Mass Spectrometry and Analytical Chemistry

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Analysis was once the major discipline of chemistry, and most research sought better ways to identify and quantitate chemical substances. Just 50 years ago, fresh from the U.S. Infantry, I returned to the University of Nebraska to start graduate research with Professor H. Armin Pagel, a *real* analytical chemist. He had earned his Ph.D. under Professors I. M. Kolthoff and E. B. Sandell, authors of the authoritative textbook *Quantitative Analysis*. My "modern" analytical research involved the quantitative extraction of organic acids with tributyl phosphate [1], the amazing new solvent of the "Purex" process that to this day is the primary method for plutonium purification. My Cornell graduate research with Professor William T. Miller, an organofluorine chemist, did involve synthesis, but had state-of-the-art instrumentation for fractional distillation, UV spectra, and high pressure reactions. I had a great postdoctoral experience at the University of Iowa with Professor Ralph L. Shriner, author with R. C. Fuson of the classic *Qualitative Organic Analysis*.

In 1950 I was introduced to mass spectrometry at the Dow Chemical Company, Midland, MI, by Victor J. Caldecourt, Jason L. Saunderson, and Norman Wright. This was in the Spectroscopy Laboratory that had world-class capabilities in infrared, Raman, NMR,

X-ray powder diffraction, emission spectroscopy, and radiochemical methods. Thanks to the tutelage of du Pont's Steve dal Nogare and ICI's H. N. Wilson, we also added gas chromatography and then gas chromatography-mass spectrometry [2]. In contrast, Dow's Analytical Laboratory had volumetric and gravimetric analysis, electrochemistry, and spectrophotometry. My forced awareness of this growing dichotomy in what should be the field of "analytical chemistry" was sharpened with my transfer to the Boston area and Dow's Eastern Research Laboratory, whose basic research mission gave me a fine incentive to become acquainted with some of the best academic chemistry departments. During those years many of these departments drastically downscaled or dropped their analytical chemistry.

This low point of the field had a bright side for me personally. Professor L. B. "Buck" Rogers was implementing revolutionary changes in the Analytical Division of the Chemistry Department at Purdue University, and in 1964 he invited me to join in this. Important evidence of how wonderful this position has been for me personally is given in Tables 1 and 2, which list my Ph.D. students and co-authors, respectively, and in this special journal issue authored by some of these people. Although I am unusually indebted to all of

Table 1. Ph.D. recipients, 1968–1995

1968	Edward M. Chait	1980	Barbara L. Atwater
1968	William F. Haddon	1982	Michael P. Barbalas
1969	Robert D. Board	1984	Douglas B. Stauffer
1969	Richard D. Klimowski	1985	Paul O. Danis
1971	David J. McAdoo	1986	I. Jonathan Amster
1971	John E. Coutant	1988	Joseph A. Loo
1971	Timothy Wachs	1988	Rong Feng
1971	Richard A. Kornfeld	1990	Evan R. Williams
1972	Philip Irving	1990	Bing-Huang Wang
1972	Shih-Chuan Tsai	1990	Stanton Loh
1973	Kain-Sze Kwok	1991	Mei-Yi Zhang
1974	Paul F. Bente, III	1991	Kent B. Henry
1975	Gail M. Pesyna	1991	Donald E. Drinkwater
1976	Henry E. Dayringer	1992	Aberra Fura
1977	Bobby G. Dawkins	1994	Russell A. Chorush
1978	Frank M. Bockhoff	1995	Michael W. Senko
1980	In Ki Mun	1995	Peter B. O'Connor
1980	Peter J. Todd	1995	Daniel P. Little
1980	Kevin S. Haraki		

