

## John C. Edwards, Ph.D.

**Work:** Process NMR Associates LLC, 84 Patrick Lane, Suite 115, Poughkeepsie, NY 12603, USA

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### **SUMMARY:**

Recognized as world leading expert in online and laboratory industrial applications for bench-top NMR systems. Owner of dynamic liquid and solid-state NMR laboratory providing analysis services and consulting.

Doctorate and 30+ years of industrial, technical, and business experience in the field of analytical NMR and process NMR applied to petroleum, petrochemical, biochemical, food and beverage, consumer products, herbal supplements, dairy, biotechnology, polysaccharides, catalysis, specialty polymers, materials, biorefinery, biofuels, pharmaceuticals, chemical R&D and manufacturing.

Principal of Process NMR Associates, LLC – established in 1997. The only process NMR applications consultancy operating in the world. Currently operating a commercial NMR analysis service with over 300 commercial customers in the petroleum, biotechnology, pharmaceutical, food processing, alternative-energy, petrochemical, polymer, ceramics, catalyst and electronics industries. Developed new NMR technologies for process control and the laboratory, through relationships with other vendors. Consulted on application of new NMR technologies. Developed quantitative NMR applications for chemical purity analysis, complex mixture analysis, food adulteration and fraud, truth in labeling claims for herbal supplements, pure herbal raw materials, additives and preservatives, and pharmaceutical API and excipients. Currently working as an expert with USP and ValidNMR organization to bring qNMR into the analytical routine testing arena.

Applied chemometric techniques to complex NMR analyses that yielded predictive models for 40+ refinery applications using NMR as an on-line process analyzer/controller. Acknowledged as a world leader in the application of multivariate analysis to NMR spectroscopy data.

Maintained and operated the only NMR facility within Texaco Inc. Provided **all** NMR spectroscopic services (liquid-state, solid-state, multidimensional, multinuclear), including all data interpretation, for **all** areas of Texaco's research efforts in both upstream and downstream areas. Coordinated compositional work related to business unit processing problems - MTBE plant, various refinery operations, product blending operations, used-oil recycling plant, paper recycling plant, plastics/coal gasification plant. Participated as team member on projects associated with competitive analysis, product quality monitoring, environmental liability, field problem sample analysis, engine test sample analysis.

Published and presented over 180 papers in various technical journals, symposia, and national meetings.

Inventor - 3 Patents for a process analytical NMR probe and refinery process control by NMR.

**Consultant:** Consultant on NMR applications to a number of large and small industrial companies.

**Expert Witness:** Performed detailed analytical NMR analysis in support of legal litigation and patent infringement cases.

**Affiliate Professor:** Marist College, Department of Chemistry, Poughkeepsie, NY - 2002-2014

**Visiting Scientist:** Vassar College, Department of Chemistry, Poughkeepsie, NY – 2019-Present

### **EDUCATION:**

**Ph.D.** Physical Chemistry, University of South Carolina, 1990. **Advisor:** Professor Paul D. Ellis

**Dissertation:** *"Solid-State Molybdenum-95 Nuclear Magnetic Resonance Spectroscopy of Molybdenum in Catalytic Environments"*

**B.Sc. (Dunelm),** University of Durham, Durham UK, 1986, 2. I - Honours in Chemistry

University College – Football Team Captain 1985-86

**Secondary Education:** Thornleigh Salesian College, Bolton UK. 11 'O' Levels (1981), 5 'A' Levels, and 2 'S' Levels (1983)

## **PROFESSIONAL EXPERIENCE:**

**2003 to Present**

**Process NMR Associates, LLC**

### **Principal - Process and Analytical NMR Services**

- Developed many new NMR analyses for identification and quantification of pure chemicals or complex mixtures in herbal supplements, pharmaceutical API and excipients, food and beverage products, food and cosmetic additives, nutritional supplements.
- Recognized as world leading expert in the area of application development for bench-top NMR systems. Acknowledged as industrial NMR automated application development leader.
- Enabled expansion of analytical NMR services to current customer level of over 300 companies spanning all industry sectors. Current facility houses 2 x 300 MHz Varian Mercury superconducting NMR systems, 1 x 200 MHz Varian UnityPlus equipped for MAS solid-state NMR experiments, 3 x 60 MHz high resolution NMR spectrometers, 4 x 20 MHz TD-NMR systems (10mm, 20mm, 40mm, Single-sided), Shimadzu, GC, Micros-ESR, FTIR-ATR, KF-Moisture, Virtis K freeze dryer.
- Developed business connections for new NMR and FTIR-ATR instrumentation lines and applications for instrument company Cosa-Xentaur and Aspect Imaging. New line of high, mid and low field NMR instruments will revolutionize the application of NMR in the industrial marketplace.
- Developed Markets and Sales for Resonance Systems Spin Track TD-NMR Spectrometers and Applications. Also developed applications for hardware platforms spanning 20, 43, 60, 80, 200 and 300 MHz.
- Co-Founded NMR Process Systems LLC - providing process/at-line NMR analyzers and other process analytical technology solutions to industry.
- Consultant on NMR methodologies to major petroleum companies including Sasol, SK Corporation, Petronas, Shell, Valero, Holly Refining, Schlumberger, Chevron, BP.
- Consultant to Benchtop and Online NMR Manufacturers and Distributors - Qualion, Aspect Imaging, Modcon, Leap Technologies, Cosa-Xentaur, Resonance Systems
- Affiliate Professor - Marist College - NMR Training and Undergraduate Research Projects (2003 – Present)
- Research Associate – State University of New York at New Paltz – 2003-2005
- Visiting Scientist in Chemistry – Vassar College, Poughkeepsie, New York – 2019-2020

**December 1997 to 2003**

**Process NMR Associates, LLC**

### **Owner and Manager - Process and Analytical NMR**

- Co-founder and operator of Process NMR Associates, LLC. Acted as a contract process NMR application development specialist. Served as application development company and NMR consultants to Invensys, FoxboroNMR, and APV. Operated a high field analytical NMR laboratory.
- Acted as Technical Product Manager for the FoxboroNMR Ltd Process NMR Product.
- Served as Technical Sales Support on all aspects of the Process NMR business.
- Managed over 30 validation projects for the Foxboro process NMR business.
- Directly involved in development of NMR incorporated into closed loop control by APC and optimization packages
- Served as applications support and service coordinator for Foxboro Process NMR.
- Provided contract solid and liquid-state NMR support to major petroleum and chemical companies.

**October 1994 to December 1997**

**Texaco Fuel & Lubricant Technology Department**

### **Research Chemist - Process Analytical and Organic Spectroscopy Group:**

- Manager and sole-operator of all NMR services within Texaco Inc., providing solid and liquid-state NMR analyses for Texaco's business units and business partners. Lab comprised: Varian NMR Systems: UnityPlus-300, UnityPlus-200, Unity-300WB, VXR-300S ; Elbit-ATI 55 MHz Process NMR Systems: 1 lab and 2 in-line refinery systems.
- Member of Process Analytical Technology team charged with providing process instrumentation and sensing to the refining business units and the Texaco fuel marketing company. Involved in online NMR and NIR projects, as well as a mobile FT-IR facility that monitored gasoline quality at Texaco gas stations.
- Developed chemometric models for application of process NMR technology to control and optimize refinery operations such as: alkylation, fluid catalytic cracking, reforming, hydrotreating, tank-farm inventory reduction, crude assay, and gasoline blending. Aided in development of the first two commercial NMR based refinery analyzers for fuel gas analysis and alkylation control at a Texaco refinery.

- Coordinated analytical work provided to Huntsman Corporation, DSM Copolymer, Ethyl Corp., First Brands, and various universities.
- Fouling team member and analytical coordinator for a 3,500 bpd used oil recycling plant.
- Strong supporting roles in gasoline and diesel fuel additive development, lubricant additive development, compositional analysis, heavy oil upgrading, and methane-to-liquids upgrading.

