

Charles Patrick Collier

R&D Staff
Nanofabrication Research Laboratory
Center for Nanophase Materials Sciences
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831-6493
colliercp@ornl.gov
(865) 576-3638

Education

Oberlin College, Oberlin, OH	Chemistry	B.A.; B.Mus., 1991
University of California-Berkeley	Physical Chemistry	Ph.D., 1998

Professional Experience

2008–Present	Research Staff, Center for Nanophase Materials Sciences, ORNL
2001–2008	Assistant Professor, California Institute of Technology
1999–2001	Joint Hewlett-Packard – UCLA Postdoctoral Researcher
1998–1999	Postdoctoral Researcher, Dept. of Chem. and Biochemistry, UCLA
1991–1998	Graduate Research Associate, Dept. Chem., UC Berkeley
1990–1991	Undergrad. Research Assoc., Dept. Chem., Oberlin College
1990	NSF Undergrad. Research Fellow, Dept. Chem. Univ. of Utah
1989	NSF Undergrad. Research Fellow, Dept. Chem. Washington Univ

Professional and Synergetic Activities

1995–Present	American Chemical Society
1998–Present	American Physical Society
2004–Present	Biophysical Society
2005	Discussion leader for “Biomolecular and Supramolecular Electronics,” Gordon Research Conference on the Chemistry of Electronic Materials
2005–2007	Co-chair for “Molecular Electronic Circuit Assembly” track, Conference on Foundations of Nanoscience (DARPA)
2011	Co-chair for “Micro and Nanotechnology; Nanopores” platform, Biophysical Society Meeting

Honors and Awards

2004	Young Faculty Research Initiation Award, Center for Science and Engineering of Materials (NSF MRSEC)
2002	Research Innovation Award, Research Corp.
2002	Caltech President’s Fund Award
2001	UCLA Chancellor’s Award for Excellence in Postdoctoral Research

Publications (49 publications)

Full publication list follows CV.

Research Synopsis

1. *Droplets On-Demand in Nanochannels: New Opportunities for Investigating Chemical Reactivity and Catalysis in Nanoscale Reactors.*
The goal of this project is to develop a new method for producing attoliter-scale aqueous droplets on demand at the intersection of nanochannels, and to measure single-enzyme kinetics in these droplets.
2. *Addressable Nanopore Array: Multiscale Fluidic Interface to Cell Culture.*
The focus of this project is to develop and validate a fluid interface to facilitate control and sampling of the local microenvironment surrounding cultured cells.

3. *Nanopost Arrays for Neutron Scattering Investigations of Suspended Lipid Bilayer Membranes.*
The goal for this project is the demonstration of complete coverage of a nanoporous silicon substrate with a continuous fluid lipid bilayer, to enable new classes of in situ transmembrane structural studies of lipid bilayers and their interactions with membrane proteins and other molecular complexes to be carried out at neutron scattering facilities at ORNL (SNS, HFIR).
4. *Single-Molecule Transcription Kinetics in Crowded and Confined Synthetic Nanoenvironments.*
The goal of the proposed research is to relate stochastic regulatory protein-DNA interactions at the single-molecule level with phenotypes of simple synthetic inducible gene circuits in increasingly crowded and confined water-in-oil droplets.

Graduate and Postdoc Advisors:

Graduate Advisor: Richard Saykally (UC-Berkeley)
Postdoctoral Advisor: James Heath (UCLA)

Postdoctoral Scholars (recent): Seung-Yong Jung (2008–2011), Elizabeth Vargis (2012-), Jonathan Boreyko (2012-)

Total Graduate Students Advised: 8

Total Postdoctoral Scholars Advised: 7

Publications

Charles P. Collier, Ph. D.

