BIOGRAPHICAL SKETCH OF DR. MADAN M. BHASIN

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I. AWARDS AND HONORS

A. External Recognition

15. Elected AIChE Fellow, April 24, 2018.

14. Appointed Adjunct Professor, Cain Department of Chemical Engineering, Louisiana State University, LA, Dec. 2015.

13. Appointed Visiting Honorary Professor, Cardiff University, U.K. 2012.

12 Elected to first inaugural class of Fellows, Fellow of the American Chemical Society, August 2009.

11. "Distinguished West Virginian", the highest West Virginia state award was given by Governor Joe Manchin, III, Jan. 16, 2009.

10. American Chemical Society, "Industrial & Engineering Chemistry Division Fellow" award, March 22, 2009.

9. Elected Member, U.S. National Academy of Engineering, February 10, 2006.

8. Recipient of Dr. Martin Luther King, Jr. Recognition Award, Presented by The Dow Chemical Company, Dow Corning Corporation and Chemical Bank, January 20, 2003 *(Citation: In tribute to the outstanding work and dedicated community service specifically directed to furthering Dr. King's dream of love, peace, and unity within the local community and throughout this nation.)*

7. Recipient of Industrial Research Institute Technical Achievement Award, October, 2002. (Represents all industries, not just chemical industry.)

6. R. Richard Bannister Distinguished Lecture Series, West Virginia University, Dept. of Chemical Engineering, October 19, 2001.

5. Recipient of the AIChE 2001 Award in Chemical Engineering Practice, November 5, 2001.

4. Recipient of the American Chemical Society Award in Industrial Chemistry, March, 1999.

3. "Citation of Recognition" in the Congressional Record of U.S. Senate in 105th Congress, Vol. 144, No. 130, September 25, 1998. (Sponsored by Senator John D. Rockefeller, IV.)

2. Recipient of the Scientific Achievement Award of the Kanawha Valley Section of the American Chemical Society, October 1995.

1. Recipient of the Eugene Houdry Award of the North American Catalysis Society, June 1995.

B. Internal Recognition

5. Recipient of First Dow Chemical President's Award, February 6, 2006. The first award ever presented to anyone in R&D.

4. Received Herbert H. Dow Gold medal from The Dow Chemical Company, August 30, 2006. Awarded to three scientists after the year 2001. This award is named after the Founder of The Dow Chemical Company, created in 1979 to recognize researchers for continuous career achievements having significant impact on the profitability of Dow business.

3. Recipient of five UCC Special Achievement Awards for catalyst innovations delivering sustained competitive advantage to the EO/EG business area, 1980-86.

2. Recipient of the "Corporate Operations Enterprise" award for innovative new business proposals with significant value growth potential, 1987.

1. First recipient of the prestigious "Union Carbide Technical Achievement Award", May 1985 (one of five in the whole Corporation).

II. EDUCATION

Ph.D. Physical Chemistry, University of Notre Dame, Indiana, 1963. Graduate studies at Indiana University, 1959-60 for M. S. (Chem.) B.Sc. (Honors), University of Delhi, New Delhi, India, 1958.

III. EXPERIENCE

Owner. 2009 – Present. Innovative Catalytic Solutions, LLC, Charleston, W. V.

Chief Scientific Advisor: 2009 – Present. Mid-Atlantic Technology Research and Innovation Center, South Charleston, W. V.

Senior Scientist: 2004 – 2008. The Dow Chemical Company, South Charleston, W. V.

Senior Scientist: 2002 – 2006. Union Carbide Corporation, A Subsidiary of The Dow Chemical Company.

Positions held in Union Carbide Corporation, South Charleston, WV, 1963 to 2001.

Corporate Fellow: 1988 - 2001 - Industrial Chemicals Group. Supervised 6-12 Ph.D.'s and 7-14 chemists/technicians. Also, responsible for research planning/coordination of Division's catalysis programs, particularly new exploratory strategic projects. In addition, continued individual research thrusts aimed at creating "new catalysis" technologies for Union Carbide Corporation. ($3-4 Million Budget)

Group Supervisor/Senior Research Scientist: Industrial Chemicals Division, 1981-1988. Supervised 3-5 Ph.D.'s and 4-9 chemists/technicians (over $2 million budget).

Research Scientist, 1977-81, Ethylene Oxide/Glycol, supervised 2-3 persons.

Project Scientist, 1971-77, Chemicals & Plastics, supervised 2-3 persons.

Project Scientist, 1969-72, Olefins Division, supervised 2-3 persons.

Chemist, 1963-1969, Olefins Division, supervised 1 person.

IV. RESEARCH INTERESTS

Heterogeneous catalysis and surface science, applied and fundamental, which includes: selective oxidations of olefins and paraffins; selective oxidative synthesis of ethylene via methane coupling; selective hydrogenations of diolefins and dehydrogenation of paraffins; direct conversion of synthesis gas to two-carbon chemicals, hydrodesulfurization, hydrocracking; early development of the applications of Auger, ESCA, ISS, SIMS, etc. to solution of heterogeneous catalysis problems and development of physical/chemical catalyst characterization techniques, including ESR, infrared and Raman spectroscopes (also in-situ Raman).

