

## **Richard D. McCullough**

Carnegie Mellon University  
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Tel: (412) 268-1180  
Date of Birth: April 9, 1959

### **PROFESSIONAL APPOINTMENTS**

2007-Present:	Vice President for Research, Carnegie Mellon University
2001-2007:	Dean, Mellon College of Science, Carnegie Mellon University includes Biological Sciences, Chemistry, Mathematical Sciences, Physics, and 9 Centers and Institutes including the Pittsburgh Supercomputing Center.
1998-2001:	Head of Chemistry, Carnegie Mellon University
1998-Present:	Professor of Chemistry, Carnegie Mellon University
1996-1997:	Associate Head of Chemistry, Carnegie Mellon University
1995-1998:	Associate Professor of Chemistry, Carnegie Mellon University
1990-1995:	Assistant Professor of Chemistry, Carnegie Mellon University
2002-Present:	Founder, Board of Directors, and Chief Scientist (2005), Plextronics, Inc. Carnegie Mellon spin-off company based on my research and technology.
2008-Present:	Board of Directors, Innovation Works an economic development organization
2001-Present:	Board of Directors, Mellon Pittsburgh Corporation governing board for CMU/U. Pitt. joint ventures
2002-Present;	Scientific Infrastructure Investment Committee, Pittsburgh Life Sciences Greenhouse
1999-2000:	Technical Advisory Board, BF Goodrich Performance Materials
1999-2001:	Chair of the Board, Cyert Center for Early Education
2008-Present:	Advisory Board, University of Central Florida, Nanoscience Center.
2004-2006:	Washington Nanotechnology Center Steering Committee
1998-Present:	Editorial Board, <i>Advanced Materials</i>
1994-2000:	International Advisory Board, <i>Journal of Materials Chemistry</i>

1996: Visiting Professor, University of Copenhagen

## EDUCATION

1988-1990 Postdoctoral Fellow, Columbia University, New York, NY  
Research Advisor: Professor Ronald Breslow

1982-1988 Ph.D., Organic Chemistry, The Johns Hopkins University, Baltimore, MD  
Research Advisor: Professor Dwaine O. Cowan

1977-1982 B.S., Chemistry, *cum laude* 1982, The University of Texas at Dallas

## PRINCIPAL RESEARCH INTERESTS

Organic and Materials Chemistry. Regioregular Polythiophenes. Development of Printable Electronic Materials, Nanoelectronic Materials, and Engineered Devices Based on Conductive Polymers. Synthesis and Device Study of Highly Conductive Organic Conducting Polymers as Transistors, Solar Cells, and MEMS based Gas Sensors.

## HONORS

2007 American Chemical Society Pittsburgh Award

2006 Start-Up Entrepreneur of the Year Award  
Carnegie Science Center's Awards of Excellence

2005 Alumni Achievement Award, University of Texas, Dallas

2002 American Chemical Society Akron Award

1992 AT&T Special Foundation Award

1987 Sarah and Adolph Roseman Achievement Award in Research and Teaching  
awarded by The Johns Hopkins University

## RECENT HONORS TO PLEXTRONICS

Featured on the Jim Lehrer News Hour on PBS  
[http://www.plextronics.com/press\\_detail.aspx?PressReleaseID=19](http://www.plextronics.com/press_detail.aspx?PressReleaseID=19)  
Top 10 Start-ups in Greentech, <http://www.greentechmedia.com/articles/top-ten-list-introduction.html>, Greentech Media, September 2007.  
[Red Herring 100 North America](#) – April 2007, Red Herring  
[Clean Energy Entrepreneur of the Year](#) – December 2006, U.S. Dept. of Energy NREL  
[Top 50 Nanotechnology Start-ups](#) – November 2006, Lux Research  
[Start-up of the Year](#) – October 2006, Organic Semiconductors Industry  
[Wall Street Journal Innovation Award](#) – September 2006, The Wall Street Journal

**Number of Employees:** 52 (15 PhDs) as of August 14, 2008. **Investment:** Series B corporate round completed at \$20.6M. Series A round completed summer 2006 \$13.1 Million; \$33.7 since its inception in July, 2002. **Investors:** Solvay, Inc., Applied Materials, Birchmere Ventures, Draper Triangle Ventures, Firelake Capital

## SERVICE AND COMMITTEE WORK WITHIN THE UNIVERSITY

### 1990-1991

Graduate Recruiting Committee-vice chair  
Junior Organic Faculty Search Committee  
Departmental Instrumentation Committee  
Judge for CMU Sigma Xi Undergraduate Research Symposium  
Colloquium Committee

### 1991-1992

Graduate Recruiting Committee-vice chair  
Junior Organic Faculty Search Committee  
Senior Organic Faculty Search Committee  
Junior Inorganic Faculty Search Committee  
Graduate Student Oversight Committee  
Instrumentation Committee  
Committee for Chemical Use in Mellon Institute  
Judge for CMU Sigma Xi Undergraduate Research Symposium

### 1992-1993

Graduate Recruiting Committee - Chairman  
Departmental Staff Committee  
Departmental Instrumentation Committee  
Graduate Student Oversight Committee

### 1993-1994

Member of the Executive Committee in Chemistry  
Graduate Recruiting Committee-Chairman  
Departmental Instrumentation Committee  
Graduate Student Oversight Committee  
Undergraduate Laboratory Renovation Committee  
Organic Curriculum Committee  
College Committee on Health & Safety and Chemical Use in Mellon Institute  
Task Force on the Chemistry Graduate Program  
Graduate Fellowship Committee

### 1994-1995

Member of the Executive Committee in Chemistry  
Co-Chair Senior Organic Chemistry Faculty Search Committee  
Graduate Recruiting Committee-Chairman  
Departmental Infrastructure Committee  
Undergraduate Laboratory Renovation Committee  
Graduate Fellowship Committee  
MCS Graduate Handbook Committee

### 1995-1996

Co-Chair Senior Organic Chemistry Faculty Search Committee  
Department Head Search Committee  
Departmental Infrastructure Committee  
Undergraduate Laboratory Renovation Committee  
Director of Center of Molecular Analysis Search Committee

Member of the Executive Committee in Chemistry  
Departmental Strategic Planning Committee  
Task Force on Procurement Card Customer Needs  
Mellon Institute Space Committee