Center for Nanophase Materials Sciences

Oak Ridge National Laboratory

Oak Ridge, TN 37831

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1. C.P. Collier and M.L. Simpson, "Micro/Nanofabricated Environments for Synthetic Biology", *Curr. Opin. Biotechnol.* **22**, 516-526 (2011).
2. S.-Y. Jung, S.T. Retterer, and C.P. Collier, "Interfacial Tension Controlled Fusion of Individual Femtolitre Droplets and Triggering of Confined Chemical Reactions On Demand", *Lab on a Chip* **10**, 3373-3376 (2010).
3. S.-Y. Jung, S.T. Retterer, and C.P. Collier, "On-Demand Generation of Monodisperse Femtolitre Droplets by Shape-Induced Shear", *Lab on a Chip* **10**, 2688-2694 (2010).
4. N. Tayebi, Y. Narui, N. Franklin, C.P. Collier, K.P. Giapis, Y. Nishi, and Y. Zhang, "Fully Inverted Single-Digit Nanometer Domains in Ferroelectric Films", *Appl. Phys. Lett.* **96**, 023103 (2010).
5. Y. Liu, S.-Y. Jung, and C.P. Collier, "Shear-Driven Redistribution of Surfactant Affects Enzyme Activity in Well-Mixed Femtoliter Droplets", *Anal. Chem.* **81**, 4922-4928 (2009).
6. Y. Narui, D. M. Ceres, J. Chen, K. P. Giapis, and C. P. Collier, "High Aspect Ratio Silicon Dioxide-Coated Single Walled Carbon Nanotube Scanning Probe Nanoelectrodes", *J. Phys. Chem. C* **113**, 6815-6820 (2009).
7. N. Tayebi, Y. Narui, R.J. Chen, C.P. Collier, K.P. Giapis, and Y. Zhang, "Nanopencil as a Wear-Tolerant Probe for Ultrahigh Density Data Storage", *Appl. Phys. Lett.* **93**, 103112 (2008).
8. S.-Y. Jung, Y. Liu, and C.P. Collier, "Fast Mixing and Reaction Initiation Control of Single-Enzyme Kinetics in Confined Volumes", *Langmuir* **24**, 4439-4442 (2008).
9. A. Kutana, K.P. Giapis, J.Y. Chen, and C.P. Collier, "Amplitude Response of Single-Wall Carbon Nanotube Probes during Tapping Mode Atomic Force Microscopy: Modeling and Experiment", *Nano Lett.* **6**, 1669-1673 (2006).
10. C. P. Collier, "Carbon Nanotube Tips for Scanning Probe Microscopy", *Carbon Nanotubes: Properties and Applications*, M.J. O'Connell, Ed.; CRC Press: Boca Raton, 2006; pp 295-313.
11. J.Y. Chen, A. Kutana, C.P. Collier, and K.P. Giapis, "Electrowetting in Carbon Nanotubes", *Science* **310**, 1480-1483 (2005).
12. S.D. Soares, M.J. Esplandiu, W.A. Goddard III, and C.P. Collier, "Mechanisms of Single-Walled Carbon Nanotube Probe-Sample Multistability in Tapping Mode AFM Imaging", *J. Phys. Chem. B* **109**, 11493-11500 (2005).
13. J. Chen and C.P. Collier, "Noncovalent Functionalization of Single-Walled Carbon Nanotubes with Water-Soluble Porphyrins", *J. Phys. Chem. B* **109**, 7605-7609 (2005).
14. S.-Y. Jung, M.A. Holden, P.S. Cremer and C.P. Collier, "Two-Component Membrane Lithography via Lipid Backfilling", *ChemPhysChem*, **6**, 423-426 (2005).
15. H. Jung, C.K. Dalal, S. Kuntz, R. Shah, and C.P. Collier, "Surfactant Activated Dip-Pen Nanolithography", *Nano Lett.* **4**, 2171-2177 (2004).
16. M.J. Esplandiu, V.G. Bittner, K.P. Giapis, and C.P. Collier, "Nanoelectrode Scanning Probes from Fluorocarbon-Coated Single-Wall Carbon Nanotubes", *Nano Lett.* **4**, 1873-1879 (2004).

