



Curriculum Vita
Robert J. Farrauto, Ph.D.
Professor of Professional Practice (2012-present)
Earth and Environmental Engineering
Columbia University in the City of New York
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Personal

Birth Date: November 22, 1941 /New York City

Gender: Male

Citizenship: United States of America

Status: Married with two children/six grandchildren, two step-daughters

Education

Ph.D. Chemistry, 1968, Rensselaer Polytechnic Institute, Troy, New York

Advisor: David Aikens

B.S. Chemistry, 1964, Manhattan College, Bronx, New York

Current Employment Experience

September 2012- Present: Professor of Professional Practice, Columbia University,
Earth and Environmental Engineering Department, Columbia University in the City of New
York, 10027 USA

Currently supervising three PhD, four master's degree students and three undergraduates

engaged in catalysis research in air pollution control, hydrogen generation, carbon dioxide capture and catalytic conversion to synthetic natural gas.

I Currently teach two graduate (1, 2) course and three undergraduate courses (3,4,5)

- 1) “Catalysis for Emission Control” (1 semester- graduate)
- 2) “Industrial Catalysis” (1 semester- graduate))
- 3) “Environmental Control Pollution Reduction” (1 semester-Under graduate ABET)
- 4) “Senior Design (Capstone)” (2 semesters- Under graduate ABET)
- 5) Teaching lab (2 semesters-Under graduate ABET)

Industrial

2008-retired August 2012:

Research Vice President, BASF Catalysts (formerly Engelhard).

25 Middlesex-Essex Turnpike, Iselin, New Jersey 08830

Managed a team developing catalysts and adsorbents for the Hydrogen Economy

2005-2008:

Research Fellow/Manager of Hydrogen and Fuel Cell Technology, BASF (formerly Engelhard)

Managed a team of scientists and engineers developing catalysts for hydrocarbon fuel processing for the generation of hydrogen and fuel cells. Team commercialized 25 new products for world wide markets.

1990-1995:

Principle Scientist of Manager of Diesel Technology, Engelhard (now BASF)

Principle Investigator of a team of 20 scientists and engineers in the development and commercialization of the first monolith-diesel oxidation catalyst for heavy duty trucks, buses and light duty vehicles for the US, Asian and European market. Total revenues have exceeded \$600 million. Developed new nitric oxide catalysts and hydrocarbon traps for automobile catalytic converters

1976-1990:

Manager of Chemical and Environmental Catalysts, Engelhard (now BASF)

Managed a team of scientists and engineers developing advanced three-way catalysts for abating emissions from passenger car vehicles serving the US, Asian and European market. Managed a team in the development of improved chemical catalysts for the production of nitric acid. Supervised a research team developing and commercializing new precious metal catalysts for the hydrogenation of a wide variety of organic functional groups. Was responsible for establishing a materials characterization group serving the entire worldwide company needs for catalyst and materials product.

1974-1976

Research Scientist, Gulf Oil, Harmorville, PA

Catalyst development in upgrading petroleum and coal liquids to useful fuels and chemicals.

1968-1974

Research Scientist: Corning Glass Works, Corning New York
Catalyst development for base metal emission control catalysts

Awards: Google Scholar 50 (May 2021)

- 2019 National Academy of Inventors (election)
- 2016 Distinguished Faculty Teaching Award, Columbia University in the City of New York
- 2008 Ciapetta Lectureship Award sponsored by the North /American Catalysis Society
- 2005 Catalysis and Reaction Engineering Practice Award from the American Institute of Chemical Engineers
- 2001 International Precious Metal Institute (IPMI) Award for Outstanding Contributions in the field of precious metal catalysis
- 1998 Cross Canada Lectureship Award sponsored by the Canadian Catalysis Society
- 1995 Teaching Excellence Award from the New Jersey Institute of Technology

Society Memberships

- North and South American Editor of Applied Catalysis B: Environmental 1995-2002
- Program Chairman for the 19th North American Catalysis Society Meeting, Philadelphia, PA 2005
- American Institute of Chemical Engineers (AIChE)
- American Chemical Society (ACS)
- International Precious Metal Institute