**1996-1997**

Associate Department Head of Chemistry  
Chair, Senior/Junior Organic Chemistry Faculty Search Committee  
Department Head Search Committee  
Undergraduate Laboratory Renovation Committee  
Member of the Executive Committee in Chemistry  
Undergraduate Lab Instructor Search Committee

**1997-1998**

Department Head Search Committee  
Undergraduate Laboratory Renovation Committee - Chair  
Member of the Executive Committee in Chemistry

**1998-2000: Key Committees or Service**

Department Head  
Chair, Organic Chemistry Search Committee  
Chair, President's Task Force on Infrastructure and Laboratories Subcommittee for the CMU  
Leadership Committee on Cell, Tissue, and Bone Engineering Initiative  
MCS College Council  
MCS College Review Committee  
Electrical and Computer Engineering Head Search Committee  
Biology Head Search Committee  
Inorganic Chemistry Search Committee  
Polymer/Materials Chemistry Search Committee  
Undergraduate Laboratory Renovation Committee - Chair, leader of \$26M renovation/new construction of the Chemistry Undergraduate labs.  
Organic Chemistry Search Committee  
Assistant Vice President of Facilities Management Search Committee

**2000-2006: Key Committees or Service**

Provost Search Committee, 2000  
Chief Financial Officer Search Committee, 2003  
Co-Chair, Dean of the School of Computer Science Search Committee, 2004  
Dean of the School of Engineering Search Committee, 2004  
Comptroller Search Committee, 2004  
Chair, Custodial Contract Award Committee, 2004  
Chair, MCS College Council  
Polymer/Materials Chemistry Search Committee, 2003, 2004  
University Biotechnology Implementation Committee  
President's Council  
University Non-Tenure Review Committee  
University Tenure Review Committee  
Chair, College Tenure Review Committee  
Chair, College Non-Tenure Review Committee  
Board of Trustee's Information Technology Strategic Planning Committee (led planning for Bioinformatics/Computational Biology)

Board of Trustees' Environmental Strategic Planning Committee  
Leader of University's Biotechnology Initiative  
Hunt Botanical Institute Board Member

**2007-present: Key Committees or Service**

University Financial Process Committee, 2007  
Chair, Provost's Special Grievance Committee  
Chair of the Research Strategic Planning Committee, 2007-present.  
Vice chair of the Strategic Planning Steering Committee, 2007-present.  
Management Team Lite-university's senior leadership team, 2007-present.  
Board of Trustees' Research and Commercialization Committee, 2001-present, now co-chair

**SCIENTIFIC ACTIVITIES**

129 Invited Lectures since 1991. 137 Publications (includes conference proceedings).

**PUBLICATIONS**

1. "An Approach to the Synthesis of TMTTeF," Cowan, D. O.; Lerstrup, K.; Veciana, J.; Rovira, C.; Bailey, A.; McCullough, R. *Mol. Cryst. Liq. Cryst.* **1985**, *102*, 285-294.
  2. "Tellurium Containing Organic Metals," Cowan, D. O.; Mays, M.; Lee, M.; McCullough, R.; Bailey, A.; Lerstrup, K.; Wiygul, F.; Kistenmacher, T.; Poehler, T.; Chiang, L.-Y. *Mol. Cryst. Liq. Cryst.* **1985**, *125*, 191-204.
  3. "A Convenient Synthesis of Hexamethylenetetraselenafulvalene (HMTSF)," McCullough, R. D.; Cowan, D. O. *J. Org. Chem.* **1985**, *50*, 4644-4648.
  4. "The Synthesis and Study of New Selenium and Tellurium Heterocyclic  $\pi$ -Donors," Lerstrup, K.; Bailey, A.; McCullough, R. D.; Mays, M.; Cowan, D. O. *Synth. Met.* **1986**, *19*, 647-652.
  5. "Tetratellurafulvalene (TTeF)," McCullough, R. D.; Kok, G. B.; Lerstrup, K. L.; Cowan, D. O. *J. Am. Chem. Soc.* **1987**, *109*, 4115-4116.
  6. "Initial Study of the New Tellurium Containing Charge Transfer Organic Metal: Tetratellurafulvalene-Tetracyanoquinodimethane (TTeF-TCNQ)," Mays, M. D.; McCullough, R. D.; Cowan, D. O.; Poehler, T. O.; Bryden, W. A.; Kistenmacher, T. J. *Solid State Commun.* **1988**, *65*, 1089-1092.
  7. "An Improved Synthesis of Tetratellurafulvalene via 1,2-Bis(trimethylstannylethylene)," McCullough, R. D.; Bailey, A. B.; Mays, M. D.; Cowan, D. O. *Synth. Met.* **1989**, *27*, 487-492.
  8. "New Organic p-Donors: Analogues of HMTSF and HMTTeF," Bailey, A. B.; McCullough, R. D.; Mays, M. D.; Cowan, D. O.; Lerstrup, K. A. *Synth. Met.* **1989**, *27*, 425-430.
  9. "Electrical and Magnetic Studies on Some New Organic Conductors Made With Tetratellurafulvalene (TTeF)," Mays, M. D.; McCullough, R. D.; Bailey, A. B.; Cowan, D. O.; Poehler, T. O.; Kistenmacher, T. J. *Synth. Met.* **1989**, *27*, 493-498.
  10. "Substrate Selectivity in Epoxidation by Metalloporphyrin and Metallo salen Catalysts Carrying Binding Groups," Breslow, R.; Brown, A. B.; McCullough, R. D.; White, P. W. *J. Am. Chem. Soc.* **1989**, *111*, 4517-4518.
  11. "Organic Metals Containing Tellurium," Cowan, D. O.; McCullough, R. D.; Bailey, A.; Lerstrup, K.; Talham, D.; Herr, D.; Mays, M. *Phosphorus, Sulfur, Silicon, Relat. Elem.* **1992**, *67*, 277-294.
- At Carnegie Mellon**
12. "Enhanced Electrical Conductivity in Regioselectively Synthesized Poly(3-alkylthiophenes)," McCullough, R. D.; Lowe, R. D. *J. Chem. Soc., Chem. Commun.* **1992**, 70-72.