**September 1990 - October 1994**

**Texaco Research and Development**

**Project Chemist** - Organic Spectroscopy, Compositional and Thermal Analysis Group.

- Assumed partial responsibility for liquid-state NMR analysis as well as maintained full responsibility for solid-state NMR applications throughout Texaco. Areas of responsibility included all areas of Texaco's upstream and downstream research efforts (polymers, catalysts, fuel/lubricant additives, complex mixture analysis, membranes, gasification, heavy oil upgrading, methane-to-liquids upgrading, competitive analysis, base oil, gasoline, diesel, crude composition, process failure analysis, and compositional analysis). Services supplied involved all experimental design, data collection, processing, and interpretation.
- Received Texaco's Outstanding Contributor Award for advancing the understanding of the complex structure of combustion chamber and other engine deposits.
- Analytical representative on the Clean System-3 fuel additive development team.
- Justified the expansion of Texaco's NMR capabilities from two spectrometers to four, and networked the system to allow home-access and control of the spectrometers.
- Expanded NMR domain within Texaco to include the exploration departments, in particular geochemical and log analysis areas.
- NMR spectroscopist responsible for all solid-state NMR analyses (wideline, CRAMPS, CP-MAS, nutation, 2-dimensional).
- Developed a large program to correlate fuel and fuel-additive chemistries with engine performance and engine deposit quantity and chemistry.
- Developed structure-reactivity relationships in catalyst systems utilizing multinuclear ( $^1\text{H}$ ,  $^2\text{H}$ ,  $^{27}\text{Al}$ ,  $^{31}\text{P}$ ,  $^{23}\text{Na}$ ,  $^{133}\text{Cs}$ ,  $^{13}\text{C}$ ,  $^{29}\text{Si}$ ,  $^{11}\text{B}$ ,  $^{95}\text{Mo}$ ,  $^{15}\text{N}$ ,  $^{17}\text{O}$ ,  $^{33}\text{S}$ ) solid-state NMR characterization. Catalyst systems included zeolites, clays, aluminophosphates, oxides, mixed oxides, oxide supported metals, modified buckminsterfullerenes, and carbons.

**August 1986 - September 1990**

**University of South Carolina**

**1987-1990 Research Assistant** - Chemistry Department, NMR Laboratory

**1986-1987 Teaching Assistant** - Chemistry Department, General Chemistry

**PROFESSIONAL AFFILIATIONS:**

Member-American Chemical Society, Petroleum Chemistry and Fuel Chemistry Divisions

Mid-Hudson New York, ACS Section Secretary (2005 and 2008-2010), Chair-Elect (2006, 2011, 2019), Chair (2007, 2012, 2020), Past Chair (2007, 2013, 2021), Webmaster (2005-2014).

Other Memberships - AOAC, Society of Applied Spectroscopy, American Oil Chemists Society, American Herbal Products Association (Associate Member), AMPERE, Royal Society of Chemistry, International Society of Magnetic Resonance, MBAA - Master Brewers Association of Americas, ASBC - American Society of Brewing Chemists, BA - Brewers Association, American Botanical Council, United States Association of Cider Makers

**JOURNAL EDITOR, COMMITTEE MEMBER, BOARD OF DIRECTORS:**

Organizing Committee Member and Treasurer - Practical Applications of NMR in Industry Conference (PANIC)

<http://www.panicnmr.com> - 2012-2016

Treasurer - PANIC NMR Association, Inc. - Non-Profit Scientific Conference Company - 2015-2016

American Chemical Society - Chair (2007, 2013), Committee Member, Webmaster - Mid-Hudson Section - 2005-2014

Magnetic Resonance in Chemistry - Wiley - Editor Special Issue dedicated to Benchtop NMR - 2016

Board of Directors and Treasurer - Crowd-Funding Research Experiences for Undergraduates (CREU) - <https://creu.tilt.com/> - 2014-2016

Co-Chair of AOAC Group Developing Standard Method for Aloe Vera Identification and Quantification - April 2016-Present

IUPAC Group III (organic and biomolecular) Member of International NMR Expert Committee working on NMR Data Format Project - "A critical review of reporting and storage of NMR data for spin-half nuclei in small molecules" - 2016-Present

Member of qNMR Method Development Group formed by USP and CENAPT - 2016 - Present

ValidNMR Committee Member – Research Coordinator – qNMR Proficiency Testing

### **AWARDS**

Texaco Research and Development Department: Outstanding Contributor Award – 1993

University of South Carolina: Outstanding Teaching Assistant Award - 1987.

Peyton C. Teague Graduate Scholarship Award, 1986.

### **PEER REVIEWED PUBLICATIONS:**

1. "Measurement of Quadrupolar Coupling Constants, Shielding Tensor Elements, and the Relative Orientation of the Quadrupolar and Shielding Tensor Principal Axis Systems for  $^{87}\text{Rb}$  and  $^{85}\text{Rb}$  in Rubidium Salts by Solid-State Nuclear Magnetic Resonance". J.T. Cheng, J.C. Edwards, P.D. Ellis, **J. Phys. Chem.**, **94**, 553 (1990).
2. "Solid-State  $^{95}\text{Mo}$  NMR Study of (Aryldiazenido)- and (Organohydrazido)-Polyoxomolybdates. Investigation of Model Compounds of Catalytic Molybdenum Environments". J.C. Edwards, J. Zubieta, S.N. Shaikh, Q. Chen, S. Bank, P.D. Ellis, **Inorg. Chem.**, **29**, 3381 (1990).
3. "A  $^{95}\text{Mo}$  Solid-State NMR Study of Hydrodesulfurization Catalysts. 1. The Formation of Fresh HDS Catalyst Precursors by Adsorption of Polyoxomolybdates onto  $\gamma$ -Alumina". J.C. Edwards, R.D. Adams, P.D. Ellis, **J. Amer. Chem. Soc.**, **112**, 8349 (1990)
4. "Cross-Polarization for Quadrupolar Nuclei - Proton to Molybdenum-95". J.C. Edwards, P.D. Ellis, **Magn. Reson. Chem.**, **28**, S59 (1990).
5. "Solid-State  $^{95}\text{Mo}$  NMR Study of Hydrodesulfurization Catalysts. 2. Investigation of Reduced/Sulfided Molybdena-Alumina Catalysts and the Effect of Promoter Ions on 'Fresh' and Reduced/Sulfided Molybdena-Alumina Catalysts". J.C. Edwards, P.D. Ellis, **Langmuir**, **7**, 2117 (1991).
6. "FT-IR and Solid-State NMR Investigation of Phosphorus Promoted Hydrotreating Catalyst Precursors". E.C. Decanio, J.C. Edwards, T.R. Scalzo, D.A. Storm, J.W. Bruno, **J. Catal.**, **132**, 498-511 (1991).
7. "Effects of  $\text{B}^{3+}$  Content of B-ZSM-11 and B-ZSM-5 on Acidity and Chemical and Thermal Stability". M.W. Simon, S.S. Nam, W.Q. Xu, S.L. Suib, J.C. Edwards, C.L. O'Young, **J. Phys. Chem.**, **96**, 6381 (1992).
8. "Deactivation of Hydrotreating Catalysts", J.G. Weissman, S. Lu, B.M. McElrath, J.C. Edwards, **Studies in Surface Science and Catalysis**, **73**, 377-384 (1992).
9. " $^{27}\text{Al}$  NMR, FT-IR AND Ethanol- $^{18}\text{O}$  TPD Characterization of Fluorided Aluminas". E.C. Decanio, V.P. Nero, J.C. Edwards, J.W. Bruno, **J. Catal.**, **140**, 84 (1993).
10. "Average Molecular Structure of Gasoline Engine Combustion Chamber Deposits Obtained By Solid-State  $^{13}\text{C}$ ,  $^{31}\text{P}$ , and  $^1\text{H}$  Nuclear Magnetic Resonance Spectroscopy". J.C. Edwards, P.J. Choate, **SAE Paper 932811**, presented at the Fuels and Lubricants Meeting of the Society of Automotive Engineers, October 21, (1993).
11. "Relationship Between Combustion Chamber Deposits and SI Engine Performance". P.J. Choate, J.C. Edwards, **SAE Paper 932812**, presented at the Fuels and Lubricants Meeting of the Society of Automotive Engineers, October 21, (1993).
12. "Observation of  $[\text{Al}(\text{OH})_n(\text{H}_2\text{O})_{6-n}]_n$  ( $\text{MoO}_4$ ) in Hydrotreating Catalyst Precursors by Solid-State  $^{27}\text{Al}$  NMR". J.C. Edwards, E.C. Decanio, **Catal. Lett.**, **19**, 121 (1993).
13. " $^{13}\text{C}$  and  $^{15}\text{N}$  Cross-Polarization Magic Angle Spinning NMR Spectra of  $^{15}\text{N}$ -Enriched 2-Phenethylamine Adsorbed on an Activated Clay". S.Bank, B. Yan, J.C. Edwards, G. Ofori-Okai, **Langmuir**, **10**, 1528 (1994).
14. "Performance and Characterization of Zirconium Modified Hydroprocessing Catalysts". J.G. Weissman, E.C. Decanio, J.C. Edwards, **Catal. Lett.** **24**, 113 (1994).