17. I.R. Shapiro, S. Soares, M.J. Esplandiu, L.A. Wade, W.A. Goddard, and C.P. Collier, "Influence of Elastic Deformation on Single-Wall Carbon Nanotube Atomic Force Microscopy Probe Resolution", *J. Phys. Chem. B* **108**, 13613-13618 (2004).
18. J.O. Jeppesen, C. P. Collier, J.R. Heath, Y. Luo, K.A. Nielsen, J. Perkins, J. Fraser Stoddart, and E. Wong, "Artificial Molecular Devices Based on Tetrathiafulvalene", *J. Phys. IV France* **114**, 511-513 (2004).
19. L.A. Wade, I.R. Shapiro, Z. Ma, S.R. Quake, and C.P. Collier, "Correlating AFM Probe Morphology to Image Resolution for Single-Wall Carbon Nanotube Tips", *Nano Lett.* **4**, 725-731 (2004).
20. H. Jung, R. Kulkarni, and C.P. Collier, "Dip-Pen Nanolithography of Reactive Alkoxysilanes on Glass", *J. Am. Chem. Soc.* **125**, 12096-12097 (2003).
21. Y. Luo, C. P. Collier, J. O. Jeppesen, K. A. Nielsen, E. DeIonno, G. Ho, J. Perkins, H.-R. Tseng, T. Yamamoto, J. F. Stoddart, and J. R. Heath, "Two-Dimensional Molecular Electronics Circuits", *ChemPhysChem* (cover article) **3**, 519-525 (2002).
22. C.P. Collier, B. Ma, E.W. Wong, J.R. Heath, and F. Wudl, "Photochemical Response of Electronically Reconfigurable Molecule-Based Switching Tunnel Junctions", *ChemPhysChem* **3**, 458-461 (2002).
23. H. Choi, X. Yang, G.W. Mitchell, C.P. Collier, F. Wudl, and J.R. Heath, "The Structure of a Tetraazapentacene Molecular Monolayer", *J. Phys. Chem. B* **106**, 1833-1839 (2002).
24. C.P. Collier, J.O. Jeppesen, Y. Luo, J. Perkins, E.W. Wong, J.R. Heath, and J.F. Stoddart, "Molecular-Based Electronically Switchable Tunnel Junction Devices", *J. Am. Chem. Soc.* **123**, 12632-12641 (2001).
25. A.R. Pease, J.O. Jeppesen, J.F. Stoddart, Y. Luo, C.P. Collier, and J.R. Heath, "Switching Devices Based on Interlocked Molecules", *Acc. Chem. Res.* **34**, 433-444 (2001).
26. J. Perkins, C.P. Collier, J.R. Heath, J.O. Jeppesen, Y. Luo, K.A. Nielsen, A.R. Pease, J.F. Stoddart, and E.W. Wong, "Toward Artificial Molecular Devices", *Mol. Electron. Bioelectron.* **12**, 69-74 (2001).
27. C.P. Collier, G. Mattersteig, E.W. Wong, Y. Luo, K. Beverly, J. Sampaio, F.M. Raymo, J.F. Stoddart, and J.R. Heath, "A [2]Catenane-Based Solid State Reconfigurable Switch", *Science* **289**, 1172-1175 (2000).
28. S. Henrichs, C. P. Collier, R. J. Saykally, Y. R. Shen, and J. R. Heath, "The Dielectric Function of Ag Quantum Dot Monolayers Compressed through the Metal/Insulator Transition", *J. Am. Chem. Soc.* **122**, 4077-4083 (2000).
29. E.W. Wong, C.P. Collier, M. Belohradský, F.M. Raymo, J.F. Stoddart, and J.R. Heath, "Fabrication and Transport Properties of Single-Molecule Thick Electrochemical Junctions", *J. Am. Chem. Soc.* **122**, 5831-5840 (2000).
30. C.P. Collier, E.W. Wong, M. Belohradský, F.M. Raymo, J.F. Stoddart, P.J. Kuekes, R.S. Williams, and J.R. Heath, "Electronically Configurable Molecular-Based Logic Gates", *Science* **285**, 391-394 (1999).
31. C.P. Collier, S. Henrichs, J. R. Heath, "Direct Measurement of Local Field Factors for Second Harmonic Generation from Quantum Dot Langmuir Monolayers Compressed through the Metal-Insulator Transition", *Phil. Mag. B* **79**, 1299-1305 (1999).
32. S. Henrichs, J. Sample, J. Shiang, C.P. Collier, R.J. Saykally, and J.R. Heath, "Positive and Negative Contrast Lithography on Silver Quantum Dot Monolayers", *J. Phys. Chem. B* (cover article) **103**, 3524-3528 (1999).
33. G. Markovich, C.P. Collier, S.E. Henrichs, F. Remacle, R.D. Levine, and J.R. Heath, "Architectonic Quantum Dot Solids", *Acc. Chem. Res.* *Special Issue on Nanochemistry*, **32**, 415-423 (1999).