Plenary Lectures and Keynote lectures from 2006-Present

- Keynote lecturer, November 2016 at the International Chemical Engineering Conference in Quebec City, Canada. “Dual function materials for CO₂ capture and conversion” and Niobium oxide promoted Co oxidation catalysts for pollution abatement”
- Keynote lecturer, International Conference on Catalysis, Munich, Germany, July 2012 “Cleaning Automotive Emissions.”
- Keynote lecturer, The International Conference on Ceria, Udine, Italy 2012, “Ceria: the first base metal oxide catalyst for diesel emission control”
- XX Reaction Engineering December 2012 “New Catalysts and Reactor designs for the Hydrogen Economy”, Luxembourg
- Mitsui Keynote lecture ship Award, March 2009: “Automobile Catalysis: Past, Present and Future”. Tokyo, Japan
- Idemat, Porguellos, France “The Road to the Hydrogen Economy,” May 2007

- Natural Gas Conversion Conference, Natal, “The Convergence of Fundamental and Applied Catalysis in Solving Industrial Problems.” May 2007
- Mittasch Conference, BASF Ludwigshafen, Germany, “Advances in Environmental and Petroleum Catalysis by Engelhard” November 2006
- 13th Nordic Conference on Catalysis, Goteborg, Sweden “New Catalysts for the Hydrogen Economy” October 2008
- 50th Anniversary of the Japanese Catalysis Society “From the Internal Combustion engine to the engine of the future: The Fuel Cell” November 2008

Books authored

Heck, Ronald and Farrauto, Robert J. “*Catalytic Air Pollution Control: Commercial Technology*” Third edition, Wiley and Sons, New York, NY, NJ 2009. Two precious editions.

Bartholomew, Calvin. and Farrauto, Robert J. “*Fundamentals of Industrial Catalytic Processes*” Second edition, Wiley and Sons, New York, NY, 2006

Farrauto, Robert J., Dorazio, L. and Bartholomew, C., “*Introduction to Catalysis and Industrial Catalytic Processes*” Wiley and Sons, New York, NY, 2016

US Patents: Commercialized Technology

US 5,462,907, “CeO₂ containing diesel oxidation catalyst”, **R.J. Farrauto**, K. Voss and R.M. Heck. Commercial product for Cummins Engine Company and others with approximate revenues 10’s of millions of US dollars. This was the first diesel oxidation catalyst with no precious metal commercialized.

US 5,627,124, “Ceria-alumina catalyst,” **Farrauto, R.** K. Voss and R.M. Heck.
See US 5,462,907 (above)

US 5,491,120, “Oxidation catalyst with bulk ceria, a second metal oxide, and platinum,” K. Voss, B. Yavuz, **R. Farrauto** and M. Galligan. Commercial product for Volkswagen with approximate revenues 10’s of millions of US dollars.

US 6,274, 107, “Zeolite containing oxidation catalyst and method of use,” B. Yavuz, K. Voss, M. Deeba, J. Adomaitis, **R.J. Farrauto**, See US 5,491,120

US 6, 248, 684, “Zeolite containing oxidation catalysts and method of use,” B. Yavuz, K. Voss, M. Deeba, J. Adomaitis, **R. Farrauto**, Commercial product see US 5,491,120

US 5,108,730, "Room temperature lite off catalyst," H.C. Lee, **R.J. Farrauto**, and W.R. Hatfield. Commercial product but revenues unknown

US 4,863,893, "Low temperature lite off catalyst," **R.J. Farrauto**, H.C. Lee and W.R. Hatfield. Commercial product but revenues unknown

US 5,756,053, "System and method for abatement of food cooking," J. Hoke, M. Larkin, R. J. **Farrauto**, K. Voss, R. Whitely and L.M. Quick. Commercial product for fast food restaurants. Revenues unknown

US 5,580,535, "System and method for abatement of food cooking fumes," J. Hoke, M. Larkin, **R.J. Farrauto**, K. Voss, R. Whitely, and L.M. Quick. Commercial product but revenues unknown

44. US 6,849,572, "Process for generating hydrogen-rich gas," S. Hwang and **R. Farrauto**. Revenues unknown.

US 8,444,402, "Preferential oxidation catalyst with Pt, Cu and Fe," Shore, L. and **Farrauto R.J.** Revenues unknown