15. "Molecular Representations of Ratawi and Alaska North Slope Asphaltenes Based on Liquid- and Solid-State NMR". D.A. Storm, J.C. Edwards, S.J. Decanio, E.Y. Sheu, **Energy & Fuels** **8**, 561 (1994).
16. "Solid-State MAS  $^1\text{H}$  NMR Characterization of Gamma-Alumina and Modified Gamma-Aluminas". E.C. Decanio, J.C. Edwards, J.W. Bruno, **J. Catal.**, **148**, 76 (1994).
17. "Effect of Secondary Porosity on Gas Oil Cracking Activity". E.P. Dai, L.P. Neff, J.C. Edwards, published in the ACS Symposium Series : "Fluid Catalytic Cracking III : Materials and Processes", M.L. Ocelli, P.O'Connor, Editors, Chapter 6, p63-80 (1994).
18. "A Spectroscopic and Catalytic Study on the Formation and Thermal Decomposition of Sodium Ionic Clusters in NaX Zeolite: A Mechanism for Defect Site Formation". M.W. Simon, J.C. Edwards, S.L. Suib, **J. Phys. Chem.**, **99**, 4698 (1995).
19. "N-Butene Skeletal Isomerization to Isobutylene on Shape-Selective Catalysts: Ferrierite/ZSM-35". W-Q. Xu, Y-G. Yin, C.L. O'Young, J.C. Edwards, S.L. Suib, **J. Phys. Chem.**, **99**, 9443 (1995).
20. "Sludge Formation During Heavy-Oil Upgrading". D.A. Storm, S.J. Decanio, J.C. Edwards, E.Y. Sheu, published in the Proceedings of the 6th UNITAR International Conference on Heavy Crude and Tar Sands, Houston, Texas, February 12-17, (1995), p 365-372.
21. "The Synthesis and Structure of a Chiral Layered Aluminophosphate Containing the Template  $\text{Co}(\text{tn})_3^{3+}$ ". D.A. Bruce, A.P. Wilkinson, J.A. Bertrand, M.G. White, J. Edwards, **Chem Comm**, **1995**, 2059 (1995).
22. "Chemical Characterization of Coal Tar-Water Interfacial Films". E.C. Nelson, G. Marsh, J.C. Edwards, R.G. Luthy, A. Ramaswami, S. Ghosal, **Env. Sci. Tech.** **30**, 1014 (1996).
23. "Characterization and Aging of Hydrotreating Catalysts Exposed to Industrial Processing Conditions". J.G. Weissman, J.C. Edwards, **Applied Catal.**, **142(2)**, 289 (1996).
24. "Modification of Non-Template Synthesized Ferrierite/ZSM-35 for n-Butene Skeletal Isomerization to Isobutylene", Wen-Qing Xu, Yuan-Gen Yin, Steven L. Suib, John C Edwards, Chi-Lin O'Young, **J. Catal.** **163 (2)**, 232 (1996).
25. "Sediment Formation During Heavy Oil Upgrading". D.A. Storm, S.J. Decanio, J.C. Edwards, E.Y. Sheu, **Petroleum Science and Technology**, **15 (1&2)**, 77 (1997)
26. "Solid-State NMR and FT-IR Investigation of 12-Tungstophosphoric Acid Supported on  $\text{TiO}_2$ ". J.C. Edwards, C.Y. Thiel, J.F. Knifton, and B. Benac, **Catal. Lett.**, **51**, 77 (1998).
27. "Molecular Composites: Design of Inclusion Complexes of Polyisobutylenes with Cyclodextrins". M.K. Mishra, J.C. Edwards, P. Subramanian, R.D. Pugliese, **Designed Monomers and Polymers**, **1(2)**, 225 (1998).
28. "Methyl tert-Butyl Ether Synthesis from tert-Butanol via Inorganic Solid Acid Catalysis", John F. Knifton, John C. Edwards, **Applied Catalysis A: General** **183(1)**, 1 (1999).
29. "Inverse Temperature Dependence of Chain Transfer Rate Constants for Chromium Metalloradicals in Polymerization of MMA". Lihao Tang, Jack R. Norton, and John C. Edwards, **Macromolecules**, **36**, 9716 (2003).
30. "Solid-State NMR and ESR Studies of Activated Carbons Produced from Pecan Shells", H. N. Cheng, Lynda H. Wartelle, K.Thomas Klasson, and John C. Edwards, **Carbon**, **48**, 2455 (2010).
31. "RCC Feedstream Analysis by  $^1\text{H}$  and  $^{13}\text{C}$  NMR: Multivariate Prediction of Physical and Chemical Properties", John C. Edwards, Jincheol Kim, to be submitted to **Energy & Fuels**

32. "Solid-State  $^{13}\text{C}$  NMR Characterisation of Combustion Chamber Deposits Formed in Direct Injection Spark Ignition (DISI) Engines During an On-Road Vehicle Trial", Stefan de Goede, Tiaan Rabe, Andre Swarts, Riaan Bekker, Sibusiso Mtongana, and John C. Edwards, **SAE Paper 2010-01-2155**, presented at the Fuels and Lubricants Meeting of the Society of Automotive Engineer, San Diego, CA, October 25-27, 2010.
33. "Comparison of Coal-Derived and Petroleum Asphaltenes by  $^{13}\text{C}$  Nuclear Magnetic Resonance, DEPT, and XRS", A. Ballard Andrews, John C. Edwards, Andrew E. Pomerantz, Oliver C. Mullins, Dennis Nordlund, and Koy Norinaga, **Energy & Fuels**, **25(7)**, 3068 (2011).
34. "Advances in Asphaltene Science and the Modified Yen-Mullins Model", Oliver C. Mullins, Hassan Sabbah, Joelle Eyssautier, Andrew E. Pomerantz, Loic Barre, A. Ballard Andrews, Yosadara Ruiz-Morales, Farshid Mostowfi, Richard McFarlane, Lamia Goual, Richard Lepkowitz, Thomas Cooper, Jhony Orbulescu, Roger M. Leblanc, John C. Edwards, Richard N. Zare, **Energy & Fuels**, 2012, 26 (7), pp 3986–4003
35. "Quantitative Proton Nuclear Magnetic Resonance Spectrometry ( $^1\text{H}$  NMR) for Determination of Acetylated Polysaccharides, Glucose, Maltodextrin, and Isocitrate in Aloe Vera Leaf Juice" John C. Edwards, **American Herbal Pharmacopoeia** - Monograph on Aloe Vera Leaf, Leaf Juice & Inner Leaf Juice, Analytical NMR Method, 2013.
36. "The Use of  $^1\text{H}$ -NMR Relaxation Times of Water Adsorbed on Soils to Monitor Environment Pollution", Leonid Grunin, Ekaterina Nikolskaya, John C. Edwards, **Air, Soil and Water Research**, 6, 1–5, 2013.
37. "Application of Quantitative Nuclear Magnetic Resonance Spectroscopy to Biological Acidification of Barley Mash", Adam Dicaprio, John C. Edwards, **J. Inst. Brew.**, 120(3), 207-211, 2014.
38. "Liquid and Solid-State  $^1\text{H}$ ,  $^{13}\text{C}$ , and  $^{11}\text{B}$  qNMR Analysis of Fruitex-B<sup>®</sup>– A Calcium Fructoborate Complex: Chemical Structure and identification, quantitative analysis and stability study", John C. Edwards, John M. Hunter, Boris V. Nemzer, **J. Food Res.**, 3(3), 115-131, 2014.
39. "The emergence of benchtop NMR systems and the exciting future of the technology", Special Edition Editorial, *Magn. Reson. Chem.*, 54, 492, 2016.
40. "Nuclear Magnetic Resonance and Headspace Solid-Phase Microextraction Gas Chromatography as Complementary Methods for the Analysis of Beer Samples", S.R. Johnson, S.E. Soprano, L.M. Wickham, N.Fitzgerald, John.C. Edwards, *Beverages*, **2017**, 3, 21.

#### **PRESENTATIONS:**

1. "Solid-State  $^{95}\text{Mo}$  Nuclear Magnetic Resonance Spectroscopy of Molybdenum in Catalytic Environments". J.C. Edwards, presented at the "Waugh Symposium" for High Resolution NMR in Solids, Massachusetts Institute of Technology, Boston MA, January 20, 1989.
2. "Solid-State Molybdenum-95 Nuclear Magnetic Resonance Spectroscopy of Hydrotreating Catalysts". J.C. Edwards, P.D. Ellis, presented at invited seminar, SUNY-Albany, Albany, NY, March 5, 1991.
3. "Structural Characterization of Alkyl Amine Intercalation Compounds of Hydrous Uranium Oxide". C.M. King, M.C. Thompson, R.B. King, J.C. Edwards, P.D. Ellis, presented at 201st Meeting of the American Chemical Society, Atlanta, Georgia, April 14-19, 1991.
4. "Solid-State  $^{31}\text{P}$ ,  $^{27}\text{Al}$ , and  $^1\text{H}$  MAS NMR of Phosphorus Promoted Hydrotreating Catalyst Precursors". J.C. Edwards, E.C. Decanio, D.A. Storm, presented at the American Chemical Society North East Regional Meeting, University of Massachusetts, Amherst, MA, June 1991.
5. "FT-IR, MAS NMR, and XRD Investigation of Phosphorus Promoted Ni-Mo/ $\text{Al}_2\text{O}_3$  Hydrotreating Catalyst Precursors". E.C. Decanio, J.C. Edwards, T.R. Scalzo, D.A. Storm, presented at the 202nd Meeting of the American Chemical Society, New York, New York, August 25-30, 1991