V. TECHNICAL ACCOMPLISHMENTS (1963-2009)

12. 2009-2018 Founded Innovative Catalytic Solutions, LLC (**www.InnoCatSol.com**). Developed consulting business and c_2C – concept to commercialization that builds on Bhasin's entire career's work at Union Carbide (37 years) and Dow Chemical (8 years). The list of various companies consulted for since 2009 are listed on the company website. In a consulting role with several companies, a novel catalyst and catalytic processes have been and are being developed. These will be described as the applications are published and patents granted.

    In April 2009, Bhasin joined the Mid-Atlantic Technology, Research & Innovation Center, Inc. (MATRIC) and was soon named Chief Scientific Advisor. In this role, he works through is global contacts to bring small-to-large contract research projects to MATRIC. At MATRIC, Bhasin worked with a team that developed a back-integration process of Ethane Oxydehydrogenation (EODH) back to natural gas (after removal of C_3 +hydrocarbons), thus providing superior economics for converting ethane into ethylene and acetic acid (in varying ratios). Aither Chemicals was formed to take advantage of this superior economical process. A US Patent (listed as number 24 in the Patent List in this document) was granted covering the integrated process.

    In 2012, Bhasin was appointed by Cardiff University's Cardiff Catalysis Institute as Visiting Honorary Professor. Shortly afterward, ExxonMobil awarded a three-year research grant for work with Professor Graham Hutchings and his group on selective conversion of "Methane to Methanol." Two publications (listed as numbers 25 and 24 in the Publications List in this document) describe the research under this project.

11. Discovered, developed, led, and assisted in commercialization of eleven generations of improved efficiency ethylene oxide catalysts, which have contributed, per year, $30 million to $60 million income without additional investment and continue to contribute. These new generation catalysts also provided a net increase in production (about 800 MM lb./yr. of added ethylene oxide capacity) equivalent to that of a new world scale plant. This catalyst technology has kept and continues to keep Union Carbide/Dow in a leadership position for over three decades. Total income to date exceeds ~1 Billion dollars. This work also provided a strong patent position for Union Carbide/Dow. In addition, no measurable efficiency difference observed on scale-up of all eleven generations of catalysts from laboratory to full commercial production. (See Patents on ethylene oxide catalysts.). Three of these Ethylene Oxide Catalyst patents have been at the center of patent infringement lawsuit against Shell Oil/Shell Chemical/Criterian Corp. in 2002/03, for which a jury awarded $153 Million to Union Carbide/Dow Chemical in November 2003. **Later Federal Circuit Court Decision, Oct 3, 2005, increased amount to $250+ million** (*see United States Court of Appeals for the Federal Circuit, 04-1475, -1512*). Determined and established the case for infringement against Shell. Then trained legal counsels from Law firms and actively participated from depositions to the two trials in the Delaware Court.

10. Recently discovered several classes of catalysts that give 70+% selectivity to ethylene plus ethane by oxidative coupling of methane at high pressures of 10+ atm. By the use of novel defect/disordered lanthanum oxycarbonate based catalytic compositions. This represents an

important paradigm shift since no one has been able to achieve higher selectivity at higher pressures – where process economics is best.

9. Led pioneering discovery of several highly selective catalysts (oxides of Mn, Pb, Sb, Bi, etc.) for methane coupling to produce ethylene via unsteady state catalysis (with Dr. George Keller, published in 1982). This work has provided a stimulus for many scientists worldwide and has now become an area of active research worldwide (over 1500 publications since our first 1982 publication). (See Publications and Presentations.)

8. Tailor-made several commercially successful ethylene oxide catalysts based on comprehensive mathematical models relating activity/selectivity to catalyst composition and manufacturing process variables.

7. Implemented Statistical Process and Quality Control in catalyst manufacture in late 70s - nearly a decade before Quality became popular in U.S. Industry. Extensive and efficient trouble-shooting plant problems on schedule and meeting production deadlines without loss in catalyst quality.

6. Developed and applied a variety of surface analytical techniques (Auger, XPS, SIMS, ISS, High Resolution Scanning Auger) for characterization of various commercial and developmental catalysts. (See Patents, Publications, Presentations, etc.)

5. Discovered and improved Rh, Rh-Fe, and other Rh catalysts for the selective conversion of synthesis gas to ethanol, acetic acid and acetaldehyde. This was the first reported selective syntheses of C_2-chemicals from CO + H_2. These catalysts are the corner-stone of a commercial plant in China. (See Patents, Publications, Presentations, etc.)

4. Discovered and developed highly active and selective catalyst for selective hydrogenation of diolefins that was better than those commercially available. (See Patents, Publications, Presentations, etc.)

3. Discovered a toluene coupling process, using sulfur to provide bibenzyl and stilbenes in widely varying ratios. (See Patents, Publications, Presentations, etc.)

2. Infrared and ESR investigations of chemisorbed species, heterogeneous and some homogeneous catalysts. (See Patents, Publications, Presentations, etc.) Also, leading state-of-the-art in-situ Raman studies of working catalysts at high temperatures and pressures.

1. Discovered and developed auto exhaust emission control catalyst on alpha-alumina monoliths (without any high surface area transition alumina washcoat) that were better than the “best” current and developmental catalysts in an automobile company. High temperature thermal stability was shown to be far superior.