13. "Design, Synthesis, and Control of Conducting Polymer Architectures: Structurally Homogeneous Poly(3-alkylthiophenes)," McCullough, R.D.; Lowe, R. D.; Jayaraman, M.; Anderson, D. L. *J. Org. Chem.*, **1993**, 58, 904-912.
14. "Design and Control of Conducting Polymer Architectures: Synthesis and Properties of Regiochemically Well-Defined Poly(3-alkylthiophenes)," McCullough, R. D.; Lowe, R. D.; Tristram-Nagle, S.; Jayaraman, M.; Anderson, D. L.; Ewbank, P. C. *Synth. Met.*, **1993**, 55, 1198-1203.
15. "Novel Coordination Complexes of Tetrathiafulvalene Derivatives," McCullough, R. D.; Seth, J.; Belot, J. A.; Majetich, S. A.; Carter, A. C. *Synth. Met.*, **1993**, 56, 1989-1994.
16. "Connected Cadmium Selenide Nanocrystallites" Majetich, S. A.; Carter, A. C.; McCullough, R. D in "*Nanophase and Nanocomposite Materials*", eds. S. Komarneni, J.C. Parker, and G.J. Thomas, Materials Research Society, Pittsburgh, PA **1993**, 286, 86-92.
17. "Self-Oriented Poly(3-Alkylthiophenes): New Insights on Structure-Property Relationships in Conducting Polymers," McCullough, R. D.; Tristram-Nagle, S.; Williams, S. P.; Lowe, R. D.; Jayaraman, M. *J. Am. Chem. Soc.* **1993**, 115, 4910-4911.
18. "Selective Generation, Isolation, and Purification of Tetrathiafulvalene Tetrathiolate: A Versatile Building Block for New Materials," McCullough, R. D.; Belot, J. A.; Seth, J. *J. Org. Chem.* **1993**, 58, 6480-6482.
19. "Toward Tuning Electrical and Optical Properties in Conjugated Polymers Using Side-Chains: The Synthesis and Physical Properties of a Series of the First Head-to-Tail Heteratom Functionalized Polythiophenes," McCullough, R. D.; Williams, S. P. *J. Am. Chem. Soc.* **1993**, 115, 11608-11609.
20. "Cadmium Selenide Nanocrystallite Networks", Majetich, S. A.; Seth, J.; McCullough, R. D.; Belot, J. A. *Z. Physik D* **1993**, 26, 210-212.
21. "Synthesis and Physical Properties of Self-Orienting, Head-To-Tail Polythiophenes," McCullough, R. D.; Williams, S. P.; Jayaraman, M.; Reddinger, J.; Miller, L.; Tristram-Nagle, S. in "*Electrical, Optical, and Magnetic Properties of Organic Solid State Materials*," Dalton, L.; Lee, C., eds., Materials Research Society, Pittsburgh, PA **1994**, 328, 215-220.

22. "Toward New Magnetic, Electronic, and Optical Materials: Synthesis and Characterization of New Bimetallic Tetrathiafulvalene Tetrathiolate Building Blocks," McCullough, R. D.; Belot, J. A. *Chem. Mater.* **1994**, 6, 1396-1403. **INVITED.** Invited manuscript for the Special Issue on Solid State Organic Chemistry dedicated to the late Margaret (Peggy) Etter.
23. "<sup>1</sup>H NMR Characterization of the CdSe Nanocrystallite Surface," Majetich, S. A.; Carter, A. C.; Belot, J. A.; McCullough, R. D. *J. Phys. Chem.*, **1994**, 98, 13705-13710.
24. "The Tuning of Conjugation by Recipe: The Synthesis and Properties of Random Head-to-Tail Poly(3-alkylthiophene) Copolymers," McCullough, R. D.; Jayaraman, M. *J. Chem. Soc., Chem. Commun.*, **1995**, 135-138.
25. "The First Synthesis and New Properties of Regioregular, Head-To-Tail Coupled Polythiophenes." McCullough, R. D.; Williams, S. P.; Tristram-Nagle, S.; Jayaraman, M.; Ewbank, P. C.; Miller, L. *Synt. Met.*, **1995**, 69, 279-282.
26. "New Bimetallic Tetrathiafulvalene Building Blocks and Self-Assembled, Two Dimensional Conductors Derived From Regioregular, Head-to-Tail Coupled Polythiophenes" McCullough, R. D.; Belot, J. A.; Williams, S. P. in "*Molecular Engineering of Advanced Materials*", Becher, J., Schaumburg, K. Eds., NATO Advanced Research Workshop Series, Series C: Mathematical and Physical Sciences, **1995**, 456, 349-363.
27. "Building Block Ligands For New Molecular Conductors: Homobimetallic Tetrathiafulvalene Tetrathiolates and Metal Diselenolenes and Ditellurolenes," McCullough, R. D.; Belot, J. A.; Seth, J.; Rheingold, A. L.; Yap, G. P. A.; Cowan, D. O. *J. Mater. Chem.*, **1995**, 5, 1581-1587. Invited manuscript for Special Issue on Molecular Conductors.
28. "Toward New Electronic, Magnetic, and Optical Materials: Structure and Properties of the First Homobimetallic Tetrathiafulvalene Tetrathiolate Building Block," McCullough, R. D.; Belot, J. A.; Rheingold, A. L.; Yap, G. *J. Am. Chem. Soc.*, **1995**, 117, 9913-9914.
29. "Dramatic Conjugational Interchange in Regiochemically Pure Polythiophenes Via a Chemoselective Recognition Response," McCullough, R. D.; Williams, S. P. *Chem. Mater.* **1995**, 7, 2001-2003.
30. "Intermolecular Association and Supramolecular Organization in Dilute Solution. 1. Regioregular Poly(3-dodecylthiophene)," Yue, S.; Berry, G. C.; McCullough, R. D. *Macromolecules*, **1996**, 29, 933-939.
31. "Evidence of a Novel Side Chain Structure in Regioregular Poly(3-Alkylthiophenes)," Prosa, T. J.; Winokur, M. J.; McCullough, R. D. *Macromolecules*, **1996**, 29, 3654-3657.
32. "Optimizing the Synthesis of Tetratellurafulvalene (TTeF)," Herr, D. E.; Mays, M. D.; McCullough, R. D.; Bailey, A. B.; Cowan, D. O. *J. Org. Chem.*, **1996**, 61, 7006-7011.
33. "Quadratic Electro-optical Measurements of Polythiophene Films by a Modified Mach-Zehnder Interferometer," Jakobsen, C.; Petersen, J. C.; Geisler, T.; Bjornholm, T.; Greve, D. R.; McCullough, R. D. *J. Opt. Soc. Am.* **1996**, 115, 235-240.
34. "Improved Electroluminescent In Poly(3-alkylthiophenes) With High Head-to-Tail Ratios," Mehta, P.; McCullough, R. D. *J. Mater. Chem.* **1996**, 6, 1763-1766.
35. "Third-Harmonic Generation From Regioregular and Regioirregular Poly(3-dodecylthiophenes). Dependence of  $c^3$  on Conjugation Length," Bjornholm, T.; Greve, D. R.; Geisler, T.; Petersen, J. C.; Jayaraman, M.; McCullough, R. D. *Adv. Mater.* **1996**, 8, 920-923.
36. "A Facile and Efficient Synthesis of Vanadocenes With Alkyl Annulated Cyclopentadienyl Rings," McCullough, R. D.; Belot, J. A. *Organometallics* **1996**, 15, 5062-5065.
37. "Self-Assembly and Disassembly of Regioregular, Water Soluble Polythiophenes: Chemoselective Ionchromatic Sensing in Water," McCullough, R. D.; Ewbank, P. C.; Loewe, R. S. *J. Am. Chem. Soc.* **1997**, 119, 631-632.
38. "Self-assembly and Chemical Response of Conducting Polymer Superstructures," McCullough, R. D.; Ewbank, P. C. *Synth. Met.* **1997**, 84, 311-312.
39. "Self-Assembly in Regioregular Polythiophenes," McCullough, R. D. *Annu. Tech. Conf.-Soc. Plast. Eng.*, **1997**, 56, 102-105.