6. "Multinuclear Solid-State NMR Investigation of Boron-Zeolites and Borosilicates". J.C. Edwards, C.L. O'Young, P.J. Giammatteo, presented at the National ACS Meeting, New York, NY, August 25-30, 1991.
7. "Deactivation of Hydrotreating Catalysts" J.G. Weissman, S. Lu, J.C. Edwards. Presented at the 12th Canadian Symposium on Catalysts, Alberta, Canada, May 25-28, 1992.
8. "FT-IR, NMR and XRD Investigation of Phosphorus Promoted Ni-Mo-Al<sub>2</sub>O<sub>3</sub> Hydrotreating Catalyst Precursors". E.C. Decanio, J.C. Edwards, T.R. Scalzo, D.A. Storm, presented at Spring Symposium of the Catalysis Society of New England, Yale University, March 18, 1992.
9. "FT-IR, NMR and XRD Investigation of Phosphorus Promoted Ni-Mo-Al<sub>2</sub>O<sub>3</sub> Hydrotreating Catalyst Precursors". E.C. Decanio, J.C. Edwards, T.R. Scalzo, D.A. Storm, presented at Spring Symposium of the Catalysis Society of Metropolitan New York, Lehigh University, March 11, 1992.
10. "Investigation of Calcined, Reduced, and Sulfided Phosphorus Promoted Ni-Mo/Al<sub>2</sub>O<sub>3</sub> Hydrotreating Catalyst Precursors". E.C. Decanio, J.C. Edwards, D.A. Storm, presented at 22nd North East regional Meeting of the ACS, Syracuse, NY, June 21-24, 1992.
11. "FT-IR, Solid-State MAS NMR and Ethanol-<sup>18</sup>O TPD Analysis of Fluorided Aluminas". E.C. Decanio, V.P. Nero, J.C. Edwards, J.W. Bruno, presented at 204th ACS National Meeting, Washington D.C., August 25-28, 1992.
12. "Acidity, Chemical and Thermal Stability of [B]-ZSM-5 and [B]-ZSM-11". M.W. Simon, S.S. Nam, W. Xu, S.L. Suib, J.C. Edwards, C.L. O'Young, presented at ACS Symposium on Recent Advances in Molecular Sieve Materials, Denver, Colorado, March 1993.
13. "Comparison of Molecular Representation of Ratawi and Alaska North Slope Asphaltenes Based on Liquid and Solid-State NMR". D.A. Storm, J.C. Edwards, S.J. Decanio, E.Y. Sheu, presented at ACS Symposium on Resid Upgrading, Denver, Colorado, March 28-April 2, 1993.
14. "Effect of Secondary Porosity on Gas Oil Cracking Activity". E.P. Dai, L.P. Neff, J.C. Edwards, presented at the Symposium on Advances in Fluid Catalytic Cracking, 206th ACS Meeting, Chicago, IL, August 22-27, 1993.
15. "Elucidation of the Inorganic Chemistry of Hydrotreating Catalyst Additives". E.C. Decanio, J.C. Edwards, D.A. Storm, presented at the National ACS Meeting, Denver, Colorado, March 28-April 2, 1993.
16. "Investigation of Phosphate and Sulfate Promoted Ni-Mo/Al<sub>2</sub>O<sub>3</sub> Hydrotreating catalyst Precursors". E.C. Decanio, J.C. Edwards, D.A. Storm, J.W. Bruno, presented at 13th North American Meeting of the Catalysis Society, Pittsburgh, Pennsylvania, May 2-7, 1993.
17. "Molecular Modeling Studies of Phosphate Chains on Gamma-Alumina". J.R. Ugolini, E.C. Decanio, J.C. Edwards, P.S. Subramanian, K.J. Chou, presented at the Fall National ACS Meeting, Chicago, Illinois, August 22-27, 1993.
18. "Mechanisms of Formation of Combustion Chamber Deposits". W.P. Acker, R.T. Hahn, F.J. Deblase, J.C. Edwards, R.L. Sung, presented at CRC Combustion Chamber Deposit Meeting, Orlando, Florida, November 1993.
19. "Applications of Solid- and Liquid-State <sup>13</sup>C and <sup>1</sup>H Nuclear Magnetic Resonance to the Analysis of Ethylene-Propylene Copolymers". G. Marsh, J.C. Edwards, M. Mishra, presented at the Spring National ACS Meeting, San Diego, California, March 13-18, 1994.
20. "Process Applications of NMR on Flowing Gaseous Streams". P.J. Giammatteo, G. Marsh, J.C. Edwards, presented at the 35th Experimental NMR Conference, Asilomar, California, April 10-15, 1994.

21. "The Role of Chemists in the Petroleum Industry". J.C. Edwards, presented under the auspices of the Industrial Research Institute, at Vassar College, Poughkeepsie, New York, March 9, 1994.
22. "Characterization of Gasoline Engine Combustion Chamber, Intake Valve and Crankcase Deposits by Solid-State <sup>13</sup>C CP/MAS NMR Spectroscopy". J.C. Edwards, presented at the 36th Rocky Mountain Conference on Analytical Spectroscopy, Denver, Colorado, July 31-August 5, 1994.
23. "Sludge Formation During Heavy-Oil Upgrading". D.A. Storm, S.J. Decanio, J.C. Edwards, E.Y. Sheu, presented at the 6th UNITAR International Conference on Heavy Crude and Tar Sands, Houston, Texas, February 12-17, 1995.
24. "Process Applications of NMR on Flowing Gaseous Streams. Part II". P.J. Giammatteo, J.C. Edwards, presented at the 36th Experimental NMR Conference, Boston MA, March 26-30, 1995.
25. "Monitoring the Chemistry of Phosphorus Compounds in Lubricants". J.R. Sieber, J.C. Edwards, presented at the 44th Annual Denver X-Ray Conference, Colorado Springs, Colorado, July 31 - August 4, 1995.
26. "Modification of Non-Template Synthesized Ferrierite/ZSM-35 for N-Butene Skeletal Isomerization to Isobutylene". W.Q. Xu, Y.G. Yin, S.L. Suib, J.C. Edwards, C.-L. O'Young, presented at the Fall National ACS Meeting, Chicago IL, August 1995.
27. "Design of 'Beaded Molecular Strings' ". M.K. Mishra, J.C. Edwards, P.M. Subramanian, R.D. Pugliese, presented at International Ionic Polymerization Conference, Istanbul, Turkey, September 2-9, 1995.
28. "Development of a Process NMR Gasoline Analysis System". J.C. Edwards, P.J. Giammatteo, G.P. Firmstone, P.D. Cusatis, presented at the 37th Experimental NMR Conference, Pacific Grove, CA, March 17-22, 1996.
29. "Process Applications of NMR on Flowing Gaseous Streams. Part III. The Installation and Operation of an On-Line NMR in a Refinery". P.J. Giammatteo, J.C. Edwards, T. Cohen, M.W. Blakley, presented at the 37th Experimental NMR Conference, Pacific Grove, CA, March 17-22, 1996.
30. "<sup>2</sup>H NMR of Low Temperature Crystallization Processes in Base Oils Utilizing a Perdeuterated Probe Molecule". J.C. Edwards, P.J. Giammatteo, A.J. Stipanovic, M.P. Smith, presented at the 37th Experimental NMR Conference, Pacific Grove, CA, March 17-22, 1996.
31. "Multinuclear and Multidimensional Solid-State NMR Investigations of Combustion Chamber Deposits". J.C. Edwards, presented at the National ACS Meeting, Petroleum Division, New Orleans, LA, March 24-29, 1996.
32. "NMR Based Refinery Process Control Systems: New Technology for Process Optimization". P.J. Giammatteo, J.C. Edwards, G.P. Firmstone, presented at the Texaco Technology Conference, Houston TX, July 15-17, 1996.
33. "NMR Based Process Analysis and Control: New Technology for Process Optimization". P.J. Giammatteo, J.C. Edwards, presented at the Instrument Society of America Meeting, Chicago IL, October 7-11, 1996
34. "The Nature of 12-Tungstophosphoric Acid-on-Titania Catalysts". J.C. Edwards, C.Y. Thiel, B.L. Benac, J.F. Knifton, presented at the ACS Southwest Regional Meeting, Houston, Texas, October 17-19, 1996.
35. "High Resolution NMR Based Process Control for Petroleum Refining - Part I". P.J. Giammatteo, J.C. Edwards, presented at the Eastern Analytical Conference, Somerset, New Jersey, November 18, 1996.
36. "High Resolution NMR Based Process Control for Petroleum Refining - Part II". J.C. Edwards, P.J. Giammatteo, presented at the Eastern Analytical Conference, Somerset, New Jersey, November 18, 1996.
37. "High Resolution NMR Based Process Control for Petroleum Refining". P.J. Giammatteo, J.C. Edwards, presented at the Annual New Jersey ISA Chapter Meeting, Princeton, New Jersey, November 20, 1996.