VI. Papers and Articles Published

25. “Investigating the Influence of Acid Sites in Continuous Methane Oxidation with N2O over Fe/MFI Zeolites”, Y. Chow, N. Drummer, J. Carter, C. Williams, G. Shaw, D. Willock, S. Taylor, S. Yacob, R. Meyer, M.M. Bhasin, and G. Hutchings, Catalysis Science and Technology, 2018, 8, 154.

24. “A Kinetic Study of Methane Partial Oxidation over FEZSM-5 US Patenting N20 as an Oxidant”, Y. Chow, N. Drummer, J. Carter, C. Williams, G. Shaw, D. Willock, S. Taylor, S. Yacob, R. Meyer, M.M. Bhasin, and G. Hutchings, ChemPhysChem 10.1002/cphc.201701202.

23. “Direct Coal Liquefaction: Insights from Patent Analytics,” M. M. Bhasin, B. Uppala, Catalysis Review, March 2010. 6-9

22. High Selectivity Methane Coupling at High Pressure Using Novel, Defect/Disordered Rare Earth Oxy Carbonates-Based Catalyst Systems, Proceedings of the 14 International Congress on Catalysis, Seoul, South Korea, July 2008.

21. “Is true oxydehydrogenation of Lower Alkanes Possible,” M. M. Bhasin, Topics in Catalysis Vol. 23, Nos. 1-4, August 2003

20. Synthetic Organic Chemicals, Chapter in Riegel’s Handbook of Industrial Chemistry, Tenth Edition, 821-879, 2003 (Kulwer Academic/Plenum Publishers)

19. Dehydrogenation and Oxidative Dehydrogenation of Paraffins to Olefins, M. M. Bhasin, J. H. McCain, B. V. Vora, T. Imai, P. R. Pujado (of UOP), Applied Catalysts A: General, 221 (2001), 397-419

18. “Importance of Surface Science and Fundamental Studies in Heterogeneous Catalysis,” M. M. Bhasin, CATALYSIS LETTERS 59 (1999) 1-7

17. “Effects of 1,2 Dichloroethane Addition on the Optimal Silver Catalyst Distribution in Pellets for Epoxidation of Ethylene,” K. L. Yeung, A. Gavriilidis, A. Varma, M. M. Bhasin, JOURNAL OF CATALYSIS 174, (1998) 1-12.

16. “Development of Active Oxide Catalysts for the Direct Oxidation of Methane to Formaldehyde,” R. G. Herman, Q. Sun, C. Shi, K. Klier, C. B. Wang, H. Hu, I. E. Wachs, and M. M. Bhasin, CATALYSIS TODAY 37 (1997) 1-14.

15. “Methane and Alkane Conversion Chemistry,” Sarkany, J., Sun, Q., DiCosimo, J. I., Herman, R. G. and Klier, K., Edited. by M.M. Bhasin and D. W. Slocum, Plenum Press, New York (1995).

14. “Alkali Promoter Synergism in Selective Oxidation,” Proceedings of the 10th International Congress on Catalysis, Guczi, L. Et.al., New Frontiers in Catalysis, page 1431-1439, 1993 Elsevier Science Publishers B. V.

13. “Novel Catalyst System for Treating Exhaust Gases from Internal Combustion and Stationary Source Engines,”, M. M. Bhasin, D. A. Nagaki, P. Koradia, D. C. Sherman, C. Ankrum, SAE Paper #930254, March 1993.

12. "Selective Oxidation of Methane to Formaldehyde and C2 Hydrocarbons over Double Layered Sr/La2O3 and MoO3/SiO2 Catalyst Bed", Q. Sun, J. I. Di Cosimo, R. G. Herman, K. Klier, M. M. Bhasin, CATALYSIS LETTERS, 15 (1992), pg. 371-376.

11. "Feasibility of Ethylene Synthesis Via Oxidative Coupling of Methane", M. M. Bhasin, Studies in Surface Science & Catalysis, Vol. 36, pp 343-357 Elsevier, 1988.

10. "Synthesis of Ethylene Via Oxidative Coupling of Methane. 1. Determination of Active Catalysts", G. E. Keller and M. M. Bhasin, J. Catalysis, 73, No. 1, 9-19 (1982).

9. "Application of Auger and ESCA Spectroscopies", M. M. Bhasin, Chem. Engr. Progress, 60-67, March 1981.

8. "Rhodium Based Catalyst for the Conversion of Synthesis Gas to Two-Carbon Chemicals", P. C. Ellgen, W. J. Bartley, M. M. Bhasin and T. P. Wilson, Preprints, Advances in Fischer-Tropsch Chemistry, ACS Div. of Petroleum Chemistry, Anaheim, CA, pages 616-623, March 12-17, 1978.

7. "Synthesis Gas Conversion Over Supported Rhodium and Rhodium-Iron Catalysts", M. M. Bhasin, W. J. Bartley, P. C. Ellgen and T. P. Wilson, J. Catalysis, 54, 120-128 (1978).

6. "Auger Electron Spectroscopy--A Passing Curiosity or a Practical Surface Analytical Tool for Heterogeneous Catalysis", Catalysis in Organic Syntheses 1976, P. N. Frylander and H. Greenfield, Academic Press, pages 48-73, 1976.

