

Personal report

An analytical chemist of stature and pioneer in flow analysis:

Gary Dale Christian[☆]**1. Introduction**

The 12th International Conference on Flow Injection Analysis including related techniques (ICFIA XII/JAFIA) was dedicated to Gary Dale Christian for an enormous contribution as a distinguished international scientist and his devotion to ICFIA through all the years. It was therefore not a surprise that he received the JAFIA Scientific Honor Award medal and certificate at this Conference for his pioneering work in FIA, an award that JAFIA and the Division of the Japan Society for Analytical Chemistry (JSAC) grant only every 5 years and an award that was particularly special as a 20th anniversary recognition. As guest editor of this special edition of *Talanta* on 12th ICFIA, it is therefore my privilege to follow with you the pioneering career of this leading analytical chemist and special personality in the family of flow-based systems who celebrated his 66th birthday on 25th November 2003, just before the conference. As person who worked in flow-based systems from the late 1960s and early 1970s at Sasol, I know the work of Gary Christian from the early 1970s, but I met him for the first time when as Chairman of the First National Symposium on Analytical Science, 19–23 March 1990, in South Africa, where I invited him with Sasol as sponsor to give a plenary lecture on Flow Injection Analysis in Process Analysis. With Gary's involvement in the Center for Process Analytical Chemistry (CPAC) at the University of Washington at that stage, he brought a vast expertise with him and his presentation on approaches and insights in process analysis inspired a number of changes in my personal attitude in research. With Graham Marshall at that stage at the University of Washington under Jarda Ruzicka, the informal discussions with Gary were extremely valuable; so when Graham returned from the USA the platform was set for my research in developing robust, cost-effective instrumentation for process analytical systems in collaboration with the Council for Mineral

Technology (MINTEK). The visit by Gary Christian to my country, therefore, definitely generated a new trend and success on my own research. It is therefore with interest that I read recently in the May 2004 edition of *Chemical and Engineering News* [1] of the celebration of 20 years of service by the Center for Process Analytical Chemistry (CPAC) to industry where CPAC thrived by evolving to meet the needs of industry.

Gary Dale Christian is very well known for his numerous contributions on various aspects of analytical chemistry ranging from electro-analytical chemistry, atomic spectroscopy, process analysis, flow injection analysis and electro-injection analysis, and has also been very active in the field of education. His detailed CV of almost 100 pages is very impressive and distinctive of this thorough analytical chemist.

2. Education, employment, awards and community service

Gary Dale Christian received his B.S. in 1959 from the University of Oregon and Ph.D. from the University of Maryland in 1964. He was a research analytical chemist at the Walter Reed Army Institute of Research from 1961 to 1967. He joined the University of Kentucky in 1967 and in 1972 moved to the University of Washington as Professor of Chemistry. He was Divisional Dean of Sciences in the College of Arts and Sciences, 1993–2001, and Faculty Director of the Center for Process Analytical Chemistry from 1995 to 1998. He was a Fulbright Scholar at the Université Libre de Bruxelles in 1978–1979, and was an Invited Professor at the University of Geneva in 1979. He was the recipient of the 1988 ACS Division of Analytical Chemistry Award for Excellence in Teaching, the 1995 *Talanta* Gold Medal, and the 1996 American Chemical Society Fisher Award in Analytical Chemistry. He was awarded the Université Libre de Bruxelles Medal of Honor, the Charles University Commemorative Medal, the Deakin University Geoff Wilson Medal, the Japanese Association for Flow Injection Analysis Scientific Honor Award Medal, and the University of Ghent Honorary Certificate of Research.

[☆] The 12th International Conference on Flow Injection Analysis, including related techniques (ICFIA 2003), held in Merida, Venezuela, December 7–13, 2003, dedicated to Prof. Gary Dean and Sue Christian for their contribution and devotion through all the years.