38. "Investigation of Low Temperature Crystallization Processes in Base Oils Utilizing a Perdeuterated Probe Molecule and  $^2\text{H}$  NMR". J.C. Edwards, A.J. Stipanovic, P. J. Giammatteo, M.P. Smith, Invited presentation at the American Chemical Society National Meeting, San Francisco, CA, April 13-17, 1997.
39. "XPS and Solid-State NMR of Soot Produced in a Heavy-Duty Diesel Engine: Impact of Lubricant Additive Chemistry on Wear Performance". J.K. Mowlem, J.C. Edwards, presented at the 215th National ACS Meeting, Dallas, TX, March 29 – April 3, 1998.
40. "On-line Acid Strength Measurement and Sulfuric Acid Alkylation Process Control Using Process NMR". J.C. Edwards and Paul J. Giammatteo, presented at the ISA Analytical Division Meeting, Research Triangle Park, April 26-29, 1998.
41. "Lubricant Additive Chemistry Effects of Diesel Engine Soot on Wear Performance as Studied by XPS and Solid-State NMR", J.K. Mowlem, and J.C. Edwards, presented at the 72nd Colloid and Surface Science Symposium, Pennsylvania State University, June 21-24, 1998.
42. "Utilization of Process NMR for On-Line Acid Strength Determination and Sulfuric Acid Alkylation Process Control" J.C. Edwards, P.J. Giammatteo, E. Ross, presented at ISA Expo98, Houston, Texas, October 19-22, 1998.
43. "Process NMR Applications in the Refinery: Utilization, Closed Loop Control, and Value-Added Statements" J.C. Edwards, Presented at the Delaware ACS-SAS Process Analytical Topical Group Meeting, June 2002.
44. "Detailed Hydrocarbon Analysis of Naphtha by On-Line NMR : Integration of Real-Time NMR Feed Analysis With Advanced Process Control and Optimization" J.C. Edwards, P.J. Giammatteo , Presented at Eastern Analytical Symposium, Somerset, New Jersey, November 18-21, 2002.
45. "On-Line Analysis of Crude Feeds and Distillation Products: Utilization of On-Line NMR on a Refinery's Crude Distillation Unit", P.J. Giammatteo, J.C. Edwards, Presented at Eastern Analytical Symposium, Somerset, New Jersey, November 18-21, 2002.
46. "Process MRA Lube Plant Application", Silvia Guanziroli, Roberto Giardino (EniTecnologie), Antonio Farina (ENI Refining & Marketing), Victor Lough (Invensys), John C. Edwards. Presented at the ERTC Computing Conference, Milan, Italy, June 23-25 2003.
47. "Process NMR Applications: Utilization, Closed Loop Control, and Value Added Statements", John C. Edwards and Paul J. Giammatteo, Presented at CPAC Fall 2003 Sponsor Meeting, Seattle, WA, November 3-6, 2003.
48. " High resolution NMR for On-Line Process Analysis and Control: Application and Utilization in Petroleum Refining and Petrochemical Industries. ", Paul J. Giammatteo and John C. Edwards, Presented at Eighteenth International Forum Process Analytical Chemistry - IFPAC, Arlington, VA, January 12-15, 2004
49. "Crude Oil Blending." Paul J. Giammatteo and John C. Edwards, Presented at the International School of Hydrocarbon Measurement, Oklahoma City, OK, May 18-20, 2004
50. "The Overlooked Spectroscopy - NMR and Process Analytical Technology" John C. Edwards, Presented at the Society of Applied Spectroscopy New York Section Meeting, December 1, 2004
51. "Pulse, Acquire, Control : Ten Years of Online High Resolution NMR in Refining, Petrochemical, and Food manufacturing", John C. Edwards and Paul Giammatteo, Presented at the 46th Experimental NMR Conference, Providence, RI, April 10-15, 2005.
52. "The Overlooked Spectroscopy - NMR and Process Analytical Technology" John C. Edwards, Presented at the Mid-Hudson Section ACS Meeting, Vassar College, Poughkeepsie, NY, May 12, 2005

53. "*The Overlooked Spectroscopy - NMR and Process Analytical Technology*" John C. Edwards, Presented at Scientific Update Conference on PAT in Organic Process R&D, Cambridge, MA, June 29, 2005
54. "*Pulse, Acquire, Control : Ten Years of Online High Resolution NMR in Refining, Petrochemical, and Food manufacturing*", John C. Edwards and Paul Giammatteo, Presented at NERM 2005, Fairfield, CT, July 14-17, 2005
55. "*The Wonderful World of Non-Traditional NMR*", John C. Edwards, Invited Presentation at the ACS student Section Meeting, Marist College, Poughkeepsie, NY December 6, 2006
56. "*Pulse, Acquire, Control : Ten Years of Online High Resolution NMR in Refining, Petrochemical, and Food manufacturing*", John C. Edwards, Invited Presentation at Elms College, Chicopee MA, April 17, 2007
57. "*Pulse, Acquire, Control : Ten Years of Online High Resolution NMR in Refining, Petrochemical, and Food manufacturing*", John C. Edwards, Invited Presentation at Cooper Union, New York, NY, September 18, 2007
58. "*New Developments in Non-Traditional NMR Applications*", John C. Edwards, Invited Presentation at 9<sup>th</sup> Upstate New York NMR Symposium, SUNY-ESF, Syracuse, NY, October 12, 2007
59. "*Introduction to High Resolution NMR in Process Control*", John C. Edwards, Presented at Eastern Analytical Symposium, Somerset, NJ, November 14, 2007
60. "*How to Derive Considerable Returns from 1970's Style NMR - Quantitative  $\pi/4$   $^1\text{H}$  Pulses at 60 MHz*", John C. Edwards, Invited Presentation at the North Jersey ACS - NMR Spectroscopy Group Meeting, Iselin, NJ, December 12, 2007
61. "*Solid-State  $^{13}\text{C}$  NMR Applied to Petroleum Related Materials - Combustion Deposits, Asphaltenes, Residues, Kerogen, Shale, Bitumen, Coal, the Works*", John C. Edwards, Invited Presentation at the SACI/RSC Solid-State NMR Spectroscopy Workshop, University of Stellenbosch, Stellenbosch, South Africa, February 4-7, 2008
62. "*Aspects of Liquid and Solid-State NMR Applied to Materials Science*", John C. Edwards, Invited Presentation at the SACI/RSC Solid-State NMR Spectroscopy Workshop, University of Stellenbosch, Stellenbosch, South Africa, February 4-7, 2008
63. "*Pore Surface of Cellulose as Studied by Low-Resolution NMR*", E. Nikolskaya, Y. Grunin, John C. Edwards, L. Grunin, Presented at the 9<sup>th</sup> International Bologna Conference Magnetic Resonance in Porous Media, Cambridge, MA, July 13-17, 2008
64. "*RCC Feedstream Analysis by  $^1\text{H}$  and  $^{13}\text{C}$  NMR: Multivariate Prediction of Physical and Chemical Properties*", John C. Edwards, Jincheol Kim, Presented at ACS 236<sup>th</sup> National Meeting, Philadelphia, PA, August 17-21, 2008
65. "*Counting Carbons for Tighter Control: Combining GC and NMR to Improve Distillate Manufacturing*" Paul J. Giammatteo, John C. Edwards, George Winter, Presented at 104<sup>th</sup> Gulf Coast Conference, Galveston, TX, January 20-21, 2009.
66. "*Analytical Data For Engineering Support: Improving the Lab/Process Interface*" Paul J. Giammatteo, John C. Edwards, Presented at 104<sup>th</sup> Gulf Coast Conference, Galveston, TX, January 20-21, 2009
67. "*Integrated Analysis and Control to Enhance Clean Fuels Production*" Tal Cohen, Paul J. Giammatteo, John C. Edwards, Presented at 54<sup>th</sup> Annual Symposium of the ISA Analysis Division, Houston, TX, April 19-23, 2009.
68. "*A Self-Employed Application Chemists Odyssey in the World of Analytical Instrument Development The Viability of a \$50K High Resolution NMR and \$15K ESR Spectrometers*", John C. Edwards, Invited Presentation to the Mid-Hudson ACS Section, Marist College, Poughkeepsie, NY, September 23, 2009.