40. "Saturation effects in the Nonlinear Optical Response of Regioregular, Highly Conjugated Poly(3-alkylthiophene) Thin Films," *Synth. Met.* **1997**, *84*, 531-532.
41. Bjørnholm, T.; Greve, D. R.; McCullough, R. D. In *Supramolecular Engineering of Synthetic Metallic Materials: Conductors and Magnets*; Veciana, J., Rovira, C., Amabilino, D. B., Eds.; NATO ASI Series C, Volume 518, Kluwer: Dordrecht, **1998**; pp 477-483.
42. "Regioregular, Head-to-Tail Coupled Poly(3-alkylthiophene) and its Derivatives," McCullough, R. D.; Ewbank, P. C. in the *Handbook of Conducting Polymers*, 2nd edition, Marcel Dekker, **1998**, Chapter 9. 225-258. **INVITED**
43. "The Chemistry of Conducting Polythiophenes," McCullough, R. D. *Adv. Mater.* **1998**, *10*, 1-24 (review). **INVITED**
44. "Structured Amphiphilic Regioregular Polythiophene Nanosheet Conductors: 2-D Self-Assembly of Highly Conjugated Polymers," Thomas Bjørnholm, Daniel R. Greve, Niels Reitzel, Kristian Kjær, Paul Howes, Mani Jayaraman, Paul C. Ewbank, Richard D. McCullough *J. Am. Chem. Soc.* **1998**, *120*, 7643-7644.
45. Greve, D. R.; Reitzel, N.; Hassenkam, T.; Bøgelund, J.; Kjaer, K.; Howes, P. B.; Larsen, N. B.; Jayaraman, M.; McCullough, R. D.; Bjørnholm, T. "Directed self-assembly of amphiphilic regioregular polythiophenes on the nanometer scale." *Synth. Met.* **1999**, *102*, 1502-1505.
46. "The Chemistry of Polythiophenes: From Synthesis to Self-Assembly to Intelligent Materials," McCullough, R. D. *Handbook of Oligothiophenes and Polythiophenes*, **1999**, 1-44.
47. "A Very Simple Method to Prepare Head-to-Tail Coupled, Regioregular Poly(3-alkylthiophenes) Using Grignard Metathesis," Loewe, R. S.; Khersonsky, S. M.; McCullough, R. D. *Adv. Mater.* **1999**, *11*, 250-253.
48. "Investigating the Synthesis of Unsymmetrical Tetrathiafulvalene Derivatives: Improved Yields by the Hidden Equivalent Method," McCullough, R. D.; Petruska, M. A.; Belot, J. A. *Tetrahedron*, **1999**, *115*, 2231-2238.
49. "Employing MALDI-MS on Polyalkylthiophenes: Analysis of Molecular Weights, Molecular Weight Distributions, End Group Structures, and End Group Modifications," Liu, J.; Loewe, R. S.; McCullough, R. D. *Macromolecules* **1999**, *32*, 5777-5785.
50. "Polythiophene Nanowires," Bjørnholm, T.; Hassenkam, T.; Greve, D. R.; McCullough, R. D.; Jayaraman, M.; Savoy, S. M.; Jones, C. E.; McDevitt, J. T. *Adv. Mater.* **1999**, *11*, 1218-1221 (**paper featured on the cover**).
51. "Self-Assembly of Conjugated Polymers at the Air/Water Interface. Structure and Properties of Langmuir-Blodgett Films of Amphiphilic Polythiophenes," Reitzel, N.; Greve, D. R.; Kjaer, K.; Howes, P. B.; Jayaraman, M.; Savoy, S.; McCullough, R. D.; McDevitt, J. T.; Bjørnholm, T. B. *J. Am. Chem. Soc.*, **2000**, *122*, 5788-5800.
52. "Regioselective Synthesis and Analysis of Polythienylvinylene," Loewe, R. L.; McCullough, R. D. *Chem. Mater.* **2000**, *12*, 3214-3221.
53. "Water Soluble Amine Functionalized Polythiophenes Bind DNA," Ewbank, P. C.; Nuding, G.; Suenaga, H.; McCullough, R. D.; Shinkai, S. *Tetrahedron Lett.* **2000**, *42*, 155-157.
54. "Regioregular, Head-to-Tail Coupled Poly(3-alkylthiophenes) Made Easy by the GRIM Method: Investigation of the Reaction and Why It Works," Loewe, R. S.; Ewbank, P. C.; Liu, J.; Zhai, L.; McCullough, R. D. *Macromolecules* **2001**, *34*, 4324-4333.
55. "Temperature and Voltage Dependent Optical Properties of Conducting Polymer in Synthetic Opal as Photonic Crystal", Satoh, S.; Kajii, H.; Kawagishi, Y.; Tamura, T.; Fujii, A.; Ozaki, M.; McCullough, R. D.; Yoshino, K., *Synth. Met.* **2001**, *121*, 1503-1504.
57. "Self-assembly of amphiphilic conducting polymers into nanowires, nanocircuits, and multifunctional materials", McCullough, R.D.; Liu, Jinsong; Sheina, Elena; Heuze, Karine; Stokes, Kristoffer; Jayaraman, Manikandan; Bjørnholm, Thomas; McDevitt, John T., *Poly. Mater. Sci.*, **2001**, *84*, 858.
58. "Self-Assembly of Electrically Conductive Polymer Nanostructures: Synthesis and Properties of Well-Defined Regioregular Polythiophene Diblock and Triblock Copolymers," Liu,