Gary has served on the Instrumentation Advisory Panel and the Advisory Board of Analytical Chemistry and the boards of *The Analyst*, *Analytical Instrumentation*, *Fresenius' Journal of Analytical Chemistry*, and *Talanta*, and was Series Editor of *Analytical Techniques in Clinical Chemistry and Laboratory Medicine* and of *Topics in Analytical Chemistry*. He presently serves on the boards of *Analytical Letters*, the *Analytical Sciences Digital Library*, *Canadian Journal of Spectroscopy*, *CRC Critical Reviews in Analytical Chemistry*, *Electroanalysis*, *Journal of Pharmaceutical and Biomedical Analysis*, *Journal of the Saudi Chemical Society*, *Sensors*, and the *Wiley-Interscience Series in Laboratory Automation*. He has been Joint Editor-in-Chief of *Talanta* since 1989.

He chaired the subcommittee on analytical chemistry of The ACS Examination Committee, was a member of the Committee of Examiners for the Chemistry Test of the Graduate Record Examinations, and a member of the Scientific Board for the 1992 International Chemistry Olympiad. He was a member of the Chemistry Screening Committee of the Council for International Exchange of (Fulbright) Scholars, and served as a member of the Bioanalytical Biometallic Study Section of NIH. He is a member of the American Chemical Society, Society for Applied Spectroscopy, Spectroscopy Society of Canada, and Society for Electroanalytical Chemistry. He is a past Chairman of the Division of Analytical Chemistry of the American Chemical Society, and member of the Board of Directors of the Society for Electroanalytical Chemistry.

3. Research activities

Gary is the author of more than 300 papers in which flow systems featured very well. The pioneering research publications of Gary in flow systems can be traced back to 1979 with Attiyat on biamprometry with the determination of lactate and lactic acid dehydrogenase by biamprometric monitoring of hexacyanoferrate(II) in a flowing system [2], biamprometric determination of glycerol and triglycerides with open tubular carbon electrodes in flow streams [3] and a biamprometric method for the determination of molybdenum of NAD-dependent reactions using tubular carbon electrodes in flowing streams [4] with Gulberg as the third co-author with a continuation of the work in 1980 [5]. The name of James B. Callis, responsible for one of CPAC's first successes with the development of a near-infrared spectroscopic method for the measurement of the octane number of gasoline [1,6,7], appeared for the first time with Gary in 1979 with work on a video fluorometer [8]. Gary continued the work on continuous flow electrochemical systems [9–11] with Gulberg in 1981 while Kelly joined Gary in 1981–1982 on enzyme assays using flow injection analysis [12–14]. Kelly and Christian also described a miniaturised flow injection system in 1982 with their publication on capillary flow injection analysis for enzyme assay with fluorescence detection [13]. In

1984, Attiyat and Christian [15,16] moved to atomic absorption spectrometry (AAS) as detector in flow injection analysis with two papers; the first on the determination of serum zinc [15] and the second where they studied the use of methanol, ethanol, acetone and isobutyl methyl ketone(I) as carriers in flow injection analysis with AAS detection with Cu as test analyte, and with water, aqueous acetone or aqueous ethanol as sample solvent. An eight-fold enhancement of the signal (compared with that for aqueous systems) was achieved for the optimum sample-carrier solvent combination; acetone was the best sample solvent and I the best carrier [16].

The first paper of a fruitful and longstanding relationship between Gary and Jarda Ruzicka started together with James Hungerford and Cal Giddings on stopped-flow determination of reaction rate parameters that appeared in a June 1984 edition of an FIA Newsletter [17] with a follow-up by the same group in analytical chemistry in 1985 [18]. It was Gary Christian who arranged an invitation for Jarda Ruzicka to give a talk for CPAC, where Jarda was first offered a brief appointment, and later a permanent position in Department of Chemistry at the University of Washington [19].

