam, hosting), Pohang, Korea, August 26, 2013. ***Invited.***

86. W. Partridge, J. Pihl, M.-Y. Kim, S. Daw, X. Auvray, L. Olsson, J.-S. Choi, K. Kamasamudram, A. Yezerets, N. Currier, "Understanding NH_3 Coverage Distributions based on the Common Intra-Catalyst Nature of Model and Commercial SCR Catalysts," Chonnam National University, Department of Applied Chemical Engineering (Professor Gon Seo, hosting), Gwangju (Kwangju), Korea, August 27, 2013. ***Invited.***

87. B. Partridge et al., "Advanced Diagnostics for Automotive Catalysts, Exhaust Gas Recirculation, and Oil Dilution," Korea Institute of Industrial Technology, Automotive Components Center, Honam Technology Application Division (Dr. Inchul Choi, Senior Researcher, hosting), Gwangju (Kwangju), Korea, August 28, 2013. ***Invited.***

88. D. Mráček, Š. Bártová, P. Kočí, M. Marek, J.-S. Choi, J. A. Pihl, S. Daw, W. P. Partridge. "N_2O Formation During Lean NO_x Trap (LNT) Catalyst Regeneration," Southeastern Catalysis Society Meeting, Asheville, North Carolina, September 30, 2013.

89. B. Partridge et al., "Diagnostic Developments and Applications for Enabling Advanced-Efficiency Automotive Systems," Knoxville–Oak Ridge Chapter of AIChE, Knoxville, Tennessee, October 10, 2013. ***Invited.***

90. X. Auvray, W. Partridge, J.-S. Choi, J. Pihl, A. Yezerets, K. Kamasamudram, N. Currier, F. Coehlo, L. Olsson. "Modeling of NO_x SCR with NH_3 from Axial Species Distribution Measurements," CLEERS Teleconference (intra- and international attendance via teleconference), Oak Ridge National Laboratory, October 17, 2013. ***Invited.***

91. K. Thurmond, E. Duenas, S. S. Vasu, W. P. Partridge, Jr., "Development of a LED-Based Sensor for Simultaneous, Time-Resolved Measurements of CO and CO_2 from Combustion Exhausts," The Combustion Institute, Eastern States Section, Fall 2013 Technical Meeting, Clemson, South Carolina, October 14, 2013.

92. S. Y. Joshi, J. A. Pihl, W. P. Partridge, N. W. Currier, A. Kumar, K. Kamasamudram, A. Yezerets, "Modeling Spatially Resolved Concentration and NH_3 Storage Profiles During Selective Catalytic Reduction of NO_x with NH_3 Over Commercial Cu-Zeolite Catalyst," 2013 AIChE Annual Meeting, Future Automotive Catalysis Session, San Francisco, California, November 5, 2013.

93. B. Partridge et al., "Diagnostic Developments and Applications for Enabling Advanced-Efficiency Automotive Systems," Arnold Air Force Base, Arnold Engineering Development Complex, Manchester, Tennessee, November 21, 2013. ***Invited.***

94. B. Partridge et al., "Diagnostic Developments and Applications for Enabling Advanced-Efficiency Automotive Systems," Mechanical and Aerospace Engineering Department, University of Central Florida, Orlando, Florida, March 28, 2014. ***Invited.***

95. J. Yoo, D. Splitter, J. Szybist, W. Partridge, "Cycle-Resolved Intake Residual Backflow Measurement Using an Optical Probe," SAE World Congress, Diagnostic Development session, Detroit, Michigan, April 8, 2014.

96. D. Mráček, P. Kočí, M. Marek, J.-S. Choi, J. Pihl, T. Toops, W. Partridge, "Kinetics of N_2O and N_2 Peaks During and After the Regeneration of Lean NO_x Trap," 2014 DOE Crosscut Workshop on Lean Emissions Reduction Simulation, University of Michigan, Dearborn, Michigan, April 30, 2014.

97. W. P. Partridge, N. Currier, M.-Y. Kim, J. A. Pihl, R. M. Connatser, J.-S. Choi, A. Yezerets, K. Kamasamudram, "Cummins/ORNL-FEERC Combustion CRADA: NO_x Control and Measurement Technology for Heavy-Duty Diesel Engines, Self-Diagnosing SmartCatalyst Systems," 2014 DOE Vehicle Technologies Program Annual Merit Review, Washington, DC, June 19, 2014. http://energy.gov/sites/prod/files/2014/07/f17/ace032_partridge_2014_o.pdf.

