Peter V. Bonnesen

R&D Staff
Joint Appointment
Macromolecular Nanosciences Group
Center for Nanophase Materials Sciences
Chemical Separations Group
Chemical Sciences Division
Oak Ridge National Laboratory
(865) 574-6715
bonnesenpv@ornl.gov

Education

Lafayette College, Easton, PA	Chemistry	B.S. (ACS certified), 1983
University of California at Los Angeles	Inorganic Chemistry	Ph.D., 1989

Research Interests

Research interests include the design and synthesis of deuterated monomers for specialty polymers; materials for nanophase materials research; ligands and extractants used in separations science; characterization of molecules and macromolecules using Nuclear Magnetic Resonance spectroscopy; self-assembling metal-organic frameworks; and elucidation of reaction mechanisms in organic, organometallic, and inorganic syntheses.

Professional Experience:

2006-present	Research Staff, Macromolecular Nanosciences Group, Center for Nanophase Materials Sciences, Oak Ridge National Laboratory (Joint Appointment)
1993-present	Research Staff, Chemical Separations Group, Chemical Sciences Division, Oak Ridge National Laboratory
1991-1993	Postdoctoral Research Associate, University of California at Berkeley
1989-1991	Research Scientist, Specialty Industrial Polymers Division, Rohm and Haas Company, Spring House, PA

Professional and Synergistic Activities

2011–present	Editorial Board, *ISRN Chemical Engineering*
2005–present	Editorial Board, *Solvent Extraction and Ion Exchange*
1983–present	Member: American Chemical Society

Honors and Awards

2004	R&D IR-100 Award, for “Highly Selective, Regenerable Perchlorate Treatment System”
2002	Battelle Technical Council Science & Technology Challenges Competition Winner
1999	Lockheed Martin Energy Research Corporation Valuable Invention Award
1999	Lockheed Martin Research Corporation Development Awards (2)
1994	Martin Marietta Energy Systems Technology Transfer Award
1984	Department of Chemistry Teaching Award, University of California at Los Angeles

Selected Peer-Reviewed Publications (Author of more than 65 articles in refereed journals and books): Full list follows CV

Graduate and Postdoctoral Advisors:

Graduate Advisor: William H. Hersh, Queens College of CUNY;
Postdoctoral Advisor: Kenneth N. Raymond, University of California at Berkeley

Total Postdocs Advised: 3

Journal Articles

55. J. Yang, K. Hong, P. V. Bonnesen*, Synthesis of N^1-tritylethane-*1,1,2,2-*d_4-1,2-diamine: a novel mono-protected C-deuterated ethylenediamine synthon," *J. Labelled Compd. Radiopharm*. **2012,** *54***,** 463-466.

54. C. J. Borman, P. V. Bonnesen, B. A. Moyer, "Selectivity Control in Synergistic Liquid-Liquid Anion Exchange of Univalent Anions via Structure-Specific Cooperativity between Quaternary Ammonium Cations and Anion Receptors," *Anal. Chem.* **2012**, *84* (19), 8214–8221.

53. N. C. Duncan, B. D. Roach, N. J. Williams, P. V. Bonnesen, A. Rajbanshi, B. A. Moyer, "*N*,*N*'-Dicyclohexyl-*N*"-isotridecylguanidine as Suppressor for the Next Generation Caustic Side Solvent Extraction (NG-CSSX) Process," *Sep. Sci. Technol.* **2012**, *47*, 2074-2087.

52. R. Custelcean, P. V. Bonnesen, B. D. Roach, and N. C. Duncan, "Ion-Pair Triple Helicates and Mesocates Self-Assembled from Ditopic 2,2'-bipyridine-bis(urea) ligands and Ni(II) and Fe(II) Sulphate Salts," *ChemComm* **2012,** *48*, 7438-7440.