As flow injection pioneer, Gary authored or co-authored FIA 46 publications [9–18,20–54] in the 1980s featuring techniques such as stopped-flow [17,18], on-line preconcentration [20,21], kinetics [17,18,38], multi-component [24,28,45], dialysis [27], solvent extraction [35,40], doublet peaks [45], non-aqueous medium [46], on-line dilution [47,51], confluent mixing [48], split zones [51] and enzyme reactions [12,14,29] using detecting devices such as fluorimetry [12], atomic absorption spectrometry [15,16,30], inductively coupled plasma-atomic emission spectrometry [20,21], ion-selective electrodes [22,31,36], optosensing [23,29,34,39], UV–vis spectrophotometry [24,25,28,44,45,52,54], potentiometry [26,27,37,43], plasma spectroscopy [32], biamprometry [33], chemical sensor [41,42], inductively coupled plasma/mass spectrometry [53] in matrices such as blood serum [14,15,24,31,33], water and rainwater [29,39], nuclear waste solution [40] and plating baths [44].

For the period between 1990 and 2004 in the new millennium with 72 papers [55–126], Gary was involved in three variations of flow systems: flow injection [55–60,62–70,72–76,79,80,82,83,86,88–91,93,98,101,106,115,119,121,123,124], sequential injection [61,70,71,77–79,81,84,85,87,92,94–97,99,100,102–105,107–114,116,117,120,122,124,125,126] and electro-injection [113,118], the majority with Jarda Ruzicka. This research laboratory was responsible for quite a number of innovative, novel and very exciting developments during this period. It started off with a paper on flow injection analysis and chromatography: twins or siblings by Ruzicka and Christian in 1990 [55], followed by flow chemography [56], flow reversal flow injection analysis enhancing flow injection titrations [63], enhancement of Fourier transform infrared spectrometry in a single-line system [66], bioprocess monitoring [67], coulometric titrations [72], universal sandwich membrane

cell [74], immunoassays [75], flow injection cytometry [86,106], fluorescence microscopy [88] and coulometry [91], the fountain cell [93] and bead injection using flow injection analysis and sensor injection [77], fermentation monitoring [84,87], process and biotechnology [92,97,103], chemical-sensing membranes [109], renewable surface immunoassay for real-time monitoring [111], bead injection [116,117] and lab-on-valve [126] with sequential injection.

4. Books

Gary is very well known for his educational contribution in analytical chemistry. He has authored 14 books on: Atomic Absorption Spectroscopy [127,128], Trace Analysis [136], Analytical Chemistry [129,130,132,135,139,140], Instrumental Analysis [131,134], Problem Solving in Analytical Chemistry [137], and Quantitative Calculations in Pharmaceutical Practice and Research [138], as well as an ACS short-course on atomic absorption spectroscopy [133].

He was also the series editor for Analytical Techniques in Clinical Chemistry and Laboratory Medicine [141] and senior editor for Topics in Analytical Chemistry by Oxford University Press [142]. His handbook for students on Analytical Chemistry is in its 6th edition and also includes a chapter on flow systems. He also contributed on chapters in 17 books with the chapter on Process Analytical Chemistry in the approved text to the Federation of European Chemical Society Curriculum in Analytical Chemistry indicating his worldwide recognition in this field.

5. Conference activities

Gary Christian is very active with contributions on different levels at conferences. His first contribution on flow-based systems can be traced back to June 1978 at the 33rd NW regional meeting of the American Chemical Society in Seattle with Attiyat and Gulberg on a biamprometric method for the determination of NAD-dependent reactions using tubular carbon electrodes in flowing streams. He presented a number of contributions on various aspects of flow injection analysis in the 1980s especially at the Pittsburgh conferences. Although Christian and Ruzicka already presented work on flow injection analysis in 1985 at the Center for Process Analytical Chemistry in Seattle in October 1985, they took the concept to the Symposium in Process Analytical Chemistry at the 41st Northwest Regional Meeting of the ACS in Portland, OR, in June 1986. I chaired the session at Flow Analysis V at Kumamoto, Japan, in August 1991 where Gary gave a plenary lecture on the application of FIA in Process Analysis. Gary was heavily involved in conferences during the 1990s and lately in the beginning of the new millennium, and where he focussed on the USA in the 1980s, he moved into the overseas international world in the 1990s. It was during this period that Gary and Jarda started organising the WC-

FIA conference series that became the current ICFIA/JAFIA conferences (for detail, see the editorial).