5. "Auger Spectroscopic Study of the Poisoning of a Commercial Palladium-Alumina Hydrogenation Catalyst", M. M. Bhasin, J. Catalysis, 38, 218 (1975).

4. "Auger Electron Spectroscopic Study of the Surface poisoning of Copper Catalysts", M. M. Bhasin, J. Catalysis, 34, 356 (1974).

3. "Intermolecular Hydrogen Transfer in Linear Olefins and Diolefins Catalyzed by Group VIII Metal Catalysts", M. M. Bhasin, Paper No. 53, 783, Proceedings of the Fifth International Congress on Catalysis, Palm Beach, Florida, 20-26 August 1972. Ed. J. W. Hightower, North Holland Publishing Co., 1973.

2. "Infrared Study of the Effect of Surface Hydration on the Nature of Acetylenes Adsorbed on gamma-alumina", M. M. Bhasin, C. Curran and G. S. John, J. Phys. Chem., 74, 3973 (1970).

1. "A Cell for Absorption Spectroscopy of Adsorbed Molecules", M. M. Bhasin, C. Curran and G. S. John, Spectrochim, Acta., 23 A, 455 (1967).

VII. PATENTS

A. Patents Granted

25. “Alkylene Oxide Catalyst and Use Thereof”, M.A. Natal, M.M. Bhasin, H. Soo, and A. C. Liu, WO/2007/123932. US Patent 10,159,961 B2, December 25, 2018

24. “Methods for Integrated Natural Gas Purifications and Products Produced Therefrom”, US PATENT 2012/0222422 A1, M. A. Nunley, M. M. Bhasin, W. G. Etzkorn, G. E. Keller II, P. H. Wadia, September 6, 2012. US Patent 9,676,695 B2, June 13, 2017

23. “Method for Removal of Mercury from Hydrocarbon Feedstocks”, M. M. Bhasin, M. K. Brayden, F. Dupiust, F. E. Groenendijk, S. R. Seyedmonir, M.C. Smith, F. W. Vance, February 26, 2013

22. “Synthesis of Lower Alkylene Oxides and Lower Alkylene Glycols from Lower Alkanes and/or Alkenes,” M. M. Bhasin and S. W. King, US Patent 6,765,101 B1, July 20, 2004

21. “Catalysts for the Oxydative Dehydrogenation of Hydrocarbons”, R. D. Cantrell, K. D. Campbell, A. Ghenciu, D. A. Minahan, M. M. Bhasin, A. D. Westwood and K. A. Nielsen,” US Patent 6,576,803 B2, June 10, 2003

20. “Methods for Manufacturing Olefins from Lower Alkanes by Oxidative Dehydrogenation**”,** G. L. Culp, V. J. Stricker, J. R. Nelson, M. M. Bhasin and K. A. Nielsen, US Patent 6,518,476 B1, Feb. 11, 2003

19. “Catalysts for the Oxydative Dehydrogenation of Hydrocarbons”, R. D. Cantrell, K. D. Campbell, A. Ghenciu, D. M. Minahan, M. M. Bhasin, A. D. Westwood and K. A. Nielsen, US Patent 6,403,523, B1, June 11, 2002.

18. “Process and Catalyst for Synthesizing Aliphatic Cyclic and Aromatic Alkanolamines and Alkyleneamines from Alkanes and/or Alkenes”, M. M. Bhasin and S. W. King, US Patent 6,281,387, Aug. 28, 2001

17. “Catalysts Comprising Substantially Pure Alpha-Alumina Carrier for Treating Exhaust Gases”, M. M. Bhasin, M. S. Jarrell, US Patent 5,856,263, January 5, 1999

16. “Alkylene Oxide Catalysts Having Enhanced Activity and/or Stability”, P. Y. Chou, M. M. Bhasin, H. Soo, E. M. Thorsteinson, US Patent 5,504,053, April 2, 1996

15. "Alkylene Oxide Catalysts Containing High Silver Content", E. M. Thorsteinson, M. M. Bhasin, S. R. Seyedmonir, US Patent 5,187,140, February 16, 1993

14. "Catalyst Composition for Oxidation of Ethylene to Ethylene Oxide", H. Soo, P. Y. Chou, M. M. Bhasin, US Patent 5,102,848, April 7, 1992

13. “New Catalyst Composition and Process for Oxidation of Ethylene to Ethylene Oxide", M. M. Bhasin, US Patent 5,057,481, October 15, 1991

12. “Catalyst Composition for Oxidation of Ethylene to Ethylene Oxide”, M. M. Bhasin, US Patent 4,908,343, March 13, 1990

11. "Alkylene Oxide Catalysts Having Enhanced Activity and/or Efficiency", M. M. Bhasin, D. M. Minahan, S. F. Mitchell, US Patent 5,051,395, September 24, 1991

10. "Catalyst Composition and Process for Oxidation of Ethylene to Ethylene Oxide", M. M. Bhasin, P. C. Ellgen, and C. D. Hendrix, US Patent, 4,916,243, April 10, 1990

9. "Process for Preparing a Supported Silver Catalyst", G. H. Warner, M. M. Bhasin and B. Lieberman, US Patent 4,455,392, June 19, 1984