69. "Digital Concepts in Building of NMR Relaxometers and Their Advantages in the Study of Natural Polysaccharides", L.Grunin, D. Karasev, E. Nikol'skaya, J.C.Edwards, I.Kalashnikov, I.Nikolaev, Y.Grunin, N.Celisheva, presented at the 51st Experimental NMR Conference, Daytona beach, Florida, April 18-23, 2010.
70. "Improved Approach to the Calculation of Average Molecular Descriptions of Heavy Petroleum Hydrocarbons by Combined Analysis by Quantitative  $^{13}\text{C}$  and DEPT-45 NMR Experiments", John C. Edwards, Petrophase 2010, Newark, NJ, June 13-17, 2010.
71. "A Self-Employed Application Chemists Odyssey in the World of Analytical Instrument Development The Viability of a \$50K High Resolution NMR and \$15K ESR Spectrometers", John C. Edwards, Invited Presentation at University of South Dakota, Vermillion, SD, July 21 2010.
72. "Simple and Continuous Flow Reaction Monitoring by High Resolution Bench-top Permanent Magnet  $^1\text{H}$  NMR at 60 MHz", John C. Edwards, Paul J. Giammatteo, Invited presentation at SMASH 2010, in Portland Oregon, September 26-29, 2010.
73. "Bench-top and On-line High Resolution Permanent Magnet 60 MHz NMR for Reaction Monitoring and Process Control", John C. Edwards, Paul J. Giammatteo, Invited presentation at FACSS 2010, in Raleigh, NC, October 17-21, 2010.
74. "Practical Applications of Compact High-Resolution 60 MHz Permanent Magnet NMR Systems for Reaction Monitoring and Online Process Control", John C. Edwards, Invited Presentation at RSC Symposium - Reaction Monitoring Using NMR and Vibrational Spectroscopy: Current Industrial Perspectives, Sandwich, Kent, UK, March 22, 2011.
75. "Multivariate Analysis of  $^1\text{H}$  and  $^{13}\text{C}$  NMR Data of Residual Catalytic Cracker Feed-Streams: NMR Pre-Processing Strategies that Allow the Development of Predictive Models of Physical and Chemical Properties that are Independent of NMR Instrument Magnetic Field Strength", John C. Edwards, Jincheol Kim, Presented at IFPAC 2012 in Baltimore MD, January 22-25, 2012
76. "Practical Applications of Compact High-Resolution 60 MHz Permanent Magnet NMR Systems for Reaction Monitoring and Online Process Control", John C. Edwards, Paul J. Giammatteo and Mark Zell, Presented at IFPAC 2012 in Baltimore MD, January 22-25, 2012
77. "Process NMR - Latest Technology Developments, Reaction Monitoring, Process Control Applications and At-Line Analysis", John C. Edwards, presented at CPAC Spring Meeting, Seattle, WA, May 7, 2012
78. "Advances in Asphaltene Science and the Modified Yen-Mullins Model", Oliver C. Mullins, Hassan Sabbah, Joelle Eyssautier, Andrew E. Pomerantz, Loic Barre, A. Ballard Andrews, Yosadara Ruiz-Morales, Farshid Mostowfi, Richard McFarlane, Lamia Goual, Richard Lepkowitz, Thomas Cooper, Jhony Orbulescu, Roger M. Leblanc, John C. Edwards, Richard N. Zare, Presented at AIChE, Houston TX, April 1-5, 2012.
79. "Quantitative  $^1\text{H}$  qNMR Method for Complex Mixture Analysis: Determination of Acetylated Polysaccharides, Glucose, Maltodextrin, Isocitrate, Preservatives, Additives and Degradation Products in Aloe Vera Leaf Juice - Raw Material and Consumer Products", John C. Edwards, presented at SMASH 2012, Providence, RI, September 9-12, 2012
80. "Practical Applications of Compact, Cryogen-Free High-Resolution 60 MHz Permanent Magnet NMR Systems for Reaction Monitoring and Online/At-Line Process Control", John C. Edwards, Paul J. Giammatteo, Tal Cohen, presented at SMASH 2012, Providence, RI, September 9-12, 2012
81. "Calculation of Average Molecular Descriptions of Heavy Petroleum Hydrocarbons by Combined Analysis by Quantitative  $^{13}\text{C}$  and DEPT-45 NMR Experiments", John C. Edwards, presented at SMASH 2012, Providence, RI, September 9-12, 2012
82. "On-line Applications of 60 MHz High-Resolution NMR Systems in Industry: Direct Measurements, Chemometric Correlations, and Multiple Spectroscopy Data Fusion", John C. Edwards, invited talk presented at 1st Practical Applications of NMR in Industry Conference, Schaumburg, IL, October 15-17, 2012

83. "<sup>1</sup>H qNMR Determination of Acetylated Polysaccharides, Glucose, Maltodextrin, Isocitrate, Degradation Products, Preservatives and Additives in Aloe Vera Leaf Juice", John C. Edwards, presented at 1st Practical Applications of NMR in Industry Conference, Schaumburg, IL, October 15-17, 2012
84. "Compact, Cryogen-Free, High-Resolution 60 MHz Permanent Magnet NMR Systems for Reaction Monitoring and On-Line/At-Line Process Control Observing <sup>1</sup>H, <sup>19</sup>F, <sup>31</sup>P", John C. Edwards, Tal Cohen, Paul J. Giammatteo, presented at 1st Practical Applications of NMR in Industry Conference, Schaumburg, IL, October 15-17, 2012
85. "Calculation of Average Molecular Descriptions of Heavy Petroleum Hydrocarbons by Combined Analysis by Quantitative <sup>13</sup>C and DEPT-45 NMR Experiments", John C. Edwards, presented at 1st Practical Applications of NMR in Industry Conference, Schaumburg, IL, October 15-17, 2012
86. "<sup>1</sup>H qNMR Determination of Acetylated Polysaccharides, Glucose, Maltodextrin, Isocitrate, Degradation Products, Preservatives and Additives in Aloe Vera Leaf Juice", John C. Edwards, presented at the 1st Global Aloe Summit, SupplySide West - Global Expo and Conference, Las Vegas, NV November 5-9, 2012.
87. "Application of a 60 MHz Permanent Magnet NMR System to Online NMR Reaction Development in the Pharmaceutical Industry", David A. Foley, Mark T. Zell, Brian L. Marquez, John C. Edwards, Paul J. Giammatteo, presented at PittCon, Philadelphia, PA, March 17-21, 2013.
88. "New Developments in Compact High Resolution NMR Technologies: Multi-Nuclear Applications for Laboratory, At-Line, On-Line and Process Control", Paul J. Giammatteo, John C. Edwards, Tal Cohen, Presented at PittCon, Philadelphia, PA, March 17-21, 2013.
89. "Compact, Cryogen-Free, High-Resolution 60 MHz Permanent Magnet NMR Systems for Reaction Monitoring and On-Line/At-Line Process Control Observing <sup>1</sup>H, <sup>19</sup>F, <sup>31</sup>P", John C. Edwards, David A. Foley, Mark T. Zell, Brian L. Marquez, Tal Cohen, Paul J. Giammatteo, presented at the 18<sup>th</sup> Triennial ISMAR Conference, Rio de Janeiro, Brazil, May 19-24, 2013.
90. "Calculation of Average Molecular Descriptions of Heavy Petroleum Hydrocarbons by Combined Analysis by Quantitative <sup>13</sup>C and DEPT-45 NMR Experiments", John C. Edwards, A. Ballard Andrews, presented at the 18<sup>th</sup> Triennial ISMAR Conference, Rio de Janeiro, Brazil, May 19-24, 2013.
91. "Advances in Field-Deployable NMR Instruments for Laboratory and Process Applications in the Petroleum and Petrochemical Industries – Chemometrics, Direct Measurements, and Data Fusion", John C. Edwards, presented at the 246<sup>th</sup> ACS National Meeting, Indianapolis, IN, September 8-12, 2013
92. "Utilization of MNova in a Commercial NMR Testing Laboratory for 1) Development of Automated Quantitative Analysis Methods by Direct Internal Standard NMR Measurements, and 2) Pre-Processing of Large NMR Datasets for Chemometric Regression Analyses to Derive Chemical and Physical Properties", John C. Edwards, Invited Talk at the MNova User's Meeting, September 22, 2013, Santiago de Compostela, Spain.
93. "PLS Regression Model Comparison of 60 and 300 MHz <sup>1</sup>H qNMR of EPA and DHA Omega-3 Fatty Acids Obtained at Different Points in a Fish Oil Nutritional Supplement Manufacturing Process", John C. Edwards and Paul J. Giammatteo, presented at SMASH 2013, September 22-25, 2013, Santiago de Compostela, Spain
94. "PLS Regression Model Comparison of 60 and 300 MHz <sup>1</sup>H qNMR of EPA and DHA Omega-3 Fatty Acids Obtained at Different Points in a Fish Oil Nutritional Supplement Manufacturing Process", John C. Edwards and Paul J. Giammatteo, presented at NERM 2013, New Haven CT, October 23-26, 2013
95. "Descriptive Small Molecule Chemistry of Ales Produced by Wild Fermentation: <sup>1</sup>H qNMR Analysis of Organic Acid and Ester Distributions", Adam J. Dicaprio, John C. Edwards, Presented at NERM 2013, New Haven CT, October 23-26, 2013.