6. Conclusion

If one follows the great variety of involvement of Gary Christian in the various aspects of analytical chemistry, from education to research to community service then it is no wonder that his achievements are well deserved. He brought a special integrity and friendship into the family of flow systems with a flavour of enthusiasm and enjoyment that make him a true pioneer of FIA.

References

- [1] C.M. Henry, *Chem. Eng. News* 82 (20) (2004) 40–41.
- [2] A.S. Attiyat, G.D. Christian, *Fresenius' J. Anal. Chem.* 295 (1979) 157.
- [3] A.S. Attiyat, G.D. Christian, *Anal. Chim. Acta* 106 (1979) 225.
- [4] A.S. Attiyat, E.L. Gulberg, G.D. Christian, *Chem. Biochem. Environ. Instrum.* 9 (1979) 1261.
- [5] A.S. Attiyat, G.D. Christian, *Analyst* 105 (1980) 154.
- [6] D.M. Mayes, J.B. Callis, *Appl. Spectrosc.* 43 (1989) 27.
- [7] J.J. Kelly, J.B. Callis, *Anal. Chem.* 62 (1990) 1444.
- [8] D.W. Johnson, J.A. Gladden, J.B. Callis, G.D. Christian, *Rev. Sci. Instrum.* 50 (1979) 118.
- [9] E.L. Gulberg, G.D. Christian, *Anal. Chim. Acta* 123 (1981) 125.
- [10] E.L. Gulberg, G.D. Christian, *Z. Anal. Chem.* 305 (1981) 29.
- [11] E.L. Gulberg, A.S. Attiyat, G.D. Christian, *J. Autom. Chem.* 2 (1981) 189.
- [12] T.A. Kelly, G.D. Christian, *Anal. Chem.* 53 (1981) 2110.
- [13] T.A. Kelly, G.D. Christian, *Anal. Chem.* 54 (1982) 1444.
- [14] T.A. Kelly, G.D. Christian, *Talanta* 29 (1982) 1109.
- [15] A.S. Attiyat, G.D. Christian, *Clin. Chim. Acta* 137 (1984) 151.
- [16] A.S. Attiyat, G.D. Christian, *Anal. Chem.* 56 (1984) 439.
- [17] J.H. Hungerford, G.D. Christian, J. Ruzicka, J.C. Giddings, *FIA Newslett.* 1 (2) (1984).
- [18] J.H. Hungerford, G.D. Christian, J. Ruzicka, J.C. Giddings, *Anal. Chem.* 57 (1985) 1794.
- [19] J. Ruzicka, CD-ROM.
- [20] S.D. Hartenstein, J. Ruzicka, G.D. Christian, *Anal. Chem.* 57 (1985) 21.
- [21] S.D. Hartenstein, G.D. Christian, J. Ruzicka, *Can. J. Spectrosc.* 30 (1985) 144.
- [22] R.Y. Xie, V.P.Y. Gadzekpo, A.M. Kadry, Y.H. Ibrahim, J. Ruzicka, G.D. Christian, *Anal. Chim. Acta* 184 (1986) 259.
- [23] B.A. Woods, J. Ruzicka, G.D. Christian, R.J. Charlson, *Anal. Chem.* 58 (1986) 2496.
- [24] A.T. Haj-Hussein, G.D. Christian, *Microchem. J.* 34 (1986) 67.
- [25] T.D. Yerian, T.P. Hadjiioannou, G.D. Christian, *Talanta* 33 (1986) 547.
- [26] A.T. Haj-Hussein, G.D. Christian, *Anal. Lett.* 19 (1986) 825.
- [27] R.Y. Xie, G.D. Christian, *Anal. Chem.* 58 (1986) 1806.
- [28] A.T. Haj-Hussein, G.D. Christian, *Analyst* (London) 111 (1986) 65.
- [29] T.D. Yerian, G.D. Christian, J. Ruzicka, *Analyst* (London) 111 (1986) 865.
- [30] A.T. Haj-Hussein, G.D. Christian, J. Ruzicka, *Anal. Chem.* 58 (1986) 38.
- [31] R.Y. Xie, G.D. Christian, *Analyst* 112 (1987) 61.
- [32] G.D. Christian, J. Ruzicka, *Spectrochim. Acta* 24B (1987) 157.