8. "Silver Catalyst for the Manufacture of Ethylene Oxide and a Process for Preparing the Catalyst", M. M. Bhasin and G. H. Warner, U. S. 4,419,276, December 6, 1983

7. "Process for Producing Acetic Acid, Ethanol and Acetaldehyde from Synthesis Gas", M. M. Bhasin and G. L. O'Connor, British Patent 1,501,892, February 22, 1978; US Patent 4,246,186, January 20, 1981

6. "Process for Producing Ethanol from Synthesis Gas", M. M. Bhasin, British Patent 1,501,891, February 22, 1978; US Patent 4,235,801, November 25, 1980

5. "Process for Producing Two-Carbon Atom Compounds from Synthesis Gas with Minimal Production of Methanol", P. C. Ellgen and M. M. Bhasin, US Patent 4,162,262, July 24, 1979

4. "Process for Producing Ethanol, Acetic Acid and/or Acetaldehyde from Synthesis Gas", P. C. Ellgen and M. M. Bhasin, US Patent 4,0096,164, June 20, 1978

3. "Process for Producing Oxygenated Two-Carbon Compounds", P. C. Ellgen, M. M. Bhasin, US Patent 4,014,913, March 29, 1977

2. "Supported Nobel Metal Catalyst, Methods of Making Same, and Processing US Patenting Same", M. M. Bhasin, US Patent 4,038,175, July 26, 1977

1. "Selective Production of Stilbenes and/or Bibenzyls by the Coupling of Toluenes", M. M. Bhasin and K. D. Williamson, US Patent 3,548,018, December 15, 1970

B. Patent Applications

4. “Catalyst Having a Modified Silicon Carbide Support and Its Use as A Hydrogenation Catalyst”, R. Miller, A. Bhattacharyya, G. Ellyn, D. Lafyatis, A. Stolarski, R. Lobo, M. M. Bhasin, filed June 1, 2018. US Patent 0,273,463 A1, September 27, 2018

3. “Shaped Porous Bodies of Alpha-Alumina and Methods for Preparation thereof, WO/2008/054564, S.A. Wallin, J. G. Serafin, M.M. Bhasin, S.R. Lakso, K. E. Howard, P.C. Lebacon.

2. “Improved Alumina Carriers and Silver-Based Catalysts for the Production of Alkylene Oxide, WO/2005/023418, U.S. 2006/ 0258532 A1, E. M. Thorsteinson, M.M. Bhasin, A. C. Liu, J.G. Serafin, S.R. Seyedmonir and H. Soo.

1. Provisional Applications and one Non-Provisional Application.

VIII. Books

4. Methane and Alkane Conversion Chemistry, Edited by M. M. Bhasin and D. W. Slocum, Plenum Press, NY, 1995.

3. Synthetic Organic Chemicals, Chapter in Riegal Handbook of Industrial Chemistry, Tenth Edition, 821-879, 2003, Kulwer Academic/Plenum Publishers

2. "Is True Ethane Oxydehydrogenation of Lower Alkanes Possible", Chapter in Proceeding of Ind Irsee Symposium, Irsee, Germany

1. Industrial Catalytic Process, Applied Catalysis A; General 221, Chapter, pages 397-419

IX. External Presentations

Various Presentations/Courses to Client Companies Globally, 2009-2019.

90. Invited Lecture. Special Catalysis Topics of Interest to Reliance, February 12, 2018.

89. Consulting Project for UOP, Final Report of Literature Assessment, February 2018.

88. Ethylene Oxide Catalyst and Process Innovations – A Successful Journey Towards a Sustainable Industrial Process, Cardiff Catalysis Institute, October 31, 2017.

87. Ethylene Oxide Catalyst and Process Innovations – A Successful Journey Towards a Sustainable Industrial Process, Fritz, Haber Institute (Max Planck Society), October 17, 2017.

86. High Selectivity Methane Coupling at High Pressure Using Novel, Defect/Disordered Rare Earth Oxycarbonate Based Catalyst Systems, Fritz, Haber Institute (Max Planck Society), October 27, 2017.

85. Ethylene Oxide Catalyst and Process Innovations – A Successful Journey Towards a Sustainable Industrial Process, University of Notre Dame, October 26, 2017.

84. Invention and Innovation: Some Personal Reflections and EO Catalysis Facts, LanzaTech, October 19, 2017.

83. High Selectivity Methane Coupling at High Pressure Using Novel, Defect/Disordered Rare Earth Oxycarbonate Based Catalyst Systems, Louisiana State University, May 4, 2017.

82. Ethylene Oxide Catalyst and Process Innovations, Technische Universitat Berlin, January 13, 2017.

81. Ethylene Oxide Catalyst and Process Innovations, Prof. Tom Degnan's Class, "Industrial Chemical Processes" Fall 2016, University of Notre Dame, Department of Chemical and Biomolecular Engineering, September 15, 2016.

80. Invention and Innovation: Some Personal Reflections, University of Notre Dame, Department of Chemical and Biomolecular Engineering, September 16, 2016.

79. Sulfur As Oxidant for Oxidative Dehydrogenation of Ethane/Alkanes to Ethylene/Alkenes, UOP-A Honeywell Company, June 2016.