51. V. M. Prabhu, S. Kang, J. Sha, P. V. Bonnesen, S. Satija, W. Wu, and C. K. Ober. "Neutron reflectivity characterization of the photoacid reaction-diffusion latent and developed images of molecular resists for extreme-ultraviolet lithography," *Langmuir* **2012**, *28*, 7665-7678.

50. R. Custelcean, P. V. Bonnesen, N. C. Duncan, X. Zhang, L. A. Watson, G. Van Berkel, W. B. Parson, and B. P. Hay, "Urea-Functionalized M_4L_6 Cage Receptors: Self-Assembly, Dynamics, and Anion Recognition in Aqueous Solutions," *J. Am. Chem. Soc.* **2012**, *134*, 8525-8534

49. J. Yang, K. Hong, and P. V. Bonnesen*, "A method for preparing sodium acrylate-d_3, a useful and stable precursor for deuterated acrylic monomers," *J. Labelled Compd. Radiopharm.* **2011,** *54***,** 743-748.

48. V. M. Prabhu*, S. Kang, R. J. Kline, D. M. DeLongchamp, D. A. Fischer, W.-l. Wu, S. K. Satija, P. V. Bonnesen, J. Sha, C. K. Ober. "Characterization of the non-uniform reaction in chemically-amplified calix[4]resorcinarene molecular resist thin films", *Aust. J. Chem.*, **2011**, *64*, 1065-1073.

47. A. Pramanik, B. Thompson, T. Hayes, K. Tucker, D. R. Powell, P. V. Bonnesen, E. D. Ellis, K. S. Lee, H. Yu, and Md. A. Hossain*, "Seven-coordinate anion complex with a tren-based urea: Binding discrepancy of hydrogen sulfate in solid and solution states," *Organic & Biomolecular Chemistry* **2011,** *9***,** 4444-4447.

46. J. Sha, J.-K. Lee, S. Kang, V. M. Prabhu, C. L. Soles, P. V. Bonnesen, and C. K. Ober, "Architectural Effects on Acid Reaction-Diffusion Kinetics in Molecular Glass Photoresists," *Chem. Mater*. **2010**, *22*, 3093-3098.

45. F. Loustau-Chartez, R. M. Robeson, R. Custelcean, R. A. Sachleben, and P. V. Bonnesen*, "2,2,3,3,11,11,12,12-Octamethyl-1,4,7,10,13-Pentaoxacyclohexadecane: Improved Synthesis and Crystal Structure with NaSCN," *Tetrahedron Lett.* **2009**, *50*, 2936-2938.

44. R. Custelcean, J. Bosano, P. V. Bonnesen, V. Kertesz, and B. P. Hay, "Computer-Aided Design of a Sulfate-Encapsulating Receptor," *Angew. Chem. Int. Ed.* **2009**, *48*, 4025-4029.

43. L. H. Delmau, T. J. Haverlock, E. Bazelaire, P. V. Bonnesen, M. E. Ditto, and B. A. Moyer, "Alternatives to Nitric Acid Stripping in the Caustic-Side Extraction (CSSX) Process for Cesium Removal from Alkaline High-Level Waste," *Solv. Extr. Ion. Exch.*, **2009**, *27*, 172-198.

42. R. Custelcean, P. Remy, P.V. Bonnesen, D.-E. Jiang, and B.A. Moyer, "Sulfate Recognition by Persistent Crystalline Capsules with Rigidified Hydrogen-Bonding Cavities," *Angew. Chem. Int. Ed.* **2008**, *47*, 1866-1870.

41. R. M. Robeson and P. Bonnesen, "Synthesis of Novel Crown Ethers Bearing the *exo-cis*-2,3-Norbornyl Group as Potential Na^+ and K^+ Extractants," *Journal of Undergraduate Research* (Office of Science, US. DOE), **2007**, *7*, 91-96.

40. R. Custelcean, N. L. Engle, and P. V. Bonnesen, "Crystalline Hydrogen-Bonded Nanocolumns of Cyclic Thiourea Octamers," *Cryst. Eng. Comm.* **2007**, *9*, 452-455.