55 US Patents (from 1972-Present); Complete

1. US 3,743,525 "Hydraulic cements from glass powders", R.J. Farrauto and W.L. Haynes.
2. US 3,720,527 "Fast setting hydraulic cements from glass powders," R.J. Farrauto and W.L. Haynes.
3. US 3,870,658 "Copper chromite / alumina catalyst having high temperature stability," R.J. Farrauto, K. Hoekstra, and R.D. Shoup.
4. US 4,416,916, "Thin film solar energy collector," K. Aykan, R.J. Farrauto, R. Lanam and C. Jefferson.
5. US 4,321,300, "Solar energy collector," R.J. Farrauto, C.F. Jefferson and R.D. Lanam.
6. European Patent 0161743, "Nitric oxide abatement catalyst," R.M. Heck, C.D. Keith and R.J. Farrauto.
7. US 4,863,893, "Low temperature lite off catalyst," R.J. Farrauto, H.C. Lee and W.R. Hatfield. Commercial product but revenues unknown
8. US 5,108,730, "Room temperature lite off catalyst," H.C. Lee, R.J. Farrauto, and W.R. Hatfield. Commercial see 7.

9. US 4,893,465, "Process conditions for operation of the ignition catalyst for natural gas combustion," R.J. Farrauto, T. Kennelly, M.C. Hobson and E. Waterman.
10. US 5,214,912, "Process conditions for operation of ignition catalyst for natural gas combustion," R.J. Farrauto, T. Kennelly, E. Waterman and M.C. Hobson.
11. US 5,126,300, "Praseodymium-Palladium binary oxide catalyst, methods of combustion and regeneration," T. Chou, t. Kennelly and R.J. Farrauto.
12. US 5,102,639, "Praseodymium-Palladium binary oxide catalyst compositions containing the same and methods of use," T. Chou, T. Kennelly and R.J. Farrauto.
13. US 5,196,617, "Direct catalytic hydro-dechlorination of toxic organics in wastewater," S. Kovenklioglu, E. Balko, J. Hoke, R.J. Farrauto and G. Gramiccioni.
14. US 5,216,875, "Catalysts for combustion of natural gas," T. Kennelly and R.J. Farrauto.
15. US 5,378,142, "Combustion process using catalysts containing binary oxides," T. Kennelly, R.J. Farrauto, T. Chou, and J. Hochmuth.
16. US 5,474,441, "Catalyst configuration for catalytic combustion," R.J. Farrauto, J. Feeley, D. Simone, Y.K. Lui and T. Kennelly.
17. US 5,462,907, "CeO₂ containing diesel oxidation catalyst," R.J. Farrauto, K. Voss and R.M. Heck. Commercial product for Cummins Engine Company with approximate revenues 10's of millions of US dollars
18. US 5,491,120, "Oxidation catalyst with bulk ceria, a second metal oxide, and platinum," K. Voss, B. Yavuz, R.J. Farrauto and M. Galligan. Commercial product for Volkswagen with approximate revenues 10's of millions of US dollars
19. US 5,552,360, "Substrate configuration for catalytic combustion systems," R.J. Farrauto.
20. US 5,580,535, "System and method for abatement of food cooking fumes," J. Hoke, M. Larkin, R.J. Farrauto, K. Voss, R. Whitely, and L.M. Quick. Commercial product but revenues unknown
21. US 5,627,124, "Ceria-alumina catalyst," R.J. Farrauto, K. Voss and R.M. Heck. See 17.
22. US 5,750,458, "Combustion catalysts containing binary oxides," T. Chou, T. Kennelly and R.J. Farrauto.
23. US 5,756,053, "System and method for abatement of food cooking," J. Hoke, M. Larkin, R.J. Farrauto, K. Voss, R. Whitely and L.M. Quick. Commercial product for fast food restaurants. See 20.