Table 2. Other publication coauthors

Joanne A. Gilpin	Guiseppe Innorta	Cindy L. Fisher	David H. Russell
Mynard C. Hamming	A. J. Kresge	S. J. Abbott	Mohammad Sharaf
Roland S. Gohlke	Bernard G. Giessner	S. R. Jones	Robert B. Spencer
Robert C. Golesworthy	Terry E. Parks	S. A. Weinman	J. J. P. Furlong
Jonathan W. Amy	John A. Michnowicz	Jeremy R. Knowles	Brian T. Chait
William E. Baitinger	Peter Rogerson	Donald C. McGilvery	Frank H. Field
Maurice M. Bursey	W. S. Trahanovsky	Kotaro Hosokawa	Frank C.-Y. Wang
John Pinzelik	Akira Tatematsu	Earl R. Lory	Paul Klymko
Martin Senn	Hans-Kaspar Wipf	Gregory J. Wendel	James C. Ray, Jr.
Charles N. Reilley	Malcolm McCamish	Michael R. Wixom	Barry K. Carpenter
Thomas W. Shannon	Karsten Levsen	T. E. Niemi	Q. Zha
Charles R. McKinney	Ikuo Sakai	Akira Hirota	Lionel Salem
Stephen M. Kimball	Donald M. Jerina	Richard D. Bowen	Mauro Marchetti
Setsuo Takeuchi	Michael A. Baldwin	Frank P. Pagano	Andre Maquestiau
Roy W. Curtiss	Johann Winkler	Robert F. Pegues	Jeffrey Shabanowitz
Rengachari Venkataraghavan	Marianne A. Busch	J. H. Vajda	Donald F. Hunt
Nicholas J. Turro	B. A. Meyer	Alexander G. Harrison	Bernard Leyh
D. W. Weiss	Robert C. Platt	J. G. Dillard	I. G. Brown
William T. Pike	James W. Serum	S. R. Heller	J. C. Lorquet
Thomas E. Mead	Richard G. Werth	G. W. A. Milne	Brigitte Leyh-Nihant
C. Grant Warner	Patrick Arpino	Chrysotomos Wesdemiotis	B. J. Smith
Thomas A. Bryce	Robert H. Hertel	Daniel R. Bartholomew	Leo Radom
J. A. Nicholson	Robert D. Villwock	Michael T. Cheng	Andrea B. Twiss-Brooks
Charles H. Jarboe	Nico M. M. Nibbering	Gary H. Kruppa	John P. Quinn
Patricia C. Wszolek	Takao Nishishita	Frantisek Turecek	Steven I. Ryu
James H. Brewster	Christian C. Van de Sande	Steven L. Cohen	Yuer Shi
Michael L. Gross	Rudi Knutti	S.-C. Cheng	Detlev Suckau
Robert B. Fairweather	Bas Van de Graaf	Katherine M. Dully	Steven C. Beu
George E. van Lear	Paul P. Dymerski	Chuan-jie Guo	Francis M. Wampler, III
F. Peter Boer	Richard M. Prinstein	Donald W. Peterson	Ilan Vidavsky
William O. Perry	Claus Köppel	Steven O. Russo	Y. T. Li
Horst D. R. Schuddemage	T. J. Broxton	D. A. Salvucci	Y. L. Hsieh
Sixten Abrahamsson	Y. T. Pang	Werner Staedeli	Jack D. Henion
Einar Stenhagen	John F. Smith	John L. Occolowitz	Bruce Ganem
J. Okamoto	Stephen R. Lowry	Christopher J. Proctor	Pierre Longevialle
H. Tsuyama	Thomas L. Isenhour	Thomas A. McCarrick	Neil L. Kelleher
Y. Nakajima	J. B. Justice	Charles E. Hudson	J. Paul Speir
Tomatsu Noda	Michael M. Cone	A. J. Henk Boerboom	Troy D. Wood
H. William Major	David N. Witiak	Rosemary Csencsits	Theodore W. Thannhauser
James S. Smith	Victor L. Tal'roze	Robert B. Ellis	Lorenzo H. Chen
Leon J. Schiff	David D. Speck	Jacqueline A. Tso	George L. Kenyon
K. A. Zirvi	Myung S. Kim	R. B. Cody, Jr.	Colleen A. Costello
C. M. Schmidt	James D. Dill	J. A. Kinsinger	Tadhg P. Begley
Ian Howe	T. E. Smith	Sahba Ghaderi	Gary A. Valaskovic
E. B. Delany	S. R. Smith	C. E. Brown	Einar Fridriksson
Chava Lifshitz	Robert C. Dunbar	M. E. Castro	David J. Aaserud

them over the years for their research productivity with me [3], I am particularly proud of their far greater accomplishments since then. I submit that these papers are worthy of your careful study not only for their fine scientific content, but also as impressive illustrations of the renaissance in analytical chemistry, again the central science of chemistry.

Acknowledgments

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References

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