

GARY L. HALLER

Professor of Chemical & Environmental Engineering & Chemistry, Yale University

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Professional Preparation

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| • University of Nebraska, U.S.A. | Mathematics | B.S. 1962 |
| • Northwestern University, U.S.A. | Physical Chemistry | Ph.D. 1966 |
| • Oxford University, U.K. | Chemistry | Postdoc 1966 – 1967 |

Appointments at Yale

2013- Director, Henry Koerner Center for Emeritus Faculty, Yale University
1981- Professor of Chemical & Environmental Eng. and Chemistry, Yale University
1997-2008 Master, Jonathan Edwards College
1996-1999 Chair, Department of Chemical Engineering, Yale University
1990-1994 Chair, Council of Engineering, Yale University
1985-2015 Professor, Department of Chemical Engineering and Chemistry
2015-present Research Professor of Chemical Engineering
1984-2015 Henry Prentiss Becton Emeritus Professor of Engineering and Applied Science
2015-present Henry Prentiss Becton Professor of Engineering and Applied Science
1984-1987 Chair, Council of Engineering, Yale University
July-Dec. 1983 Acting Chair, Department of Chemical Engineering
Jan.-June 1981 Acting Master, Jonathan Edwards College
1980-1981 Professor of Engineering and Applied Science, Yale University
1972-1980 Associate Professor of Engineering and Applied Science, Yale University
1971-1972 Yale University, Junior Faculty Fellowship
1967-1972 Assistant Professor of Engineering and Applied Science, Yale University

Awards:

Professeur Invité à l'Université Pierre et Marie Curie (Paris VI), 1996
NIOK (Netherlands Institute for Catalysis Research) Lecturer (Guest Teacher), 1996
Lacey Lecturer in Chemical Engineering; California Institute of Technology, 1996
Ipatieff Lectureship; Northwestern University, 1996
Harry Fair Lectureship; University of Oklahoma, 1995
Robert Burwell Lectureship; The Catalysis Society, sponsored by Amoco, 1995
Yale Science and Engineering Association Meritorious Service Award, 1995
Catalysis Society of Metropolitan New York Award for Excellence in Catalysis, sponsored by Exxon Research and Engineering Company, 1993
The George C. A. Schuit Lectureship, Center for Catalytic Science and Technology; University of Delaware, October 17, 1990.
Kearney State College Outstanding Alumni Award, 1988
Donald E. Fox Chemistry Lectureship; Kearney State College, NB, 1982

Professional Experience, Other than at Yale:

Sept. 1966- Sept. 1967	NATO Postdoctoral Fellow, Oxford University
Dec. 1971- July 1972	Universite Catholique de Louvain, Belgium
Summer 1974	U. N. Ind. Dev. Org., Consultant, Bahia Blanca, Argentina
Summer 1975	Chair, Gordon Research Conference on Catalysis
Jan. 1977- Dec. 1979	Council of the Gordon Research Conferences
Jan. 1989- Dec. 1991	
Sept. 1977- Sept. 1981	International Union of Pure and Applied Chemistry, Associate Member, Commission on Colloid and Surface Chemistry
Mar. 1978 - Aug. 1978	Science Research Council, Senior Visiting Fellow, University of Edinburgh
Jan. 1982 - Dec. 1982	Chair, Division of Colloid and Surface Chemistry, American Chemical Society
July 1981 - Dec. 1981	Visiting Scholar, National Bureau of Standards
Aug. 1986 -	Member, Connecticut Academy of Science and Engineering
July 1992 -July 1996	General Chairman, 11th Intern. Congr. on Catalysis
Jan.-June 2010	Visiting Scholar, New York University
Jan. 2011- present	Visiting Professor, Technical University of Munich
Sept. 2014 – Aug. 2015	Visiting Fellow, Institute for Advanced Study, Technical University of Munich

Consulting Experience:

Jan. 1969 - July 1969	Dept. of Health, City of New Haven, CT
Sept. 1971- Dec. 1975	Monsanto Co. (Univ. Research Inst. of Conn., Inc.)
Oct. 1974 - July 1975	Olin Corp. (Univ. Research Inst. of Conn., Inc.)
Dec. 1974 - July 1975	Commerce Technical Advisory Board, U. S. Dept. of Commerce
Dec. 1975 - Jan. 1977	Environment, Inc., Branford, CT
Jan. 1975 - Dec. 1979	Warner-Lambert Co., Milford, CT
Jan. 1978 - Dec. 1980	U. S. Department of Energy
Oct. 1992 - Sept. 1993	
Summer, 1982	Union Camp Corporation
July 1982 - Dec. 1982	EXXON Research & Engineering Co.
Nov. 1982 - Nov. 1983	Olin Corp., Metals Division
April 1982- June 1984	National Science Foundation
April 1982 - 2001	CYTEC, Inc., Stamford, CT
Jan. 1986 - Jan. 1998	Sun Refining and Marketing Co.
Jan. 1986 -present	Engelhard Corp. (now BASF Corporation)
Jan. 2013-present	Primus Green Energy
Sept. 2014-2015	Morrison & Foerster LLD, New York office

Editorial Boards

1982 - 1990	Board of Editors, American Scientist
1984 -	Board of Editors, Catal. Rev. - Sci. & Eng.
1985 - 2003	Board of Editors, J. Catal.
1988 - 1993	Co-Editor, Journal of Catalysis
1988 - 1998	Advisory Board, Catalysis Letters
1989 -2001	International Editorial Board, Reaction Kinetics and Catalysis Letters
July 1998	Board of Editors, Journal of Molecular Catalysis A: Chemical

Catalysis Society

July 1989 - June 1993 President, The Catalysis Society
Jan. 1977 - June 1989 Board of Directors, The Catalysis Society
Aug. 1985 - June 1989 Vice President, The Catalysis Society
Aug. 1983 - July 1989 Foreign Secretary, The Catalysis Society

Publications

1. "Symmetry Numbers and Reaction Rates. II The Computation of the Reaction-Path Degeneracy for Bimolecular Reactions," J. Chem. Phys., 42, 584 (1965); with E.W. Schlag.
2. "The Adsorption and Reaction of Coordination Complexes on Silica Gel," Inorg. Chem. 4, 1123 (1965); with R.L. Burwell, Jr., R.G. Pearson, P.B. Tjok, and S.P. Chock.
3. "The Texture of Chromium Oxide Catalysts," J. Phys. Chem. 71, 4580 (1969); with R.L. Burwell, Jr. and K.C. Taylor.
4. "Adsorptive and Catalytic Properties of Chromia," Z. Physik. Chem. 64, 18 (1969); with R.L. Burwell, Jr., J.F. Read, and K.C. Taylor.