96. "Small Molecule Chemistry of Spontaneously Fermented Coolship Ales", Adam J. Dicaprio, John C. Edwards, Presented at NERM 2013, New Haven CT, October 23-26, 2013.
97. "NMR Based Authentication of Nutraceuticals, Herbal Supplements, and Food Additives: Economic- and Efficacy-Driven Adulteration of Aloe Vera, Herbal Erectile Dysfunction Supplements, and Acacia Gum", John C. Edwards, invited presentation at the 2<sup>nd</sup> PANIC, Charlotte, NC, February 3-5, 2014.
98. "Development of an Automated Complex Mixture Analysis qNMR Method within Mestrelab MNova - Application to Aloe Vera and the Beer Brewing Process", John C. Edwards, Adam J. Dicaprio, Michael A. Bernstein, presented at the 2<sup>nd</sup> PANIC, Charlotte, NC, February 3-5, 2014.
99. "Small Molecule Chemistry of Spontaneously Fermented Coolship Ales", Adam J. Dicaprio, John C. Edwards, presented at the 2<sup>nd</sup> PANIC, Charlotte, NC, February 3-5, 2014.
100. "Liquid and Solid-State <sup>1</sup>H, <sup>13</sup>C, and <sup>11</sup>B qNMR Analysis of Fruitex-B® - A Calcium Fructoborate Complex: Chemical Structure and identification, quantitative analysis and stability study", Boris Nemzer, John C. Edwards, presented at the 2<sup>nd</sup> PANIC, Charlotte, NC, February 3-5, 2014.
103. "Quantitative Small Mixture Analysis (SMA): Quality of Aloe Vera, Acid Profiles of Sour Beers, PDE5i Adulteration of Male Enhancement Formulations", John C. Edwards, presented at the Mnova Users Meeting at the 55<sup>th</sup> Experimental NMR Conference, Boston MA, March 23, 2014.
104. "Extending and Facilitating Simple Mixtures Analysis", M. Bernstein, C. Cobas, S. Dominguez, M. Pérez, A. Barba, J. Edwards, Presented at the 55th Experimental NMR Conference, Boston, MA March 23-27 2014.
105. "Liquid and Solid-State <sup>27</sup>Al qNMR of an Elemin Senonian Trace Minerals Supplement for Identification, Chemical Structure, Quantitation of Active Ingredient in the Product, and Product Stability", Boris Nemzer, John C. Edwards, presented at XII International Conference on the Applications of Magnetic Resonance in Food Science: Defining Food by Magnetic Resonance, Cesena, Italy, May 20-23, 2014.
106. "Liquid and Solid-State Multinuclear <sup>13</sup>C and <sup>11</sup>B qNMR FruitexB Fructoborate Complex Nutritional Supplement. Identification, Chemical Structure, Quantitation of Active Ingredient in Product, and Product Stability", Boris Nemzer, John C. Edwards, presented at XII International Conference on the Applications of Magnetic Resonance in Food Science: Defining Food by Magnetic Resonance, Cesena, Italy, May 20-23, 2014.
107. "<sup>1</sup>H qNMR of EPA and DHA Omega-3 Fatty Acid Esters - PLS Regression Models Obtained by 60 and 300 MHz NMR - At-Line and On-Line Monitoring of a Fish Oil Nutritional Supplement Manufacturing Process", John C. Edwards, Paul J. Giammatteo, Invited Lecture - presented at XII International Conference on the Applications of Magnetic Resonance in Food Science: Defining Food by Magnetic Resonance, Cesena, Italy, May 20-23, 2014.
108. "Application of High Field and Cryogen-Free Bench-Top NMR Platforms to the Monitoring and Quantitation of PDE5 Inhibitor Adulteration of Male Sexual Enhancement Supplements", John C. Edwards, Paul J. Giammatteo, Kristie Adams, Anton Bzhelyansky, presented at XII International Conference on the Applications of Magnetic Resonance in Food Science: Defining Food by Magnetic Resonance, Cesena, Italy, May 20-23, 2014.
109. "Beer Manufacturing and Analysis by NMR", John C. Edwards and Adam Dicaprio, Invited presentation presented at the Mestrelab MNova Users, Meeting - SMASH, Atlanta, GA, September 7, 2014
110. "Survey of Low Field NMR Spectrometer Platforms for Successful Screening of Sexual Enhancement and Weight Loss Supplements for Adulteration with Drugs and Drug Analogs", John C. Edwards, Kristie Adams, Anton Bzhelyansky, Invited Lecture - Presented at SMASH Conference, Atlanta, GA, September 7-10, 2014.

111. "High Throughput Petroleum Stream Analysis in Refinery Process Laboratories: Benchtop NMR Offers Timely Results with Automation & Chemometrics", Courtney Phillips, John C. Edwards, presented at 2014 Gulf Coast Conference, Galveston TX, October
- 112.. "Quantifying Fatty Acids, Including EPA and DHA Omega-3 Fatty Acids in Dietary Supplement Manufacturing without Separation Using 42 MHz, 60 MHz and 300 MHz  $^1\text{H}$  High Resolution NMR Spectroscopy", John C. Edwards and Paul J. Giammatteo, presented at 2014 AAPS Annual Meeting and Exposition, San Diego, CA, November 2-6, 2014.
113. "Rapid Screening of Dietary Supplements: Application of High Field and Cryogen-Free Bench-Top NMR Spectroscopy for Monitoring, Identifying and Quantifying PDE5 Inhibitor Adulteration in Male Sexual Enhancement Supplements", Paul J. Giammatteo, John C. Edwards, Kristie M. Adams, Anton Bzhelyansky, presented at 2014 AAPS Annual Meeting and Exposition, San Diego, CA, November 2-6, 2014.
114. "Survey of Low Field NMR Spectrometer Platforms for Successful Screening of Sexual Enhancement and Weight Loss Supplements for Adulteration with Drugs and Drug Analogs", John C. Edwards, Kristie Adams, Anton Bzhelyansky, Invited Lecture - Presented at Carolina NMR Symposium, Kannapolis, NC, November 6, 2014.
115. "From Mash to Bottle: Chemistry of the Brewing Process and NMR-Based Quality Control", Adam J. DiCaprio, John C. Edwards, Presented at Carolina NMR Symposium, Kannapolis, NC, November 6, 2014.
116. "PLS Regression Model Comparison of 60 and 300 MHz  $^1\text{H}$  qNMR of EPA and DHA Omega-3 Fatty Acids Obtained at Different Points in a Fish Oil Nutritional Supplement Manufacturing Process", John C. Edwards and Paul J. Giammatteo, presented at Carolina NMR Symposium, Kannapolis, NC, November 6, 2014.
117. "Nutritional Supplement and Diesel Fuel Application Development for Benchtop NMR Systems Operating at 42, 60, and 80 MHz – Equivalency with Supercon NMR", John C. Edwards and Paul J. Giammatteo presented at 3rd PANIC, San Diego CA, February 9-12, 2015.
118. " $^1\text{H}$  qNMR of Alcoholic Cider - Analysis of Small Molecule and Residual Sugar Chemistry" John C. Edwards, presented at the 2015 ACS Northeast Regional Meeting, Ithaca, NY, June 10-13, 2015.
119. "Nutritional Supplement and Diesel Fuel Application Development for Benchtop NMR Systems Operating at 42, 60, and 80 MHz – Equivalency with Supercon NMR" John C. Edwards, Paul J. Giammatteo, presented at the 2015 ACS Northeast Regional Meeting, Ithaca, NY, June 10-13, 2015.
120. "Survey of Low Field NMR Spectrometer Platforms for Successful Screening of Sexual Enhancement and Weight Loss Supplements for Adulteration with Drugs and Drug Analogs" John C. Edwards, Anton Bzhelyansky, Kristie Adams, presented at the 2015 ACS Northeast Regional Meeting, Ithaca, NY, June 10-13, 2015.
121. "From Mash to Bottle: Chemistry of the Beer Brewing Process and NMR-based Quality Control" John C. Edwards, Adam DiCaprio, presented at the 2015 ACS Northeast Regional Meeting, Ithaca, NY, June 10-13, 2015.
122. "Survey of Low Field NMR Spectrometer Platforms for Successful Screening of Sexual Enhancement and Weight Loss Supplements for Adulteration with Drugs and Drug Analogs" John C. Edwards, Anton Bzhelyansky, Kristie Adams, presented at the 2015 129<sup>th</sup> AOAC International Annual Meeting & Exposition, Los Angeles, CA, September 27-30, 2015.
123. "Aromaticity of Bituminous Binders and the Interaction with Polyphosphoric Acid", H. Soenen, S. Heyrman, X. Lu, P. Redelius, John.C. Edwards, to be presented at 8th International RILEM SIB Symposium, Ancona, Italy, October 7-9, 2015.
124. "The Practical Non-Existence of Official NMR-Based Test Methods - How to Change the Paradigm of NMR Exclusion", presented at the 2<sup>nd</sup> PANIC Validation Workshop, Houston, TX, February 19, 2016.