98. W. P. Partridge et al., "Cummins/ORNL-FEERC Combustion CRADA: Characterization and Reduction of Combustion Variations," 2014 DOE Vehicle Technologies Program Annual Merit Review, Washington, DC, June 18, 2014. http://energy.gov/sites/prod/files/2014/07/f17/ace077_partridge_2014_o.pdf.

99. M. P. Ruggeri, I. Nova, E. Tronconi, J. A. Pihl, T. J. Toops, W. P. Partridge, "DRIFT In Situ Study of the NO Oxidation and Standard SCR Reactions on a Cu-CHA Commercial Catalyst," 8th International Conference on Environmental Catalysis (ICEC), Asheville, North Carolina, August 7, 2014.

100. P. Kočí, D. Mráček, M. Marek, J.-S. Choi, J. Pihl, T. Toops, W. Partridge, "N_2O and N_2 Formation Dynamics During and After the Regeneration of Lean NO_x Trap," 8th ICEC, Asheville, North Carolina, August 8, 2014.

101. J.-S. Choi, J. A. Pihl, M.-Y. Kim, T. J. Toops, W. P. Partridge, P. Kočí, D. Mráček, Š. Bártová, M. Marek, "Resolving N_2O Formation Dynamics During Lean/Rich Cycling of a Commercial LNT," 2015 DOE Crosscut Workshop on Lean Emissions Reduction Simulation, University of Michigan, Dearborn, Michigan, April 28, 2015.

102. B. Partridge et al., "Diagnostic Developments and Applications for Advancing Engine and Catalyst Technologies: Successes from the Cummins-ORNL Partnership," Cummins-ORNL Joint Materials Functional Excellence Conference, Oak Ridge National Laboratory, Oak Ridge, Tennessee, April 30, 2015. ***Invited.***

103. G. Jatana et al., "Development and Use of a Multiplexed Two-Color Sensor for Mapping EGR and Back-Flowing Combustion Residual in the Intake Manifold of a Heavy Duty Diesel Engine," 9th US National Combustion Meeting, Cincinnati, Ohio, May 17–20, 2015.

104. W. P. Partridge, M.-Y. Kim, J. A. Pihl, C. S. Daw, J.-S. Choi, N. Currier, A. Yezerets, K. Kamasamudram, S. Joshi, "Cummins-ORNL\FEERC Emissions CRADA: NO_x Control and Measurement Technology for Heavy-Duty Diesel Engines, Self-Diagnosing SmartCatalyst Systems," 2015 DOE Vehicle Technologies Program Annual Merit Review, Arlington, Virginia, June 11, 2015. http://energy.gov/sites/prod/files/2015/06/f23/ace032_partridge_2015_o.pdf.

105. W. P. Partridge et al., "Cummins-ORNL\FEERC Combustion CRADA: Characterization and Reduction of Combustion Variations," 2015 DOE Vehicle Technologies Program Annual Merit Review, Arlington, Virginia, June 10, 2015. http://energy.gov/sites/prod/files/2015/06/f23/ace077_partridge_2015_o.pdf.

106. P. Kočí et al., "Mechanisms and Control of N_2O Emissions During Operation of a Commercial LNT," 24th North American Catalysis Society Meeting, Pittsburgh, Pennsylvania, June 18, 2015.

107. K. Thurmond, Z. Loparo, J. Urso, B. Partridge, Jr., J. Kapat, S. Vasu, "A Robust Fire and Hazard Detection Sensor for Space Vehicles Using LEDs," Commercial and Government Responsive Access to Space Technology Exchange 2015, Chantilly, Virginia, June 23, 2015.

108. D. Mráček, P. Kočí, M. Leskovjan, A. Arvajová, J.-S. Choi, J. A. Pihl, T. J. Toops, W. P. Partridge, "Driving the NO_x reduction selectivity to N_2, N_2O, or NH_3 in a NO_x storage catalyst," CAPoC10 (10th International Congress on Catalysis and Automotive Pollution Control), Brussel, Belgium, October 28–30, 2015.

109. M. P. Ruggeri, T. Selleri, I. Nova, E. Tronconi, J. A. Pihl, T. J. Toops, W. P. Partridge, "New Mechanistic Insights in the NH_3-SCR Reactions at Low Temperature," CAPoC10, Brussels, Belgium, October 28–30, 2015.