- [33] A.S. Attiyat, G.D. Christian, *Anal. Lett.* 20 (1987) 1099.
- [34] B.A. Woods, J. Ruzicka, G.D. Christian, *Anal. Chem.* 59 (1987) 2767.
- [35] R.H. Atallah, J. Ruzicka, G.D. Christian, *Anal. Chem.* 59 (1987) 2909.
- [36] A.S. Attiyat, G.D. Christian, *J. Flow Injection Anal.* 4 (1987) 103.
- [37] A.S. Attiyat, Y.A. Ibrahim, A.M. Kadry, R.Y. Xie, G.D. Christian, *Fresenius' J. Anal. Chem.* 329 (1987) 12.
- [38] J.M. Hungerford, G.D. Christian, *Anal. Chim. Acta* 200 (1988) 1.
- [39] B.A. Woods, J. Ruzicka, G.D. Christian, N.J. Rose, *Analyst* 113 (1988) 301.
- [40] R.H. Atallah, G.D. Christian, S. Hartenstein, *Analyst* 113 (1988) 463.
- [41] T.D. Yerian, G.D. Christian, J. Ruzicka, *Anal. Chem.* 60 (1988) 1250.
- [42] T.D. Yerian, G.D. Christian, J. Ruzicka, *Anal. Chim. Acta* 204 (1988) 7.
- [43] A.S. Attiyat, G.D. Christian, M.J. Pugia, R.A. Bartsch, *Microchem. J.* 38 (1988) 246.
- [44] D.A. Whitman, G.D. Christian, J. Ruzicka, *Analyst* 113 (1988) 1821.
- [45] D.A. Whitman, G.D. Christian, J. Ruzicka, *Anal. Chim. Acta* 214 (1988) 197.
- [46] R.J. Berman, G.D. Clark, D.A. Whitman, G.D. Christian, *Microchem. J.* 39 (1989) 20.
- [47] D.A. Whitman, G.D. Christian, *Talanta* 36 (1989) 205.
- [48] G.D. Clark, J.M. Hungerford, G.D. Christian, *Anal. Chem.* 61 (1989) 973.
- [50] G.D. Clark, G.D. Christian, J. Ruzicka, G.F. Anderson, J.A. van Zee, *Anal. Instrum.* 18 (1989) 1.
- [51] G.D. Clark, J. Ruzicka, G.D. Christian, *Anal. Chem.* 61 (1989) 1773.
- [52] N. Lacy, G.D. Christian, J. Ruzicka, *Anal. Chim. Acta* 224 (1989) 373.
- [53] H.M. Al-Swaidan, N. Lacy, G.D. Christian, *Anal. Lett.* 22 (1989) 2653.
- [54] N. Lacy, G.D. Christian, J. Ruzicka, *Quim. Anal.* 8 (1989) 201.
- [55] J. Ruzicka, G.D. Christian, *Analyst* 115 (1990) 475.
- [56] B.R. Kowalski, J. Ruzicka, G.D. Christian, *Trends Anal. Chem.* 9 (1990) 8.
- [57] J. Ruzicka, G.D. Christian, *Anal. Chim. Acta* 234 (1990) 31.
- [58] G.D. Christian, I. Krull, J. Tyson, *Anal. Chem.* 62 (1990) 455A.
- [59] W. Lindberg, G.D. Clark, C.P. Hanna, D.A. Whitman, G.D. Christian, *J. Ruzicka, Anal. Chem.* 62 (1990) 849.
- [60] N. Lacy, G.D. Christian, J. Ruzicka, *Anal. Chem.* 62 (1990) 1482.