34. C.P. Collier, T. Vossmeier, and J.R. Heath, "Nanocrystal Superlattices", *Annu. Rev. Phys. Chem.* **49**, 371-404 (1998).
35. F. Remacle, C.P. Collier, G. Markovich, J.R. Heath, U. Banin, and R.D. Levine, "Networks of Quantum Nanodots: The Role of Disorder in Modifying Electronic and Optical Properties", *J. Phys. Chem. B* **102**, 7727-7734 (1998).
36. F. Remacle, C.P. Collier, J.R. Heath, and R.D. Levine, "The Transition from Localized to Collective Electronic States in a Silver Quantum Dots Monolayer Examined by Nonlinear Optical Response", *Chem. Phys. Lett.* **291**, 453-458 (1998).
37. J.J. Shiang, J.R. Heath, C.P. Collier, and R.J. Saykally, "Cooperative Phenomena in Artificial Solids Made from Silver Quantum Dots: The Importance of Classical Coupling", *J. Phys. Chem. B* **102**, 3425-3430 (1998).
38. G. Markovich, C.P. Collier, and J.R. Heath, "Reversible Metal-Insulator Transition in Ordered Metal Nanocrystal Monolayers Observed by Impedance Spectroscopy", *Phys. Rev. Lett.* **80**, 3807-3810 (1998).
39. A.I. Boldyrev, J. Simons, J.J. Scherer, J.B. Paul, C.P. Collier, and R.J. Saykally, "On the Ground Electronic States of Copper Silicide and Its Ions", *J. Chem. Phys.* **108**, 5728-5732 (1998).
40. C.P. Collier, R.J. Saykally, J.J. Shiang, S.E. Henrichs, and J.R. Heath, "Reversible Tuning of Silver Quantum Dot Monolayers through the Metal-Insulator Transition", *Science* **277**, 1978-1981 (1997).
41. J.B. Paul, C.P. Collier, R.J. Saykally, J.J. Scherer, and A.O'Keefe, "Direct Measurement of Water Cluster Concentrations by Infrared Cavity Ringdown Laser Absorption Spectroscopy", *J. Phys. Chem. A* **101**, 5211-5214 (1997).
42. J.J. Scherer, J.B. Paul, C.P. Collier, A. O'Keefe, D.J. Rakestraw, R.J. Saykally "Cavity Ringdown Laser Spectroscopy: A New Ultrasensitive Absorption Technique", *Spectroscopy* **11**, 46-50 (1996).
43. J.B. Paul, J.J. Scherer, C.P. Collier, and R.J. Saykally, "Cavity Ringdown Laser Absorption Spectroscopy and Time-of-Flight Mass Spectroscopy of Jet-Cooled Platinum Silicides", *J. Chem. Phys.* **104**, 2782-2788 (1996).
44. J.J. Scherer, J.B. Paul, C.P. Collier, A. O'Keefe, and R.J. Saykally, "Cavity Ringdown Laser Absorption Spectroscopy and Time-of-Flight Mass Spectroscopy of Jet-Cooled Gold Silicides", *J. Chem. Phys.* **103**, 9187-9192 (1995).
45. J.J. Scherer, D. Voelkel, D.J. Rakestraw, J.B. Paul, C.P. Collier, and R.J. Saykally, "Infrared Cavity Ringdown Laser Absorption Spectroscopy (IR-CRLAS)", *Chem. Phys. Lett.* **245**, 273-280 (1995).
46. J.J. Scherer, J.B. Paul, C.P. Collier, and R.J. Saykally, "Cavity Ringdown Laser Absorption Spectroscopy and Time-of-Flight Mass Spectroscopy of Jet-Cooled Silver Silicides", *J. Chem. Phys.* **103**, 113-120 (1995).
47. J.J. Scherer, J.B. Paul, C.P. Collier, and R.J. Saykally, "Cavity Ringdown Laser Absorption Spectroscopy and Time-of-Flight Mass Spectroscopy of Jet-Cooled Copper Silicides", *J. Chem. Phys.* **102**, 5190-5199 (1995).
48. N.C. Craig, S.S. Borick, C.P. Collier, J.S. Humm, H. Kim, and L.V. Lee, "Vibrational Spectra and Assignments for 3,3,4,4-tetrafluorocyclobutene-d₀, 3,3,4,4-tetrafluorocyclobutene-d₁, and 3,3,4,4-tetrafluorocyclobutene-d₂", *Spectrochim. Acta A* **51**, 45-63 (1995).
49. T.J. Tague, P.M. Kligmann, C.P. Collier, M.A. Ovchinnikov, and C.A. Wight, "Laser-initiated Chain Reactions and Microexplosions in Solid Solutions of Simple Alkenes and Chlorine", *J. Phys. Chem.* **96**, 1288-1293 (1992).

Patents Issued:

U.S. Patent No. 7,514,214 B2, Issued: April 7, 2009

“Selective Functionalization of Carbon Nanotube Tips Allowing Fabrication of New Classes of Nanoscale Sensing and Manipulation Tools”

U.S. Patent No. 7,211,795 B2, Issued: May 1, 2007

“Method for Manufacturing Single Wall Carbon Nanotube Tips”

U.S. Patent No. 6,756,296 B2, Issued: June 29, 2004

U.S. Patent No. 6,979,639 B2, Issued: December 27, 2005

“Method for Lithographic Processing on Molecular Monolayer and Multilayer Thin Films”

U.S. Patent No. 6,198,655 B1, Issued: March 6, 2001

European Patent EP1236206 B1, Issued: September 13, 2006

“Electrically Addressable Volatile Non-Volatile Molecular-Based Switching Devices”

Patent applications published with U.S. and European Patent Offices:

1. “Method for manufacturing single wall carbon nanotube tips”
European Application No. WO2005076832, Filed August 25, 2005
2. “Coatings for carbon nanotubes”
U.S. Application No. 20050208304, Filed September 22, 2005
3. “Method and device for surfactant activated Dip-Pen Nanolithography”
U.S. Application No. 20060242740, Filed October 26, 2006
4. “Biomarker sensors and method for multi-color imaging and processing of single-molecule life signatures”
U.S. Application No. 20060246467, Filed November 2, 2006
5. “Generation of monodisperse femtoliter droplets by shape-induced shear and interfacial controlled fusion of individual droplets on demand”,
U.S. Application Serial No. 13/161,080, Filed June, 2011.