5. "N.M.R. Studies of Lithium Chloride and Lithium Bromide Solutions in Methanol-Water Mixtures," Mol. Phys. 16, 377 (1969); with C. Hall and R.E. Richards.
6. "Chemisorptive and Catalytic Behavior of Chromia," in Advances in Catalysis (D.D. Eley, H. Pines, and P.B. Weisz, eds.) Vol. 20, page 1, Academic Press (New York) 1969; with R.L. Burwell, Jr., K.C. Taylor, and J.F. Read.
7. "A Study of Adsorption on Single Crystals by Internal Reflectance Spectroscopy," J. Phys. Chem., 74, 4386 (1970); with R.W. Rice
8. "Catalytic Hydrogenation of Propylene: Verification of Maximum Rate," J. Phys. Chem. 76, 943 (1972); with S. Weiner and R. Mezaki.
9. "The Structure and Activity of Chromium Oxide Catalysts: I. Structure Analysis," J. Catal. 25, 378 (1972); with S.R. Dyne and J.B. Butt.
10. "The Structure and Activity of Chromium Oxide Catalysts. II. Influence of Catalyst Structure on Activity for Reactions of Cyclopropane," J. Catal. 25, 391 (1972); with S.R. Dyne and J.B. Butt.
11. "Adsorbed Water on Single Crystal Oxides", Proc. of Fifth Intern. Congr. on Catal. (J.W. Hightower, ed.) Vol. 1, pp. 17-317, North-Holland (Amsterdam) 1973; with R.W. Rice.
12. "Infrared Study of Adsorption in situ at the Liquid/Solid Interface," J. Colloid and Interface Sci. 44, 249 (1973); with R.T. Yang, M.J.D. Low, and J.B. Fenn.
13. "The Catalytic Activity of Silica Gel," J. Catal. 29, 486 (1973); with P.B. West and R.L. Burwell, Jr.
14. "Modification of the Higashi Model for Surface Diffusion," AIChE J. 19, 1052 (1973); with R.T. Yang and J.B. Fenn.
15. "Recycling Molecular Beam Reactor," Proc. Fourth Intern. Symp. on Molecular Beams (F.M. Devienne, ed.) Cannes, France, July 1973; with G. Prada Silva and J.B. Fenn.
16. "Resource Utilization and Environmental Impact of Alternative Beverage Containers," Proc. Environmental Impact of Nitrile Barrier Containers LOPAC: A Case Study (F.D. Wharton, Jr., ed.) published by Monsanto (St. Louis) 1973, p. 77.
17. "Detection of Dilute Organic Acids in Water by Inelastic Tunneling Spectroscopy," Surface Sci. 43, 353 (1974); with Y. Skarlatos, R.C. Barker, and Y.A. Yelon.
18. "Surface Diffusion of Stearic Acid on Aluminum Oxide," AIChE J. 20, 735 (1974); with R.T. Yang and J.B. Fenn.