- [61] J. Ruzicka, G.D. Marshall, G.D. Christian, *Anal. Chem.* 62 (1990) 1861.
- [62] R.H. Taylor, G.D. Clark, J. Ruzicka, G.D. Christian, *Analyst* 115 (1990) 1407.
- [63] G.D. Clark, Z. Zable, J. Ruzicka, G.D. Christian, *Talanta* 38 (1991) 119.
- [64] T. Gubeli, J. Ruzicka, G.D. Christian, *Talanta* 38 (1991) 851.
- [65] D.A. Whitman, M.B. Seasholtz, G.D. Christian, J. Ruzicka, B.R. Kowalski, *Anal. Chem.* 63 (1991) 775.
- [66] M. Guzman, J. Ruzicka, G.D. Christian, P. Shelley, *Vib. Spectrosc.* 2 (1991) 1.
- [67] S. Chung, X. Wen, K. Wilholm, M. DeBang, G.D. Christian, J. Ruzicka, *Anal. Chim. Acta* 249 (1991) 77.
- [68] X. Wen, H.K.J. Powell, G.D. Christian, J. Ruzicka, *Anal. Chim. Acta* 249 (1991) 451.
- [69] M. Guzman, J.L. Pe'rez Pavon, E. Rodriguez Gonzalo, C. Hatfield, J. Ruzicka, G.D. Christian, *Analyst* 116 (1991) 1043.
- [70] T. Gubeli, G.D. Christian, J. Ruzicka, *Anal. Chem.* 63 (1991) 2407.
- [71] G.D. Christian, *Quimica Nova* 14 (1991) 5.
- [72] R.H. Taylor, J. Ruzicka, G.D. Christian, *Talanta* 3 (1992) 285.
- [73] M. Guzman, M. DeBang, J. Ruzicka, G.D. Christian, *Process Control Qual.* 2 (1992) 113.
- [74] J.L.P. Pavon, E.R. Gonzalo, G.D. Christian, J. Ruzicka, *Anal. Chem.* 64 (1992) 923.
- [75] C.H. Pollema, J. Ruzicka, A. Lernmark, G.D. Christian, *Microchem. J.* 45 (1992) 121.
- [76] R.H. Taylor, C. Winbo, G.D. Christian, J. Ruzicka, *Talanta* 39 (1992) 789.
- [77] H.L. Lancaster, I. Lukkari, G.D. Christian, J. Ruzicka, *J. Flow Injection Anal.* 9 (1992) 20.
- [78] C.H. Pollema, J. Ruzicka, G.D. Christian, A. Lernmark, *Anal. Chem.* 64 (1992) 1356.
- [79] G.D. Christian, J. Ruzicka, *Anal. Chim. Acta* 61 (1992) 11.
- [80] E.R. Gonzalo, J.L.P. Pavon, J. Ruzicka, G.D. Christian, D.C. Olson, *Anal. Chim. Acta* 259 (1992) 37.
- [81] A. Baron, M. Guzman, J. Ruzicka, G.D. Christian, *Analyst* 117 (1992) 1839.
- [82] G.D. Christian, *J. Pharm. Biomed. Anal.* 10 (1992) 769.
- [83] G.D. Christian, *Flow Injection News* 2 (1992) 1.
- [84] S.C. Chung, G.D. Christian, J. Ruzicka, *Process Control Qual.* 3 (1992) 115.
- [85] M. Guzman, C. Pollema, J. Ruzicka, G.D. Christian, *Talanta* 40 (1993) 81.
- [86] W. Lindberg, J. Ruzicka, G.D. Christian, *Cytometry* 14 (1993) 230.