24. US 5,776,423, "Trimetallic zeolite catalyst for NO abatement," J. Feeley, R.J. Farrauto, M. Deeba and J. Lampert.
25. US 5,792,436, "Method for using a regenerable catalyst trap," J. Feeley, R.J. Farrauto, M. Deeba and J. Lampert.
26. US 5,804,155, "Basic zeolites / HC traps," M. Deeba and R.J. Farrauto.
27. US 5,863,851, "Combustion catalysts containing binary oxides and processes using the same," T. Kennelly, T. Chou, and R.J. Farrauto.
28. US 5,874,057, "Lean NO_x catalyst/trap method," M. Deeba, J. Feeley and R.J. Farrauto.
29. US 5,968,861, "Trimetallic zeolite catalyst and method of NO_x abatement using the same," J. Feeley, M. Deeba and R.J. Farrauto.
30. US 6,074,973, "Catalyzed hydrocarbon trap material and method," J. Lampert, M. Deeba and R.J. Farrauto.
31. US 6,080,377, "Method of abating NO_x and a catalytic material," M. Deeba, J. Feeley and R.J. Farrauto
32. US 6,150,291, "Method of abating NO_x and preparation of catalytic materials," J. Feely, M. Deeba and R. Farrauto
33. US 6,153,160, "Catalytic oxidation method", K. Voss, B. Yavuz, R. Farrauto, M. Galligan. Commercial product for Volkswagen. See 18.
34. US 6,248,684, Zeolite containing oxidation catalysts and method of use," B. Yavuz, K. Voss, M. Deeba, J. Adomaitis, R. Farrauto Commercial product see 33.
35. US 6,255,249, "Oxidation catalyst and method of use," K. Voss, B. Yavuz, R. Farrauto and M. Galligan. See 33
35. US 6,274,107, "Zeolite containing oxidation catalyst and method of use", B. Yavuz, K. Voss, M. Deeba, J. Adomaitis, R. Farrauto, See 33.
36. US 6,319,484, "Composition for abatement of VOC and apparatus and methods of the same," L. Shore, R. J. Farrauto, M. Deeba, J. Lampert and R. Heck

37. US 6,428,761, "Process for reduction of gaseous sulfur compounds," Larry Shore and R. J. Farrauto
38. US 6,436,363, "Process for generating a hydrogen rich gas," Shinn Hwang and Robert J. Farrauto
39. US 6,559,094, "Method for preparation of catalytic materials for selective oxidation and catalyst members thereof," Olga Korotkikh, Robert J. Farrauto and Andrew McFarland.
40. US 6,471,924, "Method and Apparatus for NO_x abatement in lean gaseous streams," J. Feeley, R. Farrauto and M. Deeba
41. US 6,541,419, "Process for reduction of gaseous sulfur compounds," Larry Shore and R. J. Farrauto
42. US 6,562,315, "Suppression of methanation in a WGS catalyst," Korotkikh, O., Ruettinger, W. and Farrauto, R. J.
43. US 6,790,432, "Suppression of methanation activity of Platinum group metal water gas shift catalyst," Ruettinger, W. and Farrauto, R. J.
44. US 6,849,572, "Process for generating hydrogen-rich gas," S. Hwang and R. Farrauto
45. US 6,903,050, "Method of preparation of non-pyrophoric copper alumina catalysts," O. Ilinich W. Ruettinger and R. J. Farrauto
46. US 6,913,739, "Platinum group metal promoted copper oxidation catalyst and methods for carbon monoxide remediation," L. Shore, W. Ruettinger, and R Farrauto
47. US 6,977,067 (2005), "Selective Removal of olefins from hydrocarbons feed streams," Shin Hwang and Robert J. Farrauto
48. US 7,074,375 (2006), "Method of desulfurizing a hydrocarbon gas by selective partial oxidation and adsorption" Lampert, J., Hwang, S., Shore, L. and Farrauto, R.
49. US 7,357,911 "Process conditions for Pt-Re bimetallic for water gas shift catalysts," Ruettinger, W. and Farrauto, R. J.
50. US 7,569,511 (2009) "Catalyst Composition for Alcohol Steam Reforming," Castelano, C., Keromer, G. Liu, Y and Farrauto, R.J.
51. US 8,221,693, "Use of radial flow air injection for preferential oxidation for fuel cells applications," Larry Shore and Robert J. Farrauto.
52. US 7,901,565, "Reforming a Sulfur-containing-hydrocarbon using a sulfur tolerant catalyst," Giroux, T., Waterman, E. and Farrauto, R.J

53. US 8,444,402, "Preferential oxidation catalyst with Pt, Cu and Fe," Shore, L. and Farrauto R.J.

54. US 8,926,942, "Method and system for generating hydrogen and separation from CO₂," Castaldi, M. Yegulalp, T and Farrauto, R. J