19. "Ozonation of Phenol in Water Studied by Electron Tunneling," *J. Phys. Chem.* 79, 2587 (1975); with Y. Skarlatos, R.C. Barker, and A. Yelon.
20. "Internal Reflection Spectroscopy of Adsorbed Molecules on Metal Films: CO on Pd," *J. Catal.* 40, 249 (1975); with R.W. Rice.
21. "Applications of Internal Reflection Spectroscopy to Surface Studies", *Catal. Rev. --Sci. Eng.* 13, 259 (1976); with R.W. Rice and C.Z. Wan.
22. "The Effect of Chromium Oxide Catalyst Structure on Activity and Selectivity for Butene Isomerization," *Proc. Sixth Intern. Congr. on Catalysis*, Vol. 1, p. 235, The Chemical Society (London) 1976; with J. Saint-Just.
23. "Recycling Molecular Beam Reactor," *Rev. Sci. Instru.* 48, 897 (1977); with G. Prada-Silva, K. Kester, D. Loffler and J.B. Fenn.
24. "The Role of Vibrational Energy in Surface Isomerization of Cyclopropane," *Surface Sci.* 83, 453 (1979); with G. Prada-Silva, D. Loffler, B.L. Halpern and J.B. Fenn.
25. "A Molecular Beam Study of Isomerization and Dehydrogenation of Butene on a Mica Surface," *J. Catal.* 57, 96 (1979); with D. Loffler and J.B. Fenn.
26. "Effect of Coadsorbed Water and Alcohol on the Surface Transport of Stearic Acid on $\alpha\text{-Al}_2\text{O}_3$," *J. Phys. Chem.* 83, 1154 (1979); with C.Z. Wan.
27. "Catalysis," *The World Book Encyclopedia*, Vol. C, Edition 79A, Field Enterprises Educational Corporation (Chicago) 1979, p. 220.
28. "Gas-Adsorbate Collisional Effects and Surface Diffusion in Porous Materials," *AIChE J.* 26, 355 (1980); with S.C. Thankur and L.F. Brown.
29. "Characterization of Silica-Supported Rh Catalysts: Support, Impregnation and Particle Size Effects," *Proc. Seventh Ibero-American Symposium on Catalysis*, La Plata, Argentina, 13-18 July 1980; with A.J. Rouco.
30. "Nitrogen Chemisorption on Rh Induced by a Strong Metal-Support (TiO₂) Interaction," *J. C. S. Chem. Comm.*, 1150 (1980); with D.E. Resasco.
31. "Hydrogenolysis and Hydrogenation of Hydrocarbons on Supported Rh-Ir Bimetallic Catalysts," *J. C. S., Faraday I* 71, 519 (1981); with T.C. Wong, L.F. Brown, and C. Kemball.
32. "The Mechanism of Olefin Isomerization on Different Forms of Chromia Investigated by Microwave Spectroscopy", *Proc. Seventh Intern. Congr. on Catal.*, Kodansha, Ltd., Tokyo and Elsevier Sci. Pub., 1981, Vol. B, p. 965; with C.S. John and J.K. Tyler.
33. "Vibrational Spectroscopies Applied to Chemisorption and Catalysis," *Cat. Rev. -- Sci. Eng.* 23, 477 (1981).
34. "The Seventh International Congress on Catalysis," *Cat. Rev. --Sci. Eng.* 23, 605 (1981).
35. "The Exciting Oxidation of CO on Pt," *Chem. Phys. Lett.* 81, 185 (1981); with D.A. Mantell, S.B. Ryali, B.L. Halpern, and J.B. Fenn.
36. "Reactions of Cyclopentane and 2,2-Dimethylpropane on Supported Rh-Ir Catalysts," *J. Chem. Soc., Faraday Trans. I* 77, 2519 (1981); with I.H.B. Haining and C. Kemball.
37. "Ethane Hydrogenolysis on Silica-Supported Rh-Ag Catalysis", *J. Catal.* 72, 246 (1981); with A.J. Rouco.
38. "The Effect of Dispersion on Hydrogenolysis Activity of Silica-Supported Rh," *J. de Chemie Physique* 78, 971 (1981); with A.J. Rouco.
39. "Support Effects on Selectivity over Rh Bimetallic Catalysts," *Faraday Discussions* 72, 109 (1982); with D.E. Resasco and A.J. Rouco.
40. "Catalysis by Intermetallic Compounds," *J. C. S. Special Periodical Reports: Catalysis*, Vol. 5, 1982, p. 333; with S.T. Oyama.