- J.; Sheina, E.; Kowalewski, T.; McCullough, R. D. *Angew. Chem. Int. Ed. Engl.* **2002**, *41*, 329-332.
- 59.** "Layer-by-Layer Electrostatic Self-Assembly of Polythiophene," Zhai, L. and R.D. McCullough, *Adv. Mater.* **2002**, *14*, 901-905.
- 60.** "Synthesis and Characterization of Poly(methylacrylate) Grafted from Poly(thiophene) to Form Solid State Fluorescent Materials," Constanzo, P. J.; Stokes, K. K.; (McCullough, R. D.) *Macromolecules*, **2002**, *35*, 6804-6810.
- 61.** "End-Group-Modification of Regioregular Polythiophene Through Post-Polymerization Functionalization," Liu, J.; McCullough, R. D., *Macromolecules*, **2002**, *35*, 9882-9889.
- 62.** "Tuning the Electrical Conductivity and Self-Assembly of Regioregular Polythiophene by Block Copolymerization: Nanowire Morphologies in New Di- and Triblock Copolymers," Liu, J., Sheina, E., Kowalewski, T., and R.D. McCullough, *Angew. Chem. Int. Ed.*, **2002**, *41*, 329-332.
- 63.** "Complex nanostructured materials from segmented copolymers prepared by ATRP" Kowalewski, T., McCullough, R.D., and K. Matyjaszewski *Eur. Phys. J. E*, **2003**, *10*, 5-16.
- 64.** "A Simple Method to Generate Side-chain Derivatives of Regioregular Polythiophene via the GRIM Metathesis and Post-polymerization Functionalization" Zhai, L., Pilston, R.L., Zaiger, K.L., Stokes, K. and R.D. McCullough, *Macromolecules*, **2003**, *36*, 61-64.
- 65.** "Soft-lithography Patterning of Functionalized Regioregular Polythiophenes" Zhai, L., Laird, D.W., and R.D. McCullough *Langmuir*, **2003**, *19*, 6492-6497.
- 66.** "New Phosphonic Acid Functionalized, Regioregular Polythiophenes," Stokes, K. K.; Heuzé, K.; McCullough, R. D., *Macromolecules*, **2003**, *36*, 7114-7118.
- 67.** "Regioregular Polythiophene/Gold Nanoparticle Hybrid Materials" Zhai, L., and McCullough, R.D., *J. Mater. Chem.*, **2004**, *14*, 141-143.
- 68.** "In-situ End Group Functionalization of Regioregular Poly(3-alkylthiophene) using the Grignard Metathesis Polymerization Method," Jeffries-EL, M.; Sauvé, G., and McCullough, R. D. *Adv. Mater.*, **2004**, *16*, No. 12., 1017-1019.
- 69.** "Chain Growth Mechanism for Regioregular Nickel-Initiated Cross-Coupling Polymerizations," Sheina, E. E.; Liu, J.; Iovu, M. C.; Laird, D. W.; McCullough, R. D. *Macromolecules*, **2004**, *37*, pg. 3526-3528.
- 70.** "Regioregular Poly(thiophene-3-alkanoic acid)s: Water Soluble Conducting Polymers Suitable for Chromatic Chemosensing in Solution and Solid State", Ewbank, P. C.; Loewe, R. S.; Zhai, L.; Reddinger, J.; Sauvé, G.; McCullough, R. D., *Tetrahedron*, **2004**, *60*, pg. 11269-11275.
- (invited)**
- 71.** "Regioregular Poly(3-Alkylthiophene) Conducting Block Copolymers" Iovu, M. C.; Jeffries-EL, M.; Sheina, E. E.; Cooper, J. R.; McCullough, R. D.; *Polymer*, **2005**, *46*, 8582-8586.
- 72.** "Highly Conductive, Regioregular Alkoxy-Functionalized Polythiophenes: A New Class of Stable, Low Band Gap Materials", Sheina, E. E.; Khersonsky, S. M.; Jones, E. G.; McCullough, R. D. *Chem. Mater.*, **2005**, *17*, 3317-3319.
- 73.** "Experimental Evidence for the Quasi-"Living" Nature of the Grignard Metathesis Method for the Synthesis of Regioregular Poly(3-alkylthiophenes)", Iovu, M. C.; Sheina, E. E.; Gil, R. R.; McCullough, R. D.; *Macromolecules*, **2005**, *38*, 8649-8656.
- 74.** "Facile Synthesis of End-Functionalized Regioregular Poly(3-alkylthiophene)s via Modified Grignard Metathesis Reaction," Jeffries-EL, Malika; Sauvé, G.; McCullough, R. D. *Macromolecules* **2005**, *38*, 10346-10352.
- 75.** "Nanostructure Dependence of Field-Effect Mobility in Regioregular Poly(3-hexylthiophene) Thin Film Field Effect Transistors," Zhang, R.; Li, B.; Jeffries-EL, M.; Iovu, M. C.; Sauvé, G.; Cooper, J.; Jia, S.; Tristram-Nagle, S.; Smilgies, D. M.; Lambeth, D. N.; McCullough, R. D.; Kowalewski, T. *J. Am. Chem. Soc.* **2005**, *128*, 3480-3481.