**Complete List of Journal Publications (from 1973 to Present):
Citation Index Google Scholar = 50**

1. R.J. Farrauto and W.L. Haynes, "Cements from glass powders", Amer. Cer. Soc. (Bull) **52** (3), 276 (1973).
2. W. Morgan and R.J. Farrauto, "Active sites on a copper chromite catalyst", J. Catal. **31**, 140, (1973).
3. W. Hertl and R.J. Farrauto, "Mechanism of carbon monoxide and hydrocarbon oxidation on a copper chromite catalyst", J. Catal. **29**, 352 (1973).
4. R.J. Farrauto and B. Wedding, "Poisoning by SO_x of some base metal oxide auto exhaust catalysts", J. Catal. **33**, 249 (1973).
5. B. Wedding and R.J. Farrauto, "Rapid evaluation of automotive exhaust oxidation catalysts with a differential scanning calorimeter", Ind. Eng. Chem. **13**, 45 (1974).
6. R.J. Farrauto, "Determination and application of catalytic surface area measurements," AIChE J. **70**, 9 (1974).
7. R.J. Farrauto, "Measuring catalytic surface area", Chem. Eng. Progr. **71**(1), 37 (1975).
8. R.D. Shoup, K. Hoekstra and R.J. Farrauto, "Thermal stability of a copper chromite auto-exhaust catalyst", Amer, Cer. Soc. (Bull) **54**(6), 576 (1975).
9. R.J. Farrauto, "Adsorption studies on a nickel alumina methanation catalyst", J. Catal. **41**, 482 (1976).
10. C. Bartholomew and R.J. Farrauto, "Chemistry of nickel-alumina catalysts", J. Catal. **45**, 41 (1976).
11. J. Patzer, R.J. Farrauto, and A. Montagna, "Characterization of coal liquefaction catalysts using 1-methyl naphthalene as a model compound", Ind. Eng. Chem. Proc. Des. Dev. **18**, 625 (1979).
12. R. St. Amand, J. Williams and R.J. Farrauto, "Application of metallorganic deposition for solar energy collectors", American Optical Society (AOS) Proc., 2nd Ann. Conf. Sept. (1979).

13. R.D. Lanam and R.J. Farrauto, "Solar absorber coatings", Solar Energy Research (SERI) Proc., 2nd Ann. Conf. 1981.
14. R.J. Farrauto and M.H. Hobson, "Catalyst characterization", Encyclopedia of Physical Science and Technology, Academic Press, **2**, 563 (1987).
15. R.J. Farrauto, M.H. Hobson and N. Brungard, "Relationship between catalyst characterization and performance", Catalysis of Organic Reactions, Marcel Dekker, **33**, 177 (1988).
16. R.J. Farrauto, R. McClung and A.B. Stotler, "Precious metals in the petrochemical industry", Proc. 12th Intern. Prec. Metals Inst., 1988, pp.13.
17. J.C. Bonacci, R.J. Farrauto, and R.M. Heck, "Catalytic incineration of hazardous wastes", Library for Environ. Sci., Gulf Publishing **1**(4), 130 (1988).
18. C.H. Lee and R.J. Farrauto, "Catalyst deactivation due to transient behavior in nitric acid production", Ind. Eng. Chem. Res. **28**, 1 (1989).
19. R.J. Farrauto and H.C. Lee, "Ammonia oxidation catalyst with enhanced activity", Ind. Eng. Chem. Res. **29**(7), 1125 (1990).
20. D.O. Simone, T. Kennelly, N. Brungard, and R.J. Farrauto, "Reversible poisoning of palladium catalysts for combustion of methane", Appl. Catal. **70**, 87, (1987).
21. R.J. Farrauto, t. Kennelly, E. Waterman and M.H. Hobson, "The catalytic chemistry of supported palladium for combustion of methane", Appl. Catal. **81**(2), 227 (1992).
22. J. Chen, R.M. Heck and R.J. Farrauto, "Deactivation, regeneration and poison resistant commercial catalysts", Catal. Today **11**, 517-545 (1992).
23. R.J. Farrauto and J.J. Mooney, "Reducing truck diesel emissions", Automotive Eng. **100** (2) 19 (1992).
24. R.J. Farrauto and J.J. Mooney, "Effects of sulfur on catalytic diesel oxidation Performance", SAE. 920557, Feb. (1992).
25. R.M. Heck, R.J. Farrauto and H.C. Lee, "Ozone abatement in commercial aircraft", Catal. Today, **13**, 43-58 (1992).
26. S. Kovenklioglu, Z. Coa, D. Shah, R.J. Farrauto and E. Balko, "Direct hydro-dechlorination of toxic organics in waste water", AIChE J. **38**(7), 1003 (1992).