41. "Dispersion Effects on Alkane Hydrogenolysis over Rhodium Supported on Titanium Oxide," in *Metal-Support, Metal-Additive Effects in Catalysis*, (B. Imelik et al., eds.) Elsevier (Amsterdam) 1982, p. 105, with D.E. Resasco.
42. "Characterization of the Interaction Between Rhodium and Titanium Oxide by XPS," *J. Catal.* 77, 301 (1982); with S.-H. Chien, B.N. Shelimov, D.E. Resasco, and E.H. Lee.
43. "Impurity Effects in the Interaction of Oxygen with Rh(111)," *Appl. of Surface Sci.* 10, 546 (1982); with S. Semancik and J.T. Yates, Jr.
44. "Characterization of Chromium Catalysts for Ethylene Polymerization by EPR," *Bull. Inst. Chem., Acad. Sin.* 29, 15 (1982); with S.H. Chien.
45. "Distribution of Internal Energy in CO and CO₂ Vibrationally Excited by a Hot Pt Surface," *J. Chem. Phys.*, 78, 4250 (1983); with D.A. Mantell, S.B. Ryali and J.B. Fenn.
46. "Distribution of Internal Energy in NO Vibrationally Excited by a Hot Pt Surface," *J. Chem. Phys.* 78, 6338 (1983); with D.A. Mantell, Y.-F. Maa, S.B. Ryali and J.B. Fenn.
47. "The Adsorption and Dissociation of Methyl Isocyanide on Rh(111)," *J. Chem. Phys.* 78, 6970 (1983); with S. Semancik and J.T. Yates, Jr.
48. "A Model of Metal-Oxide Support Interaction for Rh on TiO₂," *J. Catal.*, 82, 279 (1983); with D.E. Resasco.
49. "Time-Resolved Infrared Emission Studies of CO₂ Formed by CO Oxidation on Pt and Pd," *Chem. Phys. Lett.* 102, 37 (1983); with D.A. Mantell and S.B. Ryali.
50. "Indirect Effect of the Strong Metal-Support Interaction on the Metal-Metal Interaction in Rh-Ag/TiO₂ Catalysts", *Applied Catal.* 8, 99 (1983); with D.E. Resasco.
51. "The Effect of Silica Support Texture and Anion of Impregnating Solution on Ru Dispersion and on Ru-Cu Interaction," *J. Catal.* 84, 477 (1983); with D.E. Resasco and J. Wang.
52. "A Comparative Investigation of Silica Supported Ru-Cu and Ru-Ag Catalysts," *J. Catal.* 84, 297 (1983); with A.J. Rouco, J.A. Oliver and C. Kemball.
53. "Geometric and Electronic Effects of SMSI in Group VIII-TiO₂ Systems," *Proc. 8th Intern. Congr. Catal.*, Berlin, 1984, Vol. 5, V-135; with V.E. Henrich, M. McMillan, D.E. Resasco, H.R. Sadeghi and S. Sakellson.
54. "The Effect of Impurities on Chemisorption and Activity of MgO Supported Rh," *J. Catal.*, 88, 18 (1984); with J. Wang and J.A. Lercher.
55. "Reactions of n-butane and 2,2-Dimethylpropane on Silica-Supported Rh-Pt Bimetallic Catalysts," *J. Catal.*, 87, 389 (1984); with T.C. Wong, L.C. Chang, J.A. Oliver, N.R. Scaife and C. Kemball.
56. "The Nature of the Metal-Titania Interaction and its Effect on Alkane Reactions," *Proc. IX Iberoamerican Symposium on Catalysis*, Lisbon, 1984, Vol. II, p. 1475; with M. McMillan, D.E. Resasco and S. Sakellson.
57. "Novel Rh/TiO₂ and Ir/TiO₂ Catalysts for n-Butane Isomerization and Dehydrogenation," *J. Phys. Chem.*, 88, 4552 (1984); with D. Resasco.
58. "CO Oxidation on Pt: Coverage Dependence of the Product Internal Energy," *ACS Petr. Div. Preprints*, 29, 904 (1984); with D.A. Mantell, K. Kunimori and S. B. Ryali.
59. "The Interaction of Physisorbed Species with Chemisorbed Species as Studied by Infrared Spectroscopy," *J. Phys. Chem.* 88 4660 (1984); with J.T. Yates, Jr.
60. "Solid-state magic-angle spinning aluminum-27 nuclear magnetic resonance used to study alumina support and surface compound structure of catalysts." *Preprints - American Chemical Society, Division of Petroleum Chemistry* (1984), 29(3), 939-43; with McMillan, B.; Brinen, J.
61. "Spectroscopic Analysis of Local Structure and Small Particles of Catalysts," *Applications Surface Sci.*, 20, 351 (1985).