39. H. Luo, S. Dai, P. V. Bonnesen, and A. C. Buchanan III, "Separation of Fission Products Based on Ionic Liquids: Task-Specific Ionic Liquids Containing an Aza-Crown Ether Fragment," *J. Alloys Compd.* **2006**, *418*, 195-199.

38. L. H. Delmau, P. V. Bonnesen, N. L. Engle, T. J. Haverlock, F. V. Sloop, and B. A. Moyer, "Combined Extraction of Cesium and Strontium from Alkaline Nitrate Solutions", *Solvent Extr. Ion Exch*. **2006**, *24*, 197-217.

37. H. Luo, S. Dai, P. V. Bonnesen, T. J. Haverlock, B. A. Moyer, and A. C. Buchanan, "A Striking Effect of Ionic-Liquid Anions in the Extraction of Sr^{2+} and Cs^+ by Dicyclohexano-18-Crown-6," *Solvent Extr. Ion Exch*. **2006**, *24*, 19-31.

36. H.-A. Kang, N. L. Engle, P. V. Bonnesen, L. H. Delmau, T. J. Haverlock, and B.A. Moyer, "An Equilibrium Model of Pseudo-Hydroxide Extraction in the Separation of Sodium Hydroxide from Aqueous Solutions Using Lipophilic Fluorinated Alcohols and Phenols," *Sep. Sci. Technol.*, **2005**, *40* (1-2), 725-738.

35. R. Custelcean, M. G. Gorbunova, and P. V. Bonnesen, "Steric Control over Hydrogen Bonding in Crystalline Organic Solids: A Structural Study of N,N'-Dialkylthioureas," *Chem. Eur. J.*, **2005**, *11*, 1459-1466.

34. V. I. Boiadjiev, G. M. Brown, L. A. Pinnaduwage, G. Goretzki, P. V. Bonnesen, T. Thundat, "Photochemical hydrosilylation of of 11-undecenyltriethylammonium bromide with hydrogen-terminated Si surfaces for the development of robust microcantilever sensors for Cr(VI)," *Langmuir*, **2005**, *21*, 1139-1142.

33. B. A. Moyer, P. V. Bonnesen, R. Custelcean, L. H. Delmau, and B. P. Hay, "Strategies for Using Host-Guest Chemistry in the Extractive Separations of Ionic Guests," *Kem. Ind.*, **2005**, *54*(2), 65-87. (BES)

32. L. H. Delmau, P. V. Bonnesen, A.W. Herlinger, and R. Chiarizia, "Aggregation Behavior of Solvent Modifiers for the Extraction of Cesium from Caustic Media", *Solvent Extr. Ion Exch*. **2005**, *23*, 145-169.

31. L. H. Delmau, T. J. Lefranc, P, V. Bonnesen, J. C. Bryan, D. J. Presley, and B. A. Moyer, "Fundamental Studies Regarding Synergism Between a Calix[4]arene Bis-crown-6 Ether and Selected Modifiers in the Solvent Extraction of Cesium", *Solvent Extr. Ion Exch*. **2005**, *23*, 23-57.

30. H. Luo, S. Dai, and P. V. Bonnesen, "Solvent Extraction of Sr^{2+} and Cs^+ Based on Room-Temperature Ionic Liquids Containing Monoaza-Substituted Crown Ethers," *Anal. Chem.* **2004**, *76*, 2773-2779.

29. H. Luo, S. Dai, P. V. Bonnesen, A. C. Buchanan, III, J. D. Holbrey, N. J. Bridges, and R. D. Rogers, "Extraction of Cesium Ions from Aqueous Solutions Using Calix[4]arene-bis(*tert*-ctylbenzo-crown-6) in Ionic Liquids," *Anal. Chem.* **2004**, *76*, 3078-3083.