110. K. Thurmond, J. Urso, M. Villar, W. P. Partridge, Jr., S. S. Vasu, "A Light-Emitting-Diode (LED) Non-Dispersive Absorption Sensor for Early Fire and Hazardous Gases Detection," 2016 Spring Technical Meeting of the Eastern States Section of the Combustion Institute, Princeton, New Jersey, March 14, 2016.

111. G. Jatana, A. Perfetto, S. Geckler, W. Partridge, "Development of an Absorption Spectroscopy Sensor for High-Speed Oxygen Concentration Measurements in the Exhaust of I. C. Engines," 2016 Spring Technical Meeting of the Central States Section of the Combustion Institute, Knoxville, Tennessee, May 15–17, 2016.

112. W. P. Partridge, M. Salazar, J. A. Pihl, N. Currier, S. Joshi, A. Yezerets, K. Kamasamudram, "Cummins-ORNL\FEERC Emissions CRADA: NO_x Control and Measurement Technology for

Heavy-Duty Diesel Engines, Self-Diagnosing SmartCatalyst Systems," 2016 DOE Vehicle Technologies Program Annual Merit Review, Washington, DC, June 9, 2016. http://energy.gov/sites/prod/files/2016/06/f32/ace032_partridge_2016_o.pdf.

113. W. P. Partridge, G. Jatana, S. Geckler, A. Perfetto, "Cummins-ORNL Combustion CRADA: Characterization and Reduction of Combustion Variations," 2016 DOE Vehicle Technologies Program Annual Merit Review, Washington, DC, June 7, 2016. http://energy.gov/sites/prod/files/2016/06/f32/ace032_partridge_2016_o.pdf.
114. M. Villar, J. Urso, K. Thurmond, A. Parupalli, S. Vasu, J. Kapat, B. Partridge, Jr., "Progress in Development and Testing of a LED-Based Fire and Hazard Detection Sensor for Space Vehicles," Commercial and Government Responsive Access to Space Technology Exchange 2016, Westminster, Colorado, July 21, 2016.
115. W. P. Partridge, J. A. Pihl, N. Currier, S. Joshi, A. Yezerets, K. Kamasamudram, "Cummins-ORNL\FEERC Emissions CRADA: NO_x Control and Measurement Technology for Heavy-Duty Diesel Engines," 2017 DOE Vehicle Technologies Program Annual Merit Review, Washington, DC, June 8, 2017. https://energy.gov/sites/prod/files/2017/06/f34/acs032_partridge_2017_o.pdf.
116. Z. E. Loparo, J. G. Lopez, S. Neupane, K. Vodopyanov, W. P. Partridge, S. S. Vasu, "Time-Resolved Measurements of Intermediate Concentrations In Fuel-Rich *n*-Heptane Oxidation Behind Reflected Shock Waves," ASME 2017 Turbo Expo, Charlotte, North Carolina, June 26–30, 2017.
117. W. Partridge, "Resolving Transient Reaction Distributions within Honeycomb-Monolith Catalysts via SpaciMS and Spaci-like Methods," MODEGAT (Modeling of Exhaust-Gas After-Treatment) V, Bad Herrenalb, Germany, September 5, 2017. ***Invited tutorial.***
118. W. Partridge, "Resolving Transient Reaction Distributions within Honeycomb-Monolith Catalysts via SpaciMS and Spaci-like Methods," Umicore AG & Co. KG, Hanau-Wolfgang, Germany, September 8, 2017. ***Invited.***
119. W. P. Partridge, J. A. Pihl, S. Joshi, N. Currier, A. Yezerets, K. Kamasamudram, "A New Operando Method for Studying NH3-SCR Redox-Cycle Kinetics of Cu-Zeolite Catalysts via Spatiotemporally Resolved Measurements," 2017 CLEERS Workshop, Ann Arbor, Michigan, October 4, 2017.
120. W. P. Partridge, J. A. Pihl, S. Joshi, N. Currier, A. Yezerets, K. Kamasamudram, "Using SCR Transients to Improve Catalyst Models and Performance," DOE Advanced Engine Crosscut Team, Southfield, Michigan, May 10, 2018.
121. W. P. Partridge, J. A. Pihl, S. Joshi, N. Currier, A. Yezerets, K. Kamasamudram, "NO_x Control and Measurement Technology for Heavy-Duty Diesel Engines," 2018 DOE Vehicle Technologies Program Annual Merit Review, Washington, DC, June 20, 2018. https://www.energy.gov/sites/prod/files/2018/06/f52/acs032_partridge_2018_o.pdf.
122. W. P. Partridge, S. Joshi, J. A. Pihl, N. Currier, K. Kamasamudram, A. Yezerets, "Using Transient Response to Study Half-Cycle Rates of the NO SCR Cu-Redox Cycle," University of Houston, Department of Chemical and Biomolecular Engineering, Houston, Texas, October 19, 2018. ***Invited.***
123. W. P. Partridge, J. A. Pihl, S. Joshi, N. Currier, A. Yezerets, K. Kamasamudram, "NO_x Control and Measurement Technology for Heavy-Duty Diesel Engines," 2019 DOE Vehicle Technologies Program Annual Merit Review, Arlington, Virginia, June 12, 2019. https://www.energy.gov/sites/prod/files/2019/06/f63/ace032_partridge_2019_o_4.23_9.37am_0.pdf.
124. S. Curran, B. Partridge, J. Storey, M. DeBusk, M. Wissink, R. Wagner, "Next-Generation Heavy-Duty Powertrains," 2019 DOE Vehicle Technologies Program Annual Merit Review, Arlington, Virginia, June 13, 2019. https://www.energy.gov/sites/prod/files/2019/06/f63/ace133_curran_2019_o_4.26_6.21pm.pdf.