62. "Summary Abstract: CO Oxidation on Pt: Temperature Dependence of the Product Internal Energy," *J. Vac. Sci. Technol.*, A3, 1663 (1985); with D.A. Mantell, K. Kunimori, S.B. Ryali, J.B. Fenn.
63. "Carbon Monoxide Oxidation on Platinum: Coverage Dependence of the Product Internal Energy," ACS Symposium Series No. 288, M.L. Deviney and J.L. Gland, Ed., Am. Chem. Soc., Washington, D.C., 1985, p. 464, with D.A. Mantell, K. Kunimori, and S.B. Ryali.
64. "Mechanism in Heterogeneous Catalysis," Chapter 15 in *Investigation of Rates and Mechanisms of Reactions*, Interscience, (New York) 1986, pp. 951-979, with W.N. Delgass.
65. "Solid-State Magic-Angle Spinning Aluminum-27 Nuclear Magnetic Resonance Used to Study Alumina Support and Surface Compound Structure of Catalysts," *J. Catal.*, 97, 243 (1986), with M. McMillan and J.S. Brinen.
66. "EXAFS Evidence for Direct Metal-Bonding in Reduced Rh/TiO₂ Catalysts", *J. Phys. Chem.*, 90, 1733 (1986), with S. Sakellson and M. McMillan.
67. Coverage Effects in Catalytic Time-Resolved Infrared Emission Studies of Surface Catalyzed Oxidation of CO", in *Proceeding of Recent Advances in Molecular Reaction Dynamics*, R. Vetter and J. Vigue, eds., CNRS, Paris, 333, 1986; with K. Kunimori, D.A. Mantell, S.B. Ryali and J.B. Fenn.
68. "Effect of Incident Translational Energy on the Surface-Induced Isomerization of Cyclopropane," *J. Phys. Chem.*, 91, 2654 (1987); with L.Y. Tsou and J.B. Fenn.
69. "The Effect of Silica Support on Ru-Cu Cluster Morphology as Determined by Catalytic Activity", *J. Phys. Chem.*, 91, 2665, (1987); with A.J. Hong, A.J. Rouco and D.E. Resasco.
70. "The Preparation and Characterization of Vanadia Promoted Rh Catalysts Supported on Silica," *Preparation of Catalysts IV*, B. Delmon, P. Grange, P.A. Jacobs and G. Poncelet (Eds.), Elsevier, 1987, p. 125 with Y.J. Lin, R.J. Fenoglio and D.E. Resasco.
71. "The Implications of One-Dimensional Ordering of Rh on the (110) Surface of Rutile", *J. Catal.*; 104, 252, (1987); with H.R. Sadeghi, D.E. Resasco and V.E. Henrich.
72. "Comparison of Hydrogenation and Hydrogenolysis on Unsupported and Silica-Supported Rh-V₂O₃ and Pt-V₂O₃", *Faraday Symposium No. 21, Faraday Transactions I, J. Chem. Soc.*; 83, 2091, (1987); with Y.J. Lin and D.E. Resasco.
73. "XANES Evidence for Direct Metal-Metal Bonding and Electron Transfer in Reduced Rh/TiO₂ Catalysts" *J. Phys. Chem.*, 92, 189 (1988) with D.E. Resasco, R.S. Weber, S. Sakellson, and M. McMillan.
74. "Characterization of RuCu/SiO₂ Catalysts by Chemisorption, Catalysis and Spectroscopy," *Proc. 9th Intern. Congr. Catalysis*, (Eds., M. J. Phillips and M. Ternan), Vol. 3, p. 1198, Chemical Institut. of Canada, 1988, with A.J. Hong, B.J. McHugh, L. Bonneviot, D.E. Resasco and R.S. Weber.
75. "Desorption of Carbon Dioxide Molecules From A Pt(111) Surface: A Stochastic Classical Trajectory Approach," *Chem. Phys. Lett.*, 144, 533 (1988) with D.W.J. Kwong and N. DeLeon.
76. "EPR Characterization of Ti³⁺ Ions at the Metal-Support Interface in Pt/TiO₂ Catalysts," *J. Catal.*, 113, 96 (1988); with L. Bonneviot.
77. "Metal-Support Interactions between Group VIII Metals and Reducible Oxides", *Adv. Catal.*, Vol. 36;173, (1989) with D.E. Resasco.
78. "Metal-Support Effects in Pt/L-Zeolites Catalysts," *Catalysis Letters*, 3, 103 (1989) with G. Larsen.
79. "A ²⁹Si NMR Investigation of the Structure of Amorphous Silica-Alumina Supports," *Colloids and Surfaces*, 38, 133 (1989) with M. McMillan, J.S. Brinen and J. D. Carruthers.
80. "A Diamond Internal Reflection Cell for Infrared Measurements on Metal and Metal Oxide Films," *Applied Spectroscopy*, 44, 159, (1990), with C.E. Gigola.