28. E. Bazelaire, M. G. Gorbunova, P. V. Bonnesen, B. A. Moyer, and L. H. Delmau, "pH-Switchable Cesium Nitrate Extraction with Calix[4]arene Mono- and Bis-(Benzocrown-6) Ethers Bearing Amino Functionalities," *Solvent Extr. Ion Exch.* **2004**, *22*, 637-661.

27. N. L. Engle, P. V. Bonnesen*, B. A. Tomkins, L. H. Delmau, and B. A. Moyer, "Synthesis and Properties of Calix[4][arene-bis-[4-2-ethylhexyl)benzo-crown-6]: A Cesium Extractant with Improved Solubility," *Solvent Extr. Ion Exch.* **2004**, *22*, 611-636.

26. L. H. Delmau, P. V. Bonnesen, and B. A. Moyer, "A Solution to Stripping Problems Caused by Organophilic Anion Impurities in Crown-Ether Based Solvent Extraction Systems: A Case Study of Cesium Removal from Radioactive Wastes," *Hydrometallurgy* **2004**, *72*(1,2), 9-19.

25. M. G. Gorbunova, P. V. Bonnesen*, N. L. Engle, E. Bazelaire, L. H. Delmau, and B. A. Moyer, "New amino-functionalized 1,3-alternate calix[4]arenebis- and mono-(benzo-crown-6 ethers) for pH-switched cesium nitrate extraction," *Tetrahedron Lett.*, **2003**, *44*, 5397-5401.

24. T. J. Haverlock, P. V. Bonnesen, and B. A. Moyer, "Separation of NaOH by Solvent Extraction Using Weak Hydroxy Acids," *Solvent Extr. Ion Exch.* **2003**, *21(4*), 483-504.

23. P. V. Bonnesen*, L. H. Delmau, B. A. Moyer, and G. J. Lumetta "Development of Effective Solvent Modifiers for the Solvent Extraction of Cesium from Alkaline High-Level Tank Waste," *Solvent Extr. Ion Exch*., **2003**, *21(2)*, 141-170.

22. J. C. Bryan, R. A. Sachleben, C. T. Eagle, B. P. Hay, and P. V. Bonnesen, "Design, Synthesis, and Structure of Novel Cesium Receptors," *Journal of Chemical Crystallography*, **2003**, *33*, 349-355.

21. T. G. Levitskaia, P. V. Bonnesen, C. K. Chambliss, and B. A. Moyer, "Synergistic Pseudo-Hydroxide Ion Extraction: Synergism and Anion Selectivity in Sodium Extraction Using a Crown Ether and a Series of Weak Lipophilic Acids," *Anal. Chem.* **2003**, *75(3)*, 405-412.

20. C. K. Chambliss, T. J. Haverlock, P. V. Bonnesen, N. L. Engle, and B. A. Moyer, "Selective Separation of Hydroxide from Alkaline Nuclear Nuclear Tank Waste by Liquid-Liquid Extraction with Weak Hydroxy Acids," *Environ. Sci. Technol.* **2002,** *36*, 1861-1867.

19. C. R. Duchemin, N. L. Engle, P. V. Bonnesen*, T. J. Haverlock, L. H. Delmau, and B. A. Moyer, "Solvatochromic Solvent Polarity Measurements of Alcohol Solvent Modifiers and Correlation with Cesium Extraction Strength," *Solvent Extr. Ion Exch.* **2001**, *19(6)*, 1037-1058.

18. T. G. Levitskaia, B. A. Moyer, P. V. Bonnesen, A. P. Marchand, K. Krishnudu, Z. Chen, Z. Huang, H. G. Kruger, and A. S. McKim, "Novel Approach to Sodium Hydroxide Separation: Synergistic Pseudo-Hydroxide Extraction by a Fluorinated Alcohol and Cage-Functionalized Crown Ethers," *J. Am. Chem. Soc.* **2001**, *123(48)*, 12099-12100

17. H.-F. Ji, T. Thundat, R. Dabestani, G. M. Brown, P. F. Britt, and P. V. Bonnesen "Ultrasensitive Detection of CrO_4^{2-} Using a Microcantilever Sensor," *Anal. Chem.*, **2001**, *73(7)*, 1572-1576.