78. High Selectivity Methane Coupling at High Pressure US Patenting Novel, Defect/Disordered Rare Earth Oxycarbonate Based Catalyst Systems, Consortium for Interface Reaction and Catalyst Engineering (CIRCE), March 21, 2016.

77. Invention and Innovation: Some Personal Reflections, University of Notre Dame, Department of Chemical and Biomolecular Engineering, September 16, 2016.

76. Ethylene Oxide Catalyst and Process Innovations, Prof. Tom Degnan's Class, "Industrial Chemical Processes", Fall 2016. University of Notre Dame, Department of Chemical and Biomolecular Engineering, September 15, 2016.

75. Ethylene Oxide Catalyst and Process Innovations, SusChemE, International Conference on Sustainable Chemistry & October 9, 2015.

74. Ethylene Oxide Catalyst and Process Innovations, LSU College of Engineering EPIC Seminar Series, September 11, 2015.

73. High Selectivity Methane Coupling at High Pressure US Patenting Novel, Defect/Disordered Rare Earth Oxycarbonate Based Catalyst Systems, Ohio State University, The William G. Lowrie Department of Chemical and Biomolecular Engineering, October 23, 2014.

72. Untold Stories Behind OCM, ACS Fellows Symposium Honoring Ganne M. Gaffney, April 2013.

71. Direct Coal Liquefaction: Learnings from Patent Analyses, November 2012.

70. Invention and Innovation: Some Personal Reflections, ACS Fellows Symposium Philadelphia, 2012.

69. Invention and Innovation: Some Personal Reflections, M. M. Bhasin, PETROTECH, New Delhi, India, 2011.

68. Surface Science and Heterogeneous Catalysis, M. M. Bhasin, Bharat Petroleum Corporation, Limited, Greater Noida, Delhi, India, 2010.

67. Invention and Innovation: Some Personal Reflections, M. M. Bhasin, Indian Oil Corporation, Limited, Research and Development, Faridabad, India, December 2009.

66. High Selectivity Methane Coupling at High Pressure Perdue University, Indiana, October 2009.

65. High Selectivity Methane Coupling at High, Chicago; Northwestern University, October 2009.

64. Surface Science and Heterogeneous Catalysis, M. M. Bhasin, Argonne National Lab, Illinois, October 2009.

63. High Selectivity Methane Coupling at High Pressure, M. M. Bhasin, Illinois Institute of Technology, Chicago, October 2009.

62. High Selectivity Methane Coupling at High Pressure, M. M. Bhasin, University of Munich, Germany, October 2009.

61. High Selectivity Methane Coupling at High Pressure, M. M. Bhasin, University of Utrecht, Netherlands, October 2009.

60. High Selectivity Methane Coupling at High Pressure, M. M. Bhasin, Glasgow University, United Kingdom, October 2009.

59. High Selectivity Methane Coupling at High Pressure, M. M. Bhasin, Cardiff University, United Kingdom, October 2009.

58. High Selectivity Methane Coupling at High Pressure US Patenting Novel, Defect/Disordered Rare Earth Oxy carbonates-based Catalyst Systems, M. M. Bhasin, Presentation to the Reliance Technology Group, Navi Mumbai, Feb. 13, 2009.

57. “Invention and Innovation: Some Personal Reflections”, Presentation to the PETROFED (Petroleum Federation of India), New Delhi, Feb. 6, 2009.

56. “Importance of Surface Science and Fundamental Studies in Heterogeneous Catalysis,” M. M. Bhasin, Invited Lecture to the Reliance Industries Group, Reliance Technology Day, March 28, 2008.

55. “Importance of Surface Science and Fundamental Studies in Heterogeneous Catalysis,” M. M. Bhasin, Lecture at the Indian Institute of Technology at Madras, Chennai, Dec. 2007.

54. “Importance of Surface Science and Fundamental Studies in Heterogeneous Catalysis,” M. M. Bhasin, Lecture at the University Institute of Chemical Technology, Mumbai, Dec. 2007.

53. "Importance of Surface Science and Fundamental Studies in Heterogeneous Catalysis,” M. M. Bhasin, Lecture at the Indian Institute of Chemical Technology, Hyderabad, Dec. 2007.

52. “Invention and Innovation: Some Personal Reflections”, Presentation at the special AIChE Symposium in Honor of Prof. Arvind Varma's 60th Birthday, Salt Lake City, Utah, Nov. 2007.

51. “Invention and Innovation: Some Personal Reflections”, Presentation at the First Meeting of Indian and American Institute of Chemical Engineers, December 27-30, 2004, Mumbai, India

50. “Importance of Surface Science and Fundamental Studies in Heterogeneous Catalysis”, Invited Seminars, presented to Center for Environmentally Beneficial Catalysts, University of Kansas, Lawrence, KS, Nov. 4, 2004

49. Industrial Research Institute Award Lecture, “Invention and Innovation: Some Personal Reflections,” M. M. Bhasin, IRI Meeting, Boston, MA, October 2002

48. Invited Lecture: Brookhaven National Lab – Gave lecture on “Importance of Surface Science and Fundamental Studies in Heterogeneous Catalysis,” May 2, 2001.