27. T. Yu, H. Shaw and R.J. Farrauto, "Catalytic oxidation of trichloroethylene over PdO catalyst on gamma-alumina", Am. Chem. Soc. Symp. Ser. 495, Catalytic Control of Air Pollution, chap. 11, (1992).
28. Y. Wang, H. Shaw and R.J. Farrauto, "Catalytic oxidation of trace concentrations of trichloroethylene over 1.5% Pt on gamma-alumina", Am. Chem. Soc. Symp. Ser. 495, Catalytic Control of Air Pollution, chap 10 (1992).
29. R.J. Farrauto and R.M. Heck, "Precious metals in industry", Encyclopedia of Chemical Processing and Design, 1992.
30. R.J. Farrauto, R.M. Heck and B.K. Speronello, "Catalysts and the environment", Chem. Eng. News, Sept. 7, 1992, p. 34.
31. R.J. Farrauto, K.E. Voss and R.M. Heck, "A base metal oxide catalyst for reduction of diesel particulates", SAE 932720, Oct. 1992.
32. K.E. Voss, B. Yavuz, C. Hirt, and R.J. Farrauto, "Performance characteristics of a novel diesel oxidation catalyst, SAE. 940239, Feb. 1994.
33. K.E. Voss, J. Lampert, R.J. Farrauto, G. Rice, and A. Punke, "Catalytic oxidation of diesel particulates with base metal oxides", Catalysts for Air Pollution control 3 (CAPOC3), April 1994.
34. R.J. Farrauto and R.M. Heck, "Precious metals use in environmental catalysis", Intern. Precious. Metals Inst., June 1993.
35. R.M. Heck and R.J. Farrauto, "Catalytic Air Pollution control: Commercial Technology," Wiley and Sons, (1st edition, New York, 1994).
36. R.J. Farrauto, M. Larkin, J. Fu and J. Feeley, "Catalytic combustion for ultra-low emissions," Mat. Res. Soc. Symp. Proc. **344**, 101 (1994).
37. V. Bell, J., Feeley, M. Deeba and R.J. Farrauto, "In-situ high temperature studies of NO_x reduction with propylene over Cu/ZSM-5 catalysts", Catal. Lett. **29**, 15 (1994).
38. M. Deeba, R.J. Farrauto and Y.K. Lui, "Stabilization of Pt on SiO₂ promoted with lanthanum oxide and zirconium oxide", Appl. Catal. A, Gen.: **124**, 339 (1995).
39. J. Feeley, M. Deeba, R.J. Farrauto, G. Beri, and A. Haynes, "Lean NO_x reduction with hydrocarbons over Ga/S-ZrO_x and S-GaZr/Zeolite catalyst", Appl. Catal. B, Environ., **6**, 79 (1995).
40. R.J. Farrauto, J. Lampert, M. Hobson, and E. Waterman, "Thermal decomposition and reformation of Pd catalysts, support effects", Appl. Catal. B, Environ., **6**, 263 (1995).