- [87] I. Lukkari, J. Ruzicka, G.D. Christian, *Fresenius' J. Anal. Chem.* 346 (1993) 813.
- [88] K.M. Scudder, G.D. Christian, J. Ruzicka, *Exp. Cell Res.* 205 (1993) 197.
- [89] A.S. Attiyat, G.D. Christian, J.A. McDonough, B. Strzelbicka, M.-J. Goo, Z.-Y. Yu, R.A. Bartsch, *Anal. Lett.* 26 (1993) 1413.
- [90] J. Ruzicka, G.D. Christian, *Appl. Spectrosc.* 47 (1993) 18A.
- [91] R.H. Taylor, J. Rotermund, G.D. Christian, J. Ruzicka, *Talanta* 41 (1994) 31.
- [92] G.D. Christian, *J. Flow Injection Anal.* 11 (1994) 1.
- [93] D.J. Tucker, B. Toivola, C.H. Pollema, J. Ruzicka, G.D. Christian, *Analyst* 119 (1994) 975.
- [94] H.L. Lancaster, G.D. Marshall, E.R. Gonzalo, J. Ruzicka, G.D. Christian, *Analyst* 119 (1994) 1459.
- [95] P.J. Baxter, G.D. Christian, J. Ruzicka, *Analyst* 119 (1994) 1807.
- [96] P.J. Baxter, J. Ruzicka, D.C. Olson, G.D. Christian, *Talanta* 41 (1994) 347.
- [97] G.D. Christian, *Analyst* 119 (1994) 2309.
- [98] R. Chen, J. Ruzicka, G.D. Christian, *Talanta* 41 (1994) 949.
- [99] J.C. Masini, P.J. Baxter, K.R. Detweiler, G.D. Christian, *Analyst* 120 (1995) 1583.
- [100] P.J. Baxter, G.D. Christian, J. Ruzicka, *Chem. Anal.* 40 (1995) 455.
- [101] L.D. Scampavia, G. Blankenstein, J. Ruzicka, G.D. Christian, *Anal. Chem.* 67 (1995) 2743.
- [102] Y. Luo, R. Allothman, G.D. Christian, J. Ruzicka, *Talanta* 42 (1995) 1545.
- [103] P.J. Baxter, G.D. Christian, *Acc. Chem. Res.* 29 (1996) 515.
- [104] S. Nakano, Y. Luo, D.A. Holman, J. Ruzicka, G.D. Christian, *J. Flow Injection Anal.* 13 (1996) 148.
- [105] Y. Luo, R. Al-Othman, J. Ruzicka, G.D. Christian, *Analyst* 121 (1996) 601.
- [106] G. Blankenstein, L.D. Scampavia, J. Ruzicka, G.D. Christian, *Cytometry* 25 (1996) 200.
- [107] K.L. Peterson, B.K. Logan, G.D. Christian, J. Ruzicka, *Anal. Chim. Acta* 337 (1997) 99; G.D. Christian, *J. Fac. Pharm. Ankara* 76 (1997) 32.
- [108] S. Nakano, Y. Luo, D. Holman, J. Ruzicka, G.D. Christian, *Microchem. J.* 55 (1997) 392.
- [109] D.A. Holman, G.D. Christian, J. Ruzicka, *Anal. Chem.* 69 (1997) 1763.
- [110] Y. Luo, S. Nakano, D.A. Holman, J. Ruzicka, G.D. Christian, *Talanta* 44 (1997) 1563.
- [111] B. Willumsen, G.D. Christian, J. Ruzicka, *Anal. Chem.* 69 (1997) 3482.