76. "Conducting Block Copolymer Nanowires Containing Regioregular Poly(3-hexylthiophene) and Polystyrene," *J. Macromolecular Science Part A: Pure and Applied Chemistry* **2006**, 43, 1991-2000 (special issue dedicated to Professor Sukant Tripathy).
77. "Volatile Organic Compound Detection Using Nanostructured Copolymers," Li, B.; Sauve, G.; Iovu, M. C.; Jeffries-EL, M.; Zhang, R.; Cooper, J.; Santhanam, S.; Schultz, L.; Revelli, J. C.; Kusne, A. G.; (Kowalewski, T.; Snyder, J. L.; Weiss, L. E.; Fedder, G. K.; McCullough, R. D.; Lambeth, D. N. *Nanoletters* **2006**, 6, 1598-1602.
78. "Regioregular Polythiophenes," Jeffries-EL, M.; McCullough, R. D. *Handbook of Conducting Polymers, 3rd Edition*, **2007**, Chapter 9, pgs. 1-49.
79. "Conducting block copolymers of regioregular poly(3-hexylthiophene) and poly(methacrylates): Electronic materials with variable conductivities and degrees of interfibrillar order," *Macromolecular Rapid Communications*, **2007**, 28, 1816-1824.
80. "Conducting Regioregular Polythiophene Block Copolymer Nanofibrils Synthesized by Reversible Addition Fragmentation Chain Transfer Polymerization (RAFT) and Nitroxide Mediated Polymerization (NMP)," *Macromolecules* **2007**, 40, 4733-4735.
81. "High Field-Effect Mobilities for Diblock Copolymers of Poly(3-hexylthiophene) and Poly(methyl acrylate)," Sauve, G.; McCullough, R. D. *Adv. Mater.* **2007**, 19, 1822-1855.
82. "Novel Thiophene-Thiazolothiazole Copolymers for Organic Field-Effect Transistors," . Osaka, I.; Sauv , G.; Zhang, R.; Kowalewski, T.; McCullough, R. D. *Adv. Mater.* **2007**, 19, 4160-4165.
83. "Regioregular Polythiophene Solar Cells: Material Properties and Performance," Ewbank, P.; Laird, D.; McCullough, R. D. invited book chapter for *Organic Photovoltaics: Materials, Device Physics & Manufacturing Technologies*, Lavoisier, **2008**.
84. "Regioregular Polythiophenes," invited chapter for *Thiophene-Based Materials for Electronics and Photonics*, Ewbank, P.; Iovu, M.; McCullough, R. D. Wiley, 2008.
85. "Dispersion of Pristine Carbon Nanotubes Using Conjugated Block Copolymers," Ianhua, J.; Zou, J.; Liu, L.; Chen, H.; 1, Khondaker, S. I.; McCullough, R. D.; Huo, Q.; Zhai, L. *Adv. Mater.* **2008**, 20, 2055-2060.
86. "Highly Disordered Polymer Field Effect Transistors: N-alkyl dithieno[3,2-b:2',3'-d]pyrrole-based Copolymers with Surprisingly High Charge Carrier Mobilities", Liu, J.; Zhang, R.; Sauve, G.; Kowalewski, T.; McCullough, R. *J. Am. Chem. Soc.* **2008**, in press.
87. "Advances in Molecular Design and Synthesis of Regioregular Polythiophenes," Osaka, I.; McCullough, R. D. *Accounts of Chemical Research* **2008**, in press.

50+ conference publications (not listed).

#### Patents (partial list-5 total)

McCullough, Richard D.; Robert S. Loewe "Method of Forming Poly(3-substituted) Thiophenes," US Patent 6,166,172 (2000). Licensed to Plextronics.

McCullough, Richard D.; Liu, Jinsong; Ewbank, Paul C.; Sheina, Elena E. "Polythiophenes, Block Copolymers, Made Therefrom, and Methods of Forming the Same", US Patent 6,887,965 (2003). Plus 2 additional divisionals. Licensed to Plextronics.

McCullough, Richard D.; Iovu, Mihaela, "Purification Methods for Regioregular Polythiophenes," US Patent, Licensed to Plextronics.

McCullough, Richard D.; Iovu, Mihaela, "Living Grignard Metathesis Polymerization Methods for the Universal Applications," US Patent, Licensed to Plextronics.

## LECTURES – while at CMU

### 129 Invited Lectures

#### 1991

Department of Chemistry, Duquesne University

#### 1992

Symposium on Well-Defined Polymers, National American Chemical Society (ACS) Meeting, San Francisco, CA, April, 1992.

#### 1993

Florida Advanced Materials Conference, Palm Coast, FL, March 1993.

University of Michigan, Ann Arbor, MI, March, 1993.

Polaroid Corporation, Cambridge, MA, April 1993.

University of Massachusetts, Lowell, MA, April 1993.

NSF Workshop on Reactive Intermediates, Lake Tahoe, NV, June, 1993.

Physical Organic Gordon Conference, NH, June, 1993.

Symposium on Supramolecular Chemistry, Organic Division, Central Regional ACS Meeting, Pittsburgh, PA, October, 1993.

Symposium on Conducting Polymers, Polymer Division, Central Regional ACS Meeting, Pittsburgh, PA, October, 1993.

Symposium on Electrical, Optical, and Magnetic Properties of Organic Solid State Materials. Materials Research Society Meeting, Boston, MA, November, 1993.

#### 1994

PPG Industries, Inc., Pittsburgh, PA, January, 1994.

Pittsburgh Polymer Section of the ACS, Pittsburgh, PA, January, 1994

Symposium on Conjugated Polymers, Polymer Division, National ACS Meeting, San Diego, CA, March, 1994.

University of Copenhagen, Copenhagen, Denmark, May, 1994.

NATO Advanced Research Workshop on Molecular Engineering For Advanced Materials, Hindsgavl, Denmark, May, 1994.

Symposium on Organometallic Chemistry in Polymer Synthesis, Organic Division, Great Lakes & Central Regional ACS Meeting, Ann Arbor, MI, June, 1994.

International Conference on Synthetic Metals (ICSM), Seoul, Korea, July, 1994.

University of Rochester, Rochester, NY, October, 1994.

Southeastern Magnetic Resonance Conference (SEMRC), Chapel Hill, NC, October, 1994.