16. R. A. Leonard, C. Conner, M. W. Liberatore, J. Sedlet, S. B. Aase, G. F. Vandegrift, L. H. Delmau, P. V. Bonnesen, and B. A. Moyer, "Development of a Solvent Extraction Process for Cesium Removal from SRS Tank Waste," *Sep. Sci. Technol*., **2001**, *35(5&6)*, 743-766.

15. K. L. Nash, R. E. Barrans, R. Chiarizia, M. L. Dietz, M. P. Jensen, P. G. Rickert, B. A. Moyer, P. V. Bonnesen, J. C. Bryan, and R. A. Sachleben, "Fundamental Investigations of Separations Science for Radioactive Materials," *Solvent Extr. Ion Exch.* **2000**, *18*, 605-631.

14. P. V. Bonnesen, L. H. Delmau, B. A. Moyer, and R. A Leonard "A Robust Alkaline-Side CSEX Solvent Suitable for Removing Cesium from Savannah River High Level Waste," *Solvent Extr. Ion Exch*, **2000**,*18*, 1079-1108.

13. P. V. Bonnesen, G. M. Brown, S. D. Alexandratos, L. B. Bavoux, D. J. Presley, V. Patel, R. Ober, and B. A. Moyer, "Development of Bifunctional Anion Exchange Resins with Improved Selectivity and Sorptive Kinetics for Pertechnetate. Batch-Equilibrium Experiments," *Environ. Sci. Technol.* **2000**, *34*, 3761-3766.

12. A. A. Gakh, J. C. Bryan, M. N. Burnett, and P. V. Bonnesen, "Synthesis and Structure Analysis of Some Trinitromethane Salts," *J. Mol. Struct.* **2000**, *520*, 221-228.

11. B. Gu, G. M. Brown, P. V. Bonnesen, L. Liang, B. A. Moyer, R. Ober, R., and S. D. Alexandratos, "Development of Novel Bifunctional Anion-Exchange Resins with Improved Selectivity for Pertechnetate Sorption from Contaminated Groundwater," *Environ. Sci. Tech*. **2000**, *34*, 1075-1080.

10. T.J. Haverlock, P.V. Bonnesen, R.A. Sachleben, and B.A. Moyer, "Analysis of Equilibria in the Extraction of Cesium Nitrate by Calix[4]arene-bis(t-octylbenzo-crown-6) in 1,2-Dichloroethane," *J. Incl. Phenom. Macro. Chem.* **2000**, *36*, 21-37.

9. R. A. Sachleben, P. V. Bonnesen, T. Descazeaud, T. J. Haverlock, A. Urvoas, and B. A. Moyer, "Surveying the Extraction of Cesium Nitrate by 1,3-Alternate Calix[4]arene Crown-6 Ethers in 1,2-Dichloroethane," *Solvent Extr. Ion Exch.* **1999**, *17*, 1445-1459.

8. R. A. Leonard, C. Conner, M.W. Liberatore, P.V. Bonnesen, D.J. Presley, B. A. Moyer, and G. J. Lumetta, "Developing and Testing an Alkaline-Side Solvent Extraction Process for Technetium Separation from Tank Waste," *Sep. Sci. Technol.* **1999**, *34*, 1043-1068.

7. T. J. Haverlock, P.V. Bonnesen, R.A. Sachleben, and B.A. Moyer, "Applicability of a Calixarene-Crown Compound for the Removal of Cesium from Alkaline Tank Waste," *Radiochim. Acta*. **1997**, *76*, 103-108.