41. J. Feeley, M. Deeba and R.J. Farrauto, "Abatement of NO_x from diesel engines: Status and technical challenges", SAE 950747 (1995).
42. M. Deeba, J. Feeley, R.J. Farrauto, N. Steinbock and A. Punke, "Catalytic abatement of NO_x from diesel engines: Development of four-way catalysts", SAE. 952491 (1995).
43. R.M. Heck and R.J. Farrauto, "Automotive emission control: Present and future Challenges", Autom. Eng. Feb. 1996.
44. R.J. Farrauto and K. Voss, "Monolithic diesel oxidation catalyst", Appl. Catal. B, Environ. **10**, 29 (1996).
45. M. Amiridis, T. Hang and R.J. Farrauto, "A review of the selective catalytic reduction of nitric oxide by hydrocarbons", Appl. Catal. B, Environ., **10**, 203 (1996).
46. R.J. Farrauto, "New applications in monolithic supported catalysts", React. Kin. Catal. Lett. **60**(2),233 (1997).
47. R.M. Heck and R.J. Farrauto, "The automobile catalyst", Cat. Tech. **1**, 117 (1997).
48. J. Lampert, S. Kazi and R.J. Farrauto, "Pd catalyst performance for methane emissions abatement from lean burn natural gas engines", Appl. Catal. B, Environ., **14**, 211-223 (1997).
49. R.M. Heck, R.J. Farrauto and M. Durilla, "Employing metal catalysts for VOC Emission control" Pollution Engineering **30**, Apr. 52 (1998).
50. R.M. Heck and R.J. Farrauto, "Catalysis: Role of mass transfer and adsorption", Chemical Processing 61/No.11 (1998) 55
51. J. Feeley, M. Deeba and R.J. Farrauto, "A catalytic NO_x management system for lean-burn engines", Stud. Surf. Sci. Catal., Catalysis and Automotive Pollution Control IV, **116**, 529 (1998).
52. R.M. Heck and R.J. Farrauto, "Air pollution control – catalytic", Encyclopedia of Environmental Analysis and Remediation (ed. R.A. Meyers) Wiley, 1998, p. 213.
53. R.J. Farrauto and R.M. Heck, "Catalytic converters: state of the art and perspectives", Catal. Today **51**, 351 (1999).
54. R.J. Farrauto and R.M. Heck, "Environmental catalysis into the 21st century", Catal. Today **55**, 179 (2000).
55. R.J. Farrauto, "The generation of hydrogen for the solid polymer membrane fuel cell," Comptes Rendus de l'Acad. Sci. Paris, Serie IIc, Chemie, 3 (2000).

56. O. Korotkikh and R.J. Farrauto, "Selective oxidation of CO in the presence of hydrogen fuel cell applications", *Catal. Today* 62 (2000) 249.
57. Ronald M. Heck, Robert J. Farrauto and S. Gulati, "The application of monoliths for gas phase reactions" *Chemical Engineering Journal*, 82 (2001) 149
58. Xinsheng Liu, J. Lampert, D. Arendarskii and Robert J. Farrauto, "FT-IR Spectroscopic studies of hydrocarbon trapping in Ag/ZSM-5 for gasoline engines under cold start conditions" *Applied Catalysis B: Environmental* 35 (2001) 125
59. R.M. Heck and R.J. Farrauto, Auto exhaust catalysis, *Appl. Catal. A*, 221. (2001) 443
60. R.M. Heck, R.J. Farrauto and S. Gulati, The application of monoliths for gas phase reactions, *Chem. Eng. J.* 82 (2001) 149
61. Xinsheng Liu, Olga Korotkikh and Robert J. Farrauto, "Structural study of the selective catalytic oxidation of CO in hydrogen" in print *Applied Catalysis A: General* 226 (2002) 293-303
62. Shore, L. and Farrauto, R "PROX Catalysts for selective oxidation of CO for fuel cell applications" *Encyclopedia of Fuel Cells*, Wiley and Sons, 2002
63. Heck, R., Farrauto, R with Gulati, S. "Catalytic Air Pollution Control: Commercial Technology" second edition, Wiley and Sons, NY 2002
64. Farrauto, R., Hwang, H. Ruettinger, W., Shore, L. Giroux, T., Liu, Y. and Ilinich, O. *Annual Review of Materials Science*, "New Material Needs for Hydrocarbon Fuel Processing: Generating Hydrogen for the PEM Fuel Cell" 33: 1-27 (2003)
65. Farrauto, R. "From the internal combustion engine to the fuel cell: moving towards the hydrogen economy, *Science and technology in catalysis for 2002* Kodansha Elsevier, Tokyo, 2003: 21-38.
66. Farrauto, R. J. "Catalysts for Automobile Pollution Control, the State-of-the-art and Engine of the Future. Society of Automotive Engineering India 2003.
67. Ruettinger, W., Ilinich, O., Farrauto, R. J. "A new generation of water gas shift catalysts for fuel cell applications" *Journal of Power Sources* 118 (2003) 61
68. Koryabkina, N., Phatak, A., Ruettinger, W., Farrauto, R., Ribeiro, F. 2003. "Determination of kinetic parameters for water-gas shift reactions on copper catalysts under realistic conditions for fuel cell applications," *J. Catal.* 217: 233.
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