Symposium on the Chemistry and Properties of Highly Conjugated Polymers, Organic Division, Southwest Regional ACS Meeting, Ft. Worth, TX, November, 1994.

University of Texas, Austin, TX, December, 1994.

University of Texas, Arlington, TX, December, 1994.

University of Pennsylvania, Philadelphia, PA, December, 1994.

Columbia University, New York, NY, December, 1994.

#### 1995

Akron Polymer Lecture Group, Akron, OH, February, 1995.

Indiana University, Bloomington, IN, February, 1995.

Tulane University, New Orleans, LA, April, 1995.

Symposium on the Synthesis of Well-Defined Macromolecules for Function and Assembly,

National ACS Meeting, Anaheim, CA, April, 1995.  
Carl Marvel Award for Creative Invention in Polymer Chemistry Symposium Honoring Prof. Kris Matyjaszewski, National ACS Meeting, Anaheim, CA, April, 1995.  
Symposium on Materials through Molecular Design, National ACS Meeting, Anaheim, CA, April, 1995.  
Symposium on Functional Polymers, Midwest Regional ACS Meeting, Akron, OH, May, 1995.  
Wright Patterson Air Force Base, OH, May, 1995.  
University of Delaware, Newark, DE, June 1995.  
Symposium on Electrical, Optical, and Magnetic Properties of Organic Solid State Materials.  
Materials Research Society Meeting, Boston, MA, November, 1995.

## **1996**

University of Pittsburgh, Pittsburgh, PA, February 1996.  
Symposium on Inorganic-Organic Hybrid Materials, National ACS Meeting, New Orleans, LA, March, 1996.  
Dickinson College, Carlisle, PA, April 1996.  
New York University, New York, NY, April 1996.  
Center For Interdisciplinary Studies of Molecular Interactions (CISMI), Copenhagen, Denmark, May 1996.  
Symposium on Molecules For Advanced Materials and Nanostructures, University of Copenhagen, Copenhagen, Denmark, May 1996.  
Royal Institute of Technology, Stockholm, Sweden, June 1996.  
University of Groningen, Groningen, The Netherlands, June 1996.  
Risø National Laboratory, Roskilde, Denmark, June 1996.  
Philips Electronics, Eindhoven, The Netherlands, June 1996.  
Eindhoven University of Technology, The Netherlands, June 1996.  
NKT Corporation, Copenhagen, Denmark, July 1996.  
Dako Industries, Copenhagen, Denmark, July 1996.  
Symposium on Intrinsically Conductive Polymers, Midwest Regional ACS Meeting, South Carolina, November, 1996.

## **1997**

Symposium on Conducting Elastomers, Wright Patterson Air Force Base, OH, January, 1997.  
Florida Advanced Materials Conference, March, 1997  
Symposium on Electronic Polymers, ANTEC Society of Plastic Engineers, Toronto, April, 1997.  
Georgetown University, Washington, D.C., April 1997.  
George Washington University, Washington, D.C., April 1997.

## **1998**

NATO Advanced Research Workshop, "Supramolecular Engineering of Synthetic Metallic Materials: Conductors and Magnets" Barcelona, Spain, January 1998.  
Workshop on New Advanced Materials, Wright Patterson Air Force Base, Feb. 1998.  
University of Copenhagen, Symposium on "Supramolecular Chemistry as Applied to Advanced Materials," Copenhagen, Denmark, 1998.  
Bowling Green State University, April 1998.  
Vanderbilt University, Nashville, TN, November, 1998.

## **1999**

Marshall University, February 1999.  
Symposium on Nanodevices, National American Chemical Society Meeting, Anaheim, CA, March, 1999.

NSF Workshop on Reactive Intermediates, Austin, TX, May, 1999.  
Pennsylvania Governor's Institute Keynote Lecture, Pittsburgh, PA, June, 1999.  
Symposium on Inherently Conductive Polymers, Toronto, September, 1999.  
Bayer Keynote Lecture, Bayer Polymer Symposium, September, 1999.  
Symposium on High Temperature Superconductors and Hybrid Materials, American Chemical Society Southwest Regional Meeting, El Paso, Texas, October, 1999.  
Symposium on Electroactive Materials, New York, NY, December, 1999.

## **2000**

Wright Patterson Air Force Base, OH, February 2000.  
Northwestern University, IL, March 2000.  
University of Copenhagen, May 2000.  
SMARTON conference of the European National Science Foundation, May 2000.  
Keynote Lecture for the Pennsylvania Governors Institute, Carnegie Mellon University, July 2000.  
Keynote Speaker on Nanotechnology, National Starch and Chemical Company, September 2000.  
PolyMillennial 2000, Kona, HI, December, 2000.  
Pacifichem 2000, HI, December, 2000.

## **2001**

Albion College, February  
Wright Patterson Air Force Base, OH, February  
Symposium on the "Impact of Solid State and Materials Chemistry on Current Technologies,"  
National ACS Meeting, San Diego, CA, April  
Symposium on "Functional Polymers and Denrimers: From Synthesis to Applications", National  
ACS Meeting, San Diego, CA, April  
University of Nebraska, NE, May  
University of Texas, Austin, TX, September  
University of Washington, Seattle, WA, October

## **2002**

International Chemical Conference, Taipei, Taiwan, February  
Fifth International Symposium on Functional pi-Electron Systems, May

## **2003**

PPG, Monroeville, PA, February 2003.  
Symposium on "MALDI and ESI Mass Spectrometry Techniques for Polymer." National ACS Meeting, New Orleans, March 2003  
DuPont 2003 Discovery Chemistry Seminar Series, Wilmington, DE, March 2003  
Association of American Universities Deans' Conference, San Diego, CA, April 2003.  
26<sup>th</sup> Australian Polymer Symposium, Noosa, Queensland, Australia, July 2003  
Annual Review for MURIs on Multifunctional Nanosensors, AFOSR, University of Santa Barbara, Santa Barbara, CA, August 2003.  
Invited Seminar, Department of Chemistry, Syracuse University, NY, October 2003.  
Murtiashaw Lecture in the Department of Chemistry/Biochemistry, University of South Carolina, SC, October 2003.  
American Chemical Society Central Regional Annual Meeting, Pittsburgh, PA, October 2003.  
PPG Coatings, Allison Park, PA, September 2003.  
The Pennsylvania State University, University Park, PA, November 2003.  
University of Massachusetts, Amherst, MA, December 2003.