6. R. Cox, D. A. Buttry, P. Bonnesen, and K. N. Raymond, "Measuring trace uranium." *CHEMTECH* **1994**, *24*, 18-21.

5. P. V. Bonnesen, C. L. Puckett, R. V. Honeychuck, and W. H. Hersh, "Catalysis of Diels-Alder Reactions by Low Oxidation State Transition Metal Lewis Acids: Fact and Fiction." *J. Am. Chem. Soc.* **1989**, *111*, 6070-6081.

4. R. V. Honeychuck, P. V. Bonnesen, J. Farahi, and W. H. Hersh, "Catalysis of Diene Polymerization and Diels-Alder Reactions by an Octahedral Tungsten Nitrosyl Lewis Acid. X-ray Crystal Structure of the η^1-Acrolein Complex (*cis*-Me_3P)(*trans*-NO)$(CO)_3$W-O=C(H)C(H)=CH_2." *J. Org. Chem.* **1987**, *52*, 5293-5296.

3. P. V. Bonnesen, P. K. L. Yau, and W. H. Hersh, "Oxidative Syntheses of Cyclopentadienyl η^2-Acyl Complexes and Stereospecific Conversion to an η^2-Ylide Complex. X-ray Crystal Structures of Cp(NO)(I)Mo(η^2-C(O)-*p*-Tol) and Cp(NO)(I)Mo(η^2-C(O)(PMe_3)-*p*-Tol)." *Organometallics* **1987**, *6*, 1587-1590.

2. P. V. Bonnesen, A. T. Baker, and W. H. Hersh, "A New Metal-Metal Bond Forming Reaction: Synthesis, Structure and Mechanism of Formation of (η-C_5H_5)(CO)Fe(η-C(O)-*p*-tolyl)(η-CO)Mo(NO)(η-C_5H_5), a Rare η-Bound η-Acyl Compound." *J. Am. Chem. Soc.* **1986**, *108*, 8304-8305.

1. P. Bonneson, J. L. Walsh, W. T. Pennington, A. W. Cordes, and B. Durham, "Six-Coordinate Complexes with 1,10-Phenanthroline Ligands in the Trans Configuration. Preparation of *trans*-Bis(1,10-phenanthroline)ruthenium(II) Complexes and Crystal Structure of *trans*-Bis(1,10-phenanthroline)bis(pyridine) ruthenium(II) Hexafluorophosphate." *Inorg. Chem.* **1983**, *22*, 1761-1765. (Note last name was misspelled)

Book Reviews or Chapters

14. H. Luo, S. Dai, P. V. Bonnesen, and A. C. Buchanan, III, "Separation of Fission-Products Based on Room-Temperature Ionic Liquids," in *Nuclear Waste Management: Accomplishments of the Environmental Management Science Program*, P. W. Wang and T. Zachry, Eds., ACS Symposium Series N0. 943, American Chemical Society, Washington, D. C., 2006; Chap. 8, pp.146-160.

13. G. Goretzki, P. V. Bonnesen, R. Dabestani, and G. M. Brown, "Fluorophores as Chemosensors Based on Calix[4]arenes and Three Different Fluorescence Reporters," in *Nuclear Waste Management: Accomplishments of the Environmental Management Science Program*, P. W. Wang and T. Zachry, Eds., ACS Symposium Series N0. 943, American Chemical Society, Washington, D. C., 2006; Chap. 2, pp.12-33.

12. B. Gu, P. V. Bonnesen, F. V. Sloop, Jr., G. M. Brown, "Titanium Catalyzed Perchlorate Reduction and Applications," In *Perchlorate Environmental Occurrence, Interactions and Treatment*; B. Gu and J. Coates, Eds.; Springer, New York, 2006, Chapter 16, pp . 373-387.

11. B. A. Moyer, J. F. Birdwell, Jr., P. V. Bonnesen, L. H. Delmau, "Use of Macrocycles in Nuclear-Waste Cleanup: A Real-World Application of a Calixcrown in Technology for the Separation of Cesium. In Macrocyclic Chemistry—Current Trends and Future. Springer, Dordrecht, 2005, pp 383–405 (Invited review).