- [112] B. Dockendorff, D.A. Holman, G.D. Christian, J. Ruzicka, *Analyst* 35 (1998) 357.
- [113] V.P. Andreev, N.B. Ilyina, D.A. Holman, L.D. Scampavia, G.D. Christian, *Talanta* 48 (1999) 485.
- [114] N.L. Lacy, G.D. Christian, J. Ruzicka, *Microchem. J.* 62 (1999) 5.
- [115] V.P. Andreev, S.B. Koleshko, D.S. Holman, L.D. Scampavia, G.D. Christian, *Anal. Chem.* 71 (1999) 2199.
- [116] I. Lädesmäki, C. Beeson, G.D. Christian, J. Ruzicka, *Talanta* 51 (2000) 497.
- [117] C.C. Oliviera, E.A.G. Zagatto, J. Ruzicka, G.D. Christian, *Anal. Lett.* 33 (2000) 929.
- [118] V.P. Andreev, G.D. Christian, *Anal. Lett.* 34 (2001) 1579.
- [119] K. Grudpan, P. Ampan, Y. Udan, S. Jayasvati, S. Lapanantnoppakhun, J. Jakmunee, G.D. Christian, J. Ruzicka, *Talanta* 58 (2002) 1319.
- [120] N. Lenghor, J. Jakmunee, M. Vilen, R. Sara, G.D. Christian, K. Grudpan, *Talanta* 58 (2002) 1139.
- [121] P. Ampan, S. Lapanantnoppakhun, J. Jakmunee, S. Krattap Hartwell, S. Jayasvati, G.D. Christian, K. Grudpan, *Talanta* 58 (2002) 1327.
- [122] S. Tanikkul, J. Jakmunee, M. Rayanakron, K. Grudpan, B.J. Marquardt, G.M. Gross, B.J. Prazen, L.W. Burgess, G.D. Christian, R.E. Synovec, *Talanta* 59 (2003) 809.
- [123] K. Grudpan, N. Worakijcharoenchai, P. Sooksamiti, J. Jakmunee, G.D. Christian, *Indian J. Chem.* 42A (2003) 2939.
- [124] G.D. Christian, *Anal. Chim. Acta* 499 (2003) 5.
- [125] N. Lenghor, K. Grudpan, J. Jakmunee, B.A. Staggemeir, W.W.C. Quigley, B.J. Prazen, G.D. Christian, J. Ruzicka, R.E. Synovec, *Talanta* 59 (2003) 1153.
- [126] A. Ampan, J. Ruzicka, R. Atallah, G.D. Christian, J. Jakmunee, K. Grudpan, *Anal. Chim. Acta* 499 (2003) 167.
- [127] G.D. Christian, F.J. Feldman, *Atomic Absorption Spectroscopy: Applications in Agriculture, Biology and Medicine*, Wiley-Interscience, New York, 1970, xix + 490 pp.
- [128] T.C. Rains, J.A. Dean, G.D. Christian, *Atomic Absorption Spectroscopy*, The American Chemical Society, Washington, DC, 1970, 177 pp.
- [129] G.D. Christian, *Analytical Chemistry*, Xerox College Publishing, Waltham, MA, 1971, xx + 508 pp.
- [130] G.D. Christian, *Analytical Chemistry*, 2nd ed., John Wiley & Sons, Inc., New York, 1977, xvi + 648 pp.
- [131] H.H. Bauer, G.D. Christian, J.E. O'Reilly, *Instrumental Analysis*, Allyn and Bacon, Inc., Boston, MA, 1978, ix + 832 pp.
- [132] G.D. Christian, *Analytical Chemistry*, 3rd ed., John Wiley & Sons, New York, 1980, xvi + 643 pp.
- [133] G.D. Christian, M.S. Epstein, *Atomic absorption spectroscopy*, in: ACS Audio Short Course, American Chemical Society, Washington, DC, 1980.
- [134] G.D. Christian, J.E. O'Reilly, *Instrumental Analysis*, 2nd ed., Allyn and Bacon, Inc., Boston, MA, 1986, xviii + 933 pp.
- [135] G.D. Christian, *Analytical Chemistry*, 4th ed., John Wiley & Sons, New York, 1986, xvii + 676 pp.
- [136] G.D. Christian, J.B. Callis (Eds.), *Trace Analysis: Spectroscopic Methods for Molecules*, Chemical Analysis Series, vol. 84, Wiley-Interscience, New York, 1986, ix + 406 pp.
- [137] T.P. Hadjiioannou, G.D. Christian, C.E. Efstathiou, D.P. Nikolelis, *Problem Solving in Analytical Chemistry*, Pergamon Press, 1988, 618 pp with Solutions Manual.
- [138] T.P. Hadjiioannou, G.D. Christian, M.A. Kouparis, P.E. Macheras, *Quantitative Calculations in Pharmaceutical Practice and Research*, VCH Publishers, New York, 1993, xi + 461 pp.
- [139] G.D. Christian, *Analytical Chemistry*, 5th ed., John Wiley & Sons, New York, 1994, xx + 812 pp.
- [140] G.D. Christian, *Analytical Chemistry*, 6th ed., John Wiley & Sons, New York, 2003, xix + 828 pp.
- [141] Series Editor, *Analytical Techniques in Clinical Chemistry and Laboratory Medicine*, VCH Publishers, Inc., 1983–1992.
- [142] Senior Editor, *Topics in Analytical Chemistry*, Oxford University Press, 1994.

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