125. "Liquid and Solid-State  $^1\text{H}$ ,  $^{13}\text{C}$  and  $^{11}\text{B}$  NMR Analysis of Magnesium Fructoborate Complex: Chemical Structure, Identification and Stability Study" Boris Nemzer, John C Edwards, presented at the XIII International Conference on the Applications of Magnetic Resonance in Food Science, Karlsruhe, Germany, June 7-10, 2016.
126. "Identification and Characterization of Calcium and Magnesium Borate Ester Complexes Formed with Different Sugars by Multinuclear Liquid and Solid-State NMR", Boris Nemzer, John Hunter, and John C Edwards, presented at the XIII International Conference on the Applications of Magnetic Resonance in Food Science, Karlsruhe, Germany, June 7-10, 2016.
127. "The Chemical Fingerprint of Beer from a Single Experiment with Minimum Sample Preparation - A Rapid Quantitative Molecular Analysis by  $^1\text{H}$  NMR Spectroscopy," John C Edwards, presented at World Brewing Congress 2016, Denver, CO, August 13-17, 2016.
128. "Low-Field qNMR: Traditional and Chemometric Approaches" John C. Edwards, invited lecture presented at the qNMR Summit 2016 October 6-7, 2016 USP Headquarters, Rockville MD.
129. "The Complex Fingerprint Analysis of Alcoholic Beverages by Quantitative NMR (qNMR)" John C. Edwards, invited talk presented at the TTB Beverage Alcohol Laboratory, Beltsville MD, February 2, 2017.
130. "Chemometric Application Development for Benchtop Permanent Magnet NMR Systems Operating at 42, 60, and 80 MHz – Demonstration of Equivalency with Supercon 300 MHz NMR", John C Edwards, presented at 2017 Eastern Analytical Symposium, Princeton, NJ, November 13-15, 2017.
131. " $^1\text{H}$  qNMR Analysis of Alcoholic Beverages - Detailed Chemical Fingerprint Information for Quality Control and Process Understanding", John C Edwards, presented at 2017 Eastern Analytical Symposium, Princeton, NJ, November 13-15, 2017.
132. "How Much Can You Bench? Low-field Spectrometers Arriving to Quality Control, Refineries, Brewing, Continuous Manufacturing and Your Lab", Invited Talk presented at the USP qNMR Summit, Tokyo, Japan, January 29-30, 2018.
133. " $^1\text{H}$  NMR of Cider – Quantitative Chemical Fingerprints for Quality Assessment and Process Understanding", John C Edwards, presented at CiderCon 2018, Baltimore, MD January 31-February 2, 2018.
134. "Nutrients in cider: stimulating both fermentation and debate", William Grote, John C Edwards, presented at CiderCon 2018, Baltimore, MD January 31-February 2, 2018.
135. "Bacteria-free Souring and Characterizing the Fermentative Properties of *Hanseniaspora vineae* YH72", J. P. Barry, M. S. Metz, John C. Edwards, and Matthew L. Bochman, presented at MBAA-ASBC Brewing Summit 2018, Sand Diego, CA, August 12-15, 2018.
136. " $^1\text{H}$  qNMR Analysis of Herbal Supplements for Authentication, Signs of Adulteration and Labelling Claims", John C. Edwards, presented at AOAC National Meeting, Toronto, Canada, August 26-29, 2018.
137. "The Complex Fingerprint Analysis of Alcoholic Beverages by Quantitative NMR (qNMR)", John C. Edwards, presented at Bells Brewery, Comstock MI, October 12, 2018
138. " $^1\text{H}$  qNMR of Alcoholic Beverages – Detailed Chemical Component Fingerprints for Product and Process Analysis", John C. Edwards, presented at invited talk at Portland State University, Portland, OR, February 1, 2019
139. " $^1\text{H}$  qNMR of Alcoholic Beverages – Detailed Chemical Component Fingerprints for Product and Process Analysis", John C. Edwards, presented at invited talk at Mid-Hudson ACS Meeting, Vassar College, Poughkeepsie, NY, February 11, 2019.
140. "Quantitative Cannabinoid analysis of hemp by  $^1\text{H}$  qNMR: Effect of flower and leaf location on plant, field maturation profiling, decarboxylation trajectories, and finished product potency", Callan McLoughlin and John C Edwards, to be presented at the ACS National Meeting, Philadelphia PA, March 22-26, 2020.

### **BOOK CHAPTERS:**

1. "Sulfuric Acid Alkylation Process Control" John Edwards, in **Process/Industrial Instruments and Controls, 5th Ed.**, Eds. Gregory K. McMillan, Douglas M. Considine, McGraw-Hill, 1999.
2. "Laboratory Analysis" Paul Giammatteo and John Edwards, in **Environmental Instrumentation and Analysis Handbook**, Eds. Randy D. Down and Jay H. Lehr, Wiley, 2004.
3. "Process NMR Spectroscopy: Technology and On-line Applications" John C. Edwards, and Paul J. Giammatteo, Chapter 10 in **Process Analytical Technology: Spectroscopic Tools and Implementation Strategies for the Chemical and Pharmaceutical Industries, 2<sup>nd</sup> Ed.**, Editor Katherine Bakeev, Blackwell-Wiley, 2010
4. "A Review of Applications of NMR Spectroscopy in Petroleum Chemistry" John C. Edwards, Chapter 16 in **Monograph 9 on Spectroscopic Analysis of Petroleum Products and Lubricants**, Editor: Kishore Nadkarni, ASTM Books, 2011.

### **PATENTS:**

1. "NMR Probe with Flow Restriction Element", Tal Cohen, John C. Edwards, Paul J. Giammatteo, Uri Rapoport, Naim Levi, Assignee: Foxboro NMR Ltd, United States and International Patents Pending WO Patent 2,004,063,759, and US Patent App 10/751,551 (2004).
2. "Crude Oil Blending Method and System", R.W. Karg, T.A. Clinkscales, C. Swart, P.J. Giammatteo, J.C. Edwards, EP Patent 1,276,833 (2003), WO Patent 2,001,070,912 (2001).
3. "Petroleum distillation method and system", John C. Edwards, Paul J. Giammatteo, CA 2397555 A1 (2001).
4. "Method and System for Controlling a Fluid Catalytic Cracker", P. Giammatteo, J. Edwards, WO Patent 2,001,051,589 (2001).

### **Podcast Interviews**

1. <http://masterbrewerspodcast.com/014-the-chemical-fingerprint-of-beer-from-a-single-experiment-with-minimum-sample-preparation> Master Brewers Association – August 2016.
2. Cidercon Talk – February 2018 – Chemical Fingerprints of Cider – Cider Chat Podcast YouTube Page: <https://www.youtube.com/watch?v=3-mw7PhPKJs>

### **EXPERT WITNESS LITIGATION EXPERIENCE:**

1. Case 1:14-cv-00915-RGA – Merck Sharp & Dohme Corp (Plaintiff), vs Hospira (Defendant), Civil Action No. 14-915-RGA. Worked for Defendant as expert on solid-state NMR analysis. Law Firm for Defendant was Willkie Farr & Gallagher LLP Deposition and Trial – Deposition February 2016 and Trial April 2016

#### Recent litigation work:

- Jan-Apr 2017: Krill oil phospholipid formulations (patent dispute) case No. 1:16-cv-00035 : law firm is Finnegan, Henderson, Farabow, Garret & Dunner LLP – Aker Biomarine vs. Olympic Holding, Rimfrost, Emerald Fisheries and their partners Avoca and Bioriginal – case withdrawn 2 days before depositions. <sup>31</sup>P NMR of phospholipid distributions. Worked for defendant.

Have worked on litigation concerning Fischer Tropsch Lubricant Oils (patent infringement by Shell on Exxon patent) worked for Shell – settled out of court before deposition or trial. I have worked on several other patent infringement cases that were settled out of court before deposition or trial. Examples: Botox chemistry patent infringement. Composition of gun cleaning fluids – defamation lawsuit – Fireclean vs Tuhoy. Gave deposition in Australian court case - worked for defendant in formaldehyde in keratin hair straightening product Brazilian Blowout - ACCC v Dateline Imports Pty Ltd. Completed my participation but court case continued with appeals from 2011 to 2015.

### **References Available Upon Request**