125. W. P. Partridge, S. Joshi, J. A. Pihl, N. Currier, K. Kamasamudram, A. Yezerets, "Using Transient Response to Study Half-Cycle Rates of the NO SCR Cu-Redox Cycle," Queen's University Belfast, School of Chemistry and Chemical Engineering, Belfast, Northern Ireland, May 29, 2019. ***Invited.***

126. W. P. Partridge, S. Joshi, J. A. Pihl, N. Currier, K. Kamasamudram, A. Yezerets, "Using Transient Response to Study Half-Cycle Rates of the NO SCR Cu-Redox Cycle," 26th North American Catalysis Society Meeting, Chicago, Illinois, June 23–28, 2019.

127. W. P. Partridge, S. Joshi, J. A. Pihl, N. Currier, K. Kamasamudram, A. Yezerets, "Using Transient Response to Study Half-Cycle Rates of the NO SCR Cu-Redox Cycle," Cummins Post-NAM Symposium, Columbus, Indiana, June 29, 2019. ***Invited.***

128. B. Partridge, "Diagnostics Development and Application for Advancing Engine Catalyst System Technology," ORNL Tech Day, Cummins Technical Center, Columbus, Indiana, August 7, 2019. ***Invited.***

129. B. Partridge, G. Jatana, J. Yoo, A. Ramesh, D. Koeberlein, S. Geckler, T. Lutz, "Spatiotemporal Intake and Exhaust Mapping to Assess Combustion Uniformity, Engine Design, and Control," Advanced Engine Combustion Program Review Meeting, USCAR, Southfield, Michigan, August 14, 2019.

130. W. P. Partridge et al., "NO_x Control and Measurement Technology for Heavy-Duty Diesel Engines," 2020 DOE Vehicle Technologies Program Annual Merit Review, virtual meeting because of coronavirus disease of 2019 (COVID-19), June 3, 2020. https://www.energy.gov/sites/default/files/2020/05/f75/ace032_Partridge_2020_o_4.27.20_530PM_JL.pdf.

131. S. Joshi, R. Dadi, R. Daya, D. Trandal, M. Cunningham, Y. Tang, A. Kumar, W. P. Partridge, "Global Kinetic Model for Reduction Half Cycle (RHC) of the NH_3 SCR Redox Cycle," 2020 CLEERS Workshop, virtual meeting because of COVID-19, Ann Arbor, Michigan, September 16, 2020.

132. W. P. Partridge et al., "NO_x Control and Measurement Technology for Heavy-Duty Diesel Engines," 2021 DOE Vehicle Technologies Program Annual Merit Review, virtual meeting because of COVID-19, June 23, 2021. https://www.energy.gov/sites/default/files/2021-06/ace032_partridge_2021_o_5-14_851pm_KF_TM%5B1%5D.pdf.

133. S. Curran, B. Partridge, T. Lutz, M. Wissink, M. DeBusk (including for CRADA S. Neupane, G. Jatana, S. Popuri), "Next-Generation Heavy-Duty Powertrains (including the ORNL-Cummins Combustion CRADA)," 2021 DOE Vehicle Technologies Program Annual Merit Review, virtual meeting because of COVID-19, June 24, 2021. https://www.energy.gov/sites/default/files/2021-06/ace133_curran_2021_o_5-14_734pm_KS_TM.pdf.