47. Invited and presented seminar to WVU Dept. of Chemical Engineering “Bannister Distinguished Service Series,” October 19, 2001.

46. Invited Lecture “Is True Ethane Oxydehydrogenation Feasible?” M. M. Bhasin, 2nd Irsee Symposium, June 7-9, 2002, Irsee, Germany

45. Novel Catalyst System for Treating Exhaust Gases from Internal Combustion & Stationary Source Engines, Tri-State Catalyst Society Meeting, April 26, 2000.

44. “Surface Science and Heterogeneous Catalysis,” M. M. Bhasin, ACS Industrial Chemistry Award Symposium, ACS Meeting, Anaheim, CA, March 23, 1999.

43. “Doing the R/D Right: A Planned Approach to Experiments,” M. M. Bhasin, Keynote Address, Division of Chemical Technicians, ACS Meeting, Anaheim, CA, March 22, 1999.

42. “Surface Science and Heterogeneous Catalysis,” M. M. Bhasin, Keynote Address, Catalytic Advances Program, Clearwater Beach, FL, March 1, 1999.

41. “Surface Science and Heterogeneous Catalysis,” M. M. Bhasin, Keynote Address, Western State Catalyst Club Symposium, Albuquerque, NM, February 26, 1999.

40. “Alkali Promoter Synergism in Selective Oxidation,” Invited Lecture, Chemical Engineering Symposium, The University of Kansas, Lawrence, KS, April 21, 1998.

39. “Surface Science and Heterogeneous Catalysis,” Keynote Address, Tri-State Catalysis Club Symposium, April 20, 1998.
38. “Catalyst Design - Alkali Promoter Synergism,” AIChE Meeting, November 15, 1995.

37. Methane Coupling, A Progress Report -Invited Lecture at Beijing Petroleum Institute, China, November 1995.

36. Methane Coupling, A Progress Report -Invited Lecture at Xiamen University, China, November 1995.

35. Methane Coupling, A Progress Report -Invited Lecture at Lanzhou Institute of Chemical Physics, China, November 1995.

34. Methane Coupling, A Progress Report -Invited Lecture at Dalian Institute of Chemical Physics, China, November 1995.

33. Methane Coupling, A Progress Report -Invited Lecture at University College, London, November 28, 1995.

32. American Chemical Society, Kanawha Valley Section Achievement Award Address, Charleston, WV, October 18, 1995.

31. Houdry Award Address, “Importance of Surface Science & Fundamental Studies in Industrial Catalysis,” North American Catalysis Society, Snowbird, Utah, June 13, 1995.

30. “Alkali Promoter Synergism, Invited lecture at Brigham Young Univ., Provost, Utah, October 94.

29. “Alkali Promoter Synergism,” Invited lecture at University of California, Berkeley, October 94.

28. “Alkali Promoters Synergism in Selective Oxidation,” presented at the University of Cape Town, SASOL, Johannesburg, South Africa, and AECI, Johannesburg, South Africa, October 93.

27. “Oxidative Coupling of Methane - A Progress Report,” Keynote address @ International Conference on Catalysis & Catalytic Processing, Cape Town, South Africa, October 93.

26. “Alkali Promoter Synergism,” Invited lecture at a Canadian Catalysis Club, May 94.

25. Presented invited Lecture at Murphree Award Symposium honoring C. D. Chang on "Status of Selective Methane Coupling", ACS Meeting, San Francisco, April 5-10, 1992.

24. "Alkali Promoter Synergism in Selective Oxidation", Seminar—UCI R/D, Louisville, KY.

23. "Alkali Promoter Synergism in Selective Oxidation", Chemical Engineering Seminar, Texas A&M, October 15, 1992.

22. "Alkali Promoters Synergism in Selective Oxidation", M. M. Bhasin and C. D. Hendrix, International Congress on Catalysis, Budapest, Hungary, July 1992.

21. "Alkali Promoter Synergism", Chemical Engineering Symposium, University of Notre Dame, October 1991.

20. "Ethylene Synthesis via Methane Coupling--A Progress Report", invited speaker at New England Catalysis Club Symposium, May 1991.

19. "Ethylene Synthesis Via Oxidative Coupling of Methane", M. M. Bhasin, Lecture at IPMI (International Precious Metals Institute) Course, March 13, 1990.

18. "Oxidative Coupling of Methane - A Progress Report", M. M. Bhasin, Lecture at Northwestern University, February 19, 1990.

17. "Oxidative Coupling of Methane - A Progress Report", M. M. Bhasin, Keynote Address, Pacifichem - Symposium on Methane Activation, Conversion and Utilization, December 17-20, 1989, Honolulu, Hawaii.

16. "Feasibility of Ethylene Synthesis Via Catalytic Oxidative Coupling of Methane", M. M. Bhasin, Presentation to the Department of Physical Chemistry, University of Cambridge, England, U.K., May 29, 1987.

15. "Feasibility of Ethylene Synthesis Via Catalytic Oxidative Coupling of Methane", M. M. Bhasin, Presentation to the Department of Chemical Engineering and Industrial Chemistry, University of New South Wales, Sydney, Australia, May 5, 1987.

14. "Feasibility of Ethylene Synthesis Via Catalytic Oxidative Coupling of Methane", M. M. Bhasin, Paper Presented at the Methane Conversion Symposium, Auckland, New Zealand, April 27, May 1, 1987.

13. "Feasibility of Ethylene Synthesis Via Oxidative Coupling of Methane", M. M. Bhasin, Lecture: Chemical Engineering Symposium, University of Notre Dame, October 17, 1986.

12. "Ethylene Synthesis Via Catalytic Oxidative Coupling of Methane", M. M. Bhasin, Lecture at Chem. Engineering Graduate Seminar, Rice University, Houston, TX, February 7, 1985.

11. "Feasibility of Ethylene Synthesis Via Oxidative Coupling of Methane", M. M. Bhasin and G. E. Keller, February 4-6, 1985, Methane Activation Workshop - Sponsored by Gas Research Institute.

10. "Application of Auger and ESCA Spectroscopy", M. M. Bhasin - Invited Speaker at the Michigan Catalysis Society, Detroit, MI, January 1983.

9. "Comprehensive Catalyst Optimization", M. M. Bhasin and C. D. Hendrix - Invited Paper at the Eighth North American Catalysis Society Meeting, Philadelphia, May 1983.

8. "Applications of Auger and ESCA Spectroscopies", Invited Lecture - Bhabha Atomic Research Center, Trombay, India, 1982.

7. "Application of Auger and ESCA Spectroscopies", Invited Lecture, Associated Cement Co., Bombay, India 1982.

6. "Oxidative Coupling of Methane", M. M. Bhasin and G. E. Keller - Paper Presented at the Tri-State Catalysis Club Symposium, Ashland, KY, May 1982.

5. "Statistical Approach to Comprehensive Catalyst Optimization", M. M. Bhasin, Lecture - As Part of 14th Annual Catalysis and Chemical Reactor Design Short Course, May 9-14, 1982, The University of Connecticut.

4. "Synthesis of Ethylene Via Oxidative Coupling of Methane. 1. Determination of Active Catalysts", G. E. Keller and M. M. Bhasin - Presented Invited Paper at the Southwest Catalysis Society, Spring Symposium, March 12, 1980.

3. "Applications of Auger and ESCA Spectroscopies", Paper 23 A, AIChE 72nd Annual Meeting, November 1, 9-29, 1979, San Francisco, CA.

2. "Heterogeneous Catalysis", M. M. Bhasin, Lecture - Tougloo College, Tougloo, MS, 1974.

1. "Applications of Auger and ESCA Spectroscopies", M. M. Bhasin, Invited Speaker - Chemical Engineering Seminar, University of Notre Dame, IN, March 8, 1973.

X. PROFESSIONAL LEADERSHIP AND COMMUNITY ACTIVITIES

11. Member, International Activities Committee Appointed by ACS President 2011, 2014, and 2017-Present. Participated in establishing highly successful International Chapter in India, 2014.

10. ACS-Kanawha Valley Section, Councilor, 2011-current.

9. Co-organized Symposium on Fuels & Petrochemicals at the First Joint Meeting of Indian and American Institute of Chemical Engineers, December 27-30, 2004, Mumbai, India.

8. Chairman, Kanawha Valley Section of ACS, 2002, Chairman Elect – 2001, Past-Chair 2003.
As Chairman in 2002, working actively with the Executive Committee, organized the highly successful 75th Anniversary celebration of our Section (with active participation from Industries and the Universities, etc.).

7. Organized and presented papers in several National and International Symposia related to catalysis including:

(a) Catalysis of the Future," 22nd State-of-the-Art Symposium, July 20/21, 1987, University of California, Berkeley

(b) Methane and Alkane Conversion Chemistry", March 13-17, 1994, ACS Meeting, San Diego, CA, Petroleum Chemistry Division

(c) Co-organized symposium on "Nanomaterials: Synthesis, Characterization & Catalysis" at the International Pacifichem 2000, Dec. 14-19, 2000, Honolulu, Hawaii, Organizers: G. A. Somorjai, M. M. Bhasin, J. B. Moffat and K. I. Tanaka

6. Secretariat General of ACS Catalysis Secretariat, 1997/98 and Secretariat General Elect, 1996.

5. Chairman, I&EC Division of the ACS, 1990 and Chairman-Elect, 1989, Past Chair, 1991.

4. General Chairman, I&EC State-of-the-Art Summer Symposia Series 1986-88. Also served as a member of the I&EC Executive Committee for 10+ years.

3. Member, Resource Development Advisory Board, United Way, 2010-current, 2001-2004, Member Board of Directors, United Way of Kanawha Valley, WV, 1998-1999

2. Served as Chairman for India Center of W.Va. for 13 years, provided leadership for their ambitious, $1M capital program to build the India Center. The India Center was completed on scheduled in 1989 and continues to successfully function, providing a venue for a whole range of diverse community activities for all West Virginians and the natives of India. Continued to organize multicultural activities, for the past 15

years, to promote “Unity within Diversity” and “Tolerance Towards each Other” initiatives in the community. One major annual activity called “India Heritage Fair” has been very successful involving 1200-1500 persons from all over West Virginia the past 20+ years.

1. Founding Board Member of India Association, Charleston, WV, 1974. Worked with Board to develop Charter and Bylaws. Served as President in 1978.