81. "Direct Measurement of Vibrational State Population in CO₂ Produced During CO₂ Oxidation on Pd," *J. Chem. Phys.*, 92, 5752 (1990) with G.W. Coulston.
82. "Carbon-13 NMR Studies of CO Adsorbed on Supported Platinum and Palladium Catalysts Using Magic Angle Sample Spinning," *J. Phys. Chem.*, 94, 1463 (1990) with K.W. Zilm, L. Bonneviot, D.M. Hamilton and G.G. Webb.
83. "13C NMR Spectra of 13CO Adsorbed on Silica-Supported Palladium Particles: Particle Size Dependence of the Surface Diffusion Rate and 13C Knight Shift," *J. Phys. Chem.*, 94, 8495 (1990) with K.W. Zilm, L. Bonneviot, O.H. Han and M. Kermarec.
84. "Characterization of Pt Particle Interaction with L-zeolite by X-ray Absorption Spectroscopy: Binding Energy Shifts, X-ray Absorption Near-Edge Structure, and Extended X-ray Absorption Fine Structure," *J. Phys. Chem.*, 94, 8621 (1990) with B.J. McHugh and G. Larsen.
85. "Hydrogenation of Carbon Monoxide on Pt/L-Zeolite Catalysts," (proceed. First Tokyo Conference on Advanced Catalytic Science and Technology, Tokyo, July 1-5, 1990) *Catalytic Science and Technology*, Vol. 1, pp. 135-140, Kodansha Ltd. (1991), with G. Larsen.
86. "Morphology and Site Blocking Effects on Chemisorption Properties and Reactivity of Pt/TiO₂ and Sulfided Pt/Al₂O₃ Catalysts," *J. Catal.*, 130, 359 (1991), with L. Bonneviot.
87. "Dynamics of Heterogeneously Catalyzed Reactions," *Catalysis; Science and Technology*, (eds. J. R. Anderson and M. Boudart) Vol. 9, pp. 131-183, Springer-Verlag (1991) with G.W. Coulston.
88. "The Dynamics of CO Oxidation on Pd, Rh, and Pt Studied by High Resolution IR Chemiluminescence Spectroscopy," *J. Chem. Phys.* 95, 6932 (1991) with G.W. Coulston.
89. "Is There a Distribution of Transition State Energies in the Reaction Coordinate of CO Oxidation On Pt Foil?" in *Fundamental Aspects of Heterogeneous Catalysis Studied by Particle Beams* (H.H.Brongersma and R.A. van Santen, eds.), Plenum Press (New York) 1991, pp. 145-150, with G.W. Coulston.
90. "Temperature Programmed Reduction of Silica Supported Pt/Ni Catalysts Studied by XANES," *J. Phys. Chem.*, 96,1324 (1992) with A. Jentys, B.J. McHugh and J.A. Lercher.
91. "Catalysis: Fundamentals and Applications," in *Encyclopedia of Applied Physics*, Vol. 3, VCH Publishers, Inc.(1992) pg. 67, with D.E. Resasco.
92. "On the Kinetics and Mechanisms of Carbon Monoxide Oxidation on Platinum, Palladium and Rhodium Foils," *Surface Science of Catalysis: In Situ Probes and Reaction Kinetics ACS Symposium Series*, 482, p. 58 (1992), with G.W. Coulston.
93. "Polymerization of Pyrrole over Pd and SnO₂ Supported on KL-Zeolite," *J. Phys. Chem.*, 96, 4145, (1992) with G. Larsen and M. Marquez.
94. "Hydration Effects of Al₂(MoO₄)₃ and AlPO₄ Phases in Hydrotreating Catalysts Studied by Solid State Nuclear Magnetic Resonance Spectroscopy," *Catalysis Letters*, 14,.1(1992) with O. H. Han and C. Y. Lin.
95. "Concepts in Heterogeneous Catalysis" in *Metal-Ligand Interactions: from Atoms, to Clusters, to Surfaces*, (D.R. Salahub and N. Russo, eds.), Kluwer Academic Publishers (The Netherlands) 1992, pp.71-100, with R.S. Weber.
96. "Time-Resolved Infrared Emission Studies of CO₂ Formed by Catalytic Oxidation of CO on Pt and Pd Surfaces," *Bull. Chem. Soc. of Japan (English)* 65, 2450, (1992), with K. Kunimori.
97. "Characterization of Pt/L-zeolite Catalysts by Chemisorption, EXAFS and Reaction of Neopentane with H₂" *Catalysis Today*, 15, 431 (1992), with G. Larsen.
98. "A XANES-TPR Study of Pt-Re/Al₂O₃ Catalysts," *J. Phys Chem.*, 96, 9893 (1992), with F. Hilbrig and C. Michel.