134. D. Jyoti Deka, W. Partridge, "Spatiotemporal Distribution of Reactant and Product Species in a Commercial Natural Gas-TWC Under Lean-Rich Dithering," University of Houston Four-way Catalyst Project Review, July 21, 2021.

135. W. P. Partridge et al., "Impact of Field Aging on a Commercial Cu-SSZ-13 SCR Catalyst," 21st Century Truck Partnership, IC (Internal Combustion) Powertrains Meeting, virtual meeting because of COVID-19, July 22, 2021. ***Invited.***

136. D. Deka, S. Joshi, R. Daya, K. Kamasumadram, W. Partridge, "Impact of Field Aging on the Redox Half Cycles of NH_3-Selective Catalytic Reduction of NO_x over Commercial Cu-SSZ-13 Monolith Catalysts," American Chemical Society (ACS) Fall 2021 Meeting, Atlanta, Georgia and virtual meeting because of COVID-19, August 22–26, 2021.

137. R. Daya, S. Y. Joshi, D. Trandal, A. Kumar, R. K. Dadi, U. Menon, D. J. Deka, W. P. Partridge, A. Yezerets, "Kinetic Model for NH_3 Solvation, Reduction, and Reoxidation of Active Copper Sites in Cu-SSZ-13," CLEERS Workshop, virtual meeting because of COVID-19, September 13–17, 2021.

138. D. J. Deka, S. Joshi, R. Daya, A. Ladshaw, K. Kamasamudram, W. Partridge, "Impact of Field Aging on the Redox Half Cycles of NH_3-Selective Catalytic NO_x Reduction Over a Commercial Cu-SSZ-13 Monolith Catalyst," CLEERS Workshop, virtual meeting because of COVID-19, September 13–17, 2021.

139. D. Deka, S. Joshi, R. Daya, A. Ladshaw K. Kamasumadram, W. Partridge, "Impact of Field Aging on the Redox Half Cycles of NH_3-Selective Catalytic Reduction of NO_x Over Commercial Cu-SSZ-13 Monolith Catalysts," AIChE 2021 Annual Meeting, Boston, Massachusetts and virtual meeting because of COVID-19, November 16, 2021.

140. W. P. Partridge, D. J. Deka, R. Daya, A. Ladshaw, S. Joshi, K. Kamasamudram, "Field Aging Impact on NH_3 SCR Cu Redox Half Cycles Over a Commercial Cu SSZ 13 Catalyst," ACS Spring 2022 meeting, San Diego, California and virtual meeting because of COVID-19, March 24, 2022.

141. D. J. Deka, R. Daya, A. Ladshaw, S. Joshi, K. Kamasamudram, W. P. Partridge, "Field Aging Impact on NH_3 SCR Cu-Redox Half Cycles Over a Commercial Cu-SSZ-13 Catalyst," ORNL-PoliMi Tech Meeting, May 11, 2022.

142. D. J. Deka, R. Daya, A. Ladshaw, S. Joshi, K. Kamasamudram, W. P. Partridge, "Field Aging Impact on the NH_3 Selective Catalytic NO_x Reduction Redox Half Cycles Over a Commercial Cu-SSZ-13 Catalyst," 27th North American Catalysis Society Meeting (NAM27), New York, New York, May 22–27, 2022.

143. R. Daya, D. J. Deka, D. S. Trandal, U. Menon, S. Y. Joshi, W. P. Partridge, "A Unified Reaction Mechanism for the Redox of Active Cu Sites in Cu-SSZ-13 Under SCR and Oxidation Conditions," 27th North American Catalysis Society Meeting, New York, New York, May 22–27, 2022.

144. R. Daya, D. J. Deka, D. Trandal, U. Menon, H. An, W. P. Partridge, S. Y. Joshi, "New Insights on SCR Functions from Transient Response Cu Redox (TRCR) Protocols," Cummins Technical Center, Columbus, Indiana, June 22, 2022.

145. R. Daya, D. J. Deka, D. Trandal, U. Menon, W. P. Partridge, S. Y. Joshi, "A Unified Reaction Mechanism for the Redox of Active Cu Sites in Cu SSZ 13 Under SCR and Oxidation Conditions," ORNL Applied Catalysis and Emissions Research Group-Brownbag Presentation, Columbus, Indiana, August 4, 2022.