10. B. A. Moyer, P. V. Bonnesen, C. K. Chambliss, T. J. Haverlock, A. P. Marchand, H-S. Chong, A. S. McKim, K. Krishnudu, K. S. Ravikumar, V. S. Kumar, and M. Takhi, "Use of Cage-Functionalized Macrocycles and Fluorinated Alcohols in the Liquid-Liquid Extraction of NaOH and other Sodium Salts," in *Nuclear Site Remediation: First Accomplishments of the Environmental Management Science Program*, P. G. Eller and W. R. Heineman, Eds., ACS Symposium Series No. 778, American Chemical Society, Washington, D.C., 2001; Chap. 8, pp. 114-132.

9. G. M. Brown, P. V. Bonnesen, B. A. Moyer, B. Gu, S. D. Alexandratos, V. Patel, and R. Ober, "The Design of Selective Resins for the Removal of Pertechnetate and Perchlorate from Groundwater," in *Perchlorate in the Environment*, E. T. Urbansky, Ed., .Kluwer Academic/Plenum Publishers, New York, 2000: Chapt. 15, pp. 155-164.

8. P. V. Bonnesen, T. J. Haverlock, N. L. Engle, R. A. Sachleben, and B. A. Moyer, "Development of Process Chemistry for the Removal of Cesium from Acidic Nuclear Waste by Calix[4]arene-Crown-6 Ethers," in *Calixarene Molecules for Separations*, G. J. Lumetta and R. D. Rogers, Eds., ACS Symposium Series No. 757, American Chemical Society, Washington, D. C., 2000; Chap. 3, pp.26-44.

7. B. A. Moyer and P. V. Bonnesen, "Physical Factors in Anion Separations," in *Supramolecular Chemistry of Anions*, A. Bianchi, K. Bowman-James, and E. Garcia-Espana, Eds., Wiley-VCH, New York, 1997; Chap. 1, pp. 1-44.

6. P. V. Bonnesen, B. A. Moyer, T. J. Haverlock, V. S. Armstrong, and R. A. Sachleben, "Removal of Technetium from Alkaline Waste Media by a New Solvent Extraction Process," in *Emerging Technologies in Hazardous Waste Management VI*, D. William Tedder and Frederick G Pohland, Eds., American Academy of Environmental Engineers, Annapolis, MD, 1996; pp. 245-262.

5. R. Cox, D. Gomez, D. A. Buttry, P. Bonnesen, and K. Raymond, "High Surface Area Silica Particles as a New Vehicle for Ligand Immobilization on the Quartz Crystal Microbalance"; In ACS Symposium Series, No. 561, *Interfacial Design and Chemical Sensing*; Thomas E. Mallouk and D. Jed Harrison, Eds.; American Chemical Society: Washington, D.C.; 1994, pp 71-077.

4. P. V. Bonnesen, "William N. Lipscomb, Jr."; In *Nobel Laureates in Chemistry 1901-1992;* Laylin K. James, Ed.; American Chemical Society and the Chemical Heritage Foundation: Washington, D.C.;1993; pp 584-589.

3. P. V. Bonnesen, Peter V. "Geoffrey Wilkinson"; In *Nobel Laureates in Chemistry 1901-1992;* Laylin K. James, Ed.; American Chemical Society and the Chemical Heritage Foundation: Washington, D.C.;1993; pp 557-563.

2. P. V. Bonnesen, "Ernst Otto Fischer"; In *Nobel Laureates in Chemistry 1901-1992;* Laylin K. James, Ed.; American Chemical Society and the Chemical Heritage Foundation: Washington, D.C.;1993; pp 551-556.

1. P. V. Bonnesen, "Karl Ziegler"; In *Nobel Laureates in Chemistry 1901-1992;* Laylin K. James, Ed.; American Chemical Society and the Chemical Heritage Foundation: Washington, D.C.;1993; pp 449-455.