## **2004**

Symposium on Electrically Active Polymers, National American Chemical Society Meeting  
Anaheim, CA, March-April 2004  
87<sup>th</sup> Canadian Society of Chemistry Conference and Exhibition, London, Ontario, Canada,  
May 2003  
MURI Programs Conference, Cheat Lake, WV, August 2004.  
Seminar in Polymer Chemistry at the Max Planck Institute, Frankfurt, Germany, September  
2004.  
Keynote Speaker ICP Conference, Pittsburgh, PA, October 2004.  
University of Texas, Austin, TX, October 2004.  
University of Connecticut, Storrs, CT, December 2004.

## **2005**

Invited Seminar, Department of Chemistry, Juniata College, PA, January 2005.  
American Chemical Society 229th National Meeting, Marvel Award Symposium, San Diego,  
CA, March 2005.  
North Dakota State University, September 2005.  
Tripathy Memorial Symposium, University of Massachusetts, Lowell, December 2005.  
Symposium on Sensor Technology, Pacificchem, Hawaii, December 2005.

## **2006**

International Conference on Synthetic Metals, Dublin, Ireland, July 2006.  
American Chemical Society Symposium on Entrepreneurship in Polymers and Technology,  
September 2006.  
American Chemical Society Symposium on Conducting Polymers, September 2006.  
Wake Forest University, September 2006  
Johns Hopkins University, October 2006.  
Council of the Association of Science Writers, Baltimore, MD, October 2006.

## **2007**

Third International Smart Coatings Symposium, Orlando FL February 2007.  
Entrepreneurship Symposium, Pittsburgh, PA February 2007  
American Chemical Society, Symposium on 40 years of Conducting Polymers, Chicago, IL  
March 2007.  
Gordon Conference on Electronic Materials, July 2007.  
American Chemical Society Symposium on Conjugated Polymer Materials and Hybrids:  
Synthesis, Macromolecular Assemblies, and Nanostructures July 2007.  
American Chemical Society Herman Mark Scholar Award Symposium, July 2007.  
SPIE National Conference, Symposium on Organic Field Effect Transistors, August 2007.  
Colloquium Spectroscopicum Internationale XXXV, September 2007.  
Plastics Electronics Conference, October 2007.

## **2008**

University of Central Florida, February 2008.  
University of Laval, April 2008.  
International Functional pi Electron Systems (Fpi9), Graz, Austria, July 2008.  
US-Japan POLYMAT Summit, Ventura, CA, August 2008.  
US-Mexico POLYMAT Summit, Los Cabos, Mexico, December 2008.

## **10 Various Outreach Lectures**

## PAST RESEARCH FUNDING

Previously funded by NSF, Air Force, NATO, ACS, Japan NEDO, and NIOSH

## CURRENT RESEARCH FUNDING

NIOSH	“Integration of Monolithic CMOS Technologies” G. Fedder, PI	Period Covered 9/03-5/08	\$450K \$75K/yr
NSF	“Conducting Block Copolymer Nanostructures” PI: McCullough	Period Covered 8/15/04-7/31/08	\$506K
NSF-Engineering	"Optimizing of Plastic Electronic Device Architecture by Self-Assembly CoPI: McCullough CoPI: Porter	Period Covered 9/05-9/08	\$300K \$150K RDM
AFOSR	Integrated Nanosensor Systems for a Safer America PI: McCullough CoPI: Fedder	Period Covered 4/07-4/09	\$3.8M \$1M RDM

## ACTIVE SCIENTIFIC COLLABORATIONS

### External to CMU

Professor Thomas Bjørnholm, Chemistry, University of Copenhagen, Denmark

### Internal

Professor Tomasz Kowalewski, Chemistry

Professor David Lambeth, Electrical and Computer Engineering

Professor Gary Fedder, Electrical and Computer Engineering

Professor Lee Weiss, Robotics Institute

Professor Lisa Porter, Materials Science and Engineering

Professor Michael Bockstaller, Materials Science and Engineering

## CONTRIBUTIONS TO EDUCATION

### Courses Taught: 1990-Present

1990 Fall	Chemistry 09-711 Physical Organic Chemistry	Faculty Course Evaluation (FCE) 3.22/5.00
1991 Fall	Chemistry 09-711 Physical Organic Chemistry	FCE 4.00/5.00
1992 Spring	Chemistry 09-132 Experimental Techniques in Chemistry II	FCE 4.21/5.00
1992 Fall	Chemistry 09-711 Physical Organic Chemistry	FCE 4.55/5.00
1993, Spring	Chemistry 09-132 Experimental Techniques in Chemistry II	FCE 3.63/5.00
1993, Fall	Chemistry 09-811 Solid State and Materials Chemistry	FCE none
1994, Spring	Chemistry 09-132	FCE 3.42/5.00

1994, Fall	Experimental Techniques in Chemistry II Chemistry 09-811	FCE 4.20/5.00
1994, Fall	Advanced Organic Chemistry Teaching and Advising Network Class, Pilot Course of "Freshman Seminar" organization by Eric Grotzinger.	
1995, Spring	Chemistry 09-132	FCE 3.70/5.00
1995, Fall	Experimental Techniques in Chemistry II Chemistry 09-117	FCE 3.56/5.00
1996, Spring	Organic Chemistry I Chemistry 09-811	FCE 4.38/5.00
1996, Fall	Advanced Organic Chemistry time off as associate head position	
1997, Spring	Chemistry 09-132	FCE 4.61/5.00
1997, Fall	Experimental Techniques in Chemistry II Chemistry 09-811	
1998, Fall	Solid State and Materials Chemistry Chemistry 09-231	
1999, Fall	Experimental Techniques in Chemistry III Chemistry 09-231	
2000, Fall	Experimental Techniques in Chemistry III Chemistry 09-811	
	Solid State and Materials Chemistry	

#### Current Research Group

3 Current Postdoctoral Research Fellows

5 Graduate Students

1 Undergraduate

#### Former Research Group Members

6 Postdoctorals (4 in academics, 2 in industry)

9 Ph.D. Students (2 in academics, 7 in industry)

5 Visiting Research Scientists

38 Undergraduates