99. "The Formation of Metallic Particles During Temperature Programmed Reduction of Silica Supported Pt and Ni Chlorides," *J. Phys. Chem.*, 97, 484 (1993), with A. Jentys and J.A. Lercher.
100. "On the Deactivation of Pt/L-zeolite Catalysts" *Catalysis Letters*, 17, 127 (1993) with G. Larsen.
101. "The Effect of Preparation Method on Metal-Support Interaction in Pd/L-zeolite Catalysts," *Proc. 10th Intern. Congr. Catal.*, part A, p. 297, eds. L. Buczí, F. Solymosi, P. Tétényi, Akadémiai Kiadó, Budapest, 1993 with G. Larsen.
102. "Solid State Nuclear Magnetic Resonance Spectroscopic Investigation of Hydrotreating Catalysts and Related Materials," *Applied Catalysis*, 98, 195 (1993), with O. H. Han, C. Y. Lin, N. Sustache, M. McMillan, D. Carruthers and K.W. Zilm.
103. "Characterization of Pt-Ni/KL-Zeolite Bimetallic Catalysts by Chemisorption, Catalysis and X-ray Absorption," *Proc. 9th Intern. Zeolite Conf.*, R. van Ballmoos, J.B. Higgins and M.M.S. Treacy, eds., Butterworth-Heinemann, 1993, vol. 2, p. 441 with G. Larsen.
104. "Elementary Reaction Steps in Heterogeneous Catalysis: A Workshop Overview," *Elementary Reaction Steps in Heterogeneous Catalysis*, R.W. Joyner and R.A. van Santen, eds., NATO ASI Series C, Kluwer Academic Pub., Dordrecht, 1993, vol. 398, p. 473, with G.W. Coulston.
105. "The Dynamics of Alkane Adsorption on Metals," *Elementary Reaction Steps in Heterogeneous Catalysis*, R.W. Joyner and R.A. van Santen, eds., NATO ASI Series C, Kluwer Academic Pub., Dordrecht, 1993, vol. 398, p. 197 with G.W. Coulston.
106. "Electrochemical Modification of CH₃OH Oxidation Selectivity and Activity on a Pt Single-Pellet Catalytic Reactor," *J. Phys. Chem.*, 97, 6115 (1993), with C. A. Cavalca, G. Larsen, and C.G. Vayenas.
107. "Methoxy Formation/Spillover on Pd/Al₂O₃ Studied by ¹³C, H1 NMR," *Stud. Surf. Sci. & Catal.*, 77, 223 (1993). with O. H. Han, G. Larsen and K. W. Zilm.
108. "Effects of Adsorbed Oxygen Containing Molecules On the XANES of Pt in Supported Pt/SiO₂ Catalysts," *Catalysis Letters*, 21, 303 (1993) with A. Jentys, M. Englisch and J. A. Lercher.
109. "Platinum-Nickel/L-zeolite Bimetallic Catalysts: Effect of Sulfur Exposure on Metal Particle Size and n-Hexane Aromatization Activity and Selectivity," (Proceed. Intern. Sym. on Zeolites and Microporous Crystals, Nagoya, August 22-25, 1993), in *Studies in Surface Science and Catalysis*, eds. T. Hattori, T. Yashima Vol. 83, pp. 321-329, Kodansha Ltd. (1993), with D. E. Resasco, V. A. Durante, J. Kim, and G